HelloFresh SE

COMPARATIVE LIFE CYCLE ASSESSMENT OF MEALS FROM HELLOFRESH MEAL KITS, RESTAURANT DELIVERY AND SUPERMARKET

TECHNICAL SUMMARY

PREPARED BY
Quantis

The Quantis name and logo represent a high standard of quality and scientific accuracy. This technical summary has been prepared with the support of Quantis as a reference document for an ISO-compliant LCA study completed in April 2022, which is currently under review. It contains the necessary information and numbers to back up (comparative) environmental claims. **Nevertheless, the full responsibility for clarity, robustness and transparency in the creation and communication of the environmental claims (on and off the packaging) is in the sole hands of the brand making the claims.**

APRIL 2022

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1. Introduction

Meal kits, as provided by HelloFresh, represent a novel approach to preparing a meal at home that increases convenience at a competitive price for many consumers. The approach has grown rapidly over the last decade as a result. Other established approaches for provisioning a meal at home include consumers planning and purchasing ingredients at supermarkets directly or ordering food (as a prepared meal) from restaurants for home delivery.

In 2021, HelloFresh, a leading global company in the meal kit segment, sought to understand the environmental impacts of their operations vs. two other typical meal provisioning systems – restaurant delivery (RD) and supermarket purchases (SM) – and commissioned Quantis to perform a comparative Life Cycle Assessment (LCA) of meal kits using HelloFresh (HF) recipes from three different protein categories: beef, chicken, and vegetarian.

As HelloFresh's meals are often prepared for dinner, this study defines the main functional unit as one serving of the same meal recipe. The functional unit for the three protein categories was evaluated in four regional markets: the United States of America (US), Australia (AU), Germany & Austria (DE&A), and Benelux (BNL – Belgium, the Netherlands, Luxembourg). These regional markets were selected as they represent 80% of HelloFresh's total annual sales. As meal recipes are different for each region due to cultural preferences and ingredients available, environmental impacts of meal categories are not intended to be compared across regional markets.

This technical document summarizes the study's goals, method, functional unit, data sources, activities considered and environmental impact indicator results. It is intended to provide the results of the study in a clear and useful manner to inform HelloFresh's communication of environmental performance to internal and external audiences, including partners, suppliers, customers, and the broader public.

2. Life cycle assessment

Life cycle assessment (LCA) is a leading methodology for assessing environmental performance, defined by the International Organization for Standardization (ISO). It evaluates the environmental impacts of products and services throughout their life cycle, beginning with raw material extraction and including all aspects of transportation, manufacturing, use and end-of life treatment.

It is important to note that LCA does not quantify exact impacts of a product or service as challenges may exist with data availability and modeling. However, it allows us to estimate and understand potential environmental impacts a system might cause over its typical life cycle, by quantifying (within the current scientific limitations) likely emissions produced, and resources consumed.

LCA is generally used to compare different systems performing the same function and to identify relative differences in environmental impacts. An LCA can also identify opportunities to improve the environmental performance of products and processes, inform decision-making, and support marketing, communication, and educational efforts.

3. Goals + scope of the study

3.1 Goals

The objective of this LCA study was to evaluate the environmental impacts of meals provided by HelloFresh, home-delivered meals prepared by restaurants and with meals for which the ingredients are purchased at the bricks-and-mortar supermarket.

This LCA study is an ISO 14040/14044 cradle-to-grave analysis of meal kits from three different protein categories (beef, chicken, and vegetarian recipes) in four regional markets: Australia (AU); Belgium, Netherlands, and Luxembourg (BNL); Germany and Austria (DE&AT); United States of America (US).

The goals of the study are fourfold:

1) To evaluate the environmental impact across the life cycle of the different provisioning systems, with a special focus on the significant effect of food loss and waste in the distribution and preparation stages.
2) To explore scenarios, uncertainties and methodological choices that might influence results and conclusions.
3) To identify environmental hotspots of meal kits at HelloFresh and potential process improvement opportunities to reduce its environmental impact.
4) To provide data for communication and claims of sustainability information on HelloFresh meal kits to a wide range of audiences.

3.2 Scope

The scope of the study includes the entire lifecycle, beginning with the production of meal ingredients and packaging materials down to the waste treatment of the meals. The meal kits are based on HelloFresh recipes (and respective data) from each regional market; therefore, the HelloFresh system serves as the baseline for the comparison.

3.2.1 Functional unit

The functional unit is a reference unit for which all results are calculated and presented, allowing for comparison of meal provisioning systems that may substitute one another. For this comparison, a functional unit is to prepare 1 serving of the same meal recipe for at home consumption. This comparative analysis was performed for each recipe in each region.

In this study, the composition of a meal has been defined by specific HelloFresh recipes. As there are a myriad of recipes available to customers, meal recipes by HelloFresh were selected that are both top-selling and representative of sales, and which can be reproduced by the other provisioning systems.

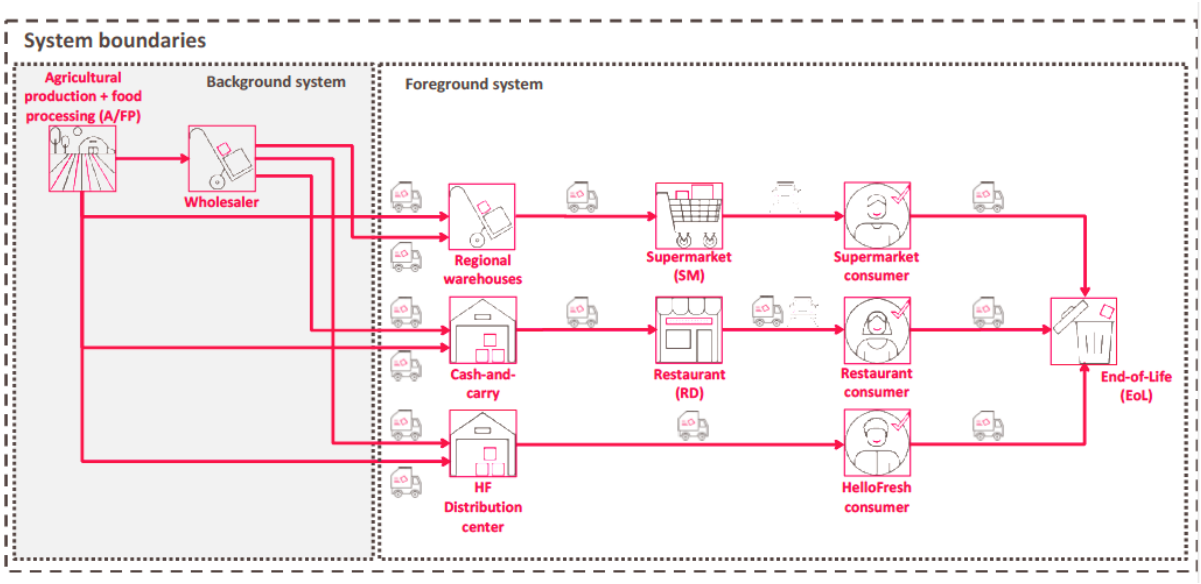
It is acknowledged that actual sizes of a meal serving (based on weight) may significantly vary when

using HelloFresh, ordering restaurant delivery, or preparing home-made meals using ingredients bought at the supermarket. As a robust data set for comparative portion size was not available at the time of this study, it has been assumed that the meal serving sizes are equal across the provisioning systems within a selected regional market. To address this limitation, potential differences in portion sizes were evaluated as a scenario for sensitivity analysis.

3.2.2 System boundaries

To better understand the differences in the meal provisioning systems, Figure 1 shows the system boundaries of each operating model. Note that in contrast to HelloFresh, both supermarkets and restaurants have an additional step (regional warehouse for supermarkets, cash-and-carry for restaurants) in their provisioning systems. For the purposes of this study, the supermarket boundary includes only the physical (bricks-and-mortar) presence and not the online grocery store system. See Annex A for a glossary and Annex B for full description of each provisioning system.

Figure 1: System description of meals prepared using HelloFresh meal kits, restaurant deliveries and supermarkets



Distinguishing Factor Between Provisioning Systems – Food Loss and Waste:

Differences between the provisioning systems arise from food loss and food waste related to each system, as it is assumed the ingredients are procured from the same background supply chain for all provisioning systems. Additionally, the rates for both differ across regional markets and ingredients and are used to calculate the amount of food that needs to be produced to obtain the same portion size on the plate when food loss and waste is higher.

Food losses occur at every life cycle stage such as during food transport and distribution. Food waste, the most significant contributor to environmental impact, is generated by the consumer, in part because the typical consumer purchases more food at a supermarket than they usually eat[1]. In contrast, we assume pre-portioned (HelloFresh meals) or prepared meals (restaurant delivery products) do not lead to a surplus of ingredients in the households of consumers.

