



# Environmental Product Declaration

## Aluminium windows

Participating manufacturers:



AluQuébec, the Quebec Aluminium Industrial cluster, is pleased to present this **industry-average (sector)** environmental product declaration (EPD) for **aluminium windows manufactured in Quebec, Canada**.

This EPD was developed in compliance with CAN/CSA-ISO 14025 and ISO 21930 by **Groupe AGÉCO** and has been verified by Industrial Ecology Consultants.

This EPD includes life cycle assessment (LCA) results for production stages, end-of-life stages, and potential benefits (cradle to gate with options). The LCA was performed by **Groupe AGÉCO**.

For more information about AluQuébec, please go to [www.aluquebec.com](http://www.aluquebec.com).

Issue date: October 4, 2024

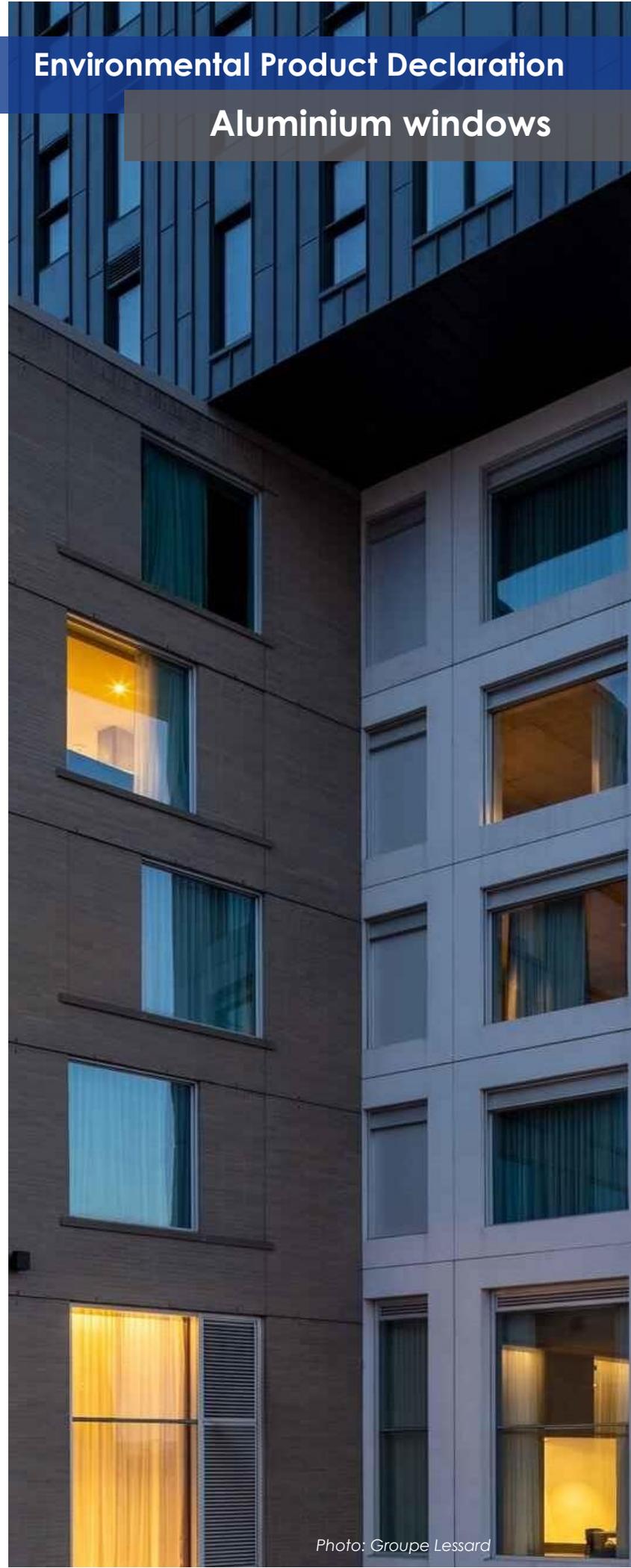


Photo: Groupe Lessard

This industry-wide (sector) environmental product declaration (EPD) for aluminium windows is in accordance with CAN/CSA-ISO 14025 and ISO 21930, and the PCR noted below. EPDs within the same product category but from different programs may not be comparable. Any EPD comparison must be performed in conformance with ISO 21930. Care should be taken when comparing results since differences in certain assumptions, data quality and datasets are unavoidable, even when using the same product category rules (PCR).

This EPD reports environmental impacts based on established life cycle impact assessment methods. The reported environmental impacts are estimates, and their level of accuracy may differ for a particular product line and reported impact. LCAs do not generally address site-specific environmental issues related to resource extraction or toxic effects of products on human health. Unreported environmental impacts include (but are not limited to) factors attributable to human health, land use change and habitat destruction. Regulations address some of these issues. EPDs do not report product environmental performance against any benchmark. Also, the EPD and PCR process is informational only and does not warranty performance. The EPD owner has the sole ownership, liability, and responsibility for the EPD.

<b>PROGRAM OPERATOR</b>	CSA Group 178 Rexdale Blvd, Toronto, ON, Canada M9W 1R3 <a href="http://www.csagroup.org">www.csagroup.org</a>
<b>PRODUCT</b>	Aluminium windows
<b>EPD REGISTRATION NUMBER</b>	#7910-2624
<b>EPD RECIPIENT ORGANIZATION</b>	AluQuébec 625 Président-Kennedy Avenue #505, Montreal, Quebec H3A 1K2, Canada <a href="http://www.aluquebec.com">www.aluquebec.com</a>
<b>REFERENCE PCRs</b>	CEN, EN 15804 and ISO 21930 standard serve as the core PCR. PCR 2019:14 Construction products (version 1.3.2), CPC code: 42120, valid from 2023-12-08, to 2024-12-20 c-PCR-007 Windows and doors (EN 17213), valid from 2024-04-30, to 2025-07-02 The International EPD® System
<b>DATE OF ISSUE</b>	October 4, 2024
<b>PERIOD OF VALIDITY</b>	October 4, 2024 to October 3, 2029

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**The PCR review was conducted by:**

The Technical Committee of the International EPD System. See [www.environdec.com](http://www.environdec.com) for a list of members. Review chair: Claudia A. Peña, University of Concepción, Chile. The review panel may be contacted via the Secretariat [www.environdec.com/contact](http://www.environdec.com/contact) or via [info@environdec.com](mailto:info@environdec.com).

