Strengthening Sustainability

in the Cement Industry

Revised 2025

IFC International Finance Corporation
WORLD BANK GROUP
Creating Markets, Creating Opportunities

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IFC—a member of the World Bank Group—is the largest global development institution focused on the private sector in emerging markets. We work in more than 100 countries, using our capital, expertise, and influence to create markets and opportunities in developing countries. In fiscal year 2024, IFC committed a record $56 billion to private companies and financial institutions in developing countries, leveraging private sector solutions and mobilizing private capital to create a world free of poverty on a livable planet.

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Overview

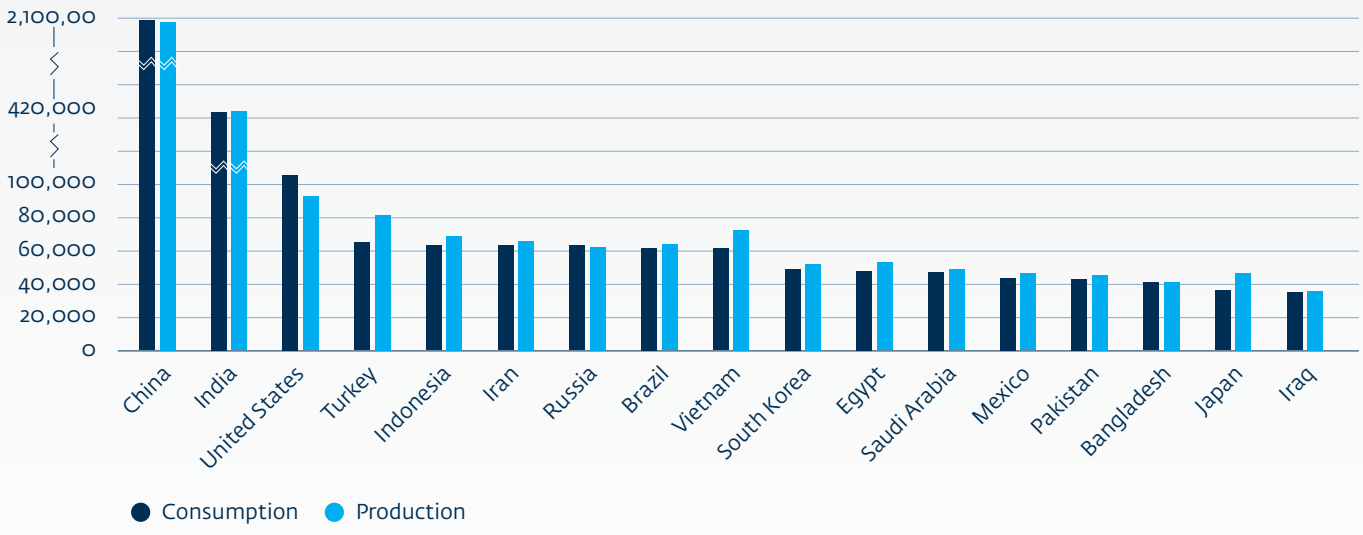
Concrete is the second-most-consumed substance on Earth after water, with 900 billion tons produced since the Industrial Revolution. The material literally holds the world together. Concrete and its binding agent, cement, are a key ingredient in the roads, buildings, and infrastructure that are essential for economies and societies to thrive and advance. The industry is also a major emitter of greenhouse gases (GHG) that are contributing to extreme weather conditions. Reducing the industry's CO_2 emissions while producing enough cement to meet demand is a complex and necessary challenge for supporting economic growth and meeting the infrastructure demands of the rising global population.

Cement industry emissions have remained stubbornly high, with process emissions at 50%–60%.[1] Since 2010, cement production has jumped by 25%.[2] Today, 4 billion metric tons are manufactured every year, generating about 7% of the world's total GHG emissions.[3] While modern technologies have reduced the industry's energy and emissions intensity, new plants continue to be commissioned, increasing total global production—and emissions. To achieve its goal of net zero emissions by 2050,[4] the industry will have to utilize more sustainable clinker substitutes; replace fossil fuels with low-carbon alternative fuels; improve thermal and electric energy efficiency and increase the use of renewable energy; optimize kiln operations and production processes; and develop and deploy new technologies. It will have to capture any remaining GHG emissions that cannot be avoided in the production process.

