About cement and concrete

**Cement** is
- A very fine, dry powder
- Manufactured and shipped globally
- Sold in bulk or bags
- 7% - 11% of a concrete mix
- The glue that holds concrete together

**Concrete** is
- Created by mixing cement, aggregate (sand & gravel), water
- Produced locally, mixed and hauled over short distances
- The 2nd most used construction product on the planet, after water

**Aggregate** is
- generally consisting of crushed stone, gravel, and sand, are mainly used in the construction of roads, rail track beds, the manufacturing of concrete, concrete products, and asphalt.
# A Strong Local Footprint

**Eastern Canada**

- Headquartered in **Toronto, Ontario**.
- **2,500** employees.
- Approximately **160** locations.
- Serving **Ontario, Quebec and the Atlantic**.
- Exporting to the **Eastern Seaboard**
- Cement, Concrete and Aggregates businesses.

**Western Canada**

- Headquartered in **Calgary, Alberta**.
- **4,000** employees.
- Approximately **225** locations.
- Serving **Western Canada and the U.S. Pacific Northwest**
- Cement, Aggregates, Concrete, Concrete Products, Asphalt & Construction businesses.

**Leader in cement, RMX, and Aggs**
Concrete and Cement Contribution to Canada

A vital participant in our economy

- 158,000 direct and indirect jobs
- $76 billion in direct, indirect and induced economic impact

Committed to building low carbon, climate-resilient communities

Concrete is the foundation of economic development

- Virtually all construction projects – above and below ground – need concrete
- Twice as much concrete is used than all other materials combined
- Second most consumed commodity in the world, second only to water
Brookfield Cement Plant

Introduction

- Brookfield, Nova Scotia
  - South of Truro
  - Colchester County

- Brookfield Cement Plant
  - 2 Kilns, 1 in operation
  - 230,000 tonne capacity
  - 85 Employees
  - Atlantic Canada’s only cement plant
  - Low Carbon Fuel use
    - Shingles
    - Plastics
    - Scrap Tires

Lafarge Canada
Brookfield Cement Plant
Lafarge & Geocycle
Partners in Fuel and Raw Material Supply

• Two different business, two different types of expertise
  • Cement Companies make cement using fuel
  • Waste Recovery Companies collect and process waste into fuel
• Fuel Suppliers will typically engage with Geocycle
Scope of Geocycle related to Waste Management business

1. Professionally source alternative resources, identification of risks (through characterization and qualification steps) is under Geocycle responsibility

2. Design and operate pre-processing activities. These operations are under Geocycle responsibility

3. Operate co-processing activities. These operations are under the plant responsibility
Cement manufacturing process

**Definition**

Cement, a hydraulic binder and a key ingredient in concretes and mortars, meant mainly for building and public construction industries.

**Sold 145 million tons of cement** by Lafarge in 2011

**Industrial performance**

An industrial expertise supported by 175 years of experience, four technical centers with over 600 engineers and technicians worldwide. Culture of knowledge, best practice and experience sharing.
Cement Kiln Operation

The rotary kiln is on a slight incline and raw materials are added at the high end and work their way down the kiln. Fuel is injected at the downhill end. Average temperature of 1450°C is reached. Flame and product are in the same vicinity. Fuels can be injected in main burner, mid-kiln, or in Pre-Heater sections.
Current Fuel Use
Across Canadian Cement Plants

- **British Columbia**
  - Treated wood chips, K-Cups, non-recyclable rubber, non-recyclable plastics, C&D, railway ties, wood fines, tire fluff, carpet

- **Alberta**
  - Studies underway

- **Ontario**
  - Lafarge (Bath) – woodwaste, virgin biomass (complete); railway ties, C&D, asphalt shingles, non-recyclable packaging, manufacturing composites, K-Cups, carpets/textiles, non-recyclable plastics & rubber (incl. tire fluff)
  - CRH (Clarkson) – Used oil, solvents
  - Lehigh (Picton) – No current use
  - St. Mary’s (Bowmanville) – Woodwaste (approved), plastics (planned)
  - St. Mary’s (St. Mary’s) – No current use
  - Federal White – No current Use

- **Quebec**
  - Used tires, C&D, shingles, etc

- **Nova Scotia**
  - Asphalt shingles, non-recyclable plastics, scrap tires
## Low Carbon Fuels

<table>
<thead>
<tr>
<th>Fuels</th>
<th>Net Carbon Intensity kg CO₂ per GJ</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Carbon: Petroleum Coke, Coal</td>
<td>&gt;90</td>
</tr>
<tr>
<td>Moderate Carbon: Natural gas, carpet, plastics, rubber</td>
<td>60-90</td>
</tr>
<tr>
<td>Low Carbon: tire fluff, shingles, railway ties</td>
<td>10-60</td>
</tr>
<tr>
<td>Near Zero Carbon: C&amp;D, wood, natural textiles</td>
<td>&lt;10</td>
</tr>
</tbody>
</table>
Business Case – Western Plant

