Methodology of Corporate Carbon Footprint Calculation

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Abbreviations

CCF	Corporate carbon footprint
CoC	Chain of custody
EF	Emission factor
FY	Fiscal year
GHG	Greenhouse gas
GHGP	Greenhouse Gas Protocol
GHGP-LSRG	Greenhouse Gas Protocol Land Sector & Removals Guidance
GWP	Global warming potential
LCA	Life cycle assessment
LUC	Land use change
PCF	Product carbon footprint
SBTi	Science Based Target Initiative
USEEIO	US Environmentally-Extended Input-Output
WFLDB	World Food Life Cycle Assessment Database
WRI	World Resources Institute
WBCSD	World Business Council For Sustainable Development

Contents

1 Introduction

Barry Callebaut seeks a sustainability leadership position in its industry and updated its climate strategy and Science Based Targets initiative (SBTi) commitment to the most recent accounting standards and best practices. Committing to a climate strategy and to SBTi requires the setting of a robust greenhouse gas (GHG) emissions baseline. Emissions from Land Use Change (LUC) in cocoa farming are the most relevant driver of Barry Callebaut's climate impact.

During 2023 and 2024, Barry Callebaut commissioned Quantis, supported by EY denkstatt, to perform a recalculation of the corporate GHG emissions for fiscal year (FY) 21/22 (new base year for SBTi commitments) and FY 22/23, aligned with the requirements of the Greenhouse Gas Protocol (GHGP) reporting standards. A full Scope 1, 2 & 3 assessment has been performed with the emission factors (EFs) from recognized databases.

The following document summarizes the most important methods, data sources, and calculation steps used for Barry Callebaut's corporate carbon footprint calculation.

2 Scope of the corporate carbon footprint

2.1 Compliance with international standards

According to ISO 14064 and the GHGP, it is fundamental to follow certain key principles when accounting and reporting GHG emissions. In Barry Callebaut's corporate carbon footprint (CCF), we follow the principles of these standards. The GHGP formulates five principles as presented in Table 1 (WRI and WBCSD, 2004).

Principle	**Definition**
Relevance	Ensure the GHG inventory appropriately reflects the GHG emissions of the company and serves the decision-making needs of its users – both internal and external to the company.
Completeness	Account for and report on all GHG emission sources and activities within the chosen inventory boundary. Disclose and justify any specific exclusion.
Consistency	Use consistent methodologies to allow for meaningful comparisons of emissions over time. Transparently document any changes to the data, inventory boundary, methods, or any other relevant factors in the time series.
Accuracy	Ensure that the quantification of GHG emissions is systematically neither over nor under actual emissions, as far as can be judged, and that uncertainties are reduced as far as practicable. Achieve sufficient accuracy to enable users to make decisions with reasonable assurance as to the integrity of the reported information.
Transparency	Address all relevant issues in a factual and coherent manner, based on a clear audit trail. Disclose any relevant assumptions and make appropriate references to the accounting and calculation methodologies and data sources used.

Table 1: Principles to ensure the quality of a study according to the Greenhouse Gas Protocol

2.2 Greenhouse Gas Protocol scopes

The CCF of Barry Callebaut is aligned with the GHGP, which categorizes GHG emissions into three scopes according to their underlying activity (WRI and WBCSD, 2004).

Scope 1 emissions are direct GHG emissions resulting from emission sources which are controlled or owned by Barry Callebaut. This especially includes the combustion of fossil fuels (i.e. gas and oil).

Scope 2 emissions are indirect GHG emissions associated with Barry Callebaut's purchase of electricity, steam, heat, or cooling.

Scope 3 includes all other emission sources in a company's value chain (upstream and downstream) and is subdivided into fifteen specific categories.

The following nine Scope 3 categories are included in the CCF due to their significance:

- 3.1 Purchased goods and services
- 3.2 Capital goods
- 3.3 Fuel- and energy-related activities
- 3.4 Upstream transportation and distribution
- 3.5 Waste generated in operations
- 3.6 Business travel
- 3.7 Employee commuting
- 3.10 Processing of sold products
- 3.12 End-of-life treatment of sold products

The remaining Scope 3 categories are not evaluated as they are not significant for Barry Callebaut, namely:

- 3.8 Upstream leased assets
- 3.9 Downstream transportation and distribution
- 3.11 Use of sold products
- 3.13 Downstream leased assets
- 3.14 Franchises
- 3.15 Investments

Figure 1 provides a visual overview of the CCF's scope: included categories are highlighted with green dots, excluded categories with red dots. Each scope and category is described in more detail in the following chapter 3.

