Environmental Product Declaration (EPD) **Revised Version 1.1**

GENERAL USE (GU) AND PORTLAND-LIMESTONE (GUL) CEMENTS

Cement Association of Canada

The Cement Association of Canada (CAC) is pleased to present this Canadian and CAC member industry average environmental product declaration (EPD) for General Use (GU) and Portland-Limestone (GUL) Cements. This EPD was developed in compliance with CAN/CSA-ISO 14025 and has been verified by François Charron Doucet, Groupe AGÉCO.

The EPD includes life cycle assessment (LCA) results for the product stage or cradle-to-gate manufacture of GU and GUL cements as produced in Canada by CAC members in 2014. It is intended for business-to-business communication.

For more information about Cement Association of Canada, please go to www.cement.ca.

Environmental Product Declaration

CSA Group Registered Based on ISO 14025 and Other Requirements

For more information visit csaregistries.ca/epd

#5357-9431

March 2016-2021

This environmental product declaration (EPD) is in accordance with CAN/CSA-ISO 14025 and the PCR noted below. EPDs from different programs may not be comparable.

PRODUCT	General Use (GU) and Portland-Limestone (GUL) Cements
DATE OF ISSUE	March 31, 2016 (v1.1)
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EPD RECIPIENT ORGANIZATION	Cement Association of Canada / Association Canadienne du Ciment Cement Association of Canada 502-350 Sparks Street Ottawa, ON, K1R 7S8 Phone: (613) 236-9471 www.cement.ca This declaration is valid for all CAC member companies manufacturing GU and GUL cements as listed below:

EPD RECIPIENT ORGANIZATION	**Ciment Québec Inc.** 145, boulevard du Centenaire, St-Basile (Portneuf) Quebec GOA 3GO Member Link (URL): http://cimentquebec.com/ **CRH Canada Group Inc.** 2300 Steeles Avenue West, 4th Floor, Concord, ON L4K 5X6 Member Link (URL): http://www.crhcanada.com/ **ESSROC Italcementi Group** 3251 Bath Pike Road, Nazareth, PA 18064-8928 Member Link (URL): http://www.essroc.com/ **Lafarge Canada Inc. (EAST)** 6509 Airport Road, Mississauga, ON L4V 1S7 **Lafarge Canada Inc. (WEST)** Suite 300, 115 Quarry Park Road SE, Calgary, AB T2C 5G9 Member Link (URL): http://www.lafarge-na.com/wps/portal/na **Lehigh Hanson Materials Ltd.** 12640 Inland Way, Edmonton, Alberta T5V 1K2 Member Link (URL): http://lehighhansoncanada.com/ **St Marys Cement Group** 55 Industrial Street, Toronto ON M4G 3W9 Member Link (URL): http://www.stmaryscement.com/ The complete list of CAC Members is available at http://www.cement.ca/en/CAC-Members.html

REFERENCE PCR	Product Category Rules For Preparing an Environmental Product Declaration For Portland, Blended Hydraulic, Masonry, Mortar, and Plastic (Stucco) Cements ASTM International September, 2014 to August, 2019 UN CPC 3744 - Cement
The PCR review was conducted by:	Nicolas Santero, Chairperson, thinkstep Hamid Farzam, CEMEX Anthony Fiorato, Consultant
EPD PROGRAM OPERATOR	CSA Group 178 Rexdale Blvd Toronto, ON Canada M9W 1R3 www.csagroup.org
This EPD and related data were independently verified by an external verifier, François Charron Doucet, Groupe AGÉCO, according to CAN/CSA-ISO 14025:2006	 François Charron Doucet, Groupe AGÉCO

DESCRIPTION OF CEMENT ASSOCIATION OF CANADA

The Cement Association of Canada (CAC) is the voice of Canada's cement manufacturers. The industry provides a reliable, domestic supply of cement required to build Canada's communities and critical infrastructure. The CAC and its members are committed to the environmentally responsible manufacturing of cement and concrete products. CAC's members are: Ciment Québec Inc., Colacem Canada Inc., CRH Canada Group, ESSROC Italcementi Group, Federal White Cement Ltd., Lafarge Canada Inc., Lehigh Hanson Materials Ltd., and St Marys Cement Group.

