HowGood

HowGood Product Carbon Footprint Methodology

Version 2, *15 February, 2024*

Who is HowGood?

HowGood is an independent research company with the world's largest database on food product sustainability. With data and analysis for more than 33,000 ingredients, chemicals, and materials, HowGood helps leading food brands, retailers and investors improve their environmental and social impact. Through in-depth, ingredient-level insights on factors ranging from greenhouse gas emissions to animal welfare to labor risk, HowGood data powers strategic decision-making for the sourcing, manufacturing, merchandising, and marketing of sustainable products. Brands identify opportunities to improve sustainability, drive greater transparency, and empower their consumers to make higher impact purchases. Visit howgood.com for more information.

What is HowGood's approach to research?

HowGood has more than 17 years of research on global food supply chains. The team consolidates and analyzes findings from over 600 accredited data sources and certifications. These include a range of resources such as international frameworks, NGO guidance and standards reports, peer reviewed life cycle assessment studies, journal articles, academic conference proceedings and texts, aggregated commercial databases, targeted industry studies, NGO research, government publications, and news reports from reputable outlets. HowGood employs the most industry-recognized methodologies and incorporates the latest scientific research. Metrics and impact assessments are updated on an ongoing, iterative basis, making HowGood's platform the leading-edge tool for product sustainability. In turn, HowGood is able to provide impact assessments that are accurate, comprehensive, and the most up-to-date. Through HowGood's sustainability intelligence platform, Latis, we are able to scale this approach across products, brands, and the entire food industry.

What is HowGood's Carbon Life Cycle Module?

HowGood's **Carbon Life Cycle Module** has been designed according to the GHG Protocol Product Life Cycle Accounting and Reporting Standard (referred to as the Product Standard) guidance for GHG emissions measurement and reduction, as well as ISO 14067. It measures the carbon footprint of an individual product for its entire life cycle, from farm through processing, transport, manufacturing, product use and disposal.

HowGood's Carbon Footprint metrics at each stage of the carbon life cycle have been designed to guide customers on the GHG impacts of their products, but we recognize that a full and complete picture of these GHGs is not possible to achieve without custom tools and calculations. HowGood's Carbon Life Cycle Module provides a good approximation of attributable GHGs at each stage of a product's life and can guide customers on where to focus their efforts for emissions reductions. For this reason, we detail here the boundaries of our metrics, assumptions made, exclusions from this analysis, as well as some of the sources and reasoning behind these decisions.

This module was built with consumer packaged goods (CPG) companies in mind. We recognize that not all of the stages detailed below apply to every customer or scenario but for completeness we include each of them in this document.

What is HowGood's research methodology for calculating product carbon footprint?

HowGood's methodology for calculating GHG emissions is developed in accordance with the GHG Protocol.

1. **Data Collection:** HowGood draws on a diverse collection of data sources, including peer reviewed journal articles to calculate the CO_2e values used within the product carbon footprint. For each data source, HowGood performs a data quality assessment based on the age and comprehensiveness of the findings. For more information on how we score the quality of the emissions factors, please see Product Carbon Footprint Data Quality Ratings.

2. **Ingredient Mapping:** Once the data is collected and analyzed, HowGood conducts a proprietary process of mapping each ingredient to its source crop, animal or material. Using global import/export data and HowGood industry partnerships, HowGood then maps each source crop to its corresponding geographic location to account for the specific on-the-ground practices, impacts, and risks in each locale.

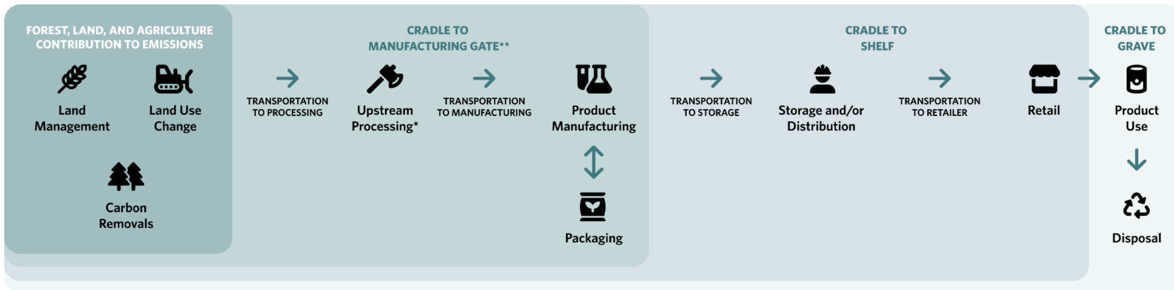
3. **Data Aggregation**: HowGood, to date, has mapped nearly every ingredient, chemical and material (33,000+ in total) in the CPG industry, including where and how it is produced. This mapping is used to aggregate data across geographic regions or ingredient categories and develop industry-average impact profiles for CO_2e across every ingredient.