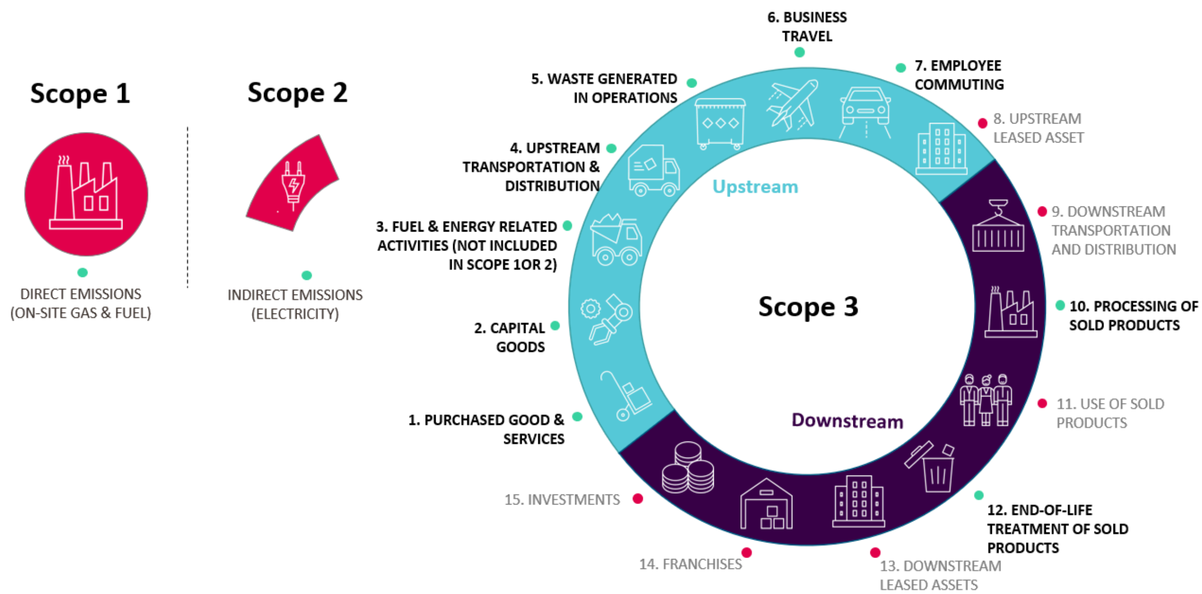

Figure 1: Greenhouse Gas Protocol scopes and categories covered in the CCF.
Inclusions = green dots; Exclusions= red dots.

3 General methodology

3.1 Organizational boundaries and value chain structure

The GHGP distinguishes between two basic approaches to consolidate emissions when calculating a CCF: A) an equity share approach and B) a control approach.
Under the control approach, a company accounts for 100% of the GHG emissions from operations under its control. It does not account for GHG emissions from operations that are relevant but which the company cannot control. Under the equity share approach, a company accounts for GHG emissions from operations according to its share of equity in the operation.

For Barry Callebaut's CCF, the **control approach** has been chosen. Barry Callebaut's CCF considers the following organizational and reporting boundaries [1]:

Within Barry Callebaut's organizational boundaries

- Barry Callebaut's cocoa factories, chocolate factories, and specialty factories
- Office energy in headquarters in Zurich, Chicago, and Singapore
- All business flights

Upstream value chain within reporting boundaries

- Cocoa farming, including impacts of land use change (LUC)
- Production of non-cocoa ingredients (sugar, dairy, oils & fats, nuts, specialties and others), including impacts of LUC
- Transport of cocoa beans, cocoa & chocolate products, and non-cocoa ingredients, including transport of products between Barry Callebaut's factories, as well as transports of products to customers, which are organized and paid by Barry Callebaut, but not in vehicles owned or leased by Barry Callebaut
- Processes to extract, refine, and deliver raw materials, fuels, and electricity
- Production of packaging for cocoa beans, cocoa products, non-cocoa ingredients, and industrial chocolate

Downstream value chain within reporting boundaries

- Recovery and disposal of packaging used for industrial chocolate
- Processing of cocoa and chocolate products sold by Barry Callebaut in customers' facilities

[1] This list only includes emission sources that have a significant impact on emission scopes 1, 2 and 3, i.e. contribute 5% or more to the respective scope emissions.

3.2 Collection of activity data

Barry Callebaut has built and collected multiple internal datasets of activity data over the past years. Furthermore, the recalculation and base year update required additional datasets that were newly collected.