DESCRIPTION OF PRODUCT

Cement is primarily used as one ingredient in the production of concrete. Concrete is used in a myriad of building and civil engineering works. Table 1 below describes the two cement products covered under this EPD.

Table 1: EPD Cement Products

Product Name	Applicable Standards	Type
Portland Cement	CSA A3001 & ASTM C150, ASTM C1157, AASHTO M85	Type GU / Type I [a)]
Portland-Limestone Cement	CSA A3001 & ASTM C595, ASTM C1157, AASHTO M240	Type GUL / Type IL [b)]

Note [a,b)]: U.S. cement type designations

Definitions

Hydraulic cement — a type of cement that sets and hardens through a chemical reaction with water and is capable of setting and hardening under water (CSA A23.1).
Note: Blended hydraulic cement, portland cement, portland-limestone cement, mortar cement, and masonry cement are examples of hydraulic cement.

Cement, portland: a product obtained by pulverizing clinker consisting essentially of hydraulic calcium silicates, to which the various forms of calcium sulphate, up to 5% limestone, water, and processing additions may be added at the option of the manufacturer (CSA A3001).

Cement, portland-limestone: a product obtained by intergrinding portland cement clinker and limestone, to which the various forms of calcium sulphate, water, and processing additions may be added at the option of the manufacturer (CSA A3001).

In Canada, CSA recognizes six types of portland cement under Standard A3001, as follows,

Type GU: General use cement

Type MS: Moderate sulphate resistant cement

Type MH: Moderate heat of hydration cement

Type HE: High early strength cement

Type LH: Low heat of hydration cement, and

Type HS: High sulphate resistant cement.

CSA 3001 defines Type GU, as a general-purpose portland cement suitable wherever the special properties of other types are not required.

In Canada, CSA recognizes four types of portland-limestone cement under Standards A3001 and A23.1, as follows,

Type GUL: General use cement

Type MHL: Moderate heat of hydration cement

Type HEL: High early strength cement, and

Type LHL: Low heat of hydration cement.

U.S. cement type designation for GU and GUL are Types I and IL, respectively. ASTM C150 defines Type I, as portland cement for use when the special properties specified for any other type is not required. ASTM C595 defines Type IL, as portland-limestone cement with up to 15% limestone permitted.

Product Standards

Applicable product standards for portland cement (Type GU) and portland-limestone cement (Type GUL), UN CPC 3744, include:

- Portland cement:
  - CSA A3001 – Cementitious Materials for Use in Concrete
  - ASTM C150 – Standard Specification for Portland Cement
  - ASTM C1157 – Standard Performance Specification for Hydraulic Cement
  - AASHTO M85 – Standard Specification for Portland Cement (Chemical and Physical)
- Portland-limestone cement:
  - CSA A3001 – Cementitious Materials for Use in Concrete
  - CSA A23.1 – Concrete Materials and Methods of Concrete Construction
  - ASTM C595 – Standard Specification for Blended Hydraulic Cements
  - ASTM C1157 – Standard Performance Specification for Hydraulic Cement
  - AASHTO M240 – Standard Specification for Blended Hydraulic Cement

Material Content

Table 2 below presents the material content of GU and GUL.

Table 2: Average Material Content for 1 metric ton (1,000 kg) of Types GU and GUL, in absolute and percentage basis

Material Inputs	**Type GU** (kg)	**%**	**Type GUL** (kg)	**%**
Clinker	920.4	92%	834.5	83%
Limestone	31.4	3%	120.5	12%
Gypsum (including anhydrites)	48.2	5%	45.0	5%
Total	**1,000**	**100%**	**1,000**	**100%**

SCOPE OF EPD

The focus of this EPD is the "Product stage" (modules A1 to A3) or cradle-to-gate manufacture of general use portland cement (GU) and portland-limestone cement (GUL). The declared unit for this EPD is the production of one metric tonne (1 t) of GU or GUL cement packaged ready for delivery. This is an industry average EPD whereby it represents an average or benchmark result for CAC's members producing the two products of interest across Canada. This declaration represents two specific cement products as an average from plants or several manufacturers. Figure 1 depicts the system boundary for the EPD as per the PCR and covers the three production information modules (A1- Raw Material Supply, A2- Transport (to the manufacturer) and A3- Manufacturing) comprising the product stage of the life cycle.