This path underscores the challenges facing high-emissions industries as they try to reduce their carbon footprint. Decarbonization of the cement industry will require transformation across the whole supply chain and unprecedented cooperation across sectors and borders, and between the developed and developing world. It will require changes in government policy and in the behavior of end users, as well as the support of banking institutions like the International Finance Corporation (IFC), which provides financing that incentivizes companies to change.

World's Top Cement Consumers and Producers, by Country (2023)

in metric tons



Note: 2023 numbers for top 20 countries are based on International Cement Review forecasts.

Source: CemNet.com n.d.

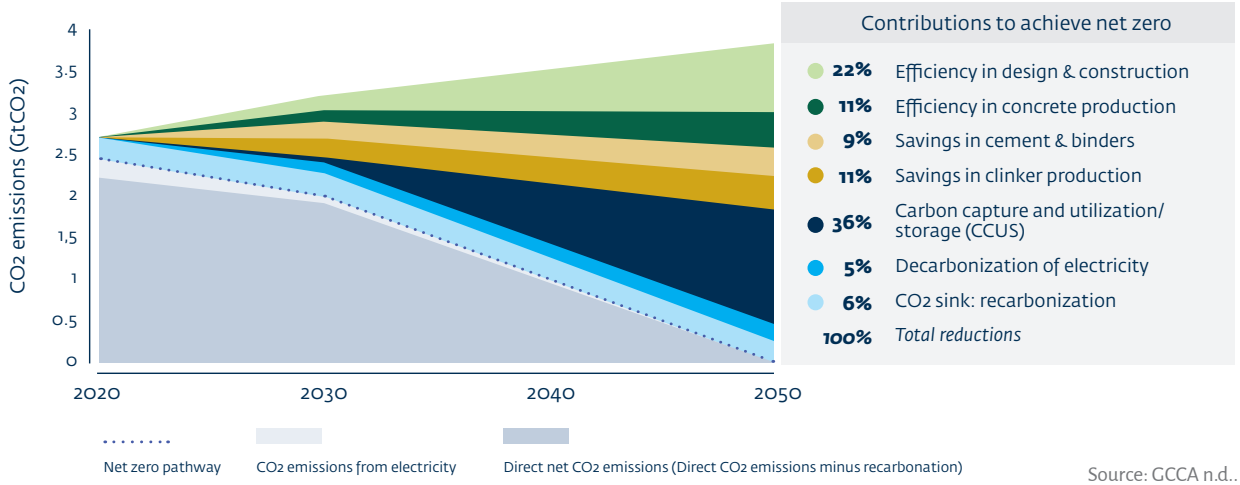
Sustainability

New technologies aimed at improving the sustainability of cement production are showing promise but many remain in early stages and will need years of development. Much attention has focused on carbon capture, utilization, and storage (CCUS), which can cut the volume of CO_2 released into the atmosphere. However, the technology is not yet fully commercially viable. Change depends on support incentives such as grants and tax breaks, and on the economics of sequestering carbon. Large industry players in Europe are working on implementing CCUS demonstration projects in partnership with technology providers. Among them, Germany's Heidelberg Materials has launched roughly a dozen such projects.[5] Its most advanced, Brevik CCS—part of a Norwegian government program to demonstrate capture, transport, and safe storage of CO_2 from industrial sources—is poised to bring "the world's first CCS [carbon capture and storage] cement to the market," said Vetle Houg, CEO of Heidelberg Materials Sement Norway.[6] The Brevik project is slated to start producing and supplying the net-zero cement, dubbed evoZero, this year.[7] Meanwhile, Swiss-based Holcim's CCUS Carbon2Business project in Lagerdorf, Germany, aims to capture more than 1.2 million tons of CO_2 annually and convert it to e-methanol and to make the facility net zero by 2029.[8]

Other emission-reduction initiatives under development—such as switching to electric kilns, and a new manufacturing process that sources lime from calcium silicate rocks instead of limestone—are getting closer to becoming commercially viable manufacturing options.[9]