Tipping Fee: $60
Processing Cost: ($65)
Shipping: ($25)
Handling Cost: ($5)
Avoided Natural Gas: $60
Carbon Pricing: $10
Subtotal: $35
Low Carbon Fuel Specifications

- Heating value
  - > 14 GJ/tne (Lower HV)
- Size
  - 90% passing 10 mm (3D)
  - 90% passing 25 mm (2D)
- Water content
  - < 15%
- Other
  - Homogeneous
  - Low carbon (net)
  - Low heavy metals
  - Low or good ash
  - Low chlorine (< 1500 ppm)
  - Tramp non-combustibles removed
Pre-Processing Example Layout

Sample flowsheets

Sample installation for shredding of coarse AF with a single shredder
Cement plants use shredded fuels – raw fuel materials need to be processed into a fuel ready to use including removal of metal fragments.
Cement plants aren’t incinerators (or waste disposal sites) for the same reason your car or this Ready Mix Concrete truck isn’t an incinerator of gasoline or diesel.
What about the ash?

• **There is no ash!**
  
  • Minerals are incorporated into the final cement product, sometimes replacing virgin mined raw materials
  
  • True of traditional fossil fuels (e.g. coal) and lower carbon fuels
  
  • Another element of a circular economy
## Cement vs Incineration: Circular Economy vs Disposal

<table>
<thead>
<tr>
<th>Consideration</th>
<th>Cement</th>
<th>Incineration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary purpose</td>
<td>Manufacturing</td>
<td>Waste management</td>
</tr>
<tr>
<td>Operating</td>
<td>1450 C avg in flame zone</td>
<td>1000 C for &gt; 1 s</td>
</tr>
<tr>
<td></td>
<td>&gt; 1000 C for &gt; 10 s</td>
<td>(Minimum Regulatory requirement)</td>
</tr>
<tr>
<td></td>
<td>(Process requirement)</td>
<td></td>
</tr>
<tr>
<td>Ash</td>
<td>Incorporated into cement</td>
<td>Disposal or sale</td>
</tr>
<tr>
<td>Fuel quality</td>
<td>Homogeneous, reliable flow, high HV, low chlorine (most cases), low mercury: coal is reference fuel</td>
<td>Systems built to manage non-homogeneous waste and typical waste characteristics</td>
</tr>
<tr>
<td>Emissions</td>
<td>Dominated by raw materials NOT fuels (except NOx, mercury, and SO₂), controlled by natural scrubbing (clinker trapping) and pollution controls.</td>
<td>Function of fuel and air pollution control systems (to manage fuel characteristics)</td>
</tr>
<tr>
<td>Circular Economy</td>
<td>Replace fossil fuels to produce a recyclable product, replace raw materials with ash minerals</td>
<td>Disposal (primary purpose) – electricity generation is a value add</td>
</tr>
</tbody>
</table>
A topical example:
Scrap tires as a lower carbon fuel, 30% lower carbon intensity than coal
Whole tires are delivered to the Cement plant and offloaded

This shows a “Truck Tipper”, some plants offload manually

“Singulator” tires are sorted into individual tires for conveyance
Individual tires are conveyed and optically sorted for size conformance

Leaving the singulator

After size conformance and weighing
Elevate tires to the top of the kiln and await injection
Tires await kiln rotation and then are injected mid-kiln
Cam Mechanism opens two “trap doors” to allow tires to slide into the chute (one door at bottom of slide, one on the kiln)

The size of this chute governs the maximum size of tire that can be used.
Combustion is instantaneous (gas temperature over 1600°C)

Source: NRCAN funded study used a FOURCA Simulation to model the thermal profile at the St. Constant, QC Lafarge Plant.
This is what we’re trying to prevent, this is low temperature, poorly mixed combustion.
Blue Circle Westbury Plant – Emission Evaluation Program

- The report summarizes these key decreases in emissions when replacing the existing fuels with tires:
  - Reduction of NOx emissions of 41%
  - Reduction of VOC emissions of 36%
  - Reduction of dioxin and furan emissions of 42%
  - Reduction of Photochemical Ozone Creation Potential (POCP) of more than 18%
  - Reduction by a factor of 10 in health effects measured by the Hypothetical Maximum Exposed Individual (HMEI).

Did you know? Lafarge plants in Canada monitor 99% of their emissions continuously
Does Fuel Replacement endanger recycling?
Energy Recovery Improves Diversion from Landfills

Sources: European Environmental Agency / Plastics Europe / U.S. EPA / CPIA / Covanta Energy

* USA & Canada includes composting

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Recycling Increases In The Presence Of Energy Recovery

Source: Covanta EFW Report 2009/2010
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