The data collection and processing approach for Barry Callebaut's CCF is as follows:

1) **Data extraction from existing datasets**
    a) Cocoa beans sourced & processed and purchased cocoa products volumes
    b) Geospatial/ polygon data of farming plots in Côte d'Ivoire, Ghana, Cameroon and Indonesia (for direct cocoa sourcing)
    c) Non-cocoa ingredients volumes
    d) Packaging production for cocoa beans, cocoa products, non-cocoa ingredients and chocolate products
    e) Transport of products to Barry Callebaut factories, intercompany transport and customer deliveries
    f) End-of-life scenarios for packaging products
    g) Energy and electricity consumption at factories
    h) Energy and electricity consumption at Barry Callebaut offices
2) **New data collection**
    a) Business flights
    b) Employee commuting
    c) Capital goods
    d) Geospatial/ polygon data of farming plots in Brazil, Ecuador & Nigeria (for direct cocoa sourcing)
3) **Completeness & plausibility check of provided raw data**
4) **Processing of raw data & integration into the CCF model**
5) **Data validation checks**
6) **Q&A iterations with data owners for clarification**

3.3 Global warming potentials

Climate change impacts are commonly expressed as mass of CO_2-equivalents (tCO_2e). For our inventory, the currently most widely used impact method from the International Panel on Climate Change's sixth assessment report (IPCC AR 6) is applied (IPCC, 2021).
The global warming potential (GWP) comprises the cumulative radiative forcing of a particular GHG compared to that of CO_2 over 100 years. Different GHGs contribute differently to radiative forcing when released into the atmosphere (Table 2).

Gas	GWP (100 years)
Carbon Dioxide (CO_2)	1
Methane (fossil)	29.8
Methane (biogenic)	27
Nitrous oxide	273
HFC-134a	1'530
CFC-11	6'230

Table 2: Global warming potential of considered greenhouse gasses as per IPCC AR6

3.4 Emission factors

Well-recognized databases are used to model GHG emissions of goods, products and services. For cocoa beans and products, the World Food Life Cycle Assessment Database (WFLDB) is prioritized, and if needed, production EFs from the ecoinvent database are applied. For non-cocoa ingredients, custom emissions factors are generated by EY denkstatt and the Barry Callebaut team, based on the databases of WFLDB, Agrifootprint and ecoinvent, as well as various LCAs and PCF studies. The non-cocoa ingredient EFs have been reviewed by Quantis to align with SBTi and GHGP requirements. A description of the default databases used across the product categories and activities of Barry Callebaut is given in Table 3.

Database	Product categories	Description	Database version
Agrifootprint	Non-cocoa ingredients	https://blonksustainability.nl/tools-and-databases/agri-footprint	6.3
UK Department for Environment, Food & Rural Affairs (DEFRA)	Employee commuting	https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2020	2020 dataset
ecoinvent	Energy, electricity, non-cocoa ingredients, all other products and activities	https://ecoinvent.org/	v3.4 and 3.9
Global Feed LCA Institute (GFLI) database, BRLUC	Non-cocoa ingredients (dairy, cane sugar and soy lecithin)	https://globalfeedlca.org/ https://brluc.cnpma.embrapa.br/	2.0
US Environmentally-Extended Input-Output (USEEIO)	Monetary data (USD)	https://www.epa.gov/land-research/us-environmentally-extended-input-output-useeio-models	v1.1 - 2017
World Food Life Cycle Assessment Database (WFLDB)	Cocoa beans and cocoa products, non-cocoa ingredients	https://quantis.com/who-we-guide/our-impact/sustainability-initiatives/wfldb-food/	v3.8

Table 3: Data sources of emission factors

Currency conversion & adjustment for inflation

The EFs from the US Environmentally-Extended Input-Output (USEEIO) database (2017) are available in USD 2017. To account for inflation and currency exchange from 2017 USD to 2022 USD, a conversion factor is included.

4 Scope 1 - Direct emissions from energy consumption

Description: This category includes all direct GHG emissions generated by the combustion of fuels (i.e., natural gas and fuel oil) at Barry Callebaut's own sites i.e. offices and factories. It also includes fuel combustion for onsite steam generation. Fuel combustion by owned and leased vehicles is considered immaterial and excluded from the footprint. Thus all material transport related emissions are reported within scope 3.
Data is collected for each factory and region. Data for offices is based on the assumption[2] of 69.7 kWh/m^2 of heat consumed on the average and coupled with data on areas for Barry Callebaut's three biggest office sites (Zurich, Singapore, Chicago). Fugitive emissions from refrigerants are immaterial and excluded from the inventory. Renewable heat generation from burning cocoa shells is considered as carbon-neutral.

