6

Cement industry net-zero tracker

While increased use of alternative fuels is a positive signal, CCUS adoption remains critical for net zero and needs to scale from less than 1% to 90% by 2050.

Key emissions data[263, 264, 265, 266, 267]

6%	Contribution to global GHG emissions
2.6 $gtCO_2e$	Scope 1 and 2 emissions
-0.3%	Emissions growth (2019-2022)
0.58 tCO_2	Emissions intensity (per tonne of cement, 2022)
92%	Fossil fuels in the fuel mix (2020)
1.5 times	Expected demand increase by 2050
<1%	Current low-emission production
<1%	Reduced emission production

Readiness key takeaways

Technology
Cement can use CCUS (TRL 6-9), clean hydrogen and clean power (TRL 5-6) for decarbonization – however, production costs are nearly double that of Portland cement.

Infrastructure
Less than 1% of infrastructure is installed today, requiring investments of up to $300 billion by 2050.[268] Rich CO_2 streams from clinker position cement as a primary candidate for CCUS.

Demand
Near-zero-emission cement held less than 1% of the market in 2022. A B2B green premium of 60-100% may be necessary, with about 1-3% affecting consumers.[269] However, this remains untested.

Policy
Early-stage cement decarbonization policies needed especially in Asia-Pacific (with 70% global cement production[270]). Policies should focus on technology incentives, carbon pricing, near-zero-emission cement standards and updated building codes.

Capital
$750-900 billion CapEx required by 2050.[272] The business case remains weak, given 11% industry profit margin and 10% WACC.[273]

Stated energy transition goals

- Industry aims for a 25% emissions intensity reduction by 2030 and net-zero emissions by 2050.[271]
- 61% of large publicly traded cement companies consider climate change in their decision-making processes.

Emission focus areas for tracker

Cement emissions can be divided into two main categories:

1. **Energy-related emissions** arise from fossil fuel used in kiln heating, material grinding and machinery operations. High temperatures transform raw materials into clinker, releasing CO_2 and other GHGs.
2. **Process emissions** stem mainly from chemical reactions during raw material conversion to clinker, emitting CO_2 through limestone calcination.

Sector priorities

Existing assets
Reduce emissions intensity of clinker production by:

- Increasing fuel substitution with biomass and renewable waste[274]
- Reducing thermal energy consumption through efficiency improvements
- Substituting clinker with supplementary cementitious materials (SCMs) and reducing the clinker-cement ratio.[275]

Next generation assets
Accelerate infrastructure development to drive absolute emissions reduction by:

- Investing in CO_2 storage and transport infrastructure
- Retrofitting cement kilns with clean hydrogen capability
- Enabling access to grid-based clean power and deploying electrified kilns.

Ecosystem
De-risk capital investment to scale technology by:

- Implementing a blend of policies, principally carbon pricing
- Incentivizing near-zero-emission production, reducing low-emission production costs through an increased shared CCUS projects at industrial hubs
- Enabling shared infrastructure and supply chain stability through strategic partnerships.

