8

Cement industry net-zero tracker

The industry must prioritize supplementary cementitious materials, efficiency strategies and bioenergy now, while advancing CCUS, electrification and fuel shifts for long-term reductions.

- The emission intensity has remained relatively stable over the past five years, largely due to slow adoption of supplementary cementitious materials (SCMs). However, large industrial-scale projects are in the pipeline, and there is momentum across the entire sector to cut emissions.
- CCUS and material-efficiency strategies are expected to reduce around 75% of the cement sector's emissions. However, significant investments are needed to scale them effectively.

2%

Decrease in absolute CO_2 emissions (2022-2023)

0.2%

Decrease in emission intensity (2022-2023)

2%

Decrease in demand (2022-2023)

CEMENT

Key performance data 2023 [328,329,330,331]

6%

Contribution to global CO_2e emissions

2.4 Gt CO_2e

Scope 1 and 2 emissions

4%

Emissions decrease (2019-2023)

0.58 tCO_2e/t

Emissions intensity

~0%

Change in emission intensity (2018-2022)

6%

Reduction in expected demand in NZE scenario by 2050, compared to 2023

<1%

Current low-emission clinker production

$1.42 trillion

Additional investment required for net zero by 2050

Performance summary

– The emission intensity has been relatively stable[332] for the last five years, primarily due to the slow adoption of supplementary cementitious materials (SCMs).

– The cement industry's absolute emissions have seen a 4%[333] decline in from 2019 to 2023, driven by a 3%[334] decline in demand for cement.

– Low-emission clinker production accounted for less than 1%[335] of total production worldwide in 2022. The share of low-emissions fuel in thermal energy use currently accounts for only 5%[336] of total production.

– The energy mix for cement consisted of 77% coal and petroleum coke, 15% natural gas, 4% non-renewable waste and 4% renewable waste.[337]

– Current infrastructure stands at less than 1%[338] for CCUS, clean power and hydrogen of the required infrastructure capacity by 2050 for net-zero emissions.

Future emissions trajectory

– The industry is forecast to reduce emissions intensity by 22%[339] by 2030 compared to 2023 levels (according to the IEA's Net Zero Scenario), and absolute CO_2e emissions are expected to be 1.91 Gt[340] in 2030.

– A total of 61%[341] of publicly traded companies in the cement industry consider climate change in their operational decision-making processes.

Readiness key takeaways

Technology	2	⊖	– CCUS, the major decarbonization lever, is still in the prototype stage (TRL 6).[342] – Material-recycling technologies are in the demonstration stage (TRL 7) and electrification and hydrogen are at the prototype stage (TRL 5).[343]
Infrastructure	1	↓	– CCUS infrastructure capacity required by 2050 is between 1.2-1.6 Gt[344] of CO_2 per year, with less than 1% currently available for the production of low-carbon cement. – By 2050, 624 GW of clean power and 6 Mt of hydrogen infrastructure is required.[345] Limited progress in incorporating hydrogen, clean power and CCUS led to a decline in score this year.
Demand	2	⊖	– The share of current near-zero emissions clinker production for cement is less than 1%.[346] – The green premium is estimated at 50-70% for B2B and 1.5-3% for B2C.[347]
Capital	2	↑	– Over $51 billion[348] in additional annual investments are required by 2050 by the cement sector, mainly for the installation of CCUS equipment. – Currently, the cement sector has an annual CapEx of $147 billion.[349] – The score increased from last year, as current capital levels increased, leading to an additional 35% of annual CapEx needed, compared to 71% previously.[350]
Policy	3	⊖	– The policies focus on reducing emissions through carbon pricing mechanisms and energy efficiency improvements. Several governments are also introducing roadmaps to guide the industry towards cleaner practices.

Sector priorities

Company-led solutions

Mid-term (by 2030)

- Use SCMs and low-carbon fuels to replace traditional fossil fuels in kilns.
- Enhance production processes and promote resource-efficient manufacturing and material efficiency.

Long-term (by 2050)

- Upgrade equipment and processes to improve energy efficiency.
- Implement CCUS systems at kiln facilities to capture CO_2 emissions.

Ecosystem-enabled solutions

Mid-term

- Build supply chains of SCMs and low-carbon fuel and facilitate their adoption.

Long-term

- Invest in the development of infrastructure for clean hydrogen and CCUS.
- Invest in material recycling technologies.

Performance

Currently, the cement industry accounts for approximately 6%[351] of global CO_2e emissions, primarily due to the energy-intensive process of clinker production. Fossil fuels account for over 95%[352] of thermal energy use in the industry, making them a critical driver for emission intensity. The primary challenge for the cement industry is balancing the reduction of CO_2 emissions with meeting rising global demand.

