GHG Reduction Potentials In The Indian Cement Industry: A Way Forward

KN Rao
Director, Energy & Environment
ACC Limited (LafargeHolcim)
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GHG Scenario - India

Total Emission - 2070000 ktco$_2$  Cement Industry (7%) - 144900 ktco$_2$

Indian Industry (65%)  Cement industry (10.8%)
Cement Technology Roadmap – Global (2009)

Emissions reduction levers:
- Energy efficiency
- Alternative fuels
- Clinker substitution
- CCS
Technology roadmap in India - 2012

Roadmap partners

In consultation with

Principal supporter

Industry supporters

www.wbcsdcement.org/india-tech-roadmap
Cement Technology Roadmap - India

Context:

- Second largest cement producer after China
- One of the most efficient in the world

<table>
<thead>
<tr>
<th></th>
<th>Range</th>
<th>Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal kCal/kg</td>
<td>650-1200</td>
<td>725</td>
</tr>
<tr>
<td>Electrical kWh/T cem</td>
<td>65 – 110</td>
<td>80</td>
</tr>
</tbody>
</table>

- Reduced total direct and indirect CO₂ emissions to an industrial average of 0.719 tonne (t) of CO₂/t cement in 2010 from a substantially higher level of 1.12 tCO₂/t cement in 1996
- In a BAU, CO₂ emissions projected to reach between 490 - 835 million tonnes (Mt) of CO₂ by 2050; a 255% to 510% increase compared to 2010 levels
- Extremely low AFR usage
- High dependency on CPP Power
- Mostly bagged cement
‘Low Carbon Technology Roadmap for the Indian Cement Industry’

Phase I
- Technology papers
- Cement demand data, data modeling, analysis
- Data coverage (85%+)
- Stakeholder outreach
  - Technology
  - Financing
  - Policy
  - Stakeholder & partner review

Phase II
- Individual plant-level analysis of roadmap
  - Potential investments identified
Cement Technology Roadmap - India

Roadmap approach:

- The road map modelling has been developed in response to the IEA 2°C (2DS) and its two variants, based on demand for materials: the Low- and High-Demand Cases

Roadmap Scope and Boundary:

- Surface mining/quarrying to the sale of cement to consumer,
- Energy and emission reduction levers specific to the cement manufacturing process
- CPP is out of scope of Cement manufacturing process and so not included in modeling
Cement Technology Roadmap - India

✓ Key levers to reduce emissions in Indian cement industry viz. increased rates of blending leading to a reduction in clinker factor etc., are identified and discussed in detail

✓ By 2050, as much as 150 MtCO$_2$ could be saved through efficiency improvement and use of alternative energy sources in CPPs

✓ Additional investment requirements (based on net present value) to achieve the CO$_2$ emissions reduction set out in this roadmap are between USD 29 billion to USD 47 billion, or 15% to 25% higher than in a BAU scenario
Roadmap findings (low demand scenario)

CO₂ emissions reduction

- 6DS: 488 MtCO₂
- 2DS: 275 MtCO₂

CO₂ intensity reduction

- 6DS: 0.62 tCO₂/t cement
- 2DS: 0.35 tCO₂/t cement

Notes: Includes only direct CO₂ emissions from cement manufacturing; indirect emissions from the use of electricity are not taken into account.

**KEY POINT:** Total savings between the 6DS and 2DS amount to 212 MtCO₂.
Socio-economic benefits derived from Roadmap levers

- **Clinker substitution & Increased AFR usage**
  - Decreases loads on landfills & incinerators & their environmental impacts, including: potential groundwater pollution, methane generation and hazardous ash residues
  - Properly designed and operated cement kilns can provide a practical, cost-effective and environmentally effective alternative to landfill and incineration
  - Energy and materials recovery, offering safe disposal options for many different types of waste
  - Creating safer livelihoods by bringing waste scavengers into the organized sector
  - Energy plantations create sustainable livelihoods in rural areas
  - Conservation of limestone & fossil fuel
Socio-economic benefits derived from Roadmap levers

• **Energy efficiency**
  - Reduction in consumption of coal and other fossil fuels has a direct bearing on contributing to the energy security of the country
  - Electricity access for all due to reduction in demand
  - Conservation of fossil fuels
  - Opportunity for job creation and GDP growth