[1] Speck M., Buchhorn F., Caplan A., Nikravech M., Schuster S., Bickel M., Keskin E., Suski P. (2020) HelloFresh Global Food Waste Study. Wuppertal Institut für Klima, Umwelt, Energie GmbH. Wuppertal, Germany.

Note: In this study, the impact of producing food that is lost and wasted is reflected in the "ingredient" stage, while the impact of treating food loss and food waste is reflected in the "food waste treatment" stage.

3.2.3 Method

The life cycle assessment (LCA) method used in this study is a global ISO standard to evaluate relative potential environmental and human health impacts of products and services throughout their life cycle. As a cradle-to-grave assessment of meal provisioning and preparation, it looks at:

- the extraction and processing of energy and material resources
- the emissions to air, water, and soil
- transportation of materials and products (including packaging)
- the end of life of the waste generated throughout the life cycle

Packaging waste is assumed to occur both at the consumer preparation stage due to pre-packed goods, as well as at the distribution stage due to packaging being discarded.

While there are differences by provisioning system, the processes have been categorized into the following life cycle stages for comparison:

LIFE CYLCE STAGE	EVALUATED PROCESSES
Ingredients	- Agricultural production and food processing plus production of lost and wasted food
Distribution	- All transportation steps from agricultural production and food processing to consumer for each provisioning system (including shopping of ingredients by consumer at supermarket) - Operations and storage at distribution centers, wholesalers, cash-and-carry, regional distribution centers, restaurants, and supermarkets
Packaging	- Packaging of ingredients - Repack in cash and carry, regional warehouse, supermarket - Packaging of meal kit and meal boxes - Packaging for delivery by restaurant - Packaging for grocery shopping - Treatment of all packaging waste (recycling, incineration, landfill)
Preparation (Consumer use phase)	- Restaurant preparation and delivery of meal to consumers - At-home preparation of meal by consumers (only related to the HelloFresh and supermarket provisioning systems)
Food Waste Treatment	- Impact of treatment of all food loss and food waste through incineration, composting, anaerobic digestion, wastewater treatment

Meal Recipes

In selecting the recipes as basis for comparison of the systems, the following criteria were applied:

- Meals (by protein category) representing highest overall sales volume for HelloFresh
- Recipes would be normally prepared at home or ordered without using HelloFresh
- All ingredients are readily available, e.g., not HelloFresh proprietary ingredients
- Ability to compare meals across all regions, considering similar but not identical recipes

The comparable meals selected for each of regional markets and protein category included:

- Burger (beef recipe)
- Chicken breast with starch and vegetables (chicken recipe)
- Pasta and vegetables (vegetarian recipe)

See Annex C to view the recipes and their respective list of ingredients per regional market and recipe category.

As a meal box contains a variable number of meal kits depending on customer orders, it was necessary to estimate an average weight of an individual meal with average packaging using yearly data on the number of boxes and meals sold. To calculate an average baseline for each recipe, the weight of ingredients, packaging of ingredients and packaging of meal boxes provided for each meal kit size per regional market, were multiplied times the number of sold meal kits per meal kit size and divided by total of all sold meal kits.

Packaging

Packaging is used for the protection, quality and/or food safety, transportation, and handling of the food and differs by consumer habits, region, amount of ingredients and packaging material used. This study looks at the burdens of packaging production and disposal.

The packaging for handling at the wholesaler, distribution centers, regional warehouse and cash-and-carry was assumed to be the same across all provisioning systems as robust data on the differences was not available.

Packaging of the ingredients sent by HelloFresh was determined based on the packaging of single ingredients for one recipe and scaled down to one meal. It is therefore specific for each meal. In contrast, the packaging for the delivery (packaging of meal box and meal kits) to the consumer was based on the total packaging materials used in 2020 divided by the number of total meals sold by HelloFresh in 2020 for each market and is the same for every meal within a specific regional market, independent from the ingredients.

It must be noted that the average packaging is different for the other provisioning systems, and the impact of transportation of packaging materials from the supplier to the different facilities is also considered in the study.

Transport

Transportation methods had to be considered individually by provisioning system, distribution stage and region due to variations in emissions standards, distances and size/mode of transportation which include air, ship, lorry (ambient, refrigerated, or frozen), vans (fossil-fuel or electric powered) – and for the last mile to and by the consumer, transport via vans, cars, public transport, scooters, bicycle or on foot[2].

Waste

This study considers waste and losses at each stage of the supply chain of the three meal types: during the agriculture and food processing stage, at the distribution center, cash-and-carry, regional warehouses, restaurant, supermarket, and at the consumer level. Main waste flows include

[2] Various regional statistics and publications informed the transportation and waste related assumptions.

food losses in the production and distribution stages, food waste from prepared meals or unused ingredients, and packaging materials. There are differences on the amounts of waste as well, according to the type of ingredient and its durability across the different life cycle stages.

Food waste rates are applied not only to assess the impact of these streams, but also to determine the total amount of produced food required to supply the specific portion size of the meal to the consumer. The volumes of waste generated at each stage are dependent on the provisioning system. This means, the consumer's in-home food waste rates are assumed to be the same between HelloFresh and restaurant delivery systems but different if the food is purchased at the physical supermarket. Finally, waste treatment options considered were anaerobic digestion, composting, landfill, and incineration with energy recovery.

Exclusions

The study does not include processes with less than 1% environmental impact on the total system, those relating to labor, commuting of workers and administrative work or where there is a lack of reliable data.

3.2.4 Critical review

The LCA study follows the International Organization for Standardization (ISO) 14040 and 14044 standards (ISO 2006a; ISO 2006b) for public disclosure of comparative assertions, and is in the process of being peer reviewed by three independent experts: Martin Heller from AgResilience Consulting, Charlotte de La Baume from Beelong Sàrl, and Mike Barry from Mike Barry Eco Ltd.

3.3 Environmental indicators considered

Environmental indicators were assessed using two methods that quantify similar indicators:

1) Life cycle impact assessment (LCIA) method CML 2 baseline 2000 (version 4.7)[3] looked at climate change (Global Warming Potential 100a), abiotic depletion, ozone layer depletion, acidification, eutrophication, photochemical ozone creation, human toxicity, terrestrial ecotoxicity, freshwater and marine aquatic ecotoxicity. (See Annex D for descriptions).

2) Product Environmental Footprint (PEF) method by the European Commission, covering 16 indicators, was used for sensitivity analyses to test the variability of the initial results These include: climate change (total, biogenic, fossil, land use change), photochemical ozone formation, acidification, eutrophication (freshwater, marine and terrestrial), land use and water scarcity.

[3] (LCIA) method developed by the Center for Environmental Science (CML) of Leiden University in the Netherlands (Guinée et al. 2001)

3.4 Data collection + modeling

3.4.1 Data quality

The data quality is paramount to calculating dependable LCA results upon which statements and decisions for environmental impacts can be made. By evaluating the data reliability, completeness, temporal, geographical and technological correlation, the overall data quality of the study is considered good.

3.4.2 Data collection

Both primary and secondary data was used, and where data was not available, assumptions or equivalences based on expert judgment were made.

HelloFresh primary data from 2020 was collected from each regional market on the ingredient amounts and origins of each recipe, packaging materials and weights of each packaging step, transportation distances and modes, and utilities of the warehouses. For restaurants and supermarkets, most recent data was used to represent 2020 and was sourced from a variety of secondary sources: statistical data, literature data and published studies. (See Annex G: References for listing of select key resources used in study).

Important data sources on the amounts of waste generated at the consumer's home are based on a variety of publications on food waste on national and regional scales. A summary list of the data sources specifically used for the average and per ingredient food loss and waste at each process step across the provisioning system is summarized in Annex E.

The background data used for life cycle inventory data were the Ecoinvent database version 3.7 (Weidema et al. 2013) and Quantis' World Food LCA Database (Bengoa et al. 2020).

All collected data from HelloFresh on amounts of ingredients and packaging materials as well as transportation has been scaled down to the functional unit using sales shares of the recipes and the total number of boxes and meals sold.

3.4.3 Modeling & sensitivity analysis

The LCA modeling tool SimaPro version 9.1.1.1 (developed by PRé Consultants) was used to calculate the environmental impacts of the different provisioning systems.

Additionally, various scenarios were analyzed to evaluate potential effects on the overall environmental impacts. Upon request of the panel reviewers, we are currently conducting an additional sensitivity analysis to address possible variations in the food waste rates which will not change the study outcomes.