Major industry associations have committed to addressing sustainability. The World Cement Association issued a statement in support of accelerating changes in the industry to achieve full decarbonization through technical development and other measures.[10] CEMBUREAU, which represents the European cement industry, recently raised its goals for reducing gross CO_2 emissions, targeting a 37% decrease for cement and a 50% reduction down the value chain by 2030.[11] And the Global Cement and Concrete Association (GCCA) has issued a set of sustainability guidelines and an ambitious roadmap for the industry to reduce emissions by 25% in the concrete manufacturing value chain by 2030 and to reach net zero carbon by 2050.[12]

Getting to Net Zero: GCCA Roadmap



Source: GCCA n.d..

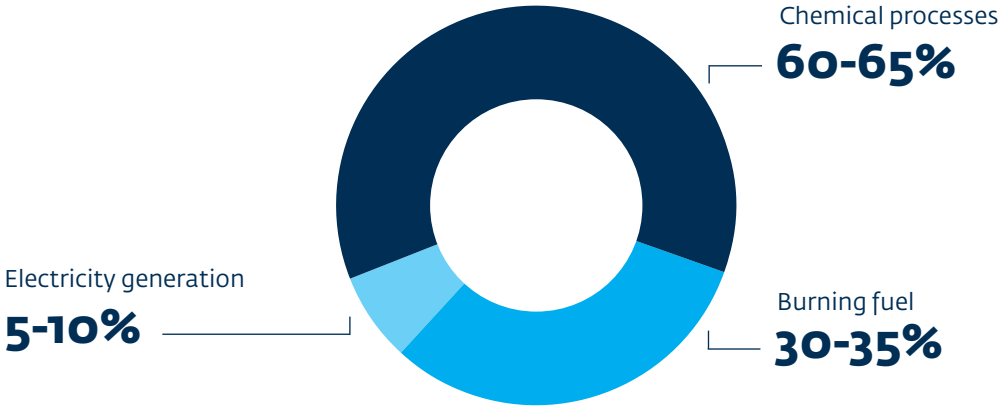
IFC welcomes these goals and roadmaps and is keen to work with cement companies in developing markets to advance their decarbonization plans in ways that are technically feasible, socially acceptable, and financially and environmentally sustainable.

Challenges & Opportunities

Today, about 60%–65% of the emissions generated from making cement comes from chemical processes and about 30%–35% from burning fuel, with the remaining 5%–10% from electricity generation. Almost all of these emissions derive from the production of clinker—gray, rock-like balls made by fusing limestone and clay and which are then ground into cement. Because clinker production requires extremely high flame temperatures of about 2,000°C, fossil fuels like coal and petroleum products are often still the cheapest, and sometimes the only, available options.

The International Energy Agency (IEA) says that to cut carbon emissions in cement production, the industry has to improve its energy efficiency, switch to lower-carbon fuels, advance innovative, near-zero-emissions production, and promote material efficiency, reducing the ratio of clinker to cement as well as total demand.[13] The industry will need to cut emissions by 4% a year through 2030 to get on track to achieve net-zero emissions by 2050, IEA says.[14]