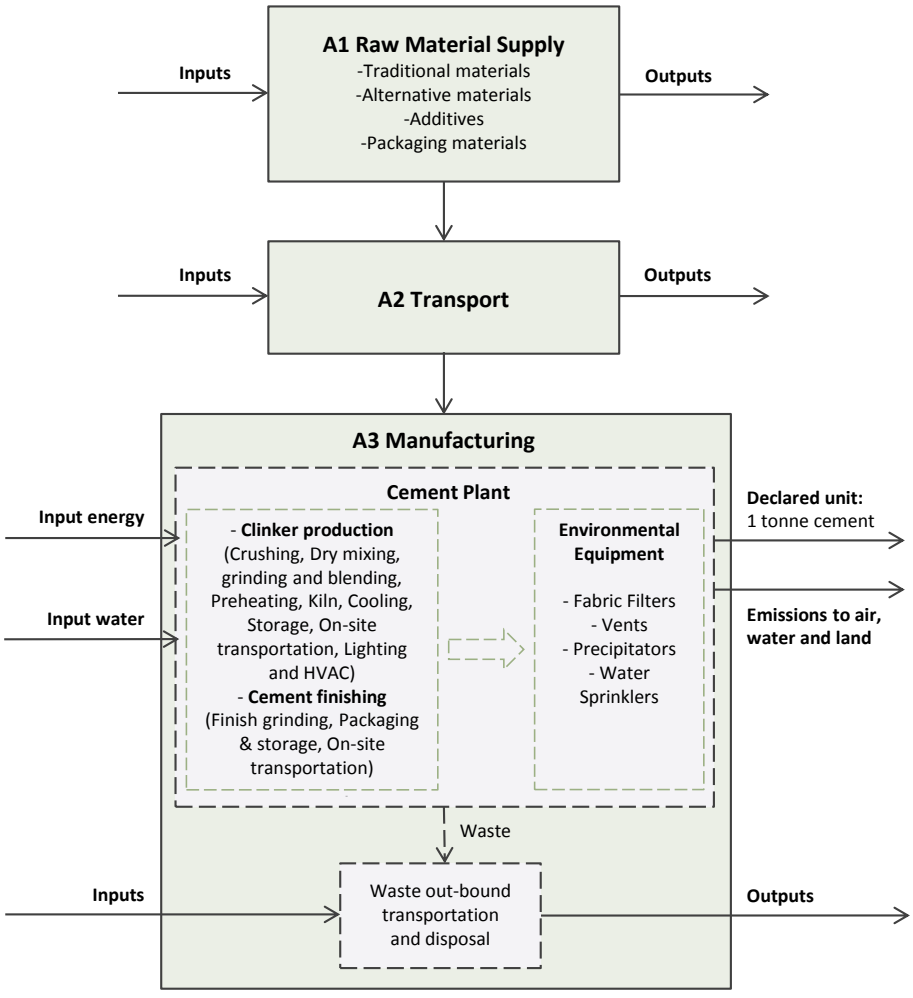

Figure 1: Cement Product Stage (modules A1 to A3)

The Product Stage includes the following processes:

- Extraction and processing of raw materials, including fuels used in extraction and transport within the process;
- Transportation of raw materials from extraction site or source to manufacturing site (including any recovered materials from source to be recycled in the process), including empty backhauls and transportation to interim distribution centers or terminals;
- Manufacturing including all energy and materials required, and all emissions and wastes produced;
- Packaging, including transportation and waste disposal, to make product ready for shipment;
- Transportation from manufacturing site to recycling/reuse/landfill for pre-consumer wastes and unutilized by-products from manufacturing, including empty backhauls; and
- Recycling/recovery/reuse/energy recovery of pre-consumer wastes and by-products from production.

Temporal, geographical and technological boundaries

The GU and GUL cement production impacts estimated by the LCA represent cements produced in Canada in 2014. Primary collected data reflect technology, processes and market conditions for this year. Overall, the primary data is representative according to the following temporal, geographical and technological criteria:

- Temporal: Limestone quarrying, clinker and cement manufacturing process inputs and outputs were obtained for the latest available calendar year (2014);
- Geographical: geographically the data represents CAC member facilities operating in Canada (76%-Ontario and west; 26%-Quebec and east), and
- Technological: Data represents a mix of the prevalent contemporary technologies (75%- dry with preheater and precalciner & dry with preheater; 25%- long dry kilns) in use in Canada by CAC's grey portland cement producing members. In Canada, no CAC member operates a wet kiln producing cement.