Modeling approach: Fuel consumption data is coupled with emissions factors from ecoinvent (v3.9) based on the type of fuel. The Scope 1 GHG emission shares were derived from these EFs by using the physical carbon content, density and net calorific value as well as quantities of CH_4 and N_2O in exhaust fumes.
Impacts of separating cocoa bean shells after bean roasting are covered by the electricity consumption at the factories.

[2] The typical value for electricity consumed in offices is derived from "denkstatt (2022): Average energy consumption of office areas in Vienna." 50,000 m^2 of office area were investigated, with a typical mix of old and new buildings.

5 Scope 2 - Indirect emissions from electricity consumption

Description: This category includes all direct GHG emissions generated by the purchase of electricity at Barry Callebaut's own sites i.e. offices and factories.
Data is collected for each factory and region. Data for offices is based on the assumption[3] of 83.7 kWh/m^2 electricity consumed on the average and coupled with data on areas for Barry Callebaut's three biggest office sites (Zurich, Singapore, Chicago).

Modeling approach: A market-based approach is used to calculate emissions from electricity consumption. For calculating market-based EFs for factories in a liberalized electricity market, factory-specific energy mixes (data from supplier invoicing) are used to calculate site-specific emission factors for electricity. Contracts on using renewable electricity are considered. Scope 2 EFs for electricity production from specific fossil fuels and for calculating the site-specific emission factors were extracted from ecoinvent datasets (v3.4).
Emissions from electricity consumed in the offices in Zurich, Chicago, and Singapore were calculated from office areas and typical electricity consumption per m^2 and year. Due to the small contribution to scope 2 emissions, electricity-related emissions from offices were calculated using location-based EFs from ecoinvent datasets (v3.9).

[3] The typical value for electricity consumed in offices is derived from "denkstatt (2022): Average energy consumption of office areas in Vienna." 50,000 m^2 of office area were investigated, with a typical mix of old and new buildings.

6 Scope 3 - Indirect emissions

6.1 Category 3.1: Purchased goods and services

This category includes all upstream (i.e., cradle-to-gate) emissions from the cultivation/production of cocoa beans, cocoa products, ingredients as well as their packaging, that are purchased by Barry Callebaut.

6.1.1 Cocoa beans and cocoa products

Modeling approach: Cocoa farming is modeled using emissions factors from the WFLDB v.3.8, using country-specific datasets where applicable or, alternatively, global average data.

Land management emissions are included in the inventory and cover the following:

- Fertilizer input and application impact
- Irrigation
- Pesticides production and application impact
- Machinery use / farm operations
- Seedlings
- Any on-farm processing
- On-farm biowaste treatment

Land Use Change (LUC) is calculated with a combination of plot-level LUC (dLUC) emission factors and - where no plot-level traceability is available - statistical country-level LUC (sLUC) EFs to approximate dLUC. For Ghana, the sLUC EFs were calculated leveraging a cocoa cultivation layer. For the remaining countries, the sLUC EFs were approximated with the dLUC EF calculated over the plots for that country. Volumes for which plot data is available account for 46% (Barry Callebaut globally weighted average) of total cocoa beans and 0% of total cocoa products purchased.

- Common data for dLUC and sLUC EFs:
    - Year of biomass loss, remote sensing, 30x30m resolution, 20 years back (Hansen et al., 2013)
    - Lost biomass density, remote sensing, 30x30m resolution, considering all carbon pools in the year of loss (Harris et al., 2021, Version 1.2.3)
    - Linear discounting over 20 years, weighing deforestation close to the assessment year higher than deforestation further away from the assessment year
- Data only for dLUC: Barry Callebaut's polygon data for farming plots

- Data only for sLUC: Cocoa cultivation layer of the year 2020, 10x10m resolution (Kalischek et al., 2023)

Cocoa FLAG removals are calculated for shade trees which are newly introduced to cocoa farming plots by Barry Callebaut. The resulting carbon removals are thus considered to be additional to what would have happened without our engagement and reported as improvements in Barry Callebaut's Scope 3 FLAG inventory. The removals are calculated annually as the real removals that occurred during the reporting year (also referred to as "ex-post" approach). The following data sets / assumptions are applied:

- Datasets of distributed shade tree seedlings for each year, including relevant species
- Survival rates of shade trees, annually monitored in a sampled approach
- Carbon content of relevant shade tree species over project lifetime (20 years), based on best available scientific literature, validated through in-field data collection
- Detection of potential removals as declining survival rates within the same planting year cohort over time
- Deduction of reversals from reported removals in the reporting year the reversals occur
- Withholding of a buffer in order to safeguard against future reversal risks. The withholding buffer is the difference between the calculated removals and the reported removals in any given year. Future reversals can be addressed by canceling removals in the withholding buffer.
- Approach and calculations are annually verified by SustainCERT.

