CarbonOne

METHODOLOGY

VERSION 2.0

2025

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ACRONYMS

B2B: Business to Business
B2C: Business to Consumer
DQI: Data Quality Indicator
GHG: Greenhouse Gases
GWP: Global Warming Potential
LCA: Life Cycle Assessment
LCI: Life Cycle Inventory
LCIA: Life Cycle Impact Assessment
LUC: Land Use Change
PCF: Product Carbon Footprint
PEFCRs: Product Environmental Footprint Category Rules
GLEC: Global Logistics Emissions Council
IPCC: Intergovernmental Panel on Climate Change

1. CONTEXT AND GOALS

1.1. ABOUT CARBONONE

CarbonOne is a purpose-driven organization focused on fighting climate change in collaboration with Canadian Food and Beverage companies. Together we are building a more resilient and sustainable food system to feed Canadians and the world for generations to come.

We welcome questions from our users, other solution providers, or the broader community regarding our methodology. Our mission is to create trusted product carbon footprints backed by science and industry best practices, and we are excited to collaborate with all interested parties in this endeavour.

"the goal to accelerate decarbonization of value chains cannot be solved by individual actors in isolation. It requires an aligned, coordinated, and open approach, driven jointly by stakeholders across all industries and value chains"
(Partnership for Carbon Transparency, page 4)

1.2. PLATFORM GOAL

CarbonOne provides a simple and affordable solution in the form of an online platform to accurately measure, improve and communicate the Product Carbon Footprint (PCF) of food and beverage products.

A PCF generated by the CarbonOne platform is intended to be used for:

- Communicating GHG emissions of a product to customers, consumers and other stakeholders.
- Identifying emissions hotspots for the purposes of targeted emissions reductions
- Tracking improvements in product emissions over time.

Comparing footprints with other published PCFs is not recommended, as there may be variations in scope and methodology. In order to facilitate fair comparisons, both Life cycle Assessment (LCA) studies need to undergo a critical review process to assess their comparative claims.

2. SCOPE

2.1. ALIGNMENT WITH INTERNATIONAL STANDARDS

PACT
PARTNERSHIP FOR CARBON TRANSPARENCY

The CarbonOne methodology was designed to be in accordance with international standards for product carbon footprint calculations.

The recently published Pathfinder Framework by the Partnership for Carbon Transparency (PACT) (Pathfinder Framework [PACT], 2021) was a welcome addition to the family of international LCA standards, and our tool meets all requirements outlined in the document. The Pathfinder Framework builds on the following existing methods and standards:

- GHG Protocol Standards: Product Lifecycle Accounting and Reporting Standard (GHG Product Standard) and Corporate Value Chain (scope 3) Standard (GHG Scope 3 Standard) by WBCSD and World Resources Institute (Bhatia, Cummis, Draucker, et al., 2011)
- ISO Standards: 14044/40 (International Organization for Standardization [ISO], 2006), 14067(International Organization for Standardization [ISO], 2018)

We are also following where relevant:

- Product Category Rules (PCRs) by the International EPD System (PCR Library | EPD International, n.d.) and other operators
- Product Environmental Footprint Category Rules (PEFCRs) by the European Commission (European Commision, 2021)
- Any other product or sector-specific rules that are compliant with the GHG Protocol.

2.2. DECLARED UNIT

The declared unit for all CarbonOne PCF calculations is 1 kg of product and its packaging (packaging is not included in the 1 kg).

Example: A loaf of bread sold to consumers in a plastic bag will have a declared unit of 1 kg of bread plus (for example) 0.1 kg plastic bag.

When users provide product or ingredient information based on volume, they are converted into weight using either a density value entered by the user or an average density sourced from Health Canada.

Example: A milk product is sold in 1-litre glass bottles which weigh 0.250 kg. Milk has a density of 1.032kg/L. The declared unit is 1 kg of milk plus 0.242kg glass bottle (the bottle weight was “scaled down” to 1 kg of milk).

2.3. ATTRIBUTIONAL LCA

In accordance with international standards and industry best practices, our tool uses the attributional approach to conducting life cycle assessments.