TABLE 12

Cement industry performance

Performance metric	Change (2019-2023)
Industry output	-3.4%[353]
Emission intensity (tCO_2/t cement)	~0%[354]
Total CO_2e emissions	-4%[355]

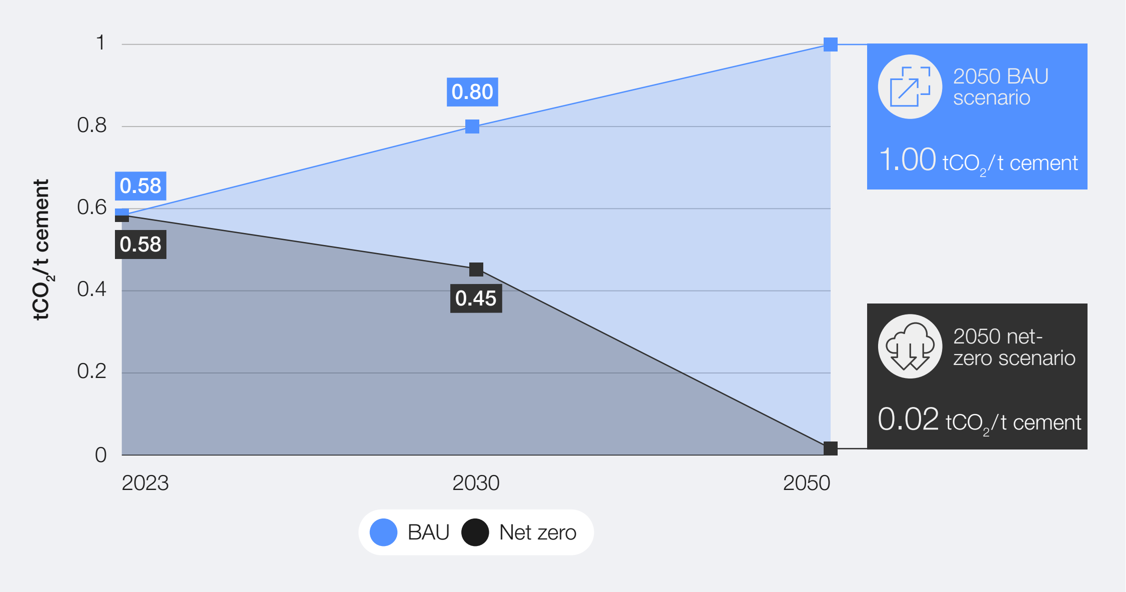
Low-emission clinker production accounted for less than 1%[356] of global production in 2022, while low-emission fuels comprised only 5%[357] of the total thermal energy used in cement production. The energy mix remains heavily reliant on carbon-intensive sources, with 77% coming from coal and petroleum coke, 15% from natural gas and just 4% from both non-renewable and renewable waste.[358] Additionally, the current infrastructure for critical decarbonization technologies such as CCUS, clean power and hydrogen sits at less than 1%[359] of the capacity needed by 2050 to meet net-zero emissions targets.

Key initiatives in the cement sector (including the adoption of circular-economy principles, enhancement of energy efficiency and exploration of alternative materials such as low-carbon clinker substitutes) are essential to achieving long-term emissions reductions. Innovations such as CCUS and the development of novel materials like geopolymer cement offer potential pathways to lower emissions. Companies like Holcim[360] (a global leader in innovative and sustainable building solutions) are investing in companies like Sublime Systems (a leading low-carbon cement technology startup) to help scale up their low-carbon cement technology. Many cement companies are integrating CCUS technologies – for instance, projects like Norcem[361] in Norway and CEMEX and Carbon Clean project[362] aim to implement carbon capture at scale.

