

Report 2024

Environmental footprint of the food saved by Too Good To Go V1.1



Blonk
CONSULTANTS

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About us

Blonk, a Mérieux NutriSciences Company is a leading international expert in food system sustainability, inspiring and enabling the agri-food sector to give shape to sustainability. Blonk's purpose is to create a sustainable and healthy planet for current and future generations. We support organizations in understanding their environmental impact in the agri-food value chain by offering advice and developing tailored software tools based on the latest scientific developments and data.

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Summary

Goal and scope of this study

Too Good to Go is the company behind the app which enables surplus food to be sold before its expiration date in 15 European countries, the US and Canada. By saving the food, food waste is avoided to a certain extent and food resources are applied more efficiently. Hereby, environmental impacts associated with food waste treatment and food production are decreased, leading to a potential reduction in environmental impacts like greenhouse gas emissions (e.g. CO₂), water use and land use. Too Good to Go wishes to improve their environmental monitoring for communication purposes and in anticipation of higher demands in clarity from the upcoming EU directive on “green claims” (European Commission, 2023).

The goal of this study is therefore to investigate the environmental impact of Too Good to Go’s activities to save food from being disposed, hereafter called “surplus food”. The impact per kilogram of food saved was calculated by comparing two scenarios: the reference scenario, in which the surplus food is being disposed of via common waste treatment pathways, and the alternative scenario, in which the surplus food is “saved” via Too Good To Go, and is consumed by humans.

Main result

The alternative scenario in which Too Good To Go’s products save food from waste pathways (reference scenario), currently reduces the climate change impact of the food system by avoiding 2.65 kg CO₂ eq. per kilogram of surplus food saved. In this result, the effect of Land Use Change (LUC) is included in order to show the widest range of environmental impacts. However, since LUC is a difficult category to measure, results are also presented without LUC; then the net impact is a bit smaller: -2.02 kg CO₂ eq./kg surplus food. The water use and land use results also showed Too Good To Go’s solutions deliver a net impact of -2.76 m²a cropland eq. / kg surplus food and -0.81 m³ depriv./ kg surplus food respectively.

Main contributions in the reference scenario

The overall climate change impact for the reference scenario was relatively small at 0.12 kg CO₂ eq./kg surplus food. The waste treatment pathways accounted for included landfill, recycling (anaerobic digestion), composting and incineration. The associated burdens and credits of these pathways were included with the landfill pathway representing the hotspot, mainly due to methane emissions.

Too Good To Go alternative scenario: Surprise Bags & Magic Parcels

In the Too Good To Go alternative scenario, the footprint of an average Surprise Bag contributed to the majority of the avoided impact since they also represent the largest market share (99% of total tonnage). Consequently, Magic Parcels had a very small contribution in the overall results (<1%). Additional activities included in analysis, like packaging and waste at the consumer, contributed a relatively small impact to this scenario. Transport of the Surprise Bags did contribute quite significantly, offsetting more than 10% of the avoided impacts, although this is not based on primary data.

Too Good To Go alternative scenario: regional differences

The results just discussed all relate to the climate change impact (incl. LUC) for the overall (*All Regions*) scenario. Given the weighted average favoured the much larger current market Europe (by total tons saved it represented 94%), the results discussed above reflect the same trends for this region. North America’s net showed an almost 15% higher environmental benefit to the scenario compared to ‘All regions’ and Europe, but given the uncertainties, this is close to insignificance. Nevertheless, all results for food savings (without the losses and additional activities) are in the same order of magnitude as the FAO food wastage footprint of -2.53 kg CO₂ eq./kg of waste food¹ (which is without LUC, so including LUC would bring the numbers even closer together).

Sensitivities: functional equivalence, “real” surplus food and robustness of the land use assessment

Three sensitivity analyses were executed in order to validate the main assumptions and methodological choices, but neither of them changed the main conclusions of the research. It was concluded that the assumptions on

¹ FAO (2013) report an annual 3.3 Gton CO₂ eq. for 1.3 Gton of wastage of edible food.

functional equivalence of the saved food (displacement factor) and the principle of surplus food, significantly influence the net impact result of Too Good To Go as evidenced by these sensitivity analyses. Uncertainties in the displacement factor could lead to a +/- 16% difference in net impact result for Too Good To Go. The uncertainty about the "real" waste factor is very influential, but hard to quantify. Thirdly, the robustness of the land use methodology was concluded to be appropriate for the given study, by using the characterized interpretation of the ReCiPe 2016 method, by which all land occupations are expressed in "m²a cropland equivalents". This does not alter the conclusions.

Recommendations for next steps for Too Good To Go

As a first step in the expression of Too Good To Go's environmental impact, this research provided useful insights in the origins and hotspots of environmental impacts. To bring this further in the coming years, the several follow-up actions are recommended to improve the certainty of the results, to ensure the continuity and validity of Too Good To Go's products, and to gain more insight into the respective products and markets.



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1. Introduction

1.1. Occasion, goal & intended application

1.1.1. Occasion: the question of Too Good To Go

Too Good to Go is the company behind the app which enables surplus food to be sold before its expiration date in 15 European countries, the US and Canada. By saving the food, food waste is avoided to a certain extent and food resources are applied more efficiently. Hereby, environmental impacts associated with food waste treatment and food production are decreased, leading to a potential reduction in environmental impacts like greenhouse gas emissions (e.g. CO₂), water use and land use.

Too Good to Go wishes to communicate their environmental results and has already taken some investigative steps. In 2021, Too Good To Go measured its carbon footprint with their partners Plan A and Planetary. Currently, they communicate their greenhouse gas emission reduction expressed in CO₂ equivalents (CO₂ eq.), based on average FAO data (related specifically to the amount of food waste internationally and the associated CO₂ eq. emissions). As a next step, Too Good To Go wishes to improve their environmental monitoring for communication purposes and in anticipation of higher demands in clarity from the upcoming EU directive on “green claims” (European Commission, 2023).

1.1.2. Goal

The goal of this study is to investigate the environmental impact of Too Good to Go’s activities to save food from being disposed, hereafter called “surplus food”. The impact per kilogram of food saved will be calculated by comparing two scenarios: the reference scenario, in which the surplus food is being disposed of via common waste treatment pathways, and the alternative scenario, in which the surplus food is “saved” via Too Good To Go, and is consumed by humans. These scenarios are explained in more detail in chapter 2. The environmental impacts will be calculated by means of a consequential Life Cycle Assessment. This methodology is further explained in Appendix I. In case of data gaps or other methodological issues, general principles from the (draft) European methodology for Product Environmental Footprinting (PEF) are used (Zampori et al., 2019).

This study will have an explorative nature and will not provide a detailed analysis of all food items and nation-specific characteristics which are in the portfolio of Too Good To Go, but will instead aim to provide insight into the company’s results in general terms. By means of this research, a solid basis is provided for further expansion of the company’s products and geographical representation.

1.1.3. Intended application & critical review

The results of this study, the environmental footprint claim regarding the saved food, will be used to inform strategy within Too Good To Go and will also be published in both external and internal communication and marketing. The results will not be used for comparative assertions.

Given the ISO standards (ISO 2006a, 2006b) require an external review before publication, this consequential LCA is being performed by Blonk Consultants and independently reviewed by three food sustainability experts: Joseph Poore, Director of the Oxford Martin Programme on Food Sustainability Analytics, Oxford University, supported by Valentina Caldart, Agri-Environmental data lead at the same institute, and Hamish Forbes, senior analyst at the Waste and Resources Action Programme (WRAP). Their review statement is submitted in Appendix IV.

1.2. Scope of this research

1.2.1. Functional unit

A functional unit is a quantified description of the performance requirements that the product system fulfils. The upstream productions burdens associated with generating the surplus food are out of scope of this study. Instead,

the focus is on downstream management of the food either through waste treatment pathways or Too Good To Go's products for consumption.

Therefore, the functional unit of this research is defined as: **1 kg of surplus food going to waste treatment pathways or to the consumer**. In this definition, the pathway from almost expiring food to charity (food banks) is out of scope, since it is the company's mission to not compete with charity but to provide a solution for the food waste which has no other useful application. The validity of this scope is evaluated in one of the sensitivity analyses.

1.2.2. Products analyzed in this study

Too Good To Go enables food saving through three products: Magic Parcels, Surprise Bags and the Too Good To Go Platform. Magic Parcels and Surprise Bags are the two products in scope for this study. The contents of each product include a broad range of foods, from savoury to sweet, as Too Good To Go is partnered with a variety of food manufacturers, retailers and food service businesses across Europe and North America. The content and point of sale for each of these product types is discussed further in chapter 2.

Contrarily to the Magic Parcels and Surprise Bags, Too Good To Go's third product, the Platform, is not targeted at consumers but specifically for retailers, enabling them to improve their stock management towards the goal of reducing food waste. In the holistic view of Too Good To Go, the Platform is a crucial factor. However, due to limited data on its use, e.g. trends in 'saved food' before and after it was introduced, it is not possible to calculate the individual impact of the Platform yet, and therefore it is excluded from the scope of this study.

1.2.3. Geographical and temporal scope

Surprise Bags

Consumers across 15 European countries, the US and Canada can select, pay for and pick up a bag of surplus food prepared by a retailer or food service outlet (restaurant, supermarket, bakery, etc). In this study, Europe will be treated as a single market with data from the most active countries used to calculate a representative average footprint for a Surprise Bag weighing 1.5kg (as based on a sample size by Too Good To Go of 200 random Surprise Bags). The US data will be used to calculate the footprint for North America with the same reasoning. Data from the whole year 2022 will be used.

Magic Parcels

Too Good To Go is responsible for packing surplus foods from manufacturers and arranging the delivery to the consumer. As a result, the contents again are highly variable but with a longer expiry date. This product is newer and is currently being rolled out across Europe. The countries which have produced the most boxes since September 2022 up till May 2023 will be used for the representative average box calculation.

1.2.4. System boundary

General approach and cut-offs

For both scenarios, the general approach was to provide an overview of average processes and impacts, reflecting the most common practises. As a general principle, completeness was prevailed over preciseness, meaning that a selection of the most relevant processes was made in order to calculate the full picture, without diving into details. What this means in practise for each scenario, is explained in the next subsections. In both scenarios, capital goods were not modelled in detail, but taken from the generic datasets (ecoinvent).

Since it is the aim of this study to focus on the comparison of activities happening in both scenarios, the environmental impacts related to the development, use and maintenance of digital applications (e.g. waste management monitoring systems in the reference scenario, and Too Good To Go's app in the alternative scenario) is not included in the scope of the research.

Reference scenario

Figure 1 shows the system boundaries of the reference scenario, in which the surplus food cannot be sold and follows a certain waste treatment pathway. Some of the waste treatment pathways deliver valuable outputs like heat, which are accounted for as environmentally beneficial ("avoided" impact) in the LCA. As said before, food remains which go to charity are out of scope, because Too Good To Go wishes only to focus on the "real waste" streams. Minor impacts, like waste collection bags or bins, were not taken into account.

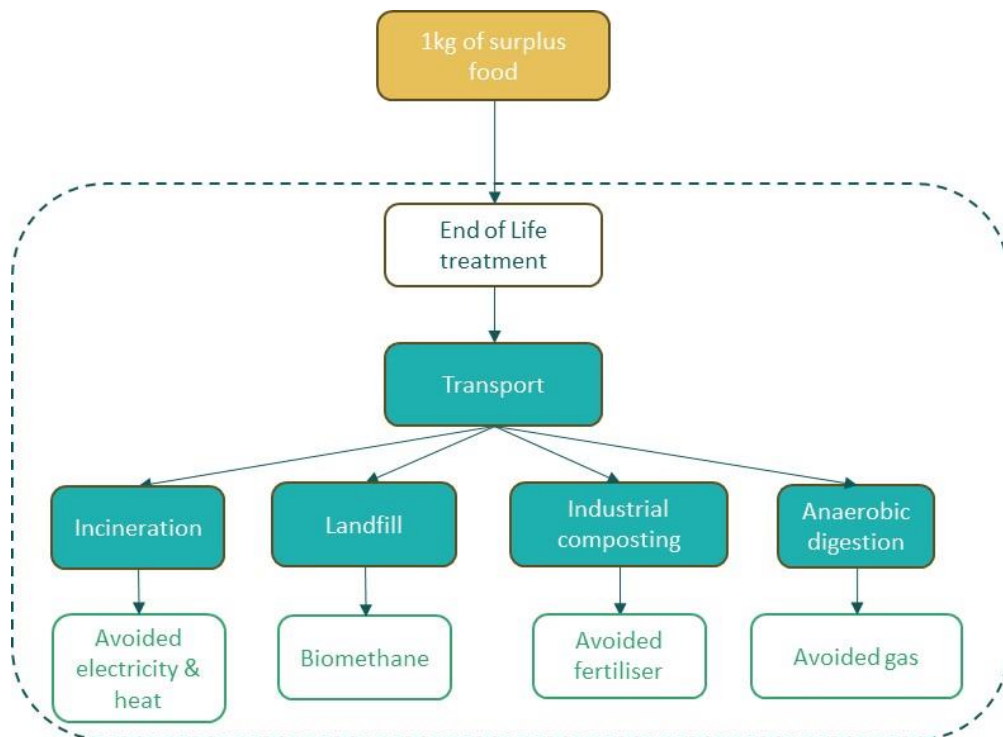
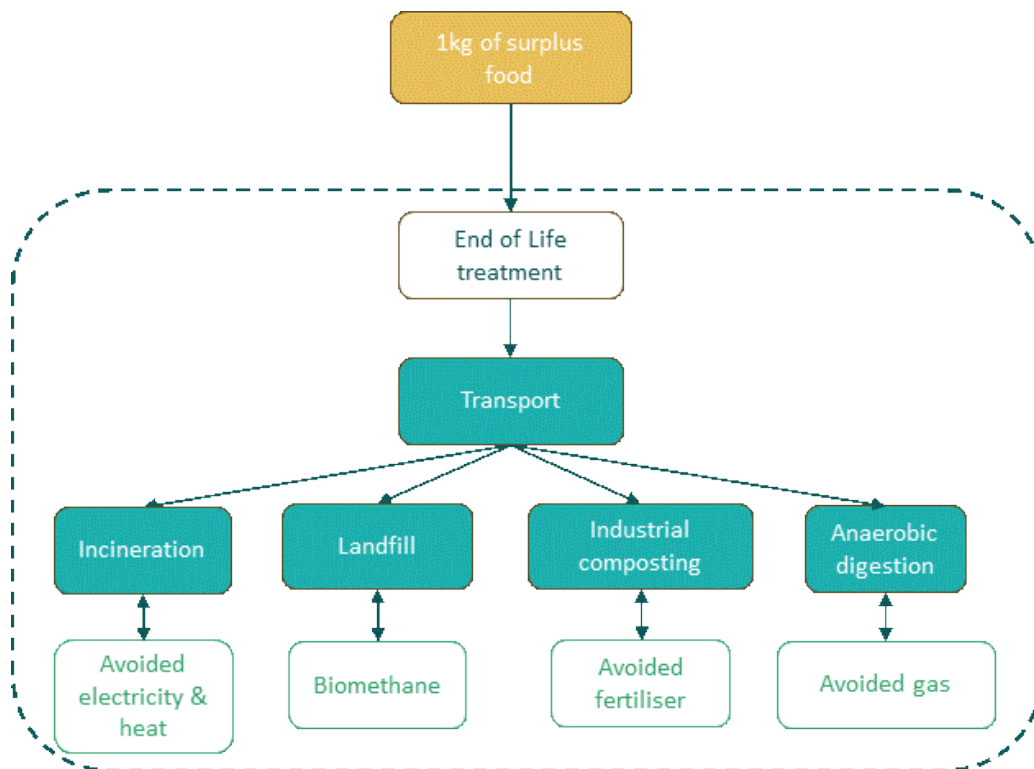


FIGURE 1 SYSTEM BOUNDARIES OF THE REFERENCE SCENARIO

Alternative scenario

Figure 2 shows the system boundaries of the alternative scenario, in which Too Good To Go enables the saving of surplus food and thereby avoiding new food production. The use phase is explicitly excluded from the scope of this study, since it is not relevant in the impact calculation; both surplus food as well as new food would need to be stored, processed, cooked et cetera, so there this is not a distinctive characteristic of the alternative scenario. For

Magic Parcels, (some) transport from manufacturer to Too Good To Go's distribution locations is happening, but not included in the calculations because Magic Parcels are reflecting only a minor part of the total impact. End of life of the packaging was not taken into account either, because of its expected small contribution to the total impact.

