Eco-Cement: Low Cost Solutions for resource efficiency

Vanderley M. John
One of the Greatest Inventions
Materials Consumption

Global average (kg/hab.year)

- Food
- Cement
- Concrete
- Water

Water consumption is greater than 50,000 kg/hab.year.
1 tonne of pure cement
~800 – 900 kg CO$_2$

CaCO$_3$ $\rightarrow$ CaO + CO$_2$
Evolution of CO2 from Cement

WHAT IS ALREADY BEEN DONE
Energy for clinker production

Energy consumption (GJ/t)

- Dry - 4-6 PC
- Dry - 4 PH
- Dry Long
- Semi-dry
- Semi-wet
- Wet Long

TODAY

..1970
Alternative fuels
Clinker substitution

WBCSD CSI GNR Data
Limits for clinker substitution

• Global shortage
  – fly ash
  – Slag
  – Natural pozzolans
  – Local abundance

• Knowledge
  – limestone
FUTURE DEMAND FOR CEMENT

- India
- China
- Others Developing

projection
A blueprint for a climate friendly cement industry. WWF-Lafarge 2008
CO2 EMISSION FROM CEMENT (%)

WWF Lafarge BAU scenario

A blueprint for a climate friendly cement industry. WWF-Lafarge 2008
CO2 EMISSION MITIGATION (%)

WBCSD CSI IEA Blue scenario

WBCSD & IEA Cement Technology Roadmap 2009
WBCSD/IEA CO₂ MITIGATION

- Carbon Capture and Storage: 56%
- Renewable Fuels: 24%
- Clinker Substitution: 10%
- Energy Efficiency: 10%

WBCSD & IEA Cement Technology Roadmap 2009
COST WBCSD/IEA CO$_2$ MITIGATION

US $354$ a $843$ billion

CCS  $\sim 80\%$

WBCSD & IEA Cement Technology Roadmap 2009
Carbon Capture and Storage Cost

USD $40–170/t \( \text{CO}_2 \)

Cement cost will increase

WBCSD & IEA Cement Technology Roadmap 2009
An increase of Cement Cost is a social problem in developing countries
Available Raw Materials

The composition of the Earth’s Crust limits the possible chemistries. But the limited range means we can explore all options.
Sustainable future demands

LOW-COST, ROBUST AND SCALABLE STRATEGIES
SBCI WORKING GROUP

LOW-CO$_2$ ECO-EFFICIENT CEMENT-BASED MATERIALS INDUSTRY
The goal

Identify established and innovative, low-cost and robust strategies to mitigate CO$_2$ emissions and increase resource efficiency of the cement-based materials supply chain.
The goal: replace CCS
The goal: replace CCS
The Method

• Life-cycle approach
• Supply-chain wide
  – Cement Production
  – Cement Use
  – Post-use
• Science-based alternatives
• Low-Cost, Low Carbon
The ambition

• **Policy-makers**
  – R&D policy
  – Climate Change policy

• **Research community**
  – Research agenda

• **Cement industry supply chain**
  – Partnership with research institutions
  – Promote Innovation
Inaugural Meeting

UNEP, Paris, March 18th 2015
## Full Members

<table>
<thead>
<tr>
<th>Letter</th>
<th>Name and Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Karen Scrivener, EPFL, Switzerland</td>
</tr>
<tr>
<td>A</td>
<td>Vanderley John, USP, Brazil</td>
</tr>
<tr>
<td>A</td>
<td>Arnon Bentur, Technion, Israel</td>
</tr>
<tr>
<td>C</td>
<td>A.K. Chatterjee, consultant, India,</td>
</tr>
<tr>
<td>A</td>
<td>Arpad Horvath, UC Berkely, USA</td>
</tr>
<tr>
<td>C</td>
<td>Bruce Blair, Lafarge, USA</td>
</tr>
<tr>
<td>A</td>
<td>Edguardo Irassar, UNICEN, Argentina</td>
</tr>
<tr>
<td>C</td>
<td>Ellis Gartner, Lafarge, France</td>
</tr>
<tr>
<td>A</td>
<td>Henri Van Damme, IFSTTAR France</td>
</tr>
<tr>
<td>A</td>
<td>John Provis, U. Sheffield, UK</td>
</tr>
<tr>
<td>C</td>
<td>Josephine Cheung, W.R. Grace, USA</td>
</tr>
<tr>
<td>NGO</td>
<td>Philippe Fonta, CSI, WBCSD/CSI, Switzerland</td>
</tr>
<tr>
<td>A</td>
<td>Ravindra Gettu, IIT Madras, India</td>
</tr>
<tr>
<td>C</td>
<td>SUI Tongbo, Sinoma, China</td>
</tr>
<tr>
<td>A</td>
<td>Surendra Sha, Northwestern U, USA</td>
</tr>
<tr>
<td>A</td>
<td>TIAN Qian, Jiangsu Research Institute, China</td>
</tr>
<tr>
<td>A</td>
<td>Wofram Schmidt, BAM, Germany</td>
</tr>
<tr>
<td>A</td>
<td>Yunus Ballim, Witts, South Africa</td>
</tr>
</tbody>
</table>

### Summary

18 members
5 continents
13 countries
Examples of solutions

- Calcined Clay Pozzolans
- Cement-use efficiency improvement
- Wastage reduction technologies
- New binders
- ...
Cement use efficiency
Low binder Concrete

DAMINELI, B. L. - D.Sc. Thesis, 2013 (to be published) . Slump> 150mm
CO₂ Intensity
(USP results)
CO₂ Intensity
(USP results)

Up to 50% reduction
CO2 Mitigation with Calcined Clay

Emission reduction (%)

- Siguaney
- Cienfuegos

<table>
<thead>
<tr>
<th></th>
<th>Siguaney</th>
<th>Cienfuegos</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-35 BY PP-25</td>
<td>14.3</td>
<td>14.4</td>
</tr>
<tr>
<td>PP-25 BY SIG B-45</td>
<td>20.1</td>
<td>22.2</td>
</tr>
<tr>
<td>P-35 BY SIG B-45</td>
<td>31.5</td>
<td>33.4</td>
</tr>
</tbody>
</table>

Sanchez, UCLV Cuba, K. Scrivener EPFL,

Emission reduction for two trial production in Cuba (Siguaney and Cienfuegos)
Schedule

• 2\textsuperscript{nd} meeting - Beijing, October 2015
• 3\textsuperscript{rd} meeting – São Paulo, March 2015
• Report published: September 2016
Final Remarks

• Sustainability requires low-cost cement
• With innovation will make it possible to mitigate CO2 from cement, without increasing its cost.
Thank you!

vmjohn@usp.br