Global Cement and Concrete Association

CONCRETE FUTURE

Cement Industry Net Zero Progress Report 2024/25

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

Contents

Foreword

Cement and concrete are the essential materials for delivering progress and building the resilient and sustainable communities our world needs.

Our industry is engaged in the most significant transformation in its history as we address the most pressing challenge our planet faces – climate change.

Around 50 of my CEO peers from the world's leading cement manufacturers have committed to a net zero future. We are already in the action of delivering a more sustainable industry – driving the global adoption of known decarbonisation levers, deploying new technologies, undertaking deep research, advancing innovation and new ways of working to make tangible progress.

However, to fully unlock our industry's decarbonisation efforts in this crucial decade to deliver, we urgently need effective policy support across a range of levers. When policymakers provide the right market conditions and policy enablers, significant CO_2 reductions are achievable.

We urgently need to see the spread of effective regulations that promote the use of municipal and industrial waste as sustainable alternative fuels for cement kilns, as well as using construction demolition waste as recycled raw materials. We need to see building codes that encourage the wider adoption of blended cement and concrete products, and establish market-driven national carbon pricing mechanisms that incentivise decarbonisation and investment in clean innovation. We need to see greater collaboration and funding to develop new technologies to decarbonise manufacturing processes and speed up the roll-out of carbon capture, utilisation, and storage.

Now is the time for a true collaboration with industry, governments, authorities and policymakers to join us in our shared mission.

Fernando González
GCCA President and Chief Executive Officer of Cemex

Three years on from the launch of the GCCA 2050 Net Zero Roadmap, as the first so-called heavy industry to set out a credible decarbonisation pathway, we are delighted to showcase the decarbonisation progress that is taking place across the sector.

Our members are demonstrating strong action against all seven levers set out in our roadmap, underlining our industry's commitment to building a sustainable future.

In this report we have identified key areas in which firm policy action is fundamental to enabling us to accelerate our reductions. We need a global landscape in which low carbon cement is demanded, incentivised and allowed to be used, a framework in which immediate actions such as embracing the circular economy can drive decarbonisation today, as well as global financing mechanisms that can underpin key technologies such as CCUS to ensure they can deliver on their huge potential.

This report shows a number of great examples, demonstrating that an acceleration of our decarbonisation efforts is not just possible, but is happening today where enabling policies exist.

It is a truly exciting time for our sector and there is a tremendous role that our industry can play to help countries deliver meaningful decarbonisation on the ground and across the built environment.

This document is a formal call to action from the GCCA and the global cement and concrete industry, for governments and policymakers around the world to show strong support to our decarbonisation goals.

Progress is taking place but for true acceleration and transformation, coherent policy support is needed. We can't delay.

Thomas Guillot
CEO of GCCA

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 provides everything from homes, schools, offices, transport networks and critical infrastructure – all of which are, and will continue to be, crucial to modern society. As our global population increases and urbanises, and in the face of a changing climate, concrete will be crucial in providing society the foundations of what it needs to prevail and prosper.

Concrete combines durability, resilience to climate-related and natural disasters, cost-effectiveness and widespread availability. 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, has 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 and hence concrete is key to delivering the vast majority of the UN sustainable development goals.

Despite concrete's essential nature, our material is responsible for approximately 7% of global CO_2 emissions. That is why in 2021, the global cement and concrete sector, led by the GCCA, committed to producing net zero concrete by 2050. This marked the first of the heavy industries to make such a commitment.

Read on to find out how our industry is taking action and making progress and how together we can do more.

Our Mission:

Concrete Future: Building a Net Zero World

Together, we are committed to building a bright, resilient and sustainable concrete future for our industry and the world.

Our Members

Our members, which represent 80% of global cement production capacity outside of China (as well as some key Chinese companies) 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:

Asia Cement Corporation
Breedon Group
BUA Cement
Buzzi
Cementir Holding
Cementos Argos
Cementos Moctezuma
Cementos Pacasmayo
Cementos Progreso
CEMEX
Cimenterie Nationale
Çimsa Cimento
CNBM
CRH
Dalmia Cement
Dangote
Emirates Steel Arkan
Fletcher Building
GCC
Heidelberg Materials
Holcim
Hima Cement
Huaxin Cement
JK Cement
JSW Cement
Medcem
MISR Cement Group
Molins
Nesher Israel Cement Enterprises
Norm
Northern Region Cement Company
Orient Cement
PT Solusi Bangun Indonesia
Schwenk Zement
Secil
Siam Cement Group
Siam City Cement
Taiheiyo Cement
TCC Group Holdings
TITAN Cement Group
TPI Polene
UltraTech Cement
UNACEM
Vassiliko Cement
Votorantim Cimentos
YTL Cement
Yura Cement

Our national and regional association partners:

Asociación de Productores de Cemento – Peru
Associação Brasileira de Cimento Portland – Brazil
Association of German Cement Manufacturers (VDZ) – Germany
Association Professionnelle des Cimentiers – Morocco
Betonhuis – Netherlands
BIBM – Europe
CANACEM – Mexico
Canadian Precast Prestressed Concrete Institute
Cement Association of Canada
Cement Concrete & Aggregates Australia
Cement Industry Federation – Australia
Cement Manufacturers Association – India
Cement Manufacturers Ireland
China Cement Association
Concrete NZ – New Zealand
European Cement Association (CEMBUREAU)
European Federation Concrete Admixtures
European Ready Mixed Concrete Organisation
Federación Iberoamericana del Hormigón Premezclado – LatAm
Federación Interamericana del Cemento (FICEM) – LatAm
Japan Cement Association
Korea Cement Association
Mineral Products Association – United Kingdom
National Ready Mixed Concrete Association – USA
Portland Cement Association – USA
South India Cement Manufacturers Association
Thai Cement Manufacturers Association
The Spanish Cement Association (Oficemen)
Turkish Cement Manufacturers Association (TürkÇimento)

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

Asia Development Bank
American Concrete Institute
The Biodiversity Consultancy
Business for Nature
BusinessGreen
Build Change
C40 Cities
Cement Breakthrough
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
The Climate Group
Convention on Biological Diversity
Decarb Connect North America
EBRD
ECRA
EPFL
Federation International Beton
First Movers Coalition
F6S
GCCSI
Gensler
German International Development Agency
GHG Protocol
Global Alliance for Buildings and Construction (GABC)
International CCS Knowledge Center
International Chamber of Commerce (ICC)
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)
LeadIT
Ministry of Foreign Affairs of Denmark
MSP – End Open Waste Burning OECD – Green Finance Resilience Action Fund
NEU
OECD
OGCI
Race to Zero
RILEM
RMI
SBTI
SINTEF
United Cities and Local Governments of Africa (UCLGA)
UNIDO
United Nations
WBCSD
We Mean Business Coalition
World Economic Forum
World Green Building Council

Support from our Stakeholders

The cement and concrete industry is a cornerstone of the global economy. It plays a crucial role in our lives, but it comes with a significant environmental cost. That's why it's essential for us to lead the important work of decarbonising this sector alongside our industry partners. As co-chairs of the Cement and Concrete Breakthrough initiative, Canada and the United Arab Emirates proudly launched the inaugural set of Cement and Concrete Breakthrough Priority Actions at the GCCA's annual conference in Bangkok in June 2024. We've been working diligently to build a critical mass of partner countries to advance this work, along with endorsing countries and others who want to contribute.

We look forward to implementing this ambitious plan with our partners and building a stronger network of countries, businesses and organisations that are looking to contribute to the global decarbonisation of cement. There is much work to be done, not only in cutting greenhouse gas emissions but also in making near-zero emission cement the preferred choice in global markets by 2030.

We'd like to thank the GCCA for being steadfast supporters of this work, and the Cement Association of Canada for their ongoing support.

Hon. François-Philippe Champagne,
Minister of Innovation, Science and Industry,
Government of Canada

Globally, cement accounts for around 7% of carbon dioxide emissions, making it one of the greatest areas of opportunity for green policy and technology.

As a global hub for industry and a responsible member of the international community, the United Arab Emirates robustly supports efforts to decarbonize heavy emitting sectors in line with the goals of the Paris Agreement.

Announced during COP28 in Dubai, the Cement and Concrete Breakthrough initiative marked a significant moment for this critical sector. In under 12 months, the initiative has made great progress, including setting out priority actions, so that the path to decarbonization for cement and concrete is clearer than it has ever been. The endorsing countries have demonstrated their determination to take on the challenge, but we must now urgently translate this resolve into clear implementation.

As co-chair of the Breakthrough initiative, the United Arab Emirates welcomes the GCCA's latest progress report and remains committed – through policy, technology and collaboration – to forging a greener path for development alongside its international partners.

His Excellency Dr. Sultan Al Jaber,
Minister of Industry and Advanced Technology

Decarbonising the built environment requires the collaborative efforts of all stakeholders in the building sector – from designers and real estate developers to building materials manufacturers. As the leading architecture and design firm in the world, Gensler applauds GCCA for supporting the creation of net-zero concrete and cement. However, for our combined efforts to make a difference, we must increase the speed and scale at which we decarbonize our building materials. The next few decades will have an outsized carbon impact as we build new structures for the needs of an unprecedented increase in our global population by an additional 2 billion people from now to 2050. The concrete and cement industry, in particular, has the opportunity to bring about a profound reduction in planet-wide carbon emissions if it can accelerate the production of low- and no-carbon products over the next two decades.

Diane Hoskins,
Global Co-Chair, Gensler

The building industry faces an urgent imperative to cut carbon emissions and achieve net zero by 2050. This requires a holistic approach that addresses embodied carbon in addition to operational emissions. The sector must adopt tailored strategies for both Northern and Southern countries, enabling emissions reductions while supporting development. Success depends on collaboration among all stakeholders, reinforced by incentives and knowledge-sharing. By embracing low-carbon cement as an immediate solution, we can strike a balance between emission reduction, affordability, and aesthetics, paving the way for a sustainable built environment for future generations.

Prof Karen Scrivener,
Professor and Director of the Laboratory of Construction Materials at Ecole Polytechnique Federale de Lausanne (EPFL)

IEAGHG applauds the work of the Global Cement and Concrete Association (GCCA) in working to decarbonise this very important sector. We are pleased to have produced several reports over the years on CCS for the cement sector, e.g. CO_2 Capture in the Cement Industry IEAGHG 2008–3, Deployment of CCS in the Cement Industry IEAGHG 2013–19, and Costs of CO_2 Capture in Industry – Cement and Steel IEAGHG 2018-TR03 , as well as organising the COP28 UNFCCC Side-event on CCS in which the GCCA was a key partner, and so we look forward to continuing to support GCCA in their important work going forwards.

Tim Dixon,
Director and General Manager, IEAGHG

Science tells us that it is virtually impossible to reduce the CO_2 emissions associated with cement and concrete production to net-zero in the near term without employing some degree of carbon capture use, and storage (CCUS) to address unavoidable emissions related to calcination of limestone. However, installation of sufficient CCUS capacity by 2050, particularly in developing regions, will be challenging without supportive policy frameworks in place. To help accelerate the deployment of CCUS in the cement industry in the Global South, the Global CCS Institute, in partnership with the GCCA and the Clean Energy Ministerial CCUS Initiative, released two reports in a new and innovative study "CCUS in the Indian Cement Industry". The first report maps potential cement facility clusters to CO_2 storage locations in proximity. The second identifies knowledge gaps and discusses policy, legal, regulatory, and financing frameworks necessary for the effective deployment of CCUS in India. The co-authoring organisations plan on replicating the study in other countries in the coming years.

Jarad Daniels,
CEO, Global CCS Institute

The mission of NEU: An ACI Center of Excellence for Carbon Neutral Concrete is to collaborate globally to drive education, awareness and adoption of the use of carbon neutral materials and technologies in the sustainably built environment. We are keenly aware that collaboration is critical to achieving our collective carbon-reduction goals. Fortunately, the Global Cement and Concrete Association understands the wisdom of collaboration and by working together, NEU and GCCA, are able to advance the sustainability goals of the cement and concrete industries.

In addition to promoting awareness and providing education to concrete industry stakeholders, NEU also addresses its mission by offering the NEU Validation/ Verification Program, which impartially assesses the environmental claims made by those offering carbon-reduction technologies through an independent, third-party process. This provides assurance to decision-makers and specifiers that may not otherwise be in a position to make such an assessment, leading them to use more effective carbon-reduction technologies.

Dean Frank,
Executive Director, NEU

As the cement and concrete industry moves forward in its decarbonisation journey, RILEM remains committed to supporting innovation and knowledge sharing within the sector. Through collaborative research and international partnerships, we aim to accelerate the adoption of sustainable technologies, materials, and processes that reduce carbon emissions. The continued focus on circular economy principles and advanced material science will be critical in achieving the 2050 net-zero goals. Together, we can drive transformative change and create a sustainable future for the built environment.

Prof. Nele De Belie,
President, RILEM

The American Concrete Institute (ACI), along with the ACI Center of Excellence for Carbon Neutral Concrete (NEU) greatly values its collaboration with GCCA and other organisations that focus on accelerating the adoption of proven new technologies. ACI and NEU are uniquely positioned to address these initiatives, and we look forward to sharing our knowledge and collaborating with key organisations to affect carbon neutral solutions for the concrete industry.

ACI and NEU previously shared a sustainability landmark at COP28 in Dubai last year, by announcing the creation of ACI CODE-323–24, Low-Carbon Concrete – Code and Commentary. ACI and NEU look forward to attending COP29 in Baku, Azerbaijan, to share the latest sustainability developments. Through certification and continuing education, ACI and NEU work to increase awareness of verified options for carbon-neutral concrete materials and related new technologies, so that smart decisions drive design and construction, resulting in a more sustainable future for the world.

Michael Paul,
President, American Concrete Institute (ACI)

Cement and concrete are essential or building homes, businesses, and infrastructure that supports our modern lives. As a vital part of the global economy, the cement industry carries a significant carbon footprint, demanding innovative solutions for a sustainable future. Drawing on our experience supporting the development and operations of CCS projects across industrial sectors, the International CCS Knowledge Centre stands with the GCCA in its mission to achieve net-zero concrete by 2050. The GCCA's proactive work in highlighting the progress and recognising the challenges in decarbonising the cement sector is commendable and we are pleased to offer our support. To achieve a net-zero future, industry and governments must collaborate on solutions such as carbon capture, utilisation, and storage, and establish policies to support a low-carbon economy.

James Fann,
President & CEO,
International CCS Knowledge Centre

The biodiversity crisis we face is unprecedented and we need to tackle it head on for us to have any chance of reaching our interconnected climate, nature and societal goals. Now is not the time to slow down. Together, governments and businesses have a historic role and responsibility to reverse nature loss. The cement and concrete sector is central to this shift towards a nature-positive economy. Businesses of all sizes must scale up actions to protect, restore and sustainably use nature. This year we have seen leading companies in the sector publish credible nature strategies to show how they will address nature loss and contribute to a nature-positive world and we urge more companies to follow their lead.

Eva Zabey,
CEO, Business for Nature

The Clean Energy Ministerial CCUS Initiative has had a long collaboration with GCCA, bringing together industry and government stakeholders to accelerate deployment of carbon management/CCUS technologies, specifically in the cement sector applications. We have held dialogues on policy frameworks, on CO_2 transport and storage infrastructure build-out, as well as on financing of CCUS projects. Collaboration is vital: no one single stakeholder group, whether industry, government or other, can deploy carbon management alone.

Many of our now sixteen member countries are incentivising carbon capture in the cement sector. For example the Norwegian full chain CCS project, Longship, brings together various capture sites, with final storage under the seabed in the Norwegian continental shelf. The transport and storage site is already constructed, and we expect to receive CO_2 from Heidelberg Materials Brevik cement plant in the spring of 2025.

We applaud your efforts and commitment! CEM CCUS highly values the collaboration with the Global Cement and Concrete Association and its members.

Henriette Nesheim,
Deputy Director-General, Ministry of Energy of Norway; and Co-Lead, Clean Energy Ministerial CCUS Initiative (CEM CCUS)

Concrete is crucial to modern infrastructure, but its environmental impact demands urgent attention. According to data collected for the IPCC, cement production contributes about 6% of CO_2 and 4.4% of CO_2-equivalent emissions. Currently, the sector is not on track to achieve net zero by 2050, and bold action is needed. Sustainability is a key focus for the FIB. In 2022, the organisation launched a Special Activity Group on Sustainability and is developing its roadmap for reducing emissions. Success requires collaboration across the entire supply chain – from suppliers and designers to builders and owners.

To make progress, we must:

- Update codes and standards to support low-carbon materials;
- Accelerate the development of new low-carbon technologies; and
- Strengthen collaboration between researchers, governments, industries, and partners.

The FIB is working with the global community to provide benchmarks and evidence-based solutions, collaborating with like-minded groups, industry, and governments to enable bold action.

Prof Stephen Foster FTSE FIEAust Ffib,
President, International Federation for Structural Concrete (FIB), UNSW Institute for Industrial Decarbonisation

Reaching the goals of the Paris Agreement is more urgent than ever and heavy industries like cement and concrete have a pivotal role to play in the green transition. Fostering innovation and bringing the results of breakthrough research and testing rapidly to production across all economies both developed and developing will be crucial. Through collaboration and partnership we can ensure technology solutions are scaled, knowledge is shared and nobody is left behind.

Per Andersson,
Head of Secretariat,
The Leadership Group for Industry Transition

Executive Summary

From Bangkok to Berlin, from Beijing to Bogota, from Lagos to Lima and from New York to New Delhi, a quiet revolution is happening. The cement and concrete industry is undergoing an industrial scale transformation to make progress against its mission of delivering net zero concrete for the world.