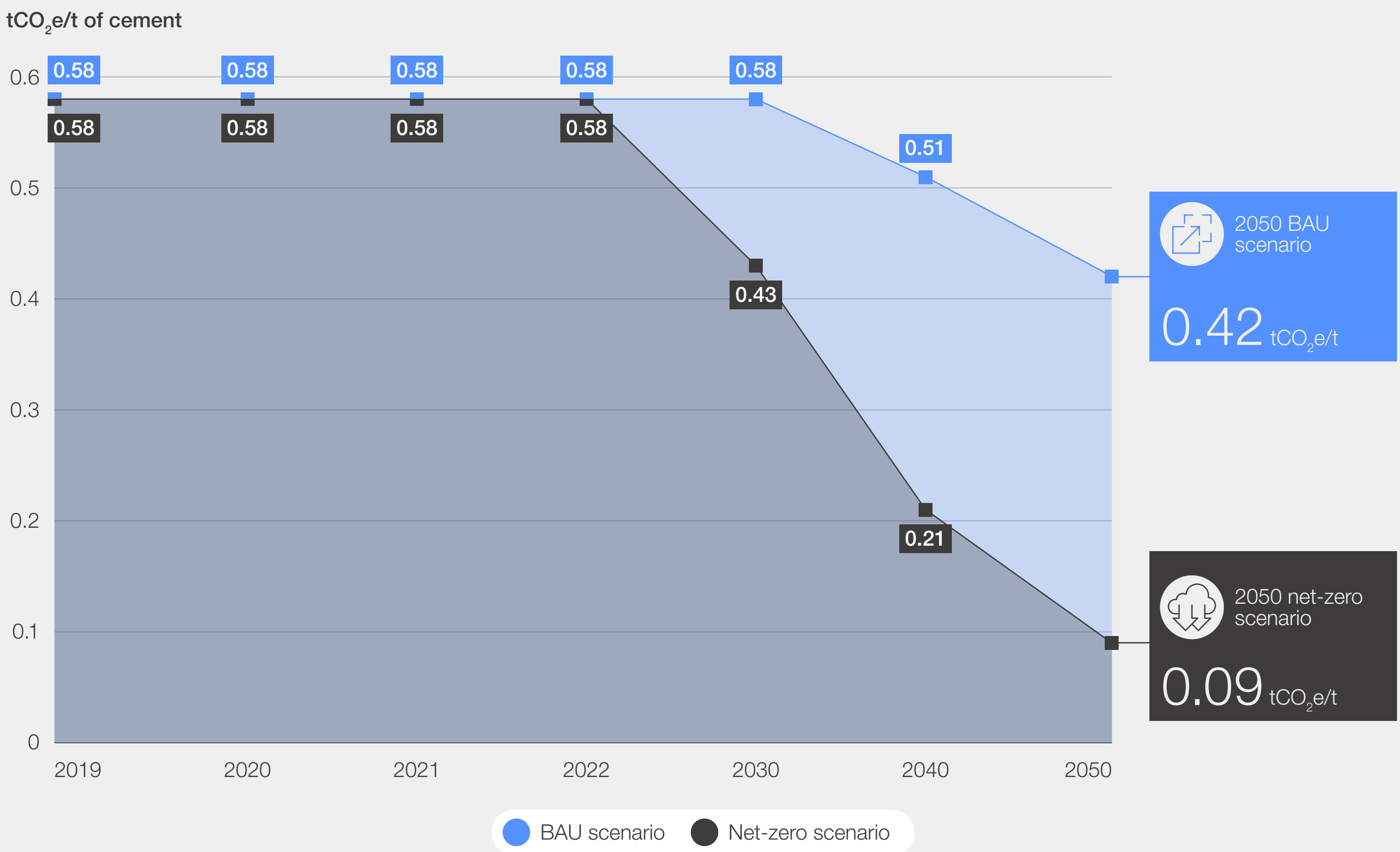
Performance

The clinker production process is the primary contributor to emissions in the cement industry, accounting for roughly 60%. The remaining 40% is generated through the intense heating energy required to heat cement kilns, primarily supplied by the combustion of coal and gas.[276]

Absolute CO_2 emissions declined by less than 1% over the last four years amid increases in global production. Emissions intensity remained static over the same time period despite a 9% rise in the clinker-to-cement ratio.[277] The average ratio is currently 72%,[278] while the proposed GCCA target is 56% by 2040.[279] The twin forces of urbanization and population growth are driving cement consumption in China (51% global demand) and India (9% global demand),[280] which necessitates accelerated action to decarbonize the sector to mitigate the impacts of increased production.

Energy intensity for cement production is a function of kiln type, combustion, fuel quality and heat transfer efficiency and averages 2-3 GJ/t. Over the last five years, global cement energy intensity decreased by 2%,[281] due to increased use of biomass and non-renewable waste in the fuel mix.

