IEA/WBCSD Roadmap targets

2012 2015 2020 2025 2030 2035 2040 2045 2050

International Energy Agency

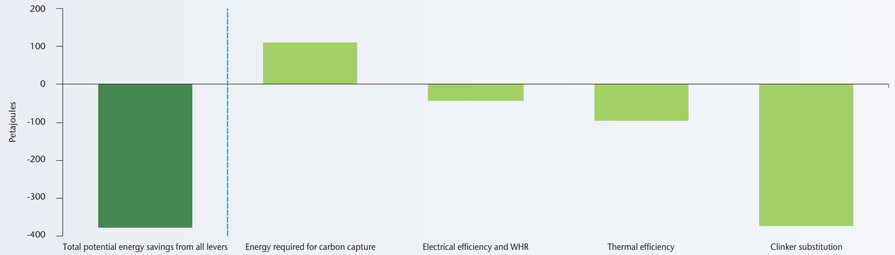
wbcsd

Key findings

The Indian cement industry is one of the most efficient in the world, yet it still produces 137 $MtCO_2$ in 2010, approximately 7% of India's total man-made CO_2 emissions.

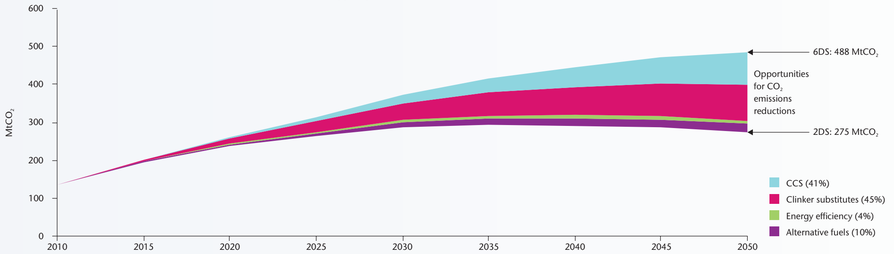
- The Indian cement industry has already achieved a reduction in total CO_2 emissions to an industrial average of 0.719 tCO_2/t cement (direct and indirect emissions) from a substantially higher level of 1.12 tCO_2/t cement in 1996.
- In the absence of appropriate technology development or policy actions, CO_2 emissions from the Indian cement industry are projected to reach between 488 $MtCO_2$ (Low-Demand Case) and 835 $MtCO_2$ (High-Demand Case) by 2050.
- The technologies, policy frameworks and investment needs outlined in this roadmap could limit the potential increase of CO_2 emissions to between 275 $MtCO_2$ and 468 $MtCO_2$ by 2050.
- The milestones set out in this roadmap for the Indian cement industry would enhance energy security by saving between 377 petajoules (PJ) and 485 PJ of energy in 2050 compared to a business-as-usual scenario.
- Key levers to reduce emissions in the Indian cement industry are: increased rates of blending and alternative fuel/raw materials (AFR) use, widespread implementation of waste heat recovery (WHR) systems and a radical step change in new technology development.
- To ensure widespread deployment and implementation of such technologies in the future, social acceptance, political will and policy development, and financial mechanisms, must be supportive.
- The additional investment required to reach emissions reduction envisioned in this roadmap is between USD 29 and USD 50 billion (INR 145 000 crore and INR 250 000 crore), or 15% to 25% higher than in a business-as-usual scenario. Such investments need to be designed effectively and put in place at the early design stage of a new cement plant.

Contribution of different levers that could lead to energy savings in the Low-Demand Case



Note: From the five levers considered – AFR, thermal and electrical efficiency, clinker substitution, WHR, and new technologies and CCS – only three will play a role in restraining the growth in energy consumption in the Indian cement industry. AFR is not expected to reduce energy consumption, new or alternative technologies such as nanotechnology or geopolymer cement are not expected to be commercially available by 2050, and CCS is likely to increase energy use.