Decarbonisation action and progress is happening at a breathtaking scale in our industry – with some great examples highlighted in this report. Technology is key to unlocking our net zero future and innovation is promoted, invested in, nurtured and developed right across our production and ways of working.

The world and its challenges of population growth, urbanisation, regional poverty, adapting to a changing planet and delivering safe, resilient, prosperous, well connected and resilient communities, all need the essential materials that our member companies produce.

For durable homes, modern wonders in our cities, for clean and efficient transport networks, and for the critical infrastructure to deliver clean water and green electricity, concrete is the backbone of our modern world. There is no material to replace concrete at the scale of the needs of the world, and no material to replace the magic binding ingredient in concrete that is cement.

That is why our member companies as custodians of these incredible materials are committed to a net zero future. Our progress is outlined in the chapters and numerous case studies ahead – presenting just a snapshot of the breadth of activity across the world.

What is clear though, despite the breadth of action and progress on our long-term project of deep decarbonisation, greater progress could be achieved today with the right policy support across the world to underpin the transition.

The cement and concrete industry has a strong record of environmental improvement. It was the first of the heavy industries to monitor, track and transparently report its carbon emissions, and the first global industry to announce and commit to a net zero future in 2021.

Set out in our 2050 Net Zero Roadmap, 2020–2030 is the decade in which we must accelerate our emissions reductions. Acceleration in areas such as using supplementary cementitious materials and co-processing (fossil fuel reduction and use of alternative fuels) are critical.

> **Despite the breadth of action and progress on our long-term project of deep decarbonisation, greater progress could be achieved today with the right policy support across the world to underpin the transition.**

This is also the decade where we bring forward the required breakthrough technologies to be ready for commercial scale deployment by 2030. Carbon Capture Utilisation and Storage (CCUS) is an essential component, and has taken a big leap forward with, for example, the scheduled mechanical completion at the end of 2024 of the world's first cement plant to produce net-zero cement at scale by capturing the CO_2 at source and storing it safely underground.

CCUS technology works, and we now need to work with stakeholders such as policymakers and the investment community to help develop, de-risk and deploy the technology and infrastructure to help transform the industry worldwide.

So far, since the 1990 baseline, we have achieved a 23% emissions reduction in CO_2. As we approach the halfway mark in "the decade to deliver" it is clear that we need to accelerate, and it is enabling policies that can unlock that transformational progress.

Only by industry and government working together can we achieve our shared net-zero goal. For our essential industry, we need policymakers around the world to act on a range of topics such as: helping to stimulate demand for low carbon cement and concrete, supporting the use of non-reusable and non-recyclable societal waste being safely treated and used as alternative for fossil fuels in our kilns, backing the use of supplementary materials, supporting circularity in the built environment, and both recognising and supporting the important role that technologies such as carbon capture use and storage can play in industrial decarbonisation.

Only action and progress *and policy support* will deliver our net zero future.

Our key policy requirements

Supplementary Materials
Use of blended cements and Supplementary Cementitious Materials (SCMs) can be increased now through policies that ensure government procurement permits SCMs and 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. Read more on p21.

Waste Treatment in Cement Kilns
The right policies enable the industry to replace the majority of fossil fuels 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. Read more on p17.

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. Read more on p19.

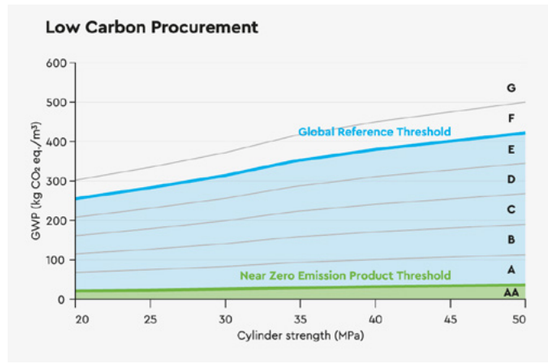
Carbon Pricing
An appropriate carbon price, as well as long-term predictability of the carbon price, allows companies to make the investments needed to reduce their CO_2. Policymakers must ensure that use of carbon pricing does not lead to distortions of competition between domestic producers and importers.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

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 Clean Energy Ministerial's Industrial Deep Decarbonisation Initiative. (www.unido.org/IDDI)

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

Above: **Refuse in Honduras is being diverted from landfill to be sustainably managed in cement kilns. Read more on p42.**

Above: **Heidelberg Materials plant in Brevik, Norway; the world's first industrial-scale carbon capture facility in the cement industry. Read more on p56.**



Above: **GCCA low carbon and near zero definitions launched at COP29 underpin low carbon procurement. Read more on p22.**

An Update from the Cement and Concrete Breakthrough

Canada is among the many nations that are working towards a cleaner and sustainable economy. Through targeted interventions like carbon pricing, industrial roadmaps and strategic financing for decarbonization, Canada is driving emissions reductions across all sectors of the economy.

Foundational industries like cement and concrete have a key role to play in mitigating the impacts of climate change. Concrete is an indispensable construction material. It is the second most consumed product on earth, after water. Given the importance of the cement and concrete sector within the global economy, it is imperative that the industry shift towards more sustainable practices that align with the goal of reaching net-zero emissions by 2050.

The global cement industry is making meaningful changes and, benefitting from the strategic guidance of the Global Cement and Concrete Association (GCCA), has made clear and substantive commitments to decarbonization, as outlined in the 2050 Roadmap to Net-Zero Concrete.

Against this backdrop, the Cement and Concrete Breakthrough was launched at COP28 in Dubai (December 2023) and is co-chaired by Canada and the United Arab Emirates. The goal is to make clean cement the preferred choice in global markets, with near-zero emission cement production established and growing in every region of the world by 2030.

The Breakthrough Agenda, launched at COP26, covers seven major emitting sectors and is backed by 59 countries. Cement and Concrete were the most recent breakthrough sector, launching at COP28 under co-chairs Canada and UAE.

As of October 2024, the Cement and Concrete Breakthrough includes a membership of 12 country partners from across North America, the Middle East, Europe and Africa. This growing membership underscores the collective desire and commitment of the global community to decarbonize the cement and concrete sector. Working together with industry partners, these national governments have recognized that sustained actions is essential in accelerating decarbonization across borders.

The launch of the Cement and Concrete Breakthrough's inaugural set of Priority Actions this past summer serves as a workplan for the groups and is a jumping point for much of this work, laying out a common vision of key challenges and opportunities for decarbonization within the sector.

These actions are centered around four themes:

1. Definitions and standards;
2. Demand creation;
3. Collaboration, education, innovation and scale-up of existing technologies; and,
4. Finance and investment.

Above: **Cement and Concrete Breakthrough was launched at COP28 in Dubai with co-chairs UAE and Canada**

The work of the Cement and Concrete Breakthrough is also facilitating the sharing of best practices along with collaborations between national governments, businesses, international organizations and other partners. Since its launch, the Cement and Concrete Breakthrough has hosted quarterly 'thematic dialogues' on key topics that underpin the decarbonization of the sector, such as building acceptance of low-carbon cement and concrete, and enhancing circularity through alternative fuels and raw materials. These discussions have helped drive pragmatic progress against the workplan, including through the development of white papers on topics such as co-processing and definitions for low-carbon cement.

Over the coming year, the Breakthrough will explore a range of policy approaches and other measures to catalyze transformation within the sector, share information to encourage and enable the adoption of innovative technologies, and showcase new investments in cement and concrete decarbonization. Above all, the Cement and Concrete Breakthrough will continue to engage a diversity of partners to ensure the work is ambitious, feasible and inclusive, while providing meaningful support to the global cement and concrete industry to reach the collective net-zero goals.

Government of Canada,
Co-Chair of Cement and Concrete Breakthrough

Roadmap to Zero:
Technology levers and policy enablers

23%

Since 1990, a 23% emissions reduction in CO_2 per tonne of cementitious has been achieved (GNR).

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 1.5°C. 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.

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 m^3 of concrete by 2030

The industry is on track to deliver CCUS technology at industrial scale at 10 plants by 2030, with latest projections forecasting triple that number.

Tracking CO_2 reductions of 100% of the global cement production is not currently possible. However leading companies have been reporting plant level data for many years as part of GNR (see below). 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 2022. Two years into this decade the reduction in CO_2 per tonne of cement is 2.2%, 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.

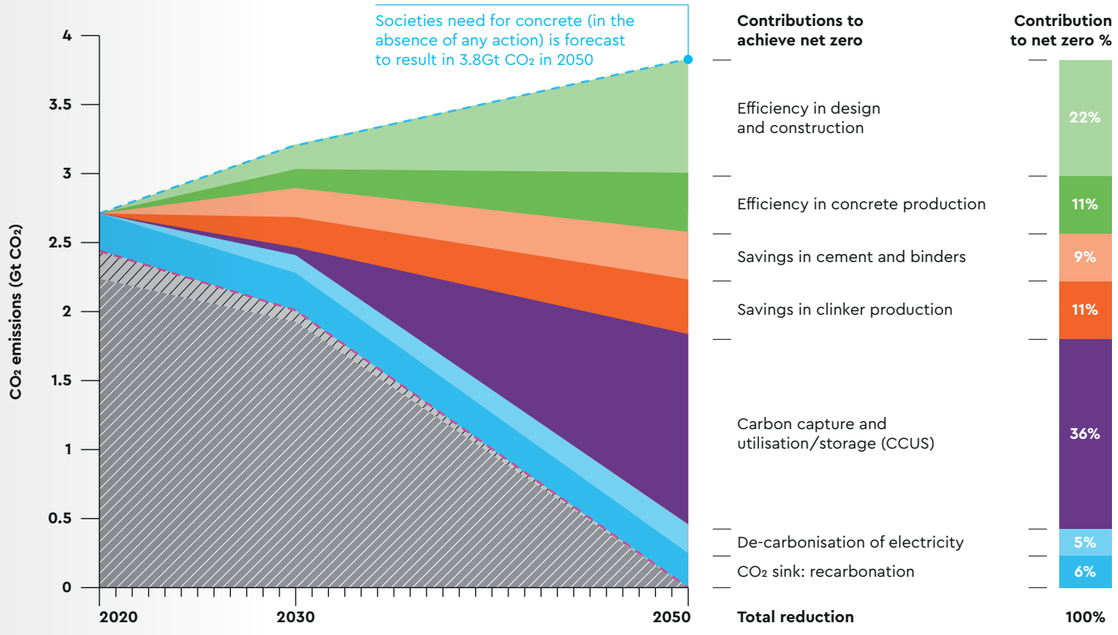
GNR: GCCA in Numbers

The GCCA commissions PWC as an independent third party to gather key data to enable monitoring and reporting against the industry's sustainability commitments. Aggregated data to comply with competition law is reported through GNR. Data are collected according to the CO_2 and Energy Protocol.

The GNR database transferred to GCCA at the end of 2018 from the Cement Sustainability Initiative (an initiative run through the World Business Council for Sustainable Development). Data is available for: 1990, 2000, and 2005 to 2022.

For more: gccassociation.org/sustainability-innovation/gnr-gcca-in-numbers/

The net zero pathway



The roadmap sets out the levers to achieve net zero across the whole lifecycle from cradle to cradle. 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 making full use of circular economy opportunities, as well as supporting the development and implementation of innovations and key infrastructure.

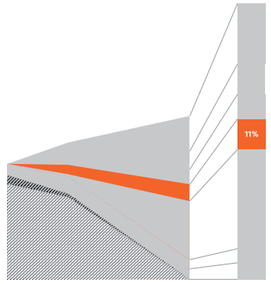
Total global CO_2 emissions from the sector in 2020 were in excess of 2.5Gt. Emissions are primarily direct CO_2 emissions which in turn are primarily from the decarbonation of limestone itself (approx. 60%) and combustion of the fuels used in the cement kiln and other plant processes (approx. 40%). 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. For the first time, and 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 use of waste materials ("alternative fuels") to replace fossil fuels, use of decarbonated raw materials, energy efficiency measures and innovations such as 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 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 that is otherwise non-reusable and non-recyclable from a range of sources, for example, municipal, agricultural, chemical and food production. The extremely high temperatures and residence times reached in cement kilns ensure 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 2022 respectively shows an increase from 19.1% to 22.7%. 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, 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 use of alternative fuels, there can be a decrease in the thermal energy efficiency.

Innovations such as 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 visit: www.gccassociation.org

> **Our industry provides a unique waste management option that combines energy recovery with mineral recycling – treating waste that is otherwise non-reusable and non-recyclable.**

Cemex, in partnership with the municipality of **Queretaro, Mexico** is delivering the country's first zero waste-to-landfill initiative. Recycling of waste for other industries has been increased. Non-recyclable waste replaces fuel in the cement kiln. Read more on p46.

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 use of alternative fuels requires 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 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.

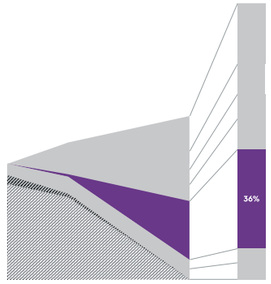
Alongside the above policies, there should be strong regulatory measures, including permit issuance and compliance procedures to ensure implementation of Best Available Technologies (BAT) when implementing co-processing in the cement industry.

Huaxin has achieved a stable fuel substitution rate of more than 60% using alternative fuels such as waste tyres, waste rubber and waste textiles at its Diwei 2500t/d clinker line in **China**. Read more on p55.

JSW Cement, India is co processing unrecyclable waste (e.g. municipal solid waste and multi layered plastics (MLP)) and rapidly increasing their thermal substitution rate from 10% to 17% over the last year. Read more on p61.

Buzzi has installed an innovative Organic Rankine Cycle (ORC) facility at its Geseke plant in **Germany**. This utilises previously unused waste heat to generate electricity equivalent to the consumption of around 250 four-person households. Read more on p36.

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 p20), 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 necessary infrastructure have been established. Progress already this decade is surpassing forecasts.

The GCCA Concrete Future 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 (see p28). In November 2024, of the 58 projects, 30 of them are industrial scale. In addition, in the pipeline and over and above publicly announced projects on the LeadIT tracker, there are already 42 projects of which 29 are industrial scale. Of the 100 projects, almost two thirds are industrial scale, and one third are expected to be completed in 2030 or before.

Also of note are the different technologies across a number of regions. Among the 42 projects (research and commercial) to be completed by end of 2030, 4 different specific carbon capture technologies are being applied. These are in Canada, China, Europe, India, North America, Rest of Asia and South America.

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/

“CCUS technology works and we are seeing an increasing number of pilots and industrial scale projects gather pace across the world in our sector.

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

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

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 items are:

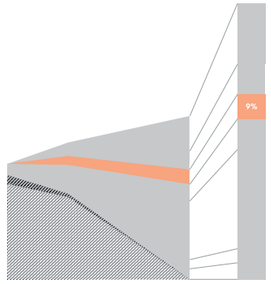
1. Use appropriate carbon pricing mechanisms to create a level playing field on carbon costs and avoid carbon leakage through adequate carbon pricing mechanisms.
2. Integrate CCUS in public financing mechanisms that covers in particular the initial investments and early operational abatement costs to allow for an investable business case.
3. 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.
4. 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.
5. Provide reliable access to sufficient and competitively priced decarbonised energy.
6. Establish public-private partnerships to speed-up CCUS developments, including shared investment in CO_2 transport and storage networks.
7. Support R&D including for new uses in other sectors of CO_2 captured by the cement and concrete industry.
8. 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.

CNBM's CCUS project in **Qingzhou Zhonglian, China** commenced operation in January 2024 producing 200,000 t CO_2/annum, exceeding 99.9% purity and an energy consumption 40% lower than alternative methods. Read more on p50.

Taiheiyo is running carbon capture demonstration equipment installed in March 2024 in **Japan**. The compact facility replaces the conventional calciner. They are developing technology to convert recovered CO_2 into synthetic methane too. Read more on p71.

Holcim is advancing seven large-scale CCUS projects based on highly scalable, mature technologies and two of these, Carbon2Business and GO4ZERO broke ground in April and May 2024. Read more on p58.

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 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 clinker to cementitious ratio. This is higher than 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 0.76 in clinker to cementitious ratio from 2020 to 2022 respectively.

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

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 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 contribute a 0.5% reduction in overall CO_2 emissions.

To speed up the progress on novel cements, GCCA 2023 Innovandi Open Challenge focussed on new materials and ingredients for low carbon concrete. Over 70 start-ups were sourced and 15 were invited to pitch. After in-depth pitching and discussions, 4 consortia have been formed between start-ups and GCCA member companies. For more information visit: www.gccassociation.org/innovandi/openchallenge2023/

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 with governments and policy makers acting as follows:

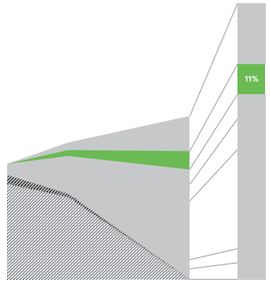
1. Ensure necessary support for review, approval and publication of standards to ensure latest standards are available.
2. Ensure cement, concrete, design and construction codes and standards, and building regulations where applicable, are aligned and congruent. For example, construction codes must refer and default to latest available material standards.
3. 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 use of blended cements, SCMs and latest material standards.
4. 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.
5. 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.
6. 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.
7. Establish government funding programmes to support development of material standards that will widen and accelerate the use of SCMs and blended cement.
8. Establish government funding programmes for product development and innovation for new SCMs.
9. 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.