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**The LCA was performed by:**

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**Independent third-party verification of the declaration and data, according to ISO 14025:2006 and ISO 21930:2017.**

Internal       **External**

  
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# AluQuébec Environmental Product Declaration Summary Sheet

## Aluminium windows

Photo: Prévost Architectural

This is a summary of the industry-wide environmental product declaration (EPD) describing the environmental performance of **aluminium windows** manufactured in Quebec, Canada.



<b>EPD commissioner and owner</b> AluQuébec	<b>Period of validity</b> October 4, 2024 to October 3, 2029	<b>Program operator and registration number</b> CSA Group #7910-2624	<b>Product Category Rule</b> PCR 2019:14 Construction products v1.3.2 (2023) c-PCR-007 (2024)	<b>LCA and EPD consultants</b> Groupe AGÉCO
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### Product description

Exterior aluminium windows, more precisely fixed windows, casement windows, horizontal slider windows, hung windows, tilt and turn windows, hopper windows and awning windows, destined to industrial, commercial, institutional or apartment buildings.

### Declared unit

1 m<sup>2</sup> of window (including frame)

### Material content (% of total product mass)

Aluminium: 21.2%  
Glazing unit: 73.5%  
Weather strip: 2.0%  
PVC: 2.3%  
Hardware: 0.8%  
Gaskets: 0.1%  
Adhesives: 0.1%

### Life cycle stages included:

Cradle to gate with options: production (A1-A3), end-of-life (C1-C4), Reuse – Recovery – Recycling potential (D) modules.

### What is a Life Cycle Assessment (LCA)?

LCA is a science-based and internationally recognized tool to evaluate the relative potential environmental impacts of products and services throughout their life cycle, beginning with raw material extraction and including all aspects of transportation, production, use, and end-of-life treatment. The method is defined by the International Organization for Standardization (ISO) 14040 and 14044 standards. For EPD development, Product Category Rules (PCR) give additional guidelines on how to conduct the LCA of the product.

### Why an Environmental Product Declaration (EPD)?

AluQuébec and its members are seeking to communicate the environmental performance of aluminium products to clients and to position their products through a rigorous and recognized communication tool, the EPD. By selecting products with an EPD, building projects can earn credits towards the Leadership in Energy and Environmental Design (LEED) rating system certification. In LEED v4 and v4.1, points are awarded in the Materials and Resources category.

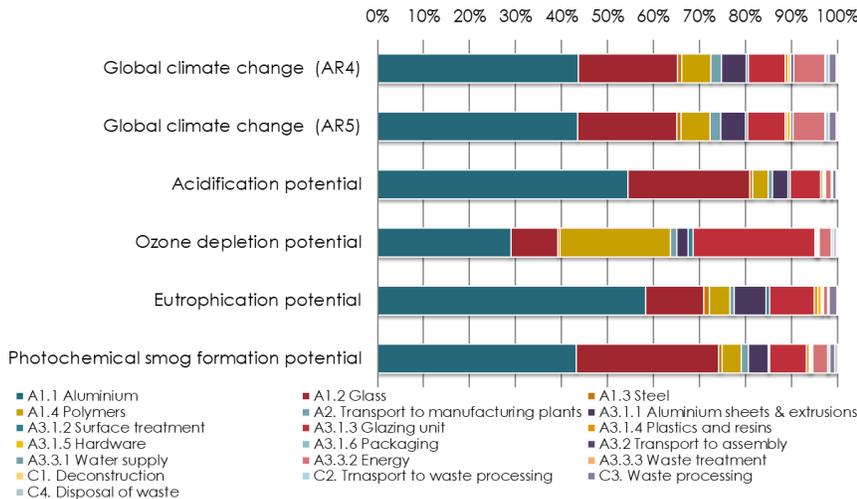


### Environmental impacts

The environmental impacts of 1 square metre of window over the production stage (A1 to A3 modules), end-of-life stage (C1 to C4 modules) and potential benefits (D module) are summarized below for the main environmental indicators (based on life cycle impact assessment methods TRACI 2.1 and CML baseline 3.09). As per the PCR, it is discouraged to use the results of modules A1-A3 without considering the results of module C. Refer to the LCA report or full EPD for more detailed results. Results on resource use, waste generated, and output flows are also presented in the full EPD.

Indicators	Results for 1 m <sup>2</sup> of window Total (A1-A3, C1-C4)
Global climate change, AR4 (kg CO <sub>2</sub> eq.)	2.01E+02
Global climate change, AR5 (kg CO <sub>2</sub> eq.)	2.04E+02
Acidification potential (kg SO <sub>2</sub> eq.)	1.34E+00
Ozone depletion potential (kg CFC-11 eq.)	5.60E-06
Eutrophication potential (kg N eq.)	4.94E-01
Photochemical smog formation potential (kg O <sub>3</sub> eq.)	1.39E+01
Abiotic depletion potential for fossil resources (MJ)	2.21E+03

### Relative contribution of each life cycle stage to the overall environmental impacts



These results are representative of aluminium windows manufactured in Quebec, Canada. They are based on data provided by 5 manufacturers which represent approximately 13% of the Quebec aluminium windows production.

Data was collected from aluminium window manufacturers for their operations occurring during 12 consecutive months within the period from January 2022 to September 2023.

### Additional environmental information

The recyclable content is 21.2% (aluminium content).

For more information: [www.aluquebec.com](http://www.aluquebec.com)

## 1. DESCRIPTION OF ALUQUÉBEC

AluQuébec, the "Quebec Aluminium Cluster", gathers aluminium producers, processors, equipment and specialized suppliers, R&D centres as well as educational institutions associated with the industry in Quebec (Canada). AluQuébec's main objective is to act as a lever for Quebec's aluminium industry by ensuring the consistency and convergence of stakeholders to facilitate and encourage global and promising actions that cater to the industry's needs with beneficial repercussions in Quebec all while ensuring a worldwide outreach.

As part of this Environmental Product Declaration (EPD) project, AluQuébec aims to support the competitiveness of Quebec's companies by enabling them to stand out in the industry, to position themselves in the marketplace and to facilitate obtaining a LEED certification, in green building projects.

This industry-wide EPD presents the life cycle environmental impacts of an average aluminium window manufactured in Quebec. The scope of this EPD is classified as cradle to gate with options. Data for this EPD were collected from five (5) manufacturers operating in the province to determine an average environmental profile for aluminium windows. These manufacturers account for approximately 13% of the total aluminium window production in Quebec.

