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For a zero-waste future

Lafarge Richmond: Using Waste as a Resource

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For a zero-waste future

Our mission: a cleaner environment and a zero-waste future
Our solution: take one industry's waste, and transform it into another's fuel and raw material

Lafarge Richmond Cement Plant

- Plant in operation for over 60 years with 1M tonne/year cement production capacity
- Mature alternative fuels program – 20 years
- $25M investment in new alternative fuel co-processing platform to provide 52% of the thermal energy requirements to manufacture cement
- New AF System was commissioned in Spring 2019.
- Typical Alternative Fuels:

  - Non-recyclable plastics
  - Construction/demo
  - Tire fibre
  - Wood residues (glues)
  - Carpet, Mattress…
  - Permitting/Regulatory Authority: Metro Vancouver

What Does Geocycle Do?

Recovering the thermal & chemical value of waste

Material recovery

- Partner with regulatory bodies, governments, communities, industry in more than 50 countries
- Recover and process waste, creating alternative fuel and raw material
- Fuel and material then used by LafargeHolcim and other cement plants

14 million

Tons of waste used as alternative fuel and material

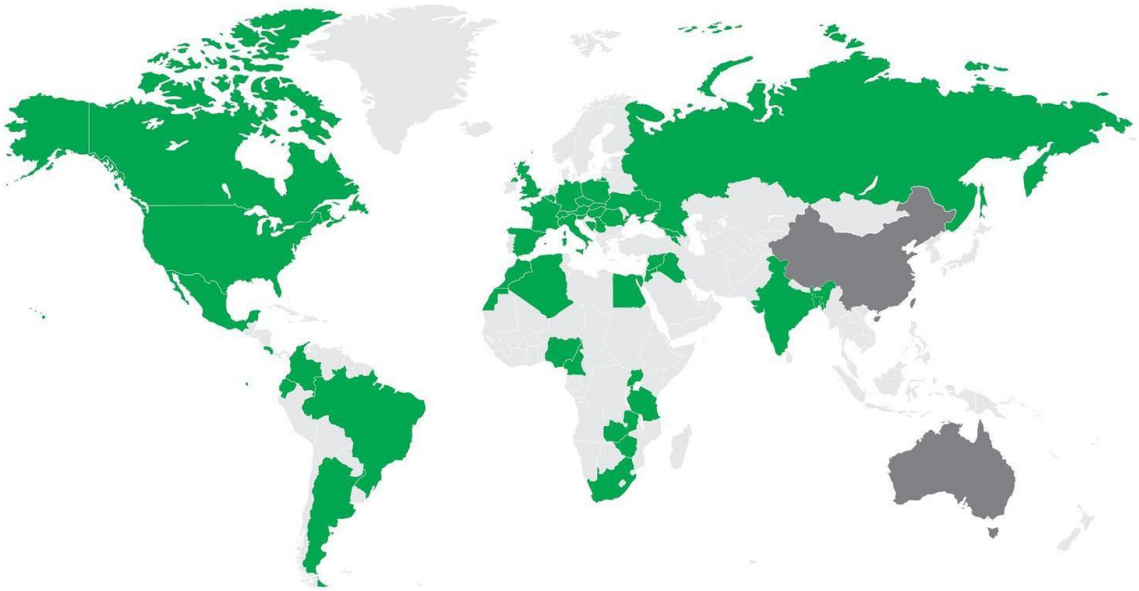
Co-processing

- Cement production process offers simultaneous energy recovery and material recycling
- Completely destroys waste materials – even hazardous types – through high temperatures, oxygen excess and long residence time.

15 Percent

of fossil fuels substituted with alternative fuels globally; plan to double that by 2030

The Geocycle Global Network



10,000 customers

80 pre-treatment facilities

180+ co-processing facilities

18% of thermal energy from alternative fuels (2018)