A new low-carbon cement, ECO3, by **CRH** contains calcined clay (clinker factor lower than 65%), and has been used in major construction projects including the landmark 85-metre-high **Tilia Tower**, near **Lausanne, Switzerland**. Read more on p52.

Cementos Argos's Rioclaro plant in **Colombia** pioneered the use of calcined clay blended cements, and has an impressive capacity of 450,000 tons per year. Read more on p41.

In **Taiwan**, following advocacy, the commodity tax for low clinker binder ratio cement is now lower, rather than higher, than that for Portland cement, enabling **Asia Cement Corporation** to supply more low clinker cements. Read more on p33.

Concrete



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 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.

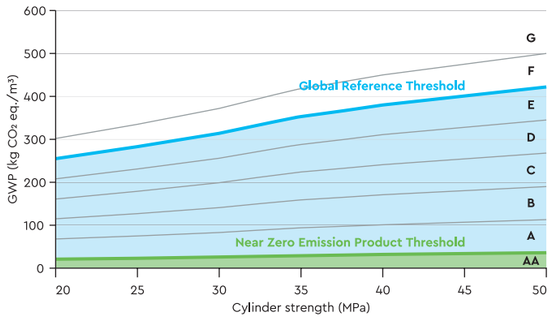
More broadly utilisation of admixtures and improved processing of aggregates are good opportunities for CO_2 emissions savings in concrete production through the more efficient use of binders. These savings have already been implemented by parts of the industry, but broader and deeper application will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

On average globally, 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.

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

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 the reporting guidelines that 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.

GCCA Low carbon and near zero definitions for concrete



GCCA has published low carbon and near zero emission definitions for concrete and cement. These use IEA cement definitions as a robust starting point. They have been developed in recognition of the aims of the Clean Energy Ministerial's Industrial Deep Decarbonisation Initiative administered by UNIDO.

They have been developed to enable adoption and adaption as required at national and/or sub national level. They leave the national or sub national authorities to set their own targets according to local decarbonisation progress and opportunities.

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 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:

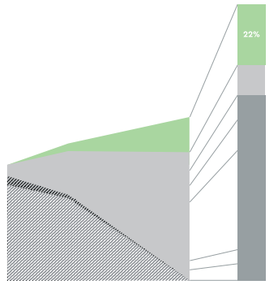
1. Low carbon procurement of products should be based on comparison of products with the same functional performance using recognised EPDs.
2. Targets for reduction compared with reference benchmarks must be:
   - stretching to deliver demand signal wanted by manufacturers and challenging enough to avoid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

In the **USA**, the **NRMCA** 2024 Concrete Innovations Awards went to 10 projects that used innovative product to lower the project embodied carbon. CO_2 reduction of 21% was achieved at this stormwater storage facility. Read more on p64.

3D concrete printing offers design freedom and construction efficiency. **Heidelberg Materials** supplied 333 tonnes of 3D concrete printing material for the largest 3D printed building to date in **Europe**. Read more on p57.

Molins will recycle 100,000 tons of demolition material from the old **Spotify Camp Nou, Spain** to be given a second life as raw materials for concrete for the new football stadium for FC Barcelona. Read more on p62.

Design and Construction



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.

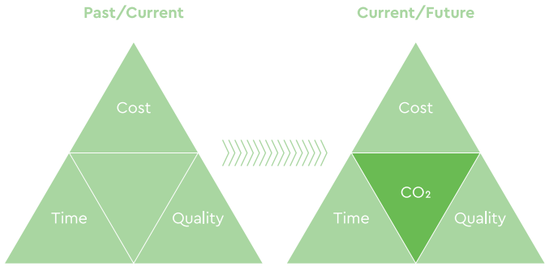
They are responsible for:

- 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 p22)
- 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 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.

Project teams need to have CO_2 emission reduction at heart of design constraint triangle



Designers are familiar with working to constraints of cost, time and quality. Clients and funders must give designers the opportunity to design to an additional constraint of whole life carbon, whilst retaining requisite quality standards (which includes durability, safety and resilience).

Designers of buildings, with support of clients, can achieve CO_2 emission reductions through their choice of concrete floor slab geometry and system, choice of concrete column spacing and optimisation of concrete strength/element size/reinforcement percentage. This can be achieved whilst still obtaining all the performance benefits of concrete construction. Infrastructure projects offer similar opportunities.

"The primary means of unlocking design levers is ensuring that reduction of CO_2 emissions becomes a design parameter.

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 realisation of the potential design and construction decarbonisation savings.

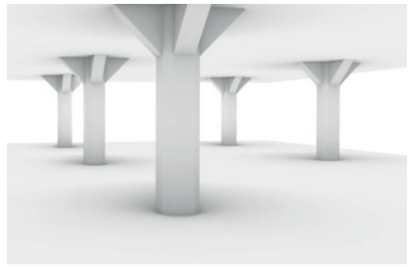
Concrete design and construction can be optimised to reduce CO_2 impact, but there are often systemic barriers and practical constraints preventing this potential from being realised. For example:

- 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.

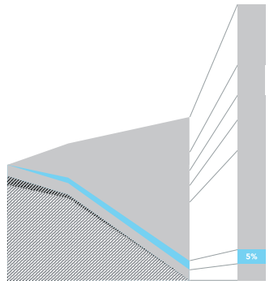
Votorantim Cimentos' Spectra product has been used by the project team on a 36-storey project in **Brazil** to optimise total concrete and steel use and reduce water and carbon emissions. Read more on p80.

Only 14% of roads in **Peru** are paved, placing the country in the lowest quartile according to World Economic Forum. **Cementos Pacasmayo** promotes optimised slab concrete roads which deliver a 32% carbon reduction. Read more on p44.



Ramboll, the global engineering and architecture company, applied carbon optimisation to the standard flat slab and introduced column flares. This led to reduction in reinforcement, a thinner slab and embodied carbon reduction of approx 5%.

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 decarbonisation of electricity production. Decarbonisation of electricity across the globe over coming decades will result in emissions from generation of electricity used in cement and concrete production to reduce to zero.

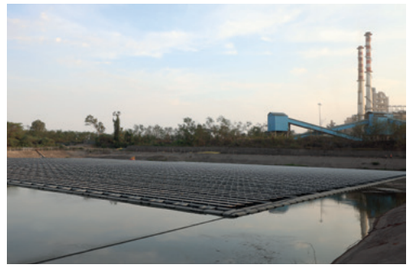
The IEA reported in October 2024 that clean energy transitions have accelerated rapidly in recent years, but need to move much faster to meet climate goals. In 2023, renewables provided 30% of global electricity supply. (1)

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

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.

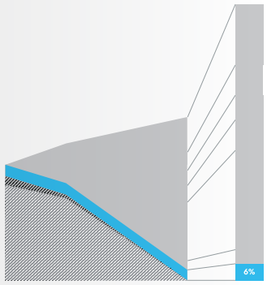
There remains a gap between the stated policies scenario and the net-zero emissions scenario for the energy sector generally and electricity in particular. Read more in IEA report (1).



In 2024, **UltraTech Cement Limited**, installed 3,600m² of floating solar photovoltaic panels, at its Awarpur Cement Works in **India** – equivalent to the sequestration benefits of 270,000 matured trees. Read more on p76.

TITAN has inaugurated a solar plant at the Zlatna Panega cement facility in **Bulgaria**. It will supply 14% of the plant's annual power needs. Surplus energy will be fed into the national grid. Read more on p74.

Recarbonation



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 p20). 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 more detailed evaluation of recarbonation and efforts to enhance recarbonation through active exposure of crushed concrete to CO_2 at end of life.

National government reporting of Carbon Uptake
The natural uptake of CO_2 in concrete at a national scale is of significance and merits reporting as part of country submission to IPCC. Detailed studies using the IVL methodology (1) have been completed in Denmark, Sweden, UK and Brazil. Work is ongoing or soon to be initiated in India, China and Australia.

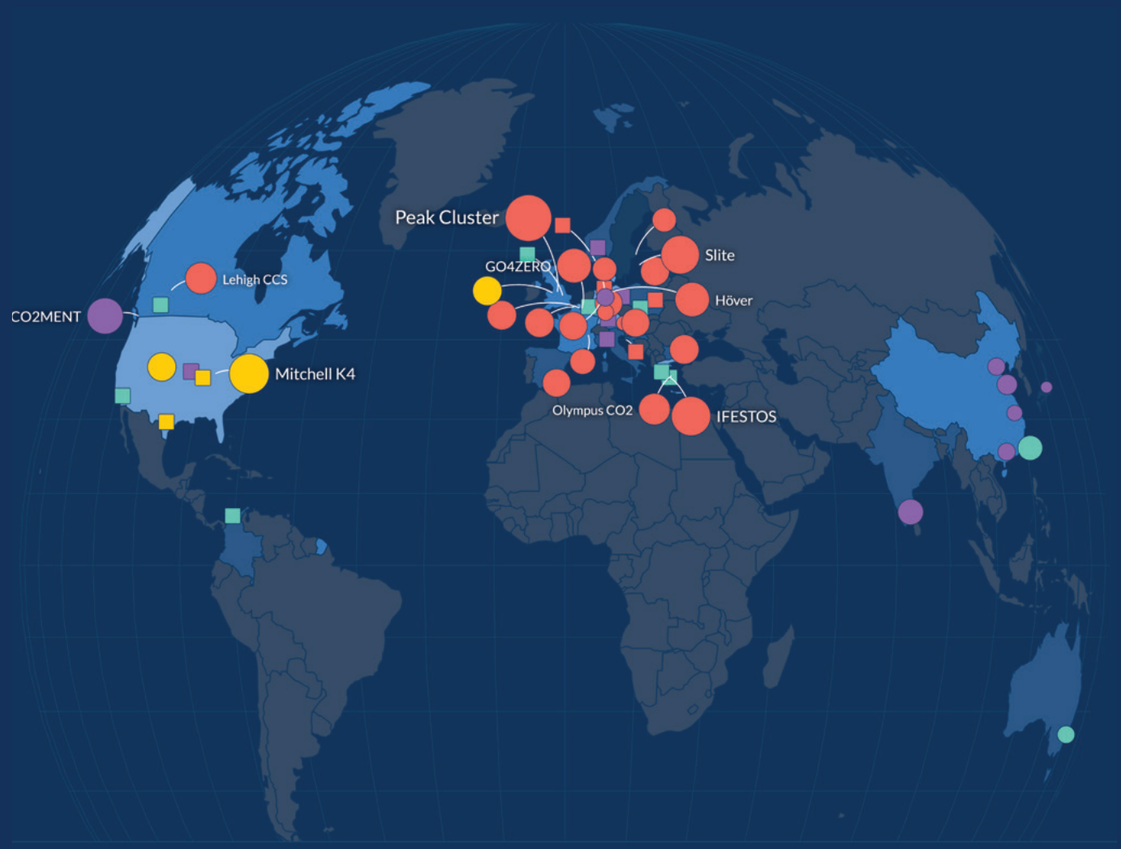
1. www.ivl.se/projekt/co2-concrete-uptake/calculation-models.html

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.

The IVL methodology (1) for national reporting to IPCC of natural carbon uptake in concrete has been applied and completed in Denmark, Sweden, UK and Brazil.

Green Cement Technology Tracker

Where have Carbon Capture projects been announced?



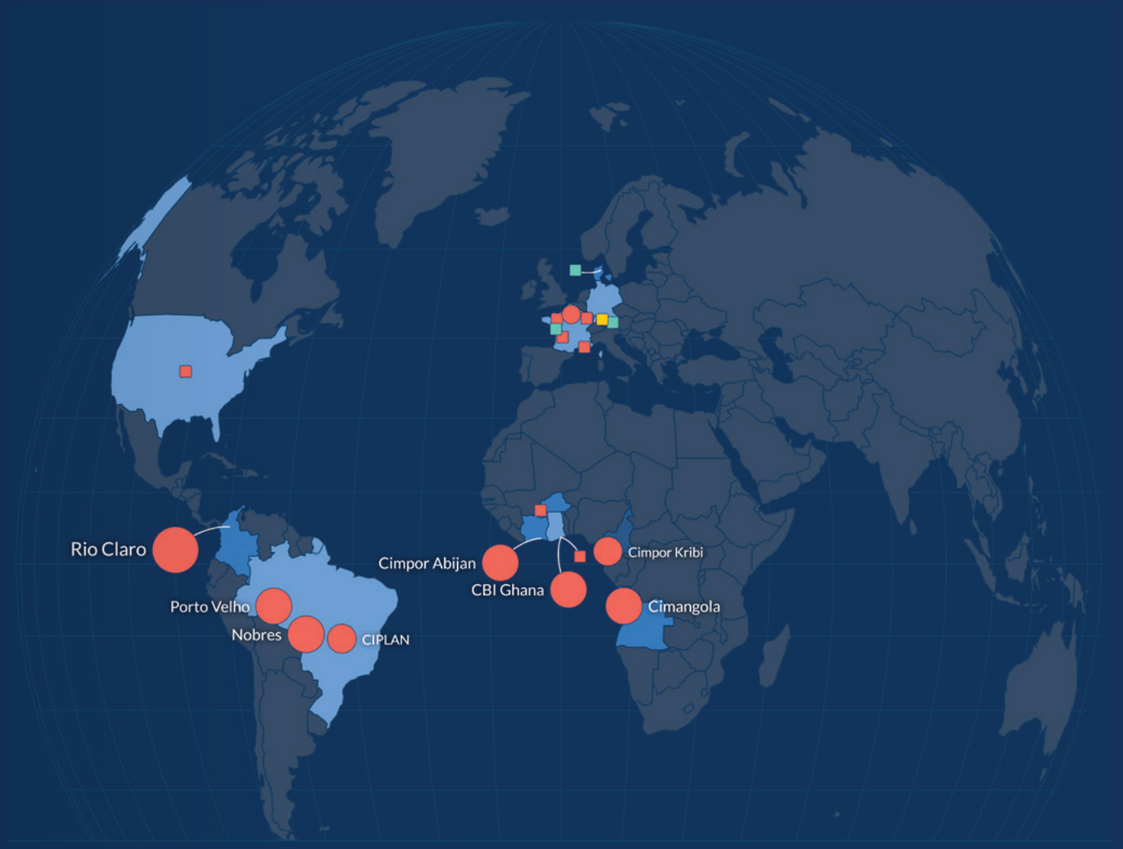
Disclaimer: No claims are being made regarding the sovereignty or status of any territories displayed on this map.

Lastly updated: May 15, 2024

Leadit LEADERSHIP GROUP FOR INDUSTRY TRANSITION

gcca Global Cement and Concrete Association

Where have Clay Calcination Kiln projects been announced?



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Lastly updated: May 15, 2024

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.

Asia Cement Corporation
- Clinker Production – Alternative Raw Materials
- Clinker Production – Co-Processing
- Cement and Binders

Betonhuis
- National Roadmap

Breedon
- Clinker Production – Alternative Raw Materials
- Renewable Energy

Buzzi S.p.A
- Clinker Production – Waste Heat Recovery
- Carbon Capture

Cement Association Canada
- Clinker Production – Co-Processing
- Carbon Capture
- Carbon Capture Utilisation

Cementir Holding
- Cement and Binders

Cementos Argos
- Cement and Binders – Calcined Clays
- Clinker Production – Co-Processing

Cementos Moctezuma
- Clinker Production – Co-Processing

Cementos Pacasmayo
- Design and Construction

Cemex
- Clinker Production – Co-Processing
- Concrete Production

Cimenterie Nationale
- Clinker Production – Waste Heat Recovery

Cimsa
- Clinker Production
- Cement and Binders

CNBM
- Carbon Capture

Concrete NZ
- National Roadmap

CRH
- Cement and Binders – Calcined Clays

Dalmia Cement
- Clinker Production – Alternative Raw Materials
- Clinker Production – Waste Heat Recovery and Renewable Energy
- Clinker Production – Co-Processing
- Water Stewardship

GCC
- Site restoration – Biodiversity

Heidelberg Materials
- Carbon Capture Utilisation and Storage
- Clinker Production – Alternative Raw Materials
- Cement and Binders – Calcined Clays
- Design and Construction – 3D Printing

Holcim
- Cement and Binders – Calcined Clays
- Carbon Capture Utilisation and Storage

Huaxin Cement
- Clinker Production – Co-Processing

JK Cement
- Clinker Production – Waste Heat Recovery
- Renewable Energy

JSW Cement
- Clinker Production – Co-Processing
- Clinker Production – Waste Heat Recovery

Molins
- Recycled Aggregates

MPA
- Cement and Binders – Calcined Clays

Norm
- Value-chain

NRMCA
- Design and Construction

PCA
- National Roadmap

SCG
- Carbon Capture Utilisation and Storage
- Renewable Energy
- Clinker Production – Co-Processing

SECIL
- Clinker Production – Co-Processing

Taiheiyo Cement
- Carbon Capture and Utilisation

TCC Group Holdings
- Clinker Production – Co-Processing
- Recycled Aggregates

TCMA
- Cement and Binders

TITAN Cement Group
- Carbon Capture
- Cement and Binders – Calcined Clays
- Clinker Production – Co-Processing
- Renewable Energy

UltraTech
- Renewable Energy
- Electric Vehicles

UNACEM
- Clinker Production – Co-Processing
- Site restoration – Biodiversity

Votorantim Cimentos
- Clinker Production – Co-Processing
- Design and Construction
- Carbon Capture
- Concrete Production

Asia Cement Corporation

Savings in clinker production

At present, the primary approach for reducing emissions at Asia Cement is through promoting a circular economy. In practical operations, domestic non-carbonate calcium oxide alternative raw materials mainly come from the steel industry. Although some of these materials have high calcium oxide content, they also contain higher levels of iron oxide. To maintain the proper chemical composition of cement, Asia Cement carefully analyses the material components and adjusts the proportions of various substitutes. While aiming for pragmatic carbon reductions, the company continues to provide high-quality products to its customers. In 2023, Asia Cement achieved a 6.4% usage rate of alternative raw materials (ARM/clinker).