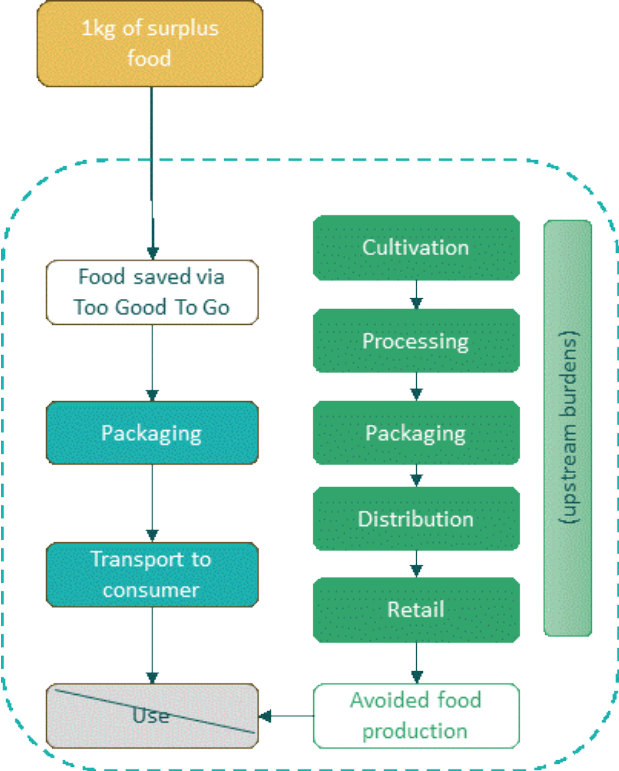


FIGURE 2 SYSTEM BOUNDARIES OF THE ALTERNATIVE SCENARIO (FOOD SAVED VIA TOO GOOD TO GO)

1.2.5. Displacement and waste of food

An important factor in this study is the displacement factor of the food “saved” via To Good To Go: how much of the food is actually displacing the same function, and to what extent are consumers purchasing “additional” or different food items via Too Good To Go? In a research by Wageningen University (Van der Haar & Zeinstra, 2019) for Too Good To Go, it was concluded that 90% of the purchased Surprise Bags were being “consumed and displacing new food”. Hence, we used the 90% displacement factor for all products in the Surprise Bags.

The inference here was that consumers are purchasing surplus food from stores they prefer and for a specific food function (e.g. bakery for bread, food service to replace a meal) and not to for additional functions (i.e. buying food they would not purchase commonly). In these cases, the items in the Surprise Bag would fulfil the same functions and potentially displace new food. Basic categories like the “Grains and grain-based products” and “Composite dishes” categories accounted for >50% of the content across the investigated countries’ Surprise Bags. Second, it could be assumed the additional bonus items which would fall out of the remit of a normal shop, would be luxury items such as those in the “Sugar and similar, confectionery and water-based sweet desserts” category. The percentage for this category (rescaled due to the exclusion of the few smaller food categories) in the Surprise Bags is rather limited, ranging from 3-7% (see more about the categories in chapter 2). Therefore, it was concluded that the 90% displacement factor would be a representative number for the goal of this study.

Besides the displacement discussion, there is an inherent assumption that not all food purchased can be consumed before fully expiring, even though Too Good To Go provides guidance their partners that all distributed food should be consumable. To account for this (un-surveyed) likelihood, a 10% waste factor is applied additionally to the displacement factor. The application of both factors might lead to an overestimation of the waste (and thus an underestimation of Too Good To Go's avoided CO₂ eq. emissions), since non-specific food donations are evaluated at 78% effective consumption (Sundin et al., 2022) while Too Good To Go's concepts enable a more specific food selection taking into account personal preferences in flavour, amounts and diet (by the nature of

selecting a specific type of Surprise Bag or Magic Parcel). The results may thus be considered on the conservative side.

Lastly, it should be noted that the forelying research aims to quantify the potential impact of saving food, by calculating the potential avoidance of environmental impacts due to food production. Obviously, it cannot be calculated directly how much food items are “not produced” due to the food savings by Too Good To Go. This research reflects thus a potential impact and not a measured impact.

1.2.6. Impact assessment methodology

The environmental impacts of these scenarios under study are evaluated using multiple methods: for the climate change impact, the IPCC 2021 GWP100 V1.01 (Forster et al., 2021) is selected as it includes the most up-to-date accepted global warming potential (GWP) characterisation factors². Greenhouse gas emissions caused by land use change (LUC, for example as a result from deforestation) are included in the climate change impact category, but are also reported separately without LUC, in line with certain European guidelines for specific food products (e.g. the PEFCR for Dairy products; European Commission, 2018). LUC emissions are calculated according to the PAS 2050:2011 method (BSI, 2011), as is also required in the European guidelines. The inclusion of LUC in the methodology means that all types of land use change are included in the calculations, affecting the carbon balance either negatively (e.g. deforestation due to land occupation for food production or other activity and thereby carbon losses) or positively (i.e. when food is saved, food production may be avoided, and thereby land conversion may be reversed, resulting in for example afforestation and carbon sequestration). LUC data have not been developed specifically for this study, but were taken from the applied databases, which include a 20 year period of equal amortization. More information can be found in for example the Agri-Footprint methodology report Part 2, section 3.2.4 (Blonk et al, 2023) as well as in Appendix I of this report.

There are many environmental impact assessment methodologies which cover a wide range of impact categories, aiming to provide the most complete overview of environmental impact. For clarity and comprehensiveness, only the impact categories which are mostly associated with food production (besides climate change) in public communication will be communicated in the main body of this report: land use and water use. The EF3.0 method consists of a standardized set of 16 environmental impact categories and indicators which is developed by the European Commission. However, since the unit of the results is difficult to understand for the intended audience (the unit “points” being too abstract to be used in public communication without further reference) and the fact that the methodology concerns severe uncertainties, it was decided to apply the EF method only for the water use and apply a different methodology for calculating land use impacts: ReCiPe 2016 (Huijbregts et al., 2016). The ReCiPe method is selected because it is an internationally accepted method which provides land use results in the most comprehensive way (m²a cropland equivalent). Nevertheless, the different options for land use impact assessment will be evaluated in a sensitivity analysis. Water use, as calculated by the EF method, is expressed as the deprivation of freshwater, taking into account regional differences in the effect of water consumption from various sources.

Midpoint impact category	Method	Unit
Climate change (incl. LUC)	IPCC 2021 GWP100 V1.01	kg CO ₂ eq.
Climate change (excl. LUC)	IPCC 2021 GWP100 V1.01	kg CO ₂ eq.
Land use	ReCiPe 2016	m ² a cropland eq.
Water use	EF 3.0	m ³ deprivation

1.2.7. Data requirements

The data, assumptions, and models in this LCA study are aligned with the level of detail and preciseness as formulated in the goal and scope; this is an explorative study aiming to provide insight in the impact of the companies’ products, and hence a mix of primary data and pragmatic choices for secondary data and assumptions is applied to realize these insights.

The leading principle is to apply primary data from Too Good To Go for the foreground processes, e.g. the amount and type of food products involved. The environmental impact of those food products is subsequently

² IPCC’s sixth assessment report (AR6, 2021) instead of IPCC’s fifth assessment report (AR5, 2013).

calculated by means of general LCA databases. The same holds for the reference scenario, where international statistics are sought to model waste treatment pathways, while their environmental impacts are based on secondary data from LCA databases. Allocation is not executed specifically for this study; general databases have been followed, including their embedded allocation procedures.

The following two databases are used in the calculations:

A) Food products at manufacturing/retail: expert database

This expert database developed Blonk Consultants and contains Life Cycle Inventories (LCIs) for different food products consumed in the Netherlands. The database is in alignment with Product Environmental Footprint (PEF) methodology and makes use of the newest Agri-footprint version (6.3) and Ecoinvent cut-off processes. The expert version is not published yet.

B) Waste management, transportation and packaging: Ecoinvent v3.8 cut-off

The Ecoinvent v3.8 database contains LCI data from various sectors such as energy production, transport, building materials, production of chemicals, metal production and fruit and vegetables. The entire database consists of over 20,000 interlinked datasets, each of which describes a life cycle inventory on a process level. In principle, the cut-off database is used, unless indicated otherwise.

To showcase important aspects to be considered regarding the consistency in this report, the data of both scenarios has been checked based on the following criteria:

- Data quality³

The data quality in the reference scenario is fair. This data is largely based on literature, defaults and background database. No primary data were collected for this scenario.

The data quality in the alternative scenario would rank as good. The primary data is recent and comes from the area under study, however, the avoided food production data from the expert database represents the Dutch market only. However, since many food products are from an international production source (i.e. the Dutch market does not represent only food grown in the Netherlands), we consider the representativeness of this database as sufficient for the generic nature of this study.

- Geographical representativeness

The reference scenarios use rest-of-world datasets for waste treatment modelling.

The primary data comes from all areas where Too Good To Go is active. However, the reference products are representative of the larger markets only. Avoided food production data comes from a Dutch database and is taken as a proxy for the whole of Europe and North America. However, since a large part of the food in the Netherlands is imported from international destinations, these data are to a certain extent internationally applicable.

- Temporal representativeness

The primary data for both scenarios is from 2022/2023. The secondary data comes from the latest version of the given databases at the start of the project, which have all been updated in 2023.

- Allocation rules

Whenever a production process delivers multiple products, the environmental impacts of this process has to be divided in some way over these products. In LCA, this division is called "allocation" and the chosen allocation method should be explained in every LCA report. In this project, the foreground data does not require allocation. The used background databases for agricultural products apply economic allocation consistently (in line with PEF CR feed) with the only exception being biophysical allocation for dairy products in alignment with the IDF (van Paassen, 2023).

³ Data quality can range from poor, fair, good, very good to excellent, following the general European guidelines for LCA (PEF: Zampori & Pant, 2019).

- System boundaries

Reference scenario: all life cycle stages for waste treatment modeling are assessed, including transport to the waste treatment location. In addition, the background data account for the production and consumption of all inputs for each treatment scenario.

Alternative scenario: all lifecycle stages are considered from cradle-to-consumer, the use phase is excluded.

- Impact assessment methodology

A selection of impact categories of the EF and ReCiPe methodology are calculated and reported. The focus of the interpretation will be on the climate change impact, supplemented with land use and water use impact categories because they are the most comprehensive and often communicated impact categories for food LCAs in public communication.

2. Data & modelling

2.1. Reference scenario

2.1.1. Surplus food destinations: waste treatment pathways

Surplus food may follow a range of waste treatment pathways. The *What a Waste2.0 Report* (Kaza et al., 2018)⁴ was used to allocate a percentage share to each applicable waste stream. The European countries where Too Good To Go currently operates according to the 2022 data, were used to arrive at a weighted average for the European percentage (based on Surprise Bag tonnage for each respective country). The same process was used for North America. The breakdown for the regions in scope is summarized in Table 1. The processes and databases used to model the impacts are given in Table 14 in Appendix II.

The transportation of the surplus food to the waste treatment facility is not included in the background data for these pathways. Default values are given in the PEF (product environmental footprint) method from the European commission (EC, 2022) for such data gaps. Therefore, a distance of 100km was used from this source and modelled as lorry >32 metric ton transportation. By lack of similar guidelines for Northern America, the same value was applied for the Northern American calculations as well.

TABLE 1 Waste stream percentage following each pathway for Europe, North America and All regions. Data adapted from the WHAT A WASTE2.0 REPORT (KAZA ET AL., 2018).

Waste treatment pathway	All regions	Europe	North America
Landfill (unspecified)	20%	18%	58%
Recycling (anaerobic digestion)	29%	29%	31%
Composting	18%	20%	1%
Incineration	33%	34%	10%

2.1.2. Avoided products generated in the waste treatment pathways

The recycled fraction of the *What a Waste2.0* data was assumed to go to anaerobic digestion, since this is the only apparent type of “recycling” of (packed) food. The anaerobic digestion process results in the production of (bio)gas and digestate, thereby avoiding the production of fossil gas.

Industrial composting is another waste stream producing an avoided product. For each kilogram of surplus food managed, 0.5kg of compost is generated according to the consequential dataset, *Biowaste {CH₃} | treatment of biowaste, industrial composting*. The credit of the avoided compost was calculated by adapting this dataset and using the cut-off database.

Heat and electricity are generated during the incineration process as byproducts. An adapted consequential background process (“treatment of biowaste, municipal incineration GLO”) was used to model these energy products, resulting in 0.11 kWh of electricity and 1.00 MJ of heat, which are recycled immediately as inputs for the municipal biowaste incineration facility and thus deliver only a small environmental benefit.

2.2. Alternative scenario

2.2.1. Product portfolio of Too Good To Go

As explained in chapter 1, both Magic Parcels and Surprise Bags are included in the scope of this LCA. However, these products are not saved in equal volumes. Magic Parcels are a newer product and are only available in a

⁴ Data was taken from Appendix B: Waste Treatment and Disposal by Country or Economy. Note, the waste generation data used in the report does not distinguish between surplus food and other sources. Moreover, there is no distinction made on the point of collection in the data used. Therefore, the applied values are a best guess approximation of food waste treatment across the regions in scope from a single source.

few European markets so far have only been introduced in September 2022. Data collected on the contents of these parcels from this date until June 2023 was used to identify the main content products in Belgium and the Netherlands. Similarly, data on the contents of the Surprise Bags was from the 2022 production year. However, to compare the most representative tonnage saved through each product, the study calculated the ratios from the production data of each product from the first six months of 2023.

TABLE 2 TOTAL TONNAGE SAVED PER PRODUCT AND REGION JANUARY-JUNE 2023.

Product	Unit	EU	North America	All Regions	Comment
Surprise Bags	Amount of "meals"	47,332,095	3,028,799	50,360,894	Saved Surprise Bags are registered as "meals" by Too Good To Go. According to internal research, Too Good To Go estimates that an average Surprise Bag weighs 1.5 kg.
	Conversion to kg	70,998,143	4,543,199	75,541,341	
Magic Parcels	Amount of "meals"	226,691	N/A	226,691	Average weight (4.4 kg) calculated by means of the data provided by Too Good To Go for Magic Parcels content in two countries.
	Conversion to kg	997,440		997,440	
Ratio SP:MP		99%	100%	99%	This value is used to calculate the total impact of Too Good To Go. This value is used for determining the waste treatment pathways
Ratio EU:NA				94%	

2.2.2. Surprise Bags

Given both data and time restrictions, it is not possible to calculate the footprint of each individual bag. Therefore, the largest Too Good To Go countries (by total tons handled) in 2022 were used to calculate representative Surprise Bags for the two regions. In Europe these were France and the United Kingdom⁵. In North America, consisting of the US and Canada, the US was the largest market (Table 21 in Appendix II).

To arrive at an illustrative typical footprint of a bag, Too Good To Go provided various data related to quantities sold per country. This data was also split into categories, although these labels were not always indicative of the contents e.g. 'other', 'ambient', or 'meal'. Therefore, for each bag, the contents as reported by the consumer were used to map the overall spread of products in the bags. The description of the items were more detailed on the types of food contained within, e.g. sausages, apples and croissants. This led to the following approach:

1. A list of all the different item descriptors for the Surprise Bags was compiled for each studied country.
2. Each individual item descriptor was given a label from the EU FoodEx classification categories: tier L1. E.g. Bread -> Grains and Grain based products (see Table 3).
3. The top three items in each category (number of times mentioned as an item descriptor) were matched to the closest representative food item in the expert database to attain indicative emission factors.
4. The environmental footprint of each category was calculated based on the weighted average of these top three products.
5. The overall bag footprint was calculated using a weighted average of the individual category footprints, based on the weights per category as resulted from step 2 (summarized in Appendix II for each country).

The expert database was built for the Dutch consumer market and contains a limited number of food items, but since it is the most extensive food item database, covering a wide range of production locations worldwide, it was considered the most appropriate database for this study. Therefore, some products do not have an exact match.

⁵ In Europe, Germany is the third big market with a marginal difference in comparison to the UK. However, given the very rough approach of this study, including more countries would not lead to significantly better results. If more regionalized results are desired, this could be included in a follow-up research. Without doing the full analysis, it is currently not possible to estimate the differences between the countries.

Proxies were chosen based overlapping ingredients or similar characteristics such as processing or cultivation method using the practitioner’s own research and expertise.

TABLE 3 TOP 10 EU FOODEx CLASSIFICATION CATEGORIES FOR THE UK. THE PERCENTAGE IS CALCULATED FROM BOTH THE NUMBER OF DIFFERENT FOOD ITEMS BUT ALSO THE NUMBER OF TIMES THEY WERE MENTIONED.

