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Toward a Sustainable Cement Industry
Substudy 8: Climate Change

March 2002

by
Ken Humphreys and Maha Mahasenan

**with contributions from
Marylynn Placet and Kim Fowler**

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An Independent Study Commissioned by:

Battelle
The Business of Innovation.



**World Business Council for
Sustainable Development**

Executive Summary

Climate change has become a prominent global issue, and governments are beginning to take significant steps to address the problem. For the cement industry, the climate change issue carries serious financial consequences, in addition to its environmental importance. Without action, the financial liabilities associated with the industry's CO₂ emissions will be large*. But, through a well-managed strategy, significant financial benefits could accrue to the industry, particularly in the near-term.

Carbon dioxide (CO₂) is the primary greenhouse gas that drives global climate change and is the only greenhouse gas emitted by the cement industry in a significant amount. The cement industry emits approximately 5% of global, manmade CO₂ emissions. When all greenhouse gas emissions generated by human activities are considered, the cement industry is responsible for approximately 3% of global emissions. Due to the unique nature of the product it manufactures, the cement industry currently emits 0.73 to 0.99 kilograms of CO₂ for every kilogram of cement produced†. At any emission rate within this range, current proposals to curb CO₂ emissions will profoundly affect the activities and finances of the industry. Future proposals will likely call for far more significant reductions.

Cement-related greenhouse gas emissions originate from fossil fuel combustion at cement manufacturing operations (about 40% of the industry's emissions); transport activities (about 5%) and the combustion of fossil fuel that is required to make the electricity consumed by the cement manufacturing operations (about 5%). The remaining cement-related emissions (about 50%) originate from the manufacturing process that converts limestone (CaCO₃) to calcium oxide (CaO), the primary precursor to cement. It is chemically impossible to convert CaCO₃ to CaO, and then cement clinker, without generating CO₂. This CO₂ is currently emitted to the atmosphere.

Table ES-1 summarizes the industry's strengths and weaknesses on the issue of climate protection.

The challenge is great, and although some companies reduced emissions by ~10% during the 1990s, the cement industry as a whole has not significantly reduced emissions over the last decade. Fortunately, there are numerous opportunities for the industry to reduce both its emissions and the associated financial liabilities. Further, the nature of the challenge has the potential to spur innovation, which could lead to new manufacturing processes, new products, and new business lines. In the face of the climate challenge, creative and proactive cement companies have the potential to emerge as leaders in carbon dioxide management across all industries and remain profitable.

* A carbon tax of \$50/tonne, an amount implicit in a number of potential government policies, would add an average of ~\$12/tonne to the manufactured cost of cement.

† Based on the average rate of emissions for the cement industry in each of 14 cement producing regions of the world. Some individual plants may have emission rates that extend outside this range.

Table ES-1. Cement Industry Status on the Issue of Climate Protection

<p>Strengths:</p> <ul style="list-style-type: none"> ▪ Some companies have demonstrated reduced average CO₂ released per ton of product ▪ A standardized CO₂ inventory protocol has been developed by ten major cement companies, together with external stakeholders <p>Weaknesses:</p> <ul style="list-style-type: none"> ▪ Heavy dependence on fossil energy ▪ Reliance on limestone-based cement ▪ Limited attention to the significant CO₂ reductions required ▪ Inadequate investment in R&D that would enable future cost-effective CO₂ reductions ▪ Intermittent engagement in climate policy activities without a clear long-term agenda 	<p>Opportunities:</p> <ul style="list-style-type: none"> ▪ Energy efficiency improvement ▪ Use of alternative raw materials (e.g., fly ash and blast furnace slag) ▪ Use of alternative, low-carbon fuels ▪ Emission reduction credits ▪ CO₂ capture and sequestration or possible resale ▪ Trading schemes to reduce costs <p>Threats:</p> <ul style="list-style-type: none"> ▪ Large financial burdens ▪ Possibility of imposed technological controls ▪ Early retirement of plants and equipment ▪ Potential for the cement industry to be overlooked in the policy debate and disadvantaged by policies designed for larger polluters ▪ Loss of market share to competing materials that are less GHG intensive
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It is therefore recommended that cement companies establish corporate carbon management programs, set company-specific and industry-wide CO₂ reduction targets, and initiate long-term process and product innovation. An industry response to this recommendation should include a strategy with at least two major parts, both parts of which must be started now:

- First, companies must progressively pursue cost-effective CO₂ reductions by: expanding sales of cement with lower clinker content (e.g., composite cement with fly ash or blast furnace slag), increasing the use of alternative fuels (bio-based, low-carbon, or waste fuels that provide a net carbon dioxide emissions reduction), and initiating energy efficiency enhancements (improving equipment and phasing out inefficient plants).
- Second, to enable additional, long-term, cost-effective CO₂ reductions, the cement industry must undertake or support R&D at a much higher level than today. This R&D must be focused on the development of highly innovative low-CO₂ products and processes, as well as low-CO₂ business ventures. Examples of such ventures, might include: capturing and sequestering CO₂, co-producing electricity and cement in low-CO₂ facilities, or earning royalty income from low-CO₂ processes or products licensed to other companies. Without a commitment to long-term innovation, the industry will likely find itself facing growing emission liabilities as individual nations commit themselves to ever-tighter CO₂ constraints in an attempt to stabilize atmospheric concentrations of greenhouse gases*.

This two-part strategy would help support specific reductions[†] of approximately 30% (from 1990 levels) by 2020[‡] and greater reductions thereafter which is commensurate with the level of

* Treaties such as the Kyoto Protocol and other government policies that target 5 to 20% reductions are only the first steps toward what will ultimately be necessary to stabilize atmospheric greenhouse gas concentrations.

[†] That is, tonnes of CO₂ per tonne of cementitious product produced.

[‡] The estimate of 30% is based on analysis discussed in this substudy. Key assumptions associated with the analysis include: 1) society is committed to stabilizing atmospheric greenhouse gas concentration at twice pre-industrial levels (note that many NGOs do not think this is a low enough level); 2) moderate economic and population growth occurs nearly doubling global cement demand by 2020 (over 1990 demand levels), with significant portions of the growth coming from China; 3) all industries act using a theoretically minimum cost approach to reduce CO₂

reductions that are necessary for the industry to be on a sustainable path forward. Because country-specific conditions vary considerably, individual companies will likely face reduction opportunities and requirements that are either larger or smaller than 30%.

The actions shown in Table ES-2 would facilitate achievement of the strategy by establishing mechanisms to document corporate-level CO₂ emission levels and reductions, setting reduction targets for various time periods, allowing companies to manage costs, and encouraging development of innovations that would dramatically decrease industry-wide emission levels over the long-term.

Table ES-2. Potential Actions for Climate Protection			
Recommendation: Establish corporate carbon management programs; set company-specific and industry-wide medium-term CO₂ reduction targets; and initiate long-term process and product innovation.			
Potential Actions	Responsibility	Timeframe	References
1. Establish a CO₂ emissions baseline and mechanisms to enable cost-effective emission reductions. Develop and implement a standardized cement industry CO ₂ accounting protocol, which allows companies to establish emissions baselines and to track and report future progress.	Cement companies working collaboratively Independent review by NGOs, governments	Short term	Substudy 8: Climate Change
2. Set challenging emission reduction targets and state them publicly. Establish goals and adjust them over time as technology and management techniques advance.	Cement companies (Note: Industry-wide and company-specific targets should be set.)	Short term and Medium term	Substudy 3: Business Case Substudy 5: KPIs Substudy 8: Climate Change
3. Cooperate with stakeholders to develop government policies, product standards, and market practices that remove barriers to: 1) the sale of innovative (but safe) cement products with lower embodied CO₂ emissions, and 2) the use of appropriate waste fuels that reduce lifecycle CO₂ emissions. Encourage industry associations to support such policies. Develop government liaison function related specifically to climate issues within individual companies.	Cement companies Cement associations Standard setting bodies Government regulatory agencies Non-governmental organizations	Short term and Medium term	Substudy 3: Business Case Substudy 6: LCA Substudy 8: Climate Change Substudy 13: Public Policy
4. Explore prospects of reducing CO₂ emission reduction costs through emissions trading or offset schemes. Investigate cost of controlling CO ₂ using various options, and compare control costs among plants and between cement industry and non-cement emission sources.	Cement Companies Governments Other industries	Short term	Substudy 8: Climate Change
5. Cooperate with governments, customers, suppliers, and competitors on pre-competitive R&D projects that develop low-carbon products and processes. Initiate a major R&D effort focused on long-term, cost-effective CO ₂ reductions. Work collaboratively to lower the risk and hasten the development of breakthrough innovations.	Cement companies Government agencies Customers Suppliers Academia	Short term, Medium term, and Long term	Substudy 7: Innovation Substudy 8: Climate Change Substudy 9: Industrial Ecology

