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TOWARD A SUSTAINABLE CEMENT INDUSTRY

An Independent Study Commissioned by

World Business Council for Sustainable Development

Battelle
The Business of Innovation

World Business Council for Sustainable Development

This study, "Toward a Sustainable Cement Industry" was commissioned by the World Business Council for Sustainable Development as one of a series of member-sponsored projects aimed at converting sustainable development concepts into action. The report represents the independent research efforts of Battelle Memorial Institute and its colleagues to identify critical issues for the cement industry today, and pathways forward toward a more sustainable future. While there has been considerable collaborative effort and exchange of ideas during this project, the opinions and views expressed here are those of Battelle.

Eric Derobert, Vice President, Operations
Howard Klee, Jr., Program Manager
Estelle Geisinger, Program Associate

Assurance Group

"We have reviewed this report in detail. We believe 'Toward a Sustainable Cement Industry' provides a significant and useful contribution to the implementation of sustainable development. While we agree with the general content, findings and conclusions, this is not an endorsement of each individual recommendation and potential future action."

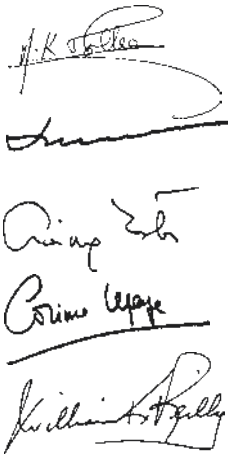
Mostafa Tolba (chair), President, ICED, Cairo, Egypt;
Former Executive Director, United Nations Environment Program

Victor Urquidi, Former President and Professor Emeritus,
Colegio de Mexico, Mexico City, Mexico

Istvan Lang, Former Secretary General and Member,
Hungarian Academy of Sciences, Budapest, Hungary

Corinne Lepage, Huglo-Lepage & Associates, Paris, France;
Former Environment Minister, France

William K. Reilly, Aqua International Partners, LP,
San Francisco, USA; Former Administrator, U.S. EPA



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The recommendations and actions toward sustainable development contained herein are based on the results of research regarding the status and future opportunities for the cement industry as a whole. Battelle has consulted with a number of organizations and individuals within the cement industry to enhance the applicability of the results. Nothing in the recommendations or their potential supportive actions is intended to promote or lead to reduced competition within the industry.

About the WBCSD

The World Business Council for Sustainable Development (WBCSD) is a coalition of 160 international companies united by a shared commitment to sustainable development via the three pillars of economic growth, ecological balance, and social progress. WBCSD members are drawn from more than 30 countries and 20 major industrial sectors. The Business Council also benefits from a Global Network of 35 national and regional business councils and partner organizations involving some 1000 business leaders globally.

Cover photo in lower left courtesy of Australian Cement Holdings Pty. Ltd.

The WBCSD Mission

To provide business leadership as a catalyst for change toward sustainable development, and to promote the role of eco-efficiency, innovation and corporate social responsibility.

Our aims

Business leadership – to be the leading business advocate on issues connected with sustainable development.

Policy development – to participate in policy development in order to create a framework that allows business to contribute effectively to sustainable development.

Best practice – to demonstrate business progress in environmental and resource management and corporate social responsibility and to share leading-edge practices among our members.

Global outreach – to contribute to a sustainable future for developing nations and nations in transition.

"Toward a Sustainable Cement Industry" is one of a number of WBCSD member-led projects undertaken to examine issues unique to a particular business sector. Other examples include research programs in Sustainable Forests, Sustainable Mobility, Mining and Electric Utilities. Each program aims to translate more general issues of sustainable development into practical and actionable terms for a specific industry. The companies involved want to create more stable platforms for future long-term investments and strengthen their business "license to operate."

Next Steps

Reports like this one are not always sufficient to achieve real action and results. Following release of Battelle's study, the sponsoring cement companies will develop and publish an Agenda for Action, detailing how they will pursue the issues and recommendations discussed here. This Agenda will include (1) commitments for future actions that the companies plan to take, both jointly and individually, (2) timeframes for achieving results, (3) plans for publicly reporting future progress, and (4) plans for ongoing stakeholder engagement.

The Agenda will be widely distributed later this year. Along with all other project documentation it will also be available on the project Web site, www.wbcsdcement.org. The WBCSD encourages interested stakeholders to join with these industry leaders in moving toward a sustainable future.

About Battelle Memorial Institute

Since opening in 1929, Battelle Memorial Institute has been at the forefront of technical and social research and development. Founded as a not-for-profit organization, Battelle develops and commercializes technology and provides management and technical solutions for industry and government. Our partnerships with the communities where we live and work provide resources to help our neighbors improve their quality of life. Battelle has grown to include more than 7,500 professionals who contribute products and solutions for clients in nearly 30 countries. Noted for its innovative work in the environmental, social, and economic sciences, Battelle has become a leader in the arena of Sustainable Development. Battelle's **Life Cycle Management Group** in Columbus, Ohio, USA has helped craft sustainable pathways for companies in the automotive, architectural and building products, cement, chemical, and consumer products industries. Battelle's Pacific Northwest Division and Battelle Europe, which contributed to this study, also provide business consulting and technical services to a wide variety of government and private sector clients.

Foreword

Many companies around the globe are re-examining their business operations and relationships in a fundamental way. They are exploring the concept of Sustainable Development, seeking to integrate their pursuit of profitable growth with the assurance of environmental protection and quality of life for present and future generations. Based on this new perspective, some companies are beginning to make significant changes in their policies, commitments, and business strategies.

This study represents an effort by ten major cement companies to explore how the cement industry as a whole can evolve over time to better meet the need for global sustainable development while enhancing shareholder value. The study findings include a variety of recommendations for the industry and its stakeholders to improve the sustainability of cement production. Undertaking this type of open, self-critical effort carries risks. The participating companies believe that an independent assessment of the cement industry's current status and future opportunities will yield long-term benefits that justify the risks. The intent of the study is to share information that will help any cement company—regardless of its size, location, or current state of progress—to work constructively toward a sustainable future.

Study Ground Rules

This report was developed as part of a study managed by Battelle, and funded primarily by a group of ten cement companies designated for this collaboration as the Working Group Cement (WGC). By choice, the study boundaries were limited to activities primarily associated with cement production. Downstream activities, such as cement distribution, concrete production, and concrete products, were addressed only in a limited way. Battelle conducted this study as an independent research effort, drawing upon the knowledge and expertise of a large number of organizations and individuals both inside and outside the cement industry. The cement industry provided a large number of case studies to share practical experience. Battelle accepted the information in these case studies and in the public information sources used.

The WGC companies provided supporting information and advice to assure that the report would be credible with industry audiences. To assure objectivity, a number of additional steps were taken to obtain external input and feedback.

- A series of six dialogues was held with stakeholder groups around the world (see Section 1.5).
- The World Business Council for Sustainable Development participated in all meetings and monitored all communications between Battelle and the WGC.
- An Assurance Group, consisting of distinguished independent experts, reviewed both the quality and objectivity of the study findings.
- External experts reviewed advanced drafts of technical substudy reports.

The geographic scope of the study was global, and the future time horizon considered was 20 years. Regional and local implementation of the study recommendations will need to be tailored to the differing states of socioeconomic and technological development.

Battelle is pleased and proud to issue this groundbreaking report, which demonstrates our commitment toward realizing business value through sustainable development. We have been impressed with the dedication and thoughtfulness of the cement companies that supported this effort. To our knowledge, there is no precedent for an independent study of this magnitude that was funded by private industry, with the express purpose of critically examining the performance of that same industry. Even more unusual is the fact that the industry's investment in this study was not prompted by any crisis or visible failure of the industry, but rather by a collective desire to be more responsive to the emerging needs of the marketplace. We sincerely hope that the information in this report will help not only cement companies, but also other enterprises around the globe, to adopt sustainable development as a cornerstone of their business strategy.

Joseph Fiksel, Ph.D.
Vice President for Life Cycle Management, Battelle

Acknowledgements

The completion of this study represents an enormous collaborative effort, involving activities around the globe over a two-year time span. Arthur D. Little, Inc. performed the initial scoping and visioning effort for the study. Then, Battelle formed an international project team to carry out the study, working with dozens of collaborating organizations and specialists to provide adequate breadth, depth, and rigor. During the course of the work a number of stakeholders commented on the ambitious scope of the project. Without the dedication of the many individuals and organizations involved, the project could not have succeeded in addressing the range of topics necessary for a comprehensive assessment of sustainable development in the cement industry. The project team especially appreciates the review and commentary on an earlier draft of this report from our Chief Financial Officer, Mark Kontos.

Working Group Cement

CEMEX, Mexico
Cimpor, Portugal
Heidelberg Cement, Germany
Holcim, Switzerland
Italcementi, Italy
Lafarge, France
RMC, United Kingdom
Siam Cement, Thailand
Taiheiyo Cement, Japan
Votorantim, Brazil

Sponsors and Contributors

ABB, Switzerland
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IPE – Investimentos e Participações Empresariais, S.A., Portugal
KHD Humboldt Wedag AG, Germany
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Fundação Luso-Americana para o Desenvolvimento (FLAD), Portugal
Ministério da Ciência e Tecnologia (MCT), Portugal
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SECIL, Companhia Geral de Cal e Cimento, S.A.,
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Ssangyong, Korea
Teixeira Duarte-Engenharia e Construções, Portugal
Teris/SITA, France
Titan Cement Company, S.A., Greece
United Nations University, Japan
WWF International, Switzerland

Communications Partners

American Portland Cement Alliance, USA
Brazilian Cement Association – ABCP, Brazil
British Cement Association (BCA), United Kingdom
CEMBUREAU, Europe
Cement Industry Federation (CIF), Australia
Japan Cement Association (JCA) – Japan
Portland Cement Association, USA
South African Cement Producers Association (SACPA)
Verein Deutscher Zementwerke E.V. (VDZ), Germany

Battelle Project Team

Battelle:

Bruce Vigon, Project Lead
Tiffany Brunetti
Joseph Fiksel
Kenneth Humphreys
Marylynn Placet
Roger Anderson
Kathryn Baker
Jill Engel-Cox
Kim Fowler
Lewis Garvin
Vinay Gadkari
Donna Gleich
Jandi Ho
Leslie Hughes
Gretchen Hund
Charles Lewinsohn
Deborah Martin
Natesan Mahasenan
Nancy McDaniel
Steve Molnar
Vicki Paddock
Mason Soule

Principal Subcontractors:

Boston Environmental Group, USA, Stephen Poltorzycki
ERM, UK, Jonathan Samuel, Sarah Selby
Five Winds International, Canada, Steven Young
Holtec Consulting Pvt. Ltd., India, K.K. Misra
Independent Consultant, USA, Diane Guyse Fiksel
TNO-MEP, The Netherlands, Jan Zeevalkink

Regional Advisors:

Sabry Aglan, Egypt (Africa/Middle East)
Francisco Barnes, Mexico (Latin America/Caribbean)
Jeff Logan, USA (Asia)
Klaus Mueller, Switzerland (Europe)

Subcontractors and Consultants

Anataike Information Development Co., China
Agesfal Management Institute, Portugal
Arthur D. Little, Inc., United Kingdom
ASIST Translations Service, Inc., USA
BCSD – Brazil, Brazil
Caroline Quinn, USA
Enfoque, Brazil
Florence Ma, China
Janet Barber, United Kingdom
Janus-Merritt Strategies, USA
Holtec Consulting Pvt. Ltd., India
Meridian Institute, USA
Ökopol Institute, Germany
PricewaterhouseCoopers (PwC), The Netherlands
Ramboll A/S, Denmark
Rethink Consulting P/L (Elery Hamilton-Smith), Australia
Thailand Environmental Institute, Thailand
The Environment Council, United Kingdom

List of Acronyms and Formulae

AFR	Alternative Fuels and Raw Materials	KPI	Key Performance Indicator
CaO	Calcium oxide	MJ	Megajoule = 10^6 (million) Joules
CEO	Chief Executive Officer	NGO	Non-Governmental Organization
CKD	Cement Kiln Dust	NO_x	Nitrogen Oxides
CO	Carbon Monoxide	OS&H	Occupational Safety and Health
CO_2	Carbon dioxide	OPC	Ordinary Portland Cement
EHS	Environment, Health & Safety	R&D	Research and Development
EMAS	Eco-Management and Audit Scheme	ROI	Return On Investment
EVA	Economic Value Added	RONA	Return On Net Assets
GDP	Gross Domestic Product	SD	Sustainable Development
GHG	Greenhouse Gases	SO_2/SO_x	Sulfur Dioxide/Sulfur Oxides
IE	Industrial Ecology	VOC	Volatile Organic Compound
ISO	International Organization for Standardization	WGC	Working Group Cement (ten core cement company sponsors)

Glossary

Aggregate Gravel, sand, crushed stone, and possibly other materials used in making concrete.

Alternative Fuels Energy containing wastes used to substitute for conventional thermal energy sources.

Alternative Raw Materials Cementitious materials used as substitutes for conventional cement raw materials.

Alternative Fuels and Raw Materials (AFR) Inputs to cement production derived from industrial, municipal, and agricultural waste streams.

Biomass Plant materials and animal waste used as a source of fuel.

Blended cement[1] Cement with a fixed percentage of pozzolans (for example, supplements such as slag and fly ash produced by the steel and electric power industries, respectively) replacing the Portland cement clinker portion of the cement mix. Blended cement is usually understood as cement that is blended by a cement manufacturer rather than a ready-mix supplier (also referred to as composite cement).

By-Product Secondary product of an industrial process.

Cement Within the cement industry, and especially the technical domain, this term is often understood as Ordinary Portland Cement.

Clinker Decarbonized, sintered, and rapidly-cooled limestone. Clinker is an intermediate product in cement manufacturing.

Concrete A material produced by mixing binder, water, and aggregate. The fluid mass undergoes hydration to produce concrete. (Average cement content in concrete is about 15%.).

Corporate Governance The system of oversight, including Board of Directors, whereby a corporation maintains accountability for protecting the interests of shareholders and other stakeholders

[1] The International Council for Local Environmental Initiatives (ICLEI), 2001, http://www.iclei.org/about.htm.

Eco-efficiency Reduction in the resource intensity of production; i.e. the input of materials, natural resources and energy compared with the output; essentially, "doing more with less."

Economic Value Added (EVA) Also known as Enterprise Value Added, EVA is a widely used financial indicator of the shareholder wealth or the "economic profit" created by a particular activity within an organization. In simple terms, EVA is the difference between After-Tax Operating Profit and Capital Charge. The After-Tax Operating Profit (ATOP) component is a function of revenues, operating costs and taxes while the Capital Charge (CC) is derived from the product of the invested capital and the weighted average cost of capital (WACC). The WACC is the weighted combination of the cost of debt and equity of the invested capital and is influenced by factors such as the financial structure of the company, business risk, current interest levels and investor expectations. A positive EVA is an indicator of wealth created, while a negative EVA means that the company or organization has destroyed wealth.

Ecosystem Services The range of supporting functions provided by an ecosystem to its inhabitants, including food, shelter, thermal regulation, and energy.

Employee satisfaction An aggregate measure of the well-being or quality of life that employees indicate they derive from their jobs.

Fly ash By-product with binding properties typically produced as a residue from coal-fired power plants.

Fossil fuel A general term for combustible geological deposits of carbon in reduced (organic) form and of biological origin, including coal, oil, natural gas, and oil shale.

Greenhouse gases Gases in the earth's lower atmosphere that may contribute to global warming, including the major component CO_2.

Hazardous waste A by-product material defined by regulation or legislation for special handling or disposition due to its characteristics as flammable, explosive, corrosive or which because of its quantity, concentration, or physical, chemical or infectious characteristics may cause or significantly contribute to an increase in serious irreversible, or incapacitating reversible illness or pose a substantial present or potential hazard to human health, safety, welfare or to the environment when improperly treated, stored, transported, used or disposed of, or otherwise managed.

Industrial ecology Framework for improvement in the efficiency of industrial systems by imitating aspects of natural ecosystems, including the cyclical transformation of wastes to input materials.

Kiln Large industrial oven for producing clinker used in manufacture of cement.

Life cycle The total set of industrial processes involved in production of a product (e.g., cement), including upstream extraction and processing of materials, manufacturing, distribution, use, and disposition or re-use of waste materials

Option value Economic value of retaining the option to pursue an opportunity in the future.

Ordinary Portland Cement (OPC) Cement that consists of approximately 95 percent ground clinker and 5 percent gypsum.

Social impacts The effects of certain actions and/or activities on society. Areas of social impact include public health and safety, aesthetic surroundings, employee health and safety, etc.

Stakeholder A person or group that has an investment, share, or interest in something, as a business or industry.

Stakeholder value Value directly relating to the stakeholders' perceptions.

Strategic enterprise value Value measurable in non-financial terms, i.e., image.

Sustainable business A business that is able to anticipate and meet the economic, environmental, and social needs of present and future generations of customers and other stakeholders.

Sustainable development Ability to continually meet the needs of the present without compromising the ability of future generations to meet their own needs.

Triple bottom line A business principle that measures corporate performance along three lines: economic prosperity, environmental stewardship, and social responsibility.

Waste A by-product material having no or minimal economic value derived from a process or activity.