CO_2 Emissions of Cement Production



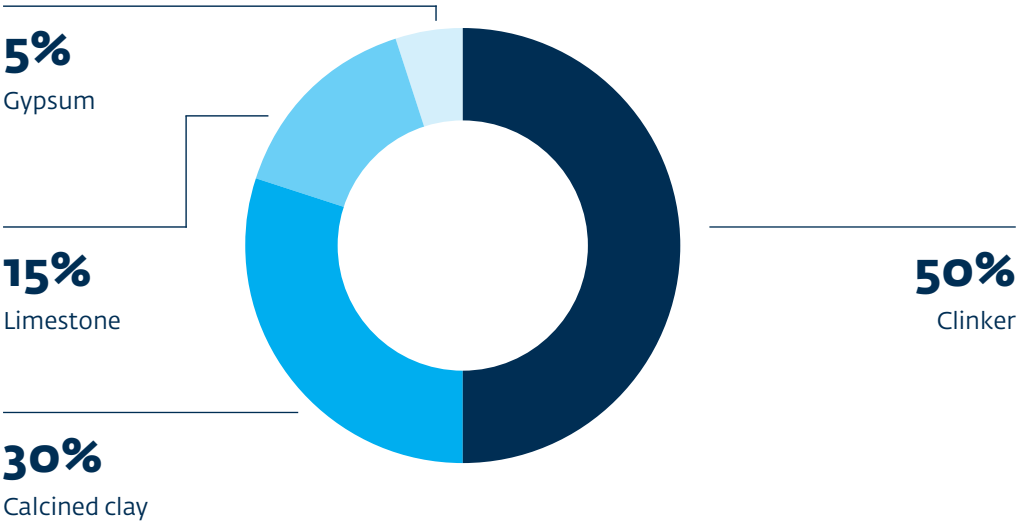
Source: GCCA

Product design

Support and promote the use and production of blended cements. Blended cement reduces the clinker-to-cement ratio by substituting clinker with limestone or industrial by-products, such as fly ash from power generation plants and blast furnace slag from steel plants. Natural carbon-free fillers such as pozzolan offer another alternative to clinker. Another replacement option is calcined clay, which requires energy to be produced, albeit less than that needed for clinker. LC3 cement, which is blended from limestone, clinker, and calcined clay, can reduce carbon emissions in the production process by up to 40% compared to ordinary Portland cement (OPC), for example. One challenge is the limited availability of materials such as blast-furnace slag and fly ash, which are expected to see quantity declines as industries decarbonize.

Perhaps the biggest hurdle is getting regulators and customers to accept new products. Good examples can be drawn from countries such as Germany, which has demonstrated that reducing the clinker ratio doesn't affect the structural integrity of the built environment using blended cement.

LC3: A New Type of Cement



Source: LC3-Project 2021.