50 countries with waste management business

11 Mio Tons of co-processed waste (2018)

8 Mio Tons of Net CO_2 emission saved (2018)

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Geocycle in NA

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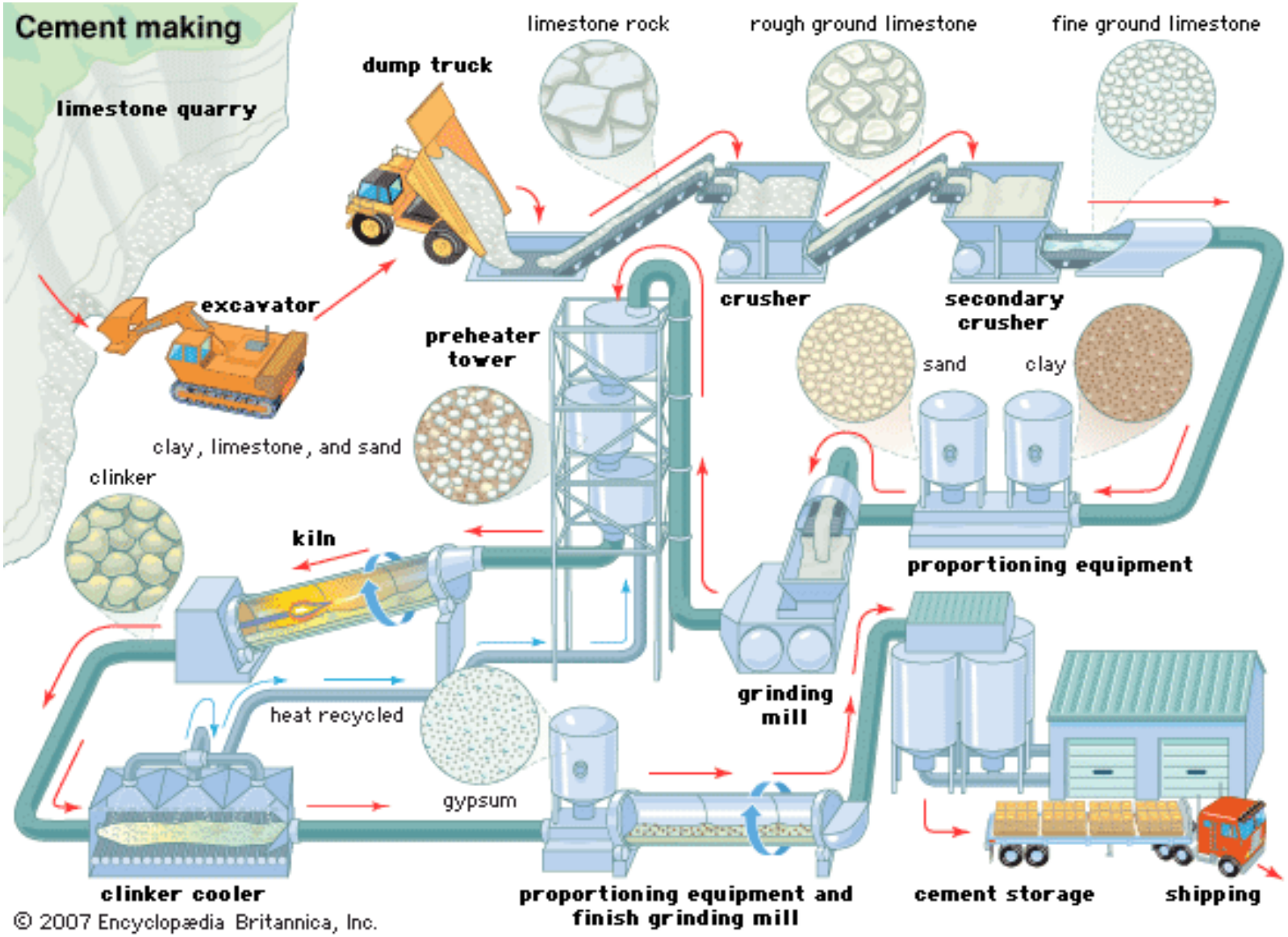
Examples of Wastes Managed by Geocycle

- Biomass
- Calcium fluoride
- Carbon fines
- Contaminated soil
- Gypsum Drywall
- Diatomaceous earth
- ETP sludge
- Asphalt Shingles
- Expired food/health products
- Expired consumer goods
- Forestry Residues

- Filter cake
- Fly ash & bottom ash
- Foundry sand
- Mill scale
- Oily wastes
- Packaging materials
- Paint wastes
- Plastics
- RDF fluff & pellets
- Redmud
- Construction and Demo (MRF) waste
- Mattresses

- Refinery wastes
- Rubber wastes
- Wood, Paper, Cardboard
- Sorted municipal solid waste
- Solvents
- Spent carbon
- Spent pot liner
- Textile waste
- Tires
- Rubber wastes
- Rail ties
- Used oil & grease

Cement Manufacturing Process



What is Pre-processing?

Pre-processing is needed to convert a wide variety of waste streams into a homogeneous in spec product suitable for co-processing in cement kilns.