Executive Summary

Progressive cement companies are recognizing that to remain competitive in the future, they must combine sound financial performance with a commitment to social responsibility, environmental stewardship, and economic prosperity. These three dimensions are referred to as the "triple bottom line" of Sustainable Development (SD). A number of cement companies have accepted the fundamental goal of SD; namely, to "meet the needs of the present without compromising the ability of future generations to meet their own needs." [2] The purpose of the study is to assess the current status of the industry as a whole with respect to SD, and to provide a vision and recommendations that cement companies and their stakeholders can pursue together in order to contribute to a more sustainable future. This report has two principal audiences: (1) for stakeholders outside the industry, it provides an overview of the cement industry, its potential for becoming more sustainable, and the roles that stakeholders can play in realizing that goal; and (2) for cement companies, it provides an independent assessment of their current status and recommendations for improving their sustainability.

Today, many forces of change are influencing the cement industry. Consolidation within the industry is occurring as global cement companies move to enter the growing markets in developing countries. At the same time, regulatory pressures and stakeholder expectations regarding health, safety, and environmental performance are increasing. There are also signs that cement products may evolve from commodities to a greater variety of differentiated products serving changing customer needs. These forces create opportunities for cement companies to seriously consider SD as a model for future growth. However, there are a number of barriers to adoption of more sustainable practices, including the inherent energy and material resource intensity of cement production, the lack of trust between companies and their stakeholders in some areas, and the resistance to change on the part of cement users and within cement companies themselves.

Successful adoption of SD by the cement industry will occur only if there is a real synergy between sustainability and profitability. In other industries, companies that have committed to SD have identified important business drivers that translate SD excellence into enterprise value. Likewise, a number of leading cement companies already have begun to demonstrate that they can realize business advantages through integration of SD into their business practices. For example, environmentally friendly practices, such as use of wastes as raw

"Growing the value we bring to society and reducing our environmental footprint are business strategies to grow shareholder value."
Gary M. Pfeiffer, Chief Financial Officer, Dupont

"We firmly believe that an approach based on sustainability is not a luxury but rather is a key element in our future success."
Bertrand Collomb, Chairman and CEO, Lafarge

Sources: Pfeiffer, G.M., speech given at The Year 2000 Conference on Environmental Innovation: Creating Sustainable Business Assets for Today and Tomorrow, March 2000.

Lafarge, "Building a Sustainable World: A First Report on Our Economic, Social, and Environmental Performance," 2001.

[2] UN World Commission on Environment and Development, "Our Common Future," Report by the Brundtland Commission, 1987.

materials and improvement in energy efficiency, can contribute to reduced operating costs and improved asset utilization. In addition to financial advantages, open engagement with local communities and other stakeholders to support better quality of life can lead to improved company image and right to operate, which ultimately lead to strategic advantage.

This study has identified eight major issues that will shape the cement industry's path toward SD improvement as shown in the figure below. As a result of extensive research conducted during the study and a series of six dialogue events with stakeholders around the world, Battelle has developed an assessment of the industry's current status with regard to these SD issues, including opportunities for progress and potential threats and barriers. Based on this assessment, Battelle has recommended a set of performance goals and indicators for adoption by the industry, and has proposed a vision of potential industry progress by the year 2020, shown below.

The study team developed a set of ten major recommendations for making progress with respect to the eight identified SD issues. These recommendations fall into two categories – those that address specific SD issues and those that will enable the industry to establish internal and external processes that facilitate more sustainable practices. Each cement company will need to select and tailor SD initiatives to their unique culture, beliefs, existing programs, asset base, market, and financial situation. For each recommendation, Battelle has suggested a set of actions that provide a starting point for consideration by cement companies.

Vision for 2020:

Cement companies have integrated sustainable development into their global operations, are known as leaders in industrial ecology and innovators in carbon dioxide management, are regarded as attractive employers, and have established relationships of trust with the communities in which they operate.

Issue-Focused Recommendations

- **Resource Productivity:** *Facilitate the practice of industrial ecology and eco-efficiency in the cement industry*. Cement production inherently consumes large amounts of materials and energy. However, cement companies can build on current practices to reduce their resource consumption and to increase the use of wastes as fuels or raw materials. Improvements will require exploration of industrial ecology partnerships, as well as research to characterize the risks and benefits of alternative fuels and raw materials to workers and the community.

- **Climate Protection:** *Establish corporate carbon management programs, set company-specific and industry-wide medium-term CO_2 reduction targets, and initiate long-term process and product innovation.* Due to a dependence on fossil energy and the calcination of limestone, the cement industry today generates about 3% of global greenhouse gas emissions. The industry can establish a CO_2 emissions baseline and develop mechanisms to enable cost-effective reductions, including emission trading or offset schemes. Collaboration will be necessary to help develop government policies, product standards, and market practices that enable CO_2 reduction strategies, and to collaborate on pre-competitive research and development of low-carbon products and processes.
- **Emission Reduction:** *Continuously improve and make more widespread use of emission control techniques.* Despite significant reductions in airborne emissions, there are still concerns over dust and combustion products from cement operations. Cement companies can work toward uniform worldwide corporate environmental standards, engage with policy makers to ensure consistent enforcement of environmental regulations, apply best practical technology for energy efficiency and pollution control, implement environmental management systems, and develop new technologies to virtually eliminate emissions.
- **Ecological Stewardship:** *Improve land-use and landscape managment practices by disseminating and applying best practices for plant and quarry management.* Cement plants and quarries may have adverse impacts on local ecology, biodiversity, and water quality. Toward ecological stewardship, cement companies can disseminate and adopt innovative siting, land use, and quarrying methods that consider cultural sensitivities and biodiversity, and find productive, environmentally sound, and socially acceptable uses for depleted quarries and retired plants.
- **Employee Well-Being:** *Implement programs to enhance worker health, safety, and satisfaction.* Health and safety management at many cement plants is not consistent with best industry practices. Cement companies can work more diligently to assure healthy and safe working conditions for employees and contractors, implement management systems for occupational safety and health, and institute programs and practices that promote employee satisfaction and well-being.
- **Community Well-Being:** *Contribute to enhancing quality of life through local stakeholder dialogue and community assistance programs.* Although cement companies make important contributions to their local communities, plants and quarries sometimes create nuisance disturbances. Cement companies can engage in open dialogue with stakeholders to understand their concerns, train cement company personnel in appropriate skills, institute sustainability reporting programs, and provide voluntary assistance to improve community well-being.
- **Regional Development:** *Promote regional economic growth and stability, especially in developing countries.* Cement plants often stimulate the local economy, but plant closures or layoffs can also create economic disruptions. Cement companies can work to better anticipate the impacts of facility siting, acquisition and closure decisions, participate with local and regional governments and other interested parties in regional planning, and support economic development and capacity building for local suppliers and disadvantaged communities.

Pursuing the above recommendations will contribute to **shareholder value creation** in a variety of ways, including quantifiable reductions in capital and operating costs as well as strategic advantages such as improved license to operate. In order to enable these types of improvements, cement companies will need to enhance their business processes, as follows.

Enabling Process Recommendations

- **Business Integration of SD:** *Integrate SD principles into business strategy and practices in order to increase shareholder value.* To make progress to the SD agenda, it is important that cement companies identify the enterprise value of SD and develop a systematic approach for integrating SD into decision-making. Senior management can articulate a corporate commitment to SD, carry out internal alignment programs, and create accountability and incentives for SD performance.
- **Innovation:** *Encourage SD-related innovations in product development, process technology, and enterprise management.* The rate of innovation in the cement industry historically has been low. To enable SD improvements, cement companies can increase their role in cement production process design, include SD considerations in the new product development process, and encourage creative SD thinking among employees by providing support, incentives and rewards for SD innovation in marketing and operations.
- **Cooperation:** *Work with other cement companies and external organizations to foster SD practices and remove barriers.* Cooperation within and outside the industry is critical for enabling genuine change. The cement industry can create a **Sustainable Development Institute of Cement and Concrete** in order to conduct joint research with equipment suppliers, concrete companies, governments, universities, and other research organizations, develop educational programs to foster the sustainable use of cement, and coordinate efforts of cement associations and other groups working with governments to set policy.

Finally, it is important to acknowledge that there is no single pathway toward sustainable development. Given the great diversity of companies across the global cement industry, it is clear that each company must carve out its own pathway, consistent with its business goals and characteristics. But no matter what the chosen pathway, Battelle believes that a key for cement companies to remain competitive in the future is openness to change. Thriving on change will require new strategies based on learning and collaboration. Conversely, resistance to change will heighten the risks of rising costs and business impediments. This report argues that it is possible for cement companies to overcome the barriers to change, improve their eco-efficiency and profitability, and secure their long-term market position by contributing to global sustainable development.

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Part 1: Introduction – Accepting the Challenge

1.1 Origin and Purpose of the Study

The millennium brings new challenges to the business community. In addition to continuing competitive and economic pressures, external parties concerned with human rights, environmental protection, and social welfare are increasingly scrutinizing companies in all sectors of the economy. Some companies have voluntarily adopted codes of conduct that try to address these issues, and have come to believe that it makes good business sense to understand and incorporate the expectations of stakeholders into their strategic goals.

As in other industries, progressive cement companies are recognizing that, to remain competitive in the future, they must combine sound financial performance with a commitment to social responsibility, environmental stewardship, and open and honest interaction with stakeholders.[3] A number of cement companies have accepted the goal of sustainable development (SD); namely, to "meet the needs of the present without compromising the ability of future generations to meet their own needs"[4] (see box below for an expanded definition). This goal implies a commitment to consider both environmental and social impacts as they strive for continued profitability and growth.

This report, developed under the auspices of the World Business Council for Sustainable Development (WBCSD), is the result of a 2-year, $4 million study sponsored by ten major cement companies from around the world, who collaborated in this project as the Working Group Cement (WGC). Together, they produce

A Broader Understanding of Sustainable Development

The concept of a sustainable industry or a sustainable company is questionable, since the notion that a segment of global society in isolation can be sustainable is not logical in the broadest sense. Environmental and equity concerns are not something just to be added to investment needs, consumption patterns, governmental activities, and the myriad of private enterprise actions. They must be an integral part of development itself, and thus must be understood as involving the whole of society, not just individual enterprises or households. Conserving energy, reducing emissions, and engaging in local activities favorable to the environment do not equate to sustainable and equitable development, unless elected governments and international organizations become deeply involved in assisting the process.

The Brundtland Commission Report and subsequent discussions provide additional details on the characteristics that contribute to this broader understanding of SD:

- SD should be pursued under conditions of increasing economic and environmental efficiency, with scientific and technological knowledge being used both to protect renewable and non-renewable resources, and to promote less polluting material inputs and cleaner outputs, and
- SD must be equitable, encompassing the idea that growth and development should contribute to the reduction of gross inequalities among various groups that have arisen in the past century.

[3] T. Schmidheiny, CEO of Holcim, Keynote address at HRH The Prince of Wales Business & Environment Program, Cambridge, UK, 2000.
[4] UN World Commission on Environment and Development, "Our Common Future," Report by the Bruntland Commission, 1987.

WBCSD Working Group Cement

- CEMEX (Mexico)
- Cimpor (Portugal)
- Heidelberg Cement (Germany)
- Holcim (Switzerland)
- Italcementi (Italy)
- Lafarge (France)
- RMC (United Kingdom)
- Siam Cement (Thailand)
- Taiheiyo Cement (Japan)
- Votorantim (Brazil)

(Country indicates the headquarters location.)

approximately one-third of the world's cement and operate in most of the world's cement-producing nations. Additional monetary and in-kind support was provided by many organizations (see Acknowledgements).

The purpose of the study is to assess the current status of the industry with respect to SD practices, and to provide a vision and recommendations for both cement companies and their stakeholders to work together toward a sustainable cement industry.[5] Achieving this vision will challenge cement companies to build SD into all aspects of their businesses, including plant siting, quarrying, plant operation, energy consumption, pollution control, research and development, employee health and safety programs, product development and use, and community interaction. By accepting and meeting this challenge, cement companies hope to fulfill stakeholder expectations, create a safe and healthful environment for their employees and surrounding communities, and find new ways to create value for their shareholders.

The cement industry cannot accomplish changes without the active commitment and participation of other groups. For example, cooperation will be necessary to develop appropriate policies and regulatory regimes by governmental bodies; to establish constructive and open communication between cement companies, non-governmental organizations (NGOs), and local communities; and to encourage use of SD-based lending and investment criteria by financial institutions. Sustainable development requires sustained teamwork.

About Cement

Cement is made by burning a mixture of limestone, clay, and small amounts of other raw materials at a high temperature; grinding the resulting substance, called clinker, and blending it with gypsum and other additives.

About Concrete

Many people think of cement and concrete as synonymous. In fact, concrete is manufactured by mixing cement with sand, small rocks (called aggregate), and water.

The Cement Industry...

- provides the construction industry with a key ingredient in the most commonly used material for the world's infrastructure – concrete
- produces about 1.5 billion tonnes of cement per year
- has grown at a rate of nearly 4 percent per year over the past decade
- operates manufacturing or processing facilities in 150 countries
- has an estimated annual turnover of $97 billion (U.S.)
- directly employs an estimated 850,000 workers worldwide.

This report has two principal audiences: (1) for stakeholders outside the industry, it provides an overview of the cement industry, its potential for becoming more sustainable, and the roles that stakeholders can play in realizing that goal; and (2) for cement companies, it provides an independent assessment of their current status and recommendations for improving their sustainability. It also identifies tools to support SD assessment and implementation and presents hypothetical scenarios of future cement companies that

[5] Sustainability is not a defined end state; measurement of progress is discussed further in Part 2.

have pursued different paths toward SD. The project included more than 150 case studies, which are discussed in more detail in the longer study report.

1.2 The Business View of Sustainable Development

SD represents a vision of industrial progress that respects both human needs and global ecosystems, preserving the foundations upon which human quality of life depends.[6] A commonly used metaphor for corporate sustainability is the "triple bottom line," which defines three dimensions of a sustainable business (Figure 1-1):[7]

- *Economic prosperity* and continuity, including creation of wealth and growth opportunities for both the business and its stakeholders.
- *Environmental stewardship*, including emissions reduction and resource conservation on both a local and a global scale.
- *Social responsibility*, including quality of life and fair treatment for both company employees and huma society as a whole.

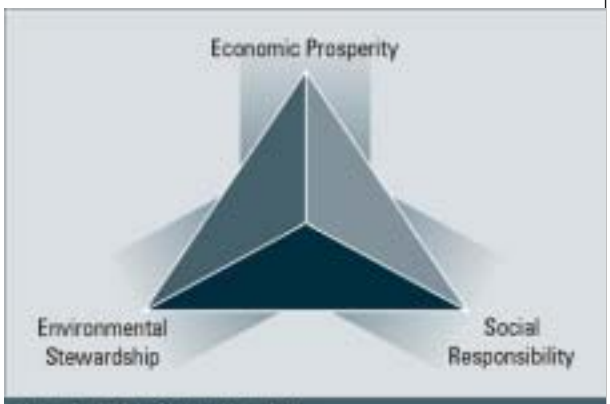

Figure 1-1. Triple Bottom Line of SD

Thus, a "sustainable business" is able to *anticipate and meet the economic, environmental, and social needs of present and future generations of customers and stakeholders*.[8]

Companies that voluntarily adopt SD are typically motivated by a clear linkage to enterprise value. Early adopters of SD have included companies in many different industries, such as chemicals, consumer products, pharmaceuticals, motor vehicles, computers and electronics, forest products, petroleum, and floor-coverings. Their primary drivers include:

- Evidence that they can create shareholder value by adopting "eco-efficient" production methods to improve both operating efficiency and market positioning.
- Increasing acceptance among chief executives of the ethical obligations associated with "corporate citizenship."
- Emergence of doctrines such as "extended producer responsibility" which broaden corporate accountability and raise public expectations regarding company behavior.
- Explosive growth of electronic communication, creating global visibility for companies.

The purpose of business SD initiatives is generally to shift the company operations from a traditional, resource-intensive, and profit-maximizing business model to a more eco-efficient, socially responsible, and **value-maximizing** model. This shift aligns well with the financial goal of increasing enterprise value. In short, sustainable businesses can compete effectively by raising profits while reducing the cost of capital – i.e., doing more with less.

[6] Hawken, P., A. Lovins, et al., *Natural Capitalism*, Little, Brown & Company, UK, 1999.
[7] Elkington, J., *Cannibals with Forks*, New Society Publishers, Canada, 1998.
[8] Fiksel, J. and D. Fiksel, "From Here to Sustainability: A Global Perspective," *Chemistry Business*, April 2001.

"Going beyond compliance to find ways to achieve the triple bottom line is what sustainable development is all about. It's the next step in corporate accountability...and it's a step the energy industry must take."

Archie Dunham, Chairman, Conoco, Inc.

Source: "The Transformation of the Oil Industry: Strategies for a New Era," Cambridge Energy Research Associates 19th Annual Executive Conference, Houston, Texas, February 2000 .

- Recognition by the financial community that sustainably managed companies tend to generate superior economic returns.

