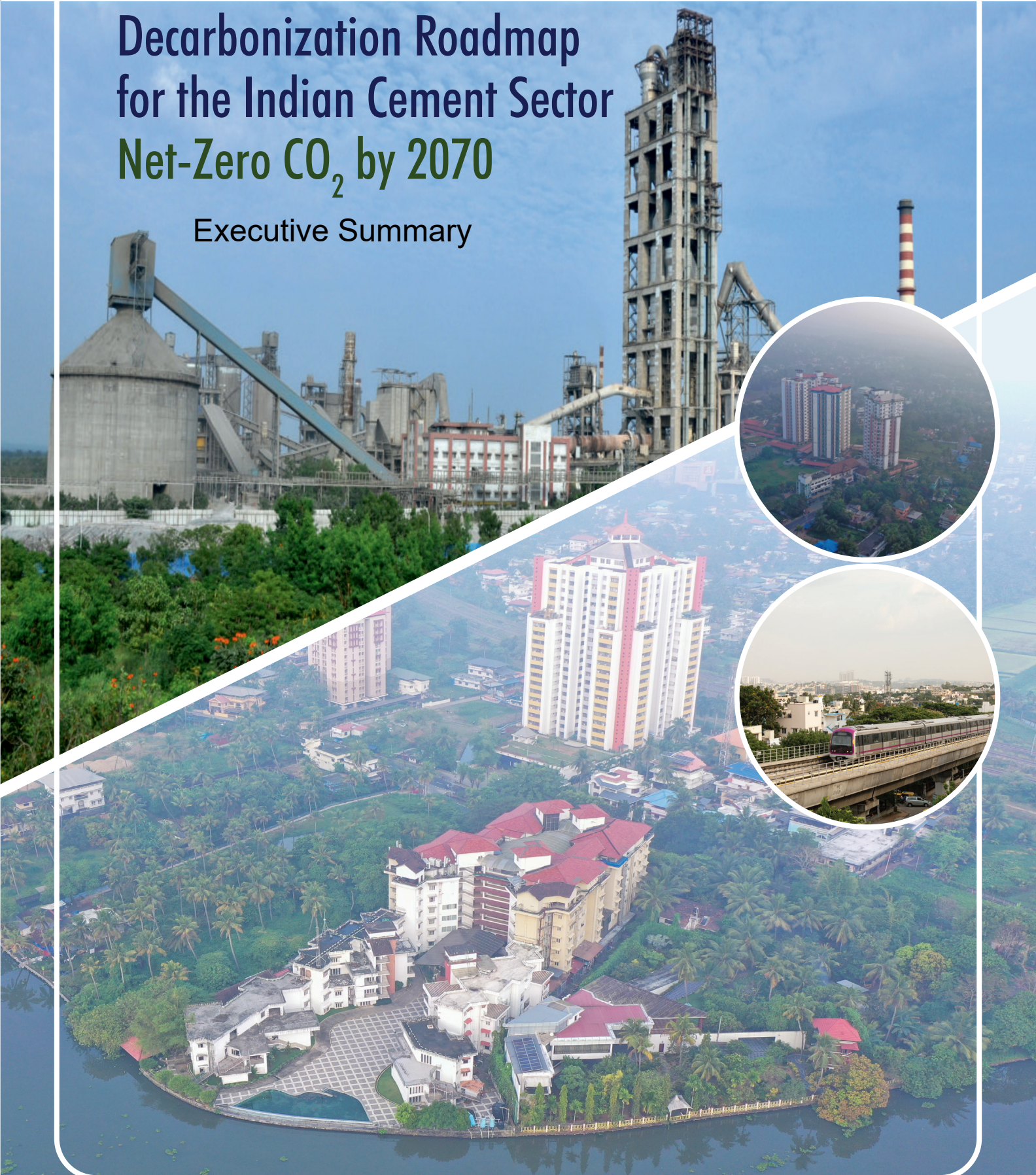


Decarbonization Roadmap for the Indian Cement Sector Net-Zero CO₂ by 2070

Executive Summary



Executive Summary

The cement industry is one of the core industries in India and holds significant importance in the country's economy. India is the second largest cement producer in the world, accounting for 8% of total installed capacity. The per capita consumption of cement in India is 257 kg, far less than the global average of 540 kg (DPIIT, 2023). The sector generates about 20,000 downstream jobs for every million tonne of cement produced (CMA, 2022).

