Industrial ecology and recycling

Why find uses for waste?
The Group is aware of the impact of its activities on the environment. As a result, Lafarge started thinking at a very early stage about ways of reconciling industrial imperatives with the preservation of ecosystems. Adding value to waste by using it as alternative fuel or materials makes it possible to:

- limit greenhouse gas emissions by reducing the use of non-renewable natural raw materials, fossil fuels (oil, coal, etc.),
- diversify energy resources and reduce energy costs by limiting dependence on the market for traditional fuels,
- serve the community by recycling waste that would otherwise have to be processed and eliminated.

Within Lafarge, the use of alternative fuels has increased by more than 30% over the last three years. In 2011, 69% of its plants used alternative fuels allowing the Group to reduce its net greenhouse gas emissions per ton of cement by 23.4%.

Alternative fuels
Waste products can be a very appealing alternative to fossil fuels. In general, alternative fuels are derived from biomass, industrial waste and byproducts:

- coffee husks,
- rice husks,
- palm nut husks,
- scrap plastic, etc.

All of these products can be recycled as alternative fuels and burned safely in cement kilns. This approach relieves the community of the need to process this waste and helps to limit CO₂ emissions. The extremely high temperatures found in cement kilns mean that the waste is totally eliminated and does not leave any residue.

Lafarge actively participates in the Clean Development Mechanisms (CDM) system initiated under the Kyoto Protocol. These mechanisms encourage the implementation of best-in-class technologies in developing countries by providing carbon credits to companies which finance sustainable development projects. For example, in:

- Malaysia, 5% of the thermal energy required for the Lafarge cement plants in Rawang and Kanthan is produced from biomass,
- Morocco, a wind farm provides 50% of the electricity required for the Tétouan cement plant.

Cement manufacturing consumes large quantities of non-renewable raw materials (minerals and fossil fuels). It is also an important source of CO₂ emissions. In response to this environmental challenge, Lafarge has been committed to industrial ecology since the mid-70s by rethinking industrial processes to transform some industries’ waste products into other industries’ resources.

Mature Co-processing  New developments
In 2011 we recorded an increase in the substitution of fossil fuels, with 13% of our energy needs for cement production met by alternative sources, such as waste and biomass (versus 11.7% in 2010). This increase is due to a combination of factors:
- development of new waste streams;
- increased percent substitution in plants already using recycled materials;
- expanding this practice to new countries.

Among the new channels is a pilot in Romania started in 2010, for sorting household waste, which will serve as a model for other locations.

With regards to the use of biomass, several achievements were made in 2011, for instance the use of wood in Nigeria, the recovery of energy from animal waste (poultry) in Pakistan and the recovery of energy from agricultural waste in Ecuador.

The biomass substitution program is now in full swing, and in the short term many developments are planned, especially in emerging countries.

**Alternative materials**

The cement manufacturing process generates CO$_2$ because the limestone needs to be heated to very high temperatures. This physical-chemical process of “decarbonization” produces clinker, which is then ground down.

It is possible to reduce the amount of clinker in cement by using alternatives, called cement admixtures. Reducing the amount of clinker in cement offers two advantages:
- a reduction in the consumption of natural, non-renewable raw materials,
- a reduction in the emission of greenhouse gases.

A cement produced with 30% admixtures uses 230 kg or 27% less CO$_2$ than a conventional cement produced without admixtures. Cement admixtures may be of:
- natural origin: limestone or pozzolanic rock,
- industrial origin: waste products from other industries, such as slag from steel-industry blast furnaces or fly ash from coal-fired power plants. These waste products have the same hydraulic binding properties as clinker.

For example, in India, the Arasmeta cement plant uses fly ash from power plants in cement manufacture.

**Breakdown of alternative fuels**

<table>
<thead>
<tr>
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<th>2011</th>
<th>2010</th>
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<tbody>
<tr>
<td>Solid waste</td>
<td>33.07%</td>
<td>32.56%</td>
</tr>
<tr>
<td>Liquid waste</td>
<td>22.09%</td>
<td>24.04%</td>
</tr>
<tr>
<td>Pure biomass</td>
<td>25.13%</td>
<td>23.07%</td>
</tr>
<tr>
<td>Tires</td>
<td>19.71%</td>
<td>20.33%</td>
</tr>
</tbody>
</table>

If we take into account the biomass fraction in waste streams, we reach a total of 36% of biomass in 2011:
- Liquid alternative fuels, such as solvents, used oil and hydrocarbons decreased from 24% to 22%.
- The quantities of solid waste and tires has remained stable.

Lafarge expertise results in safe waste solutions

The use of waste products cannot be improvised. Lafarge has implemented stringent quality control standards as well as a training policy for its engineers, technicians and foremen. In this way, it is reinforcing the use of alternative fuels and materials while controlling industrial processes. The Group’s R&D teams are also making an active contribution in this respect.