The most sensitive scenario for climate change and other impact categories is the variation in portion sizes. The effect of consumer behavior on the portion sizes per region and meal is not considered in the primary analysis. Portion sizes are known to differ between the provisioning systems, and therefore a sensitivity analysis was conducted to assess the influence of the assumption related to the portion size. To analyze the impact of potential differences in portion

sizes, dinner and plate waste as well as leftovers were used to model a range of portion sizes. The data used for this analysis came from a study commissioned by HelloFresh[4]. In general, when considering a range of larger portion sizes based on the amount of dinner and plate wastes as well as leftovers generated from all systems, the study shows that the influence is lowest with the HelloFresh food provisioning system compared with that of the restaurant delivery and supermarket systems. An exception is in the German and Austrian regional market, where the portion sizes of the restaurant meals could be lower due to potentially reduced leftovers and plate wastes from meals provided by the restaurants (based on the Speck study).

Other sensitivity analysis looked at **local sourcing** in the **US** to assess the influence of supermarket local sourcing and to demonstrate a possible alternative distribution process for HelloFresh that could reduce the environmental impact. Sensitivity analyses were also conducted to evaluate the changes in the footprint of a burger meal if **sustainable beef**[5] is used or if different background data to produce mushrooms are used in the respective chicken and vegetarian meals. Finally, as **online grocery shopping** is increasing, another sensitivity analysis looked at the impacts of lower food loss rates associated with online grocery stores without a physical presence.

Results show that by applying these measures (i.e., sourcing locally, procuring sustainable beef), the environmental impact of the HelloFresh recipe can be decreased. If other provisioning systems also employ these measures, the advantage gained by HelloFresh would decrease. To note, none of the assessed scenarios changes the conclusion of the study that the HelloFresh system has, in general, lower environmental impacts compared to the restaurant delivery and supermarket systems and in some cases the restaurant delivery system has equal or slightly lower impacts than HelloFresh.

3.5 Study limitations + assumptions

The following limitations should be considered along with the context described in earlier sections of this report when interpreting the information presented in this study:

- Study results reflect HelloFresh operations only and are not generalizable to other meal kit companies.
- HelloFresh develops its own recipes, which leads to a rather difficult definition of comparable meals across provisioning systems. Therefore, a recipe is assumed to be equal, independent from the system.
- The scope of the study does not include observations or measurements from test purchases and test orders from the restaurant.
- Consumer behavior highly influences choices made with regards to grocery shopping and delivery order. This study depicts the average operation of provisioning systems, therefore average data - such as food loss and food waste rates – were considered.
- It is assumed that the burdens of food production are equal for all provisioning systems, which may underestimate further differences at the food supply chain level.

[4] Speck M., Buchhorn F., Caplan A., Nikravech M., Schuster S., Bickel M., Keskin E., Suski P. (2020) HelloFresh Global Food Waste Study. Wuppertal Institut für Klima, Umwelt, Energie GmbH. Wuppertal, Germany.

[5] Future scenario based on the commitment by the Global Roundtable for Sustainable Beef that targets 30% lower GWP impact per kg. Source: GRSBeef (2021) https://grsbeef.org/

- The study lacks collected information on portion sizes and packaging usage for the two comparable systems (restaurant delivery and supermarkets). Therefore, it is assumed that portions of the same meal have the same size and packaging material is based on statistical and literature data.

3.6 Consistency check

The consistency check assesses whether assumptions, methods, and data for each product system are consistent with each other as well as with the goal and scope of the study. All assumptions, methods and data are consistent with each other and with the study's goal and scope. Differences in background data quality were minimized by using LCI data exclusively from the World Food LCA Database and Ecoinvent databases. System boundaries, allocation rules, and impact assessment methods have been applied consistently throughout the study.

4. Results + discussion

Assuming that the source of ingredients and portion size of the meals are equal for all provisioning systems, this study has found that the HelloFresh system has in general a lower environmental burden as compared with the provision of the same meal by an average restaurant delivery and a supermarket, and in some cases the restaurant delivery system has equal or slightly lower impacts than the HelloFresh system. These exceptions are in the US regional market, where the HelloFresh vegetarian meal has a slightly higher impact than the restaurant delivery provisioning system, and in the Benelux regional market, the HelloFresh chicken and vegetarian meals have a similar impact as in the restaurant delivery system.

Some general conclusions can be drawn that apply to all markets:

- Meals: Livestock (meat and dairy) products in particular result in high emissions. Therefore, the burger meal causes the highest emissions; the chicken meal results in the second highest emissions and is closely followed by the vegetarian meal.
- Ingredients: Ingredients are the main driver for impact on climate change and most other environmental impact categories, and for differences between the provisioning systems as it includes the production of lost and wasted food.
- Packaging: Main contributors to the packaging are the production of packaging materials for the ingredients (mainly plastics) and for delivery to consumers (especially aluminum for the restaurant delivery, and paper and carton for HelloFresh meal boxes).
- Distribution: Transport to the consumer is the main contributor to the distribution impacts. Note in the case of US meals, the contribution of transport of ingredients from the food producer to the distribution center (for HelloFresh), cash-and-carry (for restaurant delivery) and regional warehouse (for supermarket) is the main contributor.
- Preparation: Main contributor is the heating of the meals via ovens and stoves.
- Food Waste Treatment: The impact of treatment of the food waste is usually negligible in comparison to the other life cycle stages; however, it becomes noticeable in the US and

Australian regional markets where respectively 47% and 92% of food waste ends up in landfill. (Food waste is organic waste in landfill and associated with methane emissions).

4.1 Climate change impacts

The climate change environmental indicator, also known as a carbon footprint or Global Warming Potential, represents the greenhouse gas (GHG) emissions associated with the product. Figure 2 below shows the **absolute results** for every meal in each of the four regional markets and serves as the reference for calculating specific comparative claims.

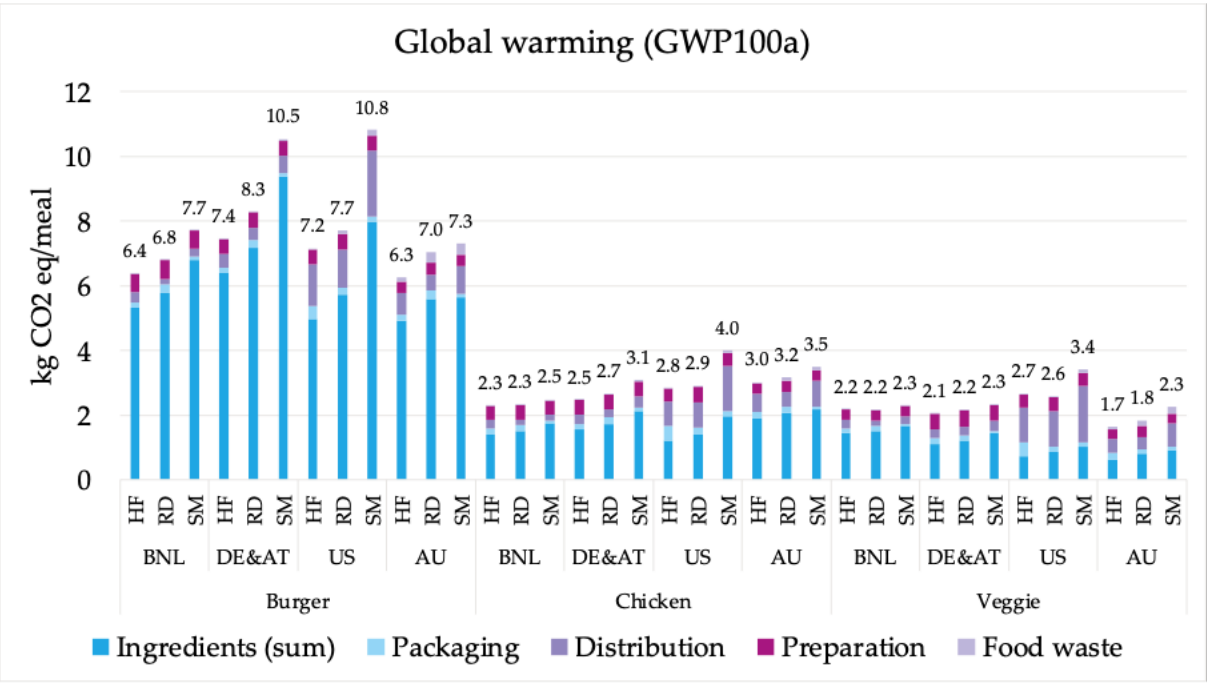
In the **US regional market**, the physical supermarket provisioning system has the highest impact across all meals. The HelloFresh provisioning system shows the lowest impact for burger and chicken meals and a slightly higher impact than the restaurant delivery systems for the vegetarian meal.

In the **Australian regional market**, the physical supermarket provisioning system has the highest impact across all meals and the HelloFresh system has the lowest impact for all meals compared to restaurant delivery and supermarket system.

In the **Benelux regional market**, the supermarket system has the highest impact on climate change for the burger meal while the HelloFresh and restaurant delivery systems have lower than the supermarket, although their impacts are similar for the chicken and vegetarian meals

In the **German and Austrian regional market**, the impact of the provisioning of all meals is the highest with the physical supermarket system and lowest for the HelloFresh system.