The purpose of business SD initiatives is generally to shift the company operations from a traditional, resource-intensive, and profit-maximizing business model to a more eco-efficient, socially responsible, and **value-maximizing** model. This shift aligns well with the financial goal of increasing enterprise value. Enterprise value added (EVA), also known as economic value added or shareholder value added, is commonly defined as the difference between after-tax net operating profit and the weighted average cost of capital. There are several ways in which SD initiatives can contribute to EVA:

- Cost reductions due to increased operational efficiency and effectiveness
- Revenue increases due to product differentiation and enhanced market acceptance
- Reduction in capital employed due to process simplification and improved utilization
- Reduction in risk weighting due to improved management practices and reduced liability.

In short, sustainable businesses can compete effectively by raising profits while reducing the cost of capital – i.e., doing more with less.

Since 1950, the world's urban population has increased nearly four-fold. Today, the urban population – almost half the people in the world – is growing three times faster than the rural population.

Source: http://www.unfpa.org/swp/swpmain.htm

Rather than following a prescribed approach, successful SD practitioners tend to integrate sustainability into their own business strategy. Typically, there are several levels of sustainable business practices, with increasing levels of difficulty. The most basic level is corporate initiatives such as philanthropic programs aimed at solving sustainability problems. The next level often involves reducing the "ecological footprint" associated with the product life cycle, including manufacturing, use, and end-of-life disposition. The most challenging level is enhancing the *inherent social value* created by the firm's products and services.

1.3 Forces of Change and Barriers

The cement industry is experiencing both structural and market changes. Awareness of SD has grown, especially among governmental and non-governmental organizations that are concerned with balancing economic priorities with environmental and social needs. Figure 1-2 summarizes the *forces of change* that are driving the industry toward SD and traditional *barriers* that can inhibit progress. These forces include:

- **Stakeholder Demands:** Stakeholders increasingly are expressing their views and taking political action. For example, environmental justice activists in the U.S. are expressing opposition to the concentration of large industrial facilities in low-income areas. This very important driver is discussed further in Section 1.4.

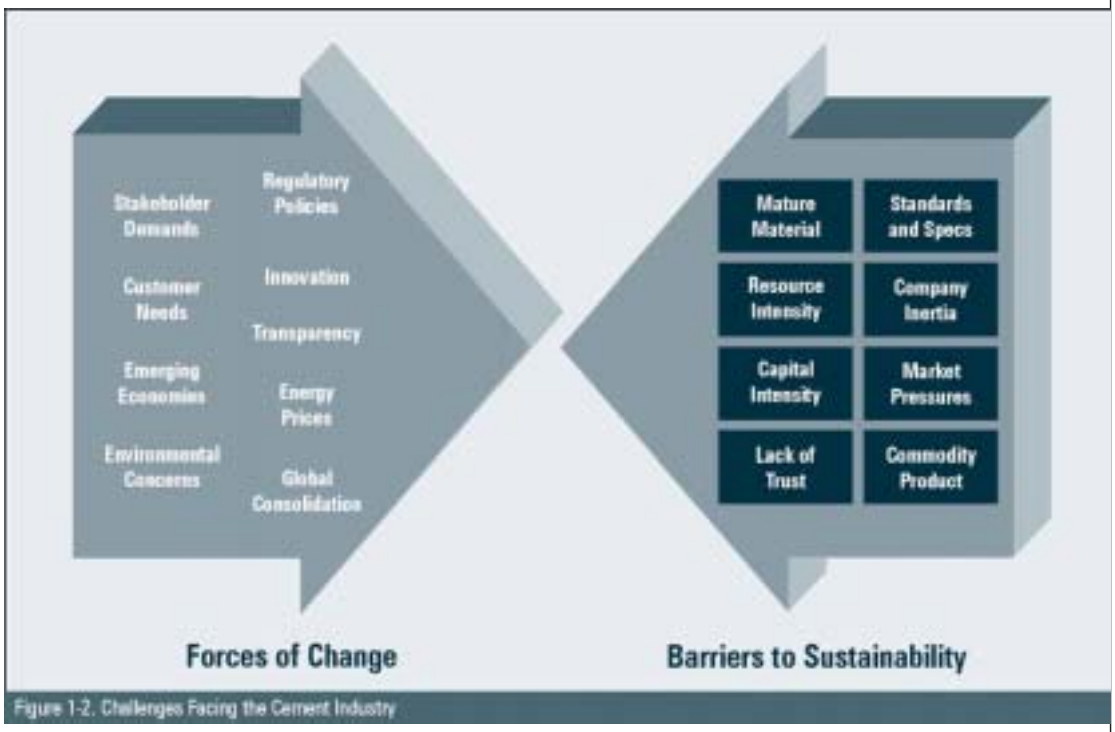

Figure 1-2. Challenges Facing the Cement Industry

- **Customer Needs:** Demand is increasing for specialty cements and concretes that meet particular customer needs. For example, some governments and other institutions have begun specifying the use of "environmentally preferable" products, including cement with lower virgin material content. Also, emerging business models – whereby large architecture and engineering firms contract to design, build, operate and eventually transfer facilities – will lead to increased emphasis on life cycle costs and durability of structures, which could increase the demand for high-performance and high-strength concretes.
- **Emerging Economies:** Population in developing nations is growing rapidly, especially in urban areas.[9] This trend, combined with emerging affluence, represents a business opportunity for the private sector. However, some groups fear that economic growth might occur at the expense of the environment and social welfare.
- **Environmental Concerns**: At a local level, communities focus on the more obvious environmental issues associated with cement plants – dust, noise, land use impacts, air and water quality. However, some are concerned about toxic emissions associated with the use of alternative fuels in cement kilns and the health effects of adding waste derived materials to cement. Although scientific studies indicate that these alternative fuels and raw materials (AFR) can be used safely, the public is sometimes skeptical, despite the waste recovery and fossil-energy reduction benefits.[10] Another major concern is that the cement industry contributes about 3 percent of global greenhouse gas emissions.
- **Regulatory Policies:** Around the world, government policies and regulations are placing increasing restrictions on industrial emissions and freedom to operate (partly in response to stakeholder pressures). Despite

[9] Note that the typical definition of "urban" area may not fully capture the infrastucture deficiencies in developing countries.
[10] Cembureau, "Environmental Benefits of Using Alternative Fuels in Cement Production: A Life-Cycle Approach," 1999.

the obstacles encountered in implementing the Kyoto protocol, many national governments will likely adopt carbon management policies. Some countries have already done so (e.g., the United Kingdom promulgated the "Climate Change Levy"[11] in order to reduce greenhouse gas emissions).

- **Innovation:** Both inside and outside the cement industry, researchers are discovering new technologies, products, and processes for the manufacture and use of cement and competing construction materials. Process innovations range from fluidized bed kilns to cement manufacture in electric power plants. Some product innovations, such as mineral or organic polymers with cement-like properties, could be viable substitutes for Ordinary Portland Cement.[12]
- **Transparency**: Public expectations for corporate behavior are changing. Businesses are increasingly being held accountable for their policies and practices with respect to human rights and environmental stewardship.[13] Disclosure has become commonplace, and electronic communication has encouraged demands for global accountability and transparency.
- **Energy Prices:** The economics of cement production are changing due to volatile energy prices. This has already motivated the industry to explore alternatives to conventional fossil fuels. At the same time, low energy prices in some regions, such as North America, may inhibit efficiency improvements and innovations.
- **Global Consolidation:** The cement industry is consolidating, and cement companies are acquiring or building plants in emerging markets such as China, India, and Indonesia.[14] Tensions between companies and local communities can occur over issues such as employment practices or disruption of natural resources by private enterprise. Cement companies will need to understand and build upon different regional and cultural characteristics in order to master the complexities of local engagement. Globalization provides the potential for dissemeination of good practices and resources for environmental and social investment.

Figure 1-2 also depicts the following barriers to sustainability in the cement industry.

- **Mature Material:** Ordinary Portland Cement is a mature product that is familiar to customers. Making changes in cement or concrete recipes or manufacturing processes has proven difficult.[15] Some materials and construction specifiers and users are resistant to changes in product characteristics.
- **Resource Intensity:** Cement production requires large amounts of energy and raw materials. Using existing processes, only incremental reductions can be achieved in the total amount of energy and limestone used to produce a unit of OPC.
- **Capital Intensity:** Cement production is one of the most capital-intensive industries and major plant modifications are expensive. A long time period may be required to recover cement plant investments, leading to a conservative attitude toward change.

[11] The Climate Change Levy is a tax on business energy use in the U.K., effective in April 2001.
[12] Battelle, "Toward a Sustainable Cement Industry: Innovation Substudy Report," http://www.wbcsdcement.org/final_reports.asp, 2002.
[13] McIntosh M., et al., *Corporate Citizenship: Successful Strategies for Responsible Companies*, Times Prentice Hall, New Jersey, 1998.
[14] International Cement Review, "The Global Cement Report: Fourth Edition," December 2000.
[15] Sauer, G., "S.W.O.T. Analysis for Cement and Concrete Industries," Engineering Foundation Conference on Advances in Cement and Concrete, July 1998.

- **Lack of Trust**: Stakeholder familiarity with cement companies and the level of mutual trust vary widely (see Section 1.4 below). The industry is often associated with dust, traffic, and eyesores such as quarries and tall smokestacks.[16] The media seldom portray the positive accomplishments of the cement industry.
- **Standards and Specifications**: Product standards for cement and concrete are intended to ensure the safety and integrity of built structures. In the past, standards required very specific product composition, and innovations such as cements containing waste were difficult to use. Although a wider range of standards is now available, some of which are based on product performance rather than composition, designers and engineers still widely specify traditional products. Some argue that these composition standards result in over specifying the concrete design of structures, which results in more cement consumption than the amount truly required for safety and structural integrity.[17] Although these practices bolster OPC sales, they contradict SD principles that encourage lower resource consumption. Product standards also can be misused to protect vested market interests.
- **Company Inertia**: One of the greatest barriers to sustainability is inertia – the tendency for cement companies to continue operating as they have in the past. Resistance to change and skepticism about new ideas are typical of mature industries. In the absence of a crisis, inertia may be difficult to overcome.
- **Market Pressures:** A shift towards usage of higher strength cement, even for non-critical applications like plastering and flooring, is occurring in many countries. In a number of cases this material is produced through use of higher quality (higher CaO content) raw material leading to faster resource depletion.
- **Commodity Product:**[18] Because cement is mainly a commodity product, prices within a given market are relatively uniform across companies. As a result, cement companies hesitate to make investments in SD that are not clearly linked to near-term cash flow.

The Role of Governance

Achieving long-term progress in SD requires a commitment to responsible governance on the part of both corporations and governments. Sound corporate governance systems are necessary for companies to attract investment capital and maintain the confidence of their shareholders and other stakeholders. In most of the developed world, the established frameworks of laws, regulations, and management practices encourage corporate responsibility and accountability. In developing and transition economies and even to some extent in the developed world, there can be instances where the existing public institutions do not provide adequate oversight mechanisms to assure sound corporate governance.[19] This creates the potential for abuses that may hamper economic and social development.

Cement companies cannot be expected to take sole responsibility for solving the challenging problems of assuring responsible governance in an increasingly globalized economy. However, it is important for cement companies to support transparency and affirm their opposition to corrupt practices. Non-governmental

[16] Chandelle, J.M., "The European Cement Industry: The Challenges Ahead," Cembureau.
[17] Holtec Consulting Pvt. Ltd., "Cement Market Study for Germany," 2001 (unpublished).
[18] A commodity product is one for which the primary basis of competition is cost.
[19] World Bank, "Corporate Governance: A Framework for Implementation," 2001.

organizations (NGOs) are playing an increasingly important role in influencing government policies and promoting principles of sound governance at both a national and international level.[20] Thus, it is in the interest of cement companies to collaborate with public and private institutions, including NGOs, religious leaders, unions, academia, and trade associations, to help design effective governance systems that benefit all stakeholders. At the same time cement companies need to ensure that their internal corporate governance policies and mechanisms are consistent with the goals of sustainable development.

1.4 Importance of Stakeholders

Historically, the principal stakeholders of concern to the cement industry were the shareholders and financial institutions that influenced their market value and access to capital. Within the past 10 years, however, the voices of other groups, such as local communities, NGOs and local governments, have become more clear and forceful. Reasons for this change include access to better information and education, recognition of stakeholder concerns by governance bodies, and the emergence of NGOs as focal points for interaction on a variety of issues.

Several cement companies have initiated dialogue efforts in specific countries, and many are involved in local community assistance. However, the cement industry as a whole has not moved effectively toward stakeholder engagement.[21] As stakeholder groups become more informed and empowered, it is important for cement companies to engage them more effectively and to move beyond "dialogue" toward cooperation founded on shared interests.[22] Collaboration with stakeholders may involve *ad hoc* initiatives or more permanent relationships such as working partnerships with individuals or institutions that have a stake in the cement industry. For example, Lafarge has formed an alliance with the World Wide Fund for Nature (WWF) to jointly pursue environmental improvements.[23]

In practice, stakeholder engagement can arouse deep emotions, and is one of the most challenging activities for company representatives and plant managers. One lesson learned from the cement industry stakeholder dialogue sessions (see box on next page) is that stakeholders are concerned about a lack of communication and engagement with the cement industry. In many countries, changing living patterns, urban growth, and ownership shifts from local to foreign management have weakened the traditional connection between cement plants and their neighbors. As a result, mistrust sometimes exists between the industry and local communities.

Stakeholders: A Definition

Stakeholders for the cement industry are all individuals and groups who see themselves as potentially affected by or who can impact cement operations at the local, national, or international scale. These include, but are not limited to, neighbors, community organizations, employees, trade unions, government agencies, the media, non-governmental organizations (NGOs), contractors, academia, and suppliers.

Discussions of stakeholder concerns often overlook the fact that company managers and employees are also important stakeholders. As community residents and citizens, they seek the

[20] Battelle and ERM, "Toward a Sustainable Cement Industry: Public Policy Instruments Substudy Report," http://www.wbcsdcement.org/final_reports.asp, 2002.
[21] Battelle, "Toward a Sustainable Cement Industry: Stakeholder Dialogue and Communications Substudy Report," http://www.wbcsdcement.org/final_reports.asp, 2002.
[22] Holliday, C. and J. Pepper, "Sustainability Through the Market: Seven Keys to Success," World Business Council on Sustainable Development, 2001.
[23] Lafarge, *Lafarge and the Environment*, March 2000.

Cement Study Stakeholder Dialogues

To help obtain a variety of perspectives on stakeholder issues specific to the cement industry, this study included two sets of dialogues. The first set of events took place in Curitiba, Brazil; Bangkok, Thailand; Lisbon, Portugal; and Cairo, Egypt and included local and national government representatives, academia, labor, science, consumers, suppliers, and non-governmental organizations, along with cement industry representatives. A second set of events, aimed at policy-makers, financial development organizations, and global environmental interest groups, was conducted in Washington, D.C. and Brussels, Belgium. Both sets were facilitated by experts in stakeholder dialogue.

Findings from these dialogues suggest that the cement industry interacts only in a limited way with local communities, many of whom feel that there are important environmental and social issues that the industry needs to address. There was acknowledgment of the positive efforts by cement companies to engage with stakeholders and to improve their environmental performance, although these efforts are not always well communicated. The following are examples of the range of comments received during the discussions:

"The cement industry is important to our economy." – *public interest group representative, Cairo*

"Local communities around cement plants have high expectations of support from the plants. [I am] particularly concerned with the loss of [our] mountain, which was a treasured part of the landscape." – *community activist, Bangkok*

"There is a need for earlier and more effective public involvement by the industry regarding waste burning." – *academia and NGO participant, Lisbon*

"The industry needs to respond to [specific] measures and targets." – *NGO representative, Brussels*

"The cement industry could be a very significant participant in the Climate Leaders [voluntary industry-government] partnership as they work to implement SD." – *governmental participant, Washington*

same opportunities and protections for their families and children that others do. Moreover, they want to be proud of their companies, both as successful businesses and as responsible pillars of the community. On a personal level, they share many aspirations of SD with the external stakeholders discussed above. Thus, employees can play a valuable role as ambassadors to the community.

Finally, engagement with shareholders is just as important as engagement with communities and environmental groups. While some shareholders may be sympathetic to environmental and social issues, the majority are concerned about the company's profitability and long-term stability. By communicating the business value of SD to shareholders, management can win their support and confidence.

1.5 Linking Sustainable Development to Enterprise Value

Given the many challenges and stakeholder concerns that confront the cement industry, sustainability may seem like an expensive proposition. For example, the traditional model of environmental management views compliance as a "necessary cost of doing business." However, this model is not appropriate for several reasons:

- Sustainability is not yet mandated by regulations, although issues such as carbon management are rapidly moving in that direction. Most corporate sustainability initiatives are voluntary, discretionary, and motivated by business logic.

- Given their cultural and economic constraints, it is unrealistic to assume that cement companies will be willing or able to incur significant costs in addressing sustainability issues unless there is a clear business case for doing so.
- Sustainability is viewed seriously in the marketplace by both customers and shareholders and will continue to grow in importance. Sustainability requires strategic consideration by the Chief Executive Officer (CEO) and other senior executives who are concerned with the viability and growth of the company.

Progress toward sustainability will only occur when there is a clear link to enterprise value.