6.1.2 Non-cocoa ingredients

For non-cocoa ingredients, purchased volumes and a broad set of EFs are used to calculate their emission contribution to the CCF.

Volume data

The activity data (volumes purchased) of non-cocoa ingredients are split into categories and subcategories. The categories Dairy, Sugar, and Oils & Fats contribute more than 90 % to the total carbon footprint of non-cocoa ingredients. Therefore, there is further differentiation within these categories by subcategories (in blue). Within these subcategories a further differentiation by country of origin, and/or supplier, and/or certification is made.

Ingredient category	Subcategory	Ingredient category	Subcategory
Dairy	**Full cream milk powder**	**Sugar**	**Beet sugar**
	Skimmed milk powder		**Cane sugar**

	Whey powder	**Emulsifiers**	**Soy lecithin**
	Butter oil		Sunflower lecithin
	Lactose		Rapeseed lecithin
	Other dairy		Other lecithins
Oils and fats	**Palm oil**	**Sweeteners**	Total sweeteners
	Palm kernel oil	**Specialties**	Total specialities
	Cocoa butter equivalent	**Flavors**	Total flavors
	Coconut oil	**Additives**	Cocoa alkalizing
	Sunflower oil		Other additives
	Rapeseed oil	**Nuts**	Hazelnuts
	Soy oil		Almonds
	Other oils & fats		Other nuts

Table 4: Non-cocoa ingredient categories and subcategories. Subcategories in blue are further differentiated by region of origin and/or supplier/certification.

Emission factor methodologies and resolution

EFs for non-cocoa ingredients cover a "cradle to supplier gate" system. Transports to Barry Callebaut are separately modeled in scope 3.4. Background databases used are the WFLDB v3.8, Agrifootprint 6.3, ecoinvent 3.9, and various life cycle assessments (LCA) and PCF studies.
General methodologies used to generate the EFs are:

- The ISO 14040/44 series (ISO 14040, 2006; ISO 14044, 2006, 2020)
- Product Environmental Footprint (PEF) methodology (EU 2021/2279 Commission Recommendation of 15 December 2021 on the use of the Environmental Footprint methods to measure and communicate the life cycle environmental performance of products and organizations)
- Product Environmental Footprint Category Rules (PEFCRs) for feed
- Sector specific IDF global Carbon Footprint standard for the dairy sector

All updated EFs were investigated and calculated by EY denkstatt and were reviewed by Quantis. EFs are generally split into three contribution categories:

1) FLAG-LUC: Emissions from LUC and from peat degradation
2) FLAG-other: Emissions from farming/land management, covering all emissions of the "cradle to final farm gate" system, except FLAG LUC emissions
3) Non-FLAG: Emissions from transport and processing

6.1.2.1 Emission factors for dairy ingredients

Emissions related to dairy ingredients are currently the most significant contributor to the total annual carbon footprint of non-cocoa ingredients.

The considered dairy subcategories are:

- Full cream milk powder (FCMP)
- Skimmed milk powder (SCMP)
- Whey powder
- Butter oil
- Lactose
- Other dairy ingredients

The EFs of final dairy ingredients are generally calculated as follows:

1) The starting point are EFs for fat and protein corrected (raw) milk (FPCM). Sources are either WFLDB 3.8, or supplier-specific EFs which fulfill minimum methodical requirements. Most supplier specific EFs had to be completed with respect to missing or incomplete LUC emissions (details are explained below).
2) The transport of raw milk is considered in the same way as modeled in WFLDB 3.8 (60 km truck transport, dataset "transport, freight, lorry with reefer, cooling, GLO", ecoinvent 3.9).
3) EFs for FPCM are multiplied by the amount of FPCM needed for each specific dairy product. This amount results directly from the division of the dry matter content of final dairy products (Dairy PEFCR, 2018) by the content of milk solids in FPCM (IDF 2022 methodology).
4) For powders, the GHG emissions of processing come from the energy needed for evaporating and spray-drying intermediate milk products (i.e., whole milk, skimmed milk, whey). On the one hand, milk solids in the respective intermediate product are considered. On the other hand, the EFs for energy used for processing are taken from ecoinvent 3.9 RoW ("rest of world") datasets.

