RSVP

ReuSe Vanguard Project

DECIPHERING THE EU'S PACKAGING LANDSCAPE

Quantification of environmental aspects for the packaging of 20 products, and qualitative assessment of the prospects for shifting from disposable to reusable (or none) packaging for seven of them in the Netherlands, Belgium, Germany, France, Spain, and the EU28 through iterative collaborative research.

MARCH 2022

Credits

Authors

José Potting (ed.), Recycling Netwerk Benelux, Utrecht (Netherlands)

Bram Honig, Recycling Netwerk Benelux, Utrecht (Netherlands)

Jason Wilcox, Reloop, Brussels (Belgium)

Design and layout
Simon Sharp (Sharp Design) and Ana Oliveira (Zero Waste Europe)

This research has been commissioned to Recycling Network Benelux (RNB) by Zero Waste Europe (ZWE) within the framework of the ReuSe Vanguard Project (RSVP).

Project partners

Funding

Executive Summary

In spring 2021, Zero Waste Europe (ZWE) started the ReuSe Vanguard Project (RSVP). The goal of RSVP is “Reusable solutions for packaging for beverages, take-away drinks, and food as well as online delivery to get to scale in Europe and become the new normal in the sectors selected”. An essential part of RSVP is to “Map the packaging landscape in Europe and detect the Ecosystemic Leverage Points (ELPs)” through an iterative collaborative research. ZWE tasked Recycling Netwerk Benelux (RNB) to take the lead in this iterative collaborative research. The other collaborators, besides ZWE (Belgium) and RNB (the Netherlands), were RSVP’s core stakeholders ECOS (Europe), ENVIU (the Netherlands), Deutsche Umwelthilfe (Germany), Reloop (global), Retorna (Spain), Rezero (Spain), and Zero Waste France (France).

The iterative collaborative research was performed in two parts. The first part quantified 20 products in terms of the type and weight of their disposable packaging, the amount of resources (raw materials) needed to produce this disposable packaging, and the quantities and types of waste and environmental pressures associated with that. The second part qualitatively assessed the possibilities for shifting from disposable to reusable packaging (or none) for seven products identified from the 20 products covered in the first part. This report summarises the results for both the first and second part.

The 20 products covered in the first part were: 1 & 2) baby food in pouches & jars; 3) beer; 4) cleaning agents; 5) conserved vegetables; 6) dry food (refined further to pasta and rice); 7) fruit juices; 8) milk & milky drinks (refined to milk); 9) oils & fluid fats for cooking (refined to olive oil); 10) postal services (refined to post & packages); 11) shampoos & shower gels (refined to hair care products); 12) soda drinks; 13) grapes; 14) water (refined to carbonated water and still water); 15) wine; 16) take-away warm drinks,; 17 & 18) take-away & delivery meals (refined to pizza and other meals); 19) textile washing soaps & softeners (limited to softeners); and 20) yoghurt.

Out of the 20 above-mentioned products, seven were selected for additional qualitative assessment, namely: cleaning agents, dry food, soda drinks & (sparkling) water, postal services, take-away & delivery meals, take-away warm drinks, and wine. Dry food and cleaning agents were disqualified as final ELPs based on the additional qualitative assessment.

Table of Contents

1. Introduction

In spring 2021, Zero Waste Europe (ZWE) started the ReuSe Vanguard Project (RSVP). The goal of RSVP is "Reusable solutions for packaging for beverages, take-away drinks and food, as well as online delivery to get to scale in Europe and become the new normal in the sectors selected". RSVP consists of two phases. Phase 1 will identify necessary logistic, legislative, media and economic conditions resulting in plans to successfully shift three to five product and market segments, referred to as 'Ecosystemic Leverage Points' (ELPs), from disposable to reusable packaging (or none). The actual transitions are to take place in Phase 2.

An essential part of Phase 1 is to "Map the packaging landscape in Europe and detect the potential ELPs" through an iterative collaborative research. ZWE tasked Recycling Netwerk Benelux (RNB) to take the lead in this iterative collaborative research. The other collaborators, besides ZWE (Belgium) and RNB (the Netherlands), were RSVP's core stakeholders. These core stakeholders were ECOS (Europe), ENVIU (the Netherlands), Deutsche Umwelthilfe (Germany), Reloop (global), Retorna (Spain), Rezero (Spain), & Zero Waste France (France).

There is a large number and wide range of products on the market, and many of these products are sold in different types of packaging. One example is soda drinks in cans or bottles, of which the latter are available in small and large volumes, and in glass or plastic, as reusables or disposables. It would have been impossible to decipher in depth the whole packaging landscape for each product on the market. The iterative collaborative research therefore took a funnel approach to arrive at the five products qualifying as ELPs for which plans to shift their packaging from disposable to reusable (or avoided) ones are to be developed. The focus in the iterative collaborative research was on disposable packaging.

The funnel approach started from all products and narrowed them down in eight steps to the final five products qualifying as ELPs. The first five steps made up the first part, and the next three steps constituted the second part of the iterative collaborative research. The funnelling steps were at the beginning of each part, and concluded the second part. The approach for the first part took the following steps:

1. Selecting 20 products for quantifying their disposable packagings.
2. Quantifying the consumption of the selected products.
3. Quantifying their disposable packaging and the materials from which these are made.
4. Quantifying the environmental pressures for producing the packaging materials.
5. Identifying the rates of waste recycling and littering of the empty packaging.

Identifying the rates of waste recycling and littering of the empty packaging The initial selection of the 20 products was done by RNB and ZWE and validated by the core stakeholders in a first workshop for this iterative collaborative research. The subsequent quantification was carried out by RNB with input by the core stakeholders (notably Reloop). The results of the first part were input to the second part of the iterative collaborative research.

The second part of the iterative collaborative research has qualitatively assessed the prospects for shifting from disposable to reusable packaging (or none) for seven products identified as potential ELPs from the 20 products covered in the first part. The approach for this second part took the following steps:

1. Identifying seven products qualifying as potential ELPs.
2. Qualitatively assessing prospects to shift from disposable to reusable packaging (or none).
3. Identification of five products qualifying as ELPs.

Again, the initial identification of seven products qualifying as potential ELPs was done by ZWE and RNB and validated by the core stakeholders in a second workshop for this iterative collaborative research. The qualitative assessment of the prospects for shifting from disposable to reusable packaging (or none) was largely done by the core group of stakeholders under the supervision of RNB.

The five products finally qualifying as ELPs, i.e. entering Phase 2 of the RSVP product focusing on accomplishing the actual transitions from disposable to reusable packaging (or none), were identified in a third and final workshop for this iterative collaborative research. In contrast to the first and second workshop, however, each of the core stakeholders, apart from ZWE and RNB, came with their preferred list of products qualifying as ELP as input, identifying the five final ones.

The first as well as the second part of the iterative collaborative research covered the Netherlands, Belgium, Germany, France, Spain, and the EU28 (i.e the present European Union & the United Kingdom, now as a former Member State). The quantification in the first part used 2019 as the last representative year before the disruptive COVID-19 pandemic emerged.

This report summarises and discusses the results for the iterative collaborative research. Chapter 2 does so for the first part, whereas Chapter 3 deals with the second part. The report ends with the main findings.

2. Results and discussion Part 1 (Steps 1-5)

In Part 1 of the iterative collaborative research, 20 products have been selected (Section 2.1), and quantified in terms of their consumption (Section 2.2), the weight of their packaging and of the materials in these packaging (Section 2.3, the related environmental pressures (Section 2.4), and rates of waste recycling and littering (Section 2.5). This chapter summarises the overall results. The quantification applies to 2019 as the base year, and covers the Netherlands, Belgium, Germany, France, Spain, and the EU28.