Based on the ingredient mapping process, HowGood assigns a default location and corresponding industry-average profile for every ingredient in a product. If deeper levels of data granularity are available (from a specific supplier, industry partner, or publication), these specifics are applied.

How does HowGood calculate carbon emissions at each stage of the carbon life cycle?

HowGood calculates carbon emissions at each stage of the carbon life cycle, defined in the framework detailed below:

HowGood Carbon Life Cycle System Boundaries



*For ingredients with nested materials, this includes material manufacturing and any additional legs of transportation associated.
**Cradle-to-Manufacturing Gate (with packaging) includes packaging, if packaging details are provided.

No additional GHGs are included in the inventory. Weighting factors for delayed emissions, aircraft emissions, offsets and avoided emissions are not included in the inventory results.

Farm-to-Farm Gate

This stage covers GHG emissions due to the growing and harvesting of the material used to create an individual ingredient in a product. The material could be a crop, animal, mineral, or petroleum product. You will find this section is longer and more detailed than the others - this is because most of the emissions for food products comes from the farm. Because of this, our research team has prioritized detailed accounting methods for this stage of the product's life cycle.

Relevant Data Provided by Customers	Relevant data Used in Calculation(s)
● Ingredient ● Ingredient Weight ● Crop Sourcing Location	● On Farm GHGs from LCAs (EF) ● Ingredient Concentration (IC)

$$Farm\ to\ Farm\ Gate\ =\ EF\ *\ IC$$

HowGood asks the customer to provide a source location for the crop to provide the data. If the customer does not know the location where the crop was grown, HowGood uses a proxy for where the crop would be grown.

GHG impact is calculated as kilograms of CO_2 equivalent per kilogram of the primary commodity ingredient (kg CO_2e/kg) before any factory or processing emissions (Cradle-to-Farm Gate). On-farm processing, cooling or fermentation, and off-farm cleaning and sorting are included, when relevant to the production of that crop. GHGs are collected at farm gate, which includes all on-farm processes including primary inputs like fertilizer, pesticides, herbicides, and farm machinery fuel needs. Manufacturing of equipment, removals, and land use change are excluded from this value. Harvesting losses are included in the final yield of the product. Additional waste is excluded as it is rarely specified in agricultural LCA studies. Biogenic emissions and removals are assumed to be neutral for crops, with the exception of rice where biogenic methane emissions are included in the final value. Some biogenic emissions are included for animals.

Identifying sources for on-farm GHGs

Measurements are directly sourced from location and crop-specific Life Cycle Assessments (LCAs) from all over the world as well as environmental assessments. Some frequent journals we consult are: International Journal of Life Cycle Assessment, Journal of Sustainable Energy & Environment, Journal of CleanerProduction, Carbon Management (TandFonline), Agricultural Systems (elsevier), Sustainability (MDPI). When searching for the on farm GHGs for a crop and location, our research team prioritizes ISO 14044 LCAs from peer reviewed journals, which use geographically relevant data inventories. We also prefer studies to be within the past 5 years. These conditions cannot always be met but we use the most accurate and reliable data we have at the time and frequently update our database when better data becomes available.

Consistent with the GHG Protocol, carbon sequestration is not included at this time. If a supplier can provide specific measurements meeting the GHG Protocol requirements for removals, then sequestration (removals) can be included in a separate, future metric.

HowGood Origin Location Proxy Identification Process

There is not enough research done on the emissions from producing crops and animals outside of the main commodities and conventional methods. Because of this, we sometimes need to choose a proxy value if we can't find a paper that covers the specific material and location for which we are searching. Our decision process around finding proxy values is below.

Whenever a cradle-to-farm gate GHG value for an origin location is not available both in primary (e.g., LCA study) and secondary (e.g., collection of carbon footprint values) sources, a proxy value is necessary. In this case we use an internal proxying protocol to identify the most appropriate comparable data.