An attributional LCA is a method used to evaluate the environmental impacts of a product by tracing the flows of energy and materials throughout its life cycle stages. An attributional LCA focuses on quantifying the environmental impacts directly associated with a product without considering any external factors or changes that may occur due to its production or use.

2.4. SYSTEM BOUNDARY

The life cycle of a food and beverage product is broken into the following stages:

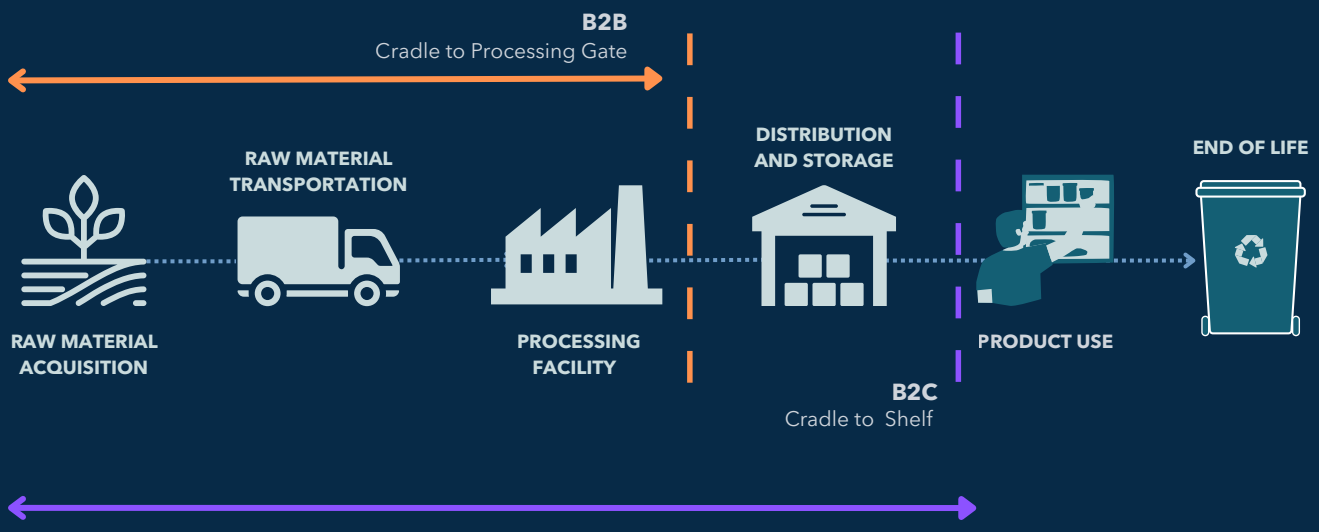
1) Raw Materials (production and preprocessing)
2) Raw Material Transportation
3) Processing Facility (B2B)
4) Distribution and Storage (B2C)
5) Product Use
6) End of Life

The CarbonOne platform accounts for stages 1 to 4 above. The user has the option to perform two analyses (see Figure 1):

1. "cradle to processing gate" (B2B), comprising all upstream and direct emissions of the product life cycle up to the reporting company's gate (Stages 1 to 3). This system boundary is in accordance with the Pathfinder Framework and can be used to share PCF results with other companies.
2. "cradle to shelf" (B2C), comprising all B2B stages as well as storage and distribution to the retail shelf (Stages 1 to 4).

The Product Use and End-of-Life stages are excluded from the PCF.

Figure 1: Life cycle stages included and excluded in the CarbonOne platform



2.4.1. PACKAGING

CarbonOne accounts for all primary and secondary packaging emissions associated with 1kg of a product. Packaging waste generated through raw material transport and product manufacturing is accounted for like other waste, as described in section 2.4.3 below.

Packaging is defined as virgin, recycled, or mixed. Following industry best practices for emission allocation of recycled products, all emissions of virgin material production are allocated to the initial user of the product. Recycled packaging materials only carry the emissions from the recycling process and subsequent legs of transportation.

2.4.2. TRANSPORTATION

All transportation emissions from raw material acquisition to product distribution are included in the PCF. Transportation emissions are calculated based on the mode of transportation between locations (road, sea, or air) and the storage requirements of each product or raw material.