FIGURE 43 **Emissions intensity trajectory, net-zero vs BAU scenario**

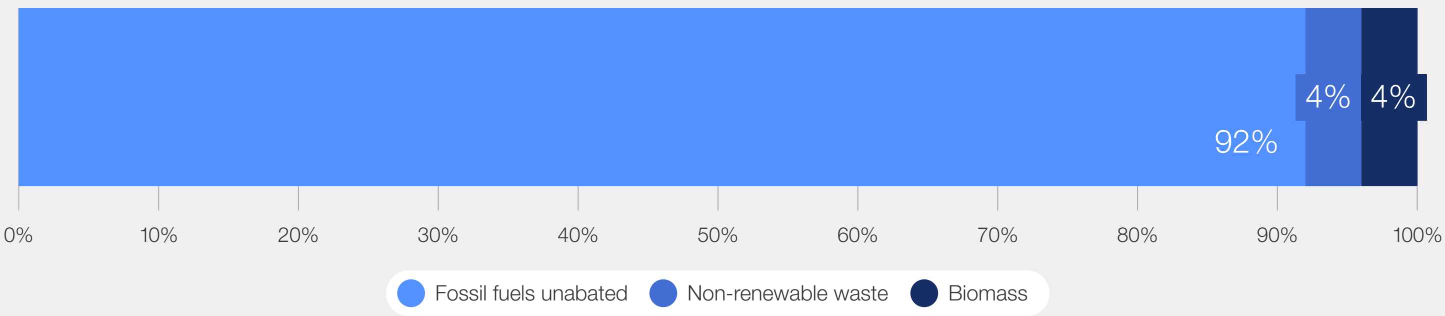


Source: IEA

Path forward

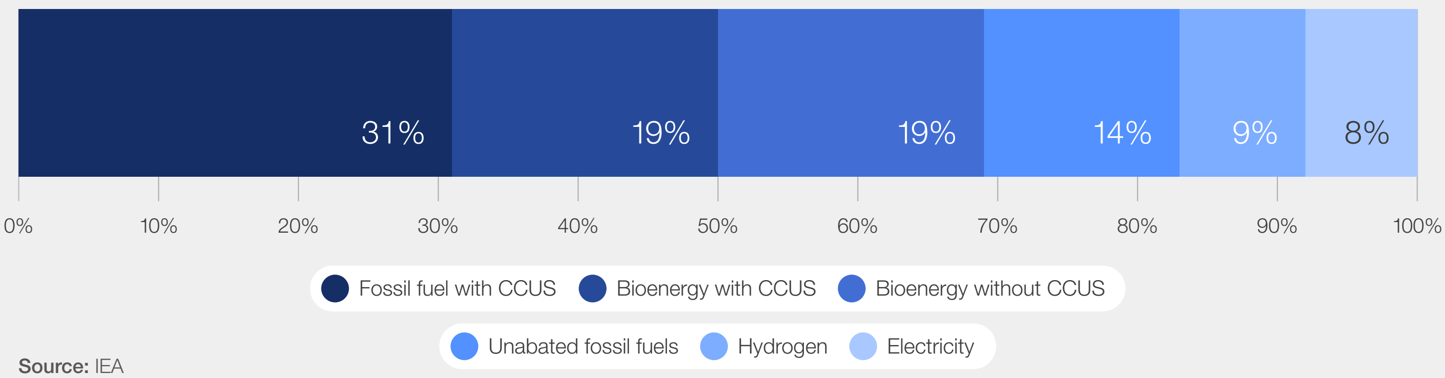
The GCCA is targeting a 20% emissions reduction by 2030 and net zero emissions by 2050 (from 2020 levels).[282] In the near term, efficiency measures, circularity measures, clinker substitution with SCMs and decarbonizing the kiln heating process may contribute to a 25% emissions reduction.[283] However, the additional reduction will require decoupling cement emissions from market demand increases through a reduction in non-abated fossil fuels from 92% of the fuel mix to 10%, requiring a significant step up in CCUS deployment. The scenario considers a 10-fold increase in the proportion of biofuels in the fuel mix and a 25% deployment of renewables, with clean hydrogen projected to represent 5%.[284] Further scaling of CCUS, clean electrification and hydrogen will likely be required in some regions.

FIGURE 44 | **2020 fuel mix**



Source: IEA

FIGURE 45 | **2050 fuel mix – net-zero scenario**



Source: IEA

2

CEMENT

Technology

Three leading decarbonization pathways have emerged, and CCUS technologies are the most developed (TRL 6-9). Clean hydrogen and clean power-based technologies are limited to prototype stage (TRL 5-6). Production costs for these technologies are nearly double the cost of Portland cement.[285]

Process emissions abatement measures

Scaling in-plant CCUS from less than 1% to 90% by the 2040's[286] to capture the CO_2 emitted during the clinker production process is critical to achieve near-zero-emissions. The CO_2 from cement process emissions is a rich stream and can be attractive to the CCUS industry alongside the right blend of policies and incentives. Lehigh Cement, a division of Heidelberg Materials in Alberta, Canada,[287] is set to launch the industry's inaugural full-scale CCUS facility. Designed to capture around 1 MTPA of CO_2 emissions, equivalent to about 95% of the plant's total emissions, the facility aims to be operational by 2026. This marks a positive step towards technology adoption among major industry players.

In the near term, cement should work to cut emissions from clinker production, scaling the deployment of both clinker substitution (SCMs) and alternative cement composition (green cement). Though commerciality and scalability challenges still need to be solved, these innovations complement the near-zero decarbonization strategies.