Option 1:

Our first option in selecting a proxy value is to look for an origin in a similar taxonomy (at least family, preferably genus or order); with similar crop type, yield, and agricultural management practices; and, in the same location or climatic/ecological region.

Option 2:

If an origin in a similar taxonomy, with comparable yield and in the same region cannot be found, we look for a similar product (e.g., similar botanical characteristics or same crop category) for the same location (preferable) or same climatic region.

Option 3:

Selecting a proxy value for the same product from a location belonging to a different region is our last option. When taking this route, we ensure that the original source has high quality data.

When choosing a proxy value, we always ensure that:

- The System Boundary is correct: ("cradle to farm gate")
- The functional unit is kg CO_2e/kg. We also specify whether it is fresh or dry weight (whenever this information is known)
- The production system is the conventional/dominant one for the origin location

Land Use Change

Land Use Change is measured in kilograms of carbon dioxide equivalent per kilogram of product (kg CO_2e / kg), and takes into account the following factors to assess emissions:

1. Land conversion or transition - Whether land conversion or transition has occurred within a landscape or jurisdiction over the preceding 20 years, in the form of deforestation or drained soils. We include pasture in our calculations, in addition to traditional cropland. This data is reported by 245 countries to the United Nations Food and Agriculture Organization (FAO).

    a. Product allocation factor: We take the shared responsibility approach to allocating emissions to any crop that was grown in a given jurisdiction that has experienced land use change. This approach attributes land use change emissions based on the percentage of land that a crop has occupied during a given year.

    b. Time discounting: We take a linear discounting (or “20 year decline”) approach to distributing emissions over the 20-year assessment period. This approach weights recent land use change heavier than it weights older land use change.

2. Crop location - We consider the jurisdiction of the crop’s location, at a national level.

3. Crop yield - We take into account the production yield of the crop in order to calculate land use change emissions per kilogram of product.

4. Ingredient concentration - We take into account the ingredient concentration value of the crop.

5. Regional feed mix - For animal-based ingredients, we consider the breakdown of pasture, soy and palm oil in the typical animal feed mixes regionally as well as the amount of feed required to produce the ingredient. For farmed aquatic species, we consider the soy in the typical diet as well as how much feed is required by the species. Regional feed mixes are typically reflective of the crops that are predominantly grown in a region, the affordability of crops and generally accepted animal welfare standards. As we increase the granularity of our Land Use Change assessment, we will add additional feed ingredients to reflect the variability of feed mixes throughout the world.

Relevant Data Provided by Customers	Relevant data Used in Calculation(s)
● Ingredient ● Ingredient Weight ● Crop Sourcing Location	● sLUC (EF) ● Ingredient Concentration (IC)

$$LUC = EF * IC$$

Carbon Removals

The impact of Carbon Removals is calculated as kilograms of CO2 equivalent per kilogram of the primary commodity ingredient. GHG removals include things like improving forest management practices, and enhancing soil carbon sequestration on working lands.

Carbon Removals are calculated following the submission of primary data from the customer, as specified by the GHG protocol. The primary data required for submission to HowGood is as follows:

Including removals in a GHG inventory requires primary data, ongoing monitoring (and reporting of removals as emissions if monitors are lost), traceability, and quantitative uncertainty estimates.

Stock Change accounting (for land emissions and removals) must be used and cover:

- Biomass
- Dead organic matter (DOM)
- Soil Carbon Pools

HowGood then uses the submitted primary data in the stock difference method as defined in the GHG protocol.

Ingredient Concentration:

One of the more complicated parts of GHG accounting across the entire food system is assessing the amount of raw material to allocate to a single ingredient produced. There are many different allocation methods using mass, value, or a combination of the two. HowGood uses a value and mass-based approach when it comes to allocation. We assess the value of the co- and by-products produced along with the weights of the final output and required raw inputs. This final value gives us our ingredient concentration. We also allow customers to input their primary data of how much raw material is required to create a final ingredient and use this value in other products. Our research team has assessed and created commodity trees across our 33,000+ ingredients to capture this raw material input to more accurately reflect the on farm emissions of an ingredient.

Our final on-farm, LUC, and carbon removal GHGs for an ingredient have the concentration value built into the final value our customers see in Latis.