Quebec is an important aluminium producer in North America. It does so almost exclusively with hydropower, which makes its aluminium less carbon intensive than when produced with electricity from coal. The use of this low carbon aluminium has therefore a significant influence on the environmental impacts of windows manufactured in Quebec. This particularity is taken into account in this study. For this reason, the results are considered representative to the sector.

This EPD will enable AluQuébec manufacturers to contribute to earning credits towards LEED® (Leadership in Energy and Environmental Design) certifications (i.e. Material and Resource credits), as well as to respond to requests from consultants for data/information on environmental performance.



Photo: Shalwin

## 2. DESCRIPTION OF PRODUCT

### 2.1. Definition and product classification

**Aluminium windows** are classified under UN CPC Code 42120 and NAICS 332321. The products covered by this EPD are exterior aluminium windows of the following types: fixed windows, casement windows, horizontal slider windows, hung windows, tilt and turn windows, hopper windows and awning windows. These covered products are destined to industrial, commercial, institutional or apartment buildings, and are manufactured in Quebec. Window frames are included.

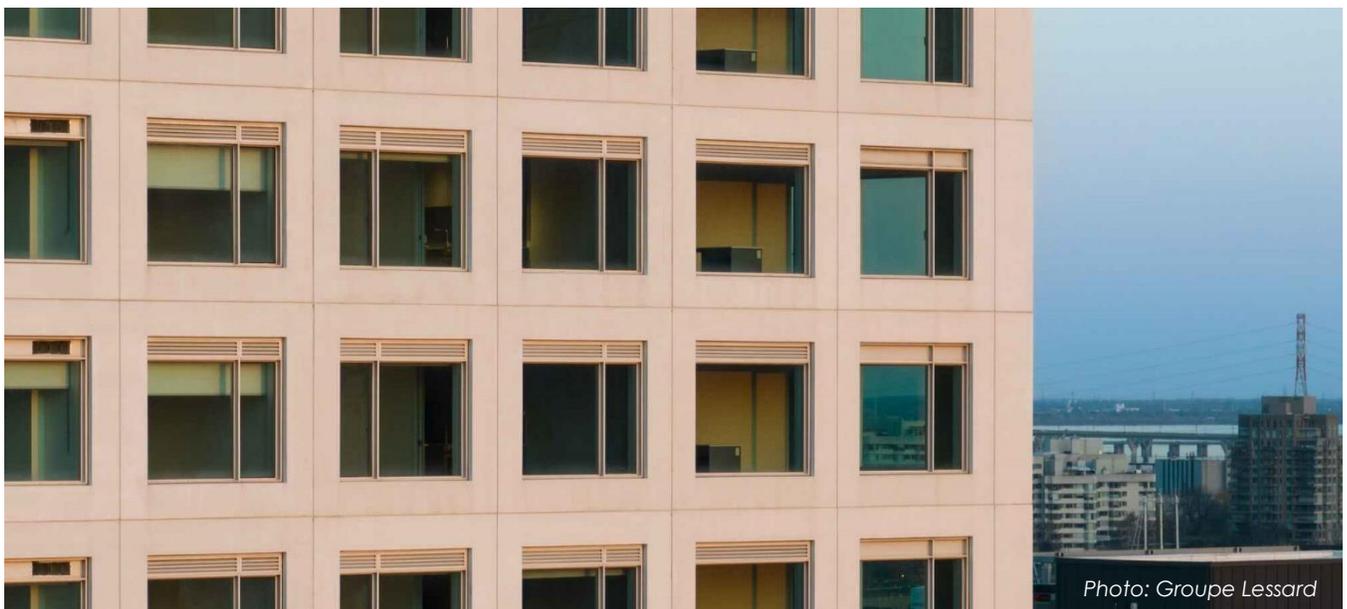
According to EN 17213:2020 (cited by the corresponding PCR), the windows elements has the standard size of 1.2 m x 1.5 m (3.9 ft x 4.9 ft).

### 2.2. Material content

A description of the composition of an aluminium window is provided in Table 1. One square meter of window weighs about 49.6 kg on average.

**Table 1: Materials in an average aluminium window**

Materials	Weight %
Aluminium (primary)	17.8%
Aluminium (secondary)	3.4%
Glazing unit	73.5%
PVC	2.3%
Weather strip	2.0%
Hardware	0.8%
Gaskets	0.1%
Adhesives	0.1%



### 2.3. Production of an aluminium window

The production of an aluminium window starts with the extraction and transformation of the raw materials it is composed of, such as aluminium, glass, steel and polymers. They are then shipped to the window component manufacturing plants to be transformed into aluminium extrusions, glazing units and other products. The components are then assembled at the window manufacturing plant. Aluminium window components are usually anodized or painted before assembly. At the end of life of the windows, they are dismantled and materials are sorted – they are then either sent to landfills (5%) or recycling facilities (95%). Aluminium goes to remelters for recycling. Figure 1 illustrates the cradle to gate with options modules included in this EPD.