For alternative fuels, Asia Cement has undertaken equipment modifications. Newly installed air ducts now direct high-oxygen tertiary hot air into the combustion furnace, effectively improving combustion efficiency. After optimisation, this adjustment not only increases the residence time of the alternative fuels and boosts their input quantity, but also allows for more flexibility in the size of the alternative fuels used, thereby effectively increasing the amount of alternative fuels consumed.

In 2023, Asia Cement's Taiwan regional business scope achieved the SBT (Science-Based Targets) for carbon reduction for the fourth consecutive year. Since the 2019 baseline year, the company has cumulatively used over 408,000 tons of circular economy materials. Both annual usage and carbon reduction have increased year by year, with a carbon reduction of 112,000 tons of CO_2e in 2023 and a cumulative reduction of 357,000 tons of CO_2e from 2019 to 2023.

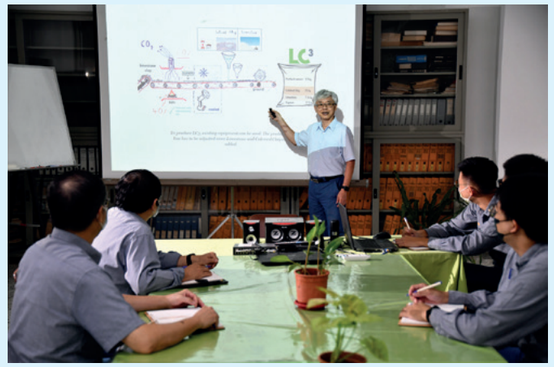
亞洲水泥 ASIA CEMENT CORPORATION

Savings in cement and binders

In Taiwan, it is common to use Portland cement with a high clinker ratio. Reducing the clinker content in existing Portland cement is a key focus for Asia Cement. In compliance with Taiwanese national standards, Asia Cement's Portland cement, in addition to limestone, also includes blast furnace slag, achieving a clinker ratio of 87%, which is close to the minimum limit of the standards. Asia Cement is also the first company in Taiwan to develop and produce low-clinker ratio cements, introducing Portland limestone cement and masonry cement, and continues to promote low-carbon cement applications to customers and government departments. Previously, Portland cement had a lower commodity tax in Taiwan, but after advocacy, the commodity tax for low-carbon cement is now lower than that for Portland cement, which benefits the expansion of the low-carbon cement market and promotes the low-carbon transition of the cement industry.

Asia Cement continues to produce low-clinker ratio low-carbon cement, breaking the current monopoly of Portland cement in Taiwan. The production of Portland limestone cement and masonry cement has reached 340,000 tons, resulting in a carbon reduction of 18,000 tons.

Asia Cement is the first company in Taiwan to develop and produce low-clinker ratio cements and continues to promote low-carbon cement applications to customers and government departments.



Betonhuis

CO_2 Concrete Roadmap for the Netherlands

Betonhuis has kicked off the implementation of the CO_2 Concrete Roadmap. With this Roadmap, the trade organisation wants to commit itself to a significant CO_2 reduction in concrete (mortar) products by 2030. The Members of Betonhuis aim for a CO_2 reduction of 25% to 30% in their production compared to 2022.

Attainable goals

The CO_2 Roadmap focuses on realistic goals up to 2030, based on known techniques and developments. Six concrete product groups, represented by the Betonhuis technical committees, have developed ambitious CO_2 reduction targets for 2030. The reduction targets vary between 25% and 30% compared to 2022. Achieving these targets depends, among other things, on the availability of new binding agents, sufficient raw materials and the cooperation of clients and manufacturers.

Betonhuis/The Netherlands summary:

- Knowledge institute for sustainable concrete (Roadmap NL)
- Works together with value chain partners in the concrete agreement
- Regional Scheme Operator Concrete Sustainability Council Netherlands
- Manager of the monitoring tool for sustainable concrete

25–30%

The members of Betonhuis aim for a CO_2 reduction of 25% to 30% in their production compared to 2022.

Achieving these targets depends, among other things, on the availability of new binding agents, sufficient raw materials and the cooperation of clients and manufacturers.

Betonhuis
Constructief Prefab

Breedon

Kinnegad Solar Farm

This project is set to be completed by Q1 2025 and will be the largest solar farm in Ireland behind the meter. It will provide 17 MW solar farm on 42 acres. This farm will save somewhere in the region of 20% of our annual energy requirements. During the peak production times from solar (summer months), we will be sourcing nearly 90% of our electricity requirements from the solar farm.

Alternative Raw Material (ARM) Project

The project objective is to reduce sulphur dioxide emissions arising from the clinker production process. Key elements of the project include an expansion of the rail network at Hope, a rail offloading system utilising an electric materials handler, onward conveying and material storage hall integrated within the site.

The project will go live by 31st March 2025 and is on track to achieve mechanical completion by year-end 2024 with commissioning during Q1 2025.

The alternative raw materials will be a combination of pulverised fuel ash (PFA), slate waste from our own quarries in North Wales and other materials of a similar composition to largely replace the shale quarried on site at Hope. The materials will be transported to Hope by rail to minimise transport CO_2.

The finished product will not be affected due to a thorough material selection process. A number of trials have demonstrated this practically.

Top: **Kinnegad Solar Farm**
Above: **High-level conveyor installation for ARM at Hope Plant**

We will be sourcing nearly 90% of our electricity requirements from the solar farm.

BREEDON

Buzzi

Dyckerhoff Geseke Plant generates green electricity from waste heat

The Dyckerhoff plant in Geseke, part of Buzzi group, has made a significant advancement in energy efficiency and environmentally friendly production by integrating an Organic Rankine Cycle (ORC) facility. This innovative system from the Munich-based company Orcan Energy, which utilises previously unused waste heat from the clinker cooler, went into trial operation in March 2024 after six months of construction. Central to this technology is a newly installed 50-ton heat exchanger that transfers waste heat to the ORC modules via a water circuit. These modules convert the heat at lower temperatures into electricity, which is then used directly on-site. Continuous operation of the facility is expected to generate over 1 million kWh of electricity annually, equivalent to the annual consumption of around 250 four-person households. This green electricity generation from waste heat will also avoid up to 900 tons of indirect CO_2 emissions (Scope 2) per year, considering the recent values of the emission factor of the electricity supplied by the grid.

Therefore, effective use of waste heat for electricity not only reduces energy costs but also greenhouse gas emissions. Efficiency technologies are crucial in the cement sector for reducing energy consumption and CO_2 emissions, thereby increasing competitiveness and contributing to climate protection. Furthermore, since 2019 the plant has operated a DeCONOx system, which has significantly reduced emissions of NOx, CO, and organic compounds.

Above and top: **Dyckerhoff Geseke Plant**
Opposite: **Deuna Plant**

Up to
900 tons

Up to 900 tons of indirect CO_2 emissions (Scope 2) per year will be avoided through green electricity generated from waste heat.

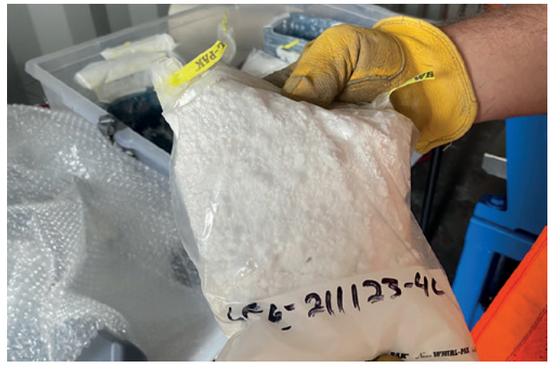
Dyckerhoff plans a significant investment for a carbon capture project at Deuna Plant

A significant investment of around 350 million euros has been planned for the construction of a carbon capture installation at the Dyckerhoff plant in Deuna (Thuringia), part of Buzzi group, which will make it one of the first plants in Germany to produce and sell net-zero cement. This project is of great interest for the sector since it addresses process-related emissions, which cannot be mitigated by alternative energies or fuels alone. After completing two feasibility studies detailed planning for the installation is underway, with an expected operational date of 2029. However, the investment is contingent on local regulatory approvals and the Dyckerhoff Supervisory Board's approval.

This project aims to reduce the plant's CO_2 emissions by approximately 620 thousand tons annually, contributing to a more than 20% reduction in Thuringia's industrial, commercial and energy conversion emissions. The existing efficient rail connection at the plant will facilitate the transportation of the captured CO_2 and the distribution of net-zero cements. Dyckerhoff is also seeking public funding to support this pioneering effort in decarbonising the cement industry, addressing the unavoidable process emissions from limestone burning to achieve climate neutrality.

> **This project is of great interest for the sector since it addresses process-related emissions, which cannot be mitigated by alternative energies or fuels alone.**

Cement Association of Canada



Top left and right: **Lafarge Hyperion Project**
Above: **The First Test Quantities of Precipitated Calcium Carbonate Produced from Flue Gas, Lafarge Canada plant located in Bath, Ontario, Canada.**

Lafarge and Hyperion Collaboration

Lafarge East, part of the Holcim Group, has partnered with Canadian carbon technology pioneer Hyperion Global Energy Corporation to pilot its Tandem Carbon Recycling System. This patented technology is designed to achieve up to 98% carbon capture efficiency by transforming captured carbon emissions into high-performance mineral components for a range of industrial applications, including sustainable building materials. By converting carbon emissions into valuable resources, this innovation supports value-added circularity for the industry, as it contributes to the production of low-carbon concrete with enhanced concrete density and strength. The technology is currently being piloted at the Bath, Ontario cement plant to further advance Lafarge's extensive range of high-performance low-carbon concrete, including the ECOPact line. The pilot implementation is capable of removing up to 1,000 tonnes of carbon annually from plant operations, with the potential to be scaled up tenfold over the next year.

Cement Association of Canada

St. Marys Low Carbon Alternative Fuel Project

This summer, St. Marys, part of Votorantim Cimentos, introduced new cement kiln infrastructure at its St. Marys, Ontario plant, marking a significant milestone in its commitment to achieving net zero emissions by 2050. This new specialised infrastructure is designed to use waste materials, such as unrecyclable plastics, as a lower-carbon fuel source, replacing up to 30% of the fuel used in cement manufacturing. This innovative initiative is projected to reduce carbon emissions by more than 39,900 tonnes by 2030 – the equivalent of removing more than 9,400 cars from the road for a year. Supported by Environment and Climate Change Canada's Decarbonisation Incentive Program, the project not only helps lower emissions to combat climate change but also diverts waste from landfills, advancing broader sustainability goals.

Heidelberg Edmonton's Carbon Capture, Utilisation and Storage Project

Heidelberg Materials, in partnership with the Government of Canada, is spearheading a groundbreaking project to establish North America's first full-scale carbon capture, utilisation, and storage (CCUS) facility at its Edmonton, Alberta plant. Following a 2019 feasibility study, this pioneering initiative aims to capture more than 1 million tonnes of carbon annually from its cement production and associated heat and power processes. Once operational, the innovative CCUS project is expected to sequester 95% of the plant's total carbon emissions. This significant reduction is equivalent to removing 220,000 cars from the road, providing power to over 190,000 homes, or preserving approximately 1.2 million acres of forest annually. A memorandum of understanding signed in April 2023 solidifies the commitment of both Heidelberg Materials and the Government of Canada to this transformative project.

95%

Once operational, the innovative CCUS project is expected to sequester 95% of the Edmonton, Alberta plant's total carbon emissions.

Lafarge's Exshaw Low-Carbon Fuel Project

Lafarge Canada, a member of the Holcim Group, has commissioned its state-of-the-art Low-Carbon Fuel facility at the Exshaw Cement Plant. Developed over the past five years through extensive environmental studies, economic and logistical reviews, and community consultation, this facility will reduce the plant's reliance on traditional fuels by replacing up to 50% of natural gas used for one of its kilns. This shift is expected to divert as much as 120,000 tonnes of construction demolition materials (CDM), a majority of which is wood based from landfills annually, resulting in lowering CO_2 emissions by as much as 30,000 tonnes annually.

Ash Grove and Carbon Upcycling Partnership

Ash Grove, a CRH company, has partnered with Calgary-based carbon utilisation startup, Carbon Upcycling Technologies. This collaboration integrates Carbon Upcycling's carbonation technology into Ash Grove's existing facility at its Mississauga, Ontario plant. The project is supporting the design and future construction of a small-scale commercial carbon mineralisation facility. Once fully operational, the system is expected to capture 3,000 tonnes of carbon annually and reduce the plant's carbon intensity by 12,000 tonnes per year. As the first industrial-scale application of Carbon Upcycling's technology within CRH's suite of companies, Ash Grove's success will pave the way for CRH to implement this innovation across its global network of cement plants.

To learn more about the project please visit:
https://www.ashgrove.com/mississauga/#carbon

Cementir Holding

Cementir D-Carb

This year, Cementir launched D-Carb®, a new umbrella brand for lower carbon white cements, available initially in the European markets before its planned global roll-out.

D-Carb® is fully aligned with Cementir's commitment to reduce carbon emissions in order to meet the Net Zero Roadmap's targets.

D-Carb® is the result of an extended team effort involving key customers in co-design activities. It has been a challenging journey as none of the currently used SCM to reduce clinker ratio can effectively replace white clinker without negatively impacting the whiteness. A fit-for-purpose grinding aid enhances the synergy within the components to achieve early ages' performances able to meet construction deadlines.

Leveraging on an improved compatibility with admixtures, D-Carb® is easy to use supporting industrial users in their journey towards more sustainable products.

Customers are reporting a smooth transition to D-Carb® as it integrates well with their production process without requiring major formulation changes.

D-Carb® is expected to replace our CEM I in several industrial applications, becoming one of the main cements within its white cement portfolio.

Top: **The production of D-Carb® at Cementir's Aalborg Portland plant**
Above: **D-Carb® white cement on pallets ready for dispatch**

“The first D-Carb® product is a CEM II/A-LL 52.5R which combines a lower-carbon footprint, -15%, with excellent early age performance, comparable to Aalborg White CEM I 52.5R.

cementirholding
CALTAGIRONE GROUP

Cementos Argos

Above and above left: **Rioclaro Plant, Colombia**

“Our calcined clay production line was one of the first high-volume lines in the world and set a global benchmark.

ARGOS

Savings in cement and binders

Pioneering calcined clay cement in Latin America: Since July 2019, our Rioclaro plant in Colombia has been at the forefront of sustainable cement production. We pioneered the use of calcined clay blended cements, a breakthrough technology that has not only increased plant capacity but also significantly reduced the clinker content, a major contributor to CO_2 emissions in cement production.

Our calcined clay production line was one of the first high-volume lines in the world and set a global benchmark. With an impressive capacity of 450,000 tons per year, it is one of the largest of its kind in Latin America.

Remarkable achievements: Focused on optimising the clinker factor for Type GU cement, our efforts have yielded impressive results. To date, we have successfully reduced the clinker factor by 14%, marking a significant step towards more sustainable cement production.

Savings in clinker production

Transforming waste into value: In 2023, we made a strategic investment of US $588,000 at our Piedras Azules plant in Comayagua, Honduras, to revolutionise our waste management and CO_2 reduction efforts. We installed an advanced system designed to shred, dose, transport, and inject one ton per hour of refuse-derived fuel (RDF) into our kiln's main burner.

In 2024, our first year of operation, we forecast the processing 2,000 tons of RDF, which will lead to a 1.7% petcoke substitution rate. Our long-term goal is to achieve a substitution rate of 8%, which will consume 5,600 tons of RDF per year.

To ensure a stable supply of RDF, we have developed a comprehensive relationship plan involving productive companies, local authorities, and communities in our area of influence. This collaborative approach will enable us to develop a consistent source of RDF and support sustainable waste management practices in the region.

Scaling Co-Processing: Since its introduction in 2015, co-processing has become a cornerstone of our sustainability strategy at Argos Colombia. What began with a modest 1,000 tons of alternative fuel from a single supplier at our Rioclaro plant has evolved into a robust system involving eight active suppliers. Together, they now supply nearly 30,000 tons of alternative fuels.

This expansion has been transformative, with our suppliers developing innovative solutions for previously unmanaged waste. By integrating these waste streams into our production processes, we are significantly reducing emissions while supporting the circular economy.

Carbon credits – a milestone: Our Cartagena plant continues to lead the way in sustainability. Building upon our groundbreaking 2023 milestone of issuing Colombia's first industrial carbon credits, we've significantly expanded our use of alternative fuels. This year, our cumulative consumption has soared to over 46,000 tons, more than doubling our previous annual average. This remarkable achievement translates to a potential generation of over 25,000 carbon credits, demonstrating our commitment to reducing emissions and contributing to a greener future.

Above: **Refuse-Derived Fuel supports sustainable waste management practices in Comayagua, Honduras**

Cementos Moctezuma

Cementos Moctezuma has improved it's path to actively and effectively address our commitment to decarbonise our industry and achieve the United Nations Sustainable Development Goals with different actions.

Increasing the co-processing rate with alternative fuels is one of the most relevant factors to achieve these goals. That's the reason why in 2021 Moctezuma invested more than $10m, to use solid waste and tyres as alternative fuels in our plant located in Cerritos, San Luis Potosi.