Figure 2: Impact on climate change of comparative systems by meal kit and regional market.



Comparative differences worth highlighting, are those where there is a difference of 10% or greater between HelloFresh and a comparative provisioning system.

In summary, as shown in Table 1 below, the HelloFresh provisioning system has a **lower impact** on climate change (10% or greater difference) in:

- nine of the twelve meal recipes as compared to the physical supermarket system and
- two of the twelve meal recipes as compared to the restaurant delivery system.

The HelloFresh system has a **similar impact** on climate change (less than 10% difference) in:

- three of twelve meal recipes as compared to the physical supermarket system and
- ten of twelve meal recipes as compared to the restaurant delivery provisioning system.

Table 1: Significant differences (10% or greater) between HelloFresh provisioning system (reference) and comparative systems restaurant delivery (RD) and supermarket (SM) per meal and regional market.

		Regional market							
		BNL		DE&AT		US		AU	
	HF vs	RD	SM	RD	SM	RD	SM	RD	SM
Meal recipes	Burger								
	Chicken								
	Vegetarian								

Legend: Red color indicates a significant (equal to or more than 10%) difference between HelloFresh and the comparative system. Gray color indicates the difference is not significant (i.e., less than 10%). Calculations are based on rounded numbers as presented in Figure 2.

As figures are rounded in Figure 2, to note is that the actual comparative difference of the HelloFresh vegetarian meal in the German & Austrian regional market is less than 10% compared to the supermarket impact and the HelloFresh vegetarian meal in the Australian market is also less than 10% compared to the restaurant delivery impact on climate change.

4.2 Other environmental impacts

In addition to Global Warming Potential (impact on climate change), the set of other environmental impact categories from CML were included in the assessment and complemented by the European Product Environmental Footprint (PEF) methodology. The study shows that most other environmental indicators evaluated presented similar trends across the provisioning systems as the impact on climate change – where the HelloFresh system generally has the lowest impact and the supermarket system the highest. The impact categories that showed an exception to this trend across systems and meals include abiotic depletion, ozone layer depletion, photochemical oxidation, acidification, and eutrophication. The detailed analysis of these is included in the full ISO compliant report.

To provide insight into one of these exceptions, we highlight the ozone layer depletion. As with impact on climate change, ingredients are the most important contributor to the ozone layer depletion in the Benelux region. Here the HelloFresh chicken and vegetarian meals show significantly higher impacts from packaging, thereby resulting in an overall higher impact on ozone

layer depletion as compared to the restaurant delivery and supermarket systems. Although aluminum in the packaging for delivery in the restaurant delivery system showed up in several categories as an important driver, the PET material in the packaging of ingredients in the HelloFresh system is the main contributor to this impact category. (See Annex F to see results graph of ozone layer depletion analysis for Benelux).

4.3 Impacts by life cycle stage

Considering all assessed environmental impacts for the provisioning of one average meal, the most relevant stage is the **ingredients** stage, which includes the cultivation and production. The impact of **distribution**, **preparation** and **packaging** stages is relatively more significant in chicken and vegetarian meals, as the relative contribution of the ingredient to the total impact is lower than for burger meals. The impact of **treatment of the food waste** is usually negligible but becomes noticeable in the US and Australian regional markets in which respectively 47% and 92% of food waste ends up in landfill. (Organic food waste in landfill is associated with methane emissions).

As each meal provisioning system is different, each life cycle stage contributes a different percentage to the total meal impact. The below table highlights which life cycle stages are more relevant to others within a given provisioning system. Additionally, I shows how the share of impact changes between different meal recipes.

Table 2: Contribution (share of impact in %) on climate change by life cycle stage of different meals.

BNL	DE&AT	US	AU
Ingredients are main contributor to the GWP for all meals. (62%-88% of total impact) **Life cycle impact for:** Burger meal: SM=88%; RD=85%; HF=83% Chicken meal: SM=71%; RD=65%; HF=62% Veggie meal: SM=73%; RD=69%; HF=67%	Ingredients are main contributor to the GWP for all meals. (54%-89% of total impact) **Life cycle impact for:** Burger meal: SM=89%; RD=87%; HF=86% Chicken meal: SM=69%; RD=65%; HF=63% Veggie meal: SM=62%; RD=56%; HF=54%	Ingredients are main contributor to the GWP for chicken and burger meals (43%-74% of total impact) **Life cycle impact for:** Burger meal: SM=74%; RD=74%; HF=69% Chicken meal: SM=49%; RD=48%; HF=43% Veggie meal: SM=30%; RD=33%; HF=28%	Ingredients are main contributor to the GWP results for all meals (38%-80% of total impact) **Life cycle impact for:** Burger meal: SM=77%; RD=80%; HF=79% Chicken meal: SM=63%; RD=66%; HF=63% Veggie meal: SM=40%; RD=44%; HF=38%
Distribution is 3rd contributor after preparation stage (3%-12% of total impact) **Life cycle impact for**: Burger meal: SM= 3%; RD= 3%; HF= 5% Chicken meal: SM= 8%; RD= 7%; HF=12% Veggie meal: SM=10%; RD= 7%; HF=12%	Distribution contribution is lower than preparation for chicken and veggie meal (9%-14% of total impact) – and similar to preparation contribution for burger meal (5%-6% of total impact). **Life cycle impact for:** Burger meal: SM= 5%; RD= 5%; HF= 6% Chicken meal: SM=11%; RD= 9%; HF=12% Veggie meal: SM=14%; RD=12%; HF=14%	Distribution is 2nd contributor for burger and chicken meals due to long distance driving (15%-35% of total impact). It is the main contributor to the veggie meal. (40%-51% of total impact) **Life cycle impact for**: Burger meal: SM=19%; RD=15%; HF=18% Chicken meal: SM=35%; RD=27%; HF=26% Veggie meal: SM=51%; RD=41%; HF=40%	Distribution is 2nd contributor for all meals due to long distance driving makes distribution. (7%-31% of total impact) **Life cycle impact for:** Burger meal: SM=12%; RD= 7%; HF=11% Chicken meal: SM=23%; RD=14%; HF=19% Veggie meal: SM=31%; RD=20%; HF=26%

BNL	DE&AT	US	AU
Packaging contributes less than preparation and distribution. (1%-8% of total impact) **Life cycle impact for**: Burger meal: SM= 1%; RD= 4%; HF= 3% Chicken meal: SM= 3%; RD= 8%; HF= 7% Veggie meal: SM= 2%; RD= 8%; HF=7%	Packaging contributes less than preparation and distribution. (1%-8% of total impact) **Life cycle impact for**: Burger meal: SM= 1%; RD= 3%; HF= 2% Chicken meal: SM= 3%; RD= 8%; HF= 7% Veggie meal: SM= 3%; RD= 8%; HF=8%	Packaging contributes less than preparation and distribution (2%-16% of total impact) except for chicken and veggie meals in HF system. **Life cycle impact for**: Burger meal: SM= 2%; RD= 3%; HF= 6% Chicken meal: SM= 4%; RD= 7%; HF=16% Veggie meal: SM= 4%; RD= 7%; HF=16%	Packaging contributes less than preparation and distribution (2%-8% of total impact) except for the veggie meal in the HF system. **Life cycle impact for**: Burger meal: SM= 2%; RD= 4%; HF= 3% Chicken meal: SM= 3%; RD= 6%; HF= 6% Veggie meal: SM= 5%; RD= 8%; HF=13%
Preparation is the 2nd contributor for all meals. (7%-19% of total impact) **Life cycle impact for**: Burger meal: SM= 7%; RD= 8%; HF= 9% Chicken meal: SM= 17%; RD=20%; HF=19% Veggie meal: SM=14%; RD=16%; HF=15%	Preparation is the 2nd contributor for chicken and veggie meals (14%-23% of total impact) and similar to distribution contribution for burger meal (4%-6% of total impact). **Life cycle impact for**: Burger meal: SM= 4%; RD= 6%; HF= 6% Chicken meal: SM=14%; RD=18%; HF=18% Veggie meal: SM=21%; RD=24%; HF=23%	Preparation related contribution ranges between 4%-6% of total impact for burger meals and 10%-17% of total impact for chicken and veggie meals. total impact. **Life cycle impact for**: Burger meal: SM= 4%; RD= 6%; HF= 6% Chicken meal: SM=10%; RD=17%; HF=14% Veggie meal: SM=12%; RD=17%; HF=15%	Preparation related contribution ranges between 5%-11% for burger and chicken meals, and 14%-19% for veggie meal. **Life cycle impact for**: Burger meal: SM= 5%; RD= 5%; HF= 6% Chicken meal: SM= 9%; RD=11%; HF=11% Veggie meal: SM=14%; RD=18%; HF=19%
Treatment of food waste related contribution is negligible for all systems. **Life cycle impact for**: Burger meal: SM= 0%; RD= 0%; HF= 0% Chicken meal: SM= 1%; RD= 0%; HF= 0% Veggie meal: SM= 1%; RD= 0%; HF= 0%	Treatment of food waste related contribution is negligible for all systems. **Life cycle impact for**: Burger meal: SM= 0%; RD= 0%; HF= 0% Chicken meal: SM= 2%; RD= 1%; HF= 0% Veggie meal: SM= 0%; RD= 0%; HF= 0%	Treatment of food waste related contribution is negligible for all systems yet more noticeable in the US given 47% food waste is landfilled. **Life cycle impact for**: Burger meal: SM= 2%; RD= 1%; HF= 0% Chicken meal: SM= 2%; RD= 1%; HF= 1% Veggie meal: SM= 3%; RD= 2%; HF= 1%	Treatment of food waste related contribution is low (1%-10%) and more noticeable given 92% food waste is landfilled. **Life cycle impact for**: Burger meal: SM= 5%; RD= 4%; HF= 2% Chicken meal: SM= 3%; RD= 3%; HF= 1% Veggie meal: SM= 9%; RD=10%; HF= 5%