Top 10 EU FoodEx (L1) Categories by %	%
Composite dishes	31.9%
Grains and grain-based products	23.9%
Meat and meat products	8.4%
Vegetables and vegetable products	8.0%
Fruit and fruit products	6.7%
Sugar and similar, confectionery and water-based sweet desserts	6.6%
Milk and dairy products	5.5%
Legumes, nuts, oilseeds and spices	3.8%
Seasoning, sauces and condiments	2.9%
Fish, seafood, amphibians, reptiles and invertebrates	2.4%
Grand Total	100.00%

The Surprise Bags were assumed to always be purchased in a paper bag as a worst case scenario (the recommendation of Too Good To Go is that consumers pick up the food bringing their own bag). The materials and quantities to model this packaging was adapted from Tonini et al. (2018) and a background Ecoinvent 3.8 dataset was used for the paper. The approach is summarised in Table 15 in Appendix II. The consumer collects the Surprise Bag from the point of sale, again the approach was to fall back to default PEF data (EC. 2022). The impact of the fuel use for the following was based on the PEF defaults, which state that 62% of the journeys are made by car travelling 5km, another 5% travelling the same distance by van and the rest by walking or cycling (no impact). Additionally we assumed that Surprise Bags are usually combined with other shopping activities; therefore only 50% of the impact was accounted for⁶.

2.2.3. Magic Parcels

Too Good To Go provided data for all countries where Magic Parcels are distributed, including production numbers and contents description. From a total of 172676 boxes, the top five most produced Magic Parcels⁷ were used to represent an average Magic Parcel. These were selected from the largest markets (Netherlands and Belgium) and identified using the production quantities per given box name. To identify the indicative contents, the listed items were sorted by weight multiplied by frequency to arrive at the top five food items for each Magic Parcel⁸. This is a very rough approach to get an indication of the impact of the boxes, but for the intended application of this study (to obtain an overall insight of the footprint of Too Good To Go) and in the light of the (current) small contribution of Magic Parcels in comparison to the total product portfolio of Too Good To Go (1%), this approach is of acceptable level of detail.

This led to the following approach:

1. The top 5 products in each indicative box were identified and matched to the closest representative food item in the expert database to attain indicative emission factors.
2. A weighted average (by mass) footprint for each box was calculated based on the top 5 items in each box (Table 4).
3. This was repeated for the top five boxes in the Netherlands and Belgium.
4. A single typical box footprint for these respected countries was again calculated using a weighted average of the top five boxes based on production number.

⁶ Note that this is still a rather conservative approach, in which it is assumed that surprise bags are bought together with an equal amount of other items. However, if the Surprise Bags are bought supplementary to other items (e.g. a full basket of groceries), the percentage of the travel allocated to Surprise Bags should be even lower.

⁷ A couple of the most produced boxes were skipped as references for the 'indicative Magic Parcel. This is because they were brand speciality boxes containing only a few niche product types. Moreover, these food items had no close matches in the database e.g. for the box specialising in liquorice products only.

⁸ Frequency was also used to avoid only liquids skewing the representative contents.

TABLE 4 ILLUSTRATIVE MAGIC BOX FROM NETHERLANDS WHERE THE PRODUCTION QUANTITIES FOR THE TOP FIVE AND CONTENTS ARE LISTED.

Netherlands			Top 5 items (weight x number per parcel type)									
Box	Box name	Production quantity	Item 1	Total weight (kg)	Item 2	Total weight (kg)	Item 3	Total weight (kg)	Item 4	Total weight (kg)	Item 5	Total weight (kg)
MO4	Magic Pakket - D	2240	Chips flower of salt zak 45gr	2520	Taste collect	784	PL Proud I	784	Zonnatura	784	Curry souj	784
MO27	A-Merken Pakket 3	2095	FUZE TEA GREEN TEA APF	2619	AK Best of F	2095	AK Coco �	2095	Calve Frite	1561	Zaanse Me	681
MO11	A-Merken Pakket 1	2000	Kokosmelk biologisch 12x25�	1000	Zonnatura M	700	Knorr WG	652	Conimex V	600	Calve Sau:	500
MO13	Je huis niet uit Pak	2000	Knorr Veg Wraps Tomaat 37	740	Zonnatura M	700	So Vegan	540	Knorr WG	460	CER NAT I	209
MO14	Magic Pakket I	2000	Kokosmelk biologisch 12x25�	1000	Knorr Veg V	740	Knorr Kais	410	La Vida V�	330	CER KOEI	252

An alternative method could have been to take a mass approach, e.g. to take the top 20% by mass of all products across all markets. However, this would have led to a skewed analysis of mainly liquid products only and therefore not provide a representative product composition in an average box.

The Magic Parcels are delivered in a cardboard box. The materials and quantities to model this packaging (including filler) were adapted from a process in the expert database for cardboard box packaging for parcels and a background Ecoinvent 3.8 dataset was used for the paper. The approach is summarised in Table 15 in Appendix II. Too Good To Go reported engaging a delivery company to transport the parcels. To model this stage, default datasets were used from the PEF: based on distribution to the final client, 100% local with 250 km travelled and 20% utilisation (EC. 2022).

2.3. Assumptions and limitations

Although this study aims to deliver the best possible insights given the available data and the high-over goal of this study, there are some important assumptions and limitations to be mentioned:

- The environmental impact of the avoided food production is assumed to approximately (90%) equal the contents of the Too Good To Go products in the compared scenarios. In other words: it was assumed that a bread in a Too Good To Go product replaces almost an equivalent bread being consumed, and not replacing other food items. This was further explained in the section on the displacement factor (§1.2.5).
- It is assumed that 90% of food saved via the Surprise Bags and Magic Parcels is consumed, the rest is being disposed of in general waste treatment pathways (based on the previously mentioned study by the Wageningen University for Too Good To Go (Van der Haar & Zeinstra, 2019)).
- The calculated environmental impact of the Surprise Bags and Magic Parcels is performed using LCI datasets from the expert database. This database was tailored for the Dutch consumer market is not updated in this study to reflect the European and US regions studied here.
- It was assumed that all Surprise Bag products are packed in paper bags. This is a conservative assumption as Too Good To Go recommends the consumers to bring their own packaging, as they would do for regular food purchases as well. On the other hand, surplus food of restaurants and take away might require additional packaging (e.g. cups, boxes), which is not included in this research since they only represent a small share of all food items saved via Too Good To Go.
- It is assumed that all food in the Surprise Bags is genuine expiring food which would be wasted if not sold, as stipulated in the Too Good To Go principles. In practice, it is possible that retailers act differently and add non-expiring food, e.g. to enhance attractiveness of the bags or to attract more customers, but no data exist on this matter. It is also possible that retailers choose to participate with Too Good To Go with food items which would still be of sufficient quality to be send to charity (food banks), but they prefer the Too Good To Go concept. This is not within the company mission of Too Good To Go, but it cannot be 100% ensured that this never happens. Therefore, the potential effect of such practices will be addressed in the sensitivity analysis.
- Where primary data was not available or complete (e.g. packaging, transport), default data from literature or databases was used as indicated in the data tables (Appendix II).
- The statistical division of food waste across the different waste treatment pathways come from international sources which likely used different methods and definitions for the captured flows. This may lead to some variability in the impact of the reference scenario, but since the impact of waste treatment

is generally lower than food production, the effect of this variability is not expected to be significant (see section 3.2).

2.4. Sensitivity analyses

From the list of limitations (previous section), the impact on the results is calculated for two topics which are most influential on the results of the study:

1. One of the key and most contentious assumptions which impacts the results interpretation is the 90% direct displacement of equivalent products. In the absence of statistically significant survey data on consumer's behaviour related to the purchasing of surplus food through Too Good To Go, a 90% rate was adopted intuitively and based on the findings from the study by Wageningen University (Van der Haar & Zeinstra, 2019). However, to further examine the influence on the impact results, displacement rates of 100%, 75% and 50% are applied in a sensitivity analysis. These rates have been chosen to reflect both full displacement but also the likelihood the products contain a higher proportion of novelty items (sweets, smoothies etc) which affect the consumer's usual food shopping trends to a lesser extent. In other words, some meals are replaced, but some food items a consumer needs for their meal preparation are not being displaced and must still be purchased as normal.
2. Another influential assumption concerns the expiration of the food in the Surprise Bags: if the food is of such a quality that it could be sold again the next day, it should not be counted as 'saved'. The base assumption of this analysis was that all food saved in the Surprise Bags can not be sold the next day, thereby following the principles of Too Good To Go. In other words, new products to boost sales or products or foods regarded as fresh were assumed to generally not be saved via Surprise Bags. However, no statistically significant research has been performed on this assumption, although as part of this study a questionnaire was sent to some consumers as well as retail partners and manufacturers. However, the response to the questionnaires was very low and the outcome revealed the difficulty in defining whether the food could be defined as surplus or not, which means that the results cannot be used in this research. However, in order to investigate the potential impact of differences in interpretation or in practise, it is calculated in a sensitivity analysis what the effect would be if not just 100%, but either 75% or 50% of the Surprise Bags or Magic Parcels would consist of non-surplus food.

Additionally, a sensitivity analysis will be executed to assess the influence of the land use impact assessment methodology, whereby the chosen methodology will be compared with two relevant other methodologies (the EF method and uncharacterized land occupation assessment).

3. Results

3.1. Overall results

There are three main results: the environmental impact of the reference scenario, the environmental impact of the alternative scenario (Too Good To Go) and the difference between the two, which is the net impact of Too Good To Go's activities. These three results are shown in Table 5 for the main impact categories (climate change, land use and water use) for all regions together (Europe + North America). In this table some numbers are negative, meaning that environmental impact is avoided due to activities which are beneficial for the environment, for example avoided heat or food production. In the next sections, we will address respectively the main contributions within the two scenarios, the regional results and the individual products (Surprise Bags and Magic Parcels).

Overall, Table 5 shows that there is an impact reduction across the most relevant environmental categories when using (the weighted and global average of) Too Good to Go's products for surplus food compared to the reference waste treatment scenario. The net impacts are all negative, meaning for every kilogram of surplus food saved from disposal, Too Good To Go avoids environmental damage. The consequential effect of Too Good To Go's activities results in avoiding 2.65 kg CO₂ eq., 2.76 m²a of land use and 0.81 m³ of water use for every kilogram of surplus food saved via Too Good To Go.

It should be noted that the climate change calculation includes the climate change impacts from fossil, biogenic and land transformation (land use change, LUC) sources⁹. This last category is difficult to model precisely, and therefore the results are reported with and without LUC emissions. Where land use change is excluded from the calculations, the impact reduction is smaller and results in a net avoidance of 2.02 kg CO₂ eq./kg surplus food saved. In the next sections, both calculations will be shown in the graphs and tables, but for clarity and completeness, only the result including LUC will be discussed.

TABLE 5 THE IMPACT RESULTS FOR REFERENCE SCENARIO (WASTE TREATMENT), THE ALTERNATIVE SCENARIO (TOO GOOD TO GO) AND THE NET IMPACT REALIZED VIA TOO GOOD TO GO. THESE RESULTS ARE A WEIGHTED AGGREGATE FOR ALL REGIONS IN SCOPE. NEGATIVE NUMBERS REFLECT ENVIRONMENTAL BENEFITS, FOR EXAMPLE DUE TO AVOIDED HEAT OR FOOD PRODUCTION.

	<i>Climate change (incl. LUC)</i>	<i>Climate change (excl. LUC)</i>	<i>Land use</i>	<i>Water use</i>
	<i>kg CO₂ eq./kg surplus food</i>	<i>kg CO₂ eq./kg surplus food</i>	<i>m²a/kg surplus food</i>	<i>m³ depriv./kg surplus food</i>
Reference scenario (waste treatment)	0.12	0.02	-0.01	0.01
Alternative scenario (Too Good To Go)	-2.52	-2.00	-2.77	-0.80
Net impact realised by Too Good To Go	-2.65	-2.02	-2.76	-0.81

Comparing the reference scenario with the alternative scenario, Table 5 shows that its overall impact of the reference scenario is relatively small across the most relevant categories, at 0.12 kg CO₂ eq./kg surplus food, while the alternative scenario avoids about 2.52 kg of CO₂ eq. per kg of surplus food. For the land and water use categories, the reference scenario had a marginal impact meaning the net avoided impact of the alternative scenario was close to the impact of the alternative scenario itself .

For the alternative scenario, these results are only the weighted total results, while the individual parameters may have different impacts. For example, the majority of the surplus food saved via Too Good To Go is through its Surprise Bag products (99% of total tonnage). However, it may be that the contribution of Magic Parcels will grow in the coming years, thereby affecting the overall results. Additionally, these results show the weighted

⁹ Note that in the current methodologies, carbon sequestration in soil, biomass or products are not accounted for. Biogenic carbon is included as a net-zero impact due to its short lifecycle; it is only reported separately to provide insight in the short term impacts.

contribution of both European and American activities of Too Good To Go. At this stage (beginning of 2023), Europe represents a much larger market for surplus food via Too Good To Go's products (94% of the total). This might as well change in the coming years and cause some changes in the overall impact of Too Good To Go. This is further discussed in the next sections.

3.2. Contribution analysis

A contribution analysis enables the most impactful activities in the impact assessment to be identified. Known as hotspots, these impactful processes are an important aspect of interpreting the results of an LCA. As such, hotspots enable the practitioner and intended audience to focus on the most influential parts of studied scenarios. Therefore, addressing these focus areas could include steps to improve the data quality where necessary and make strategic decisions on the outcome of the assessment. The following figures show which hotspots most influence the results interpretation. The contribution analyses in this section focus on the climate change impacts but similar graphical results and tables for the other most relevant impact categories can be found in Appendix III.

In Figure 3 the contribution analysis shows the main activity groups for both the reference and the alternative scenario and their climate change impacts. To identify the hotspots more easily in the reference scenario, the activity groups are disaggregated and shown on a differently scaled axis in Figure 4. Next to it, Figure 5 disaggregates the impact of the Magic Parcels from the Surprise Bags. The total impacts of each scenario are shown with a black dot. In the next sections, the main contributions of the reference scenario and the alternative scenario will be discussed.

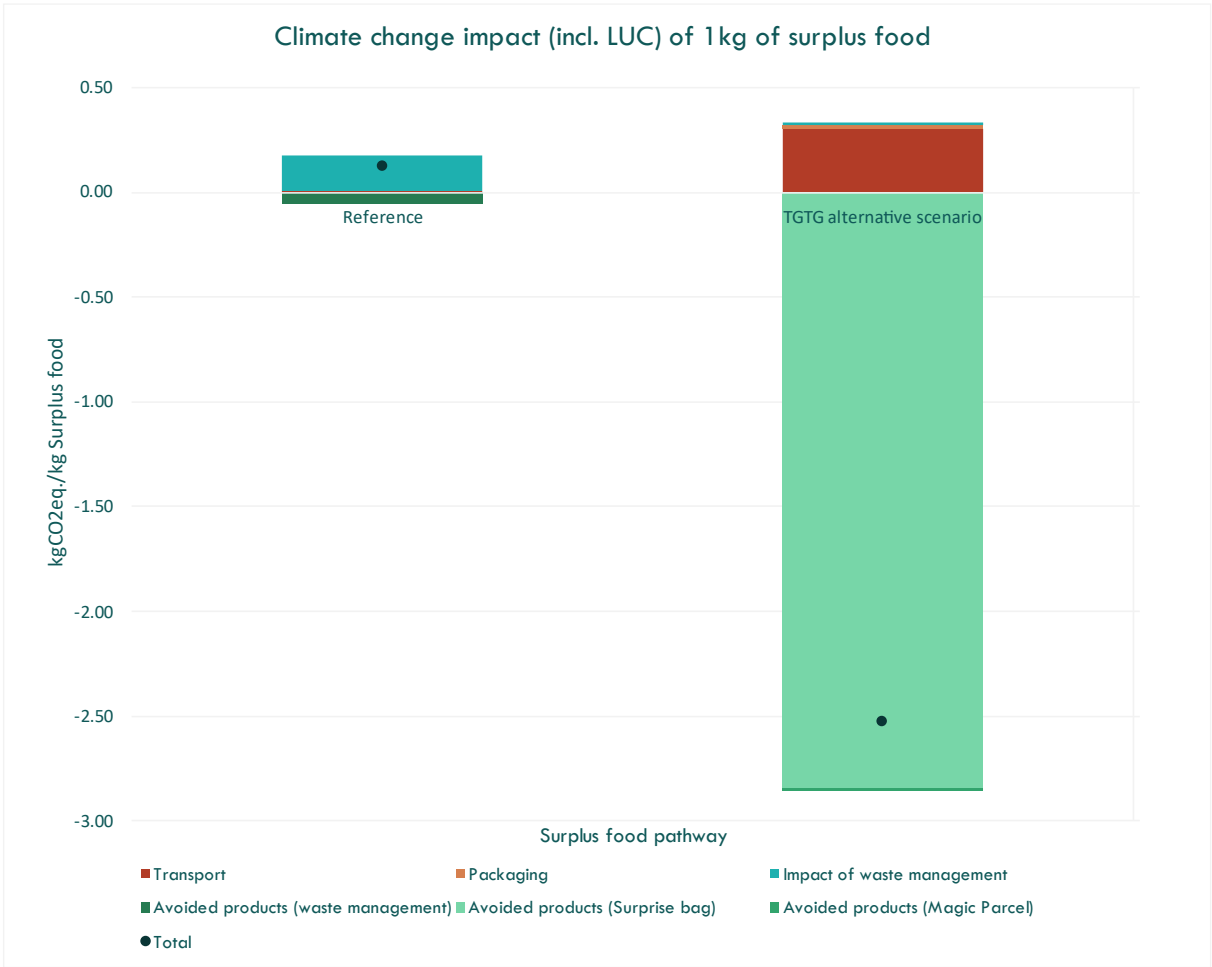


FIGURE 3 THE IMPACT RESULTS FOR BOTH THE BASELINE (REFERENCE) SCENARIO AND THE TOO GOOD TO GO ALTERNATIVE SCENARIO. THESE RESULTS ARE A WEIGHTED AGGREGATE FOR ALL REGIONS (I.E. EUROPE AND NORTH AMERICA) AND TOO GOOD TO GO'S PRODUCTS (I.E. SURPRISE BAGS & MAGIC PARCELS) IN SCOPE.