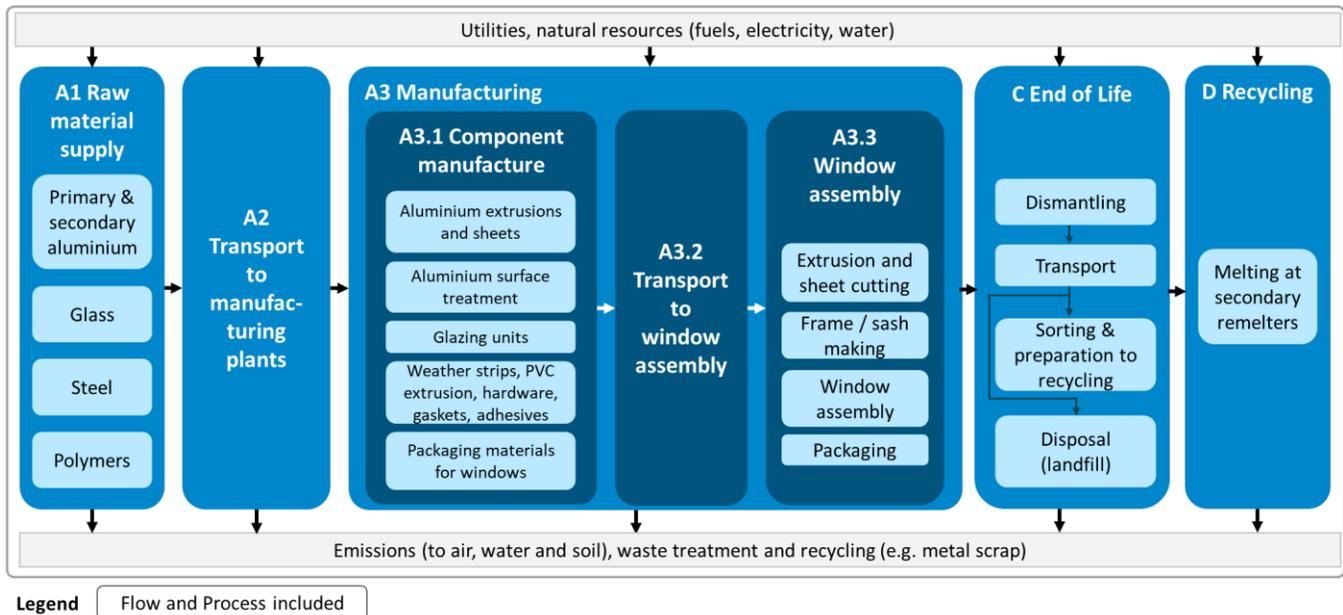


Figure 1: Process flow for the production of an aluminium window

## 3. SCOPE OF EPD

### 3.1. Declared unit

A declared unit is used in lieu of a functional unit since this cradle to gate with options EPD does not include all of the life cycle stages (i.e. the maintenance stage is not considered). It is the reference unit on which the quantities of material inputs, energy inputs, emissions and waste are based for the modelling of the life cycle of an aluminium window. LCA results are also reported on the basis of this reference unit. The declared unit is defined as follows:

**1 m<sup>2</sup> of aluminium window (including frame)**

Screens are not included in the declared unit as they are not required for the primary function of the window, as defined in the PCR.

### 3.2. System boundaries

The production, end-of-life and potential benefits modules included in this cradle to gate with options EPD are shown in Table 2.

**Table 2: Life cycle stages considered according to ISO 21930**

Product stage			Construction process stage		Use stage							End of life stage				Resource recovery stage
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Raw material supply	Transport	Manufacturing	Transport	Construction – installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction, demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	X	X	X	X	X

Legend: **x** - Considered in the cradle-to-gate with options LCA **MND** - Module not declared

More precisely, the life cycle stages include the following processes:

#### A1. RAW MATERIAL SUPPLY

The production of raw materials includes the extraction of resources and their refining into materials that are used during aluminium product manufacturing. They include materials such as aluminium, glass, steel and polymers. The aluminium is supplied from manufacturers located in Quebec.

#### A2. TRANSPORT OF RAW MATERIALS TO THE MANUFACTURING PLANT

This module includes fuel consumption and emissions related to the transportation of materials to component manufacturing plants.

#### A3. ALUMINIUM WINDOW MANUFACTURING

##### A3.1 – Component manufacture

For all products, electricity and fuel consumption, waste generation and emissions during component, and packaging production are included in this sub-module. Window components include aluminium extrusions, glazing units, weather strips, PVC, hardware, gaskets, and adhesives. Capital goods (i.e., manufacturing facility) were also included. Aluminium components undergo a surface treatment (anodization or coating). In some cases, unanodized or uncoated extrusions are delivered to the assembly plant and are sent to a subcontractor for surface treatment before assembly. This surface treatment is included in this module either way. The additional transport is included in the A3.2 module.

##### A3.2 – Transport to assembly

This module includes fuel consumption and emissions related to the transportation by truck of components and packaging to the assembly plant, as well as to surface treatment for aluminium components when treated in a different plant.

**A3.3 – Assembly**

Surface treated aluminium extrusions are cut to the desired length. Then, they are assembled to form the window frame and sash. Glazing units, weather strips, PVC, hardware and gaskets are added. Windows are sealed with adhesives. The assembled product is packaged with cardboard, polyethylene (PE) wrapping and metal strips.

This module covers the window assembly plant and includes the production of electricity and fuels (natural gas, propane, gasoline and diesel). Waste management and emissions from fuel combustion are also included. No water consumption was considered at assembly plants since it is consumed mainly by offices.

**C1. DECONSTRUCTION AND DISMANTLING**

This module covers deconstruction, including dismantling or demolition of the aluminium product from the final product, including initial on-site sorting of the materials.

**C2. TRANSPORT TO WASTE SORTING CENTER OR FINAL DISPOSAL SITE**

This module covers the transportation of the discarded aluminium products from the deconstruction to either the waste sorting plant (when recycled) or the final disposal site (when sent to a landfill or to incineration).

**C3. WASTE PROCESSING**

This module includes the collection and sorting of discarded aluminium products, cleaning and pressing. Only the discarded aluminium resulting in secondary aluminium (i.e. post-consumer aluminium) is considered in this module.

**C4. DISPOSAL OF WASTE**

This module covers the disposal stage for the discarded aluminium products that will not be sent to recycling (accounted for in module D).

**D. POTENTIAL NET BENEFITS FROM RECYCLING BEYOND THE SYSTEM BOUNDARY**

This module covers the recycling process and melting of secondary aluminium in secondary smelters. The calculated benefits represent the potential avoided impacts related to the future use of primary aluminium.

### 3.3. Geographical and temporal boundaries

The geographical boundaries are representative of current equipment and processes associated with aluminium window manufacturing in Quebec (Canada). Since the data were collected for the years 2022 and 2023, they are considered temporally representative (i.e. less than 5 years old).

## 4. ENVIRONMENTAL IMPACTS

This cradle-to-gate with options life cycle assessment has been conducted according to ISO 14040 and 14044 standards and the PCR 2019:14 for construction products, version 1.3.2 (2023) as well as the complimentary c-PCR-007 for windows and doors (2024) (The International EPD® System). Environmental impacts were calculated with the impact assessment method TRACI 2.1 and CML baseline 3.09. The description of these indicators reported are provided in the glossary (section 6).

### 4.1. Assumptions

The main assumptions included in this LCA were related to transportation parameters (distance and empty haul-back) and water consumption at the assembly plant.