In fact, progress toward sustainability will only occur when there is a clear link to enterprise value.[24] The key to SD for cement companies is discovering those links and finding ways to take advantage of them. **The financial community has begun to recognize that sustainable companies are generally better managed. In other words, those companies that accept environmental and social responsibility tend to generate superior shareholder returns.**[25] This new awareness has led to the rise of pooled investment initiatives such as Sustainability Investment Partners, and the emergence of indicators such as the EV 21 index devised by Innovest Strategic Advisers, the FTSE4Good Indices, and the Dow-Jones Sustainability Index.

Cement companies that make a genuine effort to understand stakeholder needs will discover opportunities for generating shareholder value. There are a number of specific steps that cement companies can take to capture value:

- Establish business practices that consider enterprise value and stakeholder value in all business decisions.
- Identify "win-win" initiatives that improve license to operate, market access, and profitability while addressing societal needs.
- When evaluating investment opportunities, use a comprehensive framework that identifies nontraditional sources of business value (e.g., stakeholder goodwill).
- Understand how SD contributes to shareholder value: employee motivation, brand loyalty, community trust, corporate reputation, and operating benefits.
- Develop higher-margin, differentiated, sustainable products that generate greater customer and shareholder value while using fewer resources.

"We've found a new way to win in the marketplace...one that doesn't come at the expense of our grandchildren or the earth, but at the expense of the inefficient competitor."

Ray Anderson, CEO, Interface, Inc.

Source: Daviss, B., "Profits from Principle: Five Forces Redefining Business," *The Futurist*, March 1999.

The value of SD therefore extends beyond direct revenue or profit increases. It encompasses all of the indirect sources of value that create better economic performance for the enterprise. Section 2.2 provides further definition of these pathways to value.

[24] SustainAbility, "Buried Treasure: Uncovering the Business Case for Corporate Sustainability," January 2001.
[25] Repetto, R., and D. Austin, *Pure Profit: The Financial Implications of Environmental Performance*, World Resources Institute, 2000.

Part 2: Seizing the Opportunity – A Sustainable Future

The cement industry is experiencing new challenges, as described in Part 1. Stakeholders are growing more outspoken, while demand for cement-based products is growing in many emerging economies. Due to the inevitable tension between economic growth and corporate responsibility, it is important for the cement industry to understand its current status with respect to SD, including the risks of business impediments, and to articulate its future SD goals. The current SD profile of cement production can be summarized as follows:

The current SD profile of cement production can be summarized as follows:

- On the one hand, cement production raises a number of sustainability concerns – it consumes large amounts of energy and resources, emits dust and other pollutants, disturbs large tracts of land during quarrying, and generates greenhouse gases.
- On the other hand, the cement industry contributes value to society by (a) providing a key product used in developing the infrastructure to serve social needs such as shelter, mobility, water, and sanitation, and (b) by helping to dispose of unwanted materials.

Some progressive cement companies deserve credit for implementing innovative performance improvements and adopting enlightened policies and practices at individual plants. However, despite such points of excellence, this study has found that the cement industry as a whole is not yet contributing to the extent possible toward sustainability in the regions where it operates. While environmental performance is the area of greatest concern, stakeholders have also expressed concern about social and economic performance. This situation is comparable to that of other industries that rely heavily on resource extraction and energy consumption. At a minimum, cement companies will need to address their vulnerabilities through appropriate stakeholder outreach and risk management efforts. In addition, the cement industry has some unique opportunities to capitalize on its strengths in the area of industrial ecology, which involves exchanging resources to mutual benefit.

2.1 Key Sustainable Development Issues for the Cement Industry

In order for the global cement industry to make genuine progress toward SD, it must address all three dimensions of the triple bottom line in concert. The following summarizes the important issues confronting the cement industry in each of the three dimensions – environmental, social, and economic.

Environmental issues associated with cement industry operations include the following:

- Impacts of resource extraction (fossil fuel, limestone, and other minerals) upon environmental quality, biodiversity, and landscape aesthetics
- Depletion of non-renewable or slowly renewable resources (fossil fuels or groundwater)
- Dust emissions (from quarrying, cement production, and transport)
- Other emissions that can affect air quality: nitrogen oxides (NO_X), sulfur dioxide (SO_2), carbon monoxide (CO), volatile organic compounds (VOC), dioxins, metals, etc.

- Emissions of carbon dioxide (CO_2) involved in global climate change
- Solid wastes, including cement kiln dust (in some countries where standards restrict recycling back into the production process).

Driven by increasingly stringent regulations, the cement industry has reduced the environmental "footprint" of its production activities. However, as global industrial growth continues, pollution levels in certain regions may eventually exceed the natural capacity of ecosystems. Siting of new cement plants, especially in highly developed areas, may face strict emission controls as well as community opposition. For example, rules in the United States call for "prevention of significant deterioration," which often implies zero growth in emissions.[26] Likewise, the cement industry will be increasingly pressured to reduce global warming emissions.

Finally, although cement applications are beyond the scope of this study, the construction industry generates a significant amount of waste in new construction and in demolition of aged buildings and infrastructures. Methods have been developed to recover demolition wastes and recycle them back into concrete production, thus reducing raw material costs. These types of initiatives hold promise for increasing the eco-efficiency of the overall cement life cycle.[27]

Social issues affecting the cement industry include impacts on human well-being and the satisfaction of basic needs for both cement industry employees and society in general. Cement production can have both positive and negative social impacts. Community concerns about plant operation or new facility siting include health effects, worker safety, aesthetics, noise, dust, traffic congestion, and road damage. Some cement companies are striving to manage occupational safety and health (OS&H) more effectively, but it is still largely decentralized. In many countries, OS&H performance is not publicly reported, as it is in some other heavy manufacturing industries.

On the positive side, the cement industry has demonstrated that it can offer an environmentally responsible means of productively using certain wastes that would otherwise be a burden to society. In addition, particularly in developing countries where poverty is often a dominant issue, cement companies can make significant social contributions through voluntary community assistance, training of workers, and improved infrastructures such as roads, sewers, and water supply.

Economic issues include the financial prosperity of both the cement industry and its stakeholders. The industry's major contribution to the world's economy is providing a low-cost product that is the preferred material for a variety of applications. Creation of enterprise value for cement companies is linked in many ways to their ability to address external stakeholder issues, as described in Section 1.4.

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[26] U.S. EPA, http://www.epa.gov.

[27] U.S. EPA, "Characterization of Building-Related Construction and Demolition Debris in the U.S.," Report EPA530-R-98-010, 1998; and Muller, C. "Requirements on Concrete for Future Recycling," Aachen University, Institute for Building Materials Research, Germany, 1999.

The development or expansion of cement facilities can create jobs and stimulate economic growth, but plant closures can result in adverse economic disruptions. Overall, as productivity improves, cement industry employment will tend to decrease per tonne of product.[28] The global consolidation discussed in Part 1 may benefit stakeholders in developing countries if the progressive practices, such as uniform corporate enviromental practices, that have been adopted by some cement companies become more widespread. It is critical that local and regional dialogue be maintained regarding these sensitive issues, and that the socioeconomic impacts of events such as plant closures be addressed responsibly.

This study analyzed the triple bottom line performance of the cement industry through the conduct of 13 substudies (listed in Table 2-1). As a result of these substudies, Battelle has identified eight key **issues,** which represent the main areas in which the cement industry can contribute to sustainable development (SD). These eight issues form the basis for the balance of this report, including assessment of the industry's current SD status, and recommendations for improvement.

Table 2-1. Sustainable Cement Substudies

1.	Stakeholder Dialogue	8.	Climate Change
2.	Communications Strategy	9.	Industrial Ecology
3.	SD Business Case	10.	Environment, Health, and Safety (EHS)
4.	SD Alignment	11.	Land Use and Biodiversity
5.	Key Performance Indicators (KPI)	12.	Socioeconomic Development
6.	Life Cycle Assessment (LCA)	13.	Public Policy Instruments
7.	SD Innovation		

The Sustainability Compass (Figure 2-1) illustrates the relationships of the eight SD issues to the three dimensions of the triple bottom line. Although each of the eight issues addresses all three dimensions to some extent, the issues tend to align somewhat more closely to one or two dimensions; hence their placement near the three points of the triangle. These relationships are explained in more detail in Table 2-2, which describes potential benefits of progress that the cement industry can achieve. Note that many of the issues are strongly correlated; for example, improving energy efficiency will have positive impacts upon resource productivity, climate protection, emission reduction, and shareholder value.

Figure 2-1. The Sustainability Compass

[28] ERM, "Toward a Sustainable Cement Industry: Socioeconomic Development Substudy Report," http://www.wbcsdcement.org, 2002.

Table 2-2. Potential Benefits of Progress on Each SD Issue

Issue	Environmental	Social	Economic
Resource productivity	**Decreased burdens upon fossil fuel resources and materials extraction**	Conservation of resources for future generations Waste disposal service to society	Reduced operating costs Potential new revenue sources
Climate protection	**Reduction in greenhouse gas emissions**	Improved ability to maintain current global habitation and food production patterns without disruption from sea level rise, extreme weather events, and other climate change consequences	Minimization of cement company's financial liability associated with CO_2 and creation of new business opportunities Reduction in climate-related economic damage to man-made or natural systems
Emission reduction	**Improved air and water quality; protection of pristine environments**	Minimization of dust, hazards, and other community disturbances; reduced risk of worker and community health effects; improved quality of life	Reduction of societal economic damages from pollution More cost-effective pollution prevention
Ecological stewardship	**More responsible land use, protection of natural ecosystems and biodiversity**	Improved maintenance of natural landscapes and ecosystems for personal enjoyment and aesthetic satisfaction; protection of ecosystems and biodiversity for future generations	Company's improved right to operate and enhanced image Protection of ecosystem services that provide food and other economic goods
Employee well-being	Safer and healthier working conditions	**Increased safety, health, satisfaction, pride, and motivation**	Reduction in lost time, improved productivity, career development Easier recruitment of staff
Community well-being	Reduction in environmental disturbances, including noise, odor, vibrations Improved public health & safety	**Improved access to health care,education, training, sanitation, recreation** **Improved quality of life, including aesthetics**	Improved availability and affordability of goods and services Improved quality of local labor force
Regional development	Consideration of long-term environmental impacts associated with regional development	More social staability due toeconomic prosperity Increased availability of basic infrastructure (sewers, roads, etc.)	**Improved job creation, economic growth ,and standard of living** **Increased regional capacity building**
Shareholder value creation	Increased ability to design and implement with state-of-the-art technologies with low environmental impact	Increased ability of company to contribute to the well-being of the communities in which it operates	**Improved company financial performance and competitive position**

Note: Bold-faced items show the primary benefits.

Table 2-3 provides an assessment of the current status of the cement industry with regard to the eight SD issues identified above. For each issue, the table lists

- Specific topics covered within that issue
- Strengths and weaknesses with regard to overall industry performance today
- Opportunities for future progress toward sustainability, as well as threats to the industry if progress does not occur.

Further information and factual support for the summary assessment presented here can be found in the full report, *Toward a Sustainable Cement Industry*.

Table 2-3. Summary of Cement Industry Sustainability Status

Issue	Topics Covered
Resource Productivity	■ Mineral extraction ■ Energy consumption ■ Waste recovery & re-use

Strengths:
- Substitution of unwanted wastes as alternative fuels and raw materials conserves natural resources

Weaknesses:
- Operations require large amounts of energy and raw materials

Opportunities:
- Increased application of industrial ecology
- Products with lower raw material requirements
- Efficient quarrying
- Effective waste reduction or elimination
- Energy efficiency throughout the life cycle
- Using renewable forms of energy, e.g., biomass

Threats:
- Resistance to change on the part of the cement industry and standards bodies
- Restrictions on use of waste fuels
- Increased cost of wastes as competition rises
- Limited supply of alternative materials

Issue	Topics Covered
Climate Protection	■ CO_2 emissions

Strengths:
- Some companies have demonstrated reduced average CO_2 released per ton of cement
- A standardized CO_2 inventory protocol has been developed by the WGC companies, together with external stakeholders

Weaknesses:
- Heavy dependence on fossil energy
- Reliance on limestone-based cement
- Limited attention to the significant CO_2 reductions required
- Inadequate investment in R&D that would enable future cost-effective CO_2 reductions
- Intermittent engagement in climate policy activities without a clear long-term agenda

Opportunities:
- 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
- CO_2 capture and sequestration or possible resale
- Trading schemes to reduce costs

Threats:
- 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

Table 2-3. Summary of Cement Industry Sustainability Status (Continued)

Issue	Topics Covered
Emission Reduction	■ Dust from quarrying, milling, storage, and other cement operations ■ NO_x, SO_x, and other airborne pollutants ■ Emissions from alternative fuels (e.g., waste tires) ■ Contamination of groundwater ■ Solid waste from cement kiln dust

Strengths:
- Historically high levels of dust have been sharply reduced (over 90%) in many areas
- NO_x and other airborne or waterborne pollutants have also been reduced in new and upgraded plants
- Process conditions are conducive to emissions management
- Technology exists that can reduce emissions significantly

Weaknesses:
- Concerns about formation of toxic pollutants from waste combustion
- Lack of comprehensive assessment of public health impacts of emissions
- Limited data on ecological consequences of releases
- CKD disposition is not fully addressed
- Large stock of older-vintage plants in some regions

Opportunities:
- Management systems (e.g., ISO 14000, EMAS) to support monitoring of emissions
- Communication with communities & regulators
- Research on public health effects of alternative fuels to allay concerns
- New quarrying techniques that minimize dust
- Publication of emissions at all plants

Threats:
- Loss of license to operate
- Delays in siting and plant start up
- Public opposition to waste combustion

Issue	Topics Covered
Ecological Stewardship	■ Natural resource conservation ■ Ecosystem and habitat protection ■ Prevention of contaminated runoff and infiltration into groundwater

Strengths:
- Many examples of advanced practices in quarry restoration and management

Weaknesses:
- Potential adverse impacts on ecology, biodiversity, and water quality and availability
- Potential for mobilization of heavy metals
- Potential groundwater contamination or depletion

Opportunities:
- Reduction in water use
- Minimizing or eliminating adverse landscape impacts
- Preserving and enhancing ecological services of natural & restored habitats
- Easier acquisition of construction and operating permits

Threats:
- Public opposition to quarrying
- Loss of license to operate
- Delays in plant siting and start up

Issue	Topics Covered
Employee Well-Being	■ Occupational safety & health (OS&H) for workers & contractors ■ Workplace conditions, including wages, benefits, security, rights, and growth opportunities ■ Job satisfaction, loyalty, and pride

Strengths:
- Examples of progressive employment practices in many parts of the world

Weaknesses:
- Potential for respiratory diseases, burns, allergens
- OS&H incidents typically not managed carefully or publicly reported
- Great variations in employee well-being programs across countries

Opportunities:
- Improvements in OS&H management systems & training programs
- Adoption of inherently safe plant design methods
- Key performance indicators tied to OS&H results
- Well-being programs
- Employee involvement in sustainable practices

Threats:
- Operations are impeded by poor image
- Difficulty in attracting talented employees
- Increased labor productivity leading to reduced employment levels

Table 2-3. Summary of Cement Industry Sustainability Status (Continued)

Issue	Topics Covered
Community Well-Being	■ Public safety and health ■ Pleasant living environment ■ Satisfaction of basic needs ■ Access to public services ■ Landscape aesthetics

Strengths:
- Some cement companies provide financial and in-kind support to local communities and disadvantaged groups.

Weaknesses:
- Cement operations may create disturbances, e.g., congestion, noise, dust
- Quarry sites may damage recreational, agricultural, and other forms of land use and compromise aesthetics

Opportunities:
- Understand community needs through dialogue
- Work with communities to help them meet their expressed needs (e.g., infrastructure, job training, health care, nutrition)
- Promote aesthetic uses of concrete
- Restore quarry sites to provide public amenities

Threats:
- Community resistance to permitting expansion or construction of quarries and plants

Issue	Topics Covered
Regional Development	■ Job creation ■ Economic growth and stability ■ Infrastructure development ■ Capacity building

Strengths:
- Cement is a key ingredient in a low-cost, versatile construction material - concrete
- Cement plants provide jobs, tax revenue, and local economic stimulus

Weaknesses:
- Plant openings or closings disrupt existing local economic patterns
- Employment declines due to higher productivity

Opportunities:
- Seek recognition for community development and capacity building
- Support growth of local business enterprises
- Provide assistance for displaced workers
- Creation of novel cement-based products for developing markets

Threats:
- Dynamic economic and political situations in some emerging economies make it risky for cement companies to enter markets.
- Cement industry offers to help with social issues can be perceived as "bribes" or conversely, governments could come to expect industries to provide considerable funds in order to operate in a country.