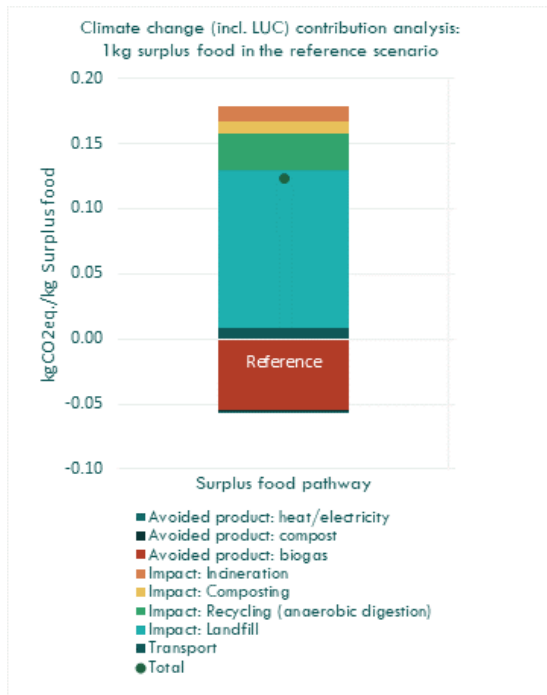


FIGURE 4 THE IMPACT RESULTS FOR THE REFERENCE SCENARIO. THESE RESULTS ARE A WEIGHTED AGGREGATE FOR ALL REGIONS IN SCOPE

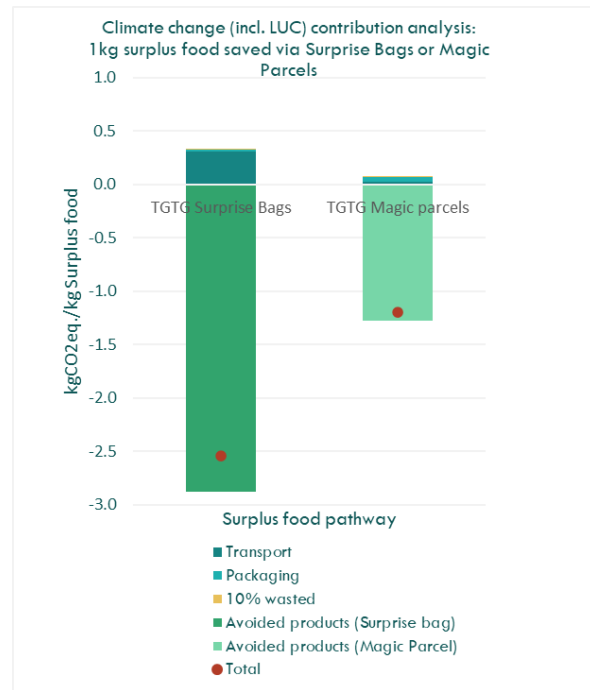


FIGURE 5 THE IMPACT RESULTS FOR ALTERNATIVE SSCENARIO. THESE RESULTS ARE A WEIGHTED AGGREGATE FOR ALL REGIONS IN SCOPE.

Reference scenario

The main insight from Figure 4, is that the waste treatment pathways of surplus food have an almost neutral environmental impact; the environmental impact of surplus food is slightly lower (0.18 kg CO₂ eq./kg surplus food, thus: a small net impact on the environment) than the benefits arising from the waste treatment (−0.06 kg CO₂ eq./kg surplus food, thus: a small avoidance of environmental impacts). The total climate change impact (including LUC, as described in §3.1) of the reference scenario is therefore 0.12 kg CO₂ eq./kg surplus food, meaning that the waste treatment delivers a (small) environmental impact.

The hotspot in the total impact of the reference scenario is the surplus food going to landfill. This pathway represents only 20% of the waste treatment scenarios on average for all regions together, however, landfilling contributed 98% of the climate change impact (0.12 kg CO₂ eq./kg of surplus food). The release of methane contributed over half of the emissions here.

The impacts of the surplus food following the other waste treatment pathways, recycling (represents 29%), composting (18%) and incineration (33%) are almost negligible in comparison to the overall climate change impact of the reference scenario. The respective contributions are all equal to or smaller than 0.03 kg CO₂ eq./kg surplus food. Additionally, the transport of the surplus food to the waste treatment locations also has a minimal impact of 0.01 kg CO₂ eq./kg of surplus food. The credits from these waste treatment pathways are also minimal (<0.01 kg CO₂ eq./kg surplus food), except for biogas delivered by anaerobic digestion (0.06 kg CO₂ eq./kg surplus food). This means that most of the impacts of the waste treatment pathways can be considered very small (<5%) in comparison to the potential benefits of the alternative scenario.

Alternative scenario: food saved by Too Good To Go

The alternative scenario results (as shown in Figure 3 and Figure 5) show that the avoided environmental burden associated with the displacement of food production in the system far outweighs the impact of purchasing the products. The reduction in impact from displacing food production is calculated from the relative footprints of an average Surprise Bag and an average Magic Parcel. Since Magic Parcels represent a much smaller share of the total product tonnage saved via Too Good To Go (1%), the contribution of Magic Parcels to the overall scenario result in Figure 3 is minimal (<−0.03 kg CO₂ eq./kg surplus food). However, as Too Good To Go expands its partners and markets for Magic Parcels this split would likely change in the future. For the current situation, it is thus no surprise that the footprint of the Surprise Bags contributed to the majority of the avoided impact. Additionally, Figure 5 reveals that the impact of saved food seems higher for Surprise Bags than for Magic Parcels, which is partially due to the modelling assumption that there was less meat (with relatively high impact)

involved in Magic Parcels than in Surprise Bags. However, it should also be emphasized that there was a much lower level of detail involved in the Magic Parcel modelling in comparison to the Surprise Bags because of their lower contribution to the total, so this number should be considered with quite some margin. In order to conclude more about the Magic Parcels food savings, more research on the content should be executed. The origin of the impacts of Surprise Bags and Magic Parcels respectively is further analysed in section 3.4.

Nevertheless, the activities of Too Good To Go also generate an additional environmental impact, although being relatively small in comparison to the associated benefits. This impact arises from activities associated with saving products: the additional packaging and transportation of the product to the consumer's home. It is assumed 90% of the food is consumed with the remaining 10% going to disposal. The associated footprint of this waste stream is calculated in the same way as in the reference scenario, resulting in 0.01 kg CO₂ eq./average kg surplus food. The impact of packaging was also small in comparison to the total impact (0.01 kg CO₂ eq./average kg surplus food). The largest share of the environmental impact in this scenario were however caused by transport, compensating more than 10% of the avoided impacts (0.31 kg CO₂ eq./average kg surplus food). Together, these activities totalled to 0.33 kg CO₂ eq./average kg surplus food, meaning the overall Too Good To Go alternative scenario is predicted to have a climate change impact of -2.52 kg CO₂ eq./average kg surplus food, meaning a net avoidance of environmental impacts.

3.3. Regional results

Too Good To Go operates in both Europe and North America, although at the time of writing only the Surprise Bag were available at the market in North America. In Table 6 the climate change impacts (incl. LUC) are shown as a weighted aggregation of Surprise Bags and Magic Parcels under 'All regions' and also separately for the constituent areas of Europe and North America.

Europe

The results for Europe largely reflect those presented in the contribution analysis for 'All regions' in the previous chapter. This is due to the skewed ratio towards Europe, where nearly 72 million tons of surplus food were saved across both products, compared to only 4.5 million tons in the North America, meaning 94% of the surplus food was saved in Europe. Additionally, the results for *Europe excluding Magic Parcels* also reflect the significant skew towards the saved food being sold in surprise bags. The ratio of 99% in favour of the Surprise Bag purchases means that Magic Parcels currently only account for a saving of 0.02 kg CO₂ eq./kg surplus food.

North America

North America's results show a higher environmental benefit compared to 'All regions' and Europe. The modelled impact of the reference scenario in North America was slightly higher than for the overall results for all regions (0.32 in comparison to 0.12 kg CO₂ eq.), and this increase was enhanced by a larger climate change benefit from avoided food production (-2.72 vs -2.52kg of CO₂ eq.), resulting in a net larger benefit in the North American region (-3.04 vs -2.65 kg CO₂ eq./kg of surplus food). The North American reference scenario used different percentage allocations for each waste stream. The significant increase in landfilling, 58% compared to Europe's average 18%, resulted in a small increase of 0.25 kg CO₂ eq./kg surplus food. However, the 2% increase in recycling (i.e. anaerobic digestion), decreased North America's reference footprint by 0.04 kg CO₂ eq./kg surplus food. The background datasets to model the conversion of food to gas and the avoidance of gas itself, were adapted between regions to reflect the differences in energy generation and ingredients. The associated changes in emission factors here also explain the differences.

TABLE 6 CLIMATE CHANGE IMPACT (INCL. LUC) RESULTS FOR EACH SCENARIO IN THE INVESTIGATED REGIONS.

Scenario	Activity	All Regions	Europe	Europe (excl. Magic Parcels)	North America
Reference	Impact of food waste treatment	0.18	0.17	0.17	0.40
	Avoided impacts (heat, gas, etc.)	-0.06	-0.05	-0.06	-0.09
	Total of reference scenario	0.12	0.11	0.11	0.32
Alternative	Impact of transport, packaging & waste	0.33	0.33	0.34	0.36
	Avoided production of food	-2.86	-2.85	-2.87	-3.08
	Total of alternative scenario	-2.52	-2.51	-2.53	-2.72
Net Impact		-2.65	-2.62	-2.64	-3.04

Table 7 and Table 8 address the land and water use impacts. The general patterns are the same as for the climate change impacts, with an exception for water use. The results for this impact indicator were twice as high for the US and the UK surprise bags compared to France. Further investigation showed this impact indicator is highly sensitive to particular food datasets, namely the inclusion of nuts in the “Legumes, nuts, oilseeds and spices” category. The water footprint of the variety of nuts included in the background food database ranged from 0.06 to 2.06 m³ and where nuts were reported for North America, the study used an average value of 1.04 m³ instead of a specific variety dataset. The gross overall water impact for 1 kg Surprise bag (excluding losses, transport, etc.) equated to 1.7 m³ for both the US and UK. However, since nuts did not top the legume category in France the overall impact was almost 5x smaller at 0.36 m³/kg surprise bag. The final aggregated results for each region maintained a wide range, the net saved water impact of North America was double that of Europe: 1.46 m³/kg surplus food compared to 0.78 m³/kg surplus food respectively. The range of land use results meanwhile was only 0.08 m²a/kg surplus food, with North America again showing a higher impact benefit.

TABLE 7 LAND USE RESULTS FOR EACH SCENARIO IN THE INVESTIGATED REGIONS

Scenario	Activity	All Regions	Europe	Europe (excl. Magic Parcels)	North America
Reference	Impact of food waste treatment	0.01	0.01	0.01	0.00
	Avoided impacts (heat, gas, etc.)	-0.02	-0.02	-0.02	-0.01
	Total of reference scenario	-0.01	-0.01	-0.01	-0.01
Alternative	Impact of transport, packaging & waste	0.15	0.15	0.16	0.16
	Avoided production of food	-2.93	-2.92	-2.93	-3.01
	Total of alternative scenario	-2.77	-2.77	-2.77	-2.85
Net Impact		-2.76	-2.76	-2.76	-2.84

TABLE 8 WATER USE RESULTS FOR EACH SCENARIO IN THE INVESTIGATED REGIONS

Scenario	Activity	All Regions	Europe	Europe (excl. Magic Parcels)	North America
Reference	Impact of food waste treatment	0.01	0.01	0.01	0.00
	Avoided impacts (heat, gas, etc.)	-0.00	0.00	0.00	-0.00
	Total of reference scenario	0.01	0.01	0.01	0.00
Alternative	Impact of transport, packaging & waste	0.04	0.04	0.04	0.04
	Avoided production of food	-0.84	-0.81	-0.81	-1.50
	Total of alternative scenario	-0.80	-0.77	-0.77	-1.46
Net Impact		-0.81	-0.78	-0.77	-1.46

3.4. Product results

Surprise Bags

In Table 9 the respective footprints for the Surprise Bags as in the different countries are given, without displacement factors, waste treatment of remains and transport to consumer. The environmental impacts for a Surprise Bag saved in Europe were calculated using a weighted average of the two largest markets, France 21% and the UK 14% (a more detailed explanation of the method can be found in section 2.2). In terms of climate change impact, different regions are quite close together, differing only 10% between the lowest (France, 2.10 kg CO₂ eq.) and highest (US: 3.44 kg CO₂ eq.) footprint per kilogram of surplus food saved. Note that the difference is purely related to differences in composition of the bags, and not to regional differences in transported distance, food production impact or packaging (as these are not regionally specified in this study).

The environmental impacts for the food in the modelled Surprise Bags in Table 9 were calculated from food items grouped into categories:

- *Composite dishes* was either the 1st or 2nd largest category (by % of food items belonging to it across the bags) and had an associated footprint which was close to that of an average bag: 2.1-3.3 kg CO₂ eq./kg food.
- *Sugar and similar, confectionery and water-based sweet desserts* was the category with the highest climate change impact per kilogram of food: 8.4-10.6 kg CO₂ eq./kg food.
- Whilst *Starchy roots or tubers, Vegetables and vegetable products* and *Fruit and fruit products* were the categories resulting in the lowest emission factors, ranging from 0.3-1.4 kg CO₂ eq./kg food.

These categories and the calculations are further explained in Appendix II. Note that these values are only indicative values which were developed specifically for the aim of this generic study of food saved via Too Good To Go, and should not be considered nor used to reflect market average footprints for certain food categories. To this end, statements about specific food category' footprints would require deeper research. The current categorisation of items described in the surprise bags was performed using Too Good To Go's consumer feedback which frequently lacked specifics, i.e. detail on how completely the bag's contents were described and important nuances such as if the composite dish was meat based or vegetarian. However, it is important to note that in this research, a functional displacement of 90% was assumed, meaning that consumers who buy bread via Too Good To Go, are expected do to that in 90% of the cases where they otherwise would have bought bread. Only in 10% of the cases, they may buy something different via Too Good To Go, for example cake. In the calculation set-up, we now dismissed 10% of the total impact claim for this reason. However, it could be investigated in more detail in a follow-up research what happens specifically for certain food groups, especially the sugar/sweets group in comparison to bread/grain purchases.