Energy emissions abatement measures

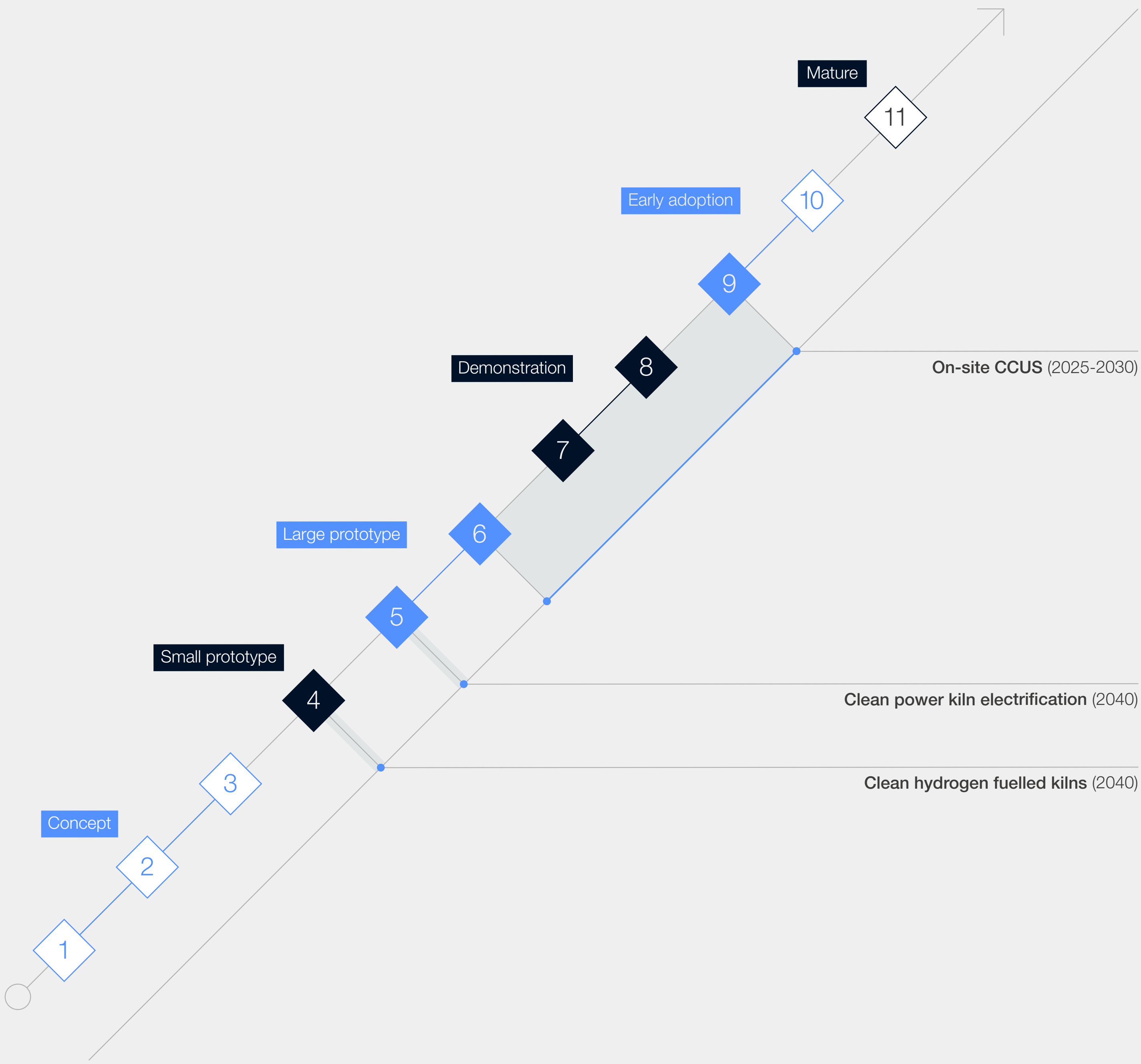
Kiln electrification supplied by clean, renewable electricity alongside clean hydrogen to replace coal and natural gas as fuel sources target the approximately 40% of emissions associated with fuel consumption. The requirements for intense heat energy align with electrification and clean hydrogen as critical net-zero pathways.

However, most projects are currently prototyped at scale, energy storage requirements to overcome intermittency need to be considered, and clean hydrogen is not currently cost-competitive or widely available. In the near term, increasing the volume of biomass in the fuel mix can reduce energy emissions while near-zero technologies advance to commercial scale.