Readiness

FIGURE 47

Emissions intensity trajectory for the cement sector

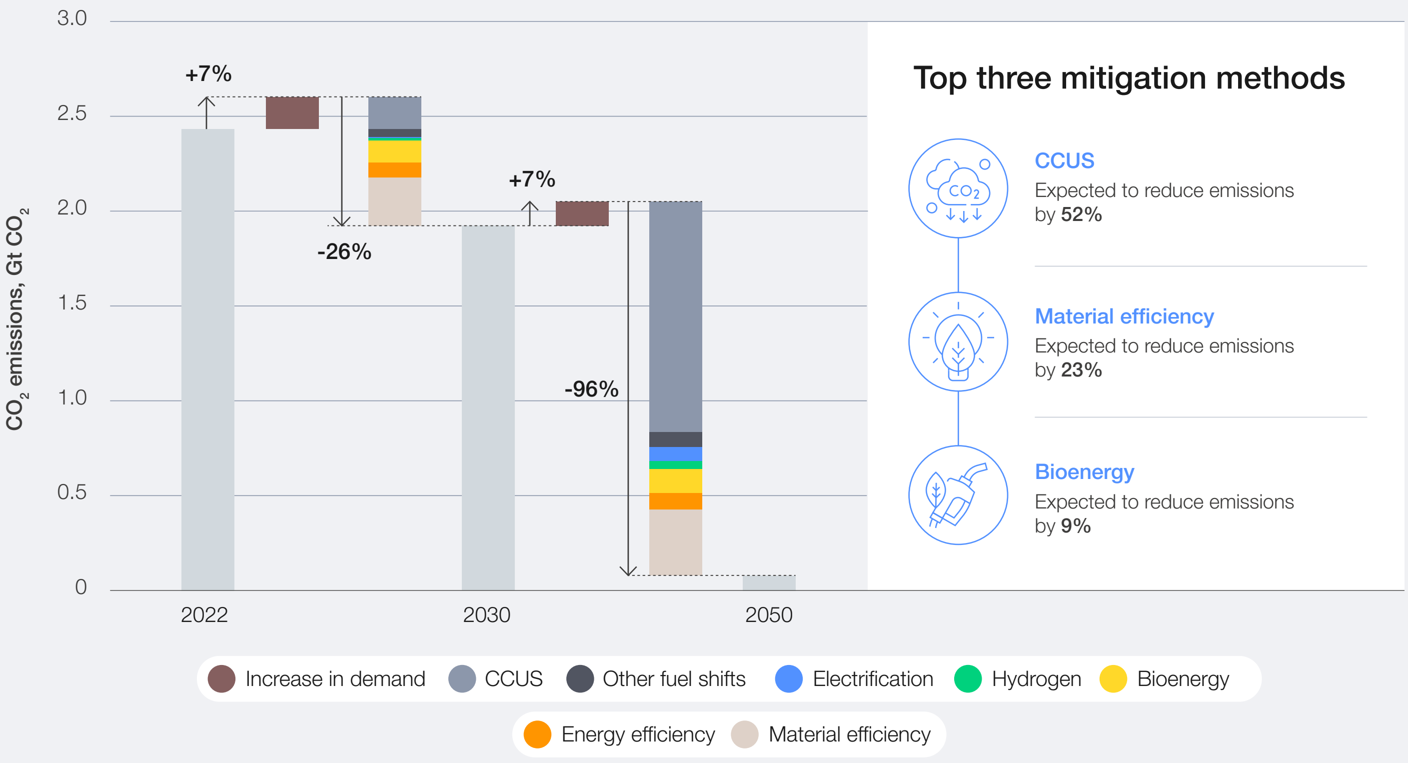


Source: IEA Net Zero Scenario.

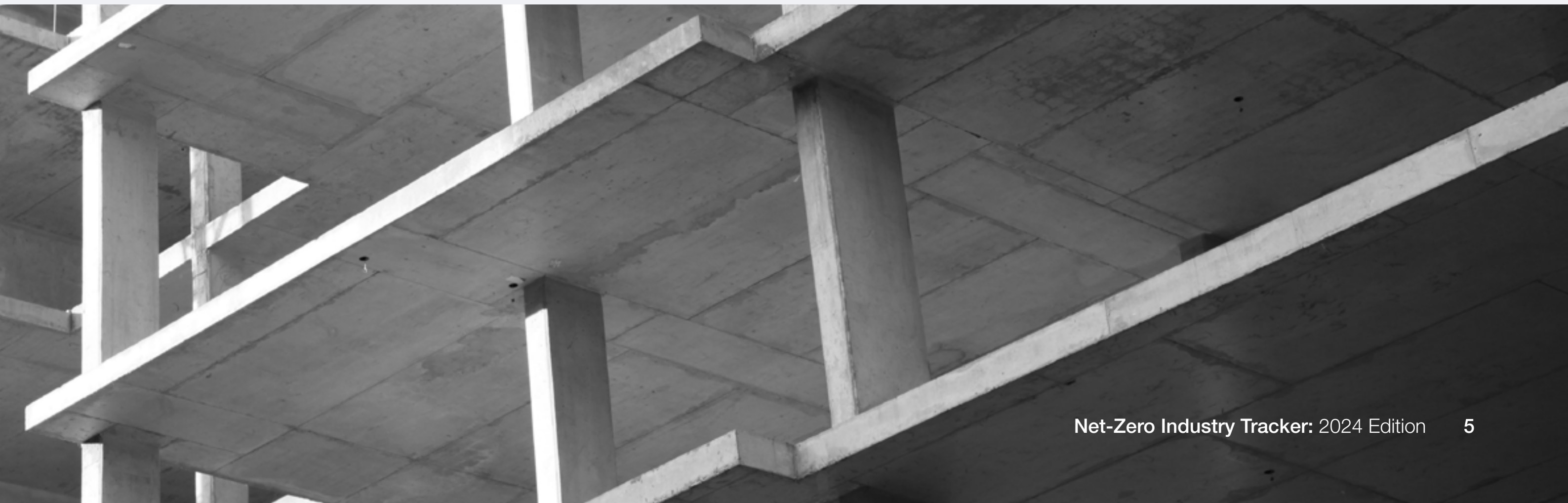
The cement sector faces significant challenges in decarbonization, with key technologies still in early stages. CCUS, a major decarbonization tool, remains in the prototype stage (TRL 6),[363] while material recycling is at TRL 7[364] and electrification and hydrogen solutions are in the prototype phase (TRL 5).[365] By 2050, the sector will need infrastructure capable of capturing 1.2-1.6 Gt[366] of CO_2 annually, but current capacity is less than 1%.[367] Additionally, 624 GW of clean power and 6 Mt of hydrogen infrastructure will be required.[368] Green premiums are high, with a 50-70% premium for CCUS cement sold to concrete producers and 1.5-3% for end consumer such as homeowners.[369] Policy efforts focus on carbon pricing and energy efficiency, while roadmaps guide cleaner practices. The industry needs over $51 billion[370] in additional annual investments by 2050 (primarily for CCUS), though the current CapEx of $147 billion has improved, with only 35% now needed for these investments (down from 71% previously).[371] Overall cement demand is expected to reduce by 5%[372] by 2050, whereas demand share will increase in regions that encounter difficulties in decarbonizing cement.