Example:
It takes almost 7 times as much raw sugar cane to produce an equivalent amount of processed granulated sugar. So, our on-farm value for the raw sugar cane will be almost 7 times as high for the ingredient of granulated cane sugar.

Transportation to Processing

This stage covers the emissions due to transportation between the farm and ingredient processing locations. It also includes all transportation involved in pre-processing or manufacturing of inputs used in the final product, up to the final transportation to the manufacturing facility. This is relevant for complex products that contain nested or component products with intermediate transportation and manufacturing stages of the product life cycle.

Relevant Data Provided by Customers	Relevant Data Used in Calculation(s)
• Ingredient • Ingredient Weight • Crop Sourcing Location • Processing Location • Manufacturing location (of components)	• Distance between locations (300+ regions creating approximately 45,000 routes between them) • Mode of transportation (8 modes of transportation, each with 3 emissions factors) • Refrigeration requirements of the commodity (none, refrigerated, or frozen) • Ingredient concentration

$$Transportation = distance * EF * IC$$
$$where\ EF\ is\ driven\ by\ the\ refrigeration\ requirements\ and\ mode\ of\ transport$$

To create this metric, we multiply the weight-distance traveled by the emissions factor of the mode of transportation used. We use the 2019 Global Logistics Emissions Council (GLEC) standard, a GHG Protocol approved industry source for global transport emissions, as our source for emissions factors. Backhauling and empty trips are included in the GLEC emissions factors. Emissions factors are based on tonne-kilometers converted to kg-kilometers to normalize against 1 kg of product maintained in the HowGood database. HowGood customers don't always have visibility into the methods and distances of transportation between the farm and processing location so HowGood uses proxy data in line with specification from the GHG Protocol.

Transportation distances are calculated using arc distance calculations between state, country, or region centroids. For the United States (where most HowGood clients are located) distances traveled within the same state are set at half the distance across the average sized state. When the farm and processing locations are both within the United States, half the distance across the country is used.

Transportation within North America is assumed to be via truck. Transportation between countries outside of the United States is assumed to be via ship.

All transportation stages of the life cycle follow the above methodology, with the exception of this stage between farm and ingredient processing, which is the only transportation stage with ingredient concentration (IC) applied. If you are transporting X ton of corn to produce 1 ton of high fructose corn syrup, this stage multiplies the per kg transport emissions by X to reflect the amount of raw material transported.

As our clients and knowledge grows, HowGood updates this proxy data using more detailed modes, including regional data outside of the US. In addition, we plan to accept primary data from customers regarding exact locations of facilities with more exact distances and modes of transportation included.

Upstream Processing

Upstream Processing is an assessment of the energy it takes for the factory processing needs of a given ingredient and the likely fuel(s) needed for that process. Some ingredients are highly processed and require considerable energy to convert them from raw source material into a product that is ready for market. This stage also includes the manufacturing of nested products used as ingredients within a more complex, final product (hereafter referred to as "materials").

Relevant Data Provided by Customers	Relevant Data Used in Calculation(s)
● Ingredient ● Ingredient Weight ● Processing Location ● Material Manufacturing Location ● Material Manufacturing Type	● Processing and manufacturing type energy requirements by fuel (100+processing types) ● Grid mix at relevant locations (calculated across 300+ regions) ● Fuel type emissions factors (7 fuel types)

$$Upstream\ Processing\ =\ \sum_{fuels} fuel\ EF\ *\ energy$$

Ingredients are assessed for energy requirements of processing after they arrive at the factory and before combination into final products. For example, wheat flour would have all stages of milling's energy requirements assessed. That would include washing, grinding, sorting, and sifting, and bleaching when applicable. **Excluded from this energy value** are overhead operations, employee transportation, and manufacturing of the equipment. HowGood then uses the grid mix at the processing location to calculate the associated emissions due to the ingredient processing.

In many cases, as it is with some extracts, or supplements, multiple parts of the processing have been accounted for where industry standards can be applied (ex: for safflower extract applies alcohol solvent extraction/spray drying process). We account for each part of the processing where that information is provided or where we can safely make standard processing assumptions. Where this information is not available or assumptions cannot be safely made, and an ingredient has multiple processing types associated, the most energy intensive processing type is used.