CO_2 emissions reduction potential between the 6°C Scenario (6DS, or business-as-usual scenario) and 2°C Scenario (2DS) from different technology options in the Low-Demand Case



Note: Total savings between the 6DS and 2DS amount to 212 $MtCO_2$.

Roadmap action plan and milestones:

	2012	2015	2020	2025	2030	2035	2040	2045	2050
Alternative fuel and raw materials	Implement appropriate policies and practices to facilitate increased use of AFR, and address public and market barriers for co-processing of AFR								
	Identify and classify suitable materials for AFR use		Further analysis to identify the right feed point for any specific AFR material and enforce quality control systems for AFR materials used						
	Disseminate information on existing AFR best practices and R&D already undertaken, including identification and mitigation of risks								
Thermal and electrical energy efficiency	Ensure financial support and incentives are in place to enable major retrofits in older cement plants. Eliminate energy subsidies that can act as barriers to implementation								
	Sustain funding to move from pilot to demonstration for fuel cell technologies, futuristic communition technologies and new types of low-carbon cement								
	Gather reliable industry-level energy and emissions data to track performance, identify benchmarks and set targets								
Clinker substitution	Develop standards and implement regulation for clinker substitutes, composite cement and Portland Limestone Cement			Update and revise standards to account for new blending sources					
	Continuous R&D to allow increased availability, and ensure quality of blending materials and clinker substitutes								
	Conduct R&D to enhance lime reactivity of dump ash/pond ash, activation of granulated slag, and to prove viability of blending materials from non-ferrous industries and mineral processing industries								
Waste heat recovery (WHR)	Further R&D to support the maximization of power generation from WHR systems			R&D to decrease investment costs and promote the use of appropriate technology					
	Ensure attractive financial incentives to enable widespread implementation of WHR								
Carbon use and CCS	R&D to support the use of CO_2 for algal growth at cement plants				Commercialisation of CO_2 use for algae growth				
	Oversee a near-term approach to facilitate development and finance for demonstration of carbon capture and storage technologies								
	Participate in the demonstration of a full-scale post-combustion cement plant and development of a pilot oxy-fuelled cement plant			Participate in the demonstration of a full-scale oxy-fuelled cement plant		Continue to accelerate commercial deployment of CCS			

Key actions in the next ten years

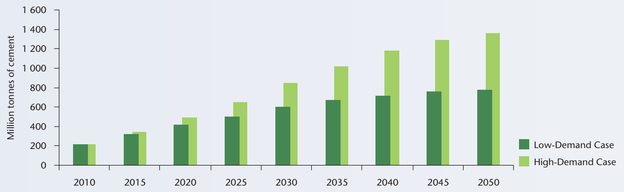
Decisive action by all stakeholders is critical to realise the vision laid out in this roadmap. To achieve the envisioned levels of efficiency improvements and emissions reduction, government and industry must take collaborative action to create an investment climate that will stimulate the scale of financing required. In particular:

- Intensify collaboration between stakeholders and among the international community to drive implementation of best available technologies and existing know-how, and to share experience and knowledge.
- Perform cement plant level assessments to analyse how low-carbon technologies can be implemented at the manufacturing facility level, and develop action plans to increase the speed and scale of implementation.
- Ensure proper legislation, regulations and standards are in place to enable increased use of clinker substitutes and to support the use of AFR in cement kilns.
- Address public and market barriers for co-processing[1] and AFR use through modified regulation, awareness-raising campaigns, industry training and education.
- Expand public awareness, international collaboration and financing for demonstration of carbon capture and carbon use for example through algal growth for carbon sequestration at cement plants. Globally, approaches to facilitate carbon capture and storage (CCS) demonstration must be elaborated.
- Ensure sustained funding and support mechanisms are in place to support the development and deployment of new or alternative technologies, such as nanotechnology and geopolymer cement, which offer the potential for CO_2 emissions reduction. Provide a major thrust in R&D to move through pilot to demonstration phases to widespread deployment.
- Facilitate widespread adoption of already-established low carbon technologies through financial mechanisms which channel adequate and predictable long-term finance to the industry in the form of CO_2 abatement revenues or up-front blended finance. All mechanisms should help accelerate the adoption of low carbon technology.