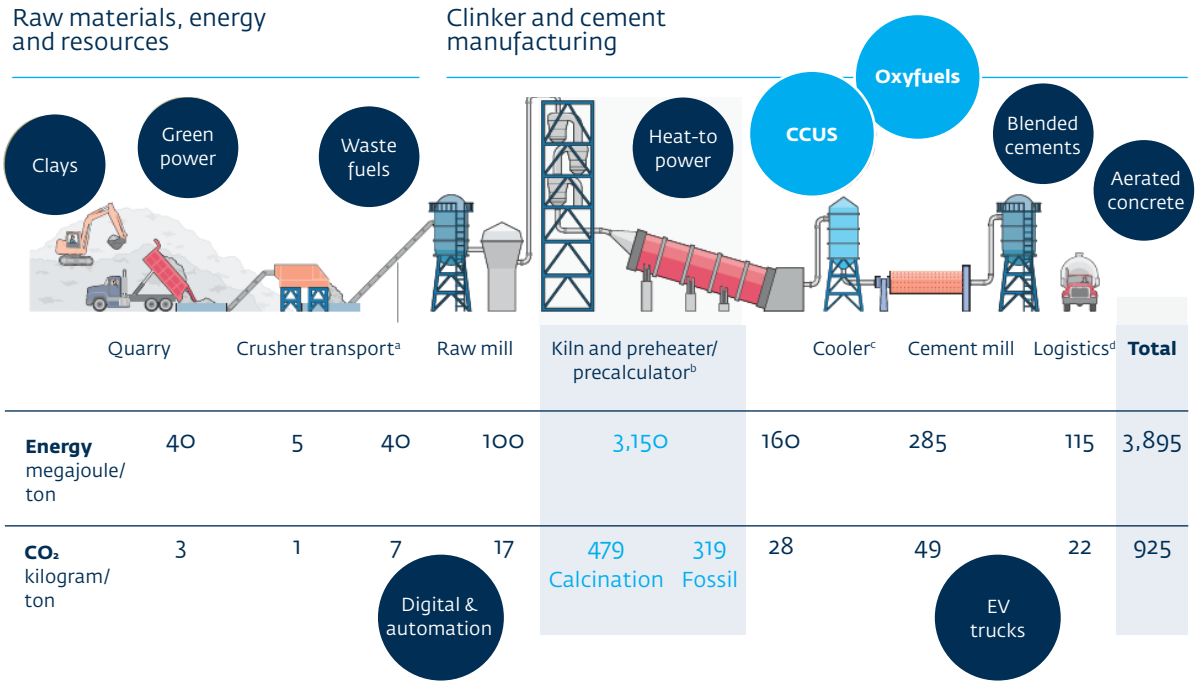
Manufacturing process

Increase use of alternative fuels to heat kilns. Alternative fuels only supply a small amount of total thermal energy used in cement production globally, but they offer strong potential. Use of alternative fuels can reduce cement emissions while tackling disposal of waste and by-products from other industries, whether municipal solid waste; industrial, nonhazardous waste; biomass; or solid and liquid waste. Adoption requires investments in technology and equipment to turn such waste into sustainable fuel sources—for example, producing refuse derived fuel (RDF) or solid recovered fuel (SRF) from municipal solid waste—and to incorporate it into the manufacturing process. The long-term viability of using green hydrogen in the cement production process at scale should also be explored.

Improve energy efficiency and decarbonize electrical energy. Ways to boost energy efficiency include integrating waste heat recovery systems, which can generate up to 30% of plants' power needs, and investing in state-of-the-art equipment, such as vertical roller mills, multistage preheaters with inline calciner, and high-efficiency coolers that can reduce kiln thermal heat requirements. Companies should increase their use of clean electrical energy, whether by developing on-site, renewable power generation from solar, wind, or integration with battery systems, or buying clean energy through power purchase agreements (PPAs).

Leverage digitalization and AI technologies to accelerate sustainability. AI can optimize the operation of kilns, mills, and grinders—the most energy-intensive aspects of the manufacturing process—by adjusting kiln temperatures and other operating parameters based on the load, raw material type, and other factors to generate energy savings and reduce emissions. AI can also facilitate the integration of less carbon-intensive energy sources into the production process; monitor the condition of production equipment for predictive maintenance to extend equipment lifespan; and improve quality control of the cement being produced to reduce waste.[15]

Opportunities for Transforming the Cement Production Process



	Quarry	Crusher transport[a]		Raw mill	Kiln and preheater/ precalculator[b]		Cooler[c]	Cement mill	Logistics[d]	**Total**
Energy megajoule/ ton	40	5	40	100	3,150		160	285	115	3,895
CO_2 kilogram/ ton	3	1	7	17	479 Calcination	319 Fossil	28	49	22	925

[a] Assumed with 1kWh/t/100m.
[b] Assumed global average, data from the Global Cement and Concrete Association, Getting the Numbers Right 2017.
[c] Assumed reciprocating grate cooler with 5kWh/t clinker.
[d] Assumed lorry transportation for average 200km.

Source: Czigler et al. 2020.

Value Chain

Enable a truly circular value chain. Building materials account for half of the solid waste generated every year worldwide—an amount that is expected to reach 2.2 billion tons per year globally this year[16] and 3.8 billion metric tonnes (4.2 billion tons) by 2050.[17] One way to reduce the amount of waste is to introduce new materials that can be more easily deconstructed and reused. Using carbon calculators such as EC3, developed by the Carbon Leadership Forum, can help building-industry stakeholders assess and compare embodied carbon emissions of construction materials and make more informed materials decisions. ISO's Environmental Product Declarations (EPDs)—which show specific carbon intensity of end-products, including cement—are having a major offtake in the market. Growing numbers of real estate developers and construction companies are requesting EPDs from cement distributors and manufacturers, stimulating decarbonization action.

Support carbon-cured concrete and recarbonation technologies. Cement products naturally absorb CO_2 from the atmosphere in a process called recarbonation. Several companies are developing technologies to accelerate recarbonation by injecting captured CO_2 into fresh concrete to make carbon-cured concrete. Captured CO_2 can also be used to accelerate the recarbonation of crushed demolition concrete into improved recycled aggregates.

Policy

Establish a policy framework to achieve net zero concrete. Many of the solutions listed above will require major investments in infrastructure, alternative energy sources, and new technologies, including for CCUS. Cement producers have been reluctant to adopt these approaches on a broad scale without economic motivation or assurance of their

commercial feasibility. For example, CO_2 pricing is nonexistent in most geographies or prices are too low to pressure cement makers to upgrade their facilities. Virgin concrete generally remains cheaper than recycled concrete.