TABLE 9 ENVIRONMENTAL IMPACTS OF THE (AVOIDED PRODUCTION OF) FOOD ITEMS IN SURPRISE BAGS, WITHOUT DISPLACEMENT FACTORS, WASTE TREATMENT OF REMAINS AND TRANSPORT TO CONSUMER

	Climate change (incl. LUC) kg CO ₂ eq/kg surplus food	Climate change (excl. LUC) kg CO ₂ eq/kg surplus food	Land use m ² a/kg surplus food	Water use m ³ depriv./kg surplus food
UK	3.32	2.63	3.45	1.70
France	3.10	2.55	3.12	0.36
EU average	3.19	2.58	3.26	0.90
US	3.42	2.78	3.34	1.67

Magic Parcels

Table 10 reports the average climate change impact for the Magic Parcels in Europe (since Magic Parcels are not represented in North America), without displacement factors, waste treatment of remains and transport to consumer. The Netherlands and Belgium were the largest markets by total tonnage saved in the studied period and the average value was calculated with the respective ratio of 54%.

The avoided environmental impacts of food in Magic Parcels were lower compared to those of the Surprise Bags, with only an avoided 1.41 kg CO₂ eq./kg surplus food. A key reason for this, is that the Magic Parcels largely contained dry products and liquids. These food items have footprints at the lower end of the range (<2.5 kg CO₂ eq./kg food item), the exceptions being soup and chocolate based products. As such, the food related environmental impacts of the Magic Parcels were half those of the Surprise Bags.

TABLE 10 ENVIRONMENTAL IMPACTS OF THE (AVOIDED PRODUCTION OF) FOOD ITEMS IN MAGIC PARCELS, WITHOUT DISPLACEMENT FACTORS, WASTE TREATMENT OF REMAINS AND TRANSPORT TO CONSUMER

	Climate change (incl. LUC) kg CO ₂ eq/kg surplus food	Climate change (excl. LUC) kg CO ₂ eq/kg surplus food	Land use m ² a/kg surplus food	Water use m ³ depriv./kg surplus food
Belgium	1.51	1.38	3.01	1.29
Netherlands	1.31	0.98	2.41	0.56
Average EU	1.41	1.19	2.73	0.95

4. Sensitivity analyses

4.1. Selection of sensitivities for further analysis

As described in section 2.4, in this study two critical assumptions were made which will be subject of a sensitivity analysis:

- 1) the functional equivalence of the “saved” products;
- 2) the status of the surplus food as “waste”.

Additionally, the uncertainty in the land use category was investigated with an additional sensitivity analysis:

- 3) the robustness of the land occupation results when compared with alternative methods.

The first used a baseline displacement factor of 90%, the effect being that in this modelled consequential scenario, new food was not being purchased and by extension it would also not be produced (from cradle). As such, 90% of the equivalent environmental impacts in the purchased surplus food would be avoided.

The second assumption concerns the definition of surplus food. To effectively reduce environmental impacts in the food sector, Too Good To Go’s products must capture a current waste stream and return it to the consumption pathway. Too Good To Go’s communication and principles are clear on how their partners must only include food items which would otherwise have to be wasted. The assumption that this practice is the norm was used as the baseline scenario. In the event that some food included in the products saved via Too Good To Go are “too” fresh and not expiring or indeed additional new supplementary¹⁰ items, then this proportion of food could not be said to be avoiding any emissions in this scenario.

In both assumptions the environmental impacts, i.e. the impact associated with Too Good To Go’s products, should be adjusted to test how far these assumptions influence the results. The same method can be applied to each, with arbitrary adjustments being made by applying a factor.

4.2. Sensitivity analysis 1: functional equivalence of surplus food

Table 11 and Figure 6 show the baseline scenario followed by the three sensitivity scenarios wherein the environmental impacts of the saved food are adjusted. The baseline scenario, termed 90%, reflects the assumed displacement in the main calculations. To test the sensitivity of the results for the assumed functional equivalence of the replaced food, the displacement factors were adjusted to 100%, 75% and 50%. The avoided impacts for all variants of the alternative scenario are presented along with the (unchanged) reference scenario. In the rows beneath the net impact is also shown and finally the percentage change between the recalculated net impact and the baseline net impact.

In case the saved food would fully displace (100%) the function of the otherwise produced food, the environmental benefits of the alternative scenario by Too Good To Go would increase with 11%. Whereas, as expected, the lower displacement rates reduce the benefits of the alternative scenario by 16% and 43% respectively. In real terms, this equates to kg of CO₂ eq. saved by the Too Good To Go’s scenarios as 2.1 and 1.4 per kg surplus food respectively. If all food was to be considered fully functional (meaning saving a donut via Too Good To Go instead of buying it directly), Too Good To Go could claim a saving of 2.81 kg CO₂ eq./kg surplus food instead of the 2.52 kg CO₂ eq./kg surplus food reported in the core results. This reported trend for the climate change impacts was consistent for the land use and water use impact categories.

The decision to use 90% therefore significantly impacts the extent to which environmental benefits can be claimed. However, it should be noted that 50% (non) functional equivalence is a very extreme scenario; which would mean that for every two items sold, the consumer would eat 1 item more than they would normally do. This might apply

¹⁰ Supplementary items could be food items which the retailer is using to either make-up the volume of the bag, try-out or in any other way attract consumers by including items which are not genuinely expiring.

for some food items (e.g. sweets), but certainly not for all. It is reasonable to presume that the saved food via Too Good To Go would replace other food items to a large extent; maybe different food items (when buying a donut leads to lower bread consumption), but how this translates into climate change impacts is hard to estimate without further research. Thus, if we only consider the 100% and 75% displacement scenarios, we can conclude that there is an error margin of +/- 16% on the environmental impact result for Too Good To Go, caused by the uncertainty in the functional equivalence. Given the low level of detail in the calculations, this 16% margin is quite acceptable.

TABLE 11 SENSITIVITY ANALYSIS 1: THE IMPACT ON THE RESULTS WHEN THE ENVIRONMENTAL IMPACTS ARE ADJUSTED TO REFLECT RATES OF 100%, 90% (BASELINE), 75% AND 50%.

	<i>Climate change (incl. LUC)</i>	<i>Climate change (excl. LUC)</i>	<i>Land use</i>	<i>Water use</i>
	<i>kg CO₂ eq./kg surplus food</i>	<i>kg CO₂ eq./kg surplus food</i>	<i>m²a/kg surplus food</i>	<i>m³ depriv./kg surplus food</i>
Reference Scenario	0.12	0.02	-0.01	0.01
Alternative Scenario (baseline: 90% displacement)	-2.52	-1.99	-2.77	-0.80
Alternative Scenario 1 (100% displacement)	-2.81	-2.22	-3.08	-0.89
Alternative Scenario 2 (75% displacement)	-2.10	-1.66	-2.31	-0.67
Alternative Scenario 3 (50% displacement)	-1.40	-1.11	-1.54	-0.44
Net Impact (baseline)	-2.65	-2.02	-2.76	-0.81
Net Impact 1 (100% displacement)	-2.93	-2.24	-3.07	-0.90
Net Impact 2 (75% displacement)	-2.22	-1.69	-2.30	-0.67
Net Impact 3 (50% displacement)	-1.52	-1.13	-1.53	-0.45

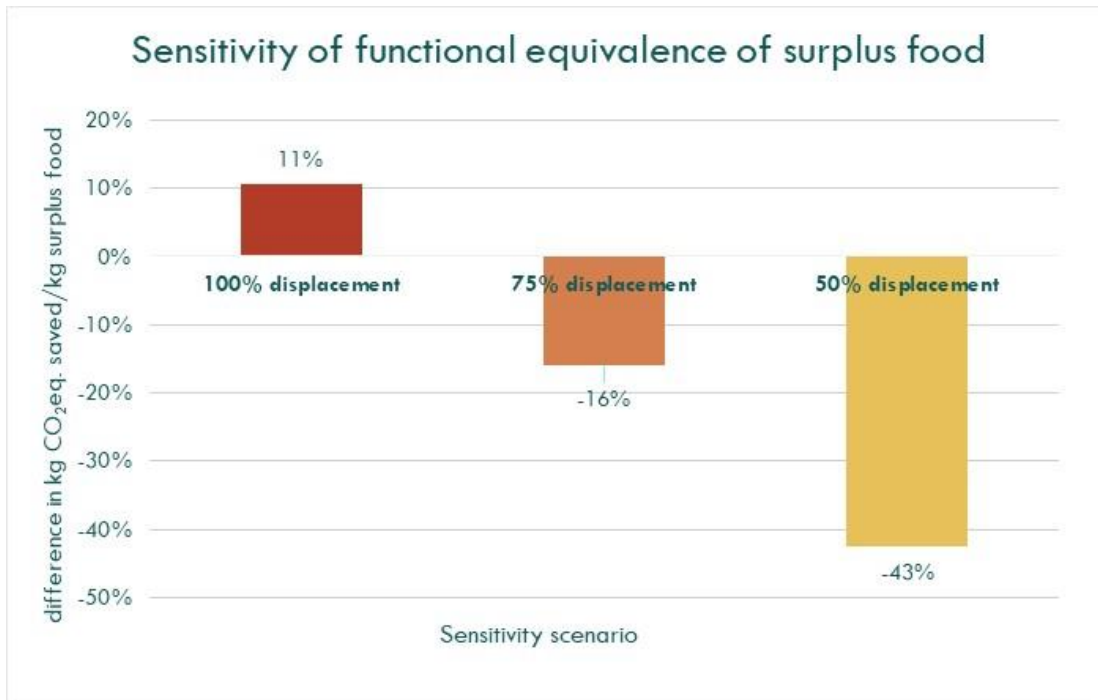


FIGURE 6 THE % CHANGE FOR THE NET IMPACT RESULTS FOR ALL REGIONS WHEN THE AVOIDED FOOD PRODUCTION IMPACTS ARE INCREASED AND DECREASED TO REFLECT DIFFERENT DISPLACEMENT RATES.

4.3. Sensitivity analysis 2: “real” surplus food or waste?

Table 12 and Figure 7 show the baseline scenario followed by the three sensitivity scenarios wherein the environmental impacts are adjusted. The baseline scenario reflects the assumption that all food placed in the products is genuinely surplus, in line with the company’s mission of Too Good To Go. To test the sensitivity of the results for this assumption, the results were adjusted to reflect different rates of surplus food in Too Good To Go’s products: at 90%, 75% and 50%¹¹. The environmental benefits for all variants of the alternative scenario are presented along with the reference scenario. In the rows beneath, the net impact is also shown and finally the percentage change between the recalculated net impact and the baseline net impact.

Reducing the percentage of environmental impacts across the sensitivity scenarios produced an equal percentage drop the final net impact. In other words, if 50% of the food included in the products could be regarded as non-surplus food then only half of the baseline result (i.e. 1.26 kg CO₂ eq./kg surplus food) would be avoided in this modelled scenario. This reported trend for the climate change impacts was consistent for the land use and water use impact categories. The decision to use a definition of 100% surplus food in the main calculations, therefore significantly impacts the extent to which avoided impacts can be claimed.

Despite this observation that it is an impactful factor in the model, it is hard to say how this can be processed in the results. If all companies would follow the Too Good To Go principles without any exception (e.g. to make a box more attractive by adding a fresh item, or to be not willing to cancel a box reservation when there is no surplus food at the end of the day), the 100% scenario would be realistic. However, random examples show that this is not always the case, but research is lacking to provide real numbers. Therefore we maintain the main results as presented in chapter 3, but add the recommendation for Too Good To Go to make sure that the 100% surplus principle is followed by all parties and to start monitoring extensively on this.

¹¹ Note, the baseline and subsequent sensitives still include the displacement factor of 90%. Therefore, the calculated percentage decreases of the environmental impacts were effectively 90%, 81%, 68% and 45%.

TABLE 12 SENSITIVITY ANALYSIS 2: THE IMPACT ON THE RESULTS WHEN THE ENVIRONMENTAL IMPACTS ARE ADJUSTED TO REFLECT DECREASING RATES OF GENUINELY EXPIRING FOOD ITEMS CONTAINED IN TOO GOOD TO GO'S PRODUCTS.

	<i>Climate change (incl. LUC)</i>	<i>Climate change (excl. LUC)</i>	<i>Land use</i>	<i>Water use</i>
	<i>kg CO₂ eq./kg surplus food</i>	<i>kg CO₂ eq./kg surplus food</i>	<i>m²a/kg surplus food</i>	<i>m³ depriv./kg surplus food</i>
Reference Scenario	0.12	0.02	0	0.01
Alternative Scenario (baseline: 100% surplus)	-2.52	-1.99	-2.77	-0.80
Alternative Scenario (90% surplus)	-2.27	-1.80	-2.50	-0.72
Alternative Scenario (75% surplus)	-1.89	-1.50	-2.08	-0.60
Alternative Scenario (50% surplus)	-1.26	-1.00	-1.39	-0.40
Net Impact (baseline: 100% surplus)	-2.65	-2.02	-2.76	-0.81
Net Impact (90% surplus)	-2.39	-1.82	-2.49	-0.73
Net Impact (75% surplus)	-2.01	-1.52	-2.07	-0.61
Net Impact (50% surplus)	-1.38	-1.02	-1.38	-0.41

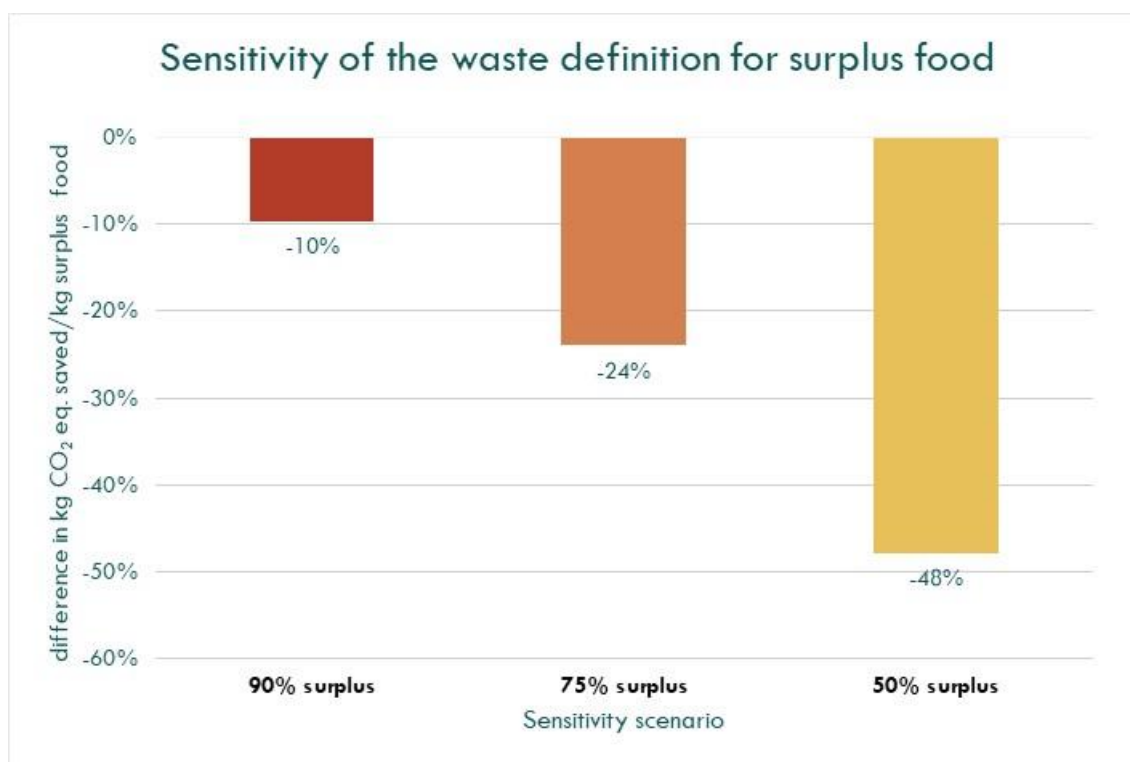


FIGURE 7 THE % CHANGE FOR THE NET IMPACT RESULTS FOR ALL REGIONS WHEN THE AVOIDED FOOD PRODUCTION IMPACTS ARE DECREASED TO REFLECT DIFFERENT RATES OF SURPLUS FOOD.

4.4. Sensitivity analysis 3: robustness of the land occupation method

Table 13 and Figure 8 to Figure 10 provide insight in the land use results as calculated with different methods:

- The EF method, expressing land use in “points”;
- The ReCiPe method, expressing land use in m²a crop equivalents;
- The land occupation without characterization, expressing land occupation in m²a.

All graphs show similar conclusions: the alternative scenario causes a large amount of avoided environmental as impacts in comparison to the reference scenario. Since there are different units used in each impact assessment method, the results are hard to compare. However, as Table 13 illustrates, the relative differences between the two scenarios differ with each method. The EF method shows the largest difference (almost 5000 times), while the two other methods show significantly smaller but yet still large differences (750 and 275 times). This indicates that by opting for the ReCiPe method in this study, not only a more comprehensive unit is given (since m²a is easier to relate to everyday’s activities of consumers than “points”), but only provide a more conservative approach. Given the uncertainties in the land use methodologies, it is important to apply the precautionary principle instead and take a conservative approach.