### 4.2. Criteria for the exclusion of inputs and outputs

Processes or elementary flows may be excluded if the life cycle inventory (LCI) data amounts to a minimum of 95% of total inflows in terms of mass and energy to the upstream and core module. No single flow representing more than 1% of the total inflows were excluded. All product components and production processes are included when the necessary information is readily available, or a reasonable estimate can be made. Based on Groupe AGÉCO's experience or the relatively low contribution of the life cycle stages to which they pertain, the following processes were excluded:

- Production, maintenance and disposal of capital equipment<sup>1</sup>.
- Any secondary packaging (e.g. pallets)
- Personnel impacts (travel to and from work, human emissions).
- Research and development activities
- Business travel.

Capital goods were included in the impact calculation. The results of the impact categories abiotic depletion of minerals and metals, land use, human toxicity (cancer), human toxicity, non-cancer and

<sup>1</sup> As per the PCR, the production and disposal of capital equipment are excluded, but the operation of the equipment is included.



ecotoxicity (freshwater) may be highly uncertain in LCAs that include capital goods/infrastructure in generic datasets, in case infrastructure/capital goods contribute greatly to the total results. This is because the LCI data of infrastructure/capital goods used to quantify these indicators in currently available generic datasets sometimes lack temporal, technological and geographical representativeness. Caution should be exercised when using the results of these indicators for decision-making purposes.

### 4.3. Data quality

#### Data sources

Table 3 presents the main sources of data used for this EPD. Producer-specific data were collected from five (5) aluminium window manufacturers for operations occurring between January 2022 and September 2023 (less than 3 years old). Generic data collected for the raw material supply processes, transportation and manufacturing of aluminium were representative of the Canadian context and used technologies.

**Table 3: Data sources for the LCA of aluminium windows**

Module	Main processes	Data source	Region	Year
A1	Raw material extraction and processing	ecoinvent 3.9	Multiple	2022
A2	Transportation to manufacturing plants	Aluminium: AluQuébec manufacturers' answers to a data collection questionnaire Other: ecoinvent 3.9	Multiple	2022-2023
A3.1	Component manufacture	ecoinvent 3.9	Multiple	2022
A3.2	Transport to window assembly	AluQuébec manufacturers' answers to a data collection questionnaire	Quebec	2022-2023
A3.3	Window assembly	AluQuébec manufacturers' answers to a data collection questionnaire	Quebec	2022-2023

The LCA model was developed with the SimaPro 9.5 software using ecoinvent 3.9 database which was released in 2022 (less than 2 years). Since most of the data within ecoinvent is of European origin and represent European industrial conditions and processes, several data were adapted to enhance their representativeness of the products and contexts being examined. ecoinvent is the most complete and recognized internationally LCA database.

#### Data quality

The overall data quality ratings show that the data used were good. This data quality assessment confirms the sufficient reliability, representativeness (technological, geographical and time-related), completeness and consistency of the information and data used for this study.

### 4.4. Allocation

When a process in the life cycle of aluminium window generated co-products or is directly connected to another system (i.e. the life cycle of another product), the following allocation methods were applied to distribute the impacts between the co-products or linked systems.

### Allocation of multi-output processes

As prioritized in the PCR used in this study, allocation for multi-output processes was done on a mass basis. Economic value allocation was not used.

### Allocation for end-of-life processes

A recycled content approach (i.e. cut-off approach) was applied when a product is recycled. The impacts associated with the recycling process are thus attributed to the products using these materials.

### ecoinvent processes with allocation

Many of the processes in the ecoinvent database also provide multiple functions, and allocation is required to provide inventory data per function (or per process). This study accepts the allocation method used by ecoinvent for those processes. The ecoinvent system model used was "Allocation, cut-off by classification". It should be noted that the allocation methods used in ecoinvent for background processes (i.e. processes representing the complete supply chain of a good or service used in the life cycle of aluminium) may be inconsistent with the approach used to model the foreground system (i.e. to model the manufacturing of an aluminium window with data collected in the literature and from manufacturers). While this allocation is appropriate for foreground processes, continuation of this methodology into the background datasets would add complexity without substantially improving the quality of the study.



## 4.5. Life cycle impact assessment - results

The results presented in this EPD are representative of an average performance, i.e. a weighted average based on the production volume of the participating manufacturers. Table 4 presents the results for one square metre of aluminium window over the product stage (A1 to A3), end-of-life stage (C1 to C4 modules) and potential benefits (D module). As per the PCR, it is discouraged to use the results of modules A1-A3 without considering the results of module C.

**Table 4: Results for the production of 1 m<sup>2</sup> of aluminium window**

Indicators	Units	Total (excl. D)	A1 to A3	C1	C2	C3	C4	D
<b>Potential environmental indicators</b>								
<b>Global climate change (GWP-GHG) (AR4)</b>	kg CO <sub>2</sub> eq.	<b>2.01E+02</b>	1.96E+02	0.00E+00	1.52E+00	3.25E+00	3.85E-01	-7.84E+01
<b>Global climate change (GWP-GHG) (AR5)</b>	kg CO <sub>2</sub> eq.	<b>2.04E+02</b>	1.99E+02	0.00E+00	1.55E+00	3.29E+00	3.95E-01	-7.91E+01
<b>Acidification potential</b>	kg SO <sub>2</sub> eq.	<b>1.34E+00</b>	1.32E+00	0.00E+00	3.27E-03	1.18E-02	2.63E-03	-6.25E-01
<b>Ozone depletion potential</b>	kg CFC-11 eq.	<b>5.60E-06</b>	5.54E-06	0.00E+00	2.67E-08	2.81E-08	1.06E-08	-1.47E-06
<b>Eutrophication potential</b>	kg N eq.	<b>4.94E-01</b>	4.83E-01	0.00E+00	1.26E-03	8.59E-03	5.63E-04	-2.10E-01
<b>Photochemical smog formation potential</b>	kg O <sub>3</sub> eq.	<b>1.39E+01</b>	1.36E+01	0.00E+00	5.42E-02	1.60E-01	6.83E-02	-5.42E+00
<b>Use of Resources</b>								
<b>Abiotic depletion potential for fossil fuels</b>	MJ, net calorific value (LHV)	<b>2.21E+03</b>	2.16E+03	0.00E+00	2.14E+01	2.06E+01	8.62E+00	-6.92E+02
<b>Renewable primary energy demand</b>	MJ, net calorific value (LHV)	<b>6.59E+02</b>	6.57E+02	0.00E+00	2.80E-01	2.31E+00	1.13E-01	-4.13E+02
<b>Non-renewable primary energy demand</b>	MJ, net calorific value (LHV)	<b>2.01E+03</b>	1.96E+03	0.00E+00	2.17E+01	2.03E+01	8.75E+00	-7.48E+02
<b>Renewable primary material resources</b>	MJ, net calorific value (LHV)	<b>1.18E+00</b>	1.18E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
<b>Non-renewable primary material resources</b>	MJ, net calorific value (LHV)	<b>3.34E+02</b>	3.32E+02	0.00E+00	0.00E+00	1.66E+00	0.00E+00	5.62E+00
<b>Secondary materials</b>	MJ, net calorific value (LHV)	<b>1.78E+01</b>	7.83E+00	0.00E+00	0.00E+00	9.95E+00	0.00E+00	8.34E+00
<b>Renewable secondary fuels</b>	kg	<b>0.00E+00</b>	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
<b>Non-renewable secondary fuels</b>	MJ, net calorific value (LHV)	<b>0.00E+00</b>	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
<b>Recovered energy</b>	MJ, net calorific value (LHV)	<b>0.00E+00</b>	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
<b>Water consumption</b>								
<b>Freshwater consumption</b>	m <sup>3</sup>	<b>3.77E+00</b>	3.75E+00	0.00E+00	3.13E-03	1.17E-02	9.24E-03	-2.13E+00