Technology pathways

FIGURE 46

Estimated TRL and year of availability for key technology pathways



Source: GCCA and ECRA

CEMENT

2 Infrastructure

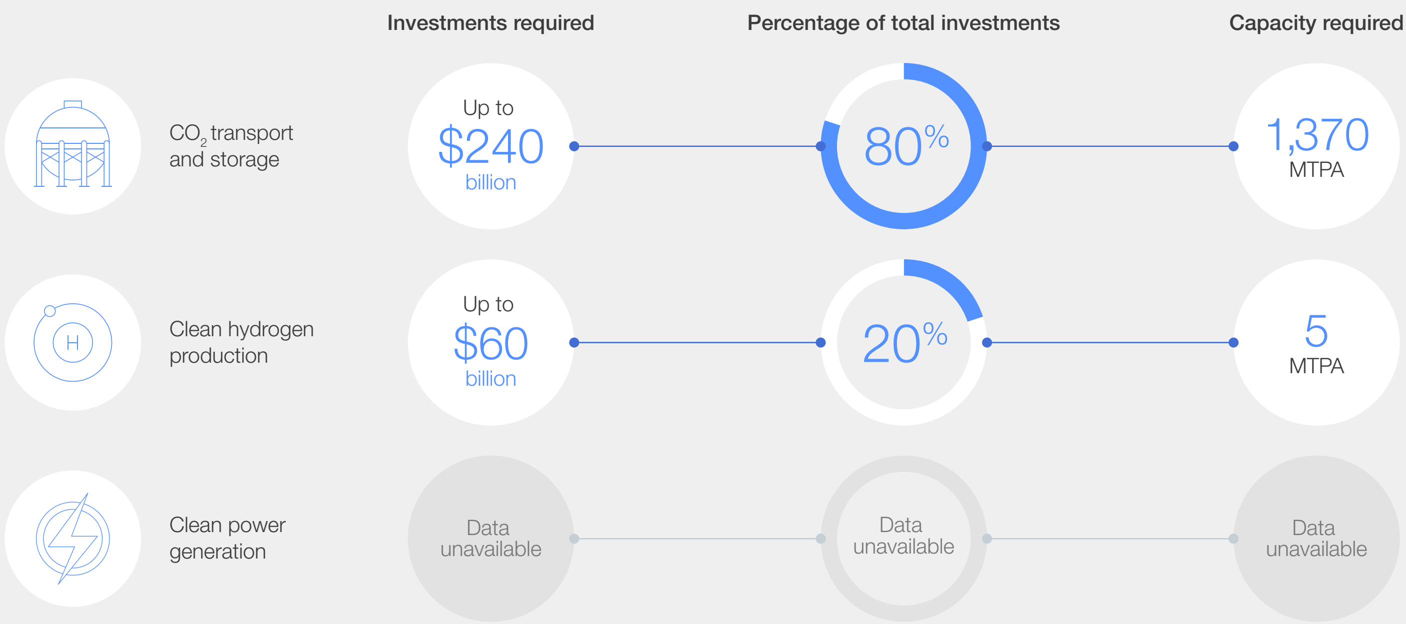
Decarbonization of cement is dependent on the availability of CCUS, clean hydrogen and clean power infrastructure. However, less than 1% of the necessary infrastructure for near-zero-emission production has been installed.[288] The total infrastructure required to support the global cement industry is estimated at up to $300 billion through 2050.[289]

The rich CO_2 streams from clinker production position the cement industry as a leading candidate for investment in CCUS. It is likely that cement production can form one of the anchors of emerging CCUS hubs, such as the Northern Lights JV Longship Project,[290] due to become operational in 2024 and capture up to 1.5 MTPA of captured carbon. Longship is Europe's first cross-border CO_2 transport and storage network, in which cement collaborates with infrastructure owners and other co-located industrial players to accelerate the build-out of CCUS infrastructure.

Given the scale of their demand, cement plants may need to consider captive on-site generation, as clean hydrogen grids may not have the capacity to meet their intermittent clean hydrogen demand profile without additional storage investment.

Clean power is a pre-requisite for delivering the CO_2 reduction potential of kiln electrification. The cost of the renewable generation, transport and distribution and likely storage for intermittency is yet to be quantified.

FIGURE 47 **Cement infrastructure investments**



Source: Accenture analysis based on multiple data sources, including GCCA, IRENA, IEA and BloombergNEF

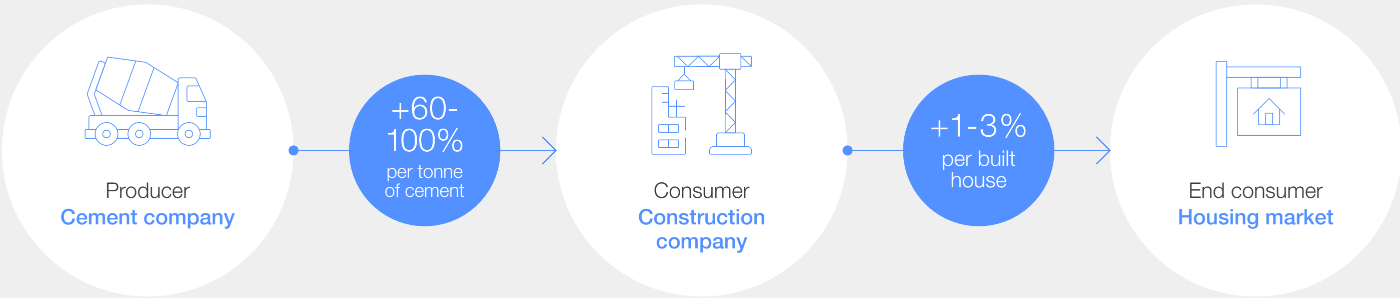
CEMENT

2 Demand

The ability of customers to absorb a green premium of 60-100% per tonne[291] is untested beyond prototype projects, as low-emission cement represents less than 1% of global supply.[292]

A 60% increase in the per tonne cost of cement translates into a 3%[293] increase in the cost of a built house. When considered as a share of the total lifetime emissions of a building, the green premium for near-zero-emission cement is more competitive.