Many times customers do not have insights into where their ingredients are processed. In this case, the location of the processing facility in relation to the farm location is determined by specific research on the nature of the crop, economic considerations, and processing specialization. Most crops are processed on or near the farm where they are grown. In this case, the same location as the farm will be chosen. There are a few specialty crops which tend to be processed away from the farm in specific regions. HowGood assesses which crops fall into this category by analyzing trade data and checking EcoInvent for references, where available.

We use region grid mix values to determine how much kg CO_2e is emitted per unit of energy when the likely fuel to be used in a process is electricity. We have these grid mix values for US states and most countries and are still developing methodology to calculate them for other compound regions (sub-national and supra-national). For fuel types other than electricity (e.g. direct burning of natural gas, coal, biomass etc), we use the carbon intensity of the applicable fuel. This enables our tool to give biogenic CO_2 emissions data required by many disclosure bodies as a separate metric. Biogenic emissions are not included in this value.

Transportation to Manufacturing

This stage covers the emissions due to upstream transportation of all materials to the final manufacturing facility.

Relevant Data Provided by Customers	Relevant Data Used in Calculation(s)
• Processing Location • Ingredient Weight • Manufacturing Location	• Distance between locations (300+ regions creating approximately 45,000 routes between them) • Mode of transportation (8 modes of transportation, each with 3 emissions factors)

See **Transportation to Processing (p.6)** for details.

Product Manufacturing

Manufacturing is an assessment of the energy it takes for the factory manufacturing needs of a given product.

Relevant Data Provided by Customers	Relevant Data Used in Calculation(s)
• Manufacturing Type • Manufacturing Location	• Energy required by Manufacturing Type (80+ manufacturing types) • Grid mix at Manufacturing Location (calculated across 300+ regions) • Fuel type emissions factors (7 fuel types)

$$Manufacturing = \sum_{fuels} fuel\,EF * energy$$

To calculate GHGs associated with product manufacturing, HowGood uses the product type/sales category and location of the manufacturing facility. Products are grouped into categories based on similar manufacturing processes. Customers can choose the manufacturing type which best describes their product, or HowGood can make a reasonable assumption based on the sales category.

The energy needs of each process or subprocess associated with the production line is collected/estimated from energy or environmental assessments and life cycle inventories as MJ/kg product per fuel type. They can include refrigeration and lighting but **exclude overhead operations, employee transportation, and manufacturing of the equipment**. We base our estimates on the manufacturing category of the product (frozen entree, cold case milk, chips & snacks, juice beverages, etc). For example, the manufacturing energy required to make yogurt or kefir would include mixing of ingredients (fruit, etc), culture/fermentation process, sterilization of equipment, sterilization of jar/vessel, heat sealing process, and refrigeration.

HowGood then uses the total energy consumption and the carbon intensity of electricity at the manufacturing location and/or emissions factors of the other fuels to calculate the associated emissions due to the product manufacturing.

When customers have conducted product LCAs and can provide manufacturing energy data with enough granularity to map to our inclusions and exclusions, we can ingest that data and create a customer and product(s) specific manufacturing type. When customers seek a third party verification of a PCF, they must submit manufacturing data for the relevant products.

See **Biogenics** for information on food waste during manufacturing.

Product Packaging

HowGood requests the specifics of each layer of packaging as well as the recycled content of the materials. The weight of the material, the number of times the packaging can be re-used, and the number of consumer units within the packaging layer all contribute to the final packaging emissions.

Relevant Data Provided by Customers	Relevant Data Used in Calculation(s)
• Packaging weight • Consumer units • Number of uses	• Manufacturing region • Packaging material energy requirements by fuel (40+ packaging materials) • Net weight of product • Weight of packaging

$$Packaging = \frac{1}{product\ weight} \sum_{packaging\ materials} (transportation + \sum_{fuels} fuel\ EF * energy) * packaging\ weight/uses/consumer\ units$$

Packaging material energies capture the energy requirements and likely fuels from extraction through production. Transportation of packaging materials to the manufacturing location is included. Transportation of waste is excluded at this time. Biogenic emissions from combustion of biomass materials are calculated separately and not included in the packaging emissions stage. Other biogenic emissions and removals are assumed to be neutral.

The recycled content method (also referred to as the cut-off or the 100-0 method) is used to allocate emissions due to recycling. For product footprint boundaries that exclude end of life emissions, recycled content is the appropriate method, per GHG Protocol Product Standard Box 9.3. When choosing to produce a cradle to grave footprint in Latis, the recycled content method is still used as end of life recycling rates are uncertain and highly variable.

