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Photo credit: Cement - Morocco, Tetouan cement plant wind farm

By improving internal CO<sub>2</sub> data management and putting in place a user-friendly tool for monitoring, analysis and simulation of mitigation alternatives, Lafarge facilitated decision-making processes and strengthened the autonomy of operational managers in implementing CO<sub>2</sub> reduction projects.



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# Lafarge's C-O-Tool: Supporting CO<sub>2</sub> mitigation decision-making.



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PARIS, FRANCE, SUMMER 2009. Vincent Mages and Gaëtan Cadéro, respectively vice president of climate change initiatives and manager of climate change initiatives at Lafarge, presented the latest version of the Lafarge C-O-Tool at the company's sustainable development committee meeting. Also present were the senior vice president of sustainable development and public affairs, the operational directors of each business line and the directors of research & development and the social policies and communication departments. Mages showed the committee an analysis comparing the CO<sub>2</sub> emission levels of a cement production plant in China with global average emissions, followed by a comparison with two other cement plants in Mexico and South Africa. Using a few more mouse clicks, he simulated the effects of different levels of production growth and changes in fuel mix on carbon emissions from the company's Chinese plant.

## Background

Lafarge, founded in 1833 as a limestone mining company, is a global leader in the building materials industry. With €15 billion in sales in 2009, the company employs over 78,000 staff. Lafarge operates along three business lines: cement; concrete and aggregates (small rock fragments such as sand or gravel); and gypsum (a construction material with insulation properties).

In 2001 Lafarge made a public commitment to reduce its global CO<sub>2</sub> emissions and became the first company in a highly intensive emissions and energy industrial sector to join WWF's Climate Savers program.

Founded in 1998, Climate Savers enables companies to join forces in committing to more ambitious reductions in their greenhouse gas emissions. The main objective of the initiative is to transform the industry's more customary incremental and/or passive approach toward climate change action and promote strategies that would have a more significant impact.

The cement industry is a highly energy intense industry, generating around 5% of the world's greenhouse gas emissions caused by human activities.<sup>1</sup> Approximately 60% of the CO<sub>2</sub> emitted during cement making occurs during the raw material carbonates calcination stage,<sup>2</sup> when the material clinker<sup>3</sup> is created. The remaining 40% of emissions occur as a result of fuel combustion to feed cement kilns. (*Refer to Exhibit 1 for a graphic representation of how CO<sub>2</sub> is emitted during the cement-making process*). Cement production is responsible for 98% of the Lafarge Group's greenhouse gas emissions.

Collaboration between WWF and Lafarge started with the development of key performance indicators for CO<sub>2</sub> emissions and with initiatives to enhance biodiversity and the restoration of forest eco-systems. Activities soon evolved to include the establishment of an agreement defining practical commitments in the areas of climate change, biodiversity, persistent pollutants, water

<sup>1</sup> World Business Council for Sustainable Development. Cement Sustainability Initiative. [wbcsdcement.org](http://wbcsdcement.org) (accessed 16 November 2008).

<sup>2</sup> Decarbonation of limestone is one of the initial steps in traditional cement production.

<sup>3</sup> Clinker, the main ingredient in cement, is a hardened granule obtained by firing a mixture of limestone and clay to a high temperature (1500°C). Cement is obtained by grinding clinker and, in some cases, supplementing it with additives.

consumption and sustainable construction for all companies within Lafarge group.

Lafarge's commitment to reduce emissions in relation to 1990 levels by 10% in absolute terms in industrialized countries and by 20% net – per ton of cement produced – worldwide, by 2010, has been achieved one year ahead through a variety of strategies developed in conjunction with Climate Savers. (Refer to Exhibit 2 for Lafarge emissions and reduction targets).

### Mitigating CO<sub>2</sub> Emissions

Lafarge and WWF jointly identified a list of areas where ambitious incremental improvements in cement production would substantially reduce CO<sub>2</sub> emissions.