FIGURE 48 **Estimated B2B and B2C green premium**



Source: Accenture analysis based on multiple data sources to include ECRA, Bloomberg and Fortune

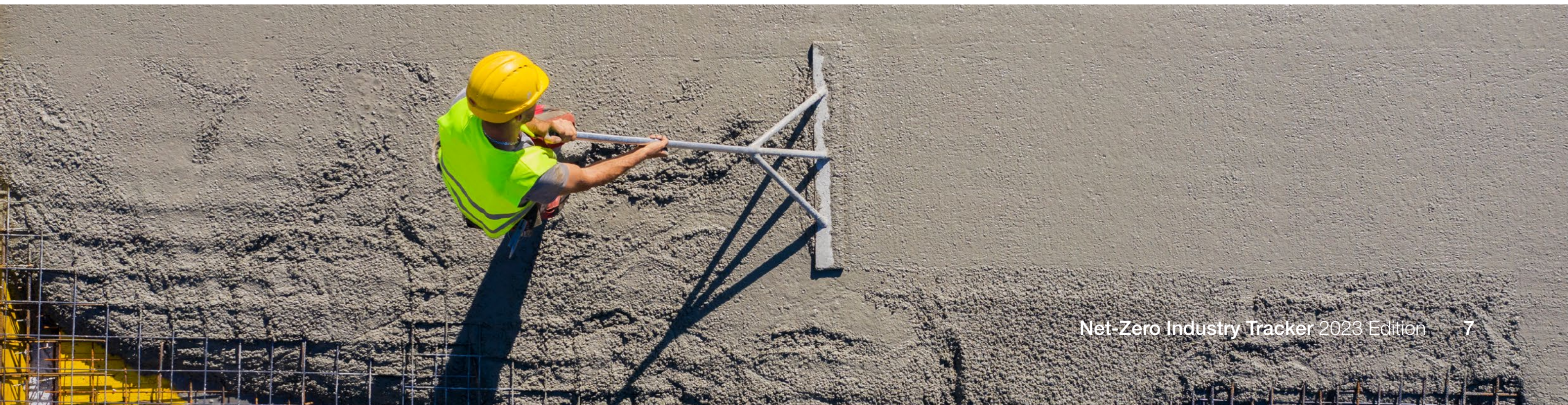
The absence of standardized definitions, certifications and traceability prevents industry from understanding the market potential.

The ability of the industry to pass along this premium or to monetize near-zero-emission cement as a differentiating attribute depends on the target consumer segment (B2B vs consumer) and geography (developed vs developing cost of housing). The largest forecasted increases in cement consumption globally align with the markets with likely the lowest ability to absorb a significant green premium.

While current adoption is low, industry demand for near-zero-emission and "green" cement products is emerging. Industry consortia, such as the FMC, are mobilizing market demand through purchase commitments. In 2023, the FMC[294] pledged to buy 10% of its annual cement supply as near-zero-emission cement by 2030. Comparable initiatives are occurring in the cement and building materials sector. In March 2023, Hoffman Cement[295] contracted with Alkern Group to supply 28% of their current production as decarbonized cement until 2027.

The absence of standardized definitions, certifications and traceability mechanisms has prevented consumers from having the necessary transparency to fully consider paying the green premium or for the industry to fully define the pathway to understand the market potential at a higher cost of production. The introduction of ISO 19694-3[296] in March 2023 may improve the tracking of CO_2 emissions.

The global construction landscape is showing signs of change as industries move to reduce CO_2 emissions on various fronts. Breakthrough developments such as low-carbon design,[297] nanotechnology,[298] algae-based biogenic cement[299] alternatives and 3D printing, which can reduce the volume of cement used in construction by up to 70%[300] may disrupt business-as-usual requirements. The cement industry may need to diversify traditional portfolios and adapt business models to remain competitive and maintain market share through the evolving landscape, balancing supply with demand for an increasing number of lower-emission products.



CEMENT

3 Policy

Policy measures to support the decarbonization of the cement industry remain at an early stage; in particular, policy frameworks are yet to be established in the Asia Pacific region, where 70% of cement is produced.[301]

Global cement production is dominated by multinational players alongside smaller local players. Local regulations, for example at urban or municipal levels, often focus on pollution control, life cycle assessments and performance standards without addressing CO_2 emissions reduction. A suite of targeted policies on the supply side can subsidize technology adoption while discouraging emissions through carbon pricing and cross-boarded adjustments. To drive demand, a transparent definition of low-emission cement is needed, together with green public procurement and updated building codes with standards for waste material use and co-processing, landfill bans or taxes and regulations on building demolition, and mandated minimum quantities of recycled materials.