2.1 Selecting 20 products (Step 1)

The EU's statistics division, Eurostat, compiles annual data of household expenditure on products and services. This expenditure is obtained through surveys at a national level. These surveys are all based on the Classification Of Individual Consumption according to Purpose (COICOP). The COICOP classification consists of five levels, with each level further subdividing and/or detailing the previous level (Eurostat, 2022a). Table 1 exemplifies this.

The COICOP classification is, as far as the authors are aware, the most detailed list of products and services for consumer expenditure. It contains over 230 products and services at the most detailed level (Eurostat, 2022a). However, despite its high level of detail, even the COICOP classification misses useful breakdowns for some products and services. It does, for example, not distinguish between new and second-hand products, and conserved vegetables are lumped together with dried and otherwise processed vegetables in one subcategory. In contrast, some subcategories are broken down to a level of detail not relevant for our purpose here. Nevertheless, the COICOP classification has been used as the starting point for selecting 20 products whose packaging has been quantified.

Table 1 - Small part of the five level COICOP classification to exemplify its level of detail (Eurostat, 2022a)

Level	COICOP-codes	Product categories and subcategories
1	CP01	Food & non-alcoholic beverages
2	CP011	- Food
3	CP0111	> Bread and cereals
4	CP01111	o Rice
5	CP01111A	→Long grain rice
4	CP01112	o Flours and other cereals
5	CP01112A	→ Wheat flour
5	CP01112B	→ Cornflakes
4	CP01113	o Bread
5	CP01113A	→ White bread, loaf
4	CP01114	o Other bakery products
4	CP01115	o Pizza and quiches
5	CP01115A	→ Pizza, frozen (500 g)
4	CP01116	o Pasta products and couscous
5	CP01116A	→ Pasta, without eggs (1 kg)
4	CP01117	o Breakfast cereals
4	CP01118	o Other cereal products
3	CP0112	> Meat
4	.....	o .....
5	.....	→ .....

The COICOP classification has been downloaded and copied in its totality into an Excel file with all the products and services listed in rows. Next, all rows with services have been hidden as supposedly no packaging is involved there. Subsequently, ZWE went through the remaining list of products to indicate which products they considered as potentially interesting because of their packaging. Then ZWE and RNB together went through the products indicated by ZWE as potentially interesting, and where relevant grouped them or divided them into subcategories. This resulted in a list of 43 products that ZWE once again went through with a few criteria to arrive at an initial list of 20 products to quantify their packaging in the first part of the iterative collaborative research. These criteria were:

- Existence of a reusable alternative for the currently common disposable packaging of a given product or for similar products.
- Considered feasibility of replacing a currently common disposable packaging of a given product by reusable alternatives.
- Main type of material from which the packaging of a given product was expected to be made (products with assumed plastic packaging were prioritised).
- The potential impact of a given product based on its market share and/or share in total household expenditure.

The initial list of 20 products has been presented to, and discussed with, the core stakeholders in a first workshop for the iterative collaborative research. This has resulted in the final list of 20 products whose disposable packaging has been quantified. For quantification purposes, some of these products have been refined further in the course of the quantification process.

The 20 selected products were 1 & 2) baby food in pouches & jars; 3) beer; 4) cleaning agents; 5) conserved vegetables; 6) dry food (refined further to pasta and rice); 7) fruit juices; 8) milk & milky drinks (refined to milk); 9) oils & fluid fats for cooking (refined to olive oil); 10) postal services (refined to post & packages); 11) shampoos & shower gels (refined to hair care products); 12) soda drinks; 13) grapes; 14) water (refined to carbonated water and still water); 15) wine; 16) take-away warm drinks; 17 & 18) take-away & delivery meals (refined to pizza and other meals); 19) textile washing soaps & softeners (limited to softeners); and 20) yoghurt.

2.2 Quantifying product consumption (Step 2)

The quantification for each selected product started with its consumption. The quantified product consumption was the basis for quantifying the weight of (the materials in) the disposable packaging for each product in Step 3. The quantities of disposable packaging, or more specifically the weight of the

materials they are made of, were in their turn the basis to quantify environmental pressures in Step 4.

Trade statistics, like those from the European Union (Eurostat, 2022b) or the Food and Agriculture Organisation (FAO, 2022), are often used as sources for product consumption data. Such trade statistics typically provide country data about their own production and import and export of, amongst others, products ready for end use (i.e. consumption) by consumers. Some trade statistics, like those from the FAO (2022), also provide product consumption data. Product consumption in a country can be approximated by adding together own production and import and subtracting the export of that product in that country. Trade statistics usually give a reasonable but not an exact indication of product consumption as they do not always seem to account for all product conversions in a country. Moreover, trade statistics do not cover all consumer products, e.g. take-away & delivery meals.

Given before comments on trade statistics, where possible, consumption of the selected products has been based on data from more reliable data sources. Data from trade statistics have been taken only for products for which no other or better sources could be identified. For surface cleaning agents and textile soaps & softeners no publicly available sources have been identified at all and their consumption is therefore based on 'educated guesses' by a producer of surface cleaning agents.

Consumption data for some of the selected products was only available for one or a few of the selected countries or the EU28. In that case, extrapolations have been made on the basis of the number of inhabitants in each country and the EU28 as taken from Eurostat (2022c). Obviously this may also have introduced uncertainties due to (cultural) differences between countries in consumption patterns (as in the case of the consumption of yoghurt, which is partly based on Dutch consumption data).

Table 2 provides the sources for quantifying the consumption of the selected products and indicates the quality of the achieved consumption data (green

is good, orange is reasonable, red is mediocre). The quantified consumption for a third of the twenty products is good. The quality of the quantified consumption for the other products was either reasonable or mediocre. When achieved product consumption results are indicated to be of reasonable or mediocre quality, this does not imply that it is (easily) possible to find better data sources allowing for improvement of the quality of the quantified product consumption results based on these sources. The quantified product consumption data represent the best quality currently achievable to date.

Table 2: Overview of sources that were the basis for quantifying the consumption of the selected products, and the weights of their packaging and materials that these are made of in the countries covered and the EU28, as well as an indication of the quality of the achieved data based on these sources (good, reasonable, mediocre; it should be noted that the obtained data represents the best quality currently available as packaging for most products has not been quantified before).

Nr.	Product category	Sources of product consumption	Sources of product packaging
1 & 2	Baby food in pouches & jars	Per capita consumption in the EU28 for 2018 taken from FAO (2022). Extrapolated to countries by number of inhabitants.	Based on self acquired & weighted, medium-size laminate pouches and glass jars for baby food (anecdotal data). Shares of baby food in pouches and glass jars are not available, so calculations are made as if 100% were to be packed in either the one or the other.
3	Beer	Market data for 2019 taken from GlobalData (for beer consumption in disposable packaging only).	Based on data from open sources, and on a variety of multiple self acquired and weighted beer packaging.