This is also a huge contribution to circular economy, in 2023 and the first semester of 2024 we have avoided that more than 40,000 tons of waste ending up in landfills, providing a second life and reincorporating them into the value chain.

Cementos Moctezuma is committed to reducing greenhouse gas emissions by 2030 and achieving our 30% co-processing rate goal.

> **At the beginning of 2023, the co-processing percentage was around 7%, so far in 2024, Cerritos has increased the co-processing rate by 16% in the best month of the year.**

Cemento MOCTEZUMA

Cementos Pacasmayo

Ultra-thin Pavements to Optimise Construction Projects and Lower CO_2 emissions

Peru faces a significant infrastructure deficit, particularly in its road network, which urgently requires attention. Currently, only 14% of its 195,400 km road network is paved, placing the country 108th out of 137 in road quality according to the World Economic Forum. The country urgently needs quality pavements to ensure adequate transportation for economic activity and improve the quality of life in urban and rural communities. Recently, there has been a rise of concrete pavements which offer a robust solution for enhancing road durability and sustainability, demonstrating a 19% reduction in carbon footprint compared to traditional construction asphalt pavements.

Furthermore, Pacasmayo promotes the use of optimised slab concrete pavements which contributes to sustainability with a total reduction in carbon footprint by 32%. Additionally, this method achieves significant cost efficiencies through three main actions: concrete consumption reduction by 30%, decrease in the load on each slab and enhancement of load distribution and the elimination of joint sealing and load transfer reinforcement. Optimised concrete pavements underscore the potential for significant environmental and material benefits in infrastructure development.

Pacasmayo

Soil stabilisation with cement: Connecting rural communities in Peru

Soil stabilisation is a practical and sustainable construction method that significantly improves rural connectivity by creating durable, cost-effective roads that link isolated communities. By reinforcing the existing soil with cement, this approach minimises the need for extensive excavation and new materials, enabling the construction of more roads that can connect rural areas efficiently. This method not only enhances access to essential services and markets but also results in up to 30% savings in construction costs, making it a highly effective solution for improving infrastructure in remote regions.

In addition, soil stabilisation offers significant benefits for the industry market by improving agricultural transportation conditions through the reduction of dust, which enhances air quality and minimises impact on nearby crops. The long-term market benefits are substantial as stabilised roads require up to 70% less maintenance, extending their lifespan and significantly reducing ongoing costs. This approach not only supports local economies by generating employment opportunities but also strengthens infrastructure, particularly in isolated communities, making it a cost-effective and sustainable solution. By addressing economic, environmental, and social needs, soil stabilisation positions itself as a valuable asset for industries focused on rural development.

By reinforcing the existing soil with cement, this approach minimises the need for extensive excavation and new materials, enabling the construction of more roads that can connect rural areas efficiently.

Cemex

Cemex works with Queretaro to become the first zero-waste city in Mexico

The municipality of Queretaro, part of the Metropolitan Area of Queretaro (one of the top 10 largest cities in Mexico), is leading the country's first zero waste-to-landfill initiative in partnership with Regenera, this Cemex business provides circularity solutions to extend the life cycle of construction products and materials through reuse in value-added products. Queretaro generates 950 tons of total waste daily, ~1 kilogram per capita of general waste. The Broquers plant, owned and managed by Regenera, is central to this effort.

Broquers was the first plant in Mexico to implement European-standard waste separation equipment, enhancing efficiency and environmental sustainability. Since Regenera assumed operations three years ago, the plant has nearly tripled its capacity, now processing 22,800 tons of waste monthly, which accounts for about 90% of Queretaro's waste.

Currently, Broquers converts over 40% of inorganic non-recyclable waste into energy for Cemex's cement plant; additionally, through its collection and sorting processes, it enables the recycling of materials by other industries, reducing landfill waste and supporting a circular economy. A new project aims to increase this amount to over 90% by drying the organic waste so it can also be used as fuel, cutting nearly 12,000 tons of CO_2 emissions monthly.

90%

Since Regenera assumed operations three years ago, the plant has nearly tripled its capacity, now processing 22,800 tons of waste monthly, which accounts for about 90% of Queretaro's waste.

©Métropole du Grand Paris

Above: **Aquatics Centre, Paris Olympics 2024**

Savings in clinker production

The Olympic Aquatic Centre at Saint-Denis is a state-of-the-art swimming facility designed for both world-class competitions and community use. Cemex contributed to its development, including the pedestrian bridge, by providing specialised concrete solutions that met the project's specific needs, maintaining high standards of quality, sustainability and innovation.

Cemex supplied over 15,000m³ of concrete between 2021 and 2023 and an additional 12,000m³ of decorative concrete from July 2023 to January 2024. Cemex's work on the Olympic Aquatic Centre and pedestrian bridge involved developing over fifty unique concrete mixes, including recycled aggregates, civil engineering concretes, architectural concretes, self-placing concretes, high-performance concretes, and lower-carbon Vertua concrete. These formulations met the project's needs for durability, aesthetic appeal, and compatibility with the chlorinated environment of the swimming pools through more sustainable building solutions. Cemex also recommended a turnkey solution to use different types of pumps depending on pouring point locations.

> **Cemex's work on the Olympic Aquatic Centre and pedestrian bridge involved developing over fifty unique concrete mixes, including recycled aggregates, and lower-carbon Vertua concrete.**

Cimenterie Nationale

Cimenterie Nationale is committed to decarbonisation and has executed a number of initiatives that are yielding significant savings in diesel oil consumption:

- Waste heat recovery from the clinker cooler of kilns 2 and 3 to CMs 5 and 8, which has allowed us to eliminate the need for the hot gas generator (HGG).
- Waste heat recovery from Kiln 4, string A, to RM1, enabling the shutdown of the HGG#1 when only Kiln 3 is running with Kiln 4, and partially when Kilns 2 and 3 are in operation.

The above two projects have had a substantial impact on reducing our CO_2 footprint.

Cimenterie Nationale is committed to decarbonisation and has executed a number of initiatives that are yielding significant savings in diesel oil consumption.

Main Projects in their Design & Engineering Stages as WHRS

1. Waste heat recovery from the clinker cooler of Kiln 4 to CM9, eliminating the need for the HGG. This is expected to be completed within one year.
2. Waste heat recovery from the Kiln 2 clinker cooler to Coal Mill 4, allowing Kiln 2 to operate independently of Kiln 3. Completion is expected within 1.5 years.
3. Waste heat recovery from the Flue gases of the 4 HFO engines (2x Wartsilas and 2x New Maks) generating 37 MW of electricity to produce ca. 4 MW using the Ranking cycle.

This project had been designed, engineered, and integrated in the future power generation system.

4. We have also implemented several "low-hanging fruit" projects, particularly in compressed air, power generation water cooling system, coal mills and Kilns fans and motors among others, changing normal electrical motors by VFD, and improvement of coal mills efficiency. Data calculated for the Coal Mill 4/5 and the compressed air network efficiency improvement is shown here below.

Department	Nominal drive power	Rated Load		Saving	Total Saving (KW)	Operation hours/Year	Saving/ Year (KWHR)	CO_2 Reduction/ Year (Ton)
		Before Improvement	After Improvement					
Coal Mill 4	250 KW	212 KW	167 KW	24 KW	764	7200	5500800	1529.2
Coal Mill 5	550 KW	540 KW	300 KW	240 KW				
Compressed air	9 X 250 KW	8 X 250 KW	6 X 250 KW	500 KW				

1 GJ ------- 77,4 KG CO_2 (based on (Ultra) Heavy fuel)
1 GJ ------- 277,7 KWHR

1 KWHR ------- 0.278 KG CO_2

Çimsa

Building sustainable living spaces by transforming our portfolio into sustainable products that have lower clinker usage rates

Within the scope of our sustainability strategy, our planning and roadmap efforts to reduce carbon emissions in 2023 continued intensively. After validation by the SBTi, our near-term greenhouse gas reduction targets, aligned with the 1.5°C scenario, were announced in May 2024.

We advance by incorporating our decarbonisation transition roadmap compatible with SBTi targets into our strategic business model and investments. As part of our roadmap, our main action areas include the use of alternative raw materials and alternative fuels, product transformation, thermal and electrical energy efficiency, the implementation of renewable energy, and advanced technologies.

We declared 2023 as the year of "Cement Product Transformation" with our mission to assume the industrial leadership in efforts to reduce product carbon intensity. In 2023, 37% of our total grey cement product portfolio was transferred to the CEM-II product group.

We aim to reduce Scope 1 and 2 product emission intensity by 42.1% by 2033, using 2021 as the base year. We have already achieved a 12% reduction compared to 2021 as part of our target.

Furthermore, we also take the classifications of the EU Taxonomy as a guide for the transformation of our products. From this perspective, we classified the products in the "Grey Cement Family" into two categories: Izo Power and Master Power, which have 15% to 50% lower emissions compared to traditional Portland Cement. In 2023, the EPD studies we initiated for our Super Grey Family members continue this year, and the number of EPD products in our portfolio is gradually increasing.

CNBM

CNBM's Qingzhou Zhonglian CCUS project

Major advancements:

- Ranking first in scale and lowest energy consumption in CCUS projects of the global cement industry
- Leading carbon capture technology through original development and disruptive innovations

Project Overview:
The liquid CO_2 capacity of this oxyfuel demonstration project is 200,000 tons/year, ranking first level in the global cement industry currently. This project adopted a combination of original technologies, making its energy consumption of production designed to be less than 1.60GJ/t.CO_2, representing a 40% decrease in energy consumption compared to MEA methods. Its energy consumption is known to be a global leader.

The project was installed from June 2023 and operated in January 2024, reaching the producing capacity of 682 t/d with energy consumption of 1.53GJ/t.CO_2 and production purity exceeding 99.9%. The main technical indicators surpassed designed expectations.

99.9%

The project reached the production capacity of 682 t/d with energy consumption of 1.53GJ/t.CO_2 and production purity exceeding 99.9%.

CNBM

Concrete NZ

Aotearoa New Zealand's Transformation to a Low Carbon Concrete Industry Project

In August 2023, the cement and concrete sector in Aotearoa New Zealand introduced its national Net-Zero Carbon Roadmap. Recently, the industry marked the roadmap's first anniversary by initiating a follow-up project aimed at engaging stakeholders from various sectors, including industry, academia, regulatory bodies, specifiers, and cultural (Māori) representatives. The objective of this transformation project is to review the roadmap's strategies, identify actionable steps to achieve the established targets, and empower project contributors to act as change agents, supporting the industry's progress towards decarbonisation.

The project will focus on advancements in research and innovation, education, impact modelling and advocacy, as well as updates to construction Standards. A key challenge remains the inertia in specifying higher proportions of Supplementary Cementitious Materials, which have historically been limited in availability.

The roadmap defined two targets for Aotearoa New Zealand's national concrete industry:

- 2030: -44% of direct and electricity-related emissions compared to a 2020 baseline
- 2050: net-zero carbon for cement production and concrete batching

The Transformation Project should enable meeting these goals through engagement with stakeholders and the regulatory environment.

"The project will focus on advancements in research and innovation, education, impact modelling and advocacy, as well as updates to construction Standards.

concretenz BUILDING RESILIENCE

CRH

Calcined clay helping to decarbonise cement production at CRH

Reducing the clinker factor in cement through the use of alternative cementitious materials is one of the levers in the GCCA's 2050 Roadmap. Less clinker results in a lower carbon footprint in the cement product. One such example is ECO3, a new low-carbon cement produced by Jura Cement, a CRH Company based in Switzerland. The first-of-its-kind, it contains calcined clay as a substitute for some of the clinker required, thereby creating an innovative low-carbon cementitious material for more sustainable construction.

> **Less clinker results in a lower carbon footprint in the cement product.**

Calcined clay can be heated at lower temperatures than those required for the production of clinker. This means less electricity and fuel are needed. The calcined clay used in ECO3 is produced from local clay reserves in Cornaux, Switzerland. Launched in the beginning of 2024 it has a clinker factor lower than 65%, with potential for further reductions through additional optimisation. One tonne of calcined clay replaces on average 3/4 tonnes of clinker, thereby saving more than 1/4 tonnes of CO_2. Concrete produced using ECO3 contains approximately 20% less CO_2 per m^3 when compared to concretes using conventional Portland limestone cement.

ECO3 cement is helping Jura Cement, a CRH Company, to decrease its level of cement specific CO_2 emissions per tonne of cementitious product, forming an important part of CRH's overall decarbonisation roadmap. It is also helping meet the growing demand for sustainable products from customers and stakeholders in Switzerland. The product has been certified according to the European low-carbon cement standard SN EN 197–5 and has already been used in major construction projects including the landmark 85-metre-high Tilia Tower, near Lausanne.

Dalmia Cement

Dalmia Cement's Journey in Decarbonisation and Water Stewardship

In its quest to become a carbon-negative cement group by 2040, Dalmia Cement has made significant strides in decarbonisation. The journey began in FY-19, when the company installed 8 MW of solar power and 9 MW of waste heat recovery systems (WHRS). Fast forward to FY-24, and these capacities have dramatically increased to 113 MW and 72 MW respectively, showcasing a robust commitment to renewable energy.

Dalmia has also innovatively tackled thermal energy usage, substituting 22% in FY-24, up from just 3.7% in FY-19. By harnessing incinerable waste from other industries, they reduced reliance on traditional fossil-based energy sources by advancing sustainable fuel alternatives including RDF and Agricultural Waste.

In its resource management strategy, Dalmia explored alternative raw materials (waste from other Industries) to replace limestone. In FY-24, the company consumed 11.5 million tonnes of alternative raw materials (ARM), which constituted 41% of the ARM used in cement production.

The impact of these initiatives is evident: Dalmia Cement successfully reduced its net carbon footprint from 546kg to 459kg per tonne of cementitious material between FY-19 and FY-24, preventing a cumulative 7 million tonnes of CO_2 emissions. This journey reflects Dalmia Cement's unwavering dedication to sustainability and innovation in the cement industry.

The company has shown water stewardship by reducing freshwater consumption, recycling wastewater, implementing design stage savings, conducting social interventions, and harvesting rainwater. These efforts have made the group 12.6 times water-positive and over 25 times water-positive at the cement plant boundary.

113 MW

In FY-19, the company installed 8 MW of solar power and 9 MW of waste heat recovery systems (WHRS). Fast forward to FY-24, and these capacities have increased to 113 MW and 72 MW.

GCC

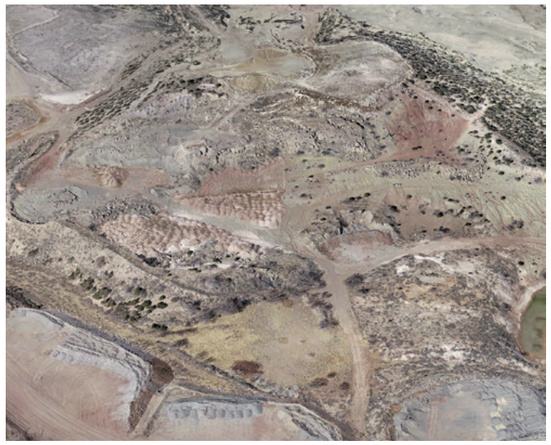
Fostering Biodiversity at the New Mexico Tijeras Reclamation Project

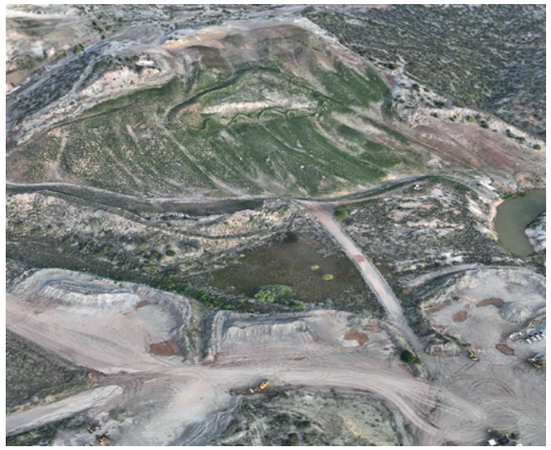
GCC has proactively conducted studies to enhance reclamation practices at its Tijeras mine, including a comprehensive revegetation test plot study that earned recognition from the New Mexico Mining and Minerals Division with an Excellence in Mining and Reclamation award.

In December 2023, GCC completed a five-year reclamation project, restoring 22 acres at Tijeras' oldest quarry. This project transformed the site into a community-designed recreational area that fosters biodiversity and revitalises local wildlife.

The reclamation incorporated bluff features and rocky habitats to attract various wildlife species. The bluff features provide roosting and nesting opportunities for birds, while the rocky habitat features offer dens and resting spots for terrestrial wildlife. The plant diversity incorporated into the seed mixture will provide food sources for various wildlife species as the plant communities grow and mature. Additionally, this quarry reclamation reduces fugitive and respirable dust while incorporating plans for recreational use, providing the community with scenic spaces for activities like hiking and biking.

In December 2023, GCC completed a five-year reclamation project, restoring 22 acres at Tijeras' oldest quarry.





Top: **Quarry before reclamation project**
Above: **Quarry after reclamation project**

GCC

Huaxin

Huaxin Diwei alternative fuel carbon reduction project

Huaxin Diwei Company's 2500t/d clinker production line has achieved the continuous, stable and large-scale application of alternative fuels such as waste tyres, waste rubber, and waste textiles through the company's independent research and development of alternative fuel pretreatment, feeding systems and alternative fuel intelligent control systems. It has achieved a stable fuel substitution rate of more than 60%, and the comprehensive energy consumption of cement clinker is less than 50kg of standard coal/ton of clinker. The direct CO_2 emissions intensity per ton of cement is 417kg, which is 123kg lower than the 540kg before the project was put into operation, achieving a CO_2 emissions reduction of 110,000 tons/year.