• **Carbon capture & utilisation**
  - Conversion of CO$_2$ to chemicals or fuel
    - Reduces dependence on natural raw materials and fuels
    - Minimizing CO$_2$ mitigation costs
Additional investments required to reach the CO$_2$ emissions in the 2DS from the 6DS (business-as-usual scenario) in India

<table>
<thead>
<tr>
<th></th>
<th>Low-Demand Case</th>
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</tr>
</thead>
<tbody>
<tr>
<td>USD billion</td>
<td>2010-20</td>
<td>2020-30</td>
<td>2030-40</td>
<td>2040-50</td>
<td>2010-50</td>
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<tr>
<td>New kilns and refurbishments</td>
<td>3 to 4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>6 to 7</td>
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<tr>
<td>Clinker substitution</td>
<td>0.1</td>
<td>0.2</td>
<td>0.1</td>
<td>0.1</td>
<td>0.5 to 0.6</td>
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<tr>
<td>Alternative fuels</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>6 to 6</td>
</tr>
<tr>
<td>Carbon capture</td>
<td>0</td>
<td>3</td>
<td>6</td>
<td>8 to 9</td>
<td>17 to 19</td>
</tr>
<tr>
<td>Total</td>
<td>6 to 7</td>
<td>5</td>
<td>8</td>
<td>10</td>
<td>29 to 32</td>
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</table>

<table>
<thead>
<tr>
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<td>USD billion</td>
<td>2010-20</td>
<td>2020-30</td>
<td>2030-40</td>
<td>2040-50</td>
<td>2010-50</td>
</tr>
<tr>
<td>New kilns and refurbishments</td>
<td>4 to 5</td>
<td>0</td>
<td>-2 to -3</td>
<td>-1</td>
<td>1 to 0</td>
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<tr>
<td>Clinker substitution</td>
<td>0.1</td>
<td>0.2</td>
<td>0.1 to 0.2</td>
<td>0</td>
<td>0.4 to 0.6</td>
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<tr>
<td>Alternative fuels</td>
<td>3 to 4</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>12 to 13</td>
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<tr>
<td>Carbon capture</td>
<td>1</td>
<td>5</td>
<td>11 to 13</td>
<td>16 to 17</td>
<td>33 to 36</td>
</tr>
<tr>
<td>Total</td>
<td>8 to 9</td>
<td>9 to 10</td>
<td>13 to 13</td>
<td>17 to 18</td>
<td>46 to 50</td>
</tr>
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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.
Phase 2 outcomes (Summary of findings from 5 plants with 15.3 MTPA share)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>No. of Projects</th>
<th>Mio (USD)</th>
</tr>
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<tbody>
<tr>
<td>Total Annual Saving</td>
<td>259</td>
<td>20.24</td>
</tr>
<tr>
<td>Annual saving without investment</td>
<td>47</td>
<td>1.23</td>
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<tr>
<td>Annual saving with investment</td>
<td>212</td>
<td>19.01</td>
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<tr>
<td>Investment required</td>
<td>212</td>
<td>68.31</td>
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<tr>
<td>Simple payback period</td>
<td>Months</td>
<td>43</td>
</tr>
<tr>
<td>GHG Reduction Potential</td>
<td>MTPA</td>
<td>375631</td>
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</table>
## Phase 2 outcomes (Status of implementation in 3 plants)

<table>
<thead>
<tr>
<th>Summary of Achievements</th>
<th>Unit</th>
<th>Identified</th>
<th>Implemented</th>
<th>%</th>
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</thead>
<tbody>
<tr>
<td>Name of the facility</td>
<td>TOTAL FOR 3 FACILITIES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No of Energy saving projects (ESP) Implemented</td>
<td>Nos.</td>
<td>168</td>
<td>67</td>
<td>39.9</td>
</tr>
<tr>
<td>Investment</td>
<td>Mio USD</td>
<td>46.49</td>
<td>0.40</td>
<td>0.01</td>
</tr>
<tr>
<td>Energy Cost Savings</td>
<td>Mio USD/Yr</td>
<td>12.09</td>
<td>1.57</td>
<td>0.02</td>
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<tr>
<td>Total CO₂ Emission Reduction from ESPs</td>
<td>tCO₂</td>
<td>245463</td>
<td>33748</td>
<td>13.7</td>
</tr>
</tbody>
</table>
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Two thirds outside of China

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