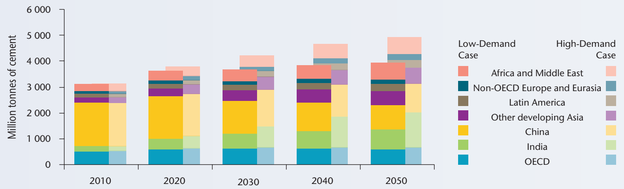
1. Co-processing is the use of suitable waste materials, generated by society or industry, in manufacturing processes, as a substitute for fossil fuel or natural raw materials.

Estimated cement production in the Low- and High-Demand Cases

Projected cement production in India



Projected cement production globally



Additional investments required to reach the CO_2 emissions in the 2DS from the 6DS (business-as-usual scenario) in India

Low-Demand Case					
USD billion	2010-20	2020-30	2030-40	2040-50	2010-50
New kilns and refurbishments	3 to 4	1	1	1	6 to 7
Clinker substitution	0.1	0.2	0.1	0.1	0.5 to 0.6
Alternative fuels	3	2	1	0	6 to 6
Carbon capture	0	3	6	8 to 9	17 to 19
Total	**6 to 7**	**5**	**8**	**10**	**29 to 32**
High-Demand Case					
USD billion	2010-20	2020-30	2030-40	2040-50	2010-50
New kilns and refurbishments	4 to 5	0	-2 to -3	-1	1 to 0
Clinker substitution	0.1	0.2	0.1 to 0.2	0	0.4 to 0.6
Alternative fuels	3 to 4	4	3	2	12 to 13
Carbon capture	1	5	11 to 13	16 to 17	33 to 36
Total	**8 to 9**	**9 to 10**	**13 to 13**	**17 to 18**	**46 to 50**

Notes: In a High-Demand Case, the savings from increased used of clinker substitutes will offset the additional investments required for new plants.

Additional investments are analysed for options that could lead to a reduction in direct CO_2 emissions in the cement production process. As such, this excludes waste heat recovery (WHR). Investments for WHR are estimated at approximately INR 80 to INR 100 million per megawatt hour (USD 1.6 to USD 2 million).

Reductions from captive power plants (CPP) are not included in the modelling of potential emissions reduction in this roadmap, but it should be noted that current investment requirements are approximately INR 5 crore (USD 1 million) per megawatt.

This information accompanies the *Technology Roadmap: Low Carbon Technology for the Indian Cement Industry*, available at www.iea.org and www.wbcsdcement.org/india-tech-roadmap.

Partners' roles

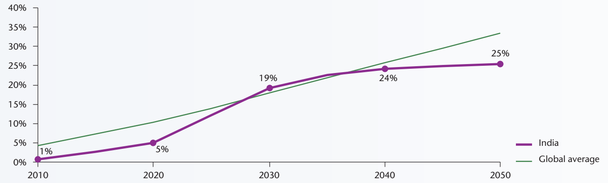
		Identifying and sharing best practices	***Driving technology research and development (R&D)***	***Driving technology diffusion and widespread uptake***	***Establishing / enhancing supportive institutional structures***	***Collecting, monitoring and assessing performance data***
Alternative fuel and raw materials	**Leadership role and direct involvement**	Industry; suppliers; associations	Industry; suppliers; government; universities; research	Industry; suppliers; associations	Industry; suppliers; government; universities; research; associations	Industry; universities
	Funding source	Suppliers; government	Industry; suppliers; government	Suppliers	Government	
Thermal and electrical energy efficiency	**Leadership role and direct involvement**	Industry; suppliers; government; research; associations	Industry; suppliers; universities; research	Industry; suppliers; associations	Industry; suppliers; government; universities; research; associations	Industry; government; research; associations
	Funding source	Suppliers; government	Industry; suppliers; government	Industry; suppliers; government	Government	
Clinker substitution	**Leadership role and direct involvement**	Industry; suppliers; research; associations; standards agencies	Industry; suppliers; universities; research; standards agencies	Industry; suppliers; associations; standards agencies	Industry; suppliers; government; universities; research; associations; standards agencies	Industry; universities; research; associations; standard
	Funding source		Industry; government	Industry; government		Industry
Waste heat recovery (WHR)	**Leadership role and direct involvement**	Industry; suppliers; associations	Industry; suppliers; universities; research	Industry; suppliers; associations	Industry; suppliers; government; universities; research; associations	Industry; universities; associations
	Funding source		Industry; suppliers; government	Government; industry		Industry
New technologies including CCS	**Leadership role and direct involvement**	Industry; suppliers; research; associations	Industry; suppliers; universities; research	Industry; suppliers; research; associations	Industry; suppliers; government; universities; research; associations	Industry; universities; research; associations
	Funding source		Industry; suppliers; government	Government; suppliers		Industry
Captive power plant (CPP)	**Leadership role and direct involvement**	Industry; suppliers; associations	Industry; suppliers; universities; research	Industry; suppliers; associations	Industry; suppliers; government; universities; research; associations	Industry; universities; associations
	Funding source		Industry; suppliers; government	Government		

