Decarbonizing the cement and concrete sector:
Integration of the full value chain to reach net zero emissions in Europe

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Objective:
How to decarbonise cementitious construction sector in Europe in the short, medium and long term?

The project was funded by the European Climate Foundation.

It is a follow up of the UNEP study which looked only Target only at cement and concrete.
Strategy: Look at the complete value chain

Different level of actions among all stakeholders

Interviews with
- European associations
- Constructors
- Cement producers
Technology assessment:
Look at all technologies available along the value chain

- Less CO$_2$ in clinker production
- Less clinker in cement (or blended in concrete)

Technologies used by cement and concrete roadmaps.

& by IPCC Chapter on industry
Technology assessment:
Look at all technologies available along the value chain

- Less CO$_2$ in clinker production
- Less clinker in cement (or blended in concrete)
- Less cement in concrete
- Less concrete in buildings

Technologies used by engineers & architects
And absent of both Industry and buildings chapter in IPCC
Detail concrete technology:
Over consumption of cement can be reduced by better granular packing

Detail concrete technology:
Over consumption of concrete can be reduced by better structural design

4,500 kg CO₂/seat

Definition of scenarios:
2 main bottlenecks for innovation in construction have been identified:

- Lack of investment
- Lack of integration of the different stakeholders in the value chain
Reference scenario: BAU

**Reference Scenario**

**Degree of Implementation**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>2015</th>
<th>2030</th>
<th>2050</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency of clinker production</td>
<td></td>
<td></td>
<td></td>
<td>Clinker scale</td>
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<tr>
<td>Alternative fuels</td>
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<td></td>
<td>Clinker scale</td>
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<tr>
<td>Clinker substitution</td>
<td></td>
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<td></td>
<td>Cement Scale</td>
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</tbody>
</table>

**CO₂ Savings Compared to 1990**

- 40% in 2015
- 45% in 2030
- 55% in 2050

*Note: Values for Alternative fuels and Clinker substitution are based on estimates and may not reflect actual implementation.*
**Scenario 1: High investment**

*Technology breakthrough*

+ 10%/20% compared to reference scenario

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**SCENARIO 1: BREAKTHROUGH TECHNOLOGY**

<table>
<thead>
<tr>
<th>Efficiency of clinker production</th>
<th>2015</th>
<th>2030</th>
<th>2050</th>
<th>SCALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinker scale</td>
<td>80%</td>
<td>83%</td>
<td>84%</td>
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</table>

<table>
<thead>
<tr>
<th>Alternative fuels</th>
<th>2015</th>
<th>2030</th>
<th>2050</th>
<th>SCALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinker scale</td>
<td>33%</td>
<td>40%</td>
<td>60%</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>% SCM substitution</th>
<th>2015</th>
<th>2030</th>
<th>2050</th>
<th>SCALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement</td>
<td>23%</td>
<td>30%</td>
<td>35%</td>
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</table>

<table>
<thead>
<tr>
<th>Carbon capture and storage</th>
<th>2015</th>
<th>2030</th>
<th>2050</th>
<th>SCALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinker scale</td>
<td>0%</td>
<td>0-5%</td>
<td>25-50%</td>
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</table>

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<thead>
<tr>
<th>Alternative binders</th>
<th>2015</th>
<th>2030</th>
<th>2050</th>
<th>SCALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement</td>
<td>0%</td>
<td>0-12%</td>
<td>10-25%</td>
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</table>

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<thead>
<tr>
<th>CO₂ savings compared to 1990</th>
<th>2015</th>
<th>2030</th>
<th>2050</th>
<th>SCALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>40%</td>
<td>50%</td>
<td>65-75%</td>
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</table>
Scenario 2 & 3: Low investment
Optimisation & circular economy

+ 20% compared to reference scenario
Different implication of the stakeholders along the value chain

- **Dry technology implementation** → Savings by cement producers
- **Alternative fuels** → Savings by waste managers
- **%SCM** → Savings by cement producers
  → Savings by the construction companies
- **% fine recycling** → Saving as demolition recycling companies
Different implication of the stakeholders along the value chain

