Industry Technology Roadmaps: a focus on Cement

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The global challenge: Climbing down the mountain

“Getting to the top is optional. Getting down is mandatory.”
Ed Viesturs
Remaining CO₂ emissions from industry and transport in the 2DS by 2060 need to be compensated with negative emissions to achieve net-zero energy sector by 2060 in the B2DS.
How do we get there? – Technology Roadmaps

**CONTEXT**
- What is the status of the technology today?
- What alternative technology options there may be available in the long-run?
- What data are needed to establish baseline conditions?

**DIAGNOSIS AND MILESTONES SETTING**
- What analytic capabilities and tools are needed to evaluate technology pathways?
- What technical expertise is needed to evaluate technology performance and limitations?

**PRIORITISING ACTION**
- Which regulators and policy leaders can provide insight on factors affecting technology adoption?
- Which private entities will be key to technology success?

**STAKEHOLDERS’ ENGAGEMENT**
IEA Technology Roadmaps: a living library

Over 30 TRMs developed and 22 technologies covered
The challenge of the sustainable transformation of industry

Significant transformations would be needed in all industrial sectors to achieve a 40% and 75% reduction of direct CO₂ emissions by 2060 compared to current levels.

Source: IEA Energy Technology Perspectives, 2017
Industry-related IEA Technology Roadmaps

Final industrial energy use, 2014 (EJ)

- Iron & steel
- Chemical & petrochemical
- Non-metallic minerals
- Non-ferrous metals
- Transport equipment
- Machinery
- Mining & quarrying
- Food & tobacco
- Paper, pulp & print
- Wood & wood products
- Construction
- Textile & leather
- Non-specified (industry)

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Global cement sector indicators, 2014

**Final energy use**
- 3\(^{rd}\) industrial energy user
- 2\(^{nd}\) industrial coal use

**Direct CO\(_2\) emissions**
- 2\(^{nd}\) industrial CO\(_2\) emitter
- 1\(^{st}\) industrial process CO\(_2\) emitter

**Estimated average cement composition**
- Reliance on industrial by-products

- **Clinker**
- **Fly ash**
- **Natural pozzolana**
- **Calcined clay**

- **BF & Steel slag**
- **Limestone**
- **Gypsum**
Strong growth in cement production growth in developing Asian countries compensates for the decline in Chinese cement sector activity.
Strategies to reduce CO₂ emissions from cement production

- Carbon emissions reduction levers can influence the potential for emissions reductions of other options.
- For instance,
  - Alternative fuels use typically requires greater thermal energy compared to conventional fossil fuels due to lower calorific content and required kiln operating conditions.
  - Carbon capture equipment requires additional energy to operate.
  - Reducing the clinker-to-cement ratio may involve the use of cement constituents requiring energy in their preparation process (e.g. calcined clay).
A 32% reduction in the global direct CO\textsubscript{2} intensity of cement by 2050 in the 2DS is supported by

- Energy efficiency levels reaching best performing levels
- A reduction of fossil fuels share in cement kilns of 26%
- Significant reductions of the clinker-to-cement ration across regions, reaching a global level of 0.6 by 2050
- Integrating carbon capture technologies in cement production with CO\textsubscript{2} captured reaching around 30% of the generated direct CO\textsubscript{2} by 2050
Alternative binding materials open possibilities for reductions of process CO₂ emissions in cement manufacturing but raw materials and operational costs, limited market applicability and standards, as well as further R&D needs in some cases, limit further deployment.

Note: PC = Portland cement, CSA = calcium sulfoaluminate, BCSA = belite calcium sulfoaluminate, CACS = carbonation of calcium silicates, MOMS = magnesium oxide derived from magnesium silicates. OPC clinker mainly contains 63% alite, 15% belite, 8% tricalcium aluminate and 9% tetracalcium alumino-ferrite. Belite clinker is considered to mainly contain 62% belite, 16% alite, 8% tricalcium aluminate and 9% tetracalcium alumino-ferrite. CSA clinker is considered to mainly contain 47.5% ye’elimite, 23.9% belite, 12.9% wollastonite and 8.6% tetracalcium alumino-ferrite. BCSA clinker is considered to mainly contain 46% belite, 35% ye’elimite and 17% tetracalcium alumino-ferrite. Commercial compositions of CACS clinker are not currently available. CACS clinker in this assessment is considered to primarily consist of wollastonite but commercial composition is likely to be different at some extent, and possibly higher in process CO₂ emissions. Process CO₂ emissions generated in CACS clinker making are in principle re-absorbed during the curing process.

Global Cement Technology Roadmap: a living process

Encompassing projects


- IEA analytical support to
  - Forthcoming Brazil Cement Technology Roadmap.
  - Forthcoming report to track progress of the India Cement Industry since 2013 when the national IEA/CSI cement roadmap was launched.