Issue	Topics Covered
Shareholder Value Creation	■ Quantifiable financial value (e.g., return on investment) ■ Strategic enterprise value (e.g., company image) ■ Future potential value (e.g., option value) over long time horizon

Strengths:
- Solid outlook for long-term growth in some regions of the globe, e.g., Asia

Weaknesses:
- Rate of innovation and R&D investment is low
- Process R&D often left to vendors
- Public image of most cement companies is not an asset
- Long capital investment recovery periods
- No control over waste markets

Opportunities:
- Development of high-margin products
- Reduced operating costs via eco-efficiency
- Faster permitting, improved right to operate
- Increased revenue through expanded markets
- Reduced capital costs via process simplification

Threats:
- Competition from substitute cement products and from other building materials
- Financial and market share value migration to concrete or construction companies that develop the capability to formulate their own waste-based cements
- Difficulty in raising capital due to perceived environmental problems
- Competition from low-cost providers that take advantage of less stringent policies

2.2 Shareholder Value Creation

As stated in Part 1, progress toward sustainability will only occur when there is a clear link to enterprise value. Based on a number of empirical studies that correlate company practices with shareholder value, the financial community has begun to recognize that sustainable companies tend to be better managed.[29] In other words, those companies that embrace environmental and social responsibility will generate superior economic returns. This new awareness has led to the rise of pooled investment initiatives such as Sustainability Investment Partners, and the emergence of indicators such as the EV 21® index devised by Innovest Strategic Advisers, the FTSE4Good Indices, and the Dow-Jones Sustainability Index.

Shareholder value creation can result from several different sources of value:

- Quantifiable enterprise value (measurable in financial terms)
- Strategic enterprise value (e.g., image) measurable in non-financial terms
- Future potential value (e.g., option value) over a long time horizon

Some sustainability initiatives contribute directly to enterprise value, e.g., revenue from utilization of wastes as alternative fuels. In addition, creating value for external stakeholders will indirectly lead to enterprise value creation for the (e.g., customer loyalty, employee satisfaction, right to operate). Thus, there is an important linkage between environmental and social sustainability achievements and the company's ability to sustain growth and profits.

In particular, each of the SD issues covered in the previous sections is linked to enterprise value creation. These linkages are illustrated in Figure 2-2, based on Battelle's ValuWeb™ methodology.[30] The arrows in the diagram show how specific improvements on the part of a cement company can generate value for society as well as enterprise value for the company. While it would be impossible to show clearly all of the potential linkages to value in a single diagram, Figure 2-2 attempts to capture a number of the important pathways for value creation. For example, Resource Productivity will be enhanced through reductions in virgin material usage and fossil fuel usage, which results in several important direct benefits to society - natural resource conservation, emission reduction, and climate protection.[31] At the same time, improved resource productivity will contribute to reduced operating costs, since material acquisition costs will be lower, as well as reduced capital costs, since the required throughput per tonne of cement will be lower, effectively increasing plant capacity. Finally, the above-mentioned societal benefits will generate indirect strategic value for the company by enhancing the company image and right to operate, which ultimately translate into competitive advantage and improved financial returns.

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[29] Repetto, R. and D. Austin, *Pure Profit: The Financial Implications of Environmental Performance*, World Resources Institute, 2000.

[30] ValuWeb™ is a methodology developed by Battelle's Life Cycle Management group for visual mapping of value contributions associated with products, processes, or systems.

[31] Taiheiyo Cement's Environmental Report 2000, p. 21, provides an example of the quantification of social benefits.

In a similar way, it is possible to trace a path from each of the key SD issues to the important direct and indirect benefits for both the cement company and its stakeholders. Some of these linkages can be quantified mathematically, while other linkages represent known correlations that are difficult to quantify precisely (e.g., the connection between employee well-being and employee productivity). Individual cement companies can use this approach to develop more detailed, customized representations of their beliefs about how key SD issues relate to their business objectives. In effect, ValuWeb™ provides a graphical view of the business case for SD.

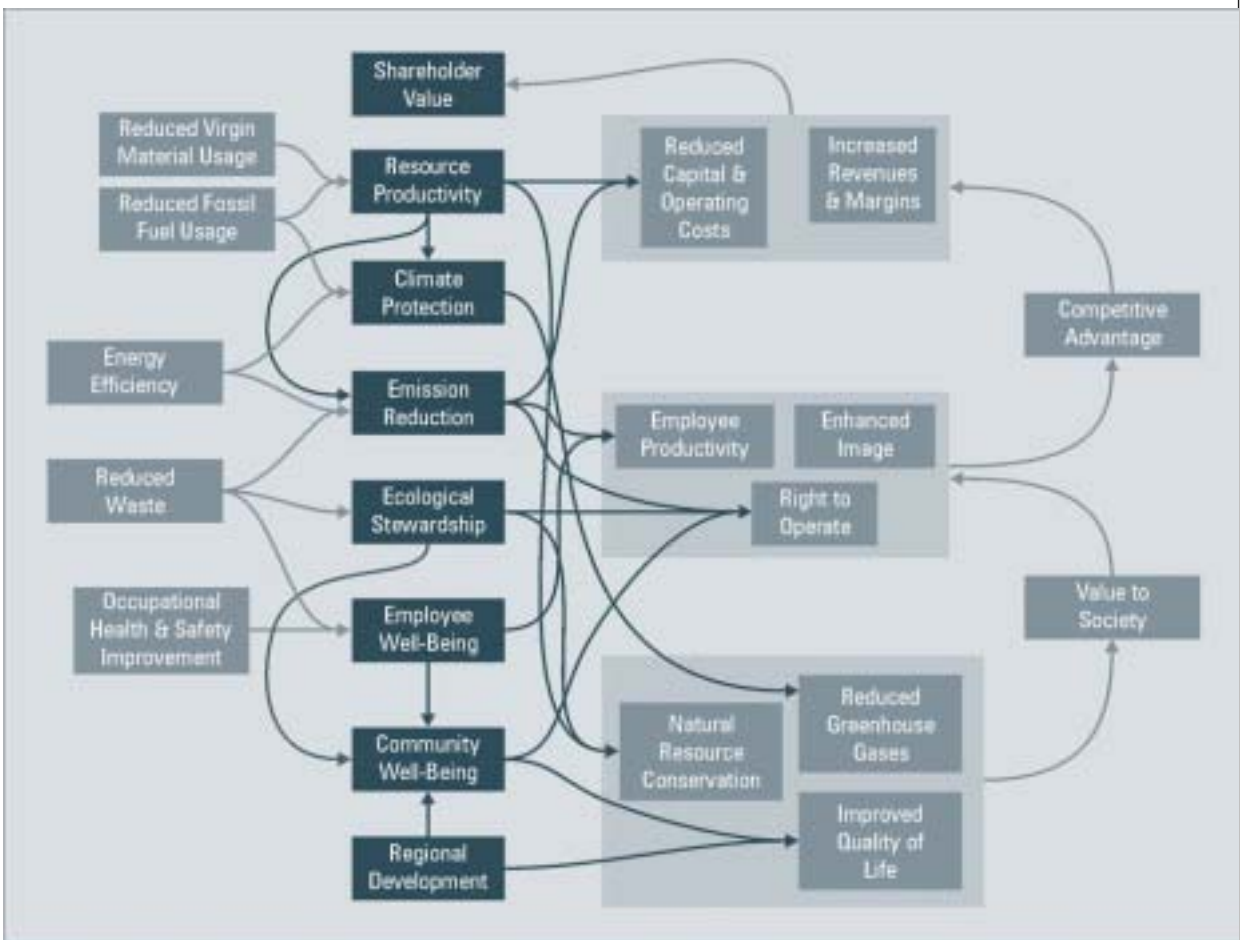

Figure 2-2. Progress on SD Issues (dark boxes) Results in Shareholder Value Creation for the Company Through Both Direct and Indirect Pathways

2.3 Vision for a Sustainable Cement Industry

The cement industry can ensure its continuity and prosperity by acknowledging its shortcomings, focusing on win-win opportunities to create value for society, and working with its stakeholders toward a long-term vision of sustainability. Battelle believes that the industry should define a SD vision for the future that expresses the aspirations of cement companies, and guides the development of principles, goals and objectives, business strategies, and specific actions. Based on the results of this study and prior input by Arthur D. Little, Inc., Battelle suggests the following vision of a desirable state for the cement industry in 2020:

Battelle's vision: By 2020, cement companies have integrated sustainable development into their global operations, are known as innovators in industrial ecology and carbon dioxide management, are regarded as attractive employers, and have established relationships of trust with the communities in which they operate.

1) **Resource productivity** – The industry makes productive use of specific materials that otherwise would be discarded as waste, and applies state-of-the-art technologies and operating practices to cost-effectively improve its efficiency in energy and material consumption.
2) **Climate protection** – The industry has implemented practical technological, operational, and market-based strategies to significantly reduce emissions of CO_2 and is technologically positioned for even greater reductions in the future.
3) **Emission reduction** – The industry has continuously improved its environmental practices and controls to achieve a minimal release of wastes or emissions that could adversely affect human health, ecosystems, and aesthetics.
4) **Ecological stewardship** – The industry develops, operates, and retires its plants and quarries in a manner that minimizes adverse impacts on the environment, including biodiversity and aesthetics, and protects and restores potentially impacted ecosystems. In doing so, it has earned support and recognition in the eyes of the community and regulators.
5) **Employee well-being** – The industry builds and operates its facilities in a way that fosters employee satisfaction and productivity, provides fair wages and benefits, and is a safe, clean, healthy, and desirable place to work.
6) **Community well-being** – The industry is well understood and respected by the communities in which it operates because companies and plants make efforts to understand community needs and to help find ways to meet those needs. The industry has implemented measures to address nuisance disturbances associated with quarrying, transportation, and plant operations.
7) **Regional development** – The industry and its associated value chain are viewed as positive contributors to local and regional economies, and countries welcome the growth and prosperity of the industry because it is considered a critical component of infrastructure development and maintenance .
8) **Shareholder value creation** – The industry provides competitive returns to investors and is able to readily secure capital resources. Cement companies that have adopted SD practices are desirable investments for sustainable development index funds, and have increased their profitability and market share.

2.4 Establishing Industry SD Goals and Performance Indicators

To pursue the vision of the future, cement companies will need to adopt strategic goals that are consistent with the triple bottom line. Battelle has developed a set of eight sustainability goals for consideration by the cement industry as a whole, which we believe address most of the stakeholder concerns identified during this study. Note that the eight goals are presented in Table 2-4 along with key performance indicators (KPIs) whereby progress can be measured. Battelle was able to recommend general indicators for only four of the goals; the other goals will require further development of consensus regarding the most meaningful indicators.[32] Several of the goals are relatively new for the cement industry – e.g., "Respect the needs of local communities" and "Support host region economies" – so that common indicators have not yet been established. We anticipate that individual cement companies will select the key performance indicators that are most appropriate for their business needs. For example, instead of tonnes of cement as a normalizing unit, some companies may prefer tonnes of cementitious material.

Table 2-4. Recommended SD Goals and Key Performance Indicators

Issues	Goal	KPIs
Resource productivity	Conserve resources by using less energy and recycling wastes	**Energy efficiency: Tonnes of cement per megajoule (quarry and plant)** **Fuel material substitution rate (%)** **Raw material substitution rate (%)**
Climate protection	Reduce greenhouse gas emissions	**Net CO_2 (kg) emissions per tonne of cement**
Emission reduction	Reduce environmental waste streams	**Waste (non-product output) produced (kg) per tonne of cement** (can include airborne emissions, waterborne effluents, fugitive dust, and solidwastes)
Ecological stewardship	Reduce adverse impacts of quarrying	*Potential KPIs: investments in quarry restoration, overburden waste reduction, water use efficiency, biodiversity action plans, etc.*
Employee well-being	Assure worker health and safety	**Incident rate (injury, work-related illness) per 200,000 hours** (can include both employees and contractors)
Community well-being	Respect the needs of local communities	*Potential KPIs: frequency of community meetings, hours of volunteer community service, public health initiatives,community opinion surveys, etc.*
Regional development	Support host region economies	Potential KPIs: job creation, local investment, technology transfer, contribution to GDP, etc.
Shareholder value creation	Create superior value for shareholders	*Potential KPIs: return on investment (ROI), return on assets (ROA), return on net assets (RONA), return on capital employed (ROCE), economic value added (EVA), etc.*

Note: Bold-faced entries represent commonly used indicators

[32] Battelle, "Toward a Sustainable Cement Industry: Key Performance Indicators Substudy Report," http://www.wbcsdcement.org/final_reports.asp, 2002.

Note that the first recommended KPI, **Tonnes of cement per megajoule,** is the inverse of a more familiar measure of energy intensity, megajoules per tonne. The purpose of this KPI is to reflect the increasing eco-efficiency of cement production in terms of output per resource unit, as discussed in Section 2.1.

Another of the KPIs that may be challenging to implement is **non-product output,** i.e., waste per tonne of cement. Most cement companies measure specific waste streams that they consider important, such as airborne NOx emissions, but do not attempt to calculate the total amount of waste generated by their operations. Battelle believes that it is important for cement companies to move toward a system-level understanding of eco-efficiency, and that the recommended KPI encourages this type of thinking. Otherwise, reduction in one type of waste stream may simply be achieved by shifting the waste to a different medium. Non-product output is theoretically equal to the difference between total materials consumed and total cement produced, which can be deduced through a mass-balance calculation. Therefore, in addition to reducing environmental impacts, reduction in non-product output will tend to reduce the cost of material procurement. At the same time, use of this KPI at an aggregate level does not preclude companies from implementing more focused indicators that track the releases of specific substances such as NOx, heavy metals, or CO_2 from individual plants.

Finally, it should be noted that there is partial overlap among several of the recommended KPIs. For example, one way to reduce CO_2 emissions is to reduce the use of fossil energy sources, which can in turn be accomplished through increased substitution of wastes as alternative fuels. However, each KPI represents an important goal that stands on its own, and it is satisfying for company personnel to have goals that are mutually reinforcing. If cement companies can implement initiatives that improve performance for multiple KPIs, they deserve full credit for their accomplishments.

Part 3: Embarking on the Path – An Agenda for Change

The vision of a sustainable cement industry in 2020 can only be realized if cement companies and their stakeholders take concerted actions that lead to meaningful changes. While some leading cement companies have already begun to integrate SD principles into their operations, the majority of them have not considered the full range of possible actions that can contribute to SD. For the industry to move beyond incremental improvements, new strategies are needed that promote fundamental change.

This section of the report recommends a strategic agenda for change over a twenty-year time frame, including potential actions by both the cement industry and its stakeholders. As illustrated in Figure 3-1, the recommendations of this study, combined with the influences of stakeholder perspectives, will help a cement company to specify its SD strategy and goals. Then, progress along the path toward SD will involve a gradual and iterative process, including communication with stakeholders, goal-setting, application of knowledge and tools, initiation of actions, evaluation of performance results, and redefinition of strategy and goals over time. Each cement company will need to manage this process and implement actions in a way that fits with its own business priorities and capabilities. Although there can be a set of indicators common to the industry, some performance indicators will need to be tailored to the particular characteristics of the company.

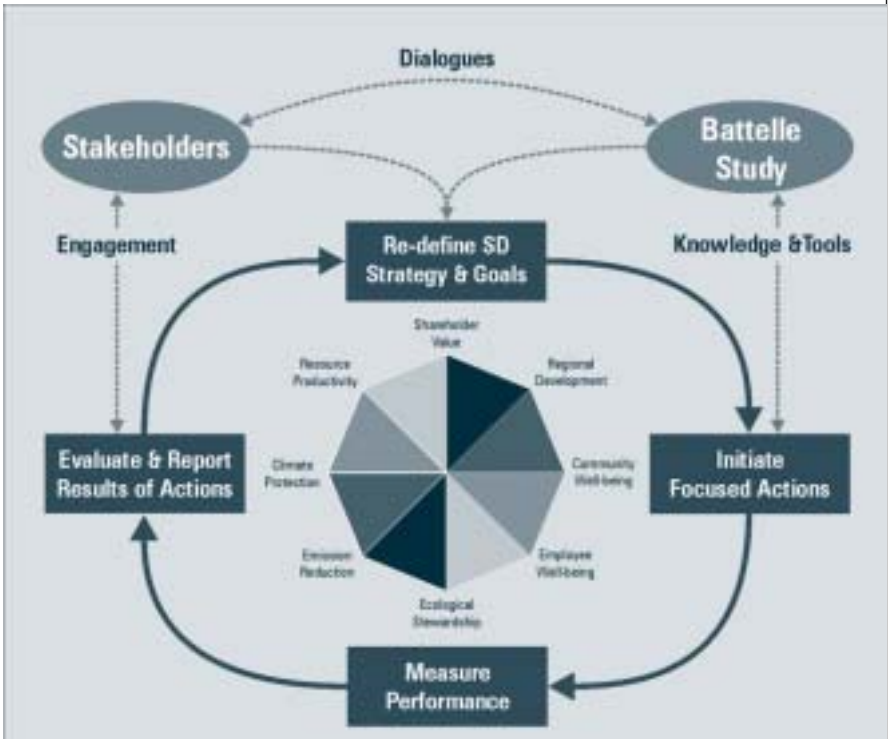

Figure 3-1. An Iterative SD Change Process for Cement Companies

The ability of the cement industry to work effectively toward SD will be greatly influenced by the evolution of public governance frameworks in different parts of the world. The major public policy and regulatory issues areas that are relevant to the industry's SD agenda include[33]

- New regulations to reduce emissions, particularly CO_2 and other climate change gases
- Regulations and local policies restricting the use of hazardous waste or other materials as fuels

[33] Battelle and ERM, "Toward a Sustainable Cement Industry: Public Policy Instruments Substudy Report," http://www.wbcsdcement.org/final_reports.asp, 2002.

