Cement is a key material for building society’s infrastructure. Demand for cement is driven by rapid urbanisation, economic development and population growth in emerging markets. International collaboration and public-private partnerships must be encouraged to help speed up research, design, development and deployment of necessary new technologies.

**Carbon capture and storage**

Four distinct “reduction levers” are available to the cement sector to reduce CO₂ emissions:

1. **Thermal and electric efficiency**: deployment of existing state-of-the-art technologies in new cement plants and retrofit of energy efficiency equipment where economically viable.
2. **Alternative fuels**: use of less carbon-intensive fossil fuels and more alternative (fossil) fuels and biomass fuels in the cement production process.
3. **Clinker substitution**: substituting carbon-intensive clinker, an intermediate in cement manufacture, with other, lower-carbon materials with cementitious properties.
4. **Carbon capture and storage (CCS)**: capturing and storing CO₂ emissions from cement production.

Cement is a key material for building society’s infrastructure. Demand reduction and/or substitution are not realistic options given growth in developing countries, increasing urbanisation and climate change adaptation needs.

**Key findings**

- Existing options to reduce emissions in the sector, while helpful, are not sufficient to counteract growth in demand. New products and technologies are needed, including CCS and new cement types.
- These new technologies will require a step change in RD&D efforts; the roadmap provides a vision for what is needed between today and 2050.
- CCS is a particularly important technology for the cement sector, required to deliver up to half of the emissions reductions needed by 2050. This will require advancement of demonstration projects in the cement sector over the next decade, to learn in parallel with other sectors how to best apply CCS technology at the necessary scale.
- The high cost of reducing CO₂ emissions in the sector will require markets with long-term stability and resultant confidence in the pricing of CO₂ by those markets.
- International collaboration and public-private partnerships must be encouraged to help speed up research, design, development and deployment of necessary new technologies.

**Cement sector CO₂ emissions reductions below the baseline, low demand scenario, 2010-2050**

<table>
<thead>
<tr>
<th>Year</th>
<th>Direct emissions (Gt CO₂)</th>
<th>CO₂ emissions reductions</th>
<th>Baseline emissions</th>
<th>Alternative fuel use and other fuel switching</th>
<th>Clinker substitution</th>
<th>Carbon capture and storage (CCS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>2.34</td>
<td>1.88</td>
<td>2.34</td>
<td>24%</td>
<td>10%</td>
<td>56%</td>
</tr>
<tr>
<td>2020</td>
<td>2.33</td>
<td>2.20</td>
<td>2.20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2030</td>
<td>2.22</td>
<td>1.86</td>
<td>1.86</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2040</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2050</td>
<td></td>
<td></td>
<td>1.35</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Regional cement production: 2006, 2015, 2030 and 2050

This paper provides a summary of the Cement Technology Roadmap 2009 which can be found in full at www.iea.org/roadmaps

Key regional milestones

This roadmap aims to propose tangible policy recommendations for governments around the world and as is written with a broad, global view. However, it acknowledges the wide differences between regions for many aspects of cement industry technology development and implementation. There are differences, for example, in alternative fuel availability, and in building standards enabling or preventing higher clinker substitution. It is key that nationally appropriate policies should be developed to reinforce this roadmap’s broad recommendations.

This map and figures show estimated cement production for the years 2006, 2015, 2030 and 2050, and regional breakdown of forecast production under BLUE high and low demand scenarios.

Between 2006 and 2050, cement production is projected to grow by 0.8-1.2% per year, reaching between 3,700 megatonnes (Mt) and 4,400 Mt in 2050. This represents a 43-72% increase compared to production in 2006.

Cement consumption in China, which currently accounts for just under half of total production, is expected to peak between 2015 and 2030, as per capita cement consumption declines towards more developed country levels. Post-2030 global cement production will be fuelled by strong demand growth in India and other developing Asian countries, and in Africa and the Middle East.

Regional cement production: 2006, 2015, 2030 and 2050

Canada and United States

Europe Union 25

Other OECD Europe

Economies in transition

China

Latin America

Other developing Asia

OECD Pacific

Africa and Middle East

India

Other developing Asia

Economies in transition

This paper provides a summary of the Cement Technology Roadmap 2009 which can be found in full at www.iea.org/roadmaps

Regional cement production: 2006, 2015, 2030 and 2050

Canada and United States

Energy use (Mtoe)

Share of alternative fuel use

Clinker to cement ratio

CO2 captured (Mt)

European Union 25

Energy use (Mtoe)

Share of alternative fuel use

Clinker to cement ratio

CO2 captured (Mt)

Other OECD Europe

Energy use (Mtoe)

Share of alternative fuel use

Clinker to cement ratio

CO2 captured (Mt)

OECD Pacific

Energy use (Mtoe)

Share of alternative fuel use

Clinker to cement ratio

CO2 captured (Mt)

China

Energy use (Mtoe)

Share of alternative fuel use

Clinker to cement ratio

CO2 captured (Mt)

Alternative fuel shares presented exclude the additional energy requirement for CCS. The CO2 storage figures presented here are based on capture potentials. Additional analysis is needed to verify the storage potentials in different regions.
This paper provides a summary of the Cement Technology Roadmap 2009 which can be found in full at www.iea.org/roadmaps.
Cement is a key material for building society’s infrastructure. Demand from developing countries, increasing urbanisation and climate change adaptation needs.