Definitions of the packaging fields available are as follows:

Field	Description / Definition
Packaging Unit Type	The following options are available: 1. **Consumer Unit** - The individual product unit that the end customer consumes after purchase. 2. **Selling Unit** - The packaged product that the end customer purchases from a retailer. 3. **Tray / Crate** - The shipping box or container that the manufacturer or distributor ships the product to the retailer in. 4. **Pallet / Transportation Unit** - The pallet or other transportation unit that the manufacturer or distributor uses to stack the trays/crates/shipping boxes onto for transport.
Consumer Units	The number of Consumer Units per packaging layer.
Material	The material the selected Packaging Unit is made from. Choose from 80+ packaging material options.
Region	The region in which the Material was manufactured. It takes into account the manufacturing type of that particular layer of packaging, and the grid mix in the region in which it was manufactured.
Material Weight	The weight of the packaging layer (kg/unit of packaging).
Uses	The average number of times that Packaging Unit Type can be reused.

Transportation from Manufacturing to Storage (Optional)

For those products that will travel to a warehouse or distribution center between being manufactured and going to retail shelves, we account for emissions due to transportation between the manufacturing facility and the storage facility.

Relevant Data Provided by Customers	Relevant Data Used in Calculation(s)

- Manufacturing Location - Warehouse Location	- Distance between locations (300+ regions creating approximately 45,000 routes between them) - Mode of transportation (8 modes of transportation, each with 3 emissions factors) - Refrigeration requirements of the product

See **Transportation to Processing (p.6)** for details.

Storage/Distribution Center (Optional)

Keeping products in a storage or distribution location prior to retail impacts a product's total emissions.

Relevant Data Provided by Customers	Relevant Data Used in Calculation(s)
- Warehouse Location - Product Cold Storage Requirements	- Grid Mix at Warehouse Location (calculated across 300+ regions) - Warehouse Cold Storage Energy (constants)

$$Storage = energy * EF$$

We are including cold storage emissions and **excluding emissions related to other overhead costs** at the distribution center or storage facility. HowGood recognizes that a product may have many storage or distribution centers. However, since our final unit is kg CO_2e/kg final product, we ask customers to choose a single location that best represents their data, and we ask if their product requires refrigeration.

Storage is assumed to be 30 days for refrigerated products, and the storage time for frozen products was unspecified in the source.

Transportation to Retailer

This stage covers the emissions attributed to a product being transported to the retailer. If a product has spent time at a distribution or warehouse facility, the starting point for this journey is considered to be the location of said center. If not, we assume the product has traveled directly from the manufacturer to the retailer.

Relevant Data Provided by Customers	Relevant Data Used in Calculation(s)
- Manufacturing Location **OR** Warehouse Location - Retail Location - Product Cold Storage Requirements	Distance between locations (300+ regions creating approximately 45,000 routes between them)

	• Mode of transportation (8 modes of transportation, each with 3 emissions factors)

See **Transportation to Processing (p.6)** for details.

Retailer

A product's next stage is to go to the retailer to be purchased by the user.

Relevant Data Provided by Customers	Relevant Data Used in Calculation(s)
• Retail Location • Product Cold Storage Requirements	• Grid Mix at Retail Location (calculated across 300+ regions) • Retailer Cold Storage Energy (constants)

$$Retailer\ = energy * EF$$

A significant amount of emissions at this stage are due to refrigerants and energy required for cold storage. Other emissions at the retailer are due to overhead operations which we have excluded from our analysis, consistent with the GHG protocol methodology. For this reason, in line with the GHG Protocol, we utilize only the energy required for cold storage at the retailer stage. This energy is combined with the average grid mix of the retailer location to calculate the final emissions at this stage. HowGood recognizes that retailers are rarely in a single location. However, since our final unit is kg CO_2e/kg final product, we ask customers to choose a single region that best covers the area where a product is sold. Out of scope for this analysis is the emissions due to a customer traveling to and from the retailer. Waste at the retailer is also excluded.

The emissions for refrigerated or frozen storage at the retailer was taken as an average value for meat and vegetables. We assume an average storage time of 30 hours for chilled products and 96 hours for frozen products.