To achieve net-zero emissions by 2050, the cement sector must adopt a multi-faceted approach to emissions reduction. Key drivers include improving material efficiency, enhancing energy efficiency and shifting towards cleaner fuels such as bioenergy, hydrogen and electrification. The two most critical levers for significant emissions reduction are the adoption of CCUS and the use of SCMs. CCUS has the potential to capture the vast CO_2 emissions from cement production, which is particularly crucial for this energy-intensive industry. SCMs, on the other hand, can reduce the reliance on clinker (the most carbon-intensive component of cement) by incorporating lower-carbon alternatives. Together, these technologies, supported by other fuel shifts and efficiency improvements, will be essential to driving deep decarbonization in the cement sector.

FIGURE 48 **Decarbonization levers and top mitigation methods (NZE Scenario)**



Source: Accenture analysis based on data from IEA.



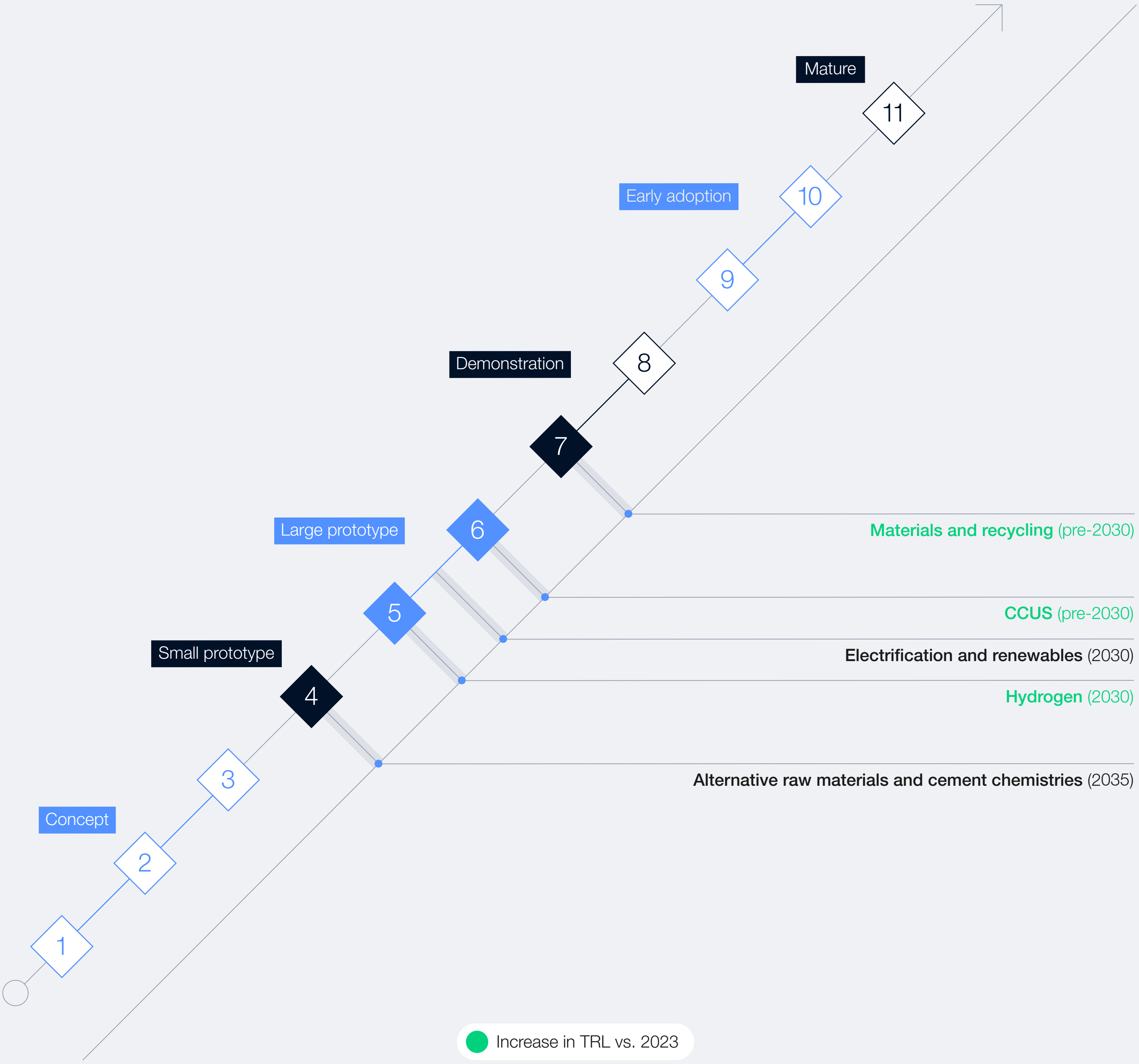
2

CEMENT

Technology

Technologies to implement the decarbonization levers are at different readiness levels. Three leading pathways have emerged: CCUS, SCMs and bioenergy.

FIGURE 49 **Decarbonization TRLs and year of commercial availability**



Source: Accenture analysis based on data from IEA ETP Clean Energy Technology Guide.