More countries are introducing carbon pricing and carbon markets, however. The World Bank reported that carbon pricing revenues in 2023 reached a record $104 billion, and that 75 carbon pricing instruments were in operation around the world.[18] Starting in 2026, the EU's carbon border levy, or Cross Border Adjustment Mechanism (CBAM), will begin to impose costs on importers of cement and select other materials that include embedded CO_2—a move that could encourage producers to shift to more sustainable manufacturing.

Some cement projects are benefiting from carbon prices under bilateral agreements between countries that allow for trading in carbon credits. These prices tend to be higher than prices they could secure in voluntary carbon markets, which allow companies and others to buy and sell carbon credits to offset their emissions and which offer a fixed price over a project's lifetime. Governments of developed countries, such as Switzerland, Norway, Japan, and Singapore, have been expanding their bilateral agreements with emerging markets to trade in carbon credits as a way to achieve emission-reduction targets set out in their Nationally Determined Contributions (NDCs). Several dozen such agreements have been enacted up to now.[19]

Governments can use a carrot-and-stick approach by providing subsidies, policy support, and regulation. The introduction of carbon pricing mechanisms would help to create a level playing field in terms of carbon costs and to prevent carbon leakage. The establishment of a competitive secondary-materials market with environmental taxes would create demand for waste material, while directives aimed at diverting waste from landfill—including, ideally, the institution of a gate fee—would improve access to residual waste streams. Other ways that government could help are by:

1

Introducing construction regulations and standards and public procurement guidelines to promote sustainable buildings and the use of low-carbon cements

2

Supporting research and development for CCUS and other innovative technologies, and the construction of infrastructure to transport and store captured CO_2

IFC Role

Besides promoting economic development and improving people's lives, IFC works with clients to help them strengthen the sustainability of their operations. This means guiding companies to make investments that generate lower carbon emissions or that can help to reduce emissions. It also means helping clients prepare for and adapt to more extreme weather events and identifying business opportunities for transitioning to a low-carbon future.

IFC has a long track record of investing in the cement industry, with more than $7 billion in committed financing in more than 300 projects in emerging markets. IFC seeks to support industry players and provide them with long-term financing, advisory services, and project development capital to scale the implementation of best-available technologies and reduce the industry's carbon footprint in developing countries. IFC has developed a Cement Decarbonization Tool to help companies in emerging markets to develop or enhance their decarbonization strategies and implementation plans.

IFC Cement Investments

Sococim Industries

IFC in 2023 arranged a:

€242 million

financing package to enable Senegal's largest integrated cement manufacturer to replace part of its current clinker lines with a new fuel-efficient one. The new system will:

Utilize up to **70%** of alternative fuels

Help reduce emissions by:

312,000 tons

of CO_2 equivalent per year by 2030[a]

Boost energy efficiency

Create jobs

The investment will enable Sococim to produce cement with very low emission rates by today's standards.[b]

In December 2024, IFC announced a follow-on, **€75 million loan** to Sococim to further support this modernization project.

Votorantim Cimentos

IFC in 2023 announced that it was providing a sustainability-linked loan to the Brazilian cement maker aimed at helping its Salto de Pirapora plant **increase its use of alternative fuels.**[c]

This project will **double** the plant's capacity to use alternative fuel, including biomass, wood chips, used tires, and refuse-derived fuel, from the current level of **30%.**

The

$150 million investment

supports the company's goal to reduce greenhouse gas emissions by fostering the use of alternative fuels.

The project will contribute to Votorantim Cimentos's decarbonization efforts, which were approved by the Science Based Targets initiative (SBTi) to be at 475 kg of CO_2 per ton of cement by 2030.

a. IFC 2023a.
b. Ibid.
c. IFC 2023b.

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Endnotes

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2 IEA 2020.
3 World Steel Association n.d.
4 Ibid.
5 Heidelberg Materials n.d.(b).
6 Heidelberg Materials 2025.
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