Application of either of the two other methods, may lead to differences in the relative comparison of the two scenarios, but in terms of absolute results, the results calculated with the two methodologies lie close together (-2.99 and -2.74 m²a/kg surplus food). We consider this insufficient reason to change the methodology of the core results, which are thus calculated with the characterized methodology of ReCiPe.

TABLE 13 SENSITIVITY ANALYSIS ON COMPARISON OF LAND USE RESULTS CALCULATED WITH THREE DIFFERENT METHODS, FOR THE REFERENCE AND ALTERNATIVE SCENARIOS.

	Land use (EF method)	Land use (ReCiPe)	Land occupation (uncharacterized)
	<i>Pt./kg surplus food</i>	<i>m²a crop eq./kg surplus food</i>	<i>m²a /kg surplus food</i>
Reference Scenario	0.05	-0.004	-0.01
TGTG Alternative Scenario	-241.05	-3.00	-2.75
Net Impact	-241.10	-2.99	-2.74
Ratio reference:alternative scenario	4821x	750x	275x

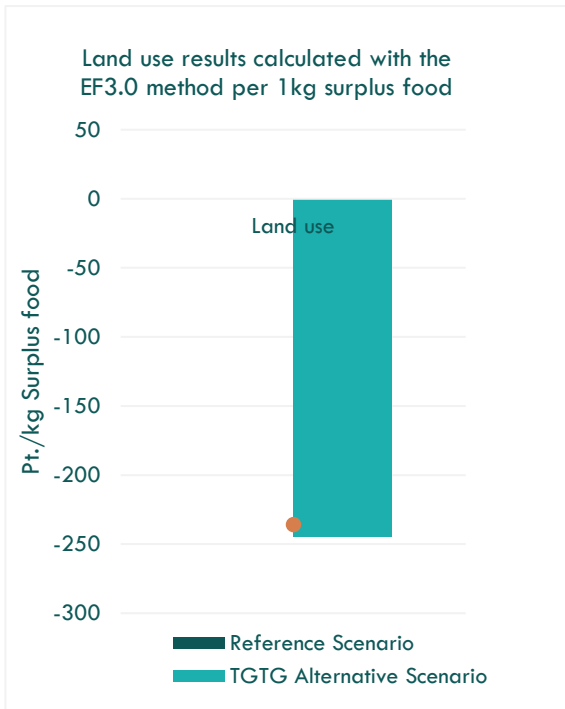


FIGURE 8 LAND USE RESULTS CALCULATED WITH THE EF3.0 METHOD FOR THE REFERENCE AND ALTERNATIVE SCENARIOS. THE NET IMPACT IS ALSO GIVEN.

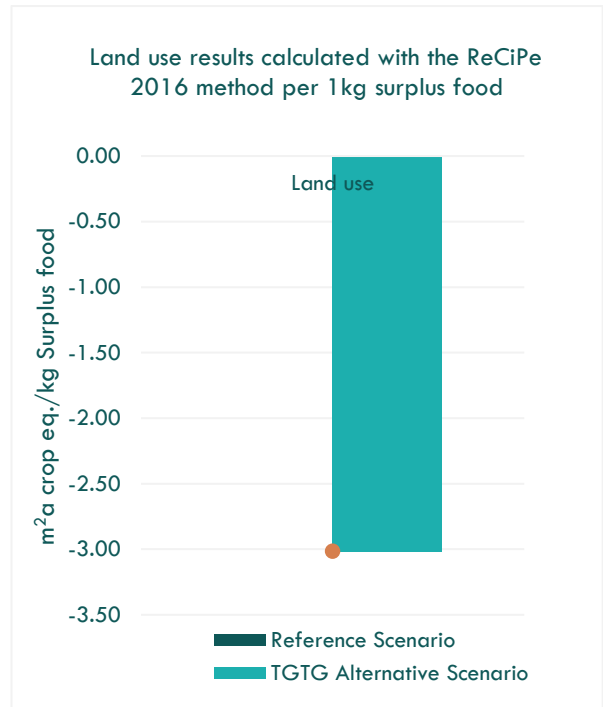


FIGURE 9 LAND USE RESULTS CALCULATED WITH THE RECIPE 2016 METHOD FOR THE REFERENCE AND ALTERNATIVE SCENARIOS. THE NET IMPACT IS ALSO GIVEN.

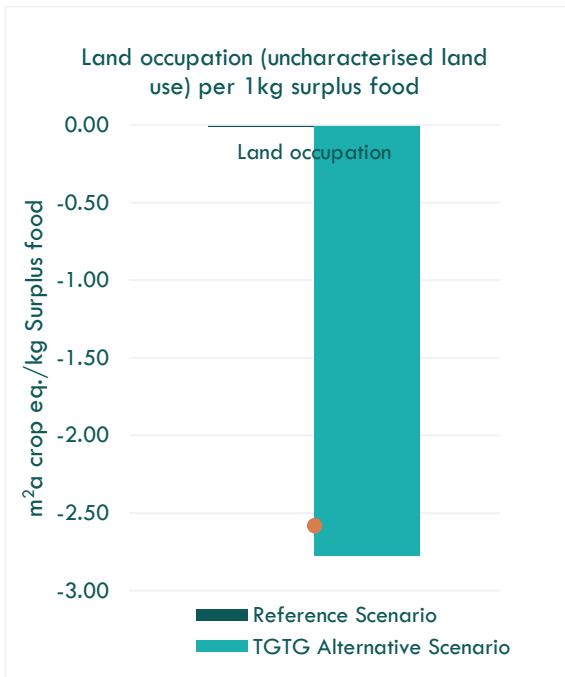


FIGURE 10 LAND OCCUPATION (UNCHARACTERISED) RESULTS FOR THE REFERENCE AND ALTERNATIVE SCENARIOS. THE NET IMPACT IS ALSO GIVEN.

4.5. Conclusion on sensitivities

The assumptions on functional equivalence of the saved food (displacement factor) and the principle of surplus food, significantly influence the net impact result of Too Good To as evidenced by these sensitivity analyses. Uncertainties in the displacement factor could lead to a +/- 16% difference in net impact result for Too Good To Go. The uncertainty about the “real” waste factor is very influential, but hard to quantify. It is recommended that Too Good To Go invests on the true following of this core company principle, including extensive monitoring. To improve the validity of Too Good To Go's claim, further research should be carried out across all of Too Good To Go's operating regions on both sensitivities.

The robustness of the land use methodology was concluded to be appropriate for the given study, by using the characterized interpretation of the ReCiPe 2016 method, by which all land occupations are expressed in “m²a cropland equivalents”. This does not alter the conclusions.

5. Conclusions & discussion

Goal

In this study the impact of Too Good to Go's ambition to provide solutions to food waste and to reduce environmental impacts of the food system was evaluated. The goal was to investigate the environmental impacts and benefits of Too Good to Go's products to save food from being disposed. The impacts and benefits of Too Good To Go's alternative scenario, provided through its products Surprise Bags and Magic Parcels, were compared to the impacts and benefits of a reference scenario using the consequential lifecycle assessment methodology. The scope of the study was from the point of sale to respectively the consumer or end of the waste treatment pathway.

Main result

The alternative scenario in which Too Good To Go's products save food from waste pathways (reference scenario), currently reduces the climate change impact of the food system by avoiding 2.65 kg CO₂ eq. per kilogram of surplus food saved. In this result, the effect of Land Use Change (LUC) is included in order to show the widest range of environmental impacts. However, since LUC is a difficult category to measure, results are also presented without LUC; then the net impact is a bit smaller: -2.02 kg CO₂ eq./kg surplus food. The water use and land use results also showed Too Good To Go's solutions deliver a net impact of -2.76 m²a cropland eq. / kg surplus food and -0.81 m³ depriv./ kg surplus food respectively. The overall effect of the solutions was evaluated at a regional level where Too Good To Go currently operates: Europe and North America. These net impact reduction numbers represent a weighted aggregation of both regions and the two products saved based on reported tonnage.

It should be noted that this is an evaluation of the current situation, where surplus food is regularly being disposed of. This means that Too Good To Go is regarded as being a solution to an existing problem and not as an integrated player in the market, and thus it can be stated that the surplus food is truly saved. Over time, Too Good To Go might become more integrated and thereby have an effect on the food system as a whole, potentially leading to higher production ratios and lower environmental benefits (if Too Good To Go becomes a part of every day groceries and food producers adapt their production volumes to include Too Good To Go's market share, it cannot be claiming to avoid other purchases). This does not mean that in time the value of Too Good To Go decreases; it only means that the true systemic impact of Too Good To Go should be evaluated critically with every future update of the results. It should also be noted that in the current situation there is such a large share of food waste, that it is unlikely that this systemic switch is about to happen within a few years.

Main contributions in the reference scenario

The overall climate change impact for the reference scenario was relatively small at 0.12 kg CO₂ eq./kg surplus food. The waste treatment pathways accounted for included landfill, recycling (anaerobic digestion), composting and incineration. The associated burdens and credits of these pathways were included with the landfill pathway representing the hotspot, mainly due to methane emissions.

Too Good To Go alternative scenario: Surprise Bags & Magic Parcels

In the Too Good To Go alternative scenario, the footprint of an average Surprise Bag contributed to the majority of the avoided impact since they also represent the largest market share (99% of total tonnage). Consequently, Magic Parcels had a very small contribution in the overall results (<1%). Additional activities included in analysis, like packaging and waste at the consumer, contributed a relatively small impact to this scenario (both 0.01 kg CO₂ eq./kg surplus food). The processes involved with the Surprise Bags had the highest contribution to the total impact of Too Good To Go because of their volume. Transport of the Surprise Bags did contribute quite significantly (0.31 kg CO₂ eq./kg surplus food, offsetting more than 10% of the avoided impacts), but by lack of primary data it was assumed that consumers would travel for 5 km to pick up a Surprise Bag (of which 62% by car and 5% by van), combining it with other shopping only half of the time. It is reasonable to think that products are most of the time bought in combined trips, either because more products are bought in the same store or because travelling for food is combined with other shopping or travels. Also, regional differences are likely to apply, for example given the fact that the median of US citizens lives within 3 km from grocery stores¹² and

¹² <https://www.ers.usda.gov/amber-waves/2019/june/us-shoppers-access-to-multiple-food-stores-varies-by-region/>

aligns with Too Good To Go's advertisement to "explore shops and restaurants in your local area". However, this should be investigated in further detail in order to rectify the calculations.

Too Good To Go alternative scenario: regional differences

The results just discussed all relate to the climate change impact (incl. LUC) for the overall (*All Regions*) scenario. Given the weighted average favoured the much larger current market Europe (by total tons saved it represented 94%), the results discussed above reflect the same trends for this region. North America's net results (-3.05 kg CO₂ eq./kg surplus food) showed an almost 15% higher environmental benefit to the scenario compared to 'All regions' and Europe, which were at -2.65 and -2.62 kg CO₂ eq./kg surplus food respectively. This difference was due to a slightly higher impact of saved food in North America, but this falls within uncertainty ranges (10% difference). In terms of environmental impacts, the avoided environmental impact associated with the food in a Surprise Bag was also slightly greater for North America (modelled on US data) at -3.04 kg CO₂ eq./kg surplus food compared to the average European Surprise Bag of 2.85 kg CO₂ eq./kg surplus food (modelled on France and the UK), but this difference is less than 10% and may therefore not be significant. All results for food savings (without the losses and additional activities) are in the same order of magnitude as the FAO food wastage footprint of -2.53 kg CO₂ eq./kg of waste food¹³ (which is without LUC, so including LUC would bring the numbers even closer together).

Sensitivities: functional equivalence, "real" surplus food and robustness of the land use assessment

In this study two critical assumptions were taken on which the validity of the results could be debated. They concern both the decisions to assume 90% of the environmental impacts associated with the purchased products are functionally equivalent to the food they replace ("displacement factor") and that these foods are truly being saved from being waste and not being marketable any day longer. The sensitivity analyses showed that both assumptions significantly influence the net impact result of Too Good To Go. Uncertainties in the displacement factor could lead to a +/- 16% difference in net impact result for Too Good To Go. However, it should be noted that the application of both a displacement as well as a waste factor, may already be a conservative assumption. It is thus not very likely that the total impact of Too Good To Go is overestimated by the full 16%.

The uncertainty about the "real" surplus is very influential, but hard to quantify. It is recommended that Too Good To Go invests on the true following of this core company principle, including extensive monitoring. Such investment would also enforce the company's aim not to compete with food banks (charity). Overall, to improve the validity of Too Good To Go's environmental claim, further research should be carried out across all of Too Good To Go's operating regions on both sensitivities.

Thirdly, the robustness of the land use methodology was concluded to be appropriate for the given study, by using the characterized interpretation of the ReCiPe 2016 method, by which all land occupations are expressed in "m²a cropland equivalents". This does not alter the conclusions.

In addition to these sensitivities, it should also be noted that the environmental impacts were calculated using a Dutch database and the impact of food production may vary across the regions. Additionally, the reported contents for the Magic Parcels and Surprise Bags were used as a guide to proportionally select food item emission factors from this dataset. However, in some case, especially composite dishes and the more unusual items contained in the Magic Parcels, no close match was available. Altogether, the lack of specificity in the described food items (e.g. "sandwich") combined with the limited range of the dataset used in this study (about 75 products to reflect thousands of products) applied in this study means it is likely that some items are significantly over or under-estimated. The practitioners anticipate this approach even itself out at the aggregate level, but advise the footprints reported are indicative rather than absolute representations of the savings.

Recommendations for next steps for Too Good To Go

As a first step in the expression of Too Good To Go's environmental impact, this research provided useful insights in the origins and hotspots of environmental impacts. To bring this further in the coming years, the following actions are recommended:

- The "displacement factor" should be investigated via a market research, pointing out to what extent consumers buy the same amount or category of food items via Too Good To Go than they would regularly do, and then it should be investigated how these changes affect the overall impact results. It

¹³ FAO (2013) report an annual 3.3 Gton CO₂ eq. for 1.3 Gton of wastage of edible food.

- would be valuable as well to include the waste factor (to what extent is the “saved” food really eaten and not wasted by the consumers) in this research as well, in order to obtain the most complete picture.
- Attention should be paid to ensure that all food is genuinely being waste and not marketable or donatable. This should be clearly monitored annually. If doubts arise on the “real waste” value of the food saved via Too Good To Go, calculations should be adjusted accordingly.
 - In a follow-up study, it would be valuable if more attention would be paid to the weight and content of the products, preferably via a standardized system where all Too Good To Go products in all countries use the same food category classification. At least the weight of all products should be investigated for a representative sample size.
 - If Too Good To Go wishes to differentiate their results communication amongst sectors, more research would be needed on the specific sub sectors (e.g. bakeries, butchers, supermarkets) and the food items in their products.
 - When updating the results, it should be critically evaluated to what extent Too Good To Go still solves an existing problem in the food system, or whether it has become part of the system, and adapt the environmental impact calculations accordingly if necessary.

From the insights from this study, there are several steps which Too Good To Go could undertake to increase their environmental as well as their societal impact:

- As said before: make sure that all food saved via Too Good To Go is pure surplus food. This could be done via a marketing campaign, by asking formal commitment of associated companies, by executing random checks or big data analysis on food selling patterns, or in many other ways.
- Pay attention to transport impact reduction, especially for the Surprise Bags. This could be done by promoting local shopping and making consumers aware of the large impact of car transport for single trips in comparison to the food saved.
- The insights of this study (and optionally follow-up research) could help if Too Good To Go would like to enhance their total impact by focusing on food categories with the largest impact and/or to develop tailored food saving strategies or concepts for specific food categories to optimize impact results.

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Appendix I Life Cycle Assessment explained

Life Cycle Assessment principles

Environmental impacts of products and services can be calculated by means of a Life Cycle Assessment (LCA). LCA is a quantitative method whereby environmental impacts arising over the entire value chain of a product or service (ISO, 2006a, 2006b) can be calculated. Too Good To Go has asked Blonk to execute an independent LCA research to provide insight in their activities.

This LCA is conducted according to the iterative, multi-step methodology proposed in ISO 14040 and 14044 LCA methodological standards (ISO 14040, 2006; ISO 14044, 2006), including an external review. In addition, the LCA follows the guidance established by the European Commission in the Product Environmental Footprint (PEF) project (Zampori, 2019) and product specific Product Environmental Footprint Category Rules (PEFCR). The LCA is conducted according to the following steps, as defined by above mentioned ISO standards.