Four distinct “reduction levers” are available to the cement sector to reduce CO₂ emissions:

1. **Thermal and electric efficiency**: deployment of existing state-of-the-art technologies in new cement plants, and retrofit of energy efficiency equipment where economically viable.
2. **Alternative fuels**: use of less carbon-intensive fossil fuels and more alternative (fossil) fuels and biomass fuels in the cement production process.
3. **Clinker substitution**: substituting carbon-intensive clinker, an intermediate in cement manufacture, with other, lower-carbon materials with cementitious properties.
4. **Carbon capture and storage (CCS)**: capturing and storing CO₂ emissions from cement production.

- **Cement** is a key material for building society’s infrastructure. Demand reduction and/or substitution are not realistic options given growth in developing countries, increasing urbanisation and climate change adaptation needs.

**Key findings**

- Existing options to reduce emissions in the sector, while helpful, are not sufficient to counteract growth in demand. New products and technologies are needed, including CCS and new cement types.
- These new technologies will require a step change in RD&D efforts; the roadmap provides a vision for what is needed between today and 2050.
- CCS is a particularly important technology for the cement sector, required to deliver up to half of the emissions reductions needed by 2050. This will require advancement of demonstration projects in the cement sector over the next decade, to learn in parallel with other sectors how to best apply CCS technology at the necessary scale.
- The high cost of reducing CO₂ emissions in the sector will require markets with long-term stability and resultant confidence in the pricing of CO₂ by those markets.
- International collaboration and public-private partnerships must be encouraged to help speed up research, design, development and deployment of necessary new technologies.

---

### Cement roadmap milestones

<table>
<thead>
<tr>
<th><strong>2010</strong></th>
<th><strong>2020</strong></th>
<th><strong>2030</strong></th>
<th><strong>2040</strong></th>
<th><strong>2050</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy efficiency</strong></td>
<td><strong>Clinker substitution</strong></td>
<td><strong>Carbon capture and storage</strong></td>
<td><strong>Alternative fuel use and fuel switching</strong></td>
<td><strong>Diffusion of BAT: phase-out of wet kilns in OECD</strong></td>
</tr>
</tbody>
</table>

**Research and development (R&D)**

- **Demonstration**
- **Deployment**
- **Commercialisation**

---

**International Energy Agency**

[www.iea.org/roadmaps](http://www.iea.org/roadmaps)

---

**CEMENT ROADMAP**

Cement sector CO₂ emissions reductions below the baseline, low demand scenario, 2010-2050

- **Baseline emissions**: 2.34 Gt
- **CO₂ emissions reductions**: 1.88 Gt
- **BLUE emissions**: 1.55 Gt
- **Alternative fuel use and other fuel switching**: 24%

---

**CEMENT ROADMAP milestones**

<table>
<thead>
<tr>
<th><strong>2010</strong></th>
<th><strong>2020</strong></th>
<th><strong>2030</strong></th>
<th><strong>2040</strong></th>
<th><strong>2050</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy efficiency</strong></td>
<td><strong>Clinker substitution</strong></td>
<td><strong>Carbon capture and storage</strong></td>
<td><strong>Alternative fuel use and fuel switching</strong></td>
<td><strong>Diffusion of BAT: phase-out of wet kilns in OECD</strong></td>
</tr>
</tbody>
</table>

**Research and development (R&D)**

- **Demonstration**
- **Deployment**
- **Commercialisation**

---

**International Energy Agency**

[www.iea.org/roadmaps](http://www.iea.org/roadmaps)

---

**Key findings**

- Four distinct “reduction levers” are available to the cement sector to reduce CO₂ emissions:
  1. **Thermal and electric efficiency**: deployment of existing state-of-the-art technologies in new cement plants, and retrofit of energy efficiency equipment where economically viable.
  2. **Alternative fuels**: use of less carbon-intensive fossil fuels and more alternative (fossil) fuels and biomass fuels in the cement production process.
  3. **Clinker substitution**: substituting carbon-intensive clinker, an intermediate in cement manufacture, with other, lower-carbon materials with cementitious properties.
  4. **Carbon capture and storage (CCS)**: capturing and storing CO₂ emissions from cement production.

---

**International Energy Agency**

[www.iea.org/roadmaps](http://www.iea.org/roadmaps)

---

**World Business Council for Sustainable Development**

[www.wbcsd.org](http://www.wbcsd.org)