Legend: HF = HelloFresh system; RD = restaurant delivery system; SM = supermarket system

5. Conclusions + recommendations

In conclusion, this study shows that in general the HelloFresh meal kit system offers environmental benefits in the provisioning of meals when compared to home-delivered prepared meals by restaurants and ingredients purchased at supermarkets, assuming that the source of ingredients is equal for all provisioning systems. What makes this possible for HelloFresh is that its meal provisioning system reduces food losses due to its approach on predicting demand, high inventory turnover, and pre-portioning of the meal ingredients.

When communicating the comparative results, it is important to qualify the impact on climate change statement by specifying the meal recipe, regional market and where relevant, the life cycle stage most responsible for the impact.

Compared to the restaurant delivery system, the HelloFresh provisioning system has a lower impact on climate change (having a 10% or greater difference) for:

- burger meals in Australian and German & Austrian regional markets

Compared to the supermarket system, the HelloFresh provisioning system has a lower impact on climate change (having a 10% or greater difference) for:

- burger meals in all regions,
- chicken meals in US, Australian and German & Austrian regional markets and
- vegetarian meals in US and Australian regional markets.

Where the difference between HelloFresh and the comparative system results is less than 10%, one can say the impacts are comparably similar, as with:

- burger meals in the US and Benelux regional markets provided via restaurant delivery,
- chicken and vegetarian meals in all regional markets provided via restaurant delivery,
- chicken meal in Benelux regional market provided via supermarket and
- vegetarian meals in Benelux and German & Austrian regional markets provided via supermarket.

Considering the conclusions and observations gained from the study, Quantis has identified some recommendations for HelloFresh to build upon in its ongoing journey to improve the environmental footprint of its meals.

CONCLUSIONS & OBSERVATIONS	RECOMMENDATIONS
Ingredients are most significant contributor to environmental footprint of all HelloFresh meals, especially burgers.	Procure low impact ingredients such as sustainable beef; encourage customers to select lower-impact meals.
The source of ingredients (cultivation and production) impacts the environmental footprint of a meal.	Improve traceability on ingredient source location and the mode of production – this will also improve the data quality and help refine sourcing decision-making.

CONCLUSIONS & OBSERVATIONS	RECOMMENDATIONS
HelloFresh distribution (transport from distribution center to consumer) has higher emissions than restaurant delivery or supermarket systems in German & Austrian and Benelux region.	Electric vehicles are an alternative to diesel-powered vehicles for the last-mile delivery, although this depends on the region and the available electricity grid mix.
The impact of the meal kit and box packaging is the main contributor to the packaging stage followed by the packaging of ingredients. In the US, the HelloFresh packaging stage contributes relatively more to the total life cycle impact as compared to restaurant deliveries and supermarkets.	HelloFresh should investigate new opportunities to reduce its packaging when distributing meal boxes to customer and/or switch to lower-impact packaging.
Food losses and waste are based on literature (secondary data), representing averages, or requiring adaptation for ingredient groups in single markets.	Update the study as soon as country specific statistics per ingredient group are available.
Data on actual portion sizes not available. Study assumes portion sizes are equal for all provisioning systems and bases food loss and waste on average regional market for all food, not on specific meals.	Conduct consumer research to qualify portion sizes per provisioning system and meal.

ABOUT QUANTIS

Quantis is a sustainability consultancy that guides top organizations to define, shape and implement intelligent environmental sustainability solutions and to communicate these in creative and credible ways. Our experts take the latest science and make it actionable. We deliver resilient strategies, robust metrics, useful tools, and credible communications.

With offices in the US, France, Switzerland, Germany, and Italy, and clients around the world, Quantis is a key player in inspiring sustainable change on a global scale.

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Questions? For more information about this document, please contact either the HelloFresh Sustainability Team: sustainability@hellofresh.com or Public Relations: pr@hellofresh.com.

Annex A: Glossary

This section includes terminology and definitions applied in the context of this study.

Cash-and-carry – Large stores or outlets supplying food products at large volumes to businesses, in this case to restaurants (comparable to the American "wholesaler").

Distribution center – Location in which HelloFresh receives and stores ingredients purchased from suppliers and prepares meal kit bags and boxes for subsequent delivery to consumers.

Meal – Prepared food according to a recipe for one or more persons.

Meal kit – Group of ingredients for the preparation of meals according to a recipe.

Portion or serving – One meal served for one person.

Portion size or serving size – Measured in mass (weight), it is the amount of food (ingredients) in one portion or serving.

Recipe – Composition of a dish or a meal, it includes information on the amount of individual ingredients for one or more persons, as well as preparation instructions.

Regional warehouses – Warehouses used to store food products purchased at large volumes from wholesalers and to be distributed to retail stores, in this case to supermarkets.

Restaurant – Establishment where food is prepared and served to consumers, either in the restaurant or delivered using takeaway packaging. In this study, only restaurant deliveries are evaluated.

Supermarket – Shop where food products are sold to consumers but not to other businesses. In this study only bricks-and-mortar (not online) presence is evaluated.

Wholesaler – Company selling food products to other businesses and retailers.

Annex B:
Explanation of provisioning systems

HelloFresh System

Ingredients are received either directly from a local farm or wholesaler each week to produce meal kits. Food loss and waste is reduced in the system due to advanced analytics predicting input needs, weekly menu changes help to increase inventory turnover; many perishables are donated to the community before they spoil, and due to pre-packaged portions.

Packaging volume and losses are minimized as most goods are purchased pre-portioned and pre-packaged, with meal kits packaging occurring in-house. In this process, different waste streams are generated and disposed of differently depending on the type of waste – food or packaging – and the regional disposal options. For food preservation during transit, separators, insulation pouches and ice packs may be placed in the boxes, depending on the regional market and the time of the year. The size of the boxes, type of packaging materials, and preservation items vary according to regional factors like weather and logistics strategy.

Distribution: Finished boxes are palletized and sent by line haul to third party logistics hubs (except for one logistics centre in Australia owned by HelloFresh and in the BNL region where HelloFresh owns the distribution fleet), where the pallets are disassembled and put in delivery vehicles of various sizes for last-mile transport. Depending on the region, the transport to logistics hubs may take place via truck and occasionally air freight; last-mile transport is done by either third parties or owned fleets.

Preparation: Customers prepare the meal using their own kitchen utensils and some staple ingredients which are not included as these are assumed to have minor impact due to their low weight per meal. Natural gas or electricity is used to cook the meal.

End of Life: Leftovers may be disposed as waste or saved for consumption at later stage.

Restaurant Delivery System

Restaurants source their ingredients from wholesalers or cash-and-carry stores as well as directly from the place of food processing. In this study, it is assumed that most ingredients are freshly bought from the cash-and-carry and that ingredients are not refrigerated for more than a week within the restaurant. It is also assumed that food is prepared and immediately delivered to customers, as opposed to deferred systems in which the meals are prepared and frozen for later heating and consumption (Tacaks et al. 2020). The delivery or transport of the meals to the consumer may be handled by the restaurant or outsourced to a third-party provider. However, the potential impacts of the delivery mode are attributed to the restaurant. Food losses through spoilage within the restaurant are accounted for as well as food waste during the preparation process (edible and inedible). The packaging necessary for transportation from the restaurant to the customer is also considered. Customers consume the meal and dispose of food and packaging as with the HelloFresh system.