CarbonOne uses a Global Logistics Emissions Council (GLEC) (Punte et al., 2019) approved intermodal freight calculator to determine the emissions of each leg of transportation in a product life cycle up until delivery at the retail location.

2.4.3. WASTE MANAGEMENT

CarbonOne accounts for waste generation and disposal during the raw material, transportation, and processing facility lifecycle stages.

Waste generated in agricultural and other upstream activities is provided in raw ingredient (secondary) data, following PCR standards and the World Food LCA Database methodology.

At the processing facility stage, we estimate a conservative predetermined waste factor and assume it is eventually sent to a landfill.

"Emissions resulting from waste treatment as part of the production process shall be calculated and included in the PCF of the company that manufactured the product and generated the waste. Emissions from the end-of-life stage of the products shall not be included in the PCF boundary."
-Pathfinder Framework

2.4.4. EXCLUDED ACTIVITIES

The following activities are excluded from CarbonOne's platform (unless materially significant):

- Manufacturing of production equipment, buildings and other capital goods
- Manufacturing of vehicles used for the transport of goods
- Business travel by personnel
- Travel to and from work by personnel
- Research and Development activities

Other activities may also be excluded if their contribution to the total PCF is negligible (e.g., a minor ingredient).

The following exclusion criteria provided by the Pathfinder Framework are used:

- Individual processes representing less than 1% of the total cradle-to-processing gate (B2B) emissions may be excluded.
- In aggregate, exclusions must represent less than 5% of the total cradle-to-processing gate emissions.

2.5. TIME BOUNDARIES

PCF results relate to a specific 12-month period determined by the user. Primary data entered by the user should represent that period.

We use the latest data from the IPCC (Allen et al., 2013) to calculate 100-year time horizon global warming potentials relative to CO_2.

2.6. ECONOMIC ALLOCATION

When allocation cannot be avoided through system expansion, and there are no established product or sector-specific allocation rules, we allocate emissions based on the economic value of the co-products.

Allocation means splitting multi-input/output processes into single output unit processes using physical, economic, or other criteria to partition the emissions between the studied product system and one or more product systems. When allocation is required, we apply economic allocation, meaning inputs and emissions to a product and its co-products are allocated based on the market value of each when they exit the common process.

2.7. IMPACT CATEGORY: CLIMATE CHANGE

The CarbonOne platform assesses the Global Warming Potential (GWP) impact category expressed in kg CO_2 equivalent (CO_2e). Final PCF results are disclosed as kg of CO_2e per kg of product.

Different greenhouse gases have different GWP values. Following international standards, we calculate the GWP over a 100-year time horizon (GWP100) for all emissions. The metric integrates the radiative forcing events over a 100-year time period and gives values relative to reference gas CO_2. Characterization factors are used to convert emissions to CO_2e.

Table 1: Global Warming Potential (GWP) characterization values relative to CO_2.
Source: Greenhouse Gas Protocol

INDUSTRIAL DESIGNATION OR COMMON NAME	CHEMICAL FORMULA	GWP VALUES FOR 100-YEAR TIME HORIZON		
		SECOND ASSESSMENT REPORT (SAR)	FOURTH ASSESSMENT REPORT (AR4)	FIFTH ASSESSMENT REPORT (AR5)
CARBON DIOXIDE	CO_2	1	1	1
METHANE	CH_4	21	25	28
NITROUS OXIDE	N_2O	310	298	265

2.8. DATA SOURCES

CarbonOne uses a mix of primary and secondary data sources.

1. Primary data (quantities of each raw material, processing facility emissions etc.) is information entered by the user and is specific to the company and the product analyzed.
2. Secondary data include emission factors and other information from various sources, such as public and private LCA databases, Environmental Product Declarations (EPDs) and Product Environmental Footprints (PEFs), industry associations, peer-reviewed journals, and government agencies.

2.8.1. REGIONALLY SPECIFIC DATA

The CarbonOne platform was designed specifically for the Canadian Food and Beverage Industry, and therefore we have prioritized building a database of regionally specific data that represents Canadian production systems.