4	Cleaning agents	Based on 'educated guesses' by a producer of cleaning agents.	
5	Conserved vegetables	2019-Data for NL, DE, & FR taken from GlobalTrade (2020). DE & FR data averaged and extrapolated to BE & ES by number of inhabitants.	Based on self acquired and weighted steel cans & glass jars (anecdotal data).
6	Fruit juices	Market data for 2019 taken from GlobalData.	Based on data from open sources, and on a variety of multiple self acquired and weighted juice packaging.
7	Hair care	Based on consumption market data for 2019 from Dutch Cosmetics Organisation (NVC, 2020), and average Dutch shampoo price from Dutch Bureau of Statistics (CBS, 2019).	Taken from RNB (2019).
8	Milk & milky drinks	2019-Data for NL, BE, DE, FR, & EU28 taken from Dutch Dairy Organisation (2020). ES based on per capita Italian consumption.	Based on Tetra Pak weight from Slecht & Wellen (2020) and material composition from TheDailyMilk.nl (2022) for milk boxes, and on self acquired and weighted 2 litre PET-jugs.
9	Yoghurt (milk-based desserts)	Extrapolation of Dutch per capita consumption of yoghurt in 2012- 2016 from RIVM (2022) with 2019 Data for milk consumption in NL, BE, DE, FR, & EU28 taken from Dutch Dairy Organisation (2020). ES	Based on Tetra Pak weight from Slecht & Wellen (2020) and material composition from TheDailyMilk.nl for milk boxes, and on self acquired and weighted Danone cups from an unidentified plastic

		based on per capita Italian consumption.	(anecdotal data).
10	Olive oil (oils & fluid fat for cooking)	2018 Data taken from FAO (2022).	Based on a single self acquired and weighted single litre PET-bottle (anecdotal data).
11	Pasta & rice (dry food)	For rice, 2018 data taken from FAO (2022). For pasta, 2015 data for per capita consumption in countries taken from Statista (2015). EU28 calculated from the country average.	Based on self-acquired and weighted single 500 grams polypropylene bag for pasta, and a single 1 kilogram bag of an unidentified type of plastic for rice (anecdotal data).
12	Post & packages	Based on 2019 data from ACM (2021) and assumptions about shares of specific post & packages streams.	Based on multiple self acquired and weighted paper envelopes (letters, addressed promotionals) & plastic covers (periodicals), on assumed bag size and LDPE thickness from Thuiswinkel.org (2018) for package bags, and on a combination of sources for cardboard package boxes.
13	Soda drinks	Market data for 2019 taken from GlobalData.	Based on data from open sources and on a variety of multiple self acquired and weighted soda drink packaging.
14	Table grapes	Consumption for other countries calculated from 2019 data for own production + import - export as taken from CBI (2021). 2016 Data for BE taken from Statista (2020). 2019 data for	Based on multiple self acquired and weighted PETclamshells for table grapes.

		EU28 calculated from EU27 data from IndexMundi (2022) + UK data from CBI (2021).	
15	take-away warm drinks	Market data taken from Statista (2019)	Taken from Kauertz et al. (2019).
16 & 17	take-away meals & delivery meals: Pizza and other meals	Consumption derived by combining and extrapolating data from Dealroom & Prioridata (2017), FSIN (2019), ABN-AMRO (2017), (ABN-AMRO, 2016) & (Deloitte, 2020)	Based on a single self acquired and weighted box for typical pizzas, and on weights of typical disposable meal containers taken from Verburgt (2020).
18	Textile soaps & softeners	Based on 'educated guesses' by a producer of surface cleaning agents.	
19	Water	Market data for 2019 taken from GlobalData.	Based on data from open sources and on a variety of multiple self acquired and weighted water packaging.
20	Wine	2018 Data taken from FAO (2022).	Taken from KVNW (2015)

The Annex section (20 products) provides quantitative details per selected product for quantifying their consumption. Where considered relevant for their packaging, the consumption of products has been broken down into subcategories, such as take-away and delivery of pizzas versus other meals or large and small bottles of soda drinks.

Figure 1 shows the per capita consumption for the 20 selected products for the countries covered and the EU28. The units for per capita consumption differ across the selected products, depending on the types of product. Where possible, consumption is expressed in the numbers of packaging in which they are typically sold. They are expressed in the quantity of product (e.g. cleaning agents and pasta & rice). Confidentiality requirements for

consumption data are applied to some products, and these are included in Figure 1 by the weight of their packaging materials (e.g. soda drinks & sparkling and still water). The quantified consumption for different products is thus not one to one comparable.

The number of yoghurt cups in Figure 1 is extremely high, namely over 60,000. This is because of the relatively small content, 125 ml, of the plastic cups. The yoghurt content in the plastic cups is exactly the same as in the one litre cardboard yoghurt boxes. Also the number of letters in paper envelopes is relatively high. In contrast, the consumption of products expressed in kg of their packaging materials seem very low. The different units in Figure 1 are somewhat misleading, and do not necessarily mean an evenly high or low weight of packaging materials and related environmental pressures.

A comparison of consumption of products expressed in kg or litres is to some extent possible. It is interesting to see that the quantity of milk (in litres) and wine (in 0.75 l bottles) drunk is in the same order of magnitude. These also have the highest consumption of the food products selected whose consumption is expressed in kg or litres.

Some products, as for baby food and postal services, show the same per capita consumption across countries and the EU28. That is because they are 'simple' extrapolations from one country to other countries and the EU28 (or from the EU28 to the countries covered). For most products, their consumption data is based on specific data for the countries covered and EU28. These consumption data obviously differ across countries and the EU28, but they are in the same order of magnitude, which supports their credibility.

Figure 1: Overview of the per capita consumption of the selected products in the covered countries and EU28 (note all products are expressed in different units relating to the y-axis; no. stands for numero or number of items)