Indicators	Units	Total (excl. D)	A1 to A3	C1	C2	C3	C4	D
<b>Waste</b>								
Hazardous waste disposed	kg	1.17E-03	1.17E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Non-hazardous waste disposed	kg	3.73E+01	3.79E-01	0.00E+00	0.00E+00	5.06E-02	3.69E+01	0.00E+00
High-level radioactive waste, conditioned, to final repository	kg	1.77E-07	1.75E-07	0.00E+00	2.44E-10	1.17E-09	9.42E-11	-9.17E-08
Intermediate- and low-level radioactive waste, conditioned, to final repository	kg	4.79E-07	4.72E-07	0.00E+00	1.25E-09	5.49E-09	5.09E-10	-1.81E-07
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for recycling	kg	2.13E+01	1.13E+01	0.00E+00	0.00E+00	9.95E+00	0.00E+00	-2.25E-02
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy	MJ, net calorific value (LHV)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Note: values may not add up due to rounding.

The aluminium windows are produced at several facilities; thus, the PCR requires that the variation in GWP-GHG results for modules A1-A3 between the reported result and the results for the underlying sites to be reported in the EPD. For 60% of production sites, the variation is below 10% (i.e., 4%); for 40% of sites, variation is 13%.

The estimated impact results are only relative statements, which do not indicate the endpoints of the impact categories, exceeding threshold values, safety margins and/or risks.

The climate impact of the Quebec electricity grid mix used in the manufacturing processes is 2.4918E-02 kg CO<sub>2</sub> eq./kWh.

## 4.6. Life cycle impact assessment - interpretation

### Life cycle impacts

Figure 2 shows the contribution of each module and submodule to the impact categories (dominance analysis). For all categories, the raw material supply module (A1) accounts for most of the potential environmental impacts of aluminium windows, dominated by primary **aluminium production** (A1.1) (between 29% and 58%). The aluminium windows under study are made mostly with primary aluminium from Quebec (Canada). **Glass production** (A1.2) is the second-largest contributor for all impact categories (between 13% and 31%), except for ozone depletion potential, which is the polymers production (A1.4) (24%). Outside module A1, an important submodule for all impact categories is **glazing unit manufacturing** (A3.1.3) (between 7% and 26%).