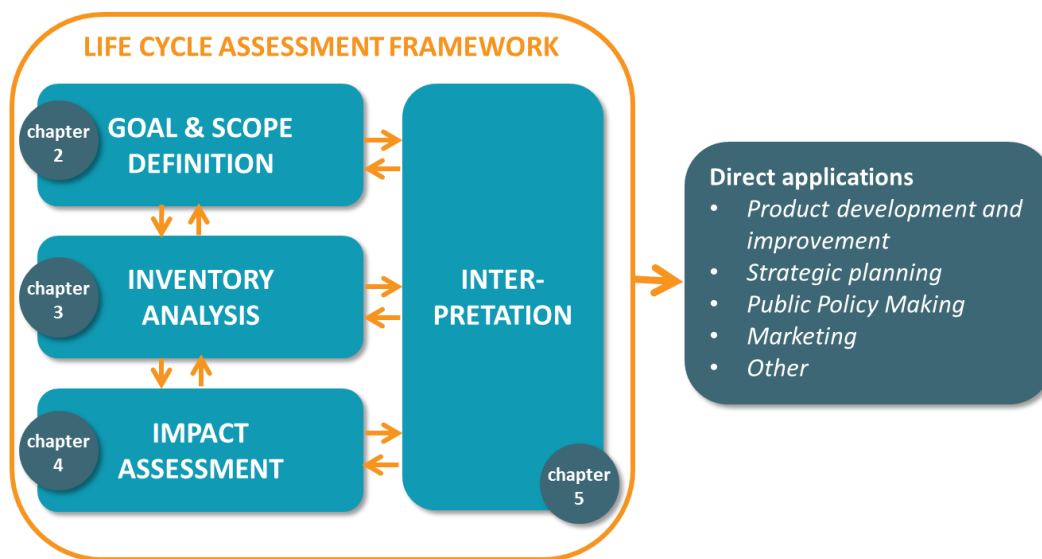


FIGURE 1: METHODOLOGICAL PHASES IN LCA BASED ON ISO 14040

- **Goal & scope definition:** This phase provides a description of the product system in terms of system boundary and functional unit.
- **Life cycle inventory analysis:** (LCI) is a methodology for estimating the consumption of resources and the quantities of waste flows and emissions caused by or otherwise attributable to a product's life cycle.
- **Life cycle impact assessment:** (LCIA) provides indicators and the basis for analysing the potential contributions of the resource extractions and emissions in an inventory to a number of potential impacts.
- **Interpretation:** in this phase the results of the analysis and all choices and assumptions made during the analysis are evaluated in terms of soundness and robustness. After this, overall conclusions are drawn.

Two general LCA approaches can be followed: attributional and consequential LCAs. Whereas attributional LCAs focus on existing product systems and their impacts, consequential LCA models are prospective as they aim to model the consequences of future decisions, in which activities are included in the evaluated product system only to the extent that they are expected to change as a result of a change in demand for the functional unit. The LCA for Too Good To Go therefore follows the consequential approach.

Land Use Change (LUC)

In this study, Land Use Change (LUC) was included as by using LCI data from an expert database based on Agri-Footprint. The section below is the description of the LUC methodology from the Agri-Footprint methodology report (Blonk et al., 2023; section 3.2.4).

Two types of land use change modelling have been applied to the different Agri-footprint versions.

- The standard Agri-footprint version uses the PEF compliant PAS 2050-1 methodology for LUC calculations.
- The FLAG version of Agri-footprint use the linear discounting for LUC emissions following the SBTi Guidance.

Each of these LUC methodologies is described in more detail below.

PAS2050-1 methodology for land use change emissions

Fossil CO₂ emissions resulting from direct land use change were estimated using the "Direct Land Use Change Assessment Tool version 2021" that was developed alongside the PAS 2050-1 (BSI, 2012). This tool provides a predefined way of calculating greenhouse gas (GHG) emissions from land use change based on FAO statistics and IPCC calculation rules, following the PAS 2050-1 methodology. GHG emissions arise when land is transformed from one use to another. The most well-known example of this is conversion of forests to crop land. This tool can be used to calculate the emissions for a specific country-crop combination and attribute them to the cultivated crops.

The calculation has been under development continuously since the publication of the PAS2050-1 and has been reviewed by the World Resource Institute and has, as a result, earned the 'built on GHG Protocol' mark. This tool can be used to quantify land use change emissions in conformance with the GHG Protocol standards (<http://www.ghgprotocol.org/standards>). The tool provides three basic functionalities, based on data availability of the user. All these approaches are described in the PAS 2050-1 published by BSI, and are made operational in this tool using various IPCC data sources (IPCC, 2019a, 2006a).

For Agri-footprint, the option "calculation of an estimate of the GHG emissions from land use change for a crop grown in a given country if previous land use is not known" was used. This estimate is based on a number of reference scenarios for previous land use, combined with data from relative crop land expansions based on FAOSTAT data. These FAO statistics then provide an estimate of the share of the current cropland (for a given crop) which is the result of land use change from forest and/or grassland to cropland. This share is calculated based on an equal amortization period of 20 years, as described in the PAS 2050-1. This results in three scenarios of land transformation (m²/ha*year): forest to (perennial or annual) cropland, grassland to (perennial or annual) cropland, and transformation between perennial and annual cropland, depending on the crop under study. The resulting GHG emissions are then the weighted average of the carbon stock changes for each of these scenarios. We use the weighted average because, in our opinion, this most accurately estimates the Land Use Change. In the development of Agri-footprint we have the principles that we want to provide consistent data across inventories, and the 'best estimate' rather than a worst-case approach, which the PAS 2050-1 advises. Please see Annex B of the PAS2050-1 for an example calculation (BSI, 2012).

In case of grassland management and roughages, data gaps from FAO statistics had to be solved. Since no grassland expansion was reported in the past 20 years by FAO statistics, no LUC impact was accounted for grassland management. Due to data gap on maize silage cultivation, maize grain was used as an approximation for maize silage in estimating the land use change impacts. Due to data gap on lucerne cultivation, LUC was assumed to be 0 (country in scope in the database are ES, IT and US).

The carbon stock change calculations used for each are based on IPCC rules and default data for soil carbon stocks and carbon stock in grassland (IPCC 2006 and 2019); FAO statistics on land coverage of specific crops, total annual and perennial cropland and total grassland and forestland to calculate conversions (including data up to 2018) and the Forest Resource Assessment provides country-specific carbon stocks in natural forests (FAO, 2020). The basic approach is to first calculate the carbon stocks in the soil and vegetation of the old situation and then subtract these from those of the new situation, to arrive at the total carbon stock change. The assumptions for carbon stocks are dependent on country, climate & soil type. Emissions from nitrogen mineralization are related to oxidation of soil organic carbon and are included in the total emissions from land use change. A nice example of such a calculation is provided in the 'Annotated example of a land carbon stock calculation' document, which can be found at the European Commission's Biofuel site. The soil organic carbon changes and related biomass references are taken from various IPCC tables, which are documented in the direct land use change tool itself.

The calculated CO₂ emissions from land use change (LUC) have been added in the database, the substance flow name is “Carbon dioxide, land transformation”. Note that land transformations are also included based on m²a.

SBTi methodology for land use change emissions

In Agri-footprint FLAG, land use change emissions are calculated using linear discounting, as described in the SBTi FLAG Guidelines. The same land use change tool is used as described earlier but with different calculations, leading to different land use change emissions compared to the PAS2050-1 method (equal amortization). Note that land transformations are not adapted for the FLAG version of AFP, these resource flows are still based on calculations from the PAS2050-1 methodology.

Linear discounting implies that LUC emissions are calculated for all (yearly) expansions which occurred of a specific crop-country combination in the last 20 years. In case the crop area expanded first, and then contracted to equal to, or less than the area 20 years ago, the total expansion is considered larger than zero. Due to fluctuations in cultivated area for crops in FAO statistics, most of the crop-country combinations are associated with some total expansion. For this reason, many crop-country combinations which lead to zero expansion (and thus zero emissions) when using equal amortization will be associated with some expansion (and thus emissions) when using linear amortization.

References

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Appendix II Data

General data

The following tables show which data are used for general parts of the calculations. The sections hereafter zoom into Surprise Bags and Magic Parcels respectively.

TABLE 14 WASTE TREATMENT PATHWAYS

Waste treatment pathway	Dataset	Database
Landfill (unspecified)	Municipal solid waste {RER} market group for municipal solid waste Cut-off, S	Ecoinvent 3.8 (cut-off)
	Municipal solid waste {RoW} treatment of, sanitary landfill Cut-off, S	Ecoinvent 3.8 (cut-off)
Recycling (anaerobic digestion)	Biowaste {CH} treatment of biowaste by anaerobic digestion Cut-off, S	Ecoinvent 3.8 (cut-off)
Composting	Biowaste {CH} treatment of biowaste, industrial composting Cut-off, S	Ecoinvent 3.8 (cut-off)
	Biowaste {RoW} treatment of biowaste, industrial composting Cut-off, S	Ecoinvent 3.8 (cut-off)
Incineration	Biowaste {GLO} treatment of biowaste, municipal incineration Cut-off, U	Ecoinvent 3.8 (cut-off)

TABLE 15 PACKAGING PROCESSES MODELLING

Packaging	Dataset	Database	Comment
Surprise bag - paper bag (kg)	Kraft paper {RER} market for kraft paper Cut-off, S	Ecoinvent 3.8 (Cut-off)	0.028 kg packaging kg-1 food product.
Magic Box - cardboard box (kg)	Corrugated board box {RER} production Cut-off, S	Ecoinvent 3.8 (Cut-off)	Cardboard box packaging for parcel. Default. Adapted from RIVM 2023. 0.025kg packaging kg-1 food product
	Corrugated board box {RER} production Cut-off, S	Ecoinvent 3.8 (Cut-off)	Cardboard box filling for parcel. Default. Adapted from RIVM 2023. 0.025kg packaging kg-1 food product.

TABLE 16 TRANSPORT PROCESSES MODELLING

Transport	Value/unit	Dataset	Database	Comment
Transport to incineration	100km	Transport, freight, lorry >32 metric ton, euro4 {RER} market for transport, freight, lorry >32 metric ton, EURO4	Ecoinvent 3.8 (Cut-off)	Transport from collection place to methanisation. PEF default (EC. 2022). Also for North America in lieu of better data
Transport to feedmill	100km	Transport, freight, lorry >32 metric ton, euro4 {RER} market for transport, freight, lorry >32 metric ton, EURO4	Ecoinvent 3.8 (Cut-off)	Transport from collection place to methanisation. PEF default (EC. 2022). Also for North America in lieu of better data.
Transport of Magic parcels to customer	250 km * 20% utilisation	Transport, freight, lorry 3.5-7.5 metric ton, euro3 {RER} market for transport, freight, lorry 3.5-7.5 metric ton, EURO3 Cut-off, S	Ecoinvent 3.8 (Cut-off)	From DC to final client. 100% local. PEF default (EC. 2022); 250 km * 20% utilisation.
Transport of Surprise Bags to customer	(62%) 5 km * 50%	Transport, passenger car, medium size, petrol, EURO 4 {GLO} market for	Ecoinvent 3.8 (Cut-off)	PEF default (EC. 2022). Also for North America in lieu of better data. Rescaled to exclude lorry transport. Multiplied by 50% for combined trips.
	(5%) 5 km * 20% utilisation * 50%	Transport, freight, lorry 3.5-7.5 metric ton, euro3 {RER} market for transport, freight, lorry 3.5-7.5 metric ton, EURO3 Cut-off, S	Ecoinvent 3.8 (Cut-off)	PEF default (EC. 2022). Also for North America in lieu of better data. Excluded, no lorry/van delivery of surprise bags. Multiplied by 50% for combined trips.
	33% 5km * 50%	n/a	n/a	PEF default (EC. 2022). Also for North America in lieu of better data. Walking/cycling: no impact modelled. Multiplied by 50% for combined trips.

Surprise Bag data

In the following tables, the product category data used to model the Surprise Bags are shown. It should be noted that these data were specifically developed for this study, based on the product analysis dataset obtained from Too Good To Go, and do not reflect a full market average. Therefore, these numbers are of sufficient quality for the purpose of this study (providing an estimate of the overall footprint of Too Good To Go) but should not be used for other purposes (e.g. to make claims about the impact of certain food categories or countries in general).

TABLE 17 SURPRISE BAG, UK AVERAGE, CONTRIBUTING FOOD ITEMS AND EMISSION FACTORS BY FOOD CATEGORY.

	% of total products in category	Climate change (incl. LUC)	Climate change (excl. LUC)	Land use	Water use
		kg CO ₂ eq	kg CO ₂ eq	m ² a	m ³ depriv.
Top 10 EU FoodEx (L1) Categories					
Composite dishes sandwich sausage rolls pasties	32%	3.3	2.8	3.8	0.36
Grains and grain-based products cakes bread baguette	24%	1.8	1.6	1.8	0.3
Meat and meat products chicken sausage bacon	8%	7.4	6.0	6.8	0.8
Vegetables and vegetable products tomatoes mushrooms carrots	8%	1.0	1.0	0.2	0.2
Fruit and fruit products strawberries apples oranges	7%	1.3	1.3	0.3	3.8
Sugar and similar, confectionery and water-based sweet desserts chocolate sweets desserts	7%	8.4	3.2	12.8	0.4
Milk and dairy products cheese yoghurt cream	5%	4.1	3.8	2.5	0.3
Legumes, nuts, oilseeds and spices beans peas almond	4%	1.3	1.3	3.2	28.4
Seasoning, sauces and condiments gravy sauce Mayo	3%	1.1	0.9	1.8	0.6
Fish, seafood, amphibians, reptiles and invertebrates tuna salmon prawn	2%	8.8	8.0	3.1	1.3
Total (weighted)		3.32	2.63	3.45	1.70

TABLE 18 SURPRISE BAG, FRANCE AVERAGE, CONTRIBUTING FOOD ITEMS AND EMISSION FACTORS BY FOOD CATEGORY.

Top 10 EU FoodEx (L1) Categories	% of total products in category	Climate change (incl. LUC)	Climate change (excl. LUC)	Land use	Water use
		kg CO ₂ eq	kg CO ₂ eq	m ² a	m ³ depriv.
Grains and grain-based products	39%	1.7	1.5	2.5	0.24
pain viennoiseries croissant					
Composite dishes	20%	2.1	1.9	1.5	0.37
sandwich salad pizza					
Meat and meat products	10%	12.0	10.5	10.4	1.10
poulet jambon Meat (assmed beef)					
Fruit and fruit products	9%	0.5	0.5	0.2	0.25
tomates bananes pommes					
Vegetables and vegetable products	8%	1.4	1.3	0.2	0.20
carottes poivron champignons					
Milk and dairy products	8%	3.0	2.8	1.8	0.24
yaourt fromage lait					
Sugar and similar, confectionery and water-based sweet desserts	3%	10.6	3.1	17.1	0.40
chocolat éclair desserts					
Fish, seafood, amphibians, reptiles and invertebrates	2%	3.9	3.5	3.1	0.55
saumon cabillaud moule					
Starchy roots or tubers and products thereof, sugar plants	1%	0.3	0.3	0.4	0.57
Potato Sweet potato pommes dauphines					
Eggs and egg products	0.2%	2.4	1.5	3.4	0.78
Eggs Mayonaise oeufs brouillés					
Total (weighted)		3.1	2.6	3.1	0.36

TABLE 19 SURPRISE BAG, US AVERAGE, CONTRIBUTING FOOD ITEMS AND EMISSION FACTORS BY FOOD CATEGORY.