Additional details describing the primary and secondary data are provided in the LCA background report – "*An Industry Average Cradle-to-Gate Life Cycle Assessment of Portland Cement (Type GU) and Portland-Limestone Cement (Type GUL) Manufactured in Canada, December, 2015*" prepared by the Athena Sustainable Materials Institute for the Cement Association of Canada.

Industry Representation

The life cycle assessment (LCA) results presented in this EPD were calculated using an industry-average life cycle inventory (LCI) of Canadian CAC member GU and GUL cement production. The LCI was assembled with data collected from a representative sample of CAC members through a survey process carried out in 2015 for 2014 annual operations. The survey sample represents 64% of all cement facilities and about 62% of total cement production operating in Canada.

Cement plants in Canada are also typically located in close proximity to a limestone quarry (limestone being the key raw material in the production of clinker) and many of CAC's members are vertically integrated and operate their own limestone quarries. LCI data were also collected for quarry operations in 2014 to represent this key raw material input. Lastly, cement plants in Canada are required to report various emissions to Environment Canada's National Pollutant Release Inventory; these data too were collected from the sample plants for the calendar year 2014 and were used to complete the LCA for the two products of interest.

The following primary data was obtained for the 2014 calendar year:

- Limestone quarrying operations (LCI inputs and outputs);
- Clinker and finished cement raw material inputs;
- Cement production amounts by type;
- Inbound transportation distances and modes for raw materials, fuels, and ancillary materials;
- Ancillary material use and water use;
- Electricity and fuel consumption;
- Combustion and process air emissions (including calcination carbon dioxide emissions);
- Waste outputs and outbound transportation distances and modes.

Exclusions, Cut-off criteria and Allocation approach

As per the ASTM PCR for cement, the Product Stage excludes the following processes:

- Production, manufacture, and construction of manufacturing capital goods and infrastructure;
- Production and manufacture of production equipment, delivery vehicles, and laboratory equipment;
- Personnel-related activities (travel, furniture, and office supplies); and
- Energy and water use related to company management and sales activities that may be located either within the factory site or at another location.

The cut-off requirements as per the ASTM PCR for cement, Section 7.2, were applied. All input/output flow data reported by the facilities were included in the LCI modeling. Mass and energy balances were conducted at the facility level to ensure that collected data were complete. The LCA followed the ISO 14044, Clause 4.4.3.3.3 [4] and did not apply any cut-off criteria such as mass, energy and environmental significance.

Allocation rules as per the ISO 14044, clause 4.3 and ASTM PCR for cement, Section 7.5, were applied and documented in the underlying 2015 CAC LCA report.

Whenever applicable, "mass" was deemed as the most appropriate physical parameter for allocation. Recovered materials (e.g. fly ash, iron slag) are considered raw materials. Only the materials, water, energy, emissions, and other elemental flows associated with reprocessing, handling, sorting, and transportation from the point of the generating industrial process to their use in the production process are considered; any allocations before reprocessing is allocated to the original product.

ENVIRONMENTAL IMPACTS

Tables 3 and 4 summarize the TRACI Life Cycle Impact Assessment (LCIA) category indicators, resource use and waste generated parameters supported in this LCA study. This section follows the ASTM PCR for cement, Section 8.0, which sets out the environmental indicators, characterization methods, resource use and waste generated parameters to be supported by the LCA.

The LCA results based on the cradle-to-gate life cycle inventory inputs and outputs analysis are summarized below. The results are calculated on the basis of one metric ton of each cement type of interest. For transparency, the LCA results of GU (Table 3) and GUL (Table 4) cement production are broken down by information module A1– Raw material supply, A2– Transport, and A3– Cement manufacturing.