- Policies governing zoning, urban sprawl, and biodiversity conservation that impact operations, restrict expansion, or limit siting of new facilities
- Evolving product stewardship policies that may require producers to accept long-term responsibility for the end-of-life disposition of their products; and
- Regulations and standards that hinder the use of alternative materials in the production process or in the product.

These policies and regulations will challenge cement companies and plants to respond with alternative production processes, emission control technologies, or more effective and complex siting, permitting and mitigation strategies. In order to assure that the opportunities described in Part 2 can be realized, it is important that cement industry collaborates with its stakeholders to promote a policy framework for sustainable development that is clear, stable, flexible, predictable and effective. This is a recurrent theme in the recommendations that follow.

Ten high-level recommendations are summarized in Table 3-1, representing a portfolio of potential initiatives that can be undertaken by cement companies and their stakeholders. The recommendations are grouped into two categories:

- Initiatives that focus on the **specific issues** relevant to the cement industry
- Initiatives that focus primarily on the **enabling processes** necessary for organizations to work toward achievement of SD goals.

In the future, companies may compete on the basis of SD by developing improved processes and novel products that give them a competitive edge. In addition, cement companies can take cooperative actions, working jointly with each other and with external stakeholders, to make progress on sustainability. Therefore, the recommendations include both company-specific initiatives and cooperative initiatives that will promote the adoption of SD.

The first category is directly related to the vision and goals for key SD issues defined in Part 2 of this report. The second category (called "enabling processes"), recommends key actions needed to ensure the success of the focused environmental and socioeconomic initiatives, including alignment of cement companies around SD principles, innovation, and cooperation with stakeholders. Most of these recommendations are derived from the 13 substudies listed in Table 2-1.

The realization of shareholder value by increasing enterprise value is not included among the issue-specific recommendations. The reason is simple – enterprise value is woven into virtually all of the recommended initiatives. Certain SD initiatives will contribute directly to enterprise value (e.g., cost savings through eco-efficiency), while other initiatives that generate environmental or socio-economic value will lead indirectly to enterprise value creation (e.g., through increased customer loyalty, employee satisfaction, and community right to operate). Thus, there is an important linkage between environmental and socio-economic SD results and the company's ability to sustain growth and profits.

Figure 3-2 illustrates how the recommended types of actions on the part of the cement industry and its stakeholders can result in accelerated progress toward SD. This diagram builds upon the business logic for shareholder value creation that was introduced in Figure 2-2. For example, actions related to *Process Innovation and Improvement* can lead to a variety of improvements in efficiency and safety that in turn have a positive impact upon a number of SD issues – Resource Productivity, Climate Protection, Emission Reduction, Ecological Stewardship, and Employee Well-being. These improvements create value for stakeholders, including employees, communities, and other interested parties, while also generating financial and strategic value for the company. It would be impossible to show clearly all of the potential actions and linkages to value in a single diagram, but Figure 3-2 displays a number of the important recommendations in this report.

The following sections provide additional details on suggested initiatives and actions corresponding to each of the high-level recommendations in Table 3-1. Actions in support of each recommendation are arranged with the critical ones at the top of each listing, indicated with an asterisk (*).

The last section describes alternative pathways that cement companies might take toward the goal of sustainability by focusing on selected areas of performance. The path chosen by each cement company will be different, because each must work within the context of its unique culture, beliefs, asset base, market, and financial situation.

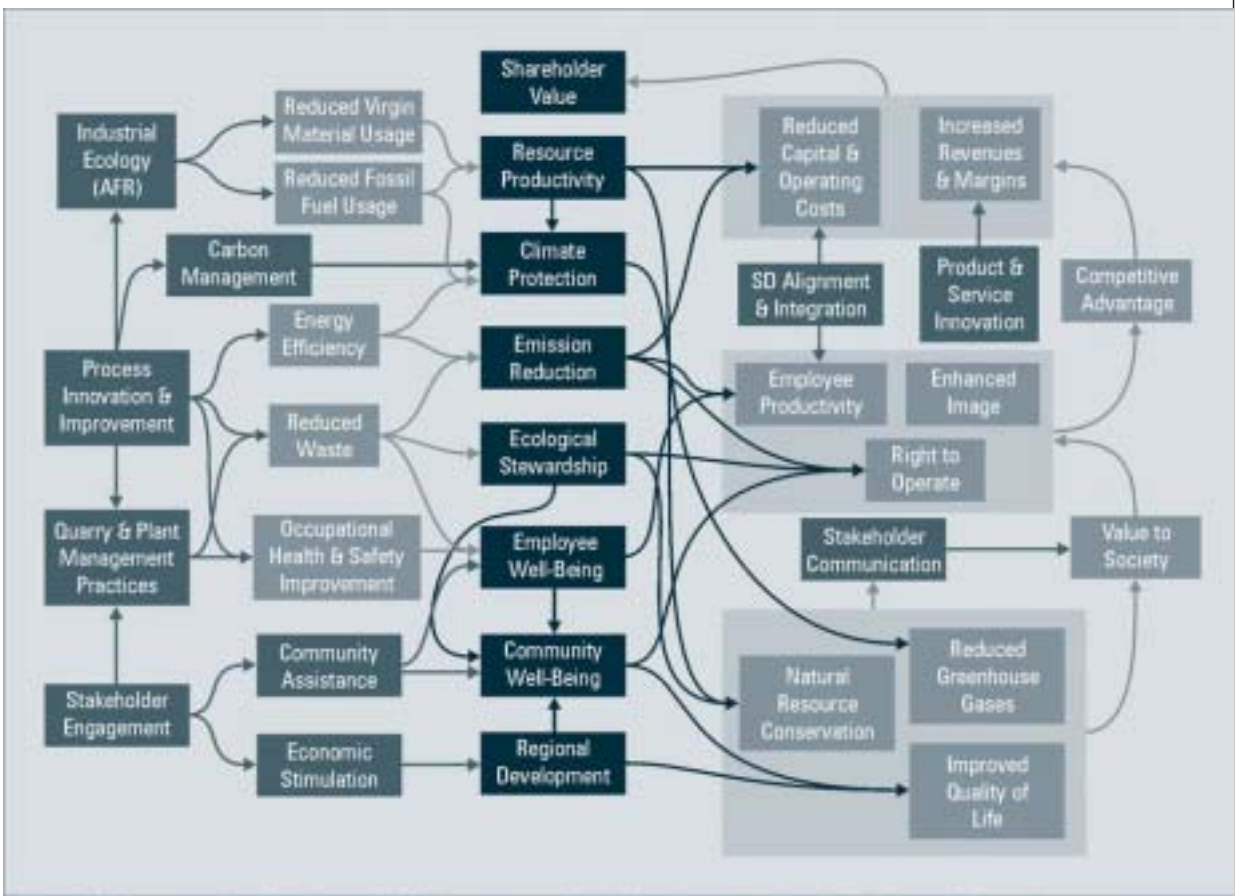

Figure 3-2. Different categories of actions result in SD improvement and shareholder value creation through both direct and indirect pathways

Table 3-1. Major Recommendations

	Recommendation	Responsibility
Issue Specific Initiatives		
1. Resource productivity	Facilitate the practice of industrial ecology and eco-efficiency in the cement industry	■ Cement companies ■ NGOs and Academia ■ Local and national government ■ Suppliers, including waste suppliers
2. Climate Protection	Establish corporate carbon management programs, set company-specific and industry-wide medium-term CO_2 reduction targets, and initiate long-term process and product innovation	■ Cement companies working individually and collaboratively ■ Industry associations ■ Standard setting bodies ■ Government regulatory agencies ■ NGOs ■ Academia
3. Emission Reduction	Continuously improve and make more widespread use of emission control techniques	■ Cement companies ■ Industry associations ■ Suppliers ■ Local and regional governments
4. Ecological Stewardship	Improve land-use practices by disseminating and applying best practices for plant and quarry management	■ Cement companies ■ Local/national governments ■ Industry associations ■ Environmental NGOs ■ Local and national governments ■ Community stakeholder groups
5. Employee Well-Being	Implement programs to enhance worker health, safety, and satisfaction	■ Cement companies ■ Regulatory agencies ■ Suppliers ■ Employees ■ Industry associations
6. Community Well-Being	Contribute to enhancing quality of life through local stakeholder dialogue and community assistance programs	■ Cement companies ■ Community stakeholder groups
7. Regional Development	Promote regional economic growth and stability by participating in long-term planning and capacity-building, especially in developing countries	■ Cement companies ■ Local & regional governments ■ Waste brokers
Enabling Process Initiatives		
8. Business Integrationof SD	Integrate SD principles into business strategy and practices in order to create shareholder value	■ Cement companies ■ Stakeholder groups
9. Innovation	Encourage SD-related innovations in product development, process technology, and enterprise management	■ Cement industry consortia ■ Equipment suppliers ■ Academia
10. Cooperation	Work with other cement companies and external organizations to foster SD practices and remove barriers	■ Cement companies ■ Concrete companies ■ Specifiers and other users ■ Industry associations ■ NGOs ■ Academic and private research organizations ■ Equipment suppliers ■ Governments

3.1 Issue-Specific Recommendations

Recommendation 1. Resource Productivity

Conservation of natural resources is a key theme of sustainability.[34] Limestone and even fossil fuels are likely to remain in plentiful supply for the foreseeable future, although prices may increase over time. Nevertheless, a decrease in extraction of virgin (natural) materials and the productive use of waste materials are important societal goals, because these actions will

- preserve undisturbed land and minerals for future generations
- decrease negative impacts on natural habitats
- lower the volume of wastes in landfills
- reduce waste disposal costs, and
- lower net CO_2 emissions.

The cement industry has made progress in using alternative fuels and raw materials (AFR) as substitutes for virgin resources such as fossil fuels, limestone, and other minerals (see photo). Steps can be taken to increase this practice in the cement industry and to better understand its benefits and costs. *Industrial ecology* provides a useful concept for helping the industry reach a higher level of resource productivity. Cement companies can work with other industries and municipalities to find new opportunities for economical exchange of waste products. To enable broad application of industrial ecology, companies can

- Conduct research on the compatibility of various waste streams with their processes
- Investigate ways to make changes in their plants or in waste suppliers' operations that would increase the feasibility or effectiveness of industrial ecology approaches
- Develop data to support comparisons of environmental, health, and cost impacts of fuels and materials
- Seek collaborative partnerships with waste suppliers and other stakeholders.

Those companies that intend to implement a proactive IE program must have the technical capability to *evaluate* a full range of IE opportunities, including both financial and environmental implications of choices over the life cycle. They can research the full life cycle effects of using wastes as fuel in cement plants versus other uses. They can analyze the compatibility of various waste streams with their individual plant characteristics. They can also investigate ways to make changes in their plants or in waste suppliers' operations that would increase the feasibility or effectiveness of industrial ecology approaches. The potential actions related to resource productivity and industrial ecology are summarized in Table 3-2.

[34] Proponents of sustainability argue that resource consumption in all industries should decrease by a minimum factor of 4 or 10, and some organizations call for even more aggressive goals of factor 20 or 50.

Table 3-2. Potential Actions to Foster Resource Productivity

Recommendation 1: Facilitate the practice of industrial ecology and eco-efficiency in the cement industry.

Potential Actions	Responsibility	References
1.1 Develop a business strategy toward use of AFR and industrial ecology. Companies should understand the financial, environmental and social incentives and disincentives of using AFR and develop a position on its use.*	■ Cement companies	■ Substudy 9: Industrial Ecology
1.2 Conduct or support research to characterize the risks and benefits of alternative fuels and raw materials to workers and the community. To fully evaluate alternatives, research must be conducted on health and environmental impacts and other aspects of AFR use.*	■ Cement companies ■ NGOs and Universities ■ Government	■ Substudy 7: Innovation ■ Substudy 9: Industrial Ecology; ■ Substudy 10: EHS
1.3 Seek engagement with multiple industrial ecology partners. Waste management infrastructure development in cooperation with other partners will help establish a stable industrial ecosystem. Multiple feedstock sources help secure supply and ensure environmentally and economically sound options.	■ Cement companies ■ Suppliers ■ Local and national government	■ Substudy 9: Industrial Ecology; ■ Substudy 7: Innovation
1.4 Enhance technical capabilities to evaluate industrial ecology opportunities. If AFR is an important component of the business strategy, the company should develop competencies to evaluate a range of AFRs from cost and environmental/social perspectives.	■ Cement companies ■ Waste suppliers	■ Substudy 9: Industrial Ecology

* Indicates a critical action

Recommendation 2. Climate Protection

The primary public policy instrument driving action to reduce CO_2 emissions is the United Nations Framework Convention on Climate Change (UNFCCC), which has been ratified by more than 180 countries. This Convention makes clear that the ultimate climate protection goal is "the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."[35] If the cement industry supports an ultimate environmental goal of stabilizing atmospheric concentrations of greenhouse gases (e.g. twice pre-industrial levels), the industry may need to reduce its global-average CO_2 emissions per tonne of product produced by ~30%[36] (from 1990 levels) by 2020. Depending upon the individual company and country of operation, some companies will likely face somewhat higher or lower targets. However, in a carbon-constrained world, **all** cement companies are likely to face significant reductions.

Furthermore, even with a global-average reduction of 30% per tonne by 2020, the cement industry's CO_2 emissions would continue to grow over the century due to the increased demand for cement. The recommendation related to climate protection is that all companies (1) establish an internal carbon management program, (2) set industry-wide

[35] United Nations Framework Convention on Climate Change, 1992; http://www.unfccc.int.

[36] See the longer study report and the Climate Change substudy report (http://www.wbcsdcement.org/final_reports.asp for additional details. Key assumptions include: (1) social commitment to stabilize greenhouse gases, (2) moderate economic and population growth nearly doubles demand by 2020, (3) all industries use minimum cost approach to reduce CO_2, (4) cement industry CO_2 emissions, as a percentage of total global CO_2, are never higher than they are today. Other potential factors affecting demand were not covered.

and company-specific medium-term goals for emission reduction based on currently available techniques, and (3) conduct longer-term research on more radical ways to reduce CO_2 emissions from cement production.

The potential actions related to climate change are summarized in Table 3-3.

Table 3-3. Potential Actions for Climate Protection

Recommendation 2: Establish corporate carbon management programs, set company-specific and industry-wide medium-term CO_2 reduction targets, and initiate long-term process and product innovation.

Potential Actions	Responsibility	References
2.1 Establish a CO_2 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	■ Substudy 8: Climate Change
2.2 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.)	■ Substudy 3: Business Case ■ Substudy 5: KPIs ■ Substudy 8: Climate Change
2.3 Cooperate with stakeholders to develop government policies, product standards,and market practices that remove barriers to: (1) the sale of innovative (and safe) cement products with lower embodied CO_2 emissions, and (2) the use of appropriate waste fuels that reduce life cycle CO_2 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	■ Substudy 3: Business Case ■ Substudy 6: LCA ■ Substudy 8: Climate Change ■ Substudy 13: Public Policy
2.4 Explore prospects of reducing CO_2 emission reduction costs through emission 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	■ Substudy 8: Climate Change
2.5 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	■ Substudy 7: Innovation ■ Substudy 8: Climate Change ■ Substudy 9: Industrial Ecology

* Indicates a critical action

Recommendation 3. Emission Reduction

In addition to emissions of the greenhouse gas, CO_2, the cement industry emits air pollutants such as nitrogen oxides (NO_x), hydrocarbons, and particulates, and can also create discharges to water bodies. Although the overall level of environmental control in the cement industry has increased considerably over the last few decades, the use of state-of-the-art controls is not universal. In addition, as population and economic activity

grow over the century, air and water resources will be increasingly strained. Battelle's recommendation related to emission reduction calls for additional process improvement and more widespread use and continuous improvement of pollution control techniques.

Some cement companies operate in multiple countries that have different levels of both regulatory stringency and enforcement. To ensure that they are adequately protecting the public and employees, cement companies should establish uniform, corporate standards for use of the most energy-efficient and low-emission technology possible within cost constraints. Companies should require that, over a reasonable time period, existing plants improve their emission profiles or cease operation. They also can work on designing new plants to have almost zero net emissions. In addition, environmental management systems with specific performance goals, as well as integrated information systems, can help ensure that companies consider emission reduction in their operating decisions. Benchmarking within the industry as well as relevant cross-industry comparisons can help with target setting.

The potential actions related to emission reduction are summarized in Table 3-4.

Table 3-4. Potential Actions to Foster Emission Reduction

Recommendation 3: Continuously improve and make more widespread use of emission control techniques.