The cement sector's growth is primarily attributed to the country's rapid urbanization and increasing demand for housing and infrastructure requirements. It is essential to strike a balance between meeting the increasing demand and incorporating sustainability and environmental concerns. Over the years, the cement industry has evolved to become one of the trend setters in the country in terms of energy efficiency, quality control, and environmental sustainability (MoEFCC, 2022); it has achieved one of the lowest emission intensities in the world.

The Indian Cement Roadmap: Net-Zero CO₂ by 2070

The Indian cement industry Net-zero CO₂ roadmap 2070 has been developed by Global Cement and Concrete Association (GCCA), India in collaboration with The Energy and Resources Institute (TERI) with an objective to chart out the pathway for a net-zero cement sector by 2070. The cement industry aims to align its strategies with India's Net-Zero 2070 target and Nationally Determined Contributions (NDCs), supported by an enabling policy framework.

The development of this roadmap was done with close involvement of key stakeholders including cement industry, architects, engineers, R&D institutions, academia, and sectoral experts. The roadmap development process used the tool prepared by the European Cement Research Academy (ECRA) for developing "The Global Cement and Concrete Industry Roadmap for Net-Zero Concrete" as the basis for quantification of various decarbonization levers.

Decarbonization Levers

It is envisaged that the cement production in India would increase from 334 million tonne in 2019-20 to 1546 million tonne in 2070 with a CAGR of 3.1% over a 50-year timeframe. This would lead to an increase in per capita cement consumption to around 877 kg. The key decarbonization levers identified to achieve net-zero CO₂ in cement industry by 2070 include: (1) Clinker efficiency (specific thermal energy consumption), (2) Alternative fuels, (3) Enhanced use of Supplementary Cementitious Materials (SCMs), (4) Decarbonization of electricity, (5) New binders, (6) Carbon Capture, Utilization and Storage (CCUS), (7) Recarbonation and (8) Cement-use efficiency.

The overall emission intensity¹ of cement sector would reduce from 0.68 tonne CO₂ per tonne cement (2020) to 0.56 tonne CO₂ per tonne cement (2030) and to 0.51 tonne CO₂ per tonne cement (2047) while envisaging net-zero by 2070. Net-zero emissions in cement sector can be achieved only through CCUS while also considering recarbonation (carbon uptake).