Table 3: LCA Results –Type GU one metric ton – absolute basis

Category Indicator	Unit	Total	A1 Raw Material Supply	A2 Transport	A3 Manufacturing
TRACI v.2.1 Category Indicators					
Global warming potential, GWP	kg CO_2 eq.	940.5	17.9	9.0	913.6
Acidification potential, AP	kg SO_2 eq.	3.7	0.16	0.1	3.5
Eutrophication potential, EP	kg N eq.	0.4	0.06	0.004	0.3
Smog creation potential, POCP	kg O_3 eq.	62.9	2.6	2.2	58.1
Ozone depletion potential, ODP	kg CFC-11 eq.	9.8E-06	1.9E-06	1.8E-08	7.8E-06
Total primary energy consumption					
Non-renewable fossil, PENR-fossil	MJ (HHV)	5594	258	122.4	5213.8
Non-renewable nuclear, PENR-nuclear	MJ (HHV)	586	38	1.5	546.7
Renewable (solar, wind, hydroelectric, and geothermal), PER-HWSG	MJ (HHV)	249	33	0.2	216.5
Renewable (biomass), PER-biomass	MJ (HHV)	481	453	0.03	27.9
Material resources consumption					
Non-renewable material resources, NRMR	kg	1490	1489.0	0.0008	0.6
Renewable material resources, RMR	kg	25	24.2	0.0013	1.3
Net fresh water, NFW	l	1793	116	1	1676
Waste generated					
Hazardous waste generated, HW	kg	0.09	0.004	0	0.09
Non-hazardous waste generated, NHW	kg	0.97	0.01	0	0.96

Table 4: LCA Results – Type GUL one metric ton – absolute basis

Category Indicator	Unit	Total	A1 Raw Material Supply	A2 Transport	A3 Manufacturing
TRACI v.2.1 Category Indicators					
Global warming potential, GWP	kg CO_2 eq.	855.6	17.4	8.3	829.9
Acidification potential, AP	kg SO_2 eq.	3.4	0.15	0.1	3.2
Eutrophication potential, EP	kg N eq.	0.38	0.05	0.004	0.3
Smog creation potential, POCP	kg O_3 eq.	57.4	2.5	2.1	52.8
Ozone depletion potential, ODP	kg CFC-11 eq.	9.0E-06	1.9E-06	1.6E-08	7.2E-06
Total primary energy consumption					
Non-renewable fossil, PENR-fossil	MJ (HHV)	5111	251	112.7	4747.3
Non-renewable nuclear, PENR-nuclear	MJ (HHV)	555	37	1.5	516.1
Renewable (solar, wind, hydroelectric, and geothermal), PER-HWSG	MJ (HHV)	237	32	0.2	204.7
Renewable (biomass), PER-biomass	MJ (HHV)	480	453	0.03	26.4
Material resources consumption					
Non-renewable material resources, NRMR	kg	1444	1443.2	0.0008	0.4
Renewable material resources, RMR	kg	25.2	24.2	0.0013	1.0
Net fresh water, NFW	l	1672	112	1	1559
Waste generated					
Hazardous waste generated, HW	kg	0.09	0.003	0	0.09
Non-hazardous waste generated, NHW	kg	0.97	0.01	0	0.96

Interpretation

Figures 2 and 3 provide LCA results analysis on a percent contribution basis. The cement production stage results are delineated by information module: A1 – Raw material supply, A2 – Transport, and A3 – Manufacturing. Across the three production modules, A3 Manufacturing contributes the largest share of the LCA results – excluding Renewable energy, biomass, Non-renewable and renewable material resources, module A3 accounts for between 79% and 99% across all indicators.