Supermarket System

Most consumers obtain their dinner meals and ingredients through grocery shopping in supermarkets (Orlando 2017). In this study, it is assumed that supermarkets mainly source food products directly from wholesalers and transport these to their regional warehouses and subsequently to retail stores (Datex Corporation 2021). However, the supply chain of some products and supermarkets may differ from this assumption. For example, some food products may be purchased directly from farmers and food producers, or they are shipped directly from wholesalers by the retail store (Nikoličić et al. 2015). For simplification purposes, the steps of agricultural production and food processing are assumed to be identical for supermarkets, restaurants, and HelloFresh. However, compared to HelloFresh, the packaging and amounts or volume of the food products purchased and sold by supermarkets is different. Customers regularly go to retail stores or supermarkets, where they buy their groceries to prepare several dinner meals and other meals at home. This study excludes the provision of ingredients used for other meals or snacks. Like the HelloFresh model, customers store the groceries until the dinner meal is cooked, using their own kitchen utensils and appliances. Similarly, customers dispose of food and packaging using same options.

Annex C:

Recipes by meal category and region

Table 4: Meal recipes (beef[6], chicken and vegetarian) for BNL region

	Beef recipe	Chicken recipe	Vegetarian recipe
Recipe name	Burger with spicy green pepper and piccalilli	Chicken breast in mustard cream sauce	Creamy linguine with broccoli
Illustration			
Ingredients from meal kit	Dried thyme	Waxy potatoes	Broccoli
	Tomato	Chestnut mushrooms	Shallot
	Cucumber	Garlic clove	Garlic clove
	Green pepper	Shallot	Sun dried tomatoes
	Mixed lettuce	Fresh rosemary	Walnut Pieces
	White ciabatta	Broccoli	Linguine
	Spiced beef burger	Whipped cream	Dried oregano
	Piccalilli	Butter	Cooking cream
	Potato wedges		Grated goat cheese
			Mushrooms
Staples	Olive oil	Olive oil	Olive oil
	Honey	White wine vinegar	Vegetable stock
	Extra virgin olive oil	Vegetable stock	Salt and pepper
	Salt and pepper	Salt and pepper	
	Mustard	Mustard	
	Butter		

6 Minced beef, proportion of fat 17%.

Table 5: Meal recipes (beef[7], chicken and vegetarian) for DE&AT region

	Beef recipe	Chicken recipe	Vegetarian recipe
Recipe name	Burger with chimichurri	Mustard crumb-topped chicken	Orzo pasta risotto with smoky mushrooms
Illustration			
Ingredients from meal kit	Brioche roll	Baby spinach	Mushroom / mushrooms brown
	Mozzarella "bocconcino"	Cooking cream (15%)	Spice mix "hello smokey"
	Tomato	Chicken broth	Onion
	Red chili pepper	Shallot	Clove of garlic
	Lemon waxed	Potatoes (triplets)	Cherry tomatoes
	Potatoes (triplets)	Carrot	Tomato pesto
	Parsley	Chicken breast fillet	Orzo pasta
	Clove of garlic	Panko flour	Grated hard cheese
	Simmental minced beef	Grainy mustard	Basil/thyme
		Clove of garlic	Mozzarella
		Butter	Baby spinach, veggie meal
			Vegetable stock
Staples	Olive oil	Olive oil	Oil
	Salt and pepper	Water	Salt and pepper
	Oil	Salt and pepper	Water
			Sugar

7 Minced beef, proportion of fat 20%.

Table 6: Meal recipes (beef[8], chicken and vegetarian) for US region

	Beef recipe	Chicken recipe	Vegetarian recipe
Recipe name	Gouda Vibes Burgers	Balsamic Fig Chicken	Silky Sicilian Mushroom Penne
Illustration			
Ingredients from meal kit	Ground beef	Shallot	Creme Fraiche
	Potato hamburger bread	Balsamic vinegar	Cheese, shredded parmesan
	Gouda cheese	Chicken stock concentrate	Penne pasta
	Yukon B potato	Fig jam	Squash, zucchini
	Yellow onion	Yukon B potato	Mushroom stock concentrate
	Roma tomato	Rosemary	Mushrooms, cremini
	Smoked paprika	Lettuce, mixed greens	Grape tomato
	Mayonnaise	Lemon	Lemon
	Sour cream	Chicken cutlets	Chives
	Chicken stock Concentrate		Spice, Italian Seasoning - "So Delizioso"
Staples	Vegetable oil	Olive oil	Olive oil
	Salt and pepper	Butter	Salt and pepper
	Sugar	Salt and pepper	Butter
		Vegetable oil	

8 Minced beef, proportion of fat 15%.

Table 7: Meal recipes (beef[9], chicken and vegetarian) for AU region

	Beef recipe	Chicken Recipe	Vegetarian recipe
Recipe name	Honey Mustard Beef Burgers	Chicken & Creamy Peppercorn Sauce	Quick Mushroom & Truffle Fettuccine
Illustration			
Ingredients from meal kit	Beef Mince	Green Beans	Green Pear
	Beetroot	Garlic clove	Garlic Clove
	Breadcrumbs	Chicken Breast	Rocket
	Burger bun	Potato Loose Washed Medium Red Skin	Parsley
	Dijon Mustard	Light cooking cream	Baby Spinach
	Garlic Clove	Chicken Stock cubes	Sliced Mushrooms
	Brown onion	Silverbeet	Grated Parmesan Cheese
	Tomato	Black peppercorns	Light Cooking Cream
	Rocket	Walnuts	Fettuccine
	Sweet Potato		Vegetable Stock Pot
	Mayonnaise		Truffle Oil
Staples	Olive oil	Olive oil	Olive oil
	Salt	Butter	Butter
	Brown sugar	Milk	Balsamic vinegar
	Balsamic vinegar	Salt	Honey
	Egg		
	Honey		
	Water		

9 Minced beef, proportion of fat 15%.

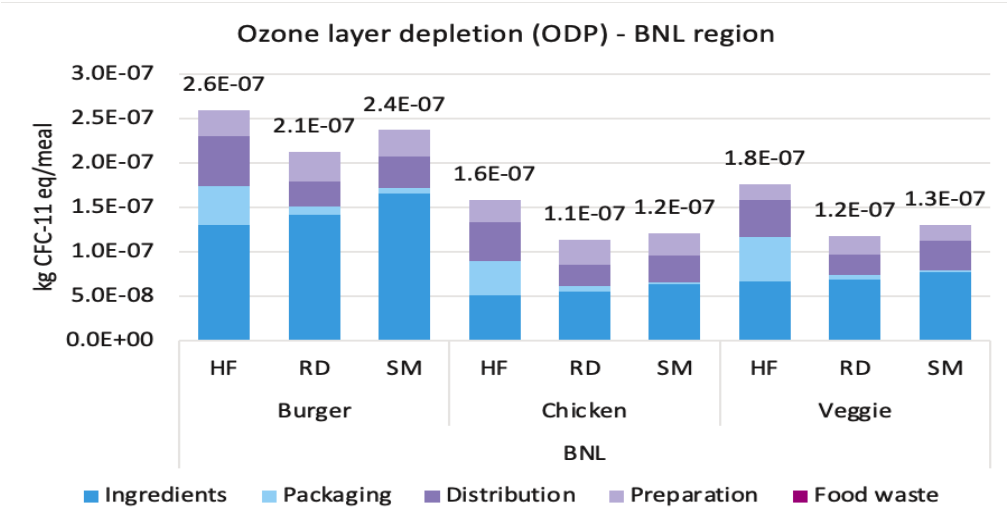
Annex D:
Description of environmental indicators

ENVIRONMENTAL INDICATOR	UNIT	DESCRIPTION
Climate change	kg CO_2 eq	The climate change impact due to greenhouse gas emissions. Also known as a carbon footprint.
Abiotic depletion	kg Sb eq	Category that measures the potential impact on resource depletion from elements resource use. The factors are determined on an ultimate reserves and rate of de-accumulation approach.
Ozone layer depletion	kg CFC-11 eq	Impact category that accounts for the degradation of stratospheric ozone due to emissions of ozone-depleting substances, for example long-lived chlorine and bromine containing gases (e.g., CFCs, HCFCs, Halons). When this ozone becomes depleted, more UV rays reach the earth. Exposure to higher amounts of UV radiation can causes damages to human health such as skin cancer, cataract and weakened immune system.
Acidification	kg SO_2 eq	Impact category that addresses impacts due to acidifying substances in the environment.
Photochemical oxidation	kg C_2H_4 eq	Impact category that accounts for the formation of ozone caused by photochemical oxidation of air emissions in the presence of nitrogen oxides (NOx) and sunlight. High concentrations of ground-level tropospheric ozone damage vegetation, human respiratory tracts, and manmade materials through reaction with organic materials.
Eutrophication	kg PO_4 eq	Impact category that addresses impacts from nutrients (mainly nitrogen and phosphorus) from sewage outfalls and fertilized farmland which accelerate the growth of algae and other vegetation in freshwater.