Top 10 EU FoodEx (L1) Categories	% of total products in category	Climate change (incl. LUC)	Climate change (excl. LUC)	Land Use	Water use
		kg CO ₂ eq	kg CO ₂ eq	m ² a	m ³ depriv.
Composite dishes pizza sandwich salad	34%	2.1	1.9	1.5	0.41
Grains and grain-based products pastries croissants muffins	25%	2.0	1.8	2.7	0.25
Meat and meat products chicken meat (assmed beef) pork	9%	11.3	9.9	9.9	1.04
Vegetables and vegetable products cabbage broccoli tomatoes	7%	0.6	0.6	0.1	0.70
Sugar and similar, confectionery and water-based sweet desserts chocolate dessert macaroons	7%	8.4	3.2	12.8	0.42
Milk and dairy products cheese ice cream yoghurt	5%	3.5	3.3	2.0	0.27
Fruit and fruit products lemon apples strawberries	4%	1.3	1.3	0.4	1.19
Seasoning, sauces and condiments sauce spread tomato sauce	4%	1.9	1.5	2.2	1.50
Fish, seafood, amphibians, reptiles and invertebrates salmon tuna cod	3%	8.5	8.2	1.9	0.71
Legumes, nuts, oilseeds and spices beans almond Nuts (aggregated)	3%	2.0	1.8	6.0	41.43
Total (weighted)		3.44	2.80	3.34	2.59

TABLE 20 SURPRISE BAG RATIOS USED TO ARRIVE AN 'ALL REGION' AND EUROPEAN AVERAGE FOOTPRINT

Ratio between FR:UK	FR, saved (metric tons)	UK, saved (metric tons)
60%	23718	16011
Ratio between EU:NA	EU, saved (metric tons)	NA, saved (metric tons)
95%	112647	5648

TABLE 21 THE TOTAL TONS OF SURPRISE BAGS SOLD BY COUNTRY AND BY % IN THE RESPECTIVE REGION

Country	Total sold (metric tons)	% of respective region
AT	5,456	5%
BE	5,616	5%
CA	1,523	27%
CH	3,734	3%
DE	15,794	14%
DK	5,147	5%
ES	7,779	7%
FR	23,718	21%
GB	16,011	14%
IE	329	0%
IT	8,094	7%
NL	9,568	8%
NO	4,336	4%
PL	4,546	4%
PT	1,709	2%
SE	810	1%
US	4,126	73%
Total	118,296	

Magic Parcel data

In the following tables, the product category data used to model the Magic Parcels are shown. It should be noted that these data were specifically developed for this study, based on the product analysis dataset obtained from Too Good To Go, and do not reflect a full market average. Therefore, these numbers are of sufficient quality for the purpose of this study (providing an estimate of the overall footprint of Too Good To Go) but should not be used for other purposes (e.g. to make claims about the impact of certain food categories or countries in general).

TABLE 22 MAGIC PARCEL EMISSION FACTORS FOR THE TOP FIVE CONTRIBUTING BOXES FOR THE NETHERLANDS AND BELGIUM

<i>Netherlands</i>						
Box name	Production quantity (amount)	Production quantity (amount)	CF iLUC (kgCO ₂ eq./kg)	CF eLUC (kgCO ₂ eq./kg)	Land Use (m ² a/kg)	Water (m ³ depriv./kg)
Magic Pakket - D	2240	2240	2.04	2.02	1.4	0.61
A-Merken Pakket 30/3	2095	2095	1.20	0.96	5.0	0.31
A-Merken Pakket 14/2	2000	2000	1.75	1.58	3.5	4.40
Je huis niet uit Pakket 14/2	2000	2000	1.21	1.09	1.2	0.75
Magic Pakket I	2000	2000	1.34	1.23	3.9	0.39
<i>Belgium</i>						
Box name	Production quantity (amount)	Production quantity (amount)	CF iLUC (kgCO ₂ eq./kg)	CF eLUC (kgCO ₂ eq./kg)	Land Use (m ² a/kg)	Water (m ³ depriv./kg)
Verrassingsdoos / Colis Surprise 1 (MO1)	5229	5229	1.56	1.37	1.4	0.41
Verrassingsdoos / Colis Surprise 5 (MO12)	3974	3974	1.08	0.86	3.7	0.53
Verrassingsdoos / Colis Surprise 7 (MO17)	3668	3668	2.60	1.50	4.4	0.21
Verrassingsdoos / Colis Surprise 6 (MO15)	3665	3665	0.72	0.64	1.8	0.59
Tao & Bionina doos / Colis Tao & Bionina (MO14)	3596	3596	0.57	0.55	0.7	1.06

Appendix III Complete results

All regions

Reference Scenario (all regions)	Activity	Comment	Impact			
			Climate Change (incl. LUC)	Climate Change (excl. LUC)	Land use	Water
			kg CO ₂ eq/kg surplus food	kg CO ₂ eq/kg surplus food	m ² a/kg surplus food	m ³ depriv./kg surplus food
Impact of waste management pathway	Transport	1 kg is typically transported 100km	0.01	0.01	0.00	0.00
	Landfill (unspecified)	20% is sent to landfill	0.12	0.01	0.00	0.00
	Recycling (anaerobic digestion)	29% is recycled	0.03	0.01	0.00	0.00
	Composting	18% is composted	0.01	0.00	0.00	0.00
	Incineration	33% is incinerated	0.01	0.01	0.00	0.00
	Total Impact	100% of 1 kg disposed	0.18	0.04	0.01	0.01
Avoided impacts	Avoided product: biogas	1 kg of surplus food avoids 0.1m ³ biogas	-0.06	-0.02	-0.02	-0.00
	Avoided product: compost	1 kg of waste generates 0.5kg of compost	-0.00	-0.00	-0.00	-0.00
	Avoided product: heat/electricity	1 kg of waste generates heat & electricity	-0.00	-0.00	-0.00	-0.00
Total impact of reference scenario			0.12	0.02	-0.01	0.01

TGTG Alternative Scenario (all regions)	Activity	Comment	Impact			
			Climate Change (incl. LUC)	Climate Change (excl. LUC)	Land use	Water use
			kg CO ₂ eq/kg surplus food	kg CO ₂ eq/kg surplus food	m ² a/kg surplus food	m ³ depriv./kg surplus food
Surprise Bags						
Avoided impacts	Average Surprise bag footprint	In EU, impact calculated from largest markets FR & UK. US data is used for North America.	-2.84	-2.30	-2.90	-0.83
Impact of purchasing (excl. consumption)	SB_Packaging	Proxy: 0.028 kg paperbag kg-1 food product	0.01	0.01	0.14	0.01
	SB_Transport	Assumed: 65% of journeys are by car travelling 5km round trip. Additionally, assumed 50% of the journey was for for 1.5kg bag.	0.31	0.31	0.01	0.03
	10% is wasted	Assumption that not all food is eaten.	0.01	0.00	0.00	0.00
Surprise bag total			-2.51	-1.98	-2.74	-0.79
Magic Parcels						
Avoided impacts	Average magic parcel footprint		-1.27	-0.02	-0.01	-0.03
Impact of purchasing (excl. consumption)	MP_Packaging	Proxy: 0.025kg cardboard box and filler kg-1 food product	0.00	0.00	0.00	0.00
	MP_Transport	Assumption: from DC to final client; 250 km * 20% utilisation	0.00	0.00	0.00	0.00
	10% is wasted	Assumption that not all food is eaten.	0.00	0.00	0.00	0.00
Magic Parcel total			-0.02	-0.01	-0.03	-0.01
Total impact of TGTG alternative scenario	<i>All regions ratio of surprise bags to magic parcels sold in 2023 was 99:1</i>		-2.52¹⁴	-2.00	-2.77	-0.80

¹⁴ The grand total reflects the ratio between Surprise Bags and Magic Parcels.

Europe

Reference Scenario (Europe)	Activity	Comment	Impact			
			Climate Change (incl. LUC)	Climate Change (excl. LUC)	Land use	Water
			kg CO ₂ eq/kg surplus food	kg CO ₂ eq/kg surplus food	m ² a/kg surplus food	m ³ depriv./kg surplus food
Impact of waste management pathway	Transport	1 kg is typically transported 100km	0.01	0.01	0.00	0.00
	Landfill (unspecified)	18% is sent to landfill	0.11	0.01	0.00	0.00
	Recycling (anaerobic digestion)	29% is recycled	0.03	0.01	0.00	0.00
	Composting	18% is composted	0.01	0.00	0.00	0.00
	Incineration	34% is incinerated	0.01	0.01	0.00	0.01
	Total Impact	100% of 1kg disposed	0.17	0.04	0.01	0.01
Avoided impacts	Avoided product: biogas	1kg of surplus food avoids 0.1m3 biogas	-0.05	-0.02	-0.02	0.00
	Avoided product: compost	1kg of waste generates 0.5kg of compost	0.00	0.00	0.00	0.00
	Avoided product: heat/electricity	1kg of waste generates heat & electricity	0.00	0.00	0.00	0.00
Total impact of reference scenario			0.11	0.02	-0.01	0.01

TGTG Alternative Scenario (Europe)	Activity	Comment	Impact			
			Climate Change (incl. LUC)	Climate Change (excl. LUC)	Land use	Water
			kg CO ₂ eq/kg surplus food	kg CO ₂ eq/kg surplus food	m ² a/kg surplus food	m ³ depriv./kg surplus food
Surprise Bags						
Avoided impacts	Average Surprise bag footprint	In EU, impact calculated from largest markets FR & UK.	-2.83	-2.29	-2.89	-0.80
Impact of purchasing (excl. consumption)	SB_Packaging	Proxy: 0.028 kg paperbag kg-1 food product	0.01	0.01	0.14	0.01
	Assumed: 65% of journeys are by car travelling 5km round trip. Additionally, assumed 50% of the journey was for this purpose.	Assumed: 65% of journeys are by car travelling 5km round trip.	0.31	0.31	0.01	0.03
	10% is wasted	Assumption that not all food is eaten.	0.01	0.00	0.00	0.00
Surprise bag total			-2.50	-1.97	-2.74	-0.76
Magic Parcels						
Avoided impacts	Average magic parcel footprint		-0.02	-0.01	-0.03	-0.01
Impact of purchasing (excl. consumption)	MP_Packaging	Proxy: 0.025kg cardboard box and filler kg-1 food product	0.00	0.00	0.00	0.00
	MP_Transport	Assumption: from DC to final client; 250 km * 20% utilisation	0.00	0.00	0.00	0.00
	10% is wasted	Assumption that not all food is eaten.	0.00	0.00	0.00	0.00
Magic Parcel total			-0.02	-0.01	-0.03	-0.01
Total impact of TGTG alternative scenario		<i>In EU ratio of surprise bags to magic parcels sold in 2023 was 99:1</i>	-2.51¹⁵	-1.99	-2.77	-0.77

¹⁵ The grand total reflects the ratio between Surprise Bags and Magic Parcels.

North America

Reference Scenario (US)	Activity	Comment	Impact			
			Carbon (incl. LUC)	Carbon (excl. LUC)	Land use	Water
			kg CO ₂ eq/kg surplus food	kg CO ₂ eq/kg surplus food	m ² a/kg surplus food	m ³ depriv./kg surplus food
Impact of waste management pathway	Transport	1 kg is typically transported 100km	0.01	0.01	0.00	0.00
	Landfill (unspecified)	58% is sent to landfill	0.36	0.03	0.00	0.00
	Recycling (anaerobic digestion)	31% is recycled	0.03	0.02	0.00	0.00
	Composting	1% is composted	0.00	0.00	0.00	0.00
	Incineration	10% is incinerated	0.00	0.00	0.00	0.00
	Total Impact	100% of 1kg disposed	0.40	0.06	0.00	0.00
Avoided impacts	Avoided product: biogas	1kg of surplus food avoids 0.1m3 biogas	-0.09	-0.05	-0.01	0.00
	Avoided product: compost	1kg of waste generates 0.5kg of compost	0.00	0.00	0.00	0.00
	Avoided product: heat/electricity	1kg of waste generates heat & electricity	0.00	0.00	0.00	0.00
Total impact of reference scenario			0.32	0.01	-0.01	0.00

TGTG Alternative Scenario (NA)	Activity	Comment	Impact			
			Carbon (incl. LUC)	Carbon (excl. LUC)	Land use	Water
			kg CO ₂ eq/kg surplus food	kg CO ₂ eq/kg surplus food	m ² a/kg surplus food	m ³ depriv./kg surplus food
Surprise Bags						
Avoided impacts	Average Surprise bag footprint	US impact data is used for North America.	-3.08	-2.50	-3.01	-1.50
Impact of purchasing (excl. consumption)	SB_Packaging	Proxy: 0.028 kg paperbag kg-1 food product	0.01	0.01	0.14	0.01
	Assumed: 65% of journeys are by car travelling 5km round trip. Additionally, assumed 50% of the journey was for this purpose.	Assumed: 65% of journeys are by car travelling 5km round trip.	0.31	0.31	0.01	0.03
	10% is wasted	Assumption that not all food is eaten.	0.03	0.00	0.00	0.00
Surprise bag total			-2.72	-2.18	-2.85	-1.46
Total impact of TGTG alternative scenario			-2.72	-2.18	-2.85	-1.46

Appendix IV Review statements

Reviewer Statement - Dr. Joseph Poore with input from Valentina Caldart

This is an exciting and interesting LCA. We were really impressed by the detail and thought that has gone into it. We have had multiple opportunities to provide substantial and detailed input. Our comments have been dealt with very well in all cases.

In accordance with the ISO 14040 and 14044 guidelines, we commented on the goal and scope, and reviewed multiple drafts of the LCA. We also reviewed the data underlying the LCA which was provided in spreadsheet form. We had some major issues and minor issues where we requested changes during the process and we are happy with the level to which they were addressed.

Importantly, we argued for the use of an uncharacterised land use indicator. LANCA expresses land use in “points” which is confusing for public communication (a goal of this LCA) and is also associated with substantial methodological uncertainty. It should be noted that the ReCiPe model is also uncertain: the characterisation is based on the global average difference between biodiversity impact between cropland and pasture, which is very coarse and covers up substantial variability. The authors at Blonk decided to use ReCiPe characterised land use indicator instead of an uncharacterized indicator, and included an uncharacterised indicator as well as LANCA as a sensitivity - this seems like a very good response to our comment here.

Also importantly, we requested more documentation around the land use change approach, particularly as this LCA involves negative emissions (drawdown). These emissions occur when cropland - no longer required due to the avoided food waste and resultant reduced land demand - reverts back to natural vegetation. This process is the opposite of the expansion of agricultural land. Given the variability in these processes, there is again uncertainty here, but not including this process misses a very large part of the environmental impact/benefit.

For future work, it would be useful to quantitatively explore the land use change scenarios in more depth: is it realistic that land returns to natural vegetation and over what time periods and how much of this can be attributed to TGTG? It would also be useful to explore how these environmental benefits will change as TGTG scales up its operations - the marginal benefits would be expected to decrease, but when does this happen and by how much?

In general, this LCA provides a methodologically robust assessment of an important initiative to reduce food waste. It reveals the substantial environmental benefits that TGTG is achieving, and the positive impact this organisation is having for the planet.

Reviewer statement – Hamish Forbes

Overall, this is a good LCA and a valuable contribution to the field of understanding the impact of interventions which reduce food waste. The technical approach is sound, and I commend the authors in particular for the constructive relationship with the peer reviewers throughout the project. As reviewers, we were given multiple opportunities to influence the development of this study. I fed back on the initial conceptual approach to communicate what I saw to be the biggest conceptual issues in accounting for savings from food waste avoidance; notably ensuring that the food ‘saved’ was actually going to waste and that the collection of food from Too Good to Go (or any other redistribution channel) does offset food purchases elsewhere.

Following review of the draft document, I raised three key issues with a substantive impact on the results, and other broader conceptual issues which pave the way for future research.

The first substantive issue was around what we consider food waste ‘recycling’ to be, as the term used in the World Bank’s ‘What a Waste’ dataset appears to be somewhat unclear. I shared the opinion that it would be more appropriate to assume that this is anaerobic digestion than to allocate it is animal feed, as was initially planned, and this feedback has been taken on constructively.

Secondly, I raised that the emission factor for landfill of food waste as used in the draft report (‘inert waste’) was not accurate to use for food waste and, as a result, likely understating the impacts of landfilling. Blonk agreed with this and changed to a more appropriate figure.

Thirdly, I felt that the initial assumptions for transportation to pick up Too Good To Go bags were too conservative. Though recognising that data was lacking to inform this accurately, the default transport distances and modes in the PEF are for grocery shopping practice which I feel is not reflective of how consumers are likely to engage with Too Good To Go. The authors took this feedback constructively and adjusted the assumptions. In future, more empirical data from Too Good To Go’s users could inform an improvement of these assumptions which may further alter results.

The other points discussed with Blonk were around the sensitivity analysis. In future, I believe it would be desirable for more research to unpick these issues around how much food is consumed from Too Good to Go / similar services and how much actually offsets production. I suggested that in future, research should look to be done at a product category level, to model different behaviours for different products (between fresh fruit, bread, cakes and sweets for example). This would allow a more nuanced and realistic understanding, and data from Too Good to Go users could be used to inform these assumptions. It is no criticism of the current report to suggest that there are many exciting avenues for future research, and I look forward to seeing where these questions can be taken next. The final report provided is an important step in understanding the environmental impact of Too Good To Go’s activities, and by extension, food waste reduction.

Hamish Forbes, Interim Lead Analyst, WRAP (Waste and Resources Action Programme)



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