Industrial Sludge | Tyre Chips | Whole Tyres | Refuse Derived Fuel | Plastic / Packaging Waste | Oil Sludge | Trade Rejects

Pre-processing

Homogenized Waste Mix

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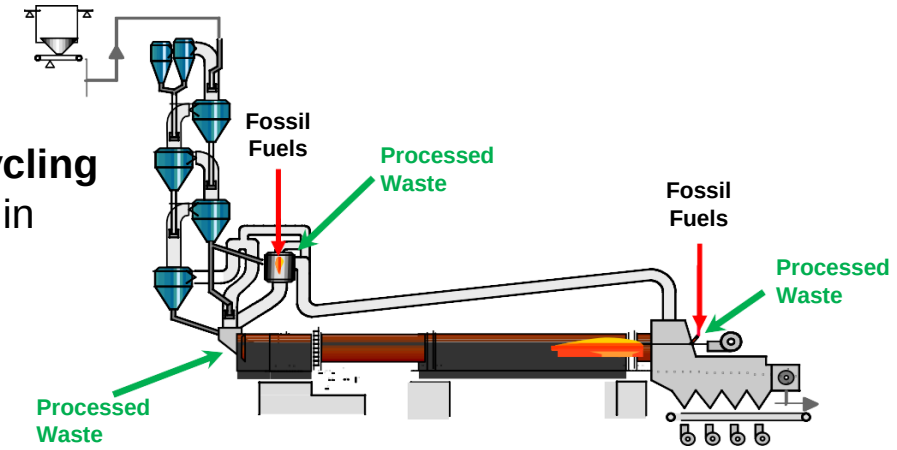
Systech Environmental Corporation

What is Co-processing?

- **Safe energy recovery** and **mineral recycling of residual streams** that cannot be kept in the loop of a circular economy



Completely decomposes waste through high temperatures and long residence time

Recovers energy and recycles mineral value of waste, if any

Leaves no residue

Leads to conservation of natural resources

Reduces greenhouse gas emission

Offers local waste management solution

Saves public funds

Promotes a circular economy

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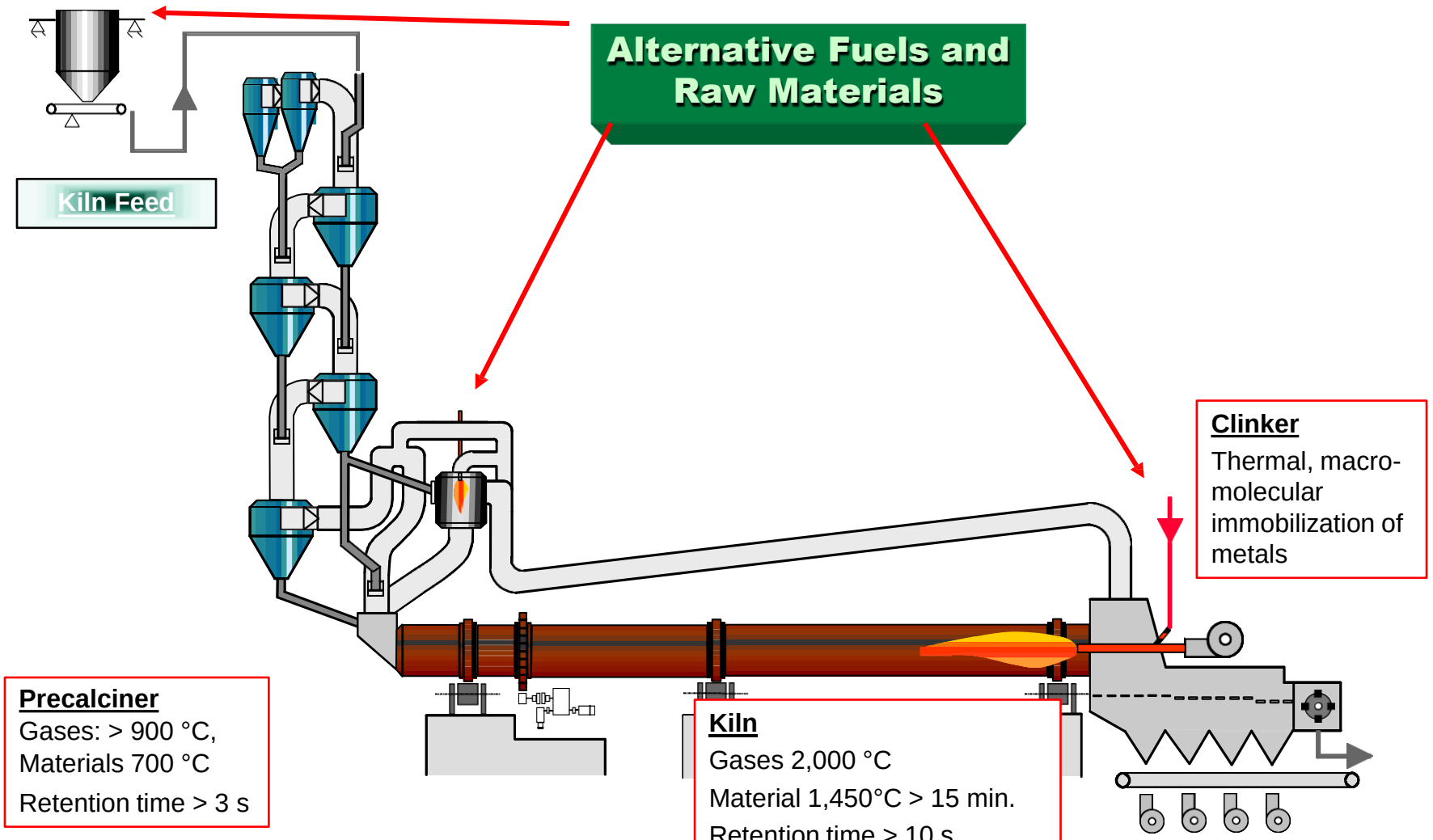
Systech Environmental Corporation