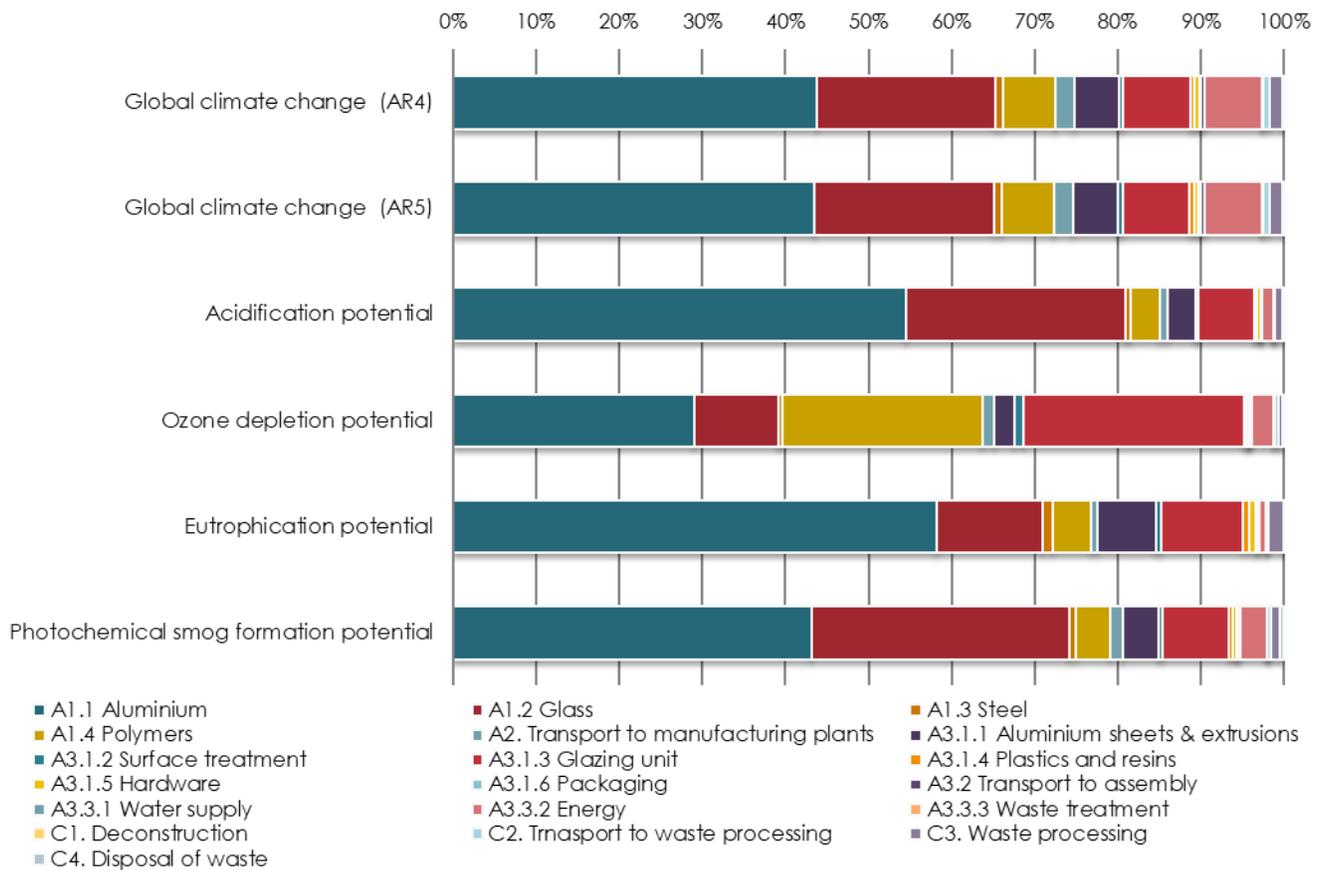


Figure 2: Relative contribution of the main processes in the production of aluminium windows

### Resource use

**Aluminium production** (A1.1) is the submodule using the largest amount of renewable primary energy (70%) because of its high consumption of hydroelectricity. Renewable primary materials resources are contained in energy consumption (A3.3.2; 90%). Eighty-two percent (82%) of non-renewable primary energy demand is shared between **aluminium production** (A1.1; 41%), **glass production** (A1.2; 23%), **glazing unit manufacturing** (A3.1.3; 9%), **polymer production** (A1.4; 9%) and **energy production for window assembly** (A3.3.2; 9%). Non-renewable primary materials resources are contained in **packaging** (A3.1.6)

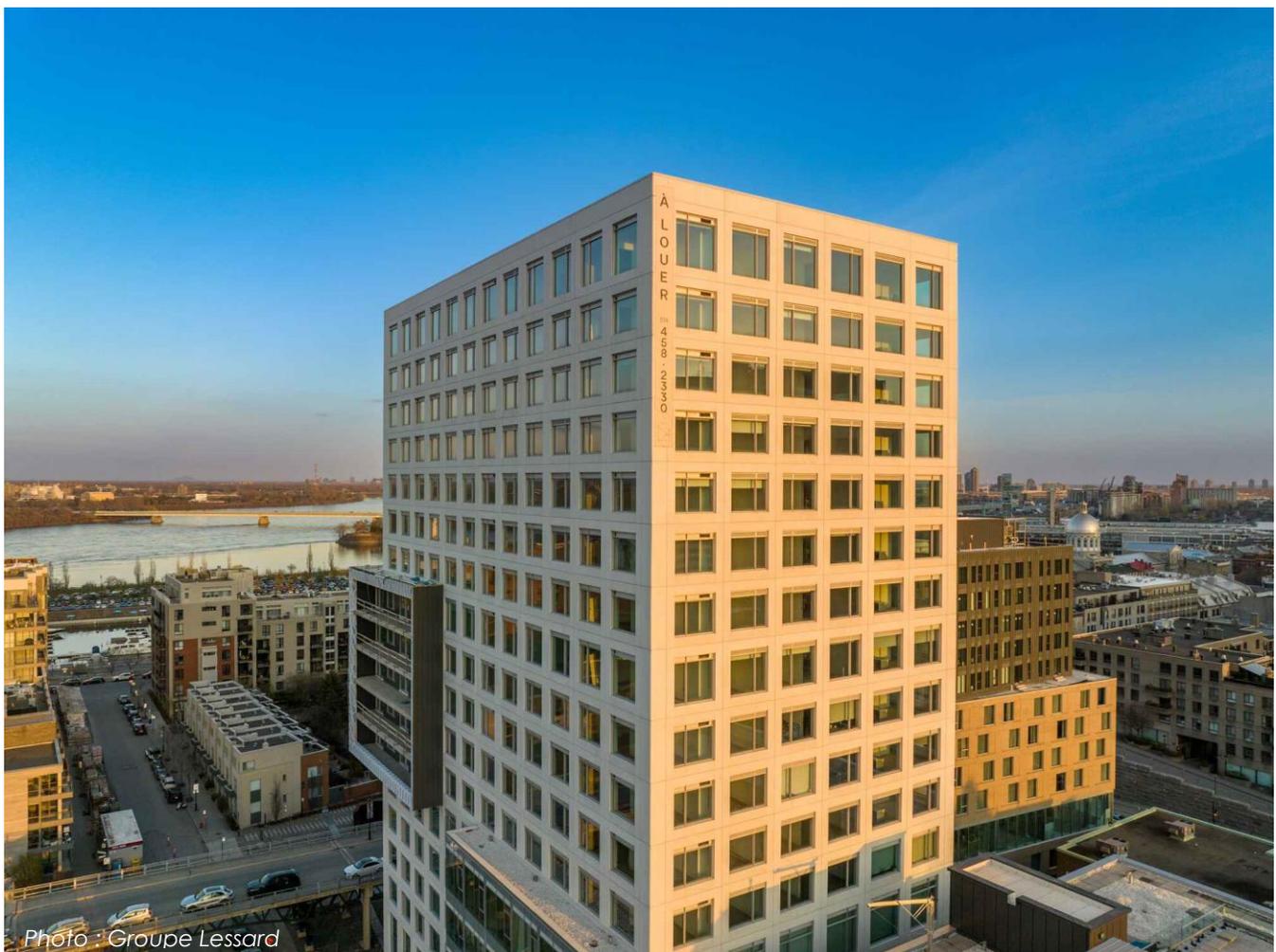
for adhesives, weather strips, gaskets, and PVC. Secondary materials are content between **aluminium production** (A1.1; 10%), **aluminium sheets and extrusion** (A3.1.1; 34%) and **waste processing** (C3; 56%). No secondary fuel or recovered energy were used by the manufacturers.

#### Waste production and water consumption

Waste categories were evaluated for the foreground processes (A3.1 **aluminium window assembly**) and for the products end-of-life. The disposal of non-hazardous was reported, as well as the disposal of a small amount of waste defined as hazardous according to Canadian laws. No radioactive waste was disposed of. **Aluminium production** (A1.1) is the submodule consuming by far the largest quantity of fresh water (66%) because of its high consumption of hydroelectricity.

## 5. ADDITIONAL ENVIRONMENTAL INFORMATION

The recyclable content is 21.2% (aluminium content).