While we strive to provide regionally specific data for all Canadian materials, we also use many globally or regionally averaged data. As our database grows, PCFs' accuracy and data quality will also increase.

3. LIFE CYCLE INVENTORY

3.1. PRODUCT CHARACTERISTICS

The life cycle model begins with the user entering specific product characteristics, such as product net and gross weights, product density and temperature control requirements. This information is used to normalize all model data to the declared unit (1 kg product) and for downstream life cycle stages requiring product-specific data. The user also specifies the reporting period that the product data refer to.

3.2. RAW MATERIALS

At the Raw Materials stage, the user enters data for all materials required to produce the finished product, including ingredients and packaging materials. All raw material information is normalized to 1 kg product.

The following types of raw materials are provided by the user:

- Ingredients
  - Unprocessed (e.g. wheat)
  - Pre-processed (e.g. wheat flour)

- Packaging materials
  - Primary (e.g. bottle)
  - Secondary (outside primary packaging to group products for shipping and handling, e.g. cardboard box)

3.2.1. MASS BALANCE

The CarbonOne platform performs a mass balance check at the ingredient level to ensure the accuracy of user-entered information.

The total weight of all the ingredients should be the same as, or more than, the final (net) weight of the product. The final product weight is usually lower than the total ingredient weight due to mass loss in production processes such as evaporation and dehydration; however, the user is alerted of extreme differences between the two.

3.2.2. WASTE MANAGEMENT

Waste in upstream stages (e.g. farm and/or processing) are accounted for in emission factors (secondary data). In addition, all raw material quantities (ingredients and packaging) are increased by a waste factor of 15% to account for waste at the transportation and processing facility stages (Poore & Nemecek (2018) and ReFED Insights Engine, (n.d.)).

3.3. RAW MATERIAL TRANSPORTATION

This is the first transportation stage and includes two legs:

- from the farm gate or material producer to a supplier
- from a supplier to the processing facility.

The user enters the location of each material origin and its temperature control requirements (ambient, refrigerated or frozen). The platform automatically calculates the most likely route, modes of shipping around the world (sea, air and road) and, eventually, carbon footprint using the emission factors from the Global Logistics Emissions Council (GLEC) (Punte et al., 2019).

3.3.1. ASSUMPTIONS

Waste in upstream stages (e.g. farm and/or processing) are accounted for in emission factors (secondary data). In addition, all raw material quantities (ingredients and packaging) are increased by a waste factor of 15% to account for waste at the transportation and processing facility stages (Poore & Nemecek (2018) and ReFED Insights Engine, (n.d.)).

3.4. PROCESSING FACILITY

In this stage, the user has two options:

- Enter Scope 1 (direct) and 2 (indirect) emissions of their processing facility (not for their entire organization) for the reporting period directly into the platform.
- Use the platform's Scope 1 and 2 emissions calculator.

The Scope 1 and 2 emissions are assigned to the product's declared unit (1 kg) based on the cost of producing the product compared to the total cost of all products made at the facility during the reporting period.

3.4.1. SCOPE 1 AND 2 EMISSIONS CALCULATOR

The Scope 1 and 2 emissions calculator include the following aspects:

- Fuels: Diesel, Natural Gas, Gasoline, Wood, Heating Oil, Propane
- Purchased CO_2
- Refrigerants
- Electricity

3.4.2. WASTE MANAGEMENT

We use a conservative waste factor of 15% (Poore & Nemecek (2018) and ReFED Insights Engine, (n.d.)) to calculate the waste quantities of raw materials (ingredients and packaging) at the transportation and processing facility stages. We make the following conservative assumptions:

- all solid waste is disposed of in a landfill as municipal waste
- the distance to the landfill is 200km (either from a transportation node or a processing facility)
- waste is transported to the landfill using an average-sized municipal garbage truck.

3.5. DISTRIBUTION AND STORAGE

The distribution and storage stage calculates the emissions from transporting the finished product and its packaging from the processing facility to end markets, including storage in distribution centres (third-party storage). The user enters all end market locations and corresponding product quantities shipped. The platform automatically calculates the most likely route, modes of shipping around the world (sea, air, and road) and, eventually, carbon footprint using the emission factors from the Global Logistics Emissions Council (GLEC) (Punte et al., 2019).