Unique Technology and Services: Co-Processing at a Cement Kiln



The Cement Kiln Can be a Superior Approach

Appropriate and efficient for recovering minerals & energy

Traps mineral residues
- Inorganic mineral residues from combustion – including most heavy metals* – are trapped in matrix of clinker and cement

Provides complete combustion
- Very high temperatures break the long-chain hydrocarbons in the waste, reducing it to its basic elements
- The wastes spend a long time inside the kiln, breaking down even the most complex chemical compounds
- Stable nature of pyroprocess guarantees complete destruction of organic components

Therefore, there is no ash residue**

Provides complete neutralization of any "acid gas"
- Since waste materials are in contact with a large flow of alkaline (basic) materials (limestone)

** Some volatile heavy metals not completely immobilized so inputs are limited*
*** Excess in chlorine or alkali may be removed as CKD*

Recovering the Thermal & Chemical Value of Waste

From an environmental performance perspective, co-processing:

- Significantly reduces greenhouse gas emissions
- Is better than landfilling or incineration, as demonstrated by life-cycle assessment studies

Co-Processing vs. Incineration

Co-Processing

Substitution of primary fuel and raw material by waste-derived materials in industrial processes

- Leaves no residue
- Combustible part of waste provides the fuel needed for clinker manufacturing and minerals substitute primary mineral materials (e.g. limestone, clay, sand, iron correctives)
- All of the material input is recovered or recycled in production
- Happens at a higher temperature and
- higher residence time
- Energy recovery efficiency is much higher than incineration

Incineration

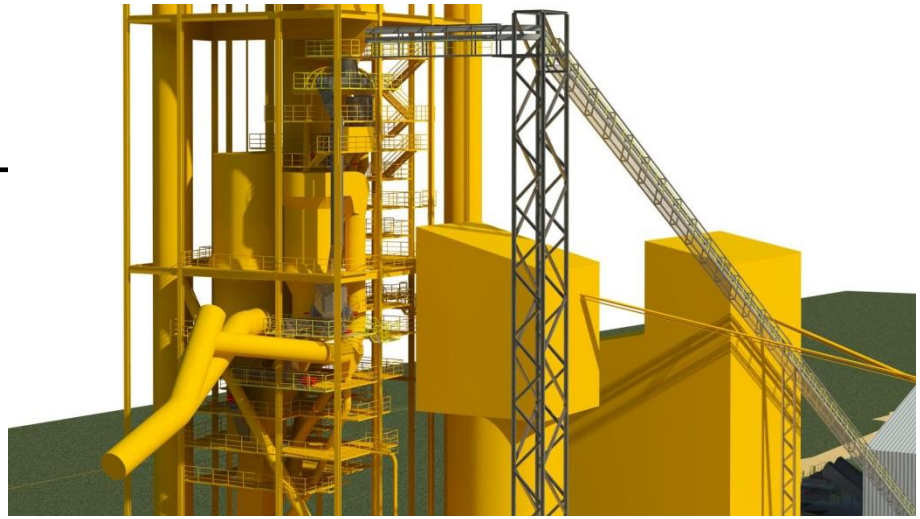
Disposal technology to reduce waste volumes and the potential negative impact of the waste material