110,000 t

The Huaxin Diwei alternative fuel carbon reduction project has achieved a CO_2 emissions reduction of 110,000 tons/year.

華新水泥股份有限公司
HUAXIN CEMENT CO., LTD.

Heidelberg Materials

Above: **Heidelberg Materials, Brevik**

Brevik CCS, Norway: The world's first industrial scale carbon capture plant in the cement industry – mechanical completion scheduled for end of 2024

At Heidelberg Materials' plant in Brevik, Norway, the world's first industrial-scale carbon capture plant in the cement industry will go into operation in 2025. Once operational, 400,000 tonnes of CO_2 per year (50% of the plant's emissions) are to be captured and transported by ship to an onshore terminal on the Norwegian west coast. From there, the liquefied CO_2 will be transported by pipeline to the storage site under the North Sea, where it will be permanently stored. As part of the project, the carbon capture plant is being integrated into the current cement plant without disrupting the ongoing cement production.

Construction is progressing well and on track. Brevik CCS is a pioneer project that has a special significance for Heidelberg Materials and the entire cement industry as it showcases that industrial-scale carbon capture and storage is possible at scale. The experiences and lessons learnt from the CCS realisation and operation in Brevik will be valuable for both the cement industry as well as other process industries. Based on the Brevik CCS project, Heidelberg Materials will be able to offer evoZero®, the world's first net-zero carbon captured cement, to customers in Europe from 2025.

Above: **Heidelberg Materials, Lengfurt**

Cap2U, Lengfurt, Germany: CO_2 as raw material – the world's first large-scale CCU facility in a cement plant

As part of a joint venture, Heidelberg Materials and Linde aim to put the world's first industrial-scale CCU facility in the cement industry into operation at Heidelberg Materials' cement plant in Lengfurt, Germany, in 2025. The groundbreaking ceremony for the Cap2U ("Capture-to-Use") project took place in June 2024. The facility will enable the captured CO_2 from cement production to be reused as a valuable raw material in industrial applications. Up to 70,000 tonnes of CO_2 are to be captured annually.

Thanks to its purity, the processed gas can be used in both the food and chemical industries, for example as carbon dioxide in mineral water. The utilisation of captured CO_2 from cement clinker production for the food industry has so far only been tested on a laboratory scale: As a first-of-its-kind initiative, the Lengfurt project aims to demonstrate the required 100% purity on an industrial scale. The project will supply a high-quality product for different applications that will meet the needs of a wide range of customers.

Through our 10+ CCUS projects already started, we aim to reduce our CO_2 emissions by 10 million tonnes cumulatively by 2030.

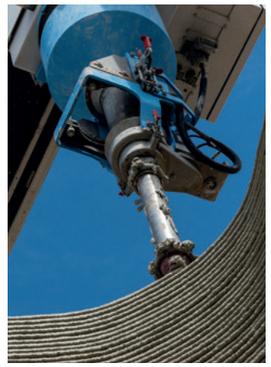
Above: **Heidelberg Materials site near Katowice**

ReConcrete: Transforming demolition material into a raw material source

As part of Heidelberg Materials' patented ReConcrete process, demolition concrete is broken down into its original constituents through a newly designed, proprietary crushing mechanism. Recycled concrete paste (RCP) is the finest fraction of the separation process. It can be either used as an alternative raw material for clinker production replacing limestone and reducing CO_2 emissions or as a secondary cementitious material.

In 2024, Heidelberg Materials commissioned an innovative recycling plant for selective separation at its production site near Katowice, Poland. The first-of-its-kind facility features a proprietary crushing mechanism that enables sophisticated separation and sorting capabilities to fully recycle demolition concrete and substitute virgin materials in concrete production. With a capacity of up to 100 tonnes of concrete per hour, Heidelberg Materials is the first company in the industry to introduce high-quality, selective concrete separation at this scale.

To complement the new facility in Katowice, Heidelberg Materials is currently building an industrial pilot facility for enforced carbonation at its cement plant in Górażdże, Poland. The RCP obtained at the recycling plant near Katowice will be transported to the pilot facility in Górażdże, where it will be exposed to the exhaust gases from the kiln. Mechanical completion of the facility is expected by end of 2024.



Above: **3D concrete printing**

3D Concrete Printing: Design Freedom, Construction Efficiency, and Sustainable Performance

Heidelberg Materials offers high-quality products as well as technical know-how to architects, engineers, manufacturers of 3D printers, and builders who want to realise buildings or concrete elements using 3D printing. Our special 3D concrete printing material was already used to print the first residential buildings in Germany in 2020. Since then, Heidelberg Materials has further developed the building material and further reduced its CO_2 content. The completely mineral building material contains a binder with a carbon footprint around 55% lower than that of classic Portland cement. It is also 100% recyclable. Through appropriate design planning, the 3D printing process itself allows for up to 70% less material consumption compared with conventional construction methods and thus a further reduction in CO_2. The process also increases the speed and productivity of the construction process and makes construction sites safer through lower dust and noise emissions and reduced use of tools. In 2023, Heidelberg Materials supplied 333 tonnes of material for the largest 3D printed building in Europe to date, which was built in Heidelberg, Germany.

Above: **Calcined Clay, Ghana**

Ghana: Low-carbon cement based on calcined clay

Using calcined clay as clinker substitute is an important measure to reduce the carbon footprint of cement and concrete. In principle, a CO_2 reduction of up to 40% is possible when substituting cement clinker with calcined clay. Heidelberg Materials is piloting calcined clay technology in Ghana, where the world's largest flash calciner is currently being built with a capacity of more than 400,000 tonnes per year.

Holcim

Leading the Way in Calcined Clay

After Holcim launched Europe's first calcined clay cement operation at its Saint-Pierre-la-Cour, France plant in 2023, the facility will produce up to 500,000 tons of low-carbon cement per year.

This ECOPlanet cement has a 30% lower CO_2 footprint compared to standard CEM I. The innovative production line is powered with 100% biomass-based alternative fuels and waste heat recovery systems, making the manufacturing of calcined clay nearly carbon-free and ultra-efficient. Several building projects with Holcim's calcined clay-based cements broke ground this year, including the Marseille Marina for the Paris 2024 Olympic Games.

As part of our European roadmap to decarbonise construction, we launched Europe's first calcined clay low-carbon cement operation at our Saint-Pierre-la-Cour plant in France in 2023. The plant aims to deliver ECOPlanet low-carbon cement with an up to 50% lower CO_2 footprint compared to ordinary cement (CEM I). This advanced production line, a world first, runs on our 'proximA Tech' proprietary technology, and will produce both clinker and calcined clay, to deliver up to 500,000 tons of low-carbon cement per year. Operations onsite are powered using 100% alternative fuels coupled with waste-heat recovery systems. The project received financial support from the French government as part of the "France Relance" plan to invest in large-scale decarbonisation and energy efficiency projects. Opening the first calcined clay cement production line in Europe is a milestone to decarbonise building. We aim to scale up our calcined clay cements in Austria, Bulgaria, Czech Republic, Germany, Romania, Spain and Switzerland. More broadly, we will continue to advance our ECOPlanet range of low-carbon cements across all regions by 2025.

Top: **Clay sample**
Middle: **Marseille Marina**
Above: **Saint-Pierre-la-Cour**
Opposite: **Obourg Plant, Belgium**

Scaling Up Carbon Capture and Storage

With its GO4ZERO and Carbon2Business Carbon Capture Utilisation and Storage (CCUS) projects, Holcim is creating new value chains and developing technologies to help companies in other sectors reduce their emissions, as we work to make net-zero cement and concrete a reality at scale this decade.

As flagship CCUS projects for Holcim, Carbon2Business and GO4ZERO broke ground in April and May 2024 respectively.

At Holcim's Obourg plant in Belgium, GO4ZERO uses state-of-the-art technologies to make a major contribution to the decarbonisation of the region's construction industry. Cement production on site will be completely transformed – from alternative raw materials to a new production line with an embedded carbon-capture solution, and unprecedented levels of circularity and environmental performance. By 2029 the new plant will produce around 2 million tons of carbon-neutral cement.

Carbon2Business at Holcim's Lägerdorf plant in Germany will capture more than 1.2 million tons of CO_2 emissions annually. The captured CO_2 will be repurposed as an industrial raw material and from 2029 cement production at Lägerdorf will be entirely net zero. With this utilisation project, Holcim is creating new value chains and developing technologies to enable the decarbonisation of companies in other sectors of industry.

https://video.holcim.com/how-ccus-technology-works-at

https://video.holcim.com/go4zero-driving-decarbonization-in

As a recognition of Holcim's leadership in carbon capture, utilisation and storage (CCUS), six of Holcim's full-scale projects received funding from the EU's Innovation Fund to capture over 5 million tons of CO_2 and produce 8 million tons of fully decarbonised cement annually by 2030.

2m tons

By 2029, Holcim's Obourg plant will produce around 2 million tons of carbon-neutral cementitious materials.

JK Cement

Accelerating Decarbonisation of Electricity: JK Cement's Expansion of Waste Heat Recovery System (WHRS) Capacity

JK Cement (JKCL) has SBTi (Science Based Target initiative) validated target of reducing its CO_2 emissions by 21.7%, from FY 2020 level of 680kg CO_2/t cementitious material to 532kg/t cementitious material by FY 2030. Being an active member of Global Cement and Concrete Association (GCCA), the company has also joined UNFCC's 2050 "Race to Zero" campaign to achieve Net Zero-emission goals for cement and concrete. Additionally, JKCL has pledged to the United Nations Energy Compact to reach a 75% share of green power by FY 2030.

Waste Heat Recovery System (WHRS) at Muddapur and Panna: WHRS plants were commissioned at JKCL's Muddapur and Panna Integrated Cement Plants in FY 2023–24. This advanced technology converts waste heat generated from kiln operations into electricity, significantly reducing the need for fossil-fuel-based grid electricity. This contributes significantly to JKCL's long-term decarbonisation goals, laying the foundation for a more sustainable future.

Decarbonisation Progress and Achievements in Energy: In FY 2023–24, JKCL successfully increased its green power mix to 51% from 44% in FY 2022–23. The WHRS capacity rose from 42.3 MW in FY 2022–23 to 82.3 MW in FY 2023–24. By utilising WHRS, the company avoided 238,102 tCO_2 in FY 2023–24. Key milestones include commissioning a 18 MW WHRS plant at the Muddapur integrated cement plant in Karnataka in February 2024, and a 22 MW plant at the Panna integrated cement plant in Madhya Pradesh in May 2023. The green power share in Muddapur plant has reached more than 90% as of FY 2023–24. No thermal captive power plant power is being used at Panna and Muddapur plants.

These projects have significantly reduced reliance on fossil-fuel based electricity, leading to a major reduction in Scope-2 GHG emissions. The company avoided 53,734 tCO_2 in Scope-2 GHG emissions by fulfilling 75,048 MWh of grid electricity requirements through these WHRS projects.

Above: **JK Cement, Muddapur, India**

18 MW

Key milestones include commissioning a 18 MW WHRS plant at the Muddapur integrated cement plant in Karnataka in February 2024.

JKCL plans to further expand its renewable power capacity from 100.64 MW in FY 2023–24 to 190.22 MW in the near future.

JSW Cement

JSW Cement progresses towards decarbonisation by Integrating Alternative Fuels and Expanding Clean Energy Use

JSW Cement, a division of the $24 billion Indian conglomerate JSW Group, is committed to the principles of the circular economy in its production processes. Over the past two years, we have significantly increased our use of alternative fuels. In cement manufacturing, most emissions are generated during the energy-intensive clinkerisation process. To address this, we have markedly reduced our reliance on traditional fuels such as coal and pet coke by co-processing waste materials like MLP, plastics, and municipal solid waste. In FY24, we achieved a thermal substitution rate (TSR) of ~10%, with a goal of reaching 30% by 2030. This has helped us avoid ~50,000 T of CO_2 emissions.

We have also implemented a Waste Heat Recovery Systems (WHRS) at two our manufacturing facilities – Shiva and Nandyal. This system captures waste heat from the kiln and converts it into usable energy, reducing heat loss and decreasing our reliance on the Indian electricity grid, which generated 0.716kg CO_2 per unit of electricity. Last year in FY24, our WHRS helped us avoid 33.7 million kg of CO_2 emissions, and we saved an additional 30.6 million kg of CO_2 through solar energy sources through PPA with JSW Energy Limited. These initiatives have increased our clean energy portfolio from ~4% in FY23 to 15% in FY24.

We have already achieved 17% TSR in Q1 of FY 2025 and aim to further increase this figure by the end of the year.

Molins

Molins will recycle 100,000 tons of material for the construction of the new Spotify Camp Nou

As part of its commitment to promoting circular economy, Molins is playing a key role in building FC Barcelona's new football stadium. The company has installed a waste recovery plant, which will allow 100,000 tons of waste from the demolition of the old Spotify Camp Nou to be given a second life as raw materials for the construction of the new Spotify Camp Nou.

By August 2024, out of the 80,700 tons of waste recycled so far, 22,600 tons have been converted into recycled aggregates used as infills and granular pavement for unbound and granular layers, 16,400 tons have been used to produce lower carbon footprint concrete, and the rest are stockpiled for use during the stadium's construction.

Molins also contributes to the decarbonisation through its new range of Susterra solutions, that distinguishes products and solutions with a strong contribution to emissions reduction, and also to the circular economy, and the promotion of a safer working environment. All 160,000m³ of concrete to be supplied for the construction of the new Spotify Camp Nou will belong to Molins' Susterra range of products, produced with recycled aggregates and with a lower carbon footprint.

Above: **Molins concrete and aggregates**

Key Performance Indicators	
Planned Susterra concrete volume supplied	160,000m³ (100%)
Susterra concrete supplied by August 2024	90,000m³ (100%)
Planned recycled waste produced	100,000 tons
Recycled waste produced by August 2024	80,700 tons
Recycled aggregates for unbound and granular layers by August 2024	22,600 tons
Recycled aggregates used to produce Susterra concrete by August 2024	16,400 tons

Molins

Mineral Products Association

Re-C3: Reclaimed Calcined Clay Cement

To determine if lower value clays, currently discarded in UK quarry/brick production sites, could be used in cement and concrete with a potential CO_2 profile 40–60% lower than CEM I. The full report is available here: Reclaimed calcined clay cements (Re-C3) (mineralproducts.org)

The project aimed to address the key barriers to production and use of reclaimed calcined clays.

A total of ten clays and two brick powders, with varying clay mineral constituents, were assessed as Supplementary Cementitious Materials (SCMs) at lab scale. Then four of these clays were calcined at pilot scale in a flash calciner and rotary kiln and rigorously analysed (along with 1 brick powder) for their strength and durability in cements and concretes.

All of the calcined clays produced using the pilot facilities, including clays with low kaolinitic content performed exceptionally in both standard and self-compacting concrete mixes. A strength class of 42.5 N was easily obtained by cements with calcined clay as a component and continued strength gain beyond 28 days.

Currently 79% of UK cement market sales is CEM I, with a total market of 10 million tonnes per annum. The new cements trialled in the project have a CO_2 profile 40–60% lower than CEM I. If fully deployed this would result in a reduction in direct emissions from UK cement production of over 4 million tonnes of CO_2 every year. This work has removed potential barriers to manufacture and use of calcined clays in the UK.

mpa Cement

NRMCA

Build with Strength: Ten Projects Selected for their Innovations in Low-Carbon Concrete

The Concrete Innovations Award Program, which is sponsored by Build With Strength, celebrates accomplishments in the design and construction of concrete structures where an NRMCA member company was involved in supplying products or services to the project. Winners represent building and infrastructure projects substantially designed and built using concrete and having improved all-around performance, including reduced carbon footprint.

The 10 winning projects in the 2024 Concrete Innovations Award Program have one thing in common: they all used innovative product to lower the embodied carbon footprint of projects, thanks to NRMCA Build With Strength initiative. The Build With Strength team works with design and build teams to review project specifications and provides recommendations on lowering carbon budgets on projects. The team uses NRMCA's guide specifications, the NRMCA Concrete Carbon Calculator and its guiding principles, The Top 10 Ways to Reduce Concrete's Carbon Footprint document to shape the way projects are designed for low carbon. In addition, NRMCA has worked on establishing benchmarks for the carbon footprint of concrete since 2012 to help design teams compare their projects to baseline projects in the NRMCA Industry-Wide Environmental Product Declaration and Benchmark Reports. These reference documents are available at www.nrmca.org/sustainability.

The 10 winning projects in the 2024 Concrete Innovations Award Program have one thing in common: they all used innovative product to lower the embodied carbon footprint of projects.

The 10 winners selected this year are:

681 Florida Street Affordable Family Housing in San Francisco (01) is recognised for its pioneering project under the Bay Area Low-Carbon Concrete Model Code, in collaboration with NRMCA Producer member Central Concrete Supply, a Vulcan Materials company. Effective teamwork led to the achievement of a 36% decrease in the embodied carbon of the concrete and resulted in an overall reduction of 23% in embodied carbon for the entire project.

Cement-Free Concrete (C-Crete) in Hubbard's Corner Project in Seattle is recognised for its innovative use of 60 tons of C-Crete in the foundations and shear walls of a commercial building. This landmark pour, a collaboration between C-Crete and NRMCA member Heidelberg Materials, marked a significant advancement in cement-free concrete technology which uses zeolite, a naturally occurring crystalline material, as a replacement for portland cement.