The Cement Business considers the use of alternatives and the pursuit of industrial ecology to be separate but complementary parts of its core business. The Business has developed a highly professional strategy as well as expertise and a dedicated organization at Group level and within operational units. The Group also establishes partnerships with local waste management companies. The industrial ecology business consists of 25 companies, often in partnerships, and has activities in 40 countries.
Material recovery in cement manufacturing can occur in two areas:
- substitution of the raw materials;
- substitutes for clinker in finished product (cement).

In 2011 we increased the total materials substitution by 2.3 million tons, mainly due to finished products substitutes, such as slag and fly ash.

Beyond its economic value, material used for clinker substitution has a direct impact on CO₂ performance, where material substitution is a major lever for reducing emissions.

Management of waste generated by our activities

The practice of waste and energy recovery from other industrial and domestic sectors has paved the way for optimal management of the waste we generate on our sites. Dust is the primary waste stream in cement manufacturing and it often can be recycled into the finished product. Around 415,000 tons of dust were collected from the kiln and recycled into the cement in 2011.

Waste leaving the cement plants and treated outside the sites represents 153,000 tons of which 90% is non-hazardous (137,000 tons). Sixty per cent of this non-hazardous waste stream was recovered in 2011 (82,347 tons). For Cement, 93% of hazardous waste was recovered and only 1,018 tons were disposed of in 2011, all at dedicated installations. For Aggregates and Concrete operations, the waste footprint is similar to that of cement with 99.7% being non-hazardous wastes (376,000 tons) and 3,000 tons of hazardous waste with two-thirds recycled and only 1,043 tons disposed of at dedicated installations.

Total number and volume of significant spills

For the second year in a row, we report no significant accidental releases of material to the environment. In 2011 three minor spills were reported which were contained and had no impact on the environment.

Percentage of materials used that are recycled input materials

Waste from operations
Serbia

LAUNCH OF THE FIRST WASTE TREATMENT INSTALLATION

Lafarge's cement plant in Beočin started the first of its kind waste co-incineration facility in Serbia. This new installation will increase the share of alternative fuels in the plant's energy mix, but it will also provide access to a cheaper energy source.

OBJECTIVES

• Reduce the share of fossil fuels in the plant's energy mix;
• Increase the long-term profitability of the activity, with no additional impact on the environment;
• Contribute to the development of waste recycling in Serbia.

SUMMARY

In March 2011, Lafarge's cement plant in Beočin (Serbia) started the operation of a newly built installation for waste preparation and coprocessing, the first of its kind in Serbia.

The 24,000 t/year capacity installation allows the use of pre-selected, chopped and shredded solid municipal and industrial waste as alternative fuel under controlled coprocessing conditions.

The operation took place in the framework of the Memorandum setting the conditions for the use of certain streams of waste in Serbia, signed with the Ministry of Environment and Spatial Planning.

RESULTS

So far, 25% of Lafarge BFC fuels came from alternative sources. The recovery and use of waste will replace an additional 11% of fossil fuel in BFC's energy mix!

Lafarge Serbia will have access to lower-cost fuel.

PROSPECTS

Taking initial operational experience into account, optimization of the line was done stepwise in the past 12 months.

In 2012, full utilization of the line is expected, bearing in mind that the SSW is THE alternative fuel for the future in Beočin.

PEOPLE CONCERNED

• Teams from the Beočin Lafarge cement plant • Lafarge Serbia • The Serbian Ministry of Environment and Spatial Planning • Local community of Beočin

CONSERVING RESOURCES AND RESOURCES RECOVERY

China - Replacing fossil fuels with household waste
Canada - Lafarge-WWF local partnership for the use of biomass
United States - A closed-loop approach to waste management
USA - A model in industrial ecology
France - Construction of a “High Environmental Quality” building
United Kingdom - Recycling bags of cement
United Kingdom - More environmentally-friendly plastic bags
South Korea - Recycling gypsum for the Cement Business at Okke
Brazil - Energy recovery from gypsum residue for cement
China - Energy efficiency in a cement plant
Germany - Solar energy use
India - Recycling industrial products
United States - Recycling slag
South Africa - Use of synthetic gypsum
United States - Using synthetic gypsum
South Korea - Conversion to natural gas
France - Recovery of miscellaneous industrial waste
France - Energy recovery from meat and bone meal
Malaysia - Biomass to energy
UK - Partnership for industrial waste recycling
UK - Green energy from biogas
Uganda - Energy recovery from coffee husks
Japan - Energy recovery from meat and bone meal
South Korea - Recycling scrap tires
Malaysia - CDM project
Uganda - Example for reducing CO2 emissions
France - Recycling return concrete
Greece - Reclamation of red mud
UK - Recovery of construction site waste
United States - Recycling scrap tires in an urban environment
Philippines - Energy recovery from rice husks
Morocco - Recycling fly ash
Austria - Using plastic as alternative fuel