- **Improve packing & reduce overestimation → Savings by concrete producers**

- **Use appropriate exposition class → Savings by engineering offices**

- **Optimise structure → Savings by engineering offices**

- **Reuse structure → Savings by demolition companies**

- **Carbon Capture and Storage → Savings by cement producers**
Different implication of the stakeholders along the value chain
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Different implication of the stakeholders along the value chain
Different implication of the stakeholders along the value chain

we can achieve similar results with much lower investment by implementing savings along the value chain
Stakeholder involvement

Barriers to act

- Dry technology implementation
  ➔ Savings by cement producers
  Require high investment on old infrastructures or closing old cement plants

- Alternative fuels
  ➔ Savings by waste managers
  Require better waste management and increase of incineration practices inside EU

- %SCM
  ➔ Savings by cement producers
  ➔ Savings by the construction companies
  As EU will run out of GBFS and FA, it requires investment in calciner for the development of calcined clays

- % fine recycling
  ➔ Saving as demolition recycling companies
  Require good separation technique on demolition site (time pb) and better crushing & sorting technique on recycling facilities (cost pb)

Higher SCM content is slowing down the construction speed. It requires more formwork on construction site (space and cost pb) or slower demolding (productivity pb)
Stakeholder involvement

But it requires more time for design and forces engineering office to take a risk in case of problem (no constraints in bidding call)

But it involves high investment (CAPEX) and will induce additional cost for cement production (OPEX)
Indicators

*KPI to involve all actors*

- We need indicators by stakeholders
  - Upstreams indicators already exist
  - Downstream (building scale) also – voluntary basis
  - No indicators to involve concrete companies, engineering offices
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- Example of possible indicators
  - For cement producers: a clinker with less than 0.7 t CO₂/tclinker
  - For concrete producers: a standard concrete containing less than 3.5 kg clinker/m³/MPa
  - For structural engineers: a structure containing less than 250 kg CO₂/ m² of building
  - For construction companies: a building containing less than 500 kg CO₂/m²
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  - For construction companies: a building containing less than 500 kg CO$_2$/m$^2$

- Example of possible incentives to drive transformation
  - Extra m$^2$ allowance for contractor when using low carbon to counterbalance reduction of productivity
  - Subsidies for extra silo capacities in concrete and gravel producers
Change in the risk culture

(From D. Hall, 2017)
Change in the risk culture

(From D. Hall, 2017)
Change in the risk culture

(From D. Hall, 2017)

Development of integrated Project delivery
Change will happen

<table>
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<tr>
<th>Sector</th>
<th>Assets</th>
<th>Usage</th>
<th>Labor</th>
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<td>ICT</td>
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<td>Media</td>
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<td>Professional services</td>
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<td>Finance and insurance</td>
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<td>Wholesale trade</td>
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<td>Chemicals and pharmaceuticals</td>
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<td>Basic goods manufacturing</td>
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<td>Mining</td>
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<td>Transportation and warehousing</td>
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<td>Education</td>
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<td>Retail trade</td>
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<td>Entertainment and recreation</td>
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<td>Personal and local services</td>
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<td>Agriculture and hunting</td>
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1 Based on a set of metrics to assess digitalization of assets (8 metrics), usage (11 metrics), and labor (8 metrics).
2 Information and communications technology.
Potential of digitalization
Possibilities to involve all stakeholders through digitalization

Example 2: Visual monitoring of supply chain.

Sce: Irizarry et al., 2013. Integration BIM and GIS to improve the visual monitoring of construction supply chain management. Automation and Construction
Potential of digitalization

Possibilities to involve all stakeholders through digitalization

Example 3: Tracking of construction companies and task planning.

Sce: Aram et al., 2013. Requirement for BIM platforms in the concrete reinforcement supply chain. Automation and Construction
Conclusion

*Climate change reduction potentials*

- Integration of efforts all along the value chain allow to reach 2050 objectives

- Reduces the need for carbon capture and storage and allow short term and low cost roadmap for European construction industry
Conclusion

*Future development in the construction sector*

- An increase in the digitalization of the sector will occur, leading to more prefabrication and the use of building information modelling.

- Resource conservation and the circular economy approach are gaining traction in economic and political circles. The construction industry will have to position itself in the conversation.

- Breakthrough technologies all require very high investment costs and will not be implemented in due time to counteract climate change. The industry is not willing to invest so much in the current situation.
Thank you for your attention
Different implication of the stakeholders along the value chain
Shared efforts or concentrated on the cement sector