¹ Includes scope-1 and scope-2 emissions; excludes emissions from CPPs

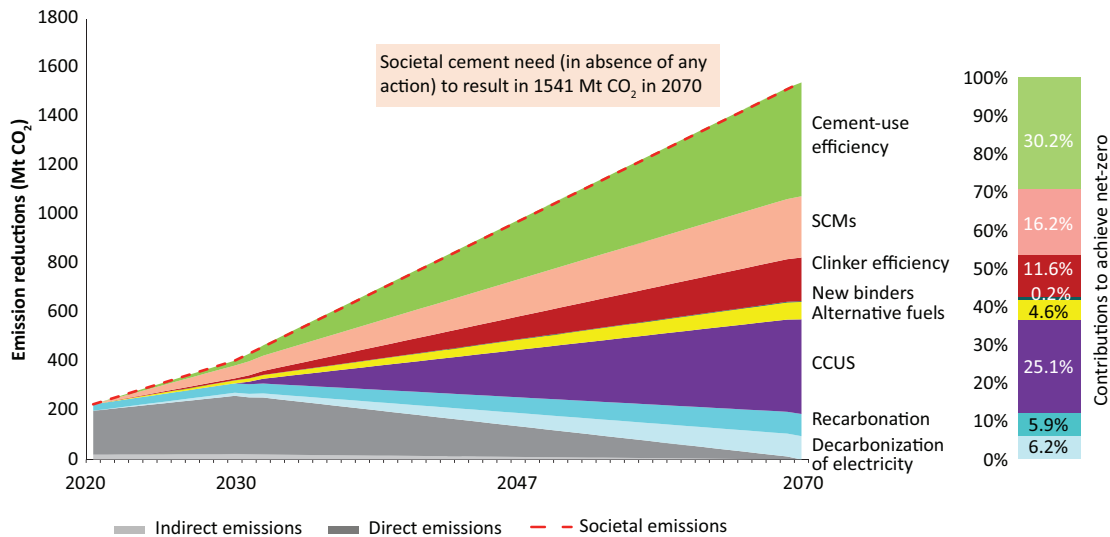


- 1. Clinker efficiency:** The average clinker efficiency i.e. specific (thermal) energy consumption (SEC) level of Indian cement plants is envisaged to reduce from 731 kcal per kg clinker in 2020 to 705 kcal per kg clinker in 2070. It is envisaged that the cement industry would increase the share biomass as fuel. Further, the low carbon fuel-mix would have substantial share of green hydrogen along with innovative technologies such as kiln electrification, solar thermal, etc. which would perhaps become viable beyond 2047.
- 2. Alternative fuels:** The Indian cement industry is envisaged to use about 35% of fossil fuel wastes as alternative fuels, which would help in shifting towards 100% low-carbon fuel-mix by 2070.
- 3. SCMs:** Blended cements will continue to dominate the Indian cement industry as compared to Ordinary Portland Cement (OPC). Apart from blended cements such as Portland Pozzolana Cement (PPC) and Portland Slag Cement (PSC), it is envisaged that composite cement, Limestone Calcined Clay Cement (LC3) and Portland Limestone Cement (PLC) would play a major role in total cement production in 2070. The overall clinker factor will reduce from 0.75 in 2020 to about 0.56 in 2070.
- 4. Decarbonization of electricity:** The industry would adopt three-pronged approach comprising: (i) efficiency improvements in electricity use, (ii) maximising WHR potential and (iii) shift to green electricity with renewable energy use (either through onsite generation, open access or 'group captive plants') for complete decarbonization of electricity. Some of the cement plants have already started moving in this direction with clear plans for 100% Renewable energy usage.
- 5. New binders:** With the ongoing initiatives for development and utilization of increasingly more clinker-efficient cements, there exists potential for innovative binders such as geopolymers, carbo-silicate and calcium hydro silicate binders. The share of new binders is small due to limited availability of required raw materials. However, extensive research is required before their actual potential can be gauged.
- 6. Carbon Capture, Utilization and Storage:** With process emissions accounting for a significant share of emissions, cement industry needs to adopt Carbon Capture, Utilization, and Storage (CCUS) to reach to the net-zero stage. As per the modelling results, CCUS would account for about 25% of total emission reductions in 2070. It is further envisaged that 'Nature-based Solutions' (NbS) e.g., agro-forestry could play a complementary role in combating carbon emissions. A collaborative approach between industry, government and other key stakeholders would strengthen the efforts.
- 7. Role of recarbonation:** Recarbonation is a natural process of CO₂ uptake by concrete which reduces whole life GHG emissions. Since India-specific recarbonation values are not available at present, the roadmap uses global values and further recommends specific studies for development of India specific numbers.
- 8. Cement use efficiency:** Discussions with various stakeholders revealed that ample opportunities exist for improving the cement use efficiency in all the end use segments. It is envisaged that the improvements in cement use efficiency would help in reducing societal demands for cement by about 30% in 2070. This includes aspects around efficiency in concrete production and efficiency in design & construction. Role of ready-mix concrete, increased use of pre-cast structures, design optimization technologies, construction site efficiency, increased lifetime of buildings, optimized mix designs, etc., are all covered under this lever.



Net-Zero CO₂ 2070 Pathway for the Cement Sector

The 2070 net-zero CO₂ pathway for Indian cement industry shows that cement-use efficiency and CCUS would be the dominant decarbonization levers in achieving net-zero by 2070, contributing for about 30% and 25% respectively of total CO₂ emissions.



Net-zero CO₂ 2070 pathway for Indian cement sector

Enabling Policy Framework

The key 'policy asks' by the Indian cement industry that would support its net-zero CO₂ 2070 journey are as follows:

Establish supply chain for alternative fuels: The cement industry would need a robust supply chain network for alternative fuels like RDF obtained from municipal solid wastes, used tyres, plastic wastes, etc. This would help in efficient utilization and better societal waste management. Suitable policies towards land availability for 'captive biomass generation' to use biomass as a partial/ full replacement of fossil fuels for thermal energy requirements would be extremely important.

Promote low carbon cements: Increased use of greener varieties of cement would require (i) introducing definition for low carbon cements, (ii) strengthening public procurement policy/ demand for low carbon cement in government funded infrastructure and housing projects and (iii) making suitable amendments and introduce new standards for blended cements. The government to also initiate detailed geological mapping for clay reserves which can be used as a complementary SCM in blended cement production especially for LC3 production.

Cement use efficiency: Cement use efficiency is an important decarbonization lever in the value chain that includes efficient concrete production and optimizing design and construction. The shift to industrial concrete production will help in efficient cement utilisation. Increased weightage for embodied CO₂ emissions reduction in green building certifications will aid efficient cement utilisation in concrete.