## 6. GLOSSARY

### 6.1. Acronyms

<b>CSA</b>	Canadian Standards Association
<b>EPD</b>	Environmental Product Declaration
<b>GHG</b>	Greenhouse gas
<b>GWP</b>	Global warming potential
<b>ISO</b>	International Organization for Standardization
<b>kg CFC-11 eq.</b>	Kilogram of trichlorofluoromethane equivalent
<b>kg CO<sub>2</sub> eq.</b>	Kilogram of carbon dioxide equivalent
<b>kg N eq.</b>	Kilogram of nitrogen equivalent
<b>kg O<sub>3</sub> eq.</b>	Kilogram of ozone equivalent
<b>kg SO<sub>2</sub> eq.</b>	Kilogram of sulfur dioxide equivalent
<b>LCA</b>	Life cycle assessment
<b>LCI</b>	Life cycle inventory
<b>LEED</b>	Leadership in Energy and Environmental Design
<b>LHV</b>	Lower heating value
<b>MJ</b>	Megajoule
<b>m</b>	Metre
<b>m<sup>2</sup></b>	Square metre
<b>m<sup>3</sup></b>	Cubic metre
<b>NO<sub>x</sub></b>	Nitrogen oxide
<b>PCR</b>	Product category rules
<b>PE</b>	Polyethylene
<b>VOC</b>	Volatile organic compound

## 6.2. Environmental impact categories and parameters assessed

The **abiotic depletion potential for fossil resources** is an indicator extracted from the CML method using the Lower Heating Value (LHV) of the resource (in MJ/kg) to represent the energy depletion in MJ. Fossil fuels are non-renewable resources. Their extraction therefore contributes to their depletion (**MJ, LHV**).

The **acidification potential** indicator refers to the change in acidity (i.e. reduction in pH) in soil and water due to human activity. The increase in NO<sub>x</sub> and SO<sub>2</sub> emissions generated by the transportation, manufacturing and energy sectors are the main causes of this impact category. The acidification of land and water has multiple consequences: degradation of aquatic and terrestrial ecosystems, endangering numerous species and food security. The concentration of the gases responsible for the acidification is expressed in sulphur dioxide equivalents (**kg SO<sub>2</sub> equivalent**).

The **eutrophication potential** indicator measures the enrichment of an aquatic or terrestrial ecosystem due to the release of nutrients (e.g. nitrates, phosphates) resulting from natural or human activity (e.g. the discharge of wastewater into watercourses). In an aquatic environment, this activity results in the growth of algae which consume dissolved oxygen present in water when they degrade and thus affect species sensitive to the concentration of dissolved oxygen. Also, the increase in nutrients in soils makes it difficult for the terrestrial environment to manage the excess of biomass produced. The concentration of nutrients causing this impact is expressed in nitrogen equivalents (**kg N equivalent**).

**Freshwater consumption** parameter accounts for the imbalance in the natural water cycle created by the water evaporated, consumed by a system or released to a different watershed (i.e. not its original source). This imbalance can cause water scarcity and affect biodiversity. This indicator refers to the waste of the resource rather than its pollution. Also, it does not refer to water that is used but returned to the original source (e.g. water for hydroelectric turbines<sup>2</sup>, cooling or river transportation) or lost from a natural system (e.g. due to evaporation of rainwater). The net quantity of freshwater consumed is expressed as a volume of water in cubic metre (**m<sup>3</sup> of water consumed**).

The **global warming potential** indicator refers to the impact of a temperature increase on the global climate patterns (e.g. severe flooding and drought events, accelerated melting of glaciers) due to the release of greenhouse gases (GHG) (e.g. carbon dioxide and methane from fossil fuel combustion). GHG emissions contribute to the increase in the absorption of radiation from the sun at the earth's surface. These emissions are expressed in units of kg of carbon dioxide equivalents (**kg CO<sub>2</sub> equivalent**).

The **ozone depletion potential** indicator measures the potential of stratospheric ozone level reduction due to the release of some molecules such as refrigerants used in cooling systems (e.g. chlorofluorocarbons). When they react with ozone (O<sub>3</sub>), the ozone concentration in the stratosphere diminishes and is no longer sufficient to absorb ultraviolet (UV) radiation which can cause high risks to human health (e.g. skin cancers and cataracts) and the terrestrial environment. The concentration of molecules that are responsible for ozone depletion is expressed in kilograms of trichlorofluoromethane equivalents (**kg CFC-11 equivalent**).

The **photochemical smog formation potential** indicator covers the emissions of pollutants such as nitrogen oxides and volatile organic compounds (VOCs) into the atmosphere. They are mainly generated by motor vehicles, power plants and industrial facilities. When reacting with the sunlight, these pollutants

<sup>2</sup> Only the water evaporated by hydroelectric reservoirs is considered consumed.

create smog which can affect human health and cause various respiratory problems. The concentration of pollutants causing smog is expressed in kg of ozone equivalents (**kg O3 equivalent**).

The **secondary materials** parameter represents the quantity of recycled materials used to manufacture a product (**kg**).

The **use of renewable/non-renewable material resources** parameters represent the quantity of material made from renewable resources or non-renewable resources used to manufacture a product, excluding recovered or recycled materials. The quantity of these resources is reported in megajoules (**MJ, LHV**).

The **use of renewable/non-renewable primary energy** parameters refer to the use of energy from renewable resources (e.g., wind, solar, hydro) and non-renewable resources (e.g., natural gas, coal, petroleum). The quantity of primary energy used is expressed in megajoules, on the basis of the net calorific value of the resources (**MJ, LHV**).

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## 8. PARTICIPATING MANUFACTURERS

All participating manufacturers in this study operate from one manufacturing plant. The addresses shown below are both the head quarters and the manufacturing plants where the activities took place.



1010, Avenue Nordique,  
Québec (Québec), G1C 0H9  
<https://www.epsylon.ca>



2025, Boulevard Dagenais Ouest,  
Laval (Québec), H7L 5V1  
<https://www.lessard.ws/>



305, 12e Avenue,  
Richelieu (Québec), J3L 3T2  
<https://prevost-architectural.com>



4565, Avenue Georges-Bornais,  
Shawinigan (Québec), G9N 6T5  
<http://shalwin.ca>



668, 5<sup>e</sup> Avenue,  
Beauceville (Québec), G5X 1L6  
<https://stekar.com/en/>