Technology pathway 1: CCUS

The calcination process in cement production, responsible for 60-65% of its CO_2 emissions, is an unavoidable chemical reaction, making CCUS essential to capture these emissions at the source. In the cement industry, CCUS is progressing through varying stages of maturity, with post-combustion capture technologies being the closest to commercialization (TRL 7-8).[373] These technologies (e.g. amine-based solvents) have been demonstrated at pilot and large-scale levels, though challenges remain in cost and scalability. Oxy-fuel combustion (TRL 6-7) and direct separation technologies (TRL 4-6) are still under development, while CO_2 utilization pathways (TRL 3-7) are progressing, particularly in concrete curing.[374] Sequestration, already commercially viable (TRL 8-9), provides an immediate storage solution. However, broad adoption will depend on overcoming technical, financial and regulatory challenges.[375] Furthermore, recarbonation in cement allows concrete to absorb 5-10% of the CO_2 emitted during production, and an additional 5-10% may be taken up during the secondary or recycled lifetime, offering a modest reduction in the material's overall carbon footprint.[376]

Technology pathway 2: SCMs and material efficiency

Material efficiency and SCMs in the cement industry focus on reducing the amount of clinker (the primary source of CO_2 emissions) by using alternative materials like fly ash, slag and natural pozzolans. These technologies are relatively mature, with SCMs having a high TRL (TRL 7-9),[377] and are already commercially available in many markets. Material efficiency strategies, such as optimizing mix designs and improving process efficiency, are also well-established (TRL 7-9).[378] While SCM technologies are commercially viable, their broader adoption is constrained by limited availability of high-quality SCMs, especially as demand increases, and the need for standardized performance testing.

Technology pathway 3: Bioenergy and renewables

Bioenergy and renewable energy technology in the cement industry focuses on integrating sustainable energy sources, such as biomass and waste-derived fuels, to reduce fossil-fuel consumption and lower carbon emissions. The TRL for these solutions is generally around TRL 5-6,[379] indicating that while the technologies are in the development and testing phases, they are not yet widely commercially available. Biomass co-firing and the use of waste fuels are being piloted in some cement plants, demonstrating their feasibility but requiring further validation and optimization for broader application. Similarly, integrating renewable energy sources like solar and wind power is still in the early stages, with limited deployment and ongoing research to assess their full potential for cement manufacturing.

1

CEMENT

Infrastructure

To achieve net-zero emissions in the cement industry by 2050, a comprehensive overhaul of existing infrastructure is essential. This overhaul must focus on CCUS, material and energy efficiency, and bioenergy development. The current CCUS infrastructure available to cement industry is less than 1%[380] of infrastructure capacity required for net zero by 2050. The implementation of large-scale CCUS is critical. This involves capturing CO_2 emissions from cement plants and either using them in other processes or storing them underground. By 2050, a pan-European CO_2 transport and storage network[381] will be necessary to facilitate this process. Norway's Brevik[382] project is a notable example of how CCUS can be integrated into cement production.

The thermal energy intensity of clinker production must decrease by 2050. This transition involves increasing the share of bioenergy and renewable sources, which is projected to rise to 16%[383] of total thermal energy. The integration of hydrogen as a fuel source is also expected to play a vital role, necessitating new energy infrastructure to support this shift. The expansion of bioenergy infrastructure will be crucial for reducing reliance on fossil fuels. This includes the use of biomass and waste-to-energy processes to supply thermal energy for cement production.

FIGURE 50 **Infrastructure for decarbonization capacity**

	Current capacity used	Capacity required (2050)
Clean power generation	Approximately 0 GW	624 GW
Clean hydrogen production	Approximately 0 MTPA	6 MTPA
CO_2 transport and storage	Approximately 0 MTPA	1,400 MTPA

Source: Accenture analysis based on data from IEA and MPP.

CEMENT

2 Demand

Overall cement demand is expected to reduce by 6%[384] by 2050. Cement production saw a significant decline in 2023, dropping by 2%[385] to 4,072 Mt, although this overall figure conceals varying regional trends. China, despite experiencing a 10.5% year-on-year decrease in production due to its real estate crisis and COVID-19 pandemic-related policies, remains the world's largest cement producer, accounting for 51% of global output.[386] India is the second-largest producer, with its share of global cement production increasing from 8% in 2021 to 9% in 2022.[387] In the medium-term, China's share is expected to decline, while growth in cement output is expected from South-East Asia, Latin America and Africa, driven by these regions' expanding infrastructure needs and development initiatives.

Despite the significant 50-70%[388] green premium for B2B transactions in the cement sector (stemming from the higher costs associated with producing low-carbon materials) the actual impact on the cost of end-user products is relatively modest, averaging around 3%.[389] This discrepancy occurs because cement typically represents a small portion of the total cost of most final products, such as buildings or infrastructure projects.

FIGURE 51 **Top countries/regions in cement production and consumption**

Percentage of overall production (2022)	
1 China	51%
2 India	9%
3 EU	7%
4 Vietnam	3%
5 US	2%

Percentage of overall consumption (2019)	
1 China	56%
2 India	8%
3 US	2%
4 Brazil	1.4%
5 Russia	1.3%

Source: United States Geological Survey (USGS) and Indexbox.

2

CEMENT

Capital

The cement industry will require additional capital investment of $1.42 trillion[390] by 2050 to develop and implement low-emission technologies and infrastructure. Plant owners are responsible for the majority of this investment, with 69% of the total funding required for net-zero efforts coming from within the sector.[391] Cement-making equipment is expected to account for 39% of the cumulative investment, followed by SCMs at 27%, underscoring the importance of reducing clinker use in cement production to lower emissions.[392] Carbon capture equipment, a key technology for decarbonization, represents 22%[393] of the capital outlay, illustrating its critical role in mitigating the sector's substantial CO_2 emissions.