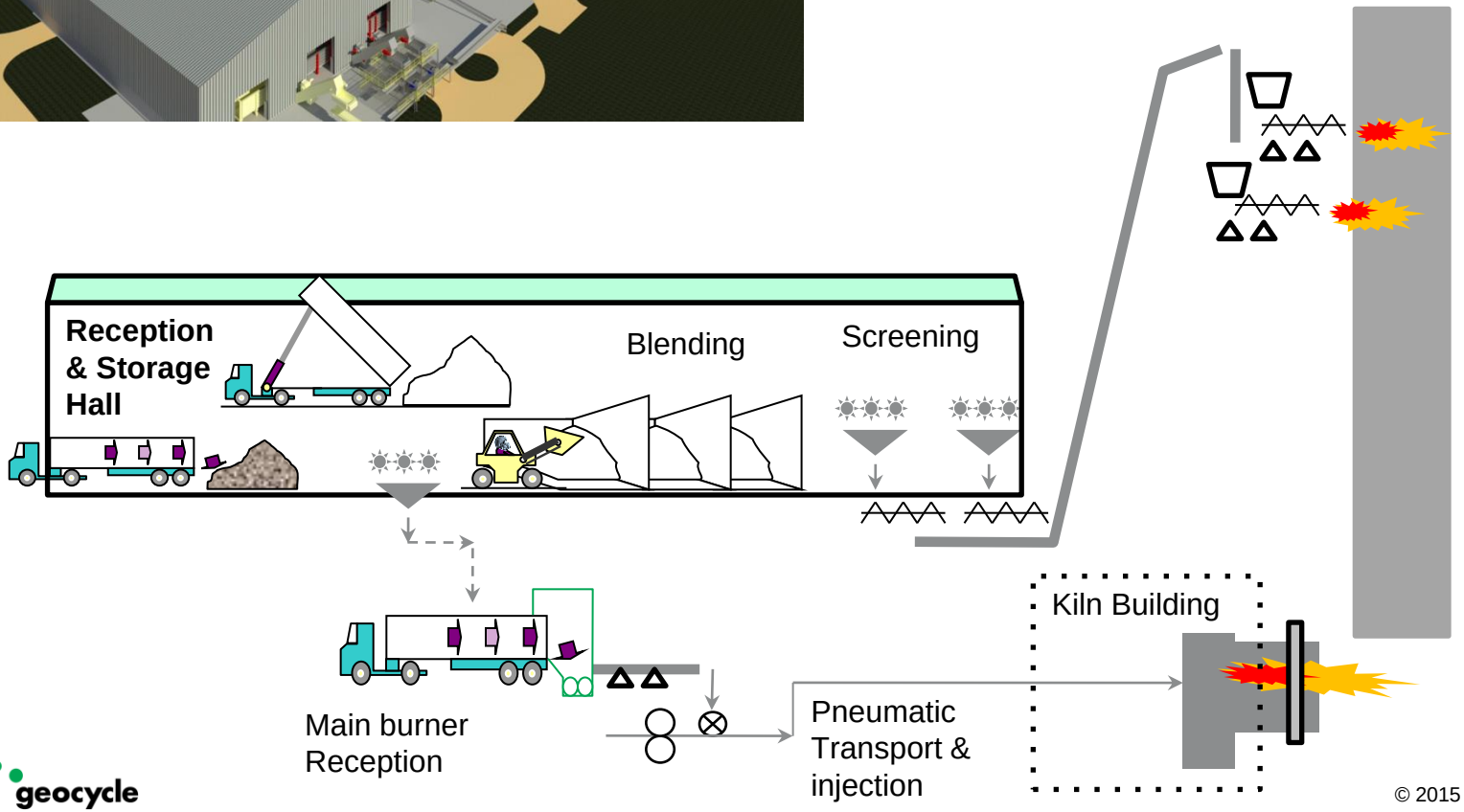
- Leaves large quantities of ash that need to be landfilled
- A typical process leaves up to 30% residues (ashes, often hazardous) that need disposal
- Energy recovery efficiency is much lower than co-processing

Alternative Fuel and Raw Material Criteria

- Internal Approval and External Approvals required before use of any alternative fuel or raw material. Expect process to take 6-12 months from start to final approval
  - Metro Vancouver is regulatory authority
- Chemically compatibility
- Physical characteristics, handling and process introduction
- Environmental considerations
- Health and safety factors
- Financial considerations
- Key Quality Indicators

Low Carbon Fuel System





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Richmond Cement Plant

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Richmond Cement Plant (Biosolids silo)

Richmond Cement Plant

Richmond Cement Plant

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