emissions; 4) the cement industry CO₂ emissions are never higher than they are today, as a fraction of the world's total fuel-related and process-related CO₂ emissions.

Table of Contents

1.	The Climate Change Challenge	1
1.1.	Total Anthropogenic and Cement Industry Greenhouse Gas Emissions	1
1.2.	Unit-Based Cement Industry Emissions	2
1.3.	The Emissions Reduction Challenge.....	6
1.4.	Summary of The Climate Change Challenge	14
2.	CO ₂ Management: Opportunities	16
2.1.	Conventional CO ₂ Management Approaches	16
2.2.	Advanced CO ₂ Management Approaches.....	24
2.3.	Flexible Market Instruments, Management Tools, & Policies	29
3.	References	33

Appendix A: Understanding the Relationship Between Cement Demand, Economic Growth, and Population Growth.....	A-1
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List of Tables

Table ES-1. Cement Industry Status on the Issue of Climate Protection	vi
Table ES-2. Potential Actions for Climate Protection	vii
Table 1-1. Year 2000 Cement Industry Emissions by Region and SubRegion.....	3
Table 1-2. Cement Industry Unit-Based Emissions by Region and Sub-Region	4
Table 1-3. Cement Industry Energy Intensities by Region and Subregion	5
Table 1-4. Cement Industry Mid-1990s Clinker Factors by Region and SubRegion.....	5
Table 2-1. Technical Emissions Reduction Potential for CO ₂ per tonne of cement by 2020.....	17
Table 2-2. Estimated Availability of Fly Ash and Blast Furnace Slag in 2020.....	19
Table 2-3. Kiln Types and Fuel Mix	20
Table A-1. Characteristics of Scenario A1	6
Table A-2. Characteristics of Scenario B1	8
Table A-3. Characteristics of Scenario A2	10
Table A-4. Characteristics of Scenario B2	12

List of Figures

Figure 1-1. Year 2000 Greenhouse Gas Emissions from the Cement Industry'	1
Figure 1-2. Projected Cement Demand	8
Figure 1-3. Global Cement Industry CO ₂ Emissions for Scenario A1 with Theoretical Assumption of No Improvement in Unit-Based Emissions	9
Figure 1-4. Conceptual Example of CO ₂ Abatement Cost Curve	11
Figure 2-1. CO ₂ Emissions Reduction Potential Using a Combination of Conventional Reduction Approaches	24
Figure 2-2. Global New Energy Cement/Power Plant	28
Figure 2-3. Alstom Combined Power and Cement Plant.....	29
Figure 2-4. CO ₂ for Enhanced Oil Recovery	29
Figure 2-5. CO ₂ for Enhanced Coal Bed Methane Recovery	29
Figure A-1. Per Capita Cement Demand vs Per Capita GDP for Japan.....	A-2
Figure A-2. Per Capita Demand vs. Per Capita GDP for Western Europe	A-2
Figure A-3. Per Capita Cement Demand vs. Per Capita GDP for the USA.	A-2
Figure A-4. Per Capita Cement Demand vs. Per Capita GDP for Australia and New Zealand.	A-2

Figure A-5. Per Capita Cement Demand vs. Per Capita GDP for Latin America.....A-3
Figure A-6. Per Capita Cement Demand vs. Per Capita GDP for ChinaA-3
Figure A-7. Per Capita Cement Demand vs. Per Capita GDP for India.....A-3
Figure A-8. Per Capita Cement Demand vs. Per Capita GDP for Korea.....A-3
Figure A-9. Actual vs. Predicted Per Capita Cement Demand for
 Selected SubregionsA-4
Figure A-10. Projected Cement Demand.....A-5