Outside the direct control of cement plant owners, other stakeholders will need to invest in infrastructure to support net-zero goals. This includes 18% of the investment going towards zero-emissions electricity generation, 13% for carbon capture, storage and transport infrastructure, and 1% for green hydrogen electrolysis capacity.[394] These external investments are vital to enabling the cement industry's transition, as clean energy and hydrogen will help reduce reliance on carbon-intensive fuels, while CCS technology will capture and store residual emissions. This highlights the collaborative effort required across the value chain to achieve net-zero in the cement sector.

FIGURE 52 **Investments required by the sector and enabled by the ecosystem**

$1.42 trillion

required in investment by 2050

Investments by the sector
(around 69% of investments)

🟢 Switch production from fossil to renewable feedstock sources

🟢 Invest in R&D for low-TRL technologies

🟢 Retrofit legacy infrastructure

🟠 Invest in CCUS and DAC technology

🔵 Adopt SCMs for reducing clinker use production

🔵 Scale circularity and materials recycling

🔵 Adopt resource-efficient manufacturing

Enabled by the ecosystem
(around 31% of total investments)

🟢 Digitize the value chain and disclose key environmental system data

🟢 Renewable electricity production

🟢 Demand creation via offtake agreements

🟠 Build CO_2 capture plants

🔵 Fast track critical innovations to commercial scale

🔵 De-risk large-scale financial investment

🟢 Hydrogen, bioenergy and renewables 🟠 CCUS 🔵 Circularity and material efficiency

Source: Accenture analysis based on data from MPP.

3

CEMENT

Policy

Global cement production is concentrated, with China accounting for 51%[395] of the total output in 2022, followed by India, the EU and the US. This highlights the critical need for targeted and effective policies to curb emissions in major cement-producing regions. Given the sector's significant contribution to global CO_2 emissions, a robust policy framework is essential to drive decarbonization and support the transition to low-carbon production methods, such as allowing certain SCMs to be used in building codes.

The adoption of standardized carbon accounting frameworks, clear scope definitions and consistent system boundaries will play a crucial role in promoting transparency and accountability across the cement industry. These measures ensure accurate emissions reporting and compliance with industry-wide sustainability targets. Initiatives from global industry bodies, like the Global Cement and Concrete Association (GCCA),[396] emphasize the importance of collaboration and the sharing of best practices in decarbonization efforts. Additionally, initiatives on standards harmonization like the Industrial Deep Decarbonisation Initiative (IDDI)[397] aim to spur early demand for low- and near-zero-emission products through green public procurement commitments.

TABLE 13 **Cement industry policy summary**

Policy type	Policy instruments	Key examples	Impact
Market-based	**Carbon price**	Canada's Output-Based Pricing System (OBPS)[398]	Large industrial facilities like cement plants are required to pay a price on carbon pollution, but receive output-based allocations to protect against competitiveness impacts, encouraging them to reduce emissions while remaining economically viable.
	Border adjustment tariff	EU Carbon Border Adjustment Mechanism (CBAM)[399]	To prevent carbon leakage (the relocation of cement production to countries with less stringent climate policies), the EU is implementing a CBAM.
	Product standard	India's BIS 1489 Standard[400]	The Bureau of Indian Standards (BIS) regulates the quality of blended cement in India, promoting the use of Pozzolana and other supplementary materials to lower the carbon intensity of cement.
Mandate-based	**Direct regulations**	EU Industrial Emissions Directive (IED)[401]	The cement sector is subject to stringent emissions limits set by the IED, which controls pollutants such as nitric oxides (NO_x), sulfur oxides (SO_x) and particulate matter.
	Direct regulations	China's National Standard on Air Pollutants for the Cement Industry[402]	China enforces regulations that limit the emissions of dust, SO_x and NO_x from cement plants. Non-compliance results in fines and possible plant closures.
	Government targets	India's 2070 Net-Zero Pledge[403]	India has set long-term targets for reducing the carbon intensity of its economy, which includes initiatives to decarbonize the cement industry by transitioning to more efficient processes, renewable energy and CO_2 capture technologies.
Incentive-based	**Subsidies**	Germany's decarbonization in industry programme[404]	The programme provides financial assistance to implement innovative decarbonization technologies, supporting industries' transition to net-zero emissions.
	Direct R&D funds/grants	US Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E)[405]	ARPA-E has allocated funds specifically for developing carbon-reducing innovations in industrial sectors such as cement. Grants support cutting-edge research in process innovation, energy efficiency and carbon capture.
	Direct R&D funds/grants	US Department of Energy's Industrial Demonstrations Program[406]	By funding large-scale projects that demonstrate the feasibility of cutting GHG emissions, the programme incentivizes the adoption of cleaner technologies, such as carbon capture, low-carbon fuels and advanced manufacturing methods.