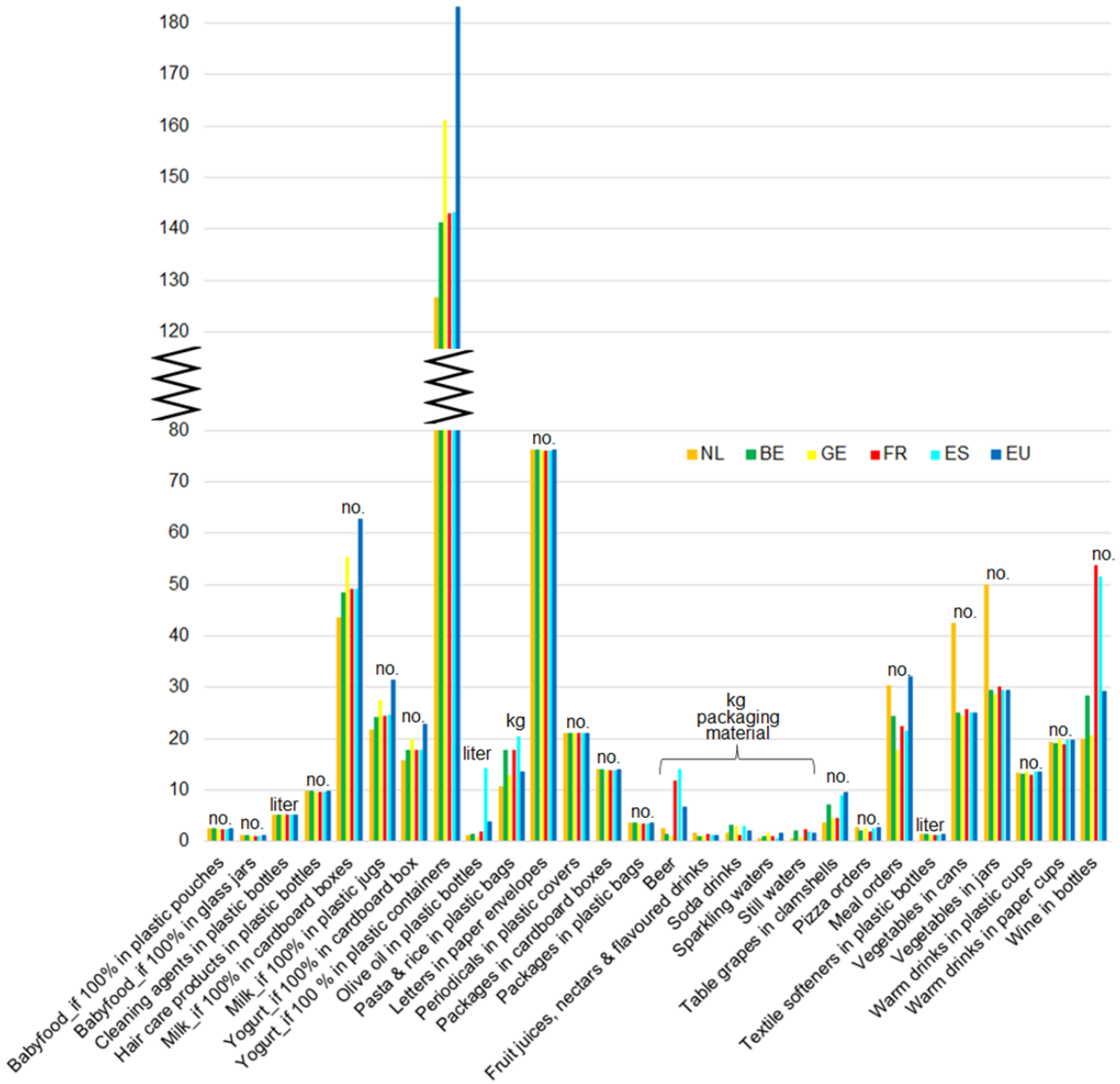
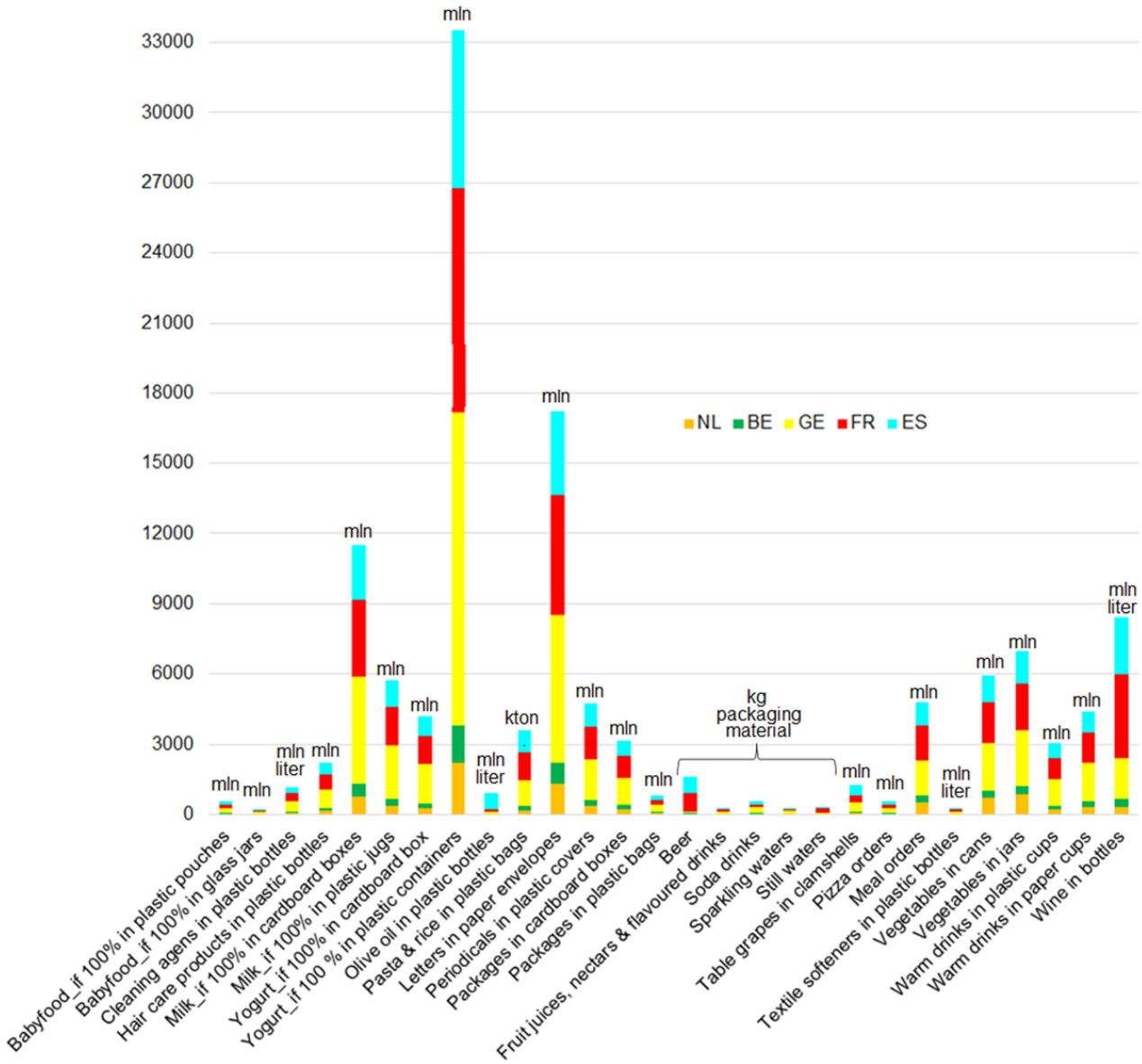


Figure 2 shows the same consumption data as in Figure 1 for the selected countries, but now multiplied by the number of inhabitants. Figure 2 thus reflects the national totals accumulated over the countries covered. The per capita consumption differences, as visible in Figure 1 (for example for conserved vegetable consumption in the Netherlands versus other countries and the EU28), are not really shown in Figure 2. In that sense, Figures 1 and 2 provide different information and insights.

The number of inhabitants of the Netherlands and Belgium is small compared to that of Germany, France, and Spain (Eurostat, 2022c). The national totals for the Netherlands and Belgium are therefore also small compared to the three 'larger' countries.

Figure 2 does not include the EU28 total consumption. This would have reduced the visibility of the national totals for the Netherlands and Belgium too much. The number of inhabitants of the countries covered accounts for nearly half (44%) of the number of all inhabitants in the EU28 (Eurostat, 2022c). The total EU28 consumption thus also roughly doubles the national totals of the Netherlands, Belgium, Germany, France, and Spain together.

Figure 2: Overview of the consumption of the selected products accumulated over the covered countries and EU28 (note all products are expressed in different units relating to the y-axis)



2.3 Quantifying disposable product packaging and materials from which they are made (Step 3)

The quantified consumption for the selected products from Section 2.2 was the basis for quantifying the weight of their disposable packaging and the materials from which they are made. The typical or most used disposable packaging types for the selected products, and their material composition and weight, have been identified for this purpose. The type of packaging (e.g. bottles or bags) and their material composition have partly been derived from publicly available sources, and have partly been based on self acquired and weighed packaging.

For some products, such as pasta or olive oil, a wide range of brands, each with their own design disposable packaging, is on the market. The quantification of the packaging for these products, if not available from publicly available sources, has been based on a single self acquired and weighed packaging. That obviously provides anecdotal data, leading to a reasonable to mediocre quantification of the packaging involved, but suffices as an indication.

For most but not all products, whose disposable packaging was self acquired and weighed, it was easy to identify the materials from which their packaging was made. However, it was typically difficult for packaging consisting of laminated materials (such as pouches for baby food), but also for plastic packaging without the icon specifying the type of plastic used (such as bags for rice and pasta).

Similarly, as for the consumption of the selected products, Table 2 specifies the sources for quantifying their disposable packaging and the materials from which they are made, and indicates the quality of the data obtained via these sources. Again, reasonable or mediocre quality does not imply that it is (easily) possible to improve the quality of the quantification of disposable packaging and materials from which they are made, based on these sources.