4. LIFE CYCLE IMPACT ASSESSMENT AND INTERPRETATION

4.1. PCF RESULTS

The PCF results are communicated to users in the following way:

- Total Cradle to Gate (B2B) PCF in kg of CO_2e per kg of product
- Total Cradle to Shelf (B2C) PCF in kg of CO_2e per kg of product

In addition, the platform calculates and displays in the form of a "life cycle map" the GHG emissions for each:

- life cycle stage
- activity (raw materials and their transportation, processing facilities and product distribution channels.

The platform also provides a product dashboard that allows the user to perform a hot spot analysis by navigating through the life cycle and seeing the contribution of each activity and life cycle stage in $kgCO_2e$ per kg of product as well as in percentage (%).

4.2. CARBONONE LABEL

Upon completion of the PCF, the user has the option to submit the PCF model for review. If CarbonOne approves the PCF results, the user has the ability to download the CarbonOne label, which displays the Cardle to Shelf (B2C) results and is intended to communicate the PCF to customers, consumers and other stakeholders.

5. GLOSSARY

Allocation: The process of dividing environmental burdens and impacts (GHG emissions in the case of product carbon footprints) among different products or co-products that are produced simultaneously from a single process or system.

Attributional LCA: The "bookkeeping" method of LCA that assesses the environmental impacts of a product by tracing and quantifying the greenhouse gas emissions and removals to the specific unit being studied and connecting the relevant processes throughout the life cycle of the product.

Biogenic Carbon: Carbon derived from living organisms or biological processes.

Carbon Footprint (CF): A measure of the total greenhouse gas emissions associated with a particular product or activity, expressed in terms of CO_2 equivalents.

Characterization Factor: A quantitative representation of the relative importance of a specific emission or resource use associated with a product or process

Consequential LCA: An LCA method that quantifies and compares the environmental impacts of alternative courses of action (i.e. an existing situation is compared with a new one that utilizes an alternative process or technology).

Cradle to Gate: An LCA model which includes upstream stages of a product life cycle, i.e. all stages from raw material extraction/production to processing facility gate.

Cradle to Grave: An LCA model which includes the whole product life cycle, i.e. all stages from raw material extraction/production to waste disposal.

Cradle to Shelf: An LCA model that includes all stages in a cradle-to-gate LCA, and adds the additional stage of product distribution (transit from processing facility to end market).

Declared Unit: The unit of analysis chosen for a product carbon footprint, which serves as the reference point to which all inputs and outputs are normalized.

Emission Factor: The amount of GHGs emitted, expressed as CO_2e, as a result of a specific activity or process.

Food Loss: Edible food that is discarded throughout the supply chain, from harvest or production up to (but not including) the point of retail sale.

Food Waste: Edible food that is discarded at the retail and consumer stages.
Functional unit: Unit of analysis used for cradle-to-grave LCAs, based on the function and performance of the studied product. The functional unit is a quantified performance measurement of a product.

Global Warming Potential (GWP): A measure of how much a particular greenhouse gas contributes to global warming over a specific time period (usually 100 years), relative to a reference gas (usually CO_2).

Land use categories: Forest land, cropland, grassland, wetlands, settlements and other lands.

Land Use Change: When demand for a specific land use results in a change in carbon stocks on that land due to a conversion from one land-use category to another or a conversion within a land-use category.

Impact Category: A grouping of environmental impacts related to a particular area of concern, such as climate change, acidification potential or human toxicity.

Interoperable: The ability for different systems, devices or software applications to exchange and use information with each other.

Platform: The CarbonOne online software tool that allows users to calculate the CF of food and beverage products.

Product Category Rule (PCR): A set of specific rules, requirements and guidelines for carbon footprint of a product quantification and communication for one or more product categories

Normalization: The process of scaling all activity and emission data collected in an LCA in relation to a reference value.

Unit of Analysis: Unit of analysis chosen for a carbon footprint to serve as the reference to normalize and quantify the inputs (materials and energy) and outputs (such as products, by-products and waste).

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