- Increased energy efficiency of production processes and reduction in overall energy consumption;
- Modernization of production plants and constant improvement of industrial processes;<sup>4</sup>
- Use of alternative fuels<sup>5</sup> and renewable energy sources;
- Use of industrial waste to manufacture cement.<sup>6</sup>

To ensure internal support for CO<sub>2</sub> reduction goals, Lafarge cascaded the mitigation execution mandate down to operations management at the production plant level. Business units and production plants have total autonomy in determining how to achieve plant-specific CO<sub>2</sub> reduction goals. They are supported by technical centers, which drive internal know-how and best practices. CO<sub>2</sub> reduction goals were further incorporated into each manager's personal objectives. Achievements in this area are part of the evaluation and reward processes through strategies like the awarding of bonuses.

In addition, Lafarge committed to invest in research focused on:

- Accelerating carbon emission reduction through modification of the chemical composition of clinker so as to produce less CO<sub>2</sub>;
- Optimization of the composition of concrete;
- Improvement of recycling processes. (refer to Exhibit 3 for R&D expenditures<sup>7</sup> on carbon mitigation and to Exhibit 4 for reduction in clinker ratio).

The life cycle of buildings – design, construction, operation and demolition – accounts for approximately 40% of energy consumption and 30% of CO<sub>2</sub> emissions.<sup>8</sup> Therefore, another important aspect of Lafarge's CO<sub>2</sub> mitigation strategy is to help to reduce the overall carbon footprint of buildings by working with a variety of stakeholders<sup>9</sup> to promote sustainable construction products and systems along the construction chain and to produce a roadmap towards zero net energy buildings.<sup>10</sup>

### The Challenge of Monitoring and Analyzing CO<sub>2</sub> Data

With approximately 160 cement production sites in 78 countries, the capacity to effectively manage, consolidate and distribute data on CO<sub>2</sub> emissions was paramount to the achievement of Lafarge's mitigation goals. Decision-makers at business units and at the corporate level required timely and relevant data at a variety of break-down levels.

<sup>4</sup> Includes constructing a new plant with the best available technologies and upgrading old cement plants.

<sup>5</sup> Examples of alternative fuel sources: rice husks in the Philippines; coffee pods in Uganda; shells from palm oil nuts in Malaysia; plastics, solvents and old tires in Germany and Chile; animal food waste in Austria. In 2009 alternative fuels accounted for 10.9% of fuel use across all business lines.

<sup>6</sup> For example, certain cement additives, particularly slag, fly ash and pozzolan, can partially replace clinker, which reduces CO<sub>2</sub> emissions per ton of cement.

<sup>7</sup> In 2009, Lafarge invested €152 million in research and development, the equivalent of 1% of the Group's sales.

<sup>8</sup> United Nations Environmental Program (UNEP). "Buildings and Climate Change: Industry call to action." [http://www.unep-sbc.org/SBCIRessources/ReportsStudies/documents/UNEP\\_SBCI\\_Buildings\\_and\\_Climate\\_Change\\_\\_Industry\\_Call\\_to\\_Action/\\_UNEP\\_SBCI\\_Call\\_to\\_action\\_final.pdf](http://www.unep-sbc.org/SBCIRessources/ReportsStudies/documents/UNEP_SBCI_Buildings_and_Climate_Change__Industry_Call_to_Action/_UNEP_SBCI_Call_to_action_final.pdf) (accessed 16 November 2009.)

<sup>9</sup> Lafarge participates in a variety of collective initiatives around sustainable building such as the Energy Efficiency in Building project, the Building Energy Foundation, Sustainable Building and Construction Initiative, the "Fondation Bâtiment Energie" and the All Sustainable Construction Partnerships. The company also develops collaborative projects with renowned architects such as Jacques Ferrier (Hypergreen project) and Marc Mimram (Living infrastructure).