The packaging for most of the 20 selected products had never been quantified before, as far as the authors are aware. Their quantified disposable packaging represents the best quality currently achievable, and makes a new and valuable contribution to the sustainability discussion about product packaging.

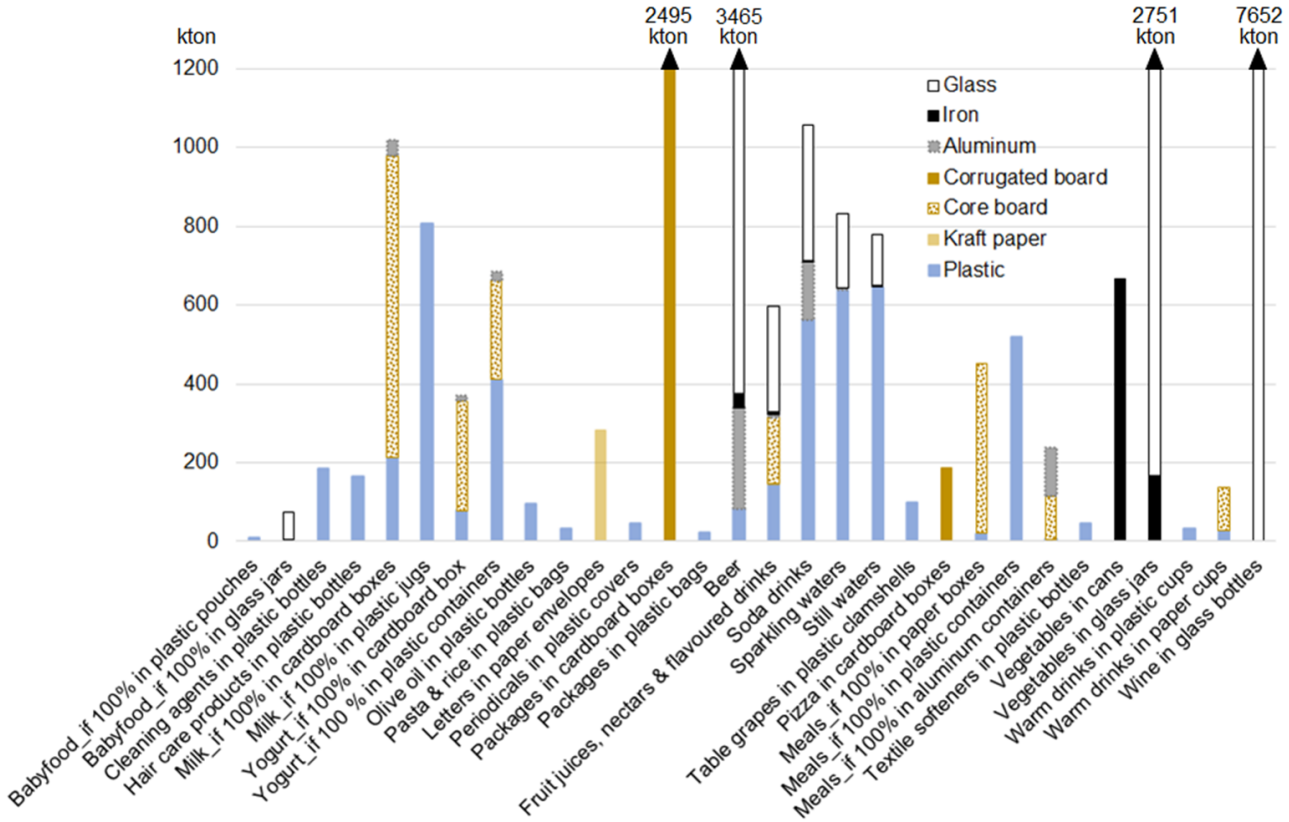
For some products, which are available in different brands but almost similar disposable packaging, multiple self acquired packaging has been weighed. Remarkably, this showed a large variation in the packaging weight for e.g. clamshells of grapes (varying from 16 to 22 grams) and for plastic covers for sending magazines by post (varying from less than 200 to over 600 grams). This large variation indicates a consistently large improvement potential for a givendisposable packaging as the lower limit indicates a so-called 'best available technology' for reducing material use.

Variation in disposable packaging weight for some products thus indicates an improvement potential for this disposable packaging. It should be noted, though, as a rule of thumb, that reusing packaging remains better than recycling disposable packaging. Obviously, when possible, using no packaging at all has preference over reusing packaging (Potting et al., 2018).

Figure 3 gives an overview of the quantified weights of the packaging and their constitutive materials for the selected products. The weights are accumulated over the countries covered and the EU28. Products with glass packaging represent by far the largest weight. A high weight is also visible for cardboard (corrugated board) shipping boxes for packages. The weight for plastic in packaging is in general relatively low, except for two litre plastic milk jugs.

The material weights are indicators for the resources needed to produce these materials, but not of the environmental pressures of resource extraction and materials production, nor of what happens in the waste stage of packaging. These are the subjects of Section 2.4 and 2.5 respectively.

Figure 3: Overview of the weights of the packaging and their constituting materials for the selected products accumulated over the covered countries and EU28



2.4 Quantifying environmental pressures for product packaging (Step 4)

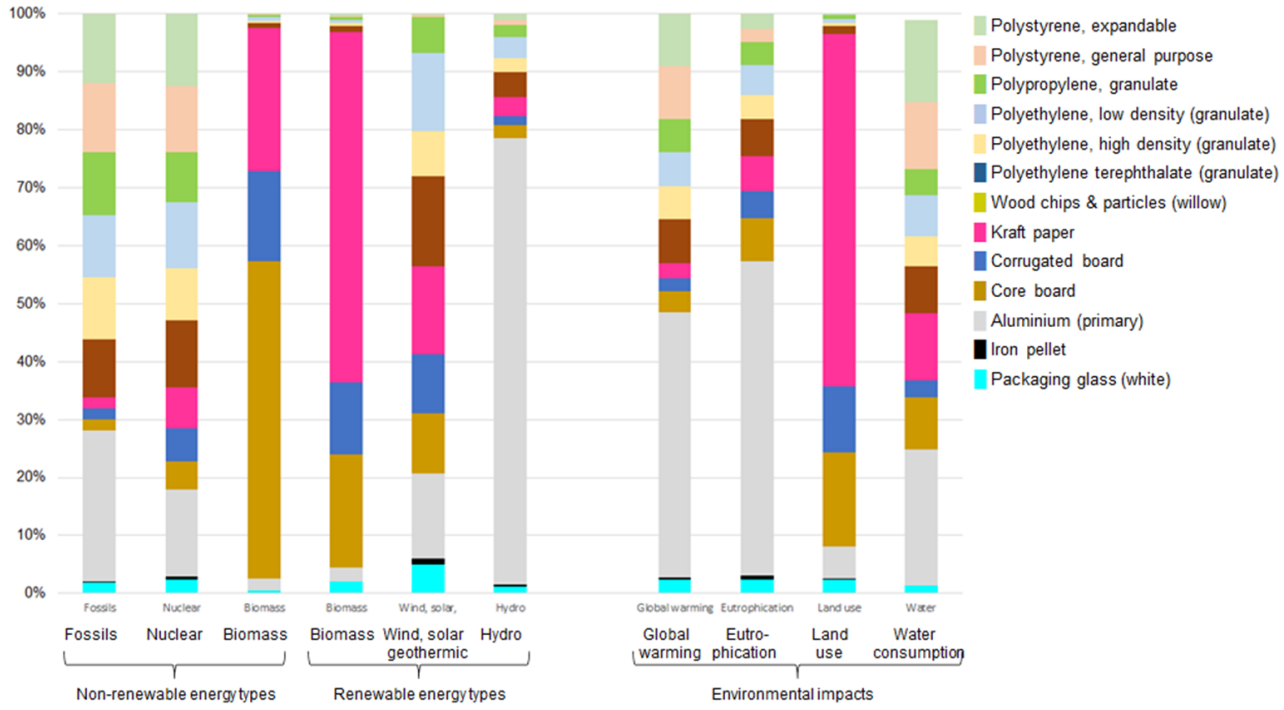
The weight of packaging materials from Figure 3 has been multiplied using conversion factors to calculate environmental pressures from the production of the materials (from resource extraction up to and including material production; i.e. excluding manufacturing packaging from those materials). The environmental pressures covered are the use of renewable and

non-renewable energy carriers, global warming, eutrophication, land use, and water consumption. The conversion factors used are widely used in life cycle assessment (LCA) studies and can be extracted from all mainstream LCA software.