Note: Industry = cement industry in India; suppliers = equipment suppliers; government = Government of India; associations = industry associations; research = research institutions; universities = universities and academic institutions.

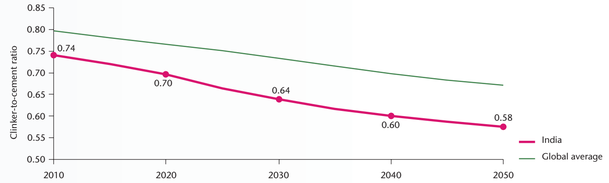
Low-Carbon Technology for the Indian Cement Industry

Key indicators for Indian cement industry to reach 2DS

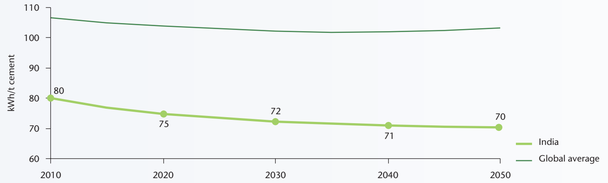
Progress indicator for share of alternative fuels and raw materials (AFR) in thermal energy use



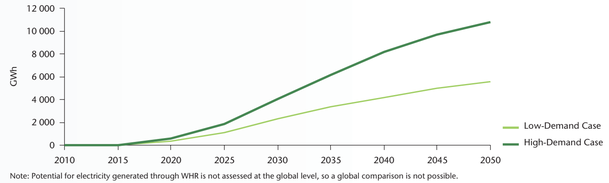
Progress indicator for clinker-to-cement ratio



Progress indicator for specific intensity of electrical requirements (excl. potential from WHR)

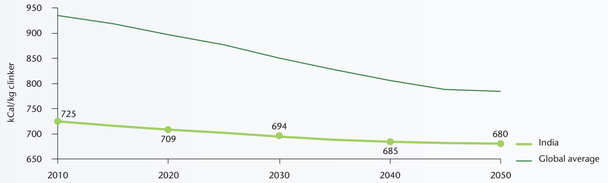


Progress indicator for additional electricity generated through WHR at cement plants

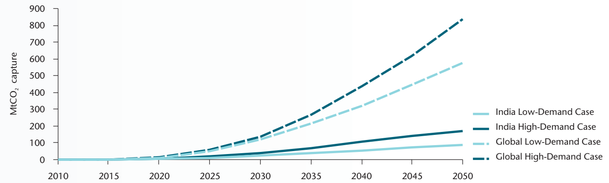


Note: Potential for electricity generated through WHR is not assessed at the global level, so a global comparison is not possible.

Progress indicator for specific intensity of thermal heat requirements



Progress indicator for carbon captured by global and Indian cement industry



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