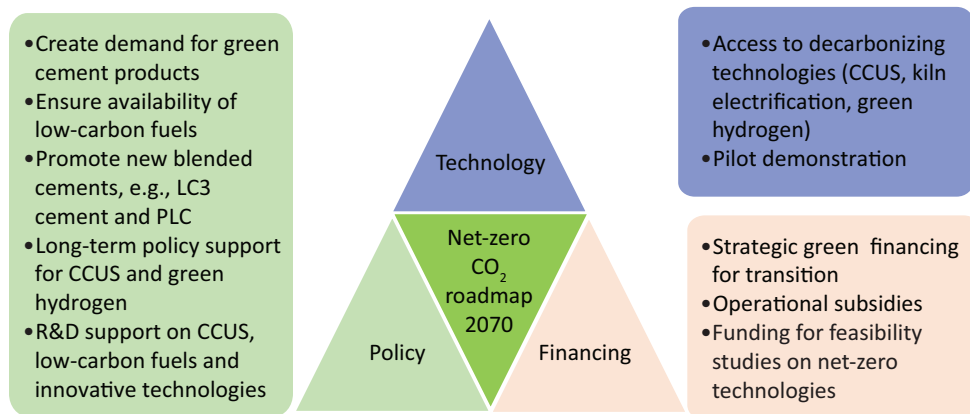
Long-term policy support for CCUS: The cement industries would require financial and policy support for conducting 'detailed studies' on CCUS projects at plant level as well as for actual implementation of CCUS projects. It may be noted that CCUS projects require additional capex which is very high and cannot be absorbed by the cement plants. Globally, CCUS projects are



funded through government supported programmes. Long-term legal certainty for CO₂ storage and transportation facilities will also be a pre-requisite. The government will need to develop essential infrastructure for CO₂ transport & storage facilities while ensuring public acceptance. Geological CO₂ storage & transport may require substantial land areas. The industry would also require tools for 'Monitoring, Verification and Accounting' for CO₂ storage system. Nature-based Solutions (NbS) can be a complementary lever to support decarbonization efforts.

Establish strategic green financing: A 'strategic green financing' programme dedicated for the cement sector would be required to support the transition process in Indian cement industry. It should support innovation, R&D and pilots for a few initial projects in areas like green hydrogen, kiln electrification, CCUS, newer cement production technologies, etc. Subsequently, as the industry progresses in adopting the deep decarbonization technologies, operational subsidies and low cost financing from international sources would be needed to ensure a transition to net-zero CO₂ cement sector.

The cement industry is ready to embark on an exciting net-zero pathway. However, this requires collaborative efforts and joint action by policymakers, relevant ministries, investors, researchers, innovators, customers, end users and financial institutions.



Key enablers for net-zero CO₂ cement sector roadmap

Decarbonizing the cement and concrete industry requires a comprehensive, multi-phase approach to policy support that addresses the varied challenges at different stages of the transition. In the near term, the industry needs policies that focus on incentivizing immediate emission reductions through adoption of available low-carbon technologies, such as energy-efficient production processes and the use of alternative fuels.

In the medium to long term, policies should promote the scaling up of emerging technologies like Carbon Capture and Storage (CCS), green hydrogen use, and alternative binders, while also supporting research into new materials and methods. This could involve public-private partnerships (PPPs), long-term funding for R&D, and carbon pricing mechanisms that reflect the true cost of low carbon production.

The industry will need a multi-pronged focus on technology adoption, innovation acceleration and research deployment for deep decarbonization. Additionally, a harmonised global approach to standards and emissions reductions will be essential to ensure competitiveness, mitigate trade risks, and drive further innovation across the sector. The policy landscape must evolve at each stage, with different tools and incentives tailored to the progress and readiness of the technology and market to deliver on decarbonization goals.



About GCCA India

Global Cement & Concrete Association (GCCA) India works with the Indian cement & concrete sector on climate change, circular economy, health & safety, SDGs and communication. GCCA India covers close to 80% of India's cement capacity. Sustainable development of the cement and concrete industry is at the core of the GCCA's work.

The GCCA gathers and publishes data on the industry's sustainability commitments, guidelines, and initiating research. 'Decarbonization Roadmap for the Indian Cement Sector: Net-Zero CO₂ by 2070' is the collective aspiration of India's leading cement companies to contribute to building the sustainable world of tomorrow.

More information about GCCA is available at <https://gccassociation.org/>

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