Since all conversion factors are expressed per kg of packaging material produced, they directly show how different packaging materials compare for their per kilogram use of energy carriers, global warming, eutrophication, land use, and water consumption. This is visible in Figure 4 (note that the colours for the materials in Figure 4 are different from those in Figure 3). Some packaging materials contribute more to the selected environmental pressures than other ones. Particularly aluminium, coreboard, and kraft paper stand out.

Figures 5 up to and including 9 show per selected product the contribution to the given environmental pressure from producing the materials from which the packaging for the selected products are made (totalled over all packaging materials per product).

Figure 4: Comparison of packaging materials based on their contribution, from resource extraction up to and including production of the packaging materials, to types of energy use (Cumulative Energy Demand V1.11), to eutrophication (CML-IA baseline V3.06 / EU25) and to global warming, land use and water consumption (ReCiPe 2016 Midpoint (H) V1.04 / World (2010) H) (note that the colours for the materials in figure 4 are different from those in figure 3)



The pattern of the contributions of environmental pressure from the product's disposable packaging in Figure 6 up to and including 9 roughly follow the pattern of their energy use in Figure 5. That is because energy use, or rather the emissions from the production of the energy used, are usually largely responsible for these environmental pressures. In other words, there is often a strong correlation between the energy used to produce materials and the other environmental pressures to produce those materials (Huijbregts et al., 2005).

The pattern of the energy use in Figure 5 up to and including 9 follows for most products to some extent the pattern of their totalled packaging material weight in Figure 3. That is because the difference between the totalled packaging materials across products is larger than the difference between the energy used to produce their packaging materials. At the same time, the differences between the energy used to produce packaging materials moderate the strong differences in packaging weight across the products in Figure 3. For example, the weight of the disposable glass bottles for wine is twice the weight of packaging materials for beer, but the energy used to produce their packaging materials is about the same between both products, due to the relative low energy use for producing glass (16 MJ/kg) compared to that for aluminium ((211 MJ/kg).

Figure 5: The use of renewable and non-renewable energy carriers for the production of the materials from which the packaging for the selected products are produced

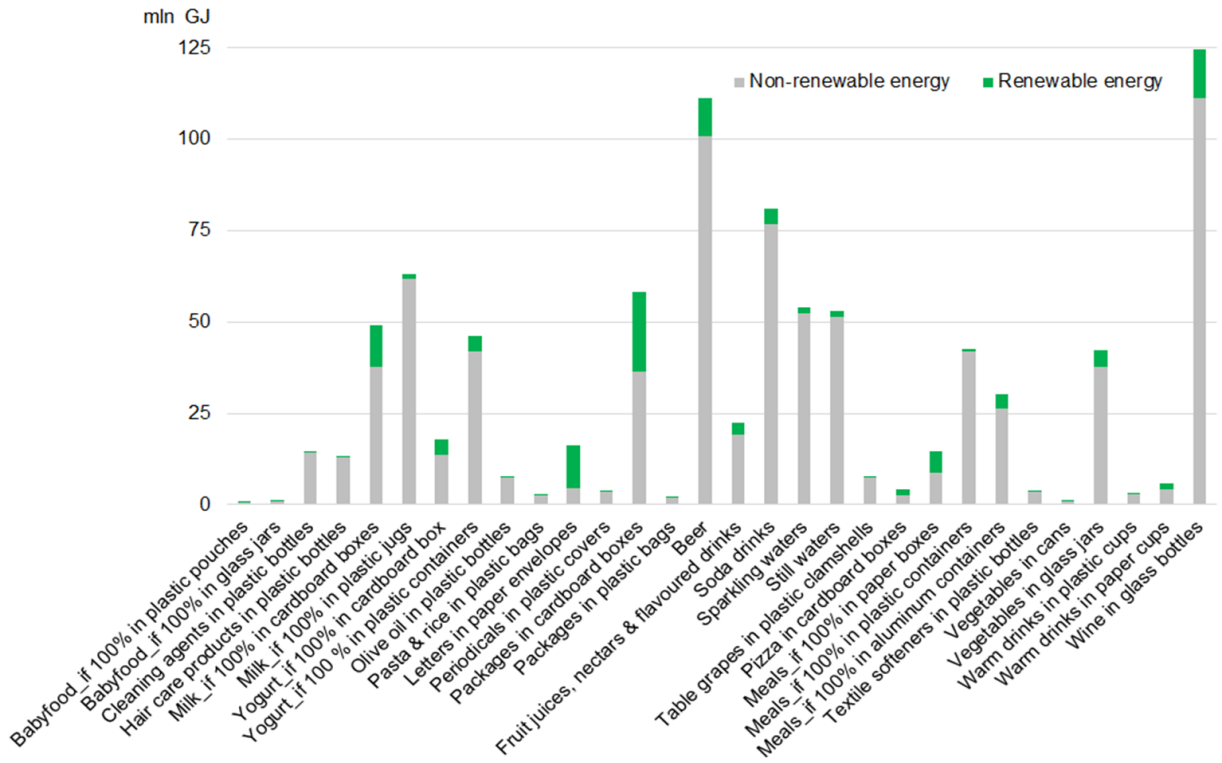


Figure 6: The contribution to global warming by the production of the materials from which the packaging for the selected products are produced