EFs for fat and protein corrected milk (FPCM) from WFLDB 3.8 or provided by suppliers were modified in the following ways:

- Country specific EFs for FPCM were taken from WFLDB 3.8 (considering 36 different countries of origin). For all datasets, the impact of soy feed was corrected by applying a higher tier approach for the carbon footprint of soy beans from Brazil (see details below).
- 8 out of the 10 most relevant dairy suppliers provided up-to-date supplier-specific EFs. Most of the inputs were received in the format developed by the carbon module working group within the SAI-SDP (sustainable dairy partnership). This template checks all aspects which are essential for good quality and comparability of EFs. For reasons of consistency, emissions from LUC and peat degradation were added or replaced by the respective emissions by WFLDB 3.8 values.
- The soy feed LUC impact of soybeans from Brazil was adapted in all datasets for FPCM. This was done by replacing the standard LUC value for soybeans from Brazil in WFLDB 3.8 by a more precise and higher quality

dataset (Global Feed LCA Institute database, version 2.0, Brazil datasets). The "BRLUC tool" calculates a satellite based regional sLUC for more than 5,500 regions in Brazil, using Landsat data, and considering all crops and double cropping in the allocation procedure. The total LUC impact is finally depreciated linearly over 20 years, as described in the SBTi FLAG guidance. The BRLUC tool methodology is aligned with the recommendations of the draft GHGP-LSRG on LUC calculations. The inconsistency in methods (BRLUC vs. WFLDB) is accepted for the benefit of choosing the best available data for soy feed from Brazil.

In addition to supplier-specific EFs for FPCM, one of Barry Callebaut's suppliers of whey powder and lactose provided data on raw material inputs, dry matter contents for intermediate and final products, and primary data on processing steps. Respective EFs for whey powder and lactose were calculated with the same steps as described above.

6.1.2.2 Emission factors for beet and cane sugar

After detailed analysis of several sources and methodologies related to the carbon footprint of **beet sugar**, the following utilization and aggregation of the best available approaches was selected to generate updated EFs for beet sugar:

- For beet cultivation, two data sources are used. For consistency reasons, sugar beet datasets from WFLDB 3.8 are preferred (data for three European and four non-European countries). Due to limited availability of WFLDB datasets, sugar beet datasets from Agrifootprint database 6.3 are also used (data for 19 European and three non-European countries).
- Beet transport to sugar factories is modeled with data from ecoinvent 3.9.
- An updated default EF for beet sugar processing is derived by using primary data on sugar beet input per kg sugar and allocating emissions from energy consumption to sugar (as one of the products) based on its lower heating value.
- For one sugar supplier, we used their primary emission data on beet transport to sugar factories and on processing beets into sugar.

For **cane sugar**, several databases were analyzed and compared. The following sources were selected as the best available approaches for EFs for cane sugar from the five most relevant origin countries:

- For Mexico, Thailand and India, values from WFLDB 3.8 are used.
- For Brazil, the GHG emissions from LUC and farming are taken from the Brazil datasets within the GFLI 2.0 database, which are based on the BRLUC-tool (cf. chapter 6.1.2.1 on dairy).
  Non-FLAG emissions (transport, processing sugar cane into cane sugar) are taken from Bonsucro data, which refer to more than 10,000 certified farmers and 145 certified mills (mostly located in Brazil).

- For the US, the Agrifootprint 6.3 database is used. 2/3 of the total EF for the US is caused by emissions from peat degradation (without enough traceable primary data in the background). Peat emissions were therefore replaced by WFLDB background data on peat emissions per country and crop.
- For all other origin countries, a weighted average of the EFs for these five countries (69 % of the global market) was calculated, based on FAO production volumes.

6.1.2.3 Emission factors for oils and fats

Palm oil, palm kernel oil: The critically reviewed 2019 LCA study of 2.-0 LCA consultants, elaborated for an industry consortium including RSPO, is still considered the best and most comparable source of EFs for certified and conventional palm products (Schmidt & De Rosa, 2019).