<sup>10</sup> Zero net energy buildings produce as much energy as they consume

Producing good quality information that could be easily synthesized to support decision-making was not an easy task. In 2000 Lafarge began to use a basic tool to calculate, monitor and report CO<sub>2</sub> emissions. However, the tool had limited functionalities and although it adequately met general reporting requirements for the Group, it was not aligned with the operational needs of individual business units.

Mages and his team knew that implementing mitigation measures beyond the “low hanging fruit” and effectively translating mitigation goals into operational decisions would increase internal demand for sophisticated CO<sub>2</sub> data management. Moreover, external stakeholder pressure in terms of carbon disclosure was mounting. Cadéro, the climate change initiatives manager, explained:

Our team had anticipated future climate change challenges for our company: More carbon regulation implies higher financial incentives to mitigate CO<sub>2</sub> emissions and also higher expectations with regard to carbon transparency from investors and stakeholders.

Lafarge’s main focus was to help operational people make CO<sub>2</sub> mitigation decisions in a fast, informed and consistent manner. The climate change team carried out market research for an analytical CO<sub>2</sub> tool that fit the needs of the company and concluded that the market was not mature enough to offer an efficient tailor-made solution. They opted for in-house development of a tool that suited their needs.

### Lafarge’s C-O-Tool

Lafarge’s C-O-Tool is an Excel-based tool providing a user-friendly interface to help operational decision-making with regard to CO<sub>2</sub> mitigation. The alpha release was developed in 2008 through an iterative process with the users. The beta release became operational on May 2009.

Even though Lafarge’s climate change team had the competencies to develop a tool in terms of both the programming and knowledge of CO<sub>2</sub> challenges and related operational issues, they faced significant challenges. Developing the tool was time intensive and had to be done in addition to their regular responsibilities. Taking the time to develop the tool was a major challenge, particularly since it was during a very busy period, leading up to the Copenhagen climate change summit and with the new EU regulations for the carbon trade market just coming into play.

From a technical standpoint, defining a mathematical model that linked CO<sub>2</sub> emissions with particular operational levers required a detailed understanding of the specific contribution of each lever to emissions in a non-linear context. Four levers were included in the model: C/K ratio (cement to clinker ratio)<sup>11</sup>, cement additives<sup>12</sup> and clinker moves; heat consumption and fuel mix.

Ensuring tool user-friendliness was another challenging task, since what was needed was a “one size fits four” design that could be used by different levels of management: technical specialists, operational managers, top managers, and the climate change corporate team. The tool was accompanied by a video tutorial explaining how to run analyses and carry out benchmarking and simulation exercises and how different users could make the most of these capabilities.

<sup>11</sup>The decarbonation phase of clinker production is the most emission-intensive phase of cement production. Thus, the higher the C/K, the lower the emission ratio per ton of cement.

<sup>12</sup>Cementitious materials or cement additives, are minerals added during the last phase of the cement production process. The use of cement additives reduces CO<sub>2</sub> emissions because a) they automatically reduce the proportion of clinker and b) they are produced from industrial waste which would otherwise have been discarded.



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Lafarge's C-O-Tool was designed with three main functionalities (refer to Exhibit 5 for a print view of Lafarge's C-O-Tool):

1. Monitoring: To provide a detailed breakdown of emissions, thus supporting a full overview of current emissions at different levels (plant, business unit, country, regional, global) and understand the levers that lead to CO<sub>2</sub> reductions.
2. Benchmarking: To support easy and intuitive comparisons between the different Lafarge plants and business units. For example, a manager in Germany could compare the CO<sub>2</sub> performance of his plant with other plants in Germany, China or France and with the European or worldwide average.
3. Forecasting/simulation: To allow for the simulation of the effects of alternative carbon reduction actions and identify the full potential for CO<sub>2</sub> reduction in a given business unit. For example, a plant manager can simulate the effect of a production process optimization on CO<sub>2</sub> emissions and the knock-on effect of selected key production levers on CO<sub>2</sub> reduction. Or, plant managers can forecast the effect on CO<sub>2</sub> emissions of, for example, specific increases on the C/K ratio levels, cement production growth or biomass rate increase in the fuel mix.