Endnotes

328. International Energy Agency (IEA). (n.d.). *Cement*. https://www.iea.org/energy-system/industry/cement.
329. International Energy Agency (IEA). (2023). *Net Zero Emissions Guide: Cement*. https://www.iea.org/reports/cement-3#dashboard.
330. International Energy Agency (IEA). (2024). *World Energy Outlook 2024*. https://iea.blob.core.windows.net/assets/47a9a222-78e4-4c43-9bab-977b4ad5326b/WorldEnergyOutlook2024.pdf.
331. Mission Possible Partnership (MPP). (2023). *Making Net-Zero Concrete and Cement Possible*. https://3stepsolutions.s3-accelerate.amazonaws.com/assets/custom/010856/downloads/Making-Net-Zero-Concrete-and-Cement-Possible-Report.pdf.
332. International Energy Agency (IEA). (n.d.). *Cement*. https://www.iea.org/energy-system/industry/cement.
333. Ibid.
334. Ibid.
335. International Energy Agency (IEA). (2023). *Net Zero Emissions Guide: Cement*. https://www.iea.org/reports/cement-3#dashboard.
336. Ibid.
337. International Energy Agency (IEA). (n.d.). *Cement*. https://www.iea.org/energy-system/industry/cement.
338. International Energy Agency (IEA). (2023). *Net Zero Emissions Guide: Cement*. https://www.iea.org/reports/cement-3#dashboard.
339. International Energy Agency (IEA). (n.d.). *Cement*. https://www.iea.org/energy-system/industry/cement.
340. International Energy Agency (IEA). (2023). *Net Zero Roadmap: A Global Pathway to Keep the 1.5°C Goal in Reach*. https://iea.blob.core.windows.net/assets/9a698da4-4002-4e53-8ef3-631d8971bf84/NetZeroRoadmap_AGlobalPathwaytoKeepthe1.5CGoalinReach-2023Update.pdf.
341. Transition Pathway Initiative. (n.d.). *Home*. https://www.transitionpathwayinitiative.org/.
342. International Energy Agency (IEA). (n.d.). *ETP Clean Energy Technology Guide*. https://www.iea.org/data-and-statistics/data-tools/etp-clean-energy-technology-guide.
343. Ibid.
344. Mission Possible Partnership (MPP). (n.d.). *Making Net-Zero, 1.5°C-Aligned Concrete and Cement Possible. https://3stepsolutions.s3-accelerate.amazonaws.com/assets/custom/010856/downloads/Making-Net-Zero-Concrete-and-Cement-Possible-Infographics.pdf.*
345. Ibid.
346. International Energy Agency (IEA). (2023). *Net Zero Emissions Guide: Cement*. https://www.iea.org/reports/cement-3#dashboard.
347. Accenture analysis.
348. Mission Possible Partnership (MPP). (2023). *Making Net-Zero Concrete and Cement Possible*. https://3stepsolutions.s3-accelerate.amazonaws.com/assets/custom/010856/downloads/Making-Net-Zero-Concrete-and-Cement-Possible-Report.pdf.
349. Accenture analysis based on S&P Capital data.
350. Accenture analysis.
351. International Energy Agency (IEA). (2023). *Net Zero Emissions Guide: Cement*. https://www.iea.org/reports/cement-3#dashboard.
352. Ibid.
353. International Energy Agency (IEA). (n.d.). *Cement*. https://www.iea.org/energy-system/industry/cement.
354. Ibid.
355. Ibid.
356. International Energy Agency (IEA). (2023). *Net Zero Emissions Guide: Cement*. https://www.iea.org/reports/cement-3#dashboard.
357. Ibid.
358. International Energy Agency (IEA). (n.d.). *Cement*. https://www.iea.org/energy-system/industry/cement.
359. International Energy Agency (IEA). (2023). *Net Zero Emissions Guide: Cement*. https://www.iea.org/reports/cement-3#dashboard.
360. Holcim. (2023). *Holcim invests in Sublime Systems to scale up innovative low-carbon technology*. https://www.holcim.com/media/company-news/investment-sublime-systems-low-carbon-technology#:~:text=Holcim%20invests%20in%20Sublime%20Systems%20to%20scale,raw%20materials%20and%20decarbonized%20energy%20to%20CCUS.

361. RPS Group. (n.d.). *Norcem Carbon Capture and Storage Project*. https://www.rpsgroup.com/projects/norcem-carbon-capture-and-storage-project-brevik-norway/#:~:text=The%20cement%20industry%20accounts%20for,terms%20of%20reaching%20climate%20goals.

362. CEMEX. (2020). *CEMEX and Carbon Clean to develop low-cost carbon capture technology*. https://www.cemex.com/w/cemex-and-carbon-clean-to-develop-low-cost-carbon-capture-technology.

363. International Energy Agency (IEA). (n.d.). *ETP Clean Energy Technology Guide*. https://www.iea.org/data-and-statistics/data-tools/etp-clean-energy-technology-guide.

364. Ibid.

365. Ibid.

366. Mission Possible Partnership (MPP). (n.d.). *Making Net-Zero, 1.5°C-Aligned Concrete and Cement Possible*. https://3stepsolutions.s3-accelerate.amazonaws.com/assets/custom/010856/downloads/Making-Net-Zero-Concrete-and-Cement-Possible-Infographics.pdf.

367. International Energy Agency (IEA). (2023). *Net Zero Emissions Guide: Cement*. https://www.iea.org/reports/cement-3#dashboard.