Potential Actions	Responsibility	References
3.1 Establish and apply uniform (worldwide) corporate standards of environmental practice. Develop standards that apply uniformly in all operations to ensure adequate protection for the public and employees wherever the company operates, even if the local regulatory regime is less strict. *	■ Cement companies ■ Industry Associations	■ Substudy 10: EHS
3.2 Apply best practical technology for energy efficiency and pollution control to existing plants. Evaluate options for lowering energy consumption and environmental impacts, and choose cost-effective options to meet corporate standards. *	■ Cement companies ■ Suppliers	■ Substudy 10: EHS ■ Substudy 7: Innovation
3.3 Engage with policy makers to ensure consistent enforcement of environmental regulations. The uniform application of existing regulations will help bring all facilities up to at least a currently required level of performance.	■ Cement companies ■ Local and regional governments	■ Substudy 11: Land Use & Biodiversity ■ Substudy 13: Public Policy
3.4 Design an almost-zero net emission plant. By continuously improving pollution control and process technology, cement plants can eventually be designed to minimize emissions. Net emissions can be further reduced through industrial ecology (see Recommendation 1).	■ Cement companies ■ Suppliers	■ Substudy 7: Innovation
3.5 Implement environmental management systems (e.g., ISO 14000, EMAS, or a company-specific system). Management systems can help to consider environmental aspects in operating decisions, and to set specific goals for emission reduction.	■ Cement companies	■ Substudy 10: EHS
3.6 Implement integrated environmental management information systems, where cost-effective. Software or new information systems could help track and report progress toward emission goals.	■ Cement companies	■ Substudy 10: EHS

* Indicates a critical action

Recommendation 4. Ecological Stewardship

Protection of ecosystems and biodiversity during land use planning, siting, operation, and closure of plants and quarries is an important aspect of sustainable development. Many best practice approaches are available to minimize disturbance, reduce damage to habitats and biodiversity, and make better use of company assets both during operation and at the end of their useful life. However, these approaches are not sufficiently widespread throughout the industry. For instance, there is insufficient guidance on restoration techniques and the management of biodiversity. Techniques such as Geographic Information Systems and visualization simulation are available, and new quarrying techniques, such as semi-open-pit mining (see below), have been developed. In addition, cement companies could site new plants in areas that foster industrial ecology, such as in industrial parks that support environmentally preferred transportation and energy sources. Finally, obsolete kilns can be used for productive purposes, such as waste processing or other innovative uses.

A summary of potential actions related to ecological stewardship is provided in Table 3-5.

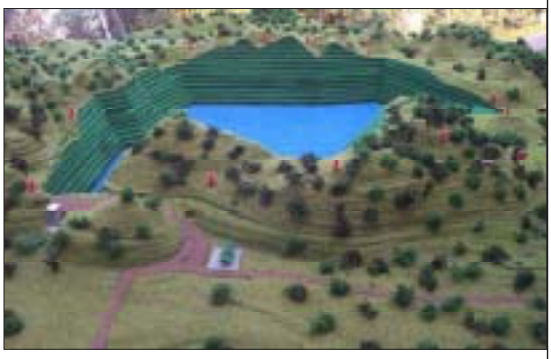

Table 3-5. Potential Actions for Ecological Stewardship

Recommendation 4: Improve land-use practices by disseminating and applying best practices for plant and quarry management.

Potential Actions	Responsibility	References
4.1 Disseminate and adopt innovative siting and land use planning methods that consider cultural sensitivities and biodiversity. Identify and use best practices during siting, planning, and operation to assess, monitor and manage development and to reduce impacts. *	■ Cement companies ■ Local/national governments ■ Trade Associations	■ Substudy 11: Land Use & Biodiversity ■ Substudy 7: Innovation
4.2 Develop and apply innovative quarrying methods. Explore the use of alternative quarrying methods that reduce adverse environmental and social impacts (e.g., semi-open-cut mining).	■ Cement companies ■ Suppliers ■ Trade Associations	■ Substudy 7: Innovation ■ Substudy 11: Land Use & Biodiversity
4.3 Find productive, environmentally sound, and socially acceptable uses for depleted quarries and retired plants. Depleted quarries could be converted to a variety of habitats. Using restoration funds created for this purpose during the extraction stage would avoid later problems. Converting retired cement plants and equipment to alternative uses could extend the value of these assets.	■ Cement companies ■ Environmental NGOs ■ Local and national governments ■ Community stakeholder groups	■ Substudy 7: Innovation ■ Substudy 11: Land Use & Biodiversity ■ Substudy 9: Industrial Ecology ■ Stakeholder Dialogue Report

* Indicates a critical action

Recommendation 5. Employee Well-Being

The most important priority for cement companies with regard to employee well-being is the assurance of occupational health and safety, both for workers and contractor personnel. The cement industry is not nearly as advanced as some other heavy manufacturing industries in the implementation of occupational health and safety management systems. In the future, cement companies might consider the design of inherently safe plants that minimize potential mishaps.

In addition, consistent with SD principles, there are a number of other employee well-being issues that a company can support, including training, career development, and professional growth; respect for employee rights, such as freedom of communication and association; promotion of balance between commitment to work and personal or family life; promotion of diversity; and prohibition of discrimination and harassment. Such measures will contribute to employee productivity and safety-consciousness, as well as loyalty and pride.

The potential actions related to employee well-being are summarized in Table 3-6.

Table 3-6. Potential Actions to Foster Employee Well-Being

Recommendation 5: Implement programs to enhance worker health, safety, and satisfaction.

Potential Actions	Responsibility	References
5.1 Ensure healthy and safe working conditions for employees and contractors. This includes compliance with occupational health and safety requirements; identification and elimination of health and safety hazards in the workplace; and employee training.*	■ Cement companies ■ Regulatory agencies ■ Suppliers	■ Substudy 10: EHS
5.2 Implement management systems for occupational safety and health. Implementation of formal management systems enables continuous improvement in health and safety performance based on documented performance objectives.	■ Cement companies ■ Employees ■ Industry associations	■ Substudy 10: EHS
5.3 Institute programs and practices that promote employee satisfaction and well-being. This can include career counseling and training, fairness policies, and benefit programs such as flex-time, dependent care services, time-off policies, or health and wellness.	■ Cement companies ■ Employees	■ Substudy 12: Socioeconomic Development
5.4 Design inherently safe plants. Plants should be designed cost-effectively in a way that minimizes the potential for accidents, employee injuries, or chronic illnesses.	■ Cement companies ■ Suppliers	■ Substudy 10: EHS

* Indicates a critical action

Recommendation 6. Community Well-Being

An important first step in fostering community well-being is learning about local stakeholder perceptions. Open and constructive engagement will help cement companies build a spirit of trust and collaboration with citizens in neighboring communities, and with public interest groups in the countries where they operate. When concerns or problems do arise, companies should respond in a transparent manner. Methods for stakeholder engagement include

- Creating citizen advisory or liaison groups
- Conducting surveys and interviews with community representatives
- Arranging for informal dialogue during "open plant" days or other events.

Cement companies should train plant managers and other company representatives to deal sensitively with local stakeholders and serve as ambassadors of the SD program. In addition, to demonstrate that their operations are safe and environmentally sound, companies can monitor and publicly report environmental, health, and safety data (e.g., air pollutant emissions), and for extra assurance they can provide third party monitoring and report verification.

In countries where the government does not provide adequate social services, some cement companies voluntarily contribute to community well-being through a variety of assistance programs aimed at improving quality of life, e.g., supporting education, construction of facilities, health care, nutrition, sanitation, or poverty relief initiatives. Cement companies can also work with government authorities and other industries to encourage a more institutionalized approach to social welfare (see also Recommendation 7).

Potential actions related to community well-being are summarized Table 3-7.

Table 3-7. Potential Actions to Foster Community Well-Being

Recommendation 6: Contribute to enhancing quality of life through local stakeholder dialogue and community assistance programs.		
Potential Actions	**Responsibility**	**References**
6.1 Engage in open dialogue with stakeholders, and train cement company personnel in appropriate skills. Managers and employees can learn to engage in two-way dialogue, deal sensitively with community needs and concerns, and build long-term trust. *	■ Cement companies ■ Community stakeholder groups	■ Substudies 1 & 2: Stakeholder Dialogue and Communications Strategy
6.2 Institute a sustainability reporting program based on feedback from stakeholders. With guidance from stakeholders about their information needs, companies can initiate a program to monitor and report on their environmental and social performance.	■ Cement companies ■ Community stakeholder groups	■ Substudies 1 & 2: Stakeholder Dialogue and Communications Strategy
6.3 Voluntarily provide assistance to local communities. Companies can respond to community needs through social investment programs and support for employee volunteer efforts.	■ Cement companies	■ Substudy 12: Socioeconomic Development
* Indicates a critical action		

Recommendation 7. Regional Development

In developing economies, cement plants are often important contributors to tax revenue and employment. In addition, the cement industry often plays a major role in regional development by providing a critical product needed for growth of infrastructure, and by procurement of supplies and services. Especially in developing countries, a focused effort to understand, improve, and communicate their economic role could help companies to solidify their market position and right to operate. Moreover, cement companies can participate constructively in regional planning of economic development.

For decisions related to siting of new plants, acquisition of existing plants, and plant closure, companies should expand their environmental impact assessment efforts to include analysis of socioeconomic issues such as employment patterns and potential economic disruptions. On the positive side, there are many ways that cement companies can use their economic leverage to encourage entrepreneurship, capacity-building, and local economic growth.

Potential actions related to regional development are summarized in Table 3-8.

Table 3-8. Potential Actions to Foster Regional Development

Recommendation 7: Promote regional economic growth and stability by participating in long-term planning and capacity-building.

Potential Actions	Responsibility	References
7.1 Conduct socioeconomic impact analysis for siting, acquisition and closure decisions. Companies should explore impacts on employment and potential economic disruptions. *	■ Cement companies	■ Substudy 12: Socioeconomic Development
7.2 Participate with local and regional governments and other interested parties in regional planning. The industry can both secure its future and assure a more sustainable regional economy by participating in long-term analysis and planning of economic development initiatives.	■ Local & regional governments ■ Cement companies	■ Substudy 12: Socioeconomic Development
7.3 Contribute to the establishment of industrial ecosystems. Work with local and regional organizations to identify and implement opportunities for exchange of materials and energy.	■ Cement companies ■ Waste brokers ■ Local & regional governments	■ Substudies 1 & 2: Stakeholder Dialogue and Communication Strategy ■ Substudy 9: Industrial Ecology
7.4 Support economic development and capacity building for local suppliers and disadvantaged communities. Seek opportunities to use local suppliers, provide training and technology transfer, and encourage entrepreneurship, especially in lower-income or disadvantaged communities.	■ Cement companies	■ Substudy 12: Socioeconomic Development

* Indicates a critical action

Recommendation 8. Business Integration of SD

Successful implementation of the previous recommendations will require that cement companies make a commitment to integration of SD principles into their business activities. This commitment must begin at the Board and CEO level, must be adopted by managers and employees through a corporate alignment effort, and must then be communicated to external stakeholders. Commitment does not mean that cement companies would adopt environmental or societal goals that are inconsistent with financial success. On the contrary, as argued in Part 2, cement companies can increase shareholder value if they consider environmental and societal needs when formulating strategies and making business decisions.

The potential actions cement companies can take to achieve business integration of SD are summarized in Table 3-9.

Table 3-9. Potential Actions to Foster Business Integration of SD

Recommendation 8: Commit to integration of SD principles into business strategy and practices in order to create shareholder value.		
Potential Actions	**Responsibility**	**References**
8.1 Identify the business value of SD and develop a systematic approach for integrating SD into decision-making. The senior management team should make the business case for SD and determine how processes must change to incorporate SD thinking into internal management and decision processes *	■ Cement companies	■ Substudy 3: SD Business Case ■ Substudy 4: SD Alignment
8.2 Articulate corporate commitment to SD. The CEO should publicly articulate - both inside and outside the company - how SD principles integrate with business strategy. *	■ Cement companies	■ Substudy 4: SD Alignment
8.3 Develop and carry out an internal alignment program. Companies should assess their current status, and design an approach to achieve alignment with SD, including visible, short-term initiatives.	■ Cement companies	■ Substudy 4: SD Alignment
8.4 Develop goals and performance indicators that are responsive to stakeholder interests. SD goals and indicators should consider stakeholder concerns, as well as shareholder value creation, over the full product life cycle.	■ Cement companies ■ Stakeholder groups	■ Substudy 5: KPIs
8.5 Openly communicate SD goals and targets, as well as performance, to internal and external stakeholders. Companies should create a reporting process and mechanisms to ensure that stakeholders are informed on a regular basis regarding SD initiatives and achievements.	■ Cement companies	■ Substudies 1 & 2: Stakeholder Dialogue and Communications Strategy
8.6 Create accountability and incentives for SD performance. Accountability for SD performance should be clearly delineated, and incentives or rewards can be linked to achievement of SD goals.	■ Cement companies	■ Substudy 4: SD Alignment
* Indicates a critical action		

Recommendation 9. Innovation

Some cement companies have made considerable progress in environmental performance and resource conservation through incremental improvements in operations and by initiating the use of AFR. However, more radical innovation in products, processes, and management concepts could hasten progress in resource conservation, environmental protection, and climate change mitigation. Innovations might also help to:

- Improve the use of wastes in cement kilns and cement products
- More effectively manage the cement life cycle (e.g., reuse of demolition waste)
- Improve the ambient environment in regions near cement plants
- Open markets in developing countries for new cement-based products, fostering economic development and improved quality of life in emerging economies
- Lead to use of cement in more sustainable ways (see examples below)

Innovation could potentially lead to lower costs, increased sales, higher-value products, advantage over current or future competitors, and higher returns to shareholders.

Even insiders do not consider the cement industry to be very innovative. Typically, cement companies spend very little R&D funding on process design and improvement but, instead, depend on vendors and suppliers for most of the process innovation. Cement companies committed to SD could take a renewed interest in and become more heavily involved in developing SD-oriented process changes. For research on pre-competitive technologies or underlying scientific principles, companies should consider collaborative efforts with equipment suppliers, other cement companies, governments, universities, and other research institutions.

Examples of process innovations:	Examples of product innovations:
■ Novel kiln designs ■ Advanced systems for integrating waste management and cement production ■ Use of biomass and renewable energy ■ Recycling of used concrete into cement ■ Producing cement during coal combustion ■ Advanced combustion processes and air pollution control ■ Application of carbon management techniques, e.g., carbon capture and sequestration	■ Cement-like products produced in novel ways ■ Cement with increased reactivity ■ Cement with less calcium content ■ Use of high proportions of renewable and waste materials in cement and concrete ■ Use of cement as an agent in environmental cleanup efforts ■ New cement products to meet the needs of developing countries ■ Concretes with longer life and/or higher strength

Potential actions related to innovation are summarized in Table 3-10.

Table 3-10. Potential Actions to Foster Innovation

Recommendation 9: Encourage SD-related innovations in product development, process technology, and enterprise management.		
Potential Actions	**Responsibility**	**References**
9.1 Increase cement company role in cement production process design. Help equipment suppliers set an R&D agenda for SD-oriented cement process change. Provide financial support for SD-oriented process R&D. Work cooperatively with other companies, suppliers, and universities on long-term, higher-risk projects leading to improved cement production processes and products. *	■ Cement industry consortia ■ Equipment suppliers ■ Universities	■ Substudy 7: Innovation
9.2 Include SD considerations in the new product development process. Include SD criteria in R&D project selection. Create novel products for developing economies that safely meet construction needs. Experiment with marketing new SD products to gain experience and overcome barriers. *	■ Cement companies	■ Substudy 7: Innovation ■ Substudy 12: Socioeconomic Development
9.3 Encourage creative SD thinking among employees by providing support, incentives and rewards for SD innovation. For example: Use knowledge management systems and cross-company meetings to share innovative ideas. Expand personnel reward schemes to encompass SD. Support development of new business concepts.	■ Cement companies	■ Substudy 7: Innovation ■ Substudy 4: SD Alignment
* Indicates a critical action		

Recommendation 10. Cooperation

Cement companies can undertake joint activities with each other or with stakeholder groups, in order to

- Leverage research resources
- Share and learn from best practices, benefiting all parties[37]
- Reach a broader set of stakeholders
- Create a common agenda for change.

A suggested action is to create an industry-wide **Sustainable Development Institute of Cement and Concrete.** This *international* institute would provide cement companies and their suppliers and customers with a focal point for developing sustainable business practices and working toward common goals. The Institute would be formed by cement companies, but would encourage participation from universities, NGOs, and existing cement-related institutions (e.g., regional and country-specific cement associations) that have an interest in pursuing worldwide sustainability goals. It would build on existing programs of research, education and policy development, broadening them to a global perspective and providing and SD focus. The Institute would work in three areas:

- Product and process research and technical studies related to SD,
- Education and training for the industry and stakeholders

[37] For example, a few poorly communicating plants or companies can give an entire industry a bad reputation.

- Promotion of SD through responsible governance (e.g., research support to help governments assess the consequences of alternative environmental policies, such as financial instruments to address climate change).

Table 3-11 summarizes the potential actions related to collaboration.

Table 3-11. Potential Actions to Foster Cooperation

Recommendation 10: Work with other organizations to foster SD practices and remove barriers.