Gig Harbor Habitat for Humanity (02) is acknowledged for constructing sustainable homes that boast a lower environmental impact, courtesy of the BioLock Admixture by Solid Carbon. Heidelberg Materials supplied the concrete for this project located in Gig Harbor, WA, utilising its Climate Earth technology to publish Environmental Product Declarations (EPDs) to show some the lowest recorded carbon footprint for commercial concrete in North America.

Indiana University Ferguson International Center in Bloomington, Indiana, is being awarded for its innovative design approach that sidestepped the use of traditional cement and aggregates, marking a notable achievement in sustainability through decreased embodied carbon. NRMCA Producer member Irving Materials Inc. worked closely with the project's architects, engineers and general contractors in creating a performance-oriented mix that aligned with the project team's low-carbon vision.

MnDOT I-35 W Stormwater Storage Facility is being recognised for its underground water storage facility in Minneapolis with a storage capacity of 4.8 million gallons across six interconnected concrete tanks, designed to mitigate flooding. Cemstone Products Company, an NRMCA Producer member, played a critical role in the design, testing and supply of 32,000 cubic yards of concrete essential for ensuring the facility's watertight integrity while lowering carbon footprint by as much as 21%.


01


02

03

New Canaan Library (03) is being recognised for its sustainability, employing materials that are locally sourced, recycled and known for their energy efficiency and low-carbon footprint. The project achieved an energy use intensity which is 89% below the U.S. baseline. Integral to this New Canaan, CT, project is the utilization of Pozzotive®, produced by Urban Mining Industries, a recycled, ground glass pozzolan produced locally, with the active participation of NRMCA member O&G Industries. Carbon footprint of the concrete was reduced by nearly 30%.

Prologis Nexus is being recognised for its groundbreaking and eco-friendly industrial building, boasting a reduction in embodied carbon emissions by more than 40%. Central Concrete Supply developed the low-carbon concrete mixes and supplied concrete for this 260,000 sq ft facility in San Leandro, CA.

SFO Harvey Milk Terminal 1 Boarding Area B (04) stands as a hallmark reconstruction endeavor at the San Francisco National Airport, containing 25 gates serving both international and domestic flights. This project has notably earned the distinction of being the first terminal globally to receive a LEED BD+C New Construction Platinum v4.0/4.1 certification. Thanks to a collaborative effort headed by Central Concrete Supply, the initiative has successfully managed to reduce embodied carbon by nearly 30%.

Seattle Storm Center for Basketball Performance, (05) designed by architects Shive-Hattery and ZGF Architects, was acknowledged for its expansive 50,000 sq ft project, aimed at securing LEED® Gold Certification. NRMCA Producer member Stoneway Concrete contributed its eco-friendly low-carbon concrete, serving as the fundamental carbon reduction element of the building which achieved up to 68% reduction in carbon footprint for some elements of the project.

The Hope Center + Berkeley Way Apartments (06) is being honored for their innovative affordable housing model, which integrates four distinct types of affordable housing into two structures. Central Concrete Supply provided roughly 4,000 cubic yards of concrete for the California project. The concrete mixes utilised 55% less cement than the average for concrete of equivalent strength.

04

05

06

The concrete industry is dedicated to reducing its carbon footprint through initiatives like Build With Strength by providing strong, resilient structures while substantially reducing environmental impact through product and process innovations. These winning projects are outstanding examples of how NRMCA members are working with design and build teams to accomplish amazing results.

More details about the nominees and winners, including images, can be viewed at www.concreteinnovations.com/2024winners.

About Build With Strength: Build With Strength is an initiative of the National Ready Mixed Concrete Association that seeks to educate the building and design communities and policymakers on the benefits of ready mixed concrete and encourage its use as the building material of choice for buildings. To learn more, visit: www.buildwithstrength.com

Norm

Norm: Contributing to Decarbonisation Efforts in Azerbaijan

Norm has been one of the leaders in the country's efforts to reduce carbon emissions across the entire value chain, promote green technologies, and transform how cement and concrete are produced and used in Azerbaijan.

The Azerbaijan Cement Producers Association (ACPA), of which Norm is a key member, has launched a Net Zero Accelerator, which provides a roadmap for reducing CO_2 emissions in line with the GCCA's Net Zero Global Industry Roadmap and Azerbaijan's Nationally Determined Contributions. This roadmap is the first of its kind in the cement and concrete sector across CIS countries.

Through the industry's collective efforts, dedication, and forward-thinking solutions, together with all stakeholders in the country, ASİA can make a significant impact.

ACPA aims to create a cleaner, more sustainable future for Azerbaijan, where development goes hand in hand with environmental responsibility. By collaborating with industry leaders, the government, and environmental organisations, it is shaping policies and advancing technologies that will make decarbonisation a reality, further establishing a future that all generations will admire – building sustainable cities, resilient infrastructure, and a healthier planet for everyone.

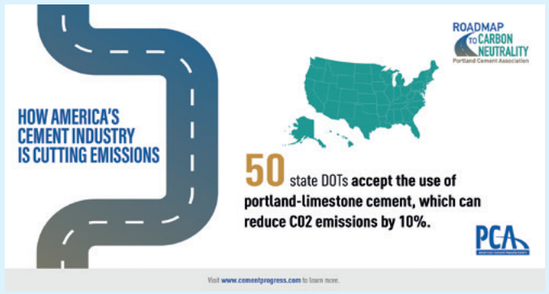
PCA

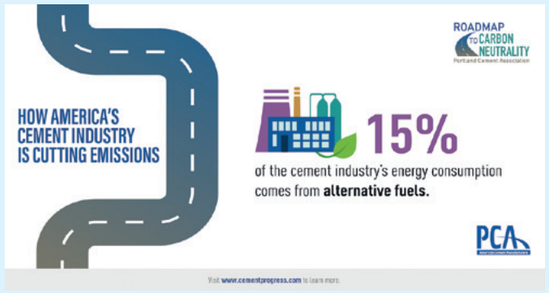
The Portland Cement Association, representing the majority of America's cement manufacturers, celebrates the third anniversary of its Roadmap to Carbon Neutrality this fall. To reach net zero by 2050, U.S. cement manufacturers are focusing on numerous levers, including lower-carbon cements, renewable energy and alternative fuels as power sources, and carbon capture, utilisation, and storage (CCUS) technologies.

Lower-carbon cements have been a significant focus. Lower-carbon portland-limestone cement is now the most common hydraulic cement in the U.S. for general concrete construction. In 2023, more than 3.9 million metric tons of carbon were avoided by the increased adoption of lower-carbon cement in the U.S., according to data from PCA's Market Intelligence group.

Moreover, lower-carbon portland-limestone cement attained a significant milestone in the U.S. this year: All 50 state Departments of Transportation now permit its use. The landmark arrives at a crucial moment. State transportation departments are major cement consumers, and this consumption will only increase as these agencies use Bipartisan Infrastructure Law funding to rehabilitate roads, bridges, and other infrastructure.

Additionally, 73% of PCA member companies use alternative and/or renewable fuels to power their plants, a figure that's up from last year and credited in part to tax incentives to employ renewable energy sources. On the CCUS front, the U.S. Department of Energy announced in March potentially more than $1.2 billion in funding for four PCA member companies to launch revolutionary CCUS projects. Each company will match the funding granted. The projects will match the federal investment, leveraging more than $2 billion to demonstrate commercial-scale decarbonisation solutions needed to advance the industrial sector to the carbon-free finish line.





Looking ahead, PCA is in the final stages of its efforts to spearhead the development of voluntary guidelines for lower-carbon cement and concrete. This initiative aims to streamline and enhance sustainability practices across the industry, a crucial step in the industry's journey toward net zero. The guidelines will be published by the end of 2025.

For more information on the U.S. cement industry's progress toward carbon neutrality, visit: https://cementprogress.com/

PCA Since 1916
America's Cement Manufacturers™

SCG

Public–Private–People Partnerships pave the way for industrial decarbonisation towards Net Zero and a model of low-carbon city by 2050

Saraburi Province is pivotal in Thailand's transition to a low-carbon economy. The province is a major hub for the cement industry, around 80% of total cement capacity in Thailand, which has been crucial to Thailand's economy since the reign of King Rama VI. This industry significantly contributes to GDP, employment, and infrastructure development. The cement industry in Saraburi supplies essential materials for construction and development projects nationwide, underpinning economic growth and urbanisation, and is supported by increasing investments in residential, commercial, and public infrastructure projects. Saraburi is a key player in achieving Thailand's climate goals and fostering a greener, more sustainable future, along with the cement industry's transition towards Thailand Net Zero Cement and Concrete Roadmap 2050 announced its success at COP27 in Egypt.

To push forward its net-zero target, the implementation of the "Saraburi Sandbox, Low Carbon City Model" project within Saraburi Province has been developed and shown at COP28 in Dubai. Not only does it play a crucial role as a strategic initiative through the area-based approach, but also show the way of fostering experiential learning and disseminating critical knowledge, achievements, and regulatory compliance across various organisations through Public-Private-People Partnerships (PPP partnerships). With collective forces of all parties in this sandbox, we proudly stand as the first nation to chart a defined Net Zero roadmap and concrete actions in line with Thailand's Nationally Determined Contributions (NDCs) and the global industrial direction set by the Global Cement and Concrete Association (GCCA). This decarbonisation journey of this industry seeks to achieve the ambitious target of Net Zero by 2050 and promptly help Saraburi province be a model of low-carbon city for Thailand. This will help pave the way for replication in other provinces in Thailand.

The details of decarbonisation through 5 NDC sectors are portrayed as follows:

SARABURI SANDBOX LOW CARBON CITY

SCG

SECIL

RETROFEED – Implementation of a smart RETROfitting framework in the process industry towards its operation with variable, biobased and circular FEEDstock

RETROFEED is a European Union Horizon 2020 project with the goal of promoting the use of bio-based raw materials and fuels in five industrial sectors by modernising key equipment and implementing an advanced control system.

SECIL, as the representative of the cement sector, aimed to improve environmental performance by replacing fossil fuels with RDF to reduce CO_2 emissions and to enhance better efficiency of the clinker production process.

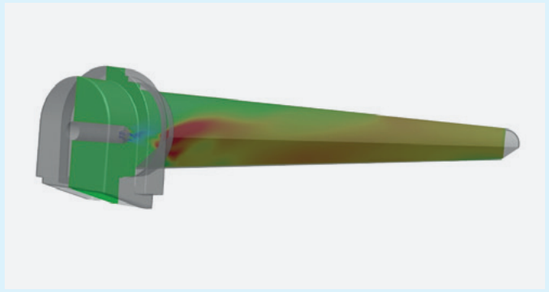
The project was developed at the Maceira-Liz plant and included the following phases:

- Development of the kiln digital model;
- Construction of a pilot-scale burner prototype and testing with different fuels/combustion conditions;
- New design of the main burner;
- Development of new sensors to improve process control;
- Industrial testing to evaluate the modifications effectiveness.

The industrial test demonstrated that the modifications made to the main kiln burner, as well as the new sensors, can increase the use of alternative fuels between 13% and 34%, with a consequent reduction of 7% to 11% in CO_2 combustion emissions.

The project also concluded that it is technically possible to use hydrogen as a fuel in a clinker kiln through a CFD model, but the validation of these results will require pilot-scale testing.

Additional information can be found at:
https://retrofeed.eu/



Top: **Maceira-Liz plant, Portugal**
Above: **Kiln model**

Taiheiyo Cement

Taiheiyo has also been developing methanation technology suitable for the cement production process to convert recovered CO_2 into synthetic methane.

Commencement of Demonstration Runs of C2SP Kiln

Taiheiyo Cement Corporation has been developing the C2SP kiln CO_2-capture technology under the project adopted by NEDO (New Energy and Industrial Technology Development Organisation) of Japan in 2022 for its Green Innovation Funding Program. Installation of the demonstration equipment for CO_2-capture in the cement production process was completed in March 2024, followed by commencement of demonstration runs.

Taiheiyo has focused its CO_2-capture technology development on the fact that about 70% of CO_2 from cement production is generated in the calciner. This has allowed the development of technology to efficiently capture CO_2 in a compact facility by replacing the conventional calciner with a unique CO_2-capture calciner. Taiheiyo Cement has been engaged in demonstration tests for CO_2-capture technology toward deployment at actual cement plants after 2030.

TCC Group Holdings Co., Ltd.

Whole Life Cycle Services for Buildings – Construction Waste Solutions: Pioneers Circular Economy with Robust R&D Strategy

TCC Group Holdings (TCC) has introduced construction waste solutions to drive a circular economy in the sector. Waste disposal GHG emissions account for 3% of a building's lifecycle. Proper disposal and reuse reduce natural resource extraction and landfill waste, decreasing industry carbon emissions. In 2024, TCC's Hualien Plant, with a monthly capacity of 12,000 metric tons, received government approval as a treatment site.

TCC leverages advanced R&D to repurpose construction waste, ensuring product quality through rigorous analysis, testing, and trial production. In 2023, TCC transformed waste concrete into recycled concrete aggregates (RCA), with tests confirming its strength matches natural sand and gravel.

Our process:

1. **Collection Management:** Strict material and transportation standards minimise dust pollution
2. **Prior Treatment:** Waste is sorted and crushed
3. **Analysis:** Material experiments are conducted
4. **Trial Production:** Trial production at cement or RMC plant verifies product quality and strength
5. **Reuse:** Waste is officially reused

The first product, permeable concrete, is used for roads at the TCC DAKA Renewable Resource Recycling Centre. This material helps build sponge cities by storing and draining water, reducing the urban heat island effect. By reducing carbon emissions without reducing strength, TCC enhances resilience against extreme weather and earthquakes.

For more details, visit the TCC 2023 Sustainability Report: https://media.taiwancement.com/web_tcc/en/report/csr/report_2023_all.pdf

Top: **TCC DAKA Renewable Resource Recycling Centre**
Above: **Permeable concrete used for roads can withstand 210kg per cm² pressure, meeting strength, carbon reduction, and environmental protection standards**

1.05m tons

TCC is Taiwan's first cement company to obtain a pilot permit for processing civil and construction waste mixtures. 1.05m tons of construction waste was reused in 2023.

TCC GROUP HOLDINGS

TCMA

Thai Cement Manufacturers Association (TCMA): Thailand's New Era of Low Carbon Cement

Following the announcement of 'MISSION 2023' in March 2022, aimed at increasing the country's potential in reducing greenhouse gas emissions from clinker substitution measure by replacing Ordinary Portland Cement (OPC) with hydraulic cement-a low carbon cement, TCMA with the full support of all sectors brought Thailand into a new era of low-carbon cement.

In January 2024, it successfully transitioned the whole cement usage across the country to hydraulic cement as the primary cement of construction, of which approximately 1,000,000 tons of carbon dioxide emission can be saved.

TCMA has been recognised by the Department of Climate Change and Environment, Ministry of Natural Resources and Environment in advancing Thai cement industry contribution's to Thailand's Nationally Determined Contribution Roadmap on Mitigation, and also the Ministry of Commerce which awarded it the Trade Association Prestige Award 2024 both Excellence Association Award and Outstanding Leadership Award.

SARABURI SANDBOX LOW CARBON CITY

Launched in August 2023, 'SARABURI SANDBOX LOW CARBON CITY', is an innovative ecosystem which enables a transition towards Net Zero 2050. It shows visible progress of collective action and support in each focus areas: – Energy transition, Fostering green industry and green product, Turning waste into value, Promoting low-carbon agriculture, and Increasing green spaces.

1m tons

TCMA transitioned Thailand's whole cement usage to hydraulic cement as the primary cement of construction, of which approx. 1,000,000 tons of carbon dioxide emission can be saved.

TCMA
THAI CEMENT MANUFACTURERS ASSOCIATION

TITAN Cement Group

Above: **Roanoke cement plant, USA**

First-of-a-kind calcined clay production line in the USA for sustainable infrastructure

Titan America's Roanoke Cement Company was selected by the U.S. Department of Energy's Office of Clean Energy Demonstrations (OCED) for a $61.7 million award to deploy a first-of-its-kind calcined clay production line at its Troutville facility. The project is part of the $6.3 billion Industrial Demonstrations Program in the USA, which is managed by OCED, and is primarily focused on CO_2 reduction.

The implementation of this innovative cement technology will substantially reduce CO_2 emissions and become a model for building more sustainable infrastructure in the USA and across the Group. The technology from this project will set a new standard for building bridges, hospitals, schools, and other critical infrastructure projects.

Above: **Kamari cement plant, Greece**

IFESTOS pioneering carbon capture project towards zero carbon cement and concrete

IFESTOS, TITAN's pioneering carbon capture project and the largest of its kind in Europe, is poised to revolutionise the production of zero-carbon cement and concrete while fostering decarbonisation synergies with regional industries. IFESTOS not only seeks to propel TITAN's decarbonisation journey but also plays a pivotal role in expediting the sector's green transition, while substantially contributing to promoting carbon capture technology throughout the continent.

The project involves the construction of a cutting-edge carbon capture facility that will capture approximately 1.9 million tons of CO_2 per year, at TITAN's Kamari plant in Athens, Greece. The captured CO_2 will be shipped to and sequestered in a permanent geological storage site in the Mediterranean. As a result, TITAN will produce about 3 million t/year of zero-carbon cement to serve the growing needs for green construction in the metropolitan area of Athens and beyond. IFESTOS has received support from the EU Innovation Fund with a grant of €234 million.

The project involves the construction of a cutting-edge carbon capture facility in Athens that will capture approximately 1.9 million tons of CO_2 per year.