Annex E:
Key data sources for food loss & waste by provisioning system

PROVISIONING SYSTEM	SOURCE FOR FOOD LOSS & WASTE DATA
HelloFresh	- Primary data from HelloFresh - Caldeira et al. 2019 - Buzby et. Al 2012 - ReFED 2019 - FAO 2011 - McGrath 2021
Restaurant Delivery	- UNEP 2021 - Caldeira et al. 2010 and 2019 - WUR 2020 - Flemish Food Supply Chain Platform for Food Loss 2017 - Buzby et al. 2012 - ReFED 2019 - FAO 2011 - McGrath 2021
Supermarket	- Caldeira et al. 2010 - Verbraucherzentrale 2021 - UNEP 2021 - WUR 2020 - Flemish Food Supply Chain Platform for Food Loss 2017 - Expert judgement (regional warehouse food loss rate) - Buzby et al. 2012 - ReFED 2019 - FAO 2011 - McGrath 2021

Annex F:
Example of ozone layer depletion impact (BNL)



Annex G: References

ABS (2018) Neighbourhood impacts on health. Australian Bureau of Statistics (ABS). https://www.abs.gov.au/articles/neighbourhood-impacts-health#neighbourhood-impacts-on-health

ABS (2020) Waste Account, Australia, Experimental Estimates. Australian Bureau of Statistics (ABS). https://www.abs.gov.au/statistics/environment/environmental-management/waste-account-australia-experimental-estimates/latest-release

Arcadis (2019) National Food Waste Baseline: Final assessment report. Arcadis. https://www.environment.gov.au/system/files/pages/25e36a8c-3a9c-487c-a9cb-66ec15ba61d0/files/national-food- waste-baseline-final-assessment.pdf

Baydar O, Melser C, Zuurmond M (2010) Supermarket within walking distance for most Dutch people. Statistics Netherlands (CBS). https://www.cbs.nl/en-gb/news/2010/36/supermarket-within-walking-distance-for-most-dutch-people.

Beck T, Bos U, Wittstock B, et al (2010) LANCA® Land Use Indicator Value Calculation in Life Cycle Assessment – Method Report. Echterdingen, Germany

Bengoa X., Chappuis C., Guignard C., Liernur A., Kounina A., Papadimitriou C., Rossi V. & Bayart J-B. (2020) World Food LCA Database Documentation. Version 3.5.1, January 2020. Quantis, Lausanne, Switzerland.

BMVBS (2011) Nahversorgung und Nahmobilität: Verkehrsverhalten und Zufriedenheit. Online-Publikation 08/2011. Bundesministerium für Verkehr, Bau und Stadtentwicklung (BMVBS), Berlin, Germany.

BMU (2018) Waste Management in Germany 2018. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), Berlin, Germany.

Bos U, Horn R, Beck T, et al (2016) LANCA® Characterization Factors for Life Cycle Impact Assessment. Version 2.0. Fraunhofer Institute for Building Physics IBP, Stuttgart, Germany.

Boulay A, Bare J, Benini L, et al (2017) The WULCA consensus characterization model for water scarcity footprints: assessing impacts of water consumption based on available water remaining (AWARE). Int J Life Cycle Assess 1–23. https://doi.org/10.1007/s11367-017-1333-8

Caldeira C, De Laurentiis V, Corrado S, et al (2019) Quantification of food waste per product group along the food supply chain in the European Union: a mass flow analysis. Resour Conserv Recycl 149:479–488. https://doi.org/10.1016/j.resconrec.2019.06.011

Datex Corporation (2021) How the Grocery Supply Chain Works. https://www.datexcorp.com/how-the-grocery-supply-chain-works/ . Accessed on 05.07.2021.

DEFAM (2012) Pesticide Usage in Ireland, Mushroom crops survey, report 2011, Department of Agriculture, Food and the Marine, Pesticide Control Division, https://www.pcs.agriculture.gov.ie/media/pesticides/content/sud/pesticidestatistics/Pesticde%20Usage%20-%202011%20Mushroom%20Survey%20Report.pdf

Derwent, R. G., Jenkin, M. E., Saunders, S. M., & Pilling, M. J. (1998). Photochemical ozone creation potentials for organic compounds in Northwest Europe calculated with a master chemical mechanism. Atmos. Environ., 32, 2429–2441.

Dimitri, C., & Effland, A. (2020). From farming to food systems: the evolution of US agricultural production and policy into the 21st century. Renewable Agriculture and Food Systems, 35(4), 391-406.

Dorr, E., Koegler, M., Gabrielle, B., & Aubry, C. (2021). Life cycle assessment of a circular, urban mushroom farm. Journal of Cleaner Production, 288, 125668.

Fight Food Waste CRC (2020) Food Waste Australian Household Attitudes and Behaviours National Benchmarking Study Final Report, Adelaide. Australia.

Flemish Food Supply Chain Platform for Food Loss (2017) Food Waste and Food Losses: Prevention and Valorisation: Monitoring Flanders 2015. Vlaams Ketenplatform Voedselverlies (Flemish Food Supply Chain Platform for Food Loss). https://www.voedselverlies.be/sites/default/files/atoms/files/Monitor_EN_final.pdf

Gaballa, S., & Abraham, A. (2007) Food Miles in Australia: A preliminary study of Melbourne, Victoria. CERES Community Environment Park, Victoria, Australia.

Gallego-Schmid A, Mendoza JMF, Azapagic A (2019) Environmental impacts of takeaway food containers. J Clean Prod 211:417–427. https://doi.org/10.1016/j.jclepro.2018.11.220

Glover, April (2019) Facts, Statistics & Solutions about food waste in Australia. Better Homes and Gardens. https://www.bhg.com.au/food-wastage-in-australia

GRSBeef (2021) https://grsbeef.org/

Guinée, J.B.; Gorrée, M.; Heijungs, R.; Huppes, G.; Kleijn, R.; Koning, A. de; Oers, L. van; Wegener Sleeswijk, A.; Suh, S.; Udo de Haes, H.A.; Bruijn, H. de; Duin, R. van; Huijbregts, M.A.J. (2002) Handbook on life cycle assessment. Operational guide to the ISO standards. I: LCA in perspective. IIa: Guide. IIb: Operational annex. III: Scientific background. Kluwer Academic Publishers, ISBN 1-4020-0228-9, Dordrecht, 692 pp.

Gunady, M. G., Biswas, W., Solah, V. A., & James, A. P. (2012). Evaluating the global warming potential of the fresh produce supply chain for strawberries, romaine/cos lettuces (Lactuca sativa), and button mushrooms (Agaricus bisporus) in Western Australia using life cycle assessment (LCA). Journal of Cleaner Production, 28, 81-87.

GVM (2018) Abfallaufkommen durch Einweggeschirr und andere Verpackungen für den Sofortverzehr. NABU Naturschutzbund and GVM Gesellschaft für Verpackungsmarktforschung mbH, Mainz, Germany.

Heard BR, Bandekar M, Vassar B, Miller SA (2019) Comparison of life cycle environmental impacts from meal kits and grocery store meals. Resour Conserv Recycl 147:189–200. https://doi.org/10.1016/j.resconrec.2019.04.008

Heijungs R, Guinée JB, Huppes G et al (1992) Environmental life cycle assessment of products—guide and backgrounds (part 2)

Hoorn T (2019) "Gaspillage alimentaire dans le secteur de la restauration commerciale : quelles solutions pour la valorisation des déchets ? ". Louvain School of Management, Université catholique de Louvain, 2019. Prom. : Miche, Bernard. http://hdl.handle.net/2078.1/thesis:21071

Huijbregts MAJ, Schöpp W, Verkuijlen E, et al (2000) Spatially Explicit Characterization of Acidifying and Eutrophying Air Pollution in Life-Cycle Assessment. J Ind Ecol 4:75–92

ISO (2006a) ISO 14040:2006(E) Environmental management — Life cycle assessment — Principles and framework. 20.

ISO (2006b) ISO 14044:2006(E) Environmental management — Life cycle assessment — Requirements and guidelines. 46.

Keyes (2021) THE ONLINE GROCERY REPORT: Coronavirus is accelerating US online grocery shopping adoption—here are the market stats, trends and companies to know. Insider Inc. https://www.businessinsider.com/online-grocery-report-2020

Leiva, F. J., Saenz-Díez, J. C., Martínez, E., Jiménez, E., & Blanco, J. (2015a). Environmental impact of Agaricus bisporus cultivation process. European Journal of Agronomy, 71, 141-148.

Leiva, F. J., Saenz-Díez, J. C., Martínez, E., Jiménez, E., & Blanco, J. (2015b). Environmental impact of Agaricus bisporus mycelium production. Agricultural Systems, 138, 38-45.