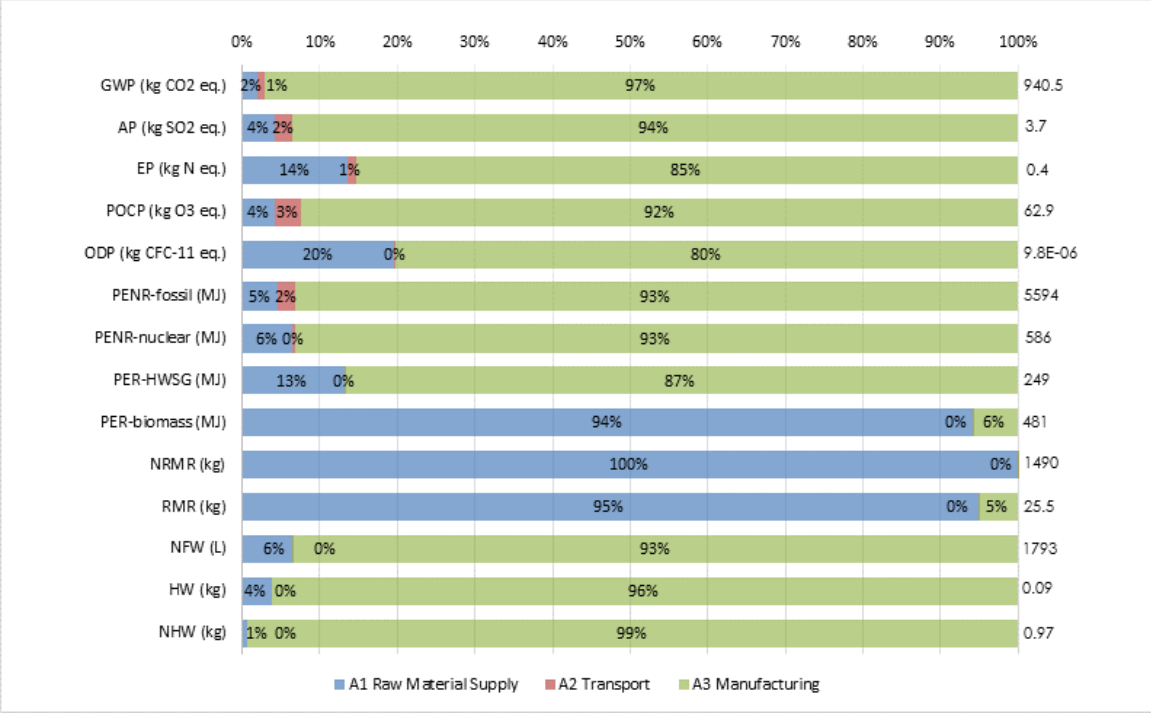

Figure 2: LCA Results – Type GU one metric ton – percentage basis

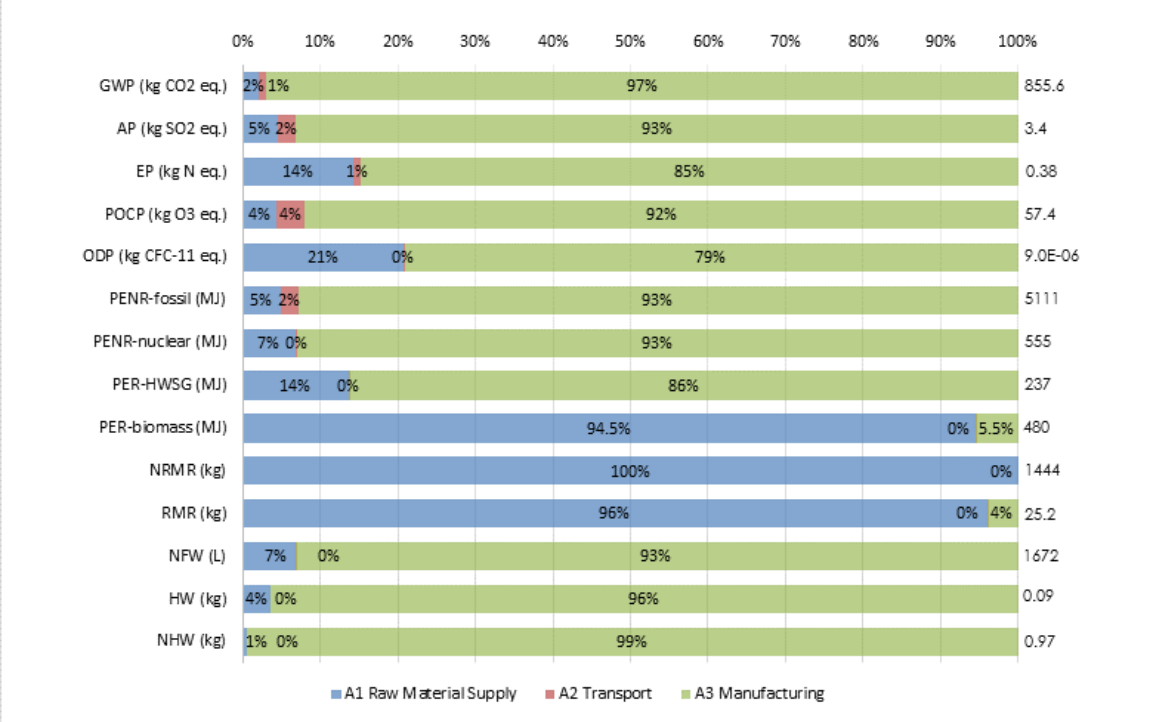

Figure 3: LCA Results – Type GUL one metric ton – percentage basis

Additional Environmental Information

- Environmental Management Systems (EMS)
  77% of the surveyed CAC member manufacturing facilities are either ISO 14001 certified (55%) or adhere to the internally developed EMS (22%). The rest of 23% do not adhere to any EMS yet.