Potential Actions	Responsibility	References
10.1 Create the Sustainable Development Institute of Cement and concrete. The charter would be to promote worldwide progress toward sustainable production and use of cement and concrete.	■ Cement companies ■ Concrete companies ■ Industry associations ■ NGOs ■ Universities ■ Equipment Suppliers ■ Specifiers ■ Research organizations ■ Governments	■ Several substudies and stakeholder dialogues
10.2 Conduct joint research with equipment suppliers, concrete companies, government, universities and other research organizations. Leverage resources with other institutions to conduct early-stage research to develop new process and product technologies. Conduct research on EHS aspects of cement products. Study life cycle impacts of using wastes and other cement supplements. (See related potential actions 3.4 and 9.1.)		■ Several substudies and stakeholder dialogues ■ Substudy 6: LCA
10.3 Develop educational and outreach programs to foster sustainable use of cement. Work with concrete manufacturers, construction companies, specifiers and other groups to develop SD guidelines for cement and concrete use. Widely distribute research results on environmental, safety, health, and societal aspects of cement products.		■ Substudy 12: Socioeconomic ■ Substudy 11: Land Use and Biodiversity
10.4 Coordinate efforts of cement associations and other groups working with governments to set policy. Apply research results to aid in the development of sound policies related to the sustainability aspects of cement (e.g., on global issues such as climate change policy). Conduct analysis to understand the SD implications of policy.		■ Substudy 13: Public Policy

3.2 Possible Futures

Carrying out the agenda and achieving the vision presented in this report will be challenging for both industry and its stakeholders. Each cement company will need to prioritize from among the numerous suggested actions, and choose a set of SD actions that fits well with its business strategy and corporate philosophy. Stakeholders will need to be productive participants in the transition toward a sustainable cement industry, not just critical observers.

Because of the diversity of companies, operating environments, and customer requirements, there is no single path to a sustainable cement industry and no single destination. As time progresses, it will become easier to identify the "unsustainable" companies than it will be to identify truly sustainable ones. Even the best performers will not succeed immediately with all sustainability issues – they will likely excel on some and struggle with others. Persistence and commitment will ultimately enable the industry as a whole to achieve the SD vision.

With these challenges in mind, this section looks ahead to the year 2020 and beyond, envisioning how cement companies that have pursued SD may be similar to or different from cement companies of today. The hypothetical examples below are based on assumed differences in company commitments and priorities. Consideration of these alternative pathways could help companies today to explore what SD means for them and to understand the potential implications of failing to deal with SD effectively.

"Rock Bottom Cement, Inc."

Rock Bottom Cement focused narrowly on minimizing the production cost of Ordinary Portland Cement. Costs associated with environmental compliance and safety, whenever prescribed by law, were considered reasonable expenditures. Extra costs for going beyond compliance were not. Stakeholder interactions were pursued on a case-by-case basis, such as when new plant sites were required. Rock Bottom Cement focused on keeping old plants operating as long as it could in order to avoid capital expenditures. As time went on, environmental regulations became more stringent and the capital expenditures were required anyway. As the need for new quarries emerged, Rock Bottom was hampered by its weak relationships with regulators and communities. It still generated profits, but its competitors and most stakeholders viewed it as the industry laggard. Developing nations, where the largest new demand for cement emerged, chose to deal largely with Rock Bottom's competitors.

"Progressive Cement, Pty"

Progressive Cement developed a strong social component to its business strategy. The company applied stringent environmental guidelines to all plants in its global operations, and devoted considerable resources to regional and community development programs. For instance, the company developed a philosophy of providing a fraction of its annual cement production, at no charge, to special community and regional projects. It also initiated a program of dialogue and communication with local communities surrounding its plants through which it identified needs and helped with financial and in-kind assistance programs. It used advanced techniques to minimize negative impacts of plant siting. It worked with local construction companies to develop new products and construction techniques amenable to local conditions.

Regional development, and community and employee well-being were considered company hallmarks. Having not placed much effort on climate protection, it was itself under increasing pressure from ever-tightening CO_2 regulations, but has been a top industry performer in reducing other emissions. Overall, it is well positioned to gain market share of cement sales in developing countries, because it has a good reputation and finds it easy to work with governments and other institutions to site new plants. In these ways it provides good shareholder value.

"High-Efficiency Cement Corporation"

High-Efficiency Cement chose to continue to pursue its core competency of manufacturing and selling cement, but chose an aggressive strategy to reduce resource consumption. Blended cements and significantly different product formulations enabled it to avoid carbon taxes and other environmental liabilities associated with the kinds of cement used in the last century. With limited opportunity for plant expansion, in the year 2002 the company created a new corporate initiative called "Extreme Efficiency" whereby management and employees drove production and energy efficiencies to the highest levels of the industry by adopting state-of-the-art technology and very aggressive industrial ecology approaches. Now, in the year 2020, the company is profitably selling a wide variety of cements using a limited number of Portland cement plants. They enjoy a reputation as industry leaders in resource productivity, climate protection, and emissions reduction. They are not particularly known for their regional or community efforts and wish they had begun to address these issues earlier. Sometimes they are criticized for squeezing out efficiency gains at the expense of employee well-being, so they recently initiated a new employee involvement program. However, overall, financial analysts rate the company a good value for shareholders.

"CemEnergy, Ltd."

A highly agile company, CemEnergy, Ltd. is an energy and eco-materials production company that uses wastes for fuel and feedstocks. It produces cement as well as metals, minerals, and other by-products. Its state-of-the-art EcoPlex 21 facility burns coal with special additives that yield high quality clinker and large amounts of electricity. It supplies water to a local town. It captures and sequesters CO_2 in un-mineable coal seams, co-producing natural gas. It has earned substantial CO_2 credits, which it sells for profit. This creative company is well known for ecological stewardship, emission reduction, climate protection, and resource stewardship. It is not well known for its stakeholder involvement efforts and at times communities and regions perceive it negatively for its use of "wastes" for fuel and feedstocks. As a result, CemEnergy is initiating a bold stakeholder involvement program. The company is known for providing excellent shareholder value and is well positioned for the future.

"Super-Tech Cement, S.p.A."

Super-Tech Cement partnered with suppliers and focused on process technology development. They developed several new processes for pollution control, efficiency improvement, as well as a novel process for making a new form of cement using lower temperatures. At first, they found that they sometimes over-emphasized technology and ignored the social dimension of sustainability. This caused difficulties with regional, community, and employee stakeholders, so they have begun to pay careful attention to these issues also. In 2020, they now profitably produce cement in almost zero-net emissions plants. The company also has a substantial income from the licensing of its process technologies to other cement companies and other industries. Emission reductions, climate protection, and resource productivity are hallmarks of the company. As a reward for their efforts, financial markets view them as providing excellent shareholder value and are very receptive to providing venture capital for the bold new technology ideas that Super-Tech pursues.

"Structural Products, S.A."

Structural Products no longer views itself as a "cement company," but instead views itself as a "structural materials company." An emphasis on business efficiency, strategic partnerships, and innovation has enabled them to dramatically increase their annual turnover, in spite of slow growth in traditional cement markets. They have reduced the magnitude of their environmental risks by diversification, and as a result of their diverse set of products, the value of their brand image has skyrocketed. Their "homes for families" program is world renowned for its work in developing countries to train communities to use low-cost cement-based building materials, while simultaneously generating corporate profits. Five percent of their annual revenue comes from their "finance and construction division," which uses eco-efficient binders to create structures with increased longevity and hence higher value, and sells the structures with a long-term guarantee. It is only through highly refined management techniques that Structural Products has been able to prosper while diversifying from its original core competency of making cement. In recognition of their efforts in pursuing a SD path, Structural Products is viewed by shareholders as a good investment, and seldom has a problem raising venture capital for its new enterprises.

3.3 Conclusions

This report began with the assertion that the cement industry could assure continued growth and profitability by adopting SD. Rather than imposing a burden on the industry, SD offers a path toward shareholder value creation by improvement in operating efficiency and stakeholder relationships. Put another way, the needs of society can be served in ways that benefit the cement industry.

At the same time, maintaining the *status quo* does not appear to be tenable, because of the risks of rising costs and adverse business impacts. The outlook for economic growth in the cement industry is threatened by increased sensitivities over environmental and social impacts of cement production. In the future, the market for cement could potentially be influenced by the emergence of "preferred" alternative construction methods and materials that are significantly less energy intensive, at least in their production phase.

With the growing influence of NGOs, stakeholder expectations regarding industry SD performance are increasing. Instead of responding defensively, the cement industry has an opportunity to engage pro-actively with stakeholders, demonstrate its understanding of their concerns, and offer thoughtful and innovative solutions. Instead of merely reacting to demands for change, the cement industry can adopt a leadership role and become an agent of change – thus better controlling its destiny.

The Sustainable Development Agenda

It appears that continued incremental improvements in eco-efficiency will not be adequate to respond to the pressures of urbanization, climate change and fuel scarcity. The cement industry will be challenged to produce step-change improvements that involve new technologies and business models. A variety of approaches are already being explored, ranging from industrial ecology to advanced materials, which promise to make such step-changes feasible. However, cement companies will need to overcome their traditional conservatism and be open to taking calculated risks, with an expanded awareness of what risks must be managed.

In developing a vision of a more sustainable cement industry in 2020, this report has described many areas in which progress toward sustainability can contribute to both stakeholder satisfaction and shareholder value. For example:

- Careful management, rehabilitation, and stewardship of quarries will protect ecological resources while satisfying the expectations of communities and regulatory agencies.
- Continued reduction of waste and emissions, including CO_2, will maintain the industry's right to operate and reduce environmental expenses and liabilities.
- Safely utilizing materials that otherwise would be discarded as waste will provide a valuable service to society while decreasing costs of material and energy and reducing CO_2 emissions.
- Especially in developing countries, contributions to economic growth and community well-being will enhance regional development and quality of life.
- Attention to employee health, safety and well being will increase productivity and make cement companies more desirable employers.

The eight major issues of the Sustainability Compass defined by Battelle provide a starting point for working toward the SD vision. This strategic perspective is supported by additional tools and knowledge contained in the supporting substudies (Appendix C).

Overcoming the Obstacles

Realistically, even the most powerful vision will encounter obstacles. Achievement of genuine change is always difficult, and the magnitude of change required for the entire cement industry is especially challenging. To pursue the recommended path, the cement industry will need the cooperation and trust of many stakeholder groups including government agencies, local communities, standards bodies, NGOs and financial institutions.

Cement industry managers must anticipate several hurdles on the road to SD:

- The first and most critical obstacle will be achieving alignment around SD throughout a cement company's organizational units and facilities.[38]
- Developing a balanced approach toward meeting the expectations of a variety of stakeholders will be difficult, and some dissatisfaction will be inevitable.
- Public policy debates will challenge the industry to participate effectively, and to demonstrate its commitment to responsible corporate governance.
- Some of the costs and benefits associated with sustainable business strategies will be more difficult to quantify, so that judgment will be required. However, it will be important to evaluate qualitative issues such as social impacts, to compare financial to non-financial outcomes, and to make trade-offs among SD issues, e.g., land use vs. energy use.
- Multinational companies will be challenged to apply SD policies and principles consistently on a global basis, while allowing for regional differences. Gaining in-depth understanding of local community issues will be particularly challenging in a diverse, worldwide company.

Due to the interconnectedness of global financial markets and the global scale of industrial logistics, regional issues can no longer be viewed in isolation. Large multinational cement companies need to understand the local markets, stakeholders, governance systems, and social values of the communities in which they operate, while striving for consistency in their global policies. Smaller, regional cement firms will need to understand emerging sustainability standards, practices, and technologies in order to remain competitive.

The Path Forward

To support the SD agenda, this study has identified a number of constructive steps that cement companies can take to align SD with their corporate goals and strategies:

- Understand specific ways in which SD contributes to enterprise value, including both financial benefits and less easily measured benefits such as employee motivation, brand loyalty, community trust, and corporate reputation.

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[38] Boston Environmental Group, "Toward a Sustainable Cement Industry: SD Alignment Substudy Report," http://www.wbcsdcement.org/final_reports.asp, 2002.

- Evaluate business opportunities using a comprehensive triple bottom line framework that identifies nontraditional sources of enterprise value, capturing both the benefits and the risks associated with sustainability issues.
- Adopt a life cycle perspective, seeking insights about the impacts of business decisions upon both upstream suppliers of equipment or materials and upon downstream users of cement products. (These considerations extend beyond the boundaries of this report.)
- Identify "win-win" sustainable solutions that improve license to operate, market access, and profitability for the enterprise while creating societal value from the perspective of external stakeholders.
- Invest in more radical research and development efforts, including innovative production processes that are less energy and material intensive, and new product formulations that address emerging market needs.
- Consider the specialized local needs of stakeholders in developed and developing economies, and develop appropriate products, technologies and management practices.
- Adopt modern supply chain management techniques to streamline manufacturing and logistical operations, including partnering with suppliers and customers.
- Collaborate with NGOs, governments, local communities, and other stakeholders to promote effective public policies and develop common SD objectives.

By incorporating environmental and social concerns into their business strategy, and exploring opportunities for innovation and improvement, Battelle believes that cement companies can help to secure their market position and economic future.

Addendum: The Sustainable Enterprise Toolkit

Pursuing the recommended pathways toward sustainability will, in many cases, require cement companies to modify their business practices. This study has investigated a variety of available tools for supporting progress toward sustainable business practices. In addition, several substudies have developed specific tools for the cement industry. The following are recommended categories of tools that would comprise a sustainable enterprise "toolkit." Wherever applicable, we highlight tools that were developed as part of this study and reference the relevant *substudy*.

Stakeholder Communication Tools

Stakeholder engagement and dialogue are important elements of the recommendations. There is a significant body of knowledge on methods for industrial enterprises to communicate effectively with stakeholders regarding environmental and social concerns.

The **Stakeholder Communication Guidebook**, developed by Battelle and ERM during this study, is designed for cement plant managers, plant operations personnel, facility planners, and communications directors and staff. Its purpose is to help them develop and conduct effective communication and stakeholder involvement between the cement industry and its stakeholders. The end goal is a stable, productive relationship between the cement industry and the communities and environment where they operate. (*Substudies 1 and 2: Stakeholder Dialogue and Communications Strategy*)

Decision Support Tools

In order to make progress toward SD, cement company decision-makers must be able create a business case for SD initiatives. They need a systematic approach to analyze the environmental, economic, and social consequences of proposed capital investments and other important business decisions.

The **Sustainable Business Decision Framework** was developed by Battelle during the course of this study, based on worldwide best practices in the development of a credible business case for decision-making. Several pilot applications were conducted to demonstrate that the framework is useful for a variety of cement industry decisions. The general philosophy behind this framework was discussed in Section 2.2. (*Substudy 3: SD Business Case*)

Organizational Development Tools

Genuine progress toward SD requires that cement companies fully integrate SD thinking into all aspects of their operations. To achieve such integration, companies will need to introduce change initiatives that channel top management commitment throughout the organization, so that individuals to make personal commitments to take action.

The Boston Environmental Group has developed a **SD Alignment Process** for the cement industry based on principles of effective change management. A number of supporting materials specific to the cement industry were developed, including briefing materials and a self-evaluation tool. (*Substudy 4: SD Alignment)*

Cement companies can take actions to foster innovation in their companies by understanding the drivers, barriers/obstacles, and enablers of innovation and developing process, product and business strategy innovations. Battelle recommends using a **Framework for SD Innovation** whereby cement companies can develop action plans for fostering innovation. (*Substudy 7: SD Innovation)*

Performance Measurement Tools

Performance measurement is a critical capability for cement companies seeking to move toward SD. Cement companies will need to reinforce their long-term goals by using key performance indicators (KPIs) that translate company-wide goals into operational targets. Cement companies face numerous challenges, both in selecting KPIs at the strategic level and in implementing these KPIs at the operational level.

The **SD Performance Measurement Process,** recommended by Battelle, is a systematic five-step process whereby cement firms can identify key SD aspects, develop corresponding objectives and performance indicators, and flow these down to the business unit and facility level. The process includes suggested performance indicators specific to the cement industry. (*Substudy 5: KPIs*)

Life Cycle Assessment Tools

Building specifiers, purchasers of materials, and other downstream customers in the cement industry value chain are increasingly demanding rigorous characterization of life cycle environmental impacts. Life cycle analysis methods help in analyzing tradeoffs among alternative processes and products.

The **Users Guide to Understanding a LCA Study**, developed by Five Winds International during the course of this study, helps companies to summarize an existing LCA study and helps identify important features such as the functional unit, system boundaries, and conclusions. *(Substudy 6: LCA)*

Eco-efficiency Tools

Companies can benefit from tools that help them gauge progress toward eco-efficiency goals such as lowering energy or raw material use per ton of product produced.

The **Industrial Ecology Self-Assessment Tool,** developed by Battelle during the course of this study, helps companies better understand the current status and level of industrial ecology related activities ongoing in their companies. (*Substudy 9: Industrial Ecology*)

Policy Analysis Tools

Analysis tools that make projections of future conditions under various sets of assumptions can be used to study the economic and environmental impacts of various policy options. For example, in this study, computer models were used to study the interactions among macro-economic conditions, cement production, energy use, and CO_2 emissions. Scenarios of the future can also be developed through less quantitative means.

Bruce Vigon, Project Manager
Battelle
505 King Avenue, Columbus OH 43201 USA
Tel.: +001-614-424-4463
Fax: +001-614-424-5601
E-mail: vigonb@battelle.org

Howard Klee, Jr., Program Manager
WBCSD
4, chemin de Conches
1231 Conches-Geneva, Switzerland
Tel: +41 22 839 31 24
Fax: +41 22 839 31 31
E-mail: klee@wbcsd.org

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Project Website: http://www.wbcsdcement.org