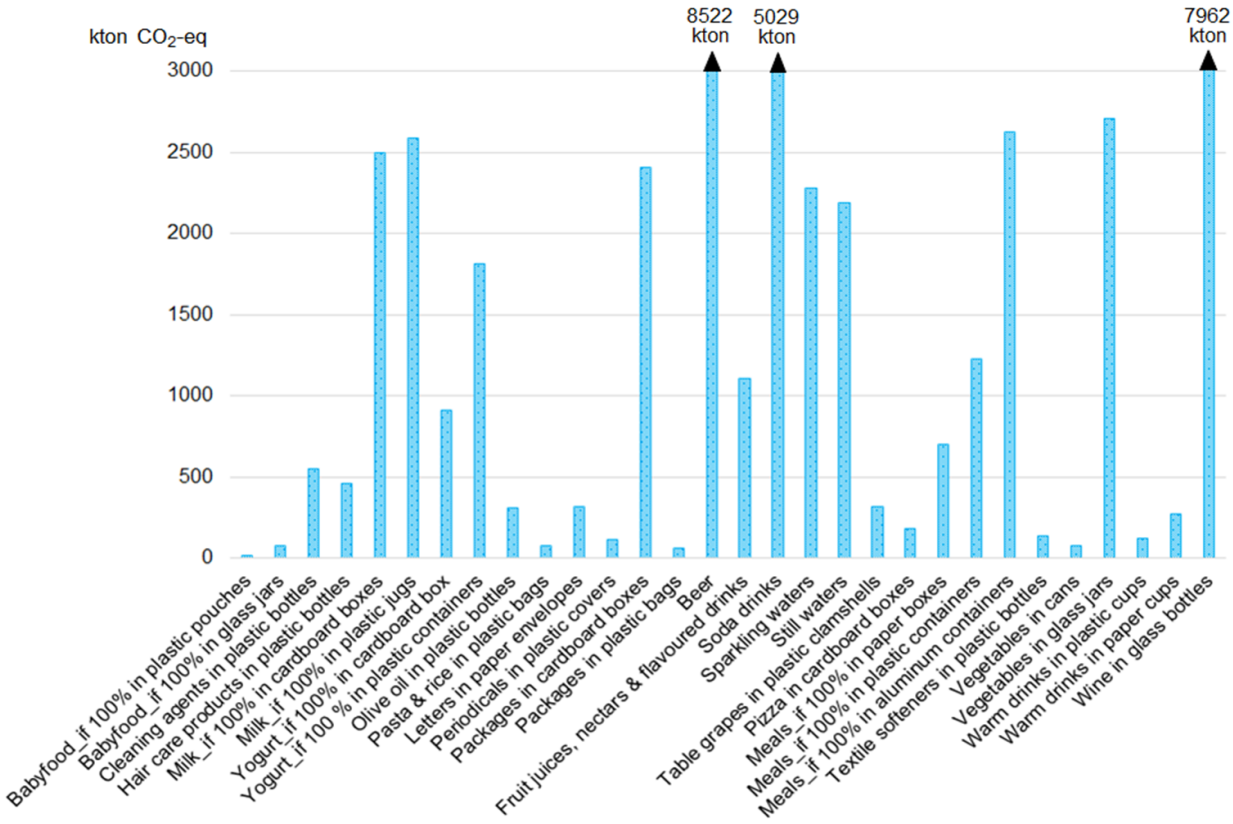


Figure 7: The contribution to eutrophication by the production of the materials from which the packaging for the selected products are produced

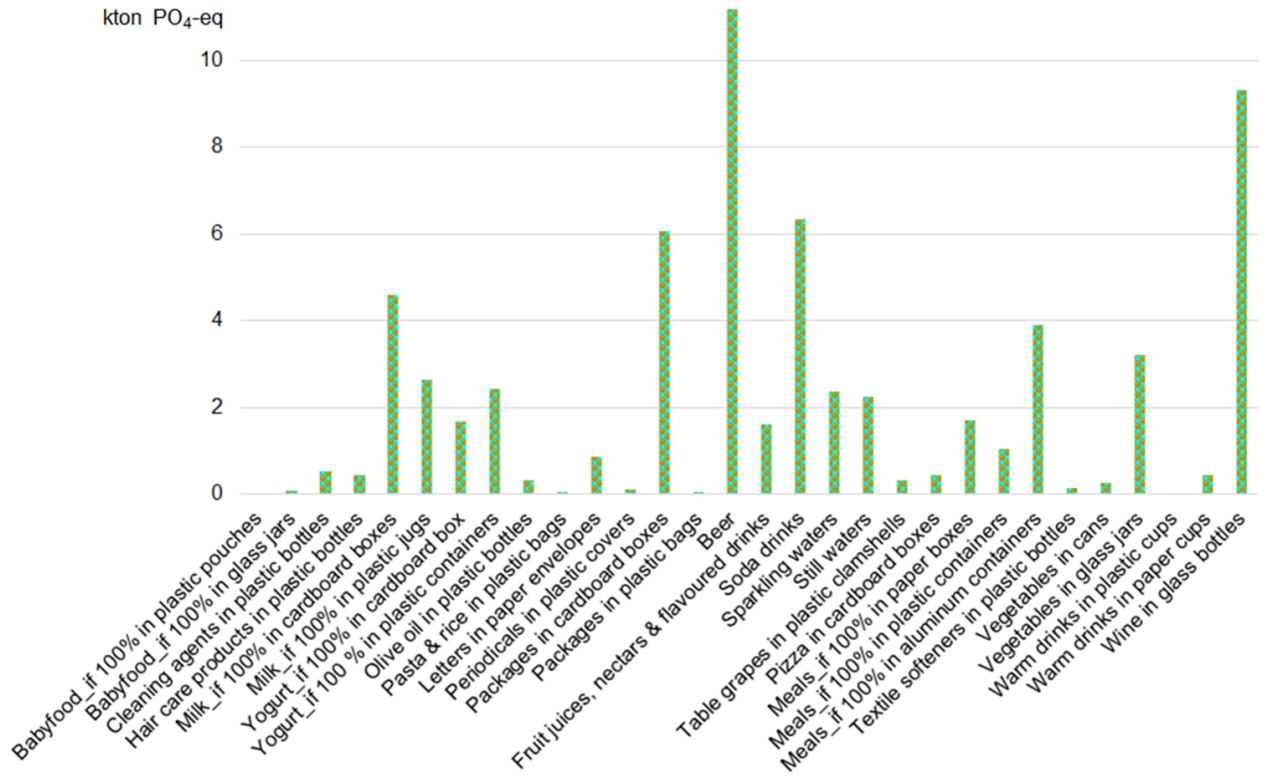


Figure 8: Land use for the production of the materials from which the packaging for the selected products are produced