368. Mission Possible Partnership (MPP). (n.d.). *Making Net-Zero, 1.5°C-Aligned Concrete and Cement Possible*. https://3stepsolutions.s3-accelerate.amazonaws.com/assets/custom/010856/downloads/Making-Net-Zero-Concrete-and-Cement-Possible-Infographics.pdf.

369. Ibid.

370. Mission Possible Partnership (MPP). (2023). *Making Net-Zero Concrete and Cement Possible*. https://3stepsolutions.s3-accelerate.amazonaws.com/assets/custom/010856/downloads/Making-Net-Zero-Concrete-and-Cement-Possible-Report.pdf.

371. Accenture analysis based on S&P Capital data.

372. International Energy Agency (IEA). (n.d.). *Cement*. https://www.iea.org/energy-system/industry/cement.

373. International Energy Agency (IEA). (n.d.). *ETP Clean Energy Technology Guide*. https://www.iea.org/data-and-statistics/data-tools/etp-clean-energy-technology-guide.

374. Ibid.

375. Ibid.

376. Cembureau. (n.d.). *Recarbonation*. https://lowcarboneconomy.cembureau.eu/5-parallel-routes/downstream/recarbonation/#:~:text=Studies%20have%20been%20conducted%20to,the%20secondary%20or%20recycled%20lifetime.

377. International Energy Agency (IEA). (n.d.). *ETP Clean Energy Technology Guide*. https://www.iea.org/data-and-statistics/data-tools/etp-clean-energy-technology-guide.

378. Ibid.

379. Ibid.

380. International Energy Agency (IEA). (2023). *Net Zero Emissions Guide: Cement*. https://www.iea.org/reports/cement-3#dashboard.

381. European Commission. (2024). *Shaping the future CO_2 transport network for Europe*. https://publications.jrc.ec.europa.eu/repository/handle/JRC136709#:~:text=This%20study%20estimates%20the%20evolution,billion%20and%20EUR%2023.1%20billion.

382. Heidelberg Materials. (n.d.). *Brevik CCS – World's first CO_2-capture facility in the cement industry*. https://www.brevikccs.com/en.

383. International Energy Agency (IEA). (2023). *Net Zero Emissions Guide: Cement*. https://www.iea.org/reports/cement-3#dashboard.

384. International Energy Agency (IEA). (n.d.). *Cement*. https://www.iea.org/energy-system/industry/cement.

385. Ibid.

386. Ibid.

387. Ibid.

388. Accenture analysis.

389. Mission Possible Partnership (MPP). (n.d.). *Making Net-Zero, 1.5°C-Aligned Concrete and Cement Possible*. https://3stepsolutions.s3-accelerate.amazonaws.com/assets/custom/010856/downloads/Making-Net-Zero-Concrete-and-Cement-Possible-Infographics.pdf.

390. Ibid.

391. Ibid.

392. Ibid.

393. Ibid.

394. Ibid.

395. U.S. Geological Survey. (2023). *Cement*. https://pubs.usgs.gov/periodicals/mcs2023/mcs2023-cement.pdf.

396. Global Cement and Concrete Association. (n.d.). *Home*. https://gccassociation.org/.

397. Industrial Decarbonization Accelerator. (n.d.). *Guidance for PCR Harmonization*. https://www.industrialenergyaccelerator.org/general/guidance-for-pcr-harmonization/.

398. Environment and Climate Change Canada. (2024). *Output-Based Pricing System*. https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/output-based-pricing-system.html.

399. European Commission. (n.d.). *Carbon Border Adjustment Mechanism*. https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en.

400. Bureau of Indian Standards. (1991). *IS 1489-1 : 1991 Portland Pozzolana Cement Specification*. https://law.resource.org/pub/in/bis/S03/is.1489.1.1991.pdf.

401. European Environment Agency. (2010). *Directive 2010/75/EC on industrial emissions*. https://www.eea.europa.eu/policy-documents/directive-2010-75-ec-on.

402. Zhang, Q., D. Tong, Y. Zheng, J. Cheng, et al. (2021). Carbon and air pollutant emissions from China's cement industry 1990-2015: trends, evolution of technologies, and drivers. *Atmospheric Chemistry and Physics*, vol. 21, no. 3, pp. 1627-1647. https://doi.org/10.5194/acp-21-1627-2021.

403. Climate Action Tracker. (n.d.). *Net zero targets*. https://climateactiontracker.org/countries/india/net-zero-targets/#:~:text=Target%20year%20%E2%80%93%20India%20aims%20to,Government%20of%20India%2C%202022a.

404. Wright, R. (2024). *Germany announces €3.3 billion plan for decarbonising industry, including underground carbon storage*. Euronews. https://www.euronews.com/green/2024/08/23/germany-announces-33-billion-plan-for-decarbonising-industry-including-underground-carbon-#:~:text=The%20German%20government%20is%20putting,aimed%20at%20medium%2Dsized%20companies.

405. Office of Clean Energy Demonstrations. (n.d.). *Advanced Research Projects Agency-Energy (ARPA-E)*. https://www.energy.gov/advanced-research-projects-agency-energy-arpa-e.

406. Office of Clean Energy Demonstrations. (n.d.). *Industrial Demonstrations Program Selected and Awarded Projects: Cement and Concrete*. https://www.energy.gov/oced/industrial-demonstrations-program-selected-and-awarded-projects-cement-and-concrete.

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