Cadéro explained that implementation of the C-O-Tool was less challenging than its design:

The tool was well received internally. First of all, it didn't require any extra work by managers and, crucially, it is user-friendly. Users don't actually need to enter data, as we manage and populate the database for them. Managers simply "play with the data" using only a few mouse clicks. Secondly, the tool suits both operational and business requirements, providing solutions to a real business problem. CO<sub>2</sub> emissions are a key issue for Lafarge; everyone is aware of that.

Christophe Nicoli, senior vice president, cementitious projects & C/K projects, commented:

The tool gives a highly visual snapshot of all the levers that lead to CO<sub>2</sub> performance and it also clearly shows the specific impact of each lever, which greatly facilitates priority setting in the decision making process.

However, the tool does not yet have a financial interface with options for cost/benefit simulations or pay-back time forecasts. Cadéro explained that while this had been the subject of long discussions with users, owing to the high level of complexity require for financial functionality, the development team decided not to include it in the alpha and beta releases.

### **New Challenges Ahead?**

End of 2009, Lafarge had reduced its emissions by 20.7% per tonne of cement produced worldwide compared to 1990 (representing a total mitigation of over 25 million tonnes of CO<sub>2</sub> equivalent per year) and by 38% below its 1990 levels in absolute terms in developed countries.<sup>13</sup>

Lafarge continues to assess its potential for making more giant steps that will have real impact on climate change. Jim Leape, Director General of WWF International, suggested a way forward:<sup>14</sup>

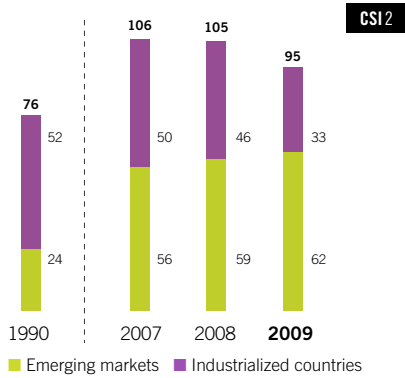
The challenge ahead for Lafarge is to extend its efforts to its entire group notably in emerging economies (Brazil, China, and India) where demand for construction materials is growing rapidly. Through this partnership, we expect Lafarge to take a leadership role in moving the entire cement sector, as well as other energy-intensive industries, towards a sustainable economy.

<sup>13</sup>The reduction performance in developed countries is a combination of the intensive use of mitigation levers as well as the effect of the decline in production volumes due to the economic downturn.

<sup>14</sup>Press-release: "Lafarge and WWF International renew their partnership for another four years." Issued 4 September 2009.

## Exhibit 1 Gross and Specific net emissions

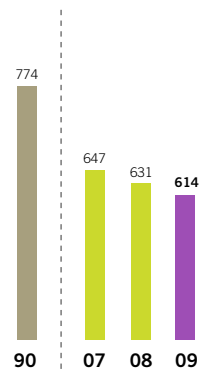
Lafarge total gross CO<sub>2</sub> emissions (millions of tons/year) **EY** **SA 12** **EN16**



Our gross emissions declined in 2009, mainly due to the impact of the recession. Overall our gross emissions have grown by a quarter over 1990. Gross emissions in industrialized countries have seen a reduction of 38%, emerging markets have more than doubled.