The current framework of the GHGP-LSRG does not clearly define if certified volumes from a mass balance chain of custody (CoC) can be used for the baseline CCF inventory. Barry Callebaut decided to use a lower EF for RSPO certified palm (kernel) oil for the segregation & mass balance CoC, based on four criteria that need to be fulfilled for using improved EFs of certification schemes:

1) Evidence-based: EF is based on field surveys for land management emissions & removals and remote sensing data for LUC emissions (i.e. deforestation cut-off date requirements are not sufficient). Evidence should be gained from a sufficiently large sample size and granularity (e.g. different values for different origins).
2) Counterfactual: A like-for-like comparable EF for the equivalent conventional product must be available. In order to ensure full comparability between the two EFs, the methodology needs to be fully aligned, which typically means they have been assessed by the same organization / during the same study. This requirement is crucial in order to consider a shift to certified raw material as an SBTi-aligned improvement.
3) Traceable: The raw material needs to be traceable to the land management unit (farm / estate) or at least to the first point of processing (e.g. palm oil mill).
4) Chain of custody (CoC): CoC up to Barry Callebaut's factory door needs to be available by segregation or at least by a controlled blending approach. Under the latter approach, volumes of traceable/certified sources are mixed with volumes of unknown sources at a known share. The certified material is thus physically contained in the final product. The current RSPO mass balance CoC fulfills these criteria with traceability from the mill level. Global mass balance schemes without sufficient traceability are not accepted.

Cocoa Butter Equivalent (CBE): EFs for palm oil were used as a proxy, as CBE is mostly made from two thirds of palm mid fraction and one third shea stearin.

Other oils: EFs for coconut oil, sunflower oil, rapeseed oil, and soybean oil were taken from WFLDB 3.8. For other oils, an average EF of all oils listed above, weighted with annual volumes, was used as a proxy.

6.1.2.4 Emission factors for emulsifiers

For soy lecithin from Brazil, an EF was generated based on the GFLI 2.0 Brazil dataset (BRLUC) for soy oil and economically reallocating to soy lecithin with data from WFLDB 3.8. For soy lecithin from other origins, an average of the EFs for US and AR from WFLDB 3.8 (available countries beside Brazil) is used.

6.1.2.5 Emission factors for other ingredients

Ingredient category	**Source of emission factor**
Sweeteners	WFLDB 3.8 dataset “market for glucose (GLO)”
Hazelnut kernels	WFLDB 3.8 dataset “Hazelnut, in shell, at farm (GLO)”. Kernel share from Milošević & Milošević (2017).
Almond kernels	WFLDB 3.8 dataset “Almond kernels, from shelling and hulling, at plant (GLO)”.
Other nuts	A weighted average EF of hazelnut and almond kernels is used as a proxy for other nuts.
Cocoa alkalizing additives	ecoinvent 3.9 dataset for “market for potassium carbonate (GLO)”
Other additives	Average of ecoinvent 3.9 datasets “market for potassium carbonate (GLO)” and “market for ammonium carbonate (GLO)”
Specialties	A proxy for “non dairy creamers” (main ingredients are: sodium caseinate, partially hydrogenated soybean oil, high-fructose corn syrup) was generated by an average of the EFs for skimmed milk powder (weighted average of all country-specific EFs, see above), soybean oil (average of WFLDB 3.8 and GFLI 2.0), and high-fructose corn syrup, from WFLDB 3.8 dataset “High-fructose corn syrup F90 (HFCS-90), at plant (GLO)”.
Flavors	Represented by the WFLDB 3.8 dataset for “market for vanilla (GLO)”

Table 5: Other ingredient categories and sources of emission factors

6.1.3 Packaging

Packaging materials for cocoa beans, cocoa products and ingredients as well as for sold products are accounted for by using LCA datasets from ecoinvent 3.9.

6.1.4 Services

Emissions from purchased services are calculated based on spend data and coupled with emissions factors from the USEEIO.

6.2 Category 3.2: Capital goods

Description: This category covers all upstream emissions (cradle to gate) from capital goods purchased by Barry Callebaut during the respective reporting year (i.e., existing assets are not considered). Capital goods are products with extensive lifetimes. For Barry Callebaut, this category includes machinery replacements or purchase of new machinery equipment, new infrastructure for site expansion, and other R&D, innovation and investment activities.

Modeling Approach: The average spend-based method is applied. Data on the economic value (USD) of the purchased capital goods is multiplied by secondary EFs (i.e. industry average emissions per monetary value of goods).

6.3 Category 3.3: Fuel and energy-related activities

Description: This category includes emissions from the production of fuels and electricity purchased by Barry Callebaut which are not already included in Scopes 1 & 2.

Modeling approach: The respective EFs were generated by subtracting the scope 1 & 2 EFs (cf. chapter 4 & 5) from total EFs (Scopes 1, 2 & 3) for gas, light fuel oil, and electricity, as listed in the ecoinvent database.