Leiva, F., Saenz-Díez, J.-C., Martínez, E., Jiménez, E. and Blanco, J. (2016), Environmental impact of mushroom compost production. J. Sci. Food Agric., 96: 3983-3990. https://doi.org/10.1002/jsfa.7587

McGrath D (2021) How Self-Auditing Affected Australian Foodservice Food Waste. PhD Dissertation RMIT University, College of Science, Technology, Engineering and Maths, School of Engineering. https://researchrepository.rmit.edu.au/esploro/outputs/doctoral/Watch-my-waste-how-self-auditing-affected-Australian-foodservice-food-waste/9921998124901341

Maga D, Hiebel M, Aryan V (2019) A comparative life cycle assessment of meat trays made of various packaging materials. Sustain 11:. https://doi.org/10.3390/su11195324

NABU (2020) Vorverpackungen bei Obst und Gemüse – Zahlen und Fakten 2019. 3. Auflage 10/2020. Naturschutzbund Deutschland (NABU) e.V., Charitéstraße 3, 10117 Berlin, Germany.

NABU (2020b) Kunststoffabfälle in Deutschland - NABU-Übersicht zu Aufkommen, Steigerung, Trends 2019. 5. Auflage 11/2020. Naturschutzbund Deutschland (NABU) e.V., Charitéstraße 3, 10117 Berlin, Germany. https://www.nabu.de/imperia/md/content/nabude/abfallpolitik/202008-plastikmuell_final.pdf

Nemecek, T., Bengoa, X., Lansche, J., Mouron, P., Rossi, V., Humbert, S. 2015. Methodological Guidelines for the Life Cycle Inventory of Agricultural Products. Version 3.0. World Food LCA Database. Quantis and Agroscope.

Nikoličić S, Kilibarda M, Atanasković P, et al (2015) Impact of RFID Technology on Logistic Process Efficiency in Retail Supply Chains. PROMET – Traffic & Transportation 27:137–146. https://doi.org/10.7307/ptt.v27i2.1539.

NRDC (2017). Wasted: How America is losing up to 40 percent of its food from farm to fork to landfill. Second edition of NRDC's original 2012 report. Natural Resources Defense Council.

Nunes ÓS, Gaspar PD, Nunes J, et al (2020) Life-cycle assessment of dairy products-Case study of regional cheese produced in Portugal. Processes 8:. https://doi.org/10.3390/PR8091182

Ocado (2018) Article "Ocado reveals near zero food waste levels" https://www.ocadogroup.com/media/press-releases/year/2018/ocado-reveals-near-zero-food-waste-levels

O'Farrell, Kyle (2020) National report – Final report: 2018–19 Australian Plastics Recycling Survey. Envisage Works – Positive Impact Consulting. https://www.environment.gov.au/system/files/resources/42de28ac-5a8e-4653-b9bd-7cc396c38fba/files/australian-plastics-recycling-survey-report-2018-19.pdf

Orlando, D. (2017) Majority of shoppers still shunning digital despite interest in alternatives. Supermarket news. https://www.supermarketnews.com/consumer-trends/majority-shoppers-still-shunning-digital-despite-interest-alternatives.

PlasticsEurope (2020) Plastics – the Facts 2020: An analysis of European plastics production, demand and waste data. PlasticsEurope. Wemmel, Belgium.

https://www.plasticseurope.org/application/files/5716/0752/4286/AF_Plastics_the_facts-WEB-2020-ING_FINAL.pdf

Potočnik, I. S., Stepanović, M., Rekanović, E., Todorović, B., & Milijašević-Marčić, S. (2015). Disease control by chemical and biological fungicides in cultivated mushrooms: button mushroom, oyster mushroom and shiitake. Pesticides and Phytomedicine/Pesticidi i fitomedicina, 30(4).

Reap, J., Roman, F., Duncan, S., Bras, B. (2008) A survey of unresolved problems in life cycle assessment. Part 1: goal and scope and inventory analysis. Int J Life Cycle Assess 13(4): 290-300

ReFED (2019) Food Waste Monitor. https://insights-engine.refed.org/food-waste-monitor?view=overview&year=2019

Robinson, B., Winans, K., Kendall, A., Dlott, J., & Dlott, F. (2019). A life cycle assessment of Agaricus bisporus mushroom production in the USA. The International Journal of Life Cycle Assessment, 24(3), 456-467.

Schmidt T, Schneider F, Leverenz D, Hafner G (2019) Lebensmittelabfälle in Deutschland – Baseline 2015. Braunschweig: Johann Heinrich von Tühnen-Institut. DOI: 10.3220/REP1563519883000

Snijder L, Nusselder S (2019) Plastic use and plastic waste processing in the Netherlands. CE Delft. Delft, The Netherlands. https://cedelft.eu/wp-content/uploads/sites/2/2021/03/CE_Delft_2T13_Plasticgebruik_en_plastic_afval_verwerking_NL_DEF.pdf

Speck M., Buchhorn F., Caplan A., Nikravech M., Schuster S., Bickel M., Keskin E., Suski P. (2020) HelloFresh Global Food Waste Study. Wuppertal Institut für Klima, Umwelt, Energie GmbH. Wuppertal, Germany.

Steeneken F., Ackley, D. (2012) A Complete Model of the Supermarket Business. BPTrends. https://www.bptrends.com/publicationfiles/01-03-2012-ART-Supermarket%20Article-steeneken-Ackley%20111226.pdf

Takacs B, Borrion A (2020) The use of life cycle-based approaches in the food service sector to improve sustainability: A systematic review. Sustain 12:. https://doi.org/10.3390/SU12093504

Trapp, Markus; Lütjen, Michael; Arango Castellanos, Juan Daniel; Jelsch, Oliver; Freitag, Michael (2017) Life cycle assessment for frozen food distribution schemes,In: Jahn, Carlos Kersten, Wolfgang Ringle, Christian M. (Ed.): Digitalization in Maritime and Sustainable Logistics: City Logistics, Port Logistics and Sustainable Supply Chain Management in the Digital Age. Proceedings of the Hamburg International Conference of Logistics (HICL), Vol. 24, ISBN 978-3-7450-4332-7, epubli GmbH, Berlin, pp. 267-284, http://dx.doi.org/10.15480/882.1490

United Nations Environment Programme (UNEP) (2021). Food Waste Index Report 2021. Nairobi.

U.S. Department of Agriculture, National Agricultural Library (2021a) Definition “Local Foods”. https://www.nal.usda.gov/legacy/aglaw/local-foods#quicktabs-aglaw_pathfinder=1

U.S. Department of Agriculture, Economic Research Service (2021b) Marketing Practices and Financial Performance of Local Food Producers: A Comparison of Beginning and Experienced Farmers. https://www.ers.usda.gov/webdocs/publications/101786/eib-225.pdf?v=6670.6

U.S. Environmental Protection Agency (2020a) National Overview: Facts and Figures on Materials, Wastes and Recycling. https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials

U.S. Environmental Protection Agency (2020b) 2018 Wasted Food Report. Office of Resource Conservation and Recovery. https://www.epa.gov/sites/production/files/2020-11/documents/2018_wasted_food_report-11-9-20_final_.pdf

van Dooren, Corné (2019) Synthesis report on Food Waste in Dutch Households in 2019. The Netherlands Nutrition Centre (Voedingscentrum). The Netherlands, Den Haag. https://www.voedingscentrum.nl/Assets/Uploads/voedingscentrum/Documents/Professionals/Pers/Persmappen/Verspilling%202019/VC_Synthesis%20report%20on%20food%20waste%20in%20Dutch%20households%202019.pdf

van Oers L, de Koning A, Guinée JB, Huppes G (2002) Abiotic resource depletion in LCA. Dutch Road and Hydraulic Engineering Institute, The Netherlands.

van Oers L, Guinée J (2016) The Abiotic Depletion Potential: Background, Updates, and Future. Resources 5:16. doi: 10.3390/resources5010016

Ver Ploeg M, Mancino L, Todd J, Clay DM, Scharadin B (2015) Where Do Americans Usually Shop for Food and How Do They Travel To Get There? Initial Findings From the National Household Food Acquisition and Purchase Survey, EIB-138, U.S. Department of Agriculture, Economic Research Service.

Verbraucherzentrale NRW e.V. (2021) Essen außer Haus: Was in Töpfen und auf den Tellern bleibt. https://www.verbraucherzentrale.de/wissen/lebensmittel/auswaehlen-zubereiten-aufbewahren/essen-ausser-haus-was-in-toepfen-und-auf-den-tellern-bleibt-59537

Weidema, B.P., Bauer, C., Hischier, R., Mutel, C., Nemecek, T., Reinhard, J., Vadenbo, C.O., Wernet, G. (2013). Overview and methodology. Data quality guideline for the ecoinvent database version 3. Ecoinvent Report 1(v3). The ecoinvent Centre. St. Gallen, Switzerland.

WUR (2020) Dutch supermarkets provide insights into food waste. Wageningen University & Research (WUR). https://www.wur.nl/en/Research-Results/Research-Institutes/food-biobased-research/show-fbr/Dutch-supermarkets-provide-insights-into-food-waste-F00DWa5.htm

JRC, Zampori L, Pant R (2019) Suggestions for updating the Product Environmental Footprint (PEF) method. Luxembourg