Above: **Pre-calciner, Kamari cement plant, Greece**

Green investment at Kamari Plant, Greece; boosts efficiency and reduces CO_2 emissions

TITAN Group has completed a €26 million green investment to upgrade the cement production line at the Kamari plant in Greece, marking a significant milestone in the Group's decarbonisation efforts. This investment involved the installation of state-of-the-art pre-calciner technology, now fully operational at the plant. The integration of this technology enables TITAN to expand its range of lower-carbon cements, addressing the growing demand from customers in Europe and the USA.

This upgrade not only enhances the plant's efficiency and competitiveness, but also underscores TITAN's commitment to reducing CO_2 emissions. With the new installation, TITAN anticipates an annual CO_2 reduction of approximately 150,000 tons while utilising nearly 200,000 tonnes of waste-derived fuels. This advancement benefits not only the Kamari plant, but also the wider Attica region, supporting comprehensive waste management, promoting recycling, and advancing the principles of the circular economy.

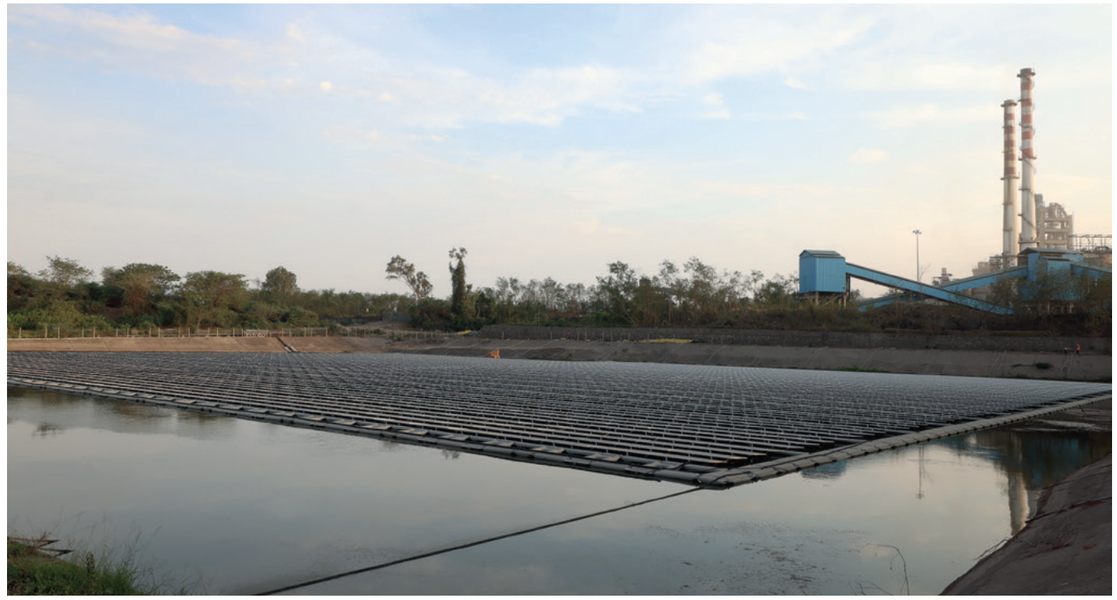
Above: **Zlatna Panega, Bulgaria**

Solar plant investment in Bulgaria advances green energy transition

TITAN's latest green energy initiative includes the inauguration of a solar plant at the TITAN Zlatna Panega cement facility in Bulgaria. This investment not only advances TITAN's Green Growth Strategy 2026, but also cements TITAN's commitment to a cleaner, more sustainable future.

The newly operational solar plant is set to supply 14% of the plant's annual power needs with clean, renewable energy. Surplus energy will be fed into the national grid, further boosting Bulgaria's transition to sustainable energy in line with the EU Green Deal. This facility is expected to reduce CO_2 emissions by approximately 3,000 tonnes each year and has the potential for future expansion. This marks TITAN's second successful solar venture following the installation at the Usje cement plant in North Macedonia in 2022.

UltraTech



Furthering Energy Transition through innovation

- Innovative approach to overcome constraints of land availability to increase renewable energy capacity
- Increase of green energy use in line with EP100 and RE100 commitments, exemplified by installation of floating solar panels on water reservoirs at Awarpur Cement Works, India
- CO_2 reduction equivalent to sequestration benefits of 270,000 mature trees

Energy transition is a key enabler of UltraTech Cement Limited's commitment to realising its Net Zero goal by 2050. UltraTech is focusing on decarbonisation of electricity by driving energy conservation across the value chain of its operations, focusing on energy efficiency improvement as well as enhancing the use of green energy in its operations.

In 2024, UltraTech Cement Limited, installed floating solar photovoltaic panels (FSPVs) in two water reservoirs of 3,600 square metre area, located in the mines area of one of its integrated manufacturing units Awarpur Cement Works in India.

The project has the potential to generate 6,173 MWh solar energy annually. This project will help to reduce ~6000 MT of CO_2 emissions annually which is equivalent to the sequestration benefits of 270,000 matured trees.

UltraTech has committed to global initiatives like EP100 and RE100. In FY 2024, UltraTech achieved its EP100 commitment way ahead of its target year of 2035, by successfully doubling its energy productivity from the base year 2010. UltraTech plans to increase the overall share of green energy in its total energy mix to 85% by 2030.

Enabling Green Mobility through sustainable transport

- Pioneering initiative focused on driving sustainable transport across operations
- Engaging with logistics partners for the replacement of conventional diesel vehicles with CNG, LNG, and Electric trucks
- Strong commitment of adding 500 electric and 1,000 CNG/LNG vehicles reflects endeavor for decarbonisation beyond manufacturing operations

UltraTech is committed to enabling sustainable transport across its operations. UltraTech has pledged to deploy 500 electric trucks and add 1,000 CNG/LNG vehicles in its operations as part of the Government of India's eFAST initiative. Towards this objective, UltraTech is engaging with its logistics partners for the deployment of CNG and LNG trucks to replace conventional diesel vehicles. UltraTech is among the first cement companies in India to introduce 'Green Logistics' in the form of CNG vehicles in 2021 and LNG vehicles in 2022. Through concerted efforts with logistic partners, the Company currently has over 420 CNG trucks and 60 LNG trucks deployed in its logistics operations.

Giving a significant boost to 'green mobility', in 2024 UltraTech introduced five electric trucks for transport of clinker from its integrated cement manufacturing unit Dhar Cement Works, located in Madhya Pradesh, to its grinding unit Dhule Cement Works, located in Maharashtra. To ensure reliable transportation, UltraTech set up three charging stations, one at each of the units and one enroute. The transportation of clinker using these five electric trucks in place of fossil-fuel based trucks will help to reduce transport emissions by about 680 MT of CO_2 annually.

680 MT

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UNACEM

Project "Debottlenecking" in Ecuador

Grupo UNACEM is a Peruvian industrial group with a diversified portfolio in the cement, concrete, and energy sectors, boasting a legacy of over 100 years and a presence in five countries: Peru, the USA, Ecuador, Chile, and Colombia.

In 2014, the group ventured into Ecuador with the acquisition of Lafarge Cementos S.A., now known as UNACEM Ecuador. Since then, it has been committed to being a leader in investment and the development of new technologies, promoting sustainable well-being and innovation in the industry.

Between August and October 2023, the "Debottlenecking" project was carried out on the clinker production line 2. This initiative allowed for an increase in the substitution of fossil fuels with alternative fuels, achieving a value of 53.76% by August 2024.

The "Debottlenecking" project reinforces our dedication to responsible industrial practices and environmental impact mitigation, positioning us as leaders in the cement industry in the adoption of sustainable technologies.

This effort not only responds to our commitment to sustainability but also directly contributes to the reduction of our greenhouse gas (GHG) emissions. These advancements are aligned with Grupo UNACEM's Roadmap and its aspiration to achieve carbon neutrality by 2050. This effort has been verified by SGS Ecuador and recognised by the Ministry of Environment, Water and Ecological Transition of Ecuador.

Debottlenecking was carried out on the clinker production Line 2 and allowed for an increase in the substitution of fossil fuels with alternative fuels, achieving a value of 53.76% by August 2024.

Private Conservation Area "Amancay Sanctuary" in Peru

For over 30 years, efforts have been underway to conserve approximately 70 hectares of hills, an ecosystem that supports a high concentration of the emblematic Amancay Flower. This flower, endemic to the hills and a symbol of Lima, blooms annually and is currently classified as vulnerable to extinction.

In 2021, our commitment to preserving this vital ecosystem was strengthened with the establishment of the Amancay Sanctuary, marking the first Private Conservation Area (ACP) in Metropolitan Lima. This expansion brings the total protected area to 787.82 hectares, comprising 70 hectares designated as the Limited Use Zone, specifically for the protection of the Amancay Flower, and 717.82 hectares as the Multiple Use Zone, where conservation-compatible activities are encouraged.

The area's zoning strategy and effective guidance of authorised routes have played a critical role in safeguarding its flora and fauna. Additionally, promoting scientific research has enhanced area management through systematic monitoring of flora and fauna. The Amancay Sanctuary is also integrated to Grupo UNACEM's sustainability strategy, which prioritises Nature-Based Solutions (NbS).

Moreover, the ACP fosters active community participation through environmental education programs, sports and recreational activities, and support for local entrepreneurship, thereby establishing a model of sustainable development.

Votorantim Cimentos

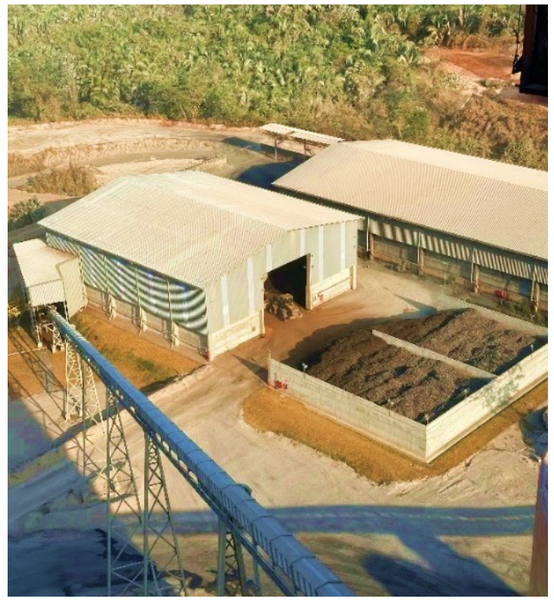
In February 2024, Votorantim Cimentos implemented a project of alternative fuels in one of its plants in Brazil, using different sources of fuels (biomass and tyres), aiming to replace almost 70% of fossil fuels utilisation. It has already achieved the target in a short period of time.

In February 2024, Votorantim Cimentos plant in Xambioá (Tocantins, Brazil) started a project that represents another important step in the company's decarbonisation journey.

The plant, that had already been operating with 34% thermal substitution rate (TSR) through the usage of charcoal into the petcoke mill, received an Alternative Fuel injection system in the calciner, enabling a TSR increase of +30%, reaching almost 65%, through the injection of tyre-derived fuel (TDF) and biomass (wood chips). This notable result, which can typically take years to achieve, demonstrates the company's commitment to the decarbonisation journey. Votorantim Cimentos' goal for this plant is to reach a TSR of 68% by 2028, but the project has already exceeded expectations in the first months of operation. Also noteworthy is the development of a low-cost CAPEX solution that helped with the feasibility of the project.

This success is attributed to the expertise of Votorantim Cimentos' team, combined with a substantial investment, solidifying the company's role as a pioneer in sustainable operations.

In Votorantim Cimentos Brazil, this important effort in TSR, combined with different process improvements and other decarbonisation levers have resulted in a significant reduction in CO_2 net emissions, which have decreased 9% in a six months period (from 493 to 449kg CO_2/ton cementitious), contributing for the company's goal to reach 475kg CO_2/ton cementitious by 2030.



Votorantim Cimentos' goal for this plant is to reach a TSR of 68% by 2028, but the project has already exceeded expectations in the first months of operation.

Optimising Total Fuel Costs: is increased thermal substitution the best strategy?

Since Votorantim Cimentos embarked on replacing fossil fuel (petcoke) with alternative fuels (AFR), the question of whether increased thermal substitution leads to optimal fuel costs has remained inconclusively answered.

Assessing AFR costs solely based on calorific value (US$/Gcal) overlooks the broader operational impacts. Alternative fuels typically exhibit higher moisture content, larger particle size, increased ash levels, and lower calorific values. These physicochemical properties often result in higher thermal and electrical consumption, sometimes coupled with reduced kiln output.

Daily variations of these properties, particularly when dealing with several types of AFR in the fuel mix, make more complex the recalculation of the ideal fuel blend. Addressing this complexity, in collaboration with a supplier, Votorantim Cimentos developed a system called AIMO (Artificial Intelligent Mix Optimiser). This innovative tool leverages the integration of machine learning with process expertise, forming a virtual twin of the kiln – an AI that is process-aware.

Currently deployed across five units in Brazil, AIMO assists operational teams in making qualified decisions for weekly planning or eventual changes in different AFR streams' delivery schedules. AIMO helps Votorantim Cimentos to focus on the best sustainable and cost-effective co-processing solution, bringing short and medium-term views to the equation, instead of just setting a target for thermal substitution.

A breakthrough developed by Engemix, Votorantim Cimentos' concrete business unit in Brazil, has been gaining ground in the building construction market.

Spectra, a single concrete mix design that can be applied to the whole structure of the construction, has been simplifying the pouring process. Designed specifically for real estate high rising buildings, Spectra is a high resistance and high flow rate concrete, with high modulus of elasticity and durability. It can replace a group of mix designs normally used in a venture, also bringing an increment to the structure's lifespan. When compared to the carbon emissions of a conventional concrete structure, Spectra may reduce up to 20% the carbon footprint, besides granting a reduction of 3% to 4% on the structures total cost.

Spectra also assures a more robust structure, due to its high modulus of elasticity, which raises the structure's lifespan. In addition, it also has higher resistance and lower porosity. Studies show that Spectra, when compared to conventional concretes, is up to 25% more durable, in average, for an urban environment, which can grant a raise of approximately 20 years in the project's lifespan. For a specific project, the use of Spectra allows the reduction of the dimensions of certain structural elements and, therefore, may lead to a reduction in the volume of the structure's concrete of up to 6%, aside from a reduction in the structure's steel consumption of about 8%, when compared to conventional concretes.

With the objective of raising the productivity and reducing costs, in 2021 one of the main building companies in Brazil used Spectra in the "SOFI" building construction, a 36-storey venture located in the Campo Belo district, in São Paulo. The building has a total area of 35,431 square metres and used 10 thousand cubic meters of concrete. The use of Spectra allowed to reduce the concrete consumption, steel, formwork and workforce, besides of the sustainability benefits, like the reduction of water and carbon emissions. In 2021, Engemix was recognised by Tegra as the best supplier in the sustainability category, due to the benefits that the Spectra concrete brought to the construction.

In June 2024, Votorantim Cimentos launched the first carbon capture pilot in a cement plant in Spain, using Hot Potassium Carbonate technology, aiming to deepen our know how and to optimise the process for future full-scale decarbonisation efforts.

In June 2024, the Votorantim Cimentos cement plant in Alconera (Badajoz, Spain) commissioned the first Carbon Capture pilot installed in a cement plant in Spain.

This pilot consists of a containerised unit using Hot Potassium Carbonate (HPC) technology to capture CO_2 from the gases emitted through the stack.

This technology involves mixing an alkaline solution of potassium carbonate with the flue gases. Through a chemical reaction with the salt, the solution selectively absorbs CO_2. Once fully scaled this technology will allow to reduce the CO_2 emissions of the cement plant by up to 95%.

The data generated from this pilot will provide invaluable insights to understanding the technology, the potential impacts of the flue gas composition under different operating conditions on the CO_2 absorption rate and potential modifications required in the clinker line to optimise the efficiency of the process when the scaling up the technology.

With the installation of this pilot, Votorantim Cimentos is aiming to increase their understanding of the impact and the challenges of operating a full-scale carbon capture plant to increase their readiness on decarbonising the cement production to reach Net Zero.

95%

Once fully scaled the Hot Potassium Carbonate technology will reduce the CO_2 emissions of the cement plant by up to 95%.

Prairie Materials, which is part of Votorantim Cimentos North America, partnered with Concrete.AI in 2021 to pursue sustainable concrete development based on machine learning AI systems. This system processes concrete performance data to quickly recommend optimisations for current mix designs to reduce carbon emissions but maintain historic performance attributes, allowing the creation of a sustainability-focused mix designs brand named Prairie+.

To capture a developing market within the Illinois (USA) concrete construction industry, Prairie Materials partnered with the supplier of a machine learning platform to rapidly optimise concrete products to achieve customer sustainability targets. After six months of development, including analysis of raw materials, historical performance of available concrete products, and creation of an optimisation platform, Prairie Materials began using Concrete.AI to develop new mixes.

Prairie Materials launched a branded line of sustainability-focused products named Prairie+ in tandem with creating new products utilising this platform.

Since 2021, Prairie Materials, which is part of Votorantim Cimentos North America, has expanded its usage of the AI platform to over 12 production locations comprising most of its annual concrete production capacity. Pilot projects, including light commercial and industrial warehousing projects, have used over 115,000 cubic yards of these AI-supported mix designs. The Prologis Cicero 3 project required 13,700 cubic yards of sustainability-focused concrete products. These products achieved an 18.7% reduction in GWP (Global Warming Potential) compared to historic products while eliminating 721 tons of CO_2 emissions. The CO_2 reduction, paired with increased performance across all major metrics, convinced the developer to switch future projects within the Illinois market to AI-supported concrete products.