Existing policy landscape

TABLE 9

Policy summary[46]

Enabler	Policy type	Policy instruments	Key examples	Impact
Technology	Incentive-based	Direct R&D funds/grants	– EU Innovation Fund[302]	$800 million in funding for six cement CCUS projects in the EU.
		Supporting regulations	– EU Net-Zero Industry Act[303]	Strengthens regulations and create an enabling environment to boost CCUS technology development and stimulate investments. Currently in the proposal stage.
	Market-based	Carbon price	– EU-ETS[304] – California ETS[305] – China ETS[306] (inclusion of cement announced, not formalized)	Incentivizes cement producers to reduce emissions.
		Border adjustment tariff	– CBAM[307] (pending implementation) – Prove It Act[308] (under discussion)	Emission-intensive cement exporters to EU face a cost escalation of up to 100%. Needs to be complemented by transparent and carbon accounting standards.
Infrastructure	Incentive-based	Direct funding support to CCUS infrastructure	– Public funding of CCUS hubs in EU[309] – Provision for CCUS hubs under Bipartisan Infrastructure Law[310]	Over $6 billion committed to develop CCUS hubs in the US and the EU.
Demand	Incentive-based	GPP	– Policies in place for green public procurement of concrete products in Germany, the Netherlands, the UK, Sweden[311] – Federal buy clean initiative in the US[312] – Key cement producers as IDDI members – the UK, India[313]	Creates a viable market for low-emission cement through GPP commitments.
	Mandate-based	Building/end-use/product codes and standards	– Embodied carbon limit policies in the Netherlands, Sweden, France and Germany[314] – US General Service Administration (GSA) low embodied-carbon concrete standards in the US[315]	Provides a clear market signal to low-emission cement production.
Capital	Incentive-based	Tax credits/ subsidies	– CCUS tax credits under IRA[316]	20-30% reduction in costs to deploy CCUS in cement plants.

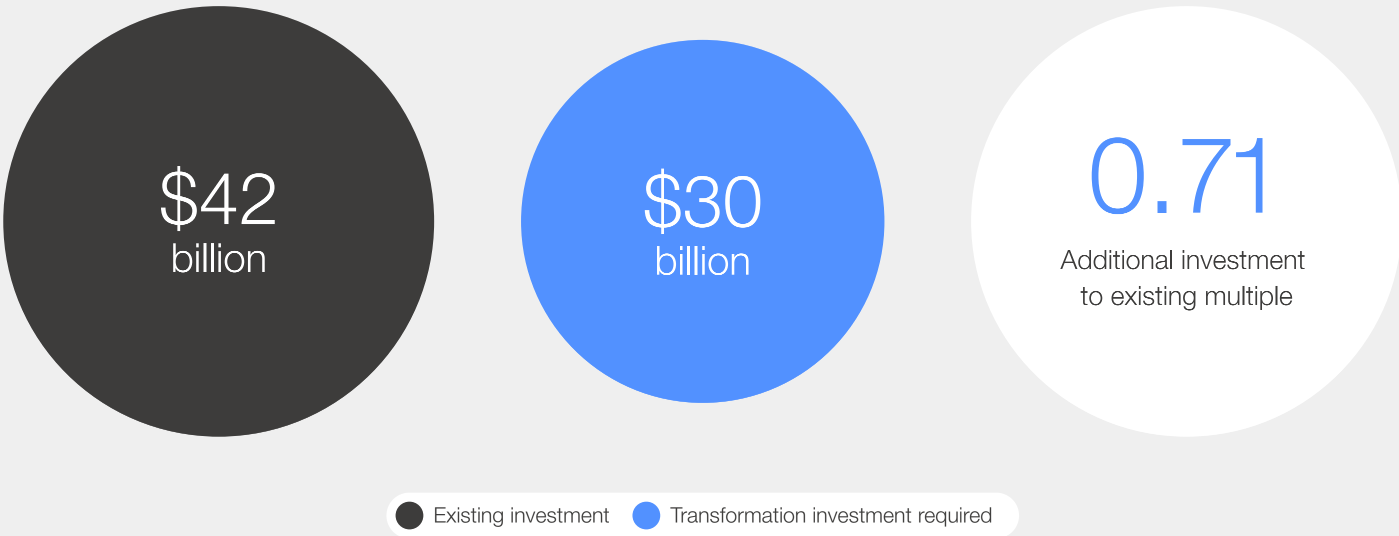
CEMENT

Capital

The cement industry is estimated to require $750-900 billion in CapEx for CCUS enabled plants by 2050.[317] This translates into an annual investment of approximately $30 billion, equivalent to 71% of existing CapEx[318] (without adding new capacity or generating additional returns). Further capital will be needed to adopt clean hydrogen and electrified kilns.

The business case for investment in near-zero-emission cement assets remains weak. Current industry profit margins of approximately 16%[319] and WACC is 10%.[320] Despite relatively low end use green premium, considering the heavy amount of CapEx involved, it may be a challenge for the industry to self finance in the absence of carbon pricing in certain regions.[321] Cement companies also need to balance capital allocation towards low-emission assets, with competing objectives of funding dividends and share buybacks to fulfil investor expectations.

