The Indian cement industry is one of the most efficient industries in the world, yet it still produces 137 MtCO₂ emissions. The key levers to reduce emissions in the Indian cement industry are: increased rates of blending and use of alternative fuel/raw materials (AFR), widespread deployment of waste heat recovery (WHR) systems, and CCS. The technologies, policy frameworks and financial incentives required to achieve the vision laid out in this roadmap. To achieve the envisioned 488 MtCO₂ equivalent of 32% CO₂ emissions reductions by 2050. Decisive action by all stakeholders is critical to realise the envisioned 488 MtCO₂ reduction potential by 2050.

**Key findings**
- The Indian cement industry has already achieved a reduction in total emissions to a level of approximately 30% of its total coal use (65 MtCO₂, 2015).
- The Indian cement industry is expected to be the largest single contributor to the global CO₂ emissions, approximately 10% of India’s total man-made CO₂ emissions.
- In the absence of aggressive technology development, policy action, and consistent efforts from the cement industry, emissions to 2030 will be substantially higher than 2015.
- In order to achieve the resource requirements of technology development, policy action, and consistent efforts from the cement industry, policy action, and consistent efforts from the cement industry, policy action, and consistent efforts from the cement industry, policy action, and consistent efforts from the cement industry.

**Roadmap action plan and milestones:**
- Implement appropriate policies and incentives to facilitate increased use of AFR and enable public and market-based mechanisms for improving AFR.
- Develop standards and implement regulation for clinker substitutes, composite cement and Portland Limestone Cement.
- Ensure financial support and incentives are in place to support the development and deployment of low-carbon technologies.
- Gather reliable industry-level energy and emissions data to track performance, identify benchmarks and set targets.
- 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.
- 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.
- Continuous R&D to allow increased availability, and to ensure quality of blending materials and clinker substitutes.
- Develop standards and implement regulation for clinker substitutes, composite cements and Portland Limestone Cement.
- Establish mechanisms to move from pilot to demonstration for fuel cell technologies, futuristic communication technologies and new types of low-carbon cement.

**Key actions in the next ten years**
- Oversee a near-term approach to facilitate development and finance for demonstration of carbon capture and storage technologies.
- 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.
- Further R&D to support the maximisation of power generation from WHR systems.
- Ensure financial support and incentives are in place to support the development and deployment of low-carbon technologies.
- 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.
- External lean process to facilitate carbon capture and storage (CCS) demonstration.
- Further R&D to support the maximisation of power generation from WHR systems.
- Ensure financial support and incentives are in place to support the development and deployment of low-carbon technologies.
- Demonstrate 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 plant oxy-fuelled cement plant.
- 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.
- Ensure financial support and incentives are in place to support the development and deployment of low-carbon technologies.
Additional investments required to reach the CO₂ emissions in the 2DS from the 4DS (business-as-usual scenario) in India

<table>
<thead>
<tr>
<th>Case</th>
<th>New kilns and refurbishments</th>
<th>Alternative fuels</th>
<th>Carbon capture</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-Demand Case</td>
<td>$180 to $280 million</td>
<td>$15 to $20 million</td>
<td>$85 to $110 million</td>
<td>$400 to $500 million</td>
</tr>
<tr>
<td>High-Demand Case</td>
<td>$220 to $320 million</td>
<td>$20 to $30 million</td>
<td>$110 to $140 million</td>
<td>$550 to $650 million</td>
</tr>
</tbody>
</table>

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

Progress indicator for clinker-to-cement ratio

<table>
<thead>
<tr>
<th>Year</th>
<th>Low-Demand Case</th>
<th>High-Demand Case</th>
<th>India</th>
<th>Global average</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>0.60</td>
<td>0.65</td>
<td>0.60</td>
<td>0.60</td>
</tr>
<tr>
<td>2020</td>
<td>0.65</td>
<td>0.70</td>
<td>0.65</td>
<td>0.65</td>
</tr>
<tr>
<td>2030</td>
<td>0.70</td>
<td>0.75</td>
<td>0.70</td>
<td>0.70</td>
</tr>
<tr>
<td>2040</td>
<td>0.75</td>
<td>0.80</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>2050</td>
<td>0.80</td>
<td>0.85</td>
<td>0.80</td>
<td>0.80</td>
</tr>
</tbody>
</table>

Notes: The indicators are based on the cement industry’s suppliers’ emissions, government’s investment in CCS, industry associations’ leadership role, and universities’ research and development (R&D).