Source: Lafarge. Sustainability Report 2009

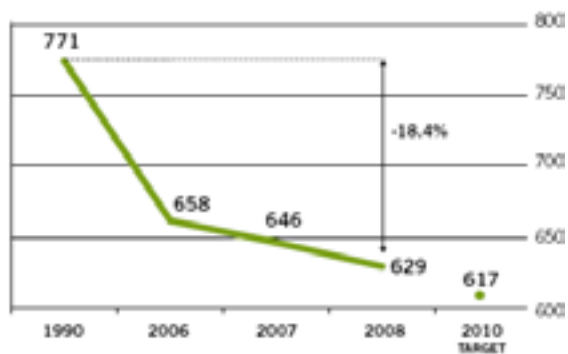
Net CO<sub>2</sub> emissions\* (per ton of cementitious product) **EY** **SA 12** **CSI 13** **B**



Our net emissions per ton were 20.7% down on 1990 levels, achieving our Sustainability Ambition for this measure one year ahead of target. For 2008 we were able to benchmark ourselves against seven other companies and Lafarge was first out of the group surveyed.

Source: Lafarge. Sustainability Report 2009

### "-20% worldwide" objective: KgCO<sub>2</sub> per tonne of cement



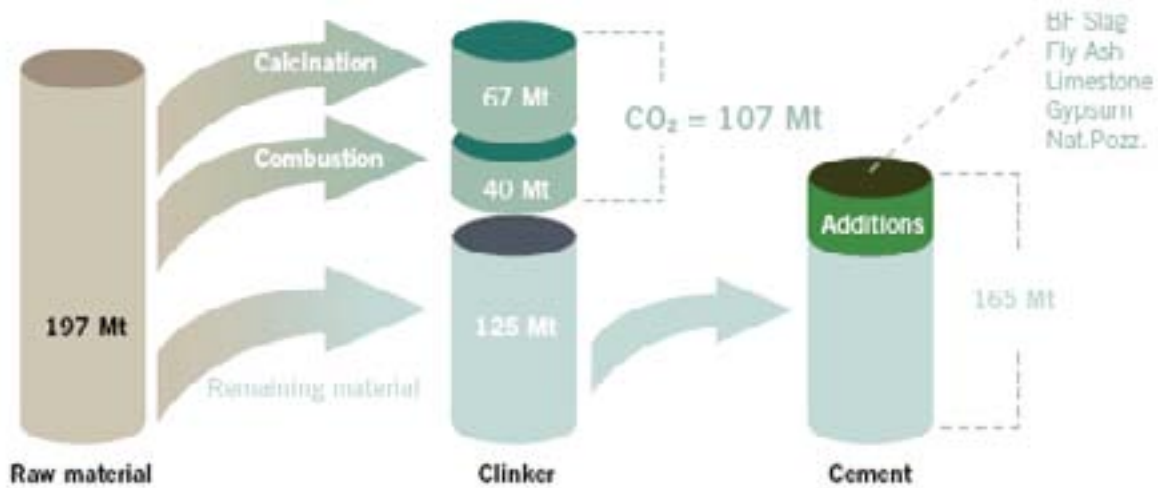
Source: Lafarge. Sustainability Report 2008

## Exhibit 2

### How CO<sub>2</sub> is emitted in the cement making process

#### Lafarge CO<sub>2</sub> Emissions in 2008

(Only non biomass waste fuels taken into account)



Source: Lafarge. Sustainability Report 2008

## Exhibit 3

### Lafarge expenditures in R&D

#### Increased focus on Sustainability within R&D (in %)

	2007	2008	2009
Reduction of CO <sub>2</sub> emissions	25%*	18%	16%
Energy efficiency		13%	15%
Natural resources	10%	10%	8%
Safety & security	5%	6%	5%
Comfort & quality of life	7%	6%	5%
Others	52%	47%	51%

\* covers both CO<sub>2</sub> and energy

Approximately half of R&D in the past three years has been focused on sustainability. We expect this to increase to three-fifths in 2010.

Source: Lafarge. Sustainability Report 2009

## Exhibit 4

### Changes in the cement clinker ratio

#### Cutting the clinker/cement factor

CSI 8

(ratio between clinker consumption and cement production calculated according to cement protocol)

B



We are steadily reducing the clinker proportion of our cement. In 2008, Lafarge was 4th out of 8 companies who reported on this indicator.

### Exhibit 5

Print-screen view of Lafarge C-O-Tool for a fictional business unit