Product Use

The penultimate stage of a product's life cycle (and the reason it was produced in the first place) is to be consumed. Emissions from the use phase of a product can vary greatly depending on if it needs cold storage as well as the length and method required for cooking, if necessary. To gain this knowledge for a broad customer base we ask the customer only if their product requires refrigeration and if it requires cooking.

Relevant Data Provided by Customers	Relevant data Used in Calculation(s)
• Retail Location • Product Cold Storage Requirements • Product Cooking Requirements	• Grid Mix at Retail Location (calculated across 300+ regions) • Consumer Use Cold Storage Energy (constants)

	• Consumer Use Cooking Energy (constants)

HowGood uses average values for refrigeration and cooking energy needs. We assume chilled products were stored for 4 days and frozen products were stored for 82 days. Assuming a product will be used where it is sold, we then combine this energy required with the grid mix to gain the final emissions calculation. We assume no waste of the consumable product. Cooking energy is an area of planned improvement.

Disposal

Once a product has been consumed, the disposal of the associated packaging must be examined.

Relevant Data Provided by Customers	Relevant data Used in Calculation(s)
• Packaging Material(s) • Packaging Shape(s)	• Packaging material EFs (disposal) (20+ materials) • Packaging shape as ratio to overall packaging (20+ shapes) • Product to packaging ratio (constant)

Various packaging materials and amounts have different associated emissions. Using the recycled content method specified in the GHG Protocol, we calculate these disposal GHGs using the packaging shape, material, and ratio information collected from the packaging phase. Consistent with the GHG Protocol, we assume all materials are disposed of via landfill. This is a desired area of improvement as regionality can have a large impact on how products are disposed of.

Out of scope for this phase are the emissions due to transportation of the waste and overhead costs of the waste/recycling facilities.

Biogenic Carbon

Biogenic carbon emissions are carbon released as carbon dioxide or methane from combustion or decomposition of biomass or biobased products. Per ISO 14067, we calculate biogenic carbon emissions separately from fossil based emissions. Biogenic carbon is accounted for in two main areas:

- Combustion of biomass fuel
- Emissions of food waste during manufacturing

Combustion of biomass fuel:

For any processing, manufacturing, or packaging processes which use a biomass fuel, biomass emissions are calculated in the same way as fossil based carbon:

$$\text{Biogenic } CO_2e = \text{biomass fuel required per kg of product} \times EF$$

Biogenic emissions from food waste:

During manufacturing, there is typically food waste. Where customer data is available, we can account for the exact loss in the system. When customer data is not available, we assume 5% loss of ingredients during product manufacturing. 42.6% of the loss is assumed to be anaerobically digested and 2.5% assumed to be landfilled (Source EPA). The emissions from decomposition are calculated as:

$$\text{Biogenic } CO_2e = \sum (\text{total mass of waste} \times \text{proportion of total waste being treated by waste treatment method} \times \text{emission factor of waste treatment method})$$

Biogenic carbon calculations are rolled up into a single value for 2 system boundaries: cradle to gate and cradle to shelf.

Cradle to Gate biogenic emissions = (processing biogenic emissions + manufacturing biogenic emissions) * 1.05 + manufacturing waste emissions

Cradle to shelf biogenic emissions = (processing biogenic emissions + manufacturing biogenic emissions) * 1.05 + manufacturing waste emissions + packaging biogenic emissions

Any other biogenic emissions not mentioned in this phase or previous phases are excluded, including biogenic emissions on farm (see farm to farm gate section for more details).

Version History

Version	Date	Author	Validator
V2	2024–02-16	Mike Kaminski	Lizz Aspley
V1	2023-09-15	Mike Kaminski	Lizz Aspley

Methodology Change Log - February 2024

- Data quality scoring added for all stages of the carbon life cycle from cradle to shelf, and data quality scoring for the overall product at the cradle-to-manufacturing-gate and cradle-to-shelf boundaries
- Source date years added for all stages of the carbon life cycle from cradle to shelf
- Biogenic emissions included in PCFs. These are included and reported within the cradle-to-manufacturing-gate and cradle-to-shelf boundaries, and separated as standalone values in PCF reports
- Manufacturing waste accounted for in Latis

- Primary manufacturing data collection & specific manufacturing type integration when customers want third party verified PCFs
- Packaging metrics functional unit harmonized with non-packaging carbon metrics
- Packaging weight included in transportation