6.4 Category 3.4: Upstream transportation and distribution

Description: According to the GHGP, Scope 3 category 4 includes emissions from transportation and distribution of products purchased in the reporting year, between a company's tier 1 suppliers and its own operations in vehicles not owned or operated by the reporting company. Category 4 also includes third-party transportation and distribution services purchased by the reporting company in the reporting year (either directly or through an intermediary), including inbound logistics, outbound logistics (e.g., of sold products), and third-party transportation and distribution between a company's own facilities.

For Barry Callebaut emissions arise from road and marine transport and distribution activities throughout the value chain. As Barry Callebaut only owns or leases a small number of trucks, almost all inbound, intercompany, and

outbound transports are operated by third party logistics companies, hence all emissions from transport & distribution are allocated to Scope 3 category 4.
Storage of purchased products in warehouses or factories is largely covered within the assessment of Scopes 1 & 2.

Modeling approach: GHG emissions from transportation of cocoa beans, non-cocoa ingredients and chocolate products are estimated by modeling typical transport routes via truck and ship for each product group.
The respective distances are combined with relevant volume flows and with EFs for the different modes of transport from ecoinvent 3.5.

6.5 Category 3.5: Waste generated in operations

Description: This category includes emissions from third-party disposal, treatment of solid waste and wastewater generated in the owned and controlled operations. It also includes losses of food waste at owned facilities. Emissions from transport of waste are optional within the GHGP and excluded from this assessment.
In this category, emissions from cocoa shells that are treated by third party waste treatment plants are also included. The cocoa shells end-of-life scenario considers 1% sent to landfill, 5% sent to incineration with energy recovery, 34% used as feed, 42% re-applied on the field as soil enhancement medium and 18% incinerated at own facilities.

Modeling approach: Waste-type-specific methods (EFs for specific waste streams and waste treatment methods) are applied. EFs per waste treatment type are retrieved from the ecoinvent 3.9 database. As per the recommendation of the GHGP, the "recycled content method" is applied, meaning that no environmental impacts or benefits are accounted for where material recycling or incineration with energy recovery is applied.

6.6 Category 3.6: Business travel

Description: This category includes emissions associated with the transportation and accommodation of employees for business related activities. Emissions from business flights are included. Due to limited data availability and a low estimated contribution in the overall footprint, other activities related to business travel (i.e. car drives/rentals, train travel or hotel stays) are excluded.

Modeling Approach: For all countries (except USA, Canada and China): Distance-based data (distance per flight) from Barry Callebaut's travel booking system are combined with secondary EFs from ecoinvent 3.9 for short, medium or long-haul flights.
For USA, Canada and China: Aggregated emissions are directly calculated by the local travel agencies that Barry Callebaut collaborates with.

6.7 Category 3.7: Employee commuting

Description: Emissions from the transportation of employees between their homes and their sites of work are included. Emissions from teleworking (i.e. employees working remotely) are optional per GHGP and therefore excluded. A reporting company's scope 3 emissions from employee commuting include the scope 1 and scope 2 emissions of employees and third-party transport providers.

Modeling Approach: An average data method was applied. It involves estimating emissions from employee commuting based on employee numbers (FTE) and average (e.g. national) data on commuting patterns. For this purpose the Quantis Commuting Model was applied. The model depends on the Full Time Equivalent (FTE) employees affiliated with the different company's sites (i.e. office/facilities countries) and statistical data on usual distance coverage for different means of transport in these countries. The EFs used for the different means of transport are taken from the DEFRA database.

6.8 Category 3.10: Processing of sold products

Description: This category is meant to include emissions from processing of sold intermediate products to third parties (e.g. manufacturers). The fate of post-sales intermediate products is only partly known, due to the diversity of potential processing routes per product category.

Modeling approach: The average electricity consumption for molding liquid chocolate is coupled with the appropriate ecoinvent 3.9 emissions factor. Data on the quantity are estimated using literature information and data from the WFLDB.

6.9 Category 3.12: End-of-life treatment of sold products

Description: This category includes emissions from third-party disposal and treatment of solid waste generated from using industrial chocolate products by Barry Callebaut's clients. Emissions from transport of waste are optional as per GHGP and excluded from this assessment.

Modeling approach: Waste-type-specific methods (EFs for specific waste streams and waste treatment methods) are applied. EFs per waste treatment type are retrieved from the ecoinvent 3.9 database. As per the recommendation of the GHGP, the "recycled content method" is applied, meaning that no environmental impacts or benefits are accounted for where material recycling or incineration with energy recovery are applied.

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