FIGURE 49 **Additional investment required to existing investment ratio**

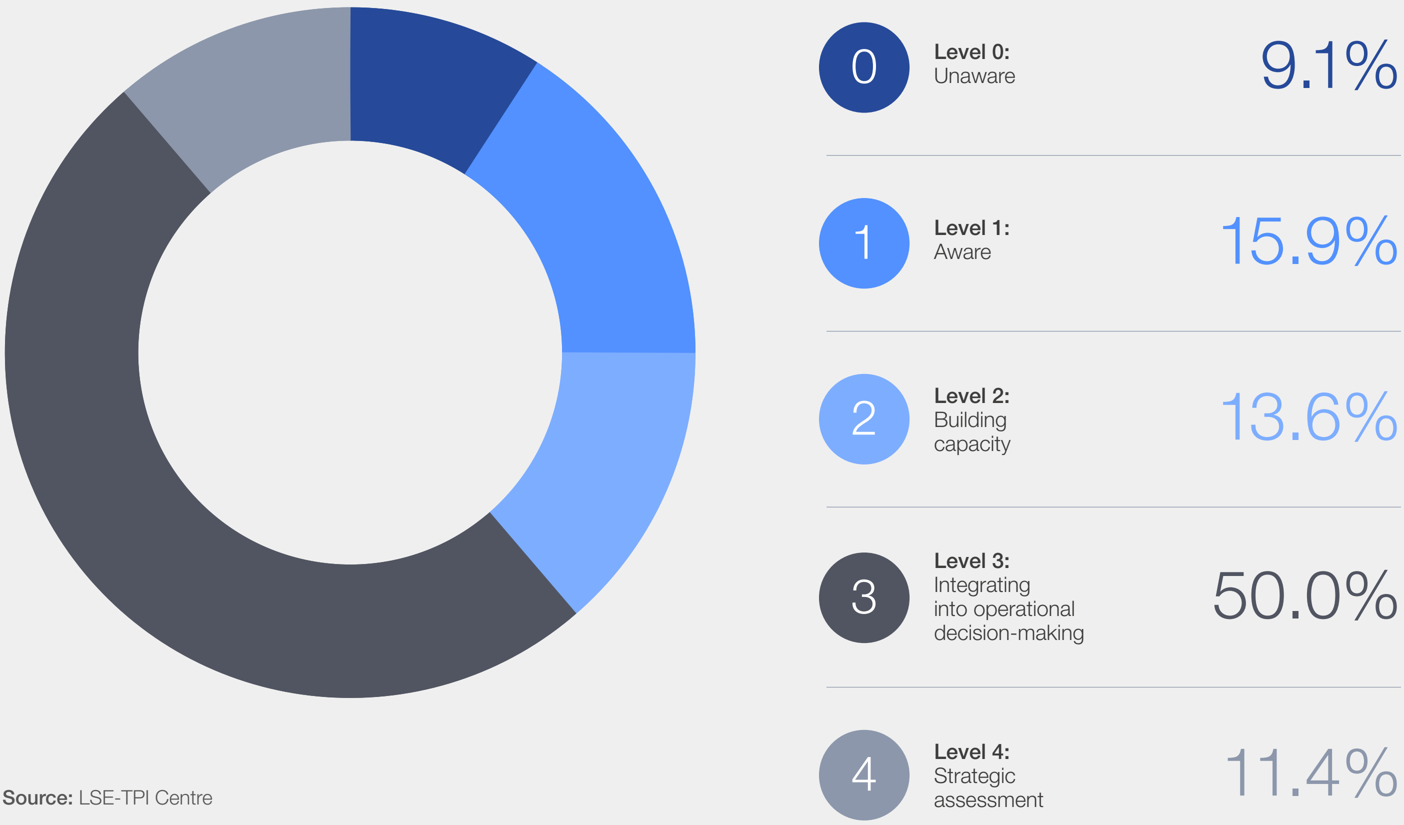


Source: Accenture analysis based on multiple data sources to include ECRA and Global CCS Institute

Funding mechanisms to direct capital to developing market cement production to incentivize institutional investors and multilateral banks could be considered, linking capital to emission reduction. Organizations like the Climate Bonds Initiative,[322] which introduced cement sector certification in 2022, aim to enhance transparency and guidance around clean investments, which may help to accelerate this effort. In Europe, the industry will need to replace 30% of kilns by 2030 and capital needs should prioritize newer assets with CCUS.[323]

Approximately 61% of large, publicly-traded cement companies consider climate change as a key consideration for their strategic assessment and integrate it into their operational decision-making.[324] Meanwhile, 14% of companies are building basic emissions management systems and process capabilities. Finally, 16% of companies acknowledge climate change as a business issue.

FIGURE 50 **Distribution of companies in the cement sector according to the management of their GHG emissions and of risks and opportunities related to the low-carbon transition**



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91–93 route de la Capite
CH-1223 Cologny/Geneva
Switzerland

Tel.: +41 (0) 22 869 1212
Fax: +41 (0) 22 786 2744
contact@weforum.org
www.weforum.org