- Environmental Protection Manufacture and Equipment
  The CAC member manufacturing facilities comply with the Canadian environmental protection requirements, monitor and report the emissions to air during the manufacturing process as per the following:

  - The Canadian National Pollutant Release Inventory (NPRI) reporting (http://www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=4A577BB9-1)

  The following process-specific emissions to air are measured at the stack after environmental control devices are utilized: particulate matter (PM)>10 microns, 2.5 microns <PM<10 microns, and PM<2.5 microns.

Environmental equipment typically used in the cement manufacturing facilities are as follows: fabric filter – high temperature (baghouse), fabric filter- low temperature (baghouse), bin vent filter, drum filter, dry filter, cartridge filter, precipitator, and water sprinkler for dust control.

- Additional Environmental Indicator
  A wide range of waste flows are recovered by the cement industry and diverted from the landfill such as fly ash, aluminum oxide (waste), incinerator ash, bottom ash, Cement Kiln Dust (CKD), mill scale, iron slag, industrial sludge, spent catalyst, waste clinker, plastics, used tires, used solvents & oil and asphalt shingles which are used as input materials or alternative fuels in the clinker production system. Table 5 provides the "recovered material" and "alternative fuels" results by information module for both Type GU and GUL, on absolute and percentage basis.

Table 5: Additional Cradle-to-gate Environmental Indicator Results - per metric ton of Type GU and GUL cements – absolute and percentage basis

Category Indicator	Unit	Total	A1 Raw Material Supply	A2 Transport	A3 Manufacturing
Type GU					
Recovered material	kg	58.3	70.9	0	-12.6
	%	100	122	0	-22
Alternative fuels	kg	14.1	0	0	14.1
	%	100	0	0	100
Type GUL					
Recovered material	kg	52.8	64.2	0	-11.4
	%	100	122	0	-22
Alternative fuels	kg	12.8	0	0	12.8
	%	100	0	0	100

Disclaimer

This EPD represents average industry performance for CAC members producing GU and GUL cements in Canada. It is solely intended for use in Business-to-Business communication and no claim of environmental superiority is inferred or implied.

This EPD and the LCA background report conform to the ASTM Product Category Rule for Preparing an Environmental Product Declaration for Portland, Blended Hydraulic, Masonry, Mortar, and Plastic (Stucco) Cements. EPDs of GU and GUL cements that follow a different PCR may not be comparable.

This EPD is a declaration of potential environmental impact. That is, the LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks. The indicators as reported herein comply with the PCR and do not support a complete list of possible environmental burdens. In addition to the impact indicator results, this EPD provides a number of resource consumption and waste generation metrics and while these data may be informative, they do not themselves provide a measure of impact on the environment.

REFERENCES

ASTM International, Product Category Rules For Preparing an Environmental Product Declaration For Portland, Blended Hydraulic, Masonry, Mortar, and Plastic (Stucco) Cements, September 2014.

ISO 21930: 2007 Building construction – Sustainability in building construction – Environmental declaration of building products.

ISO 14025: 2006 Environmental labeling and declarations - Type III environmental declarations - Principles and procedures.

ISO 14044: 2006 Environmental management - Life cycle assessment - Requirements and guidelines.

ISO 14040: 2006 Environmental management - Life cycle assessment - Principles and framework.

ISO 14021:1999 Environmental labels and declarations -- Self-declared environmental claims (Type II environmental labeling).

CSA Group Environmental Product Declaration (EPD) Program: *Program Requirements*, November 2013.

ISO 14046: 2014 Environmental management - Water footprint - Principles, requirements and guidelines.

Athena Sustainable Materials Institute 2015, An Industry Average Cradle-to-Gate Life Cycle Assessment of Portland Cement (Type GU) and Portland-Limestone Cement (Type GUL) Manufactured in Canada, January 2016.