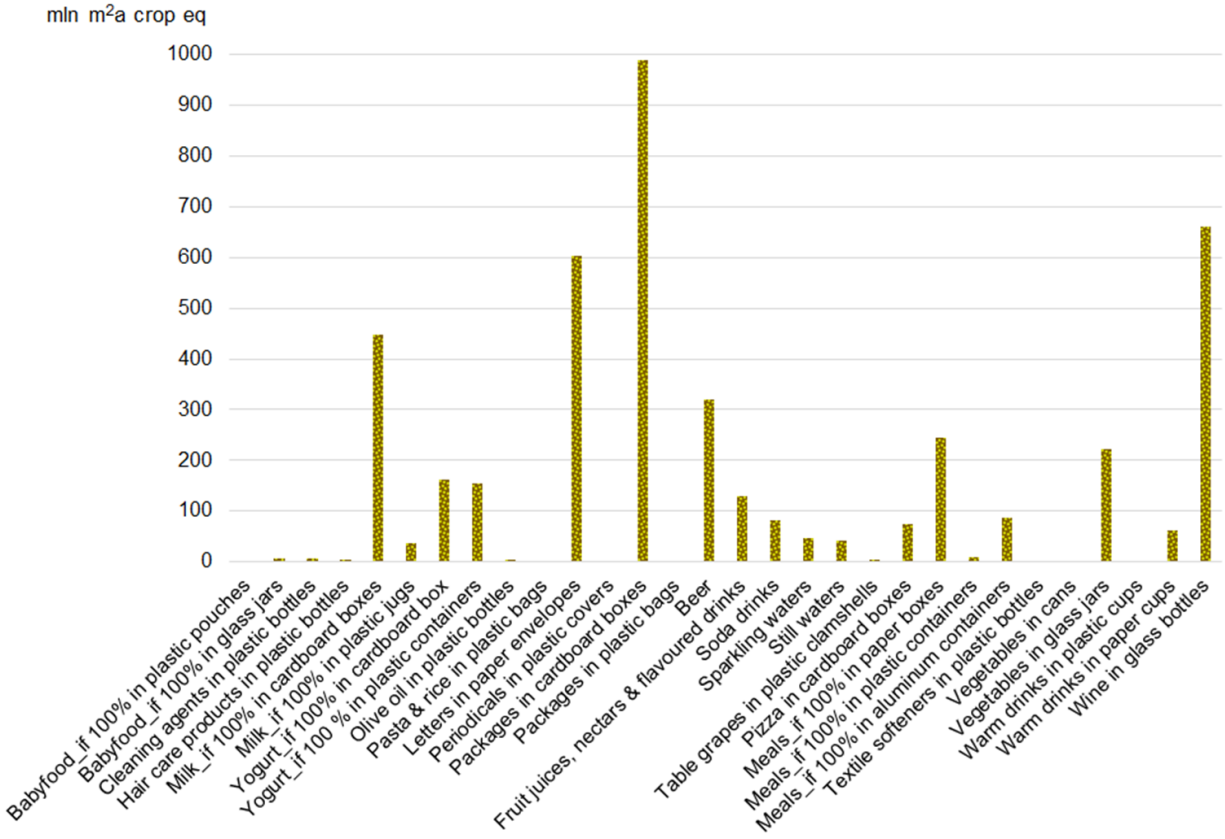
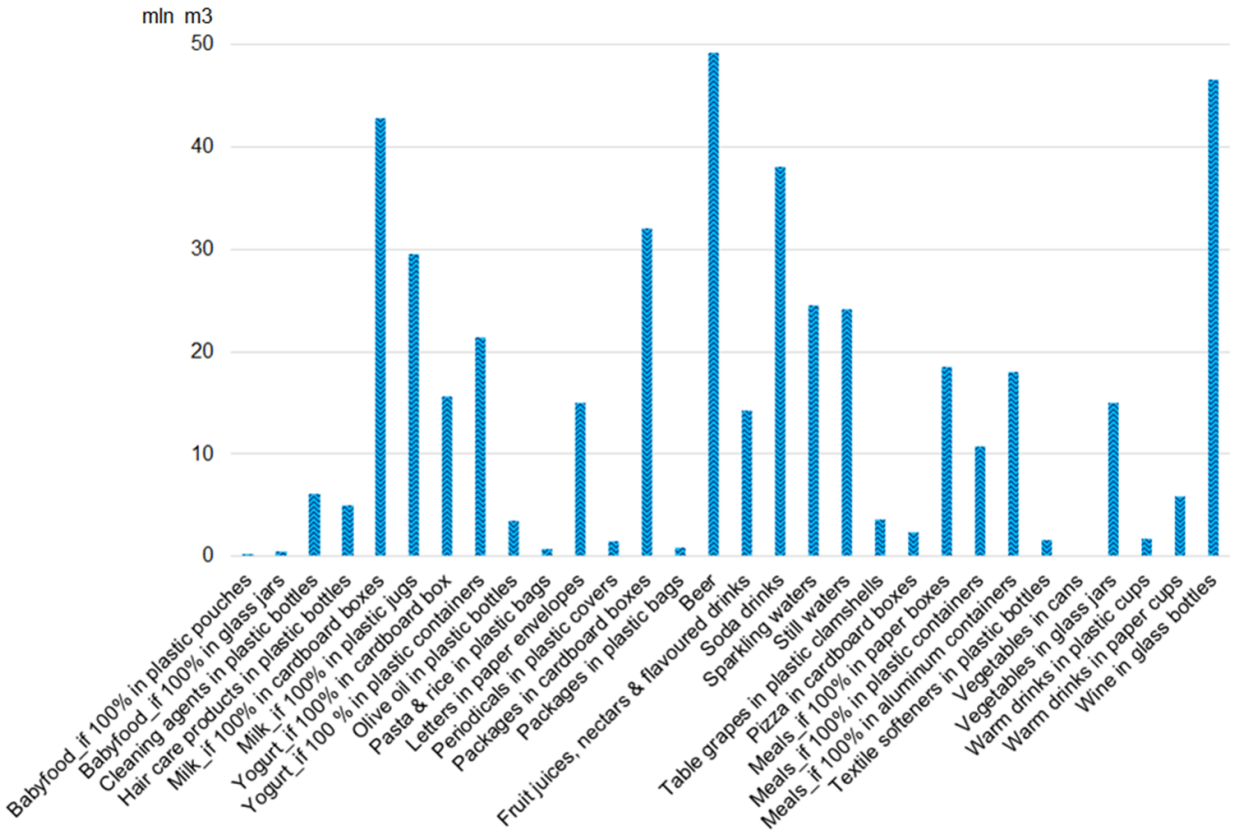


Figure 9: Water use for the production of the materials from which the packaging for the selected products are produced



2.5 Identifying rates of waste recycling and littering of packaging (Step 5)

Empty disposable packaging is in principle separately collected in the countries covered. Most, but not all, of the countries covered have implemented a deposit return on bottles and cans for soda drinks and water, and sometimes also other products. Deposit return typically warrants return

rates around 90% (Bergsma et al., 2017; Wilcox & MacKenzie, 2021). The packaging for most of the selected products in this report is not subject to return deposit, and has to be thrown away in the appropriate waste bin by consumers at home, or is afterwards recovered from commingled waste in the waste processing process.

Collection and separation of disposable packaging waste is usually by main packaging materials categories, e.g. glass, plastics, paper & cardboard, and metals. These waste streams usually need to be further separated, e.g. in specific types of plastic, before they can enter the recycling process. Table 3 gives the recycling rates per main packaging materials category for the countries covered in 2019 as provided by Eurostat (2022d). Eurostat (2022d) does not provide recycling rates for the EU28.

It should be noted that the recycling percentages from Eurostat (2022d) in Table 2 differ across countries in the way they are established, and in some cases are calculated from the weight of collected packaging (that is, without excluding losses from sorting and cleaning). The European Commission has recently published Directive 2018/852 (EC, 2018) and Implementing Decision 2019/655 (EC, 2019) to harmonise the way of establishing the percentage of recycled packaging materials, i.e. the recycling results for countries.

Directive 2018/852 (EC, 2018) and Implementing Decision 2019/655 (EC, 2019) entered into force on 5 July 2020, and may first be implemented in 2021 by the selected countries. However, Brouwer et al. (2019) explored the influence of the new way of establishing the percentage by recalculating the Dutch recycling results for 2017 (see Table 2). The Dutch recycling rates for plastics and glass have fallen considerably following this new way of establishing the percentage. The recycling percentages in Table 2 for the other countries covered are probably also an overestimate compared to whether they would have been established according to Directive 2018/852 (EC, 2018) and Implementing Decision 2019/655 (EC, 2019).

Table 2: Recycling rates for main packaging materials in Netherlands (NL), Belgium (BE), Germany (DE), France, (FR) and Spain (ES) in 2019, and for the Netherlands in 2017

	[1)] NL in 2017 L		[2)] 2019				
Packaging material	Old	New	NL	BE	DE	FR	ES
Paper & cardboard	87	87	91.0	92.3	80.6	91.4	72.9
Plastic	50	35-39	57.2	47.7	43.3	26.9	51.5
Wood	73		70.1	80.5	23.6	35.6	66.9
Metals	95		95.6	95.1	70.9	83.4	84.0
Glass	86	71-76	86.6	100.0	78.0	77.1	79.8

[1] In 2017 according to Brouwer et al. (2019) and Van Velzen et al. (2019)
[2] In 2019 according to Eurostat (2022d)

Not all empty disposable packaging ends up in a waste bin. Figures 10 and 11 provide overviews of littered packaging items as monitored in the Netherlands in 2019 (Lieverse & Ter Beek, 2020).

Figure 10: Overview of littering of food and drink packaging in the Netherlands (in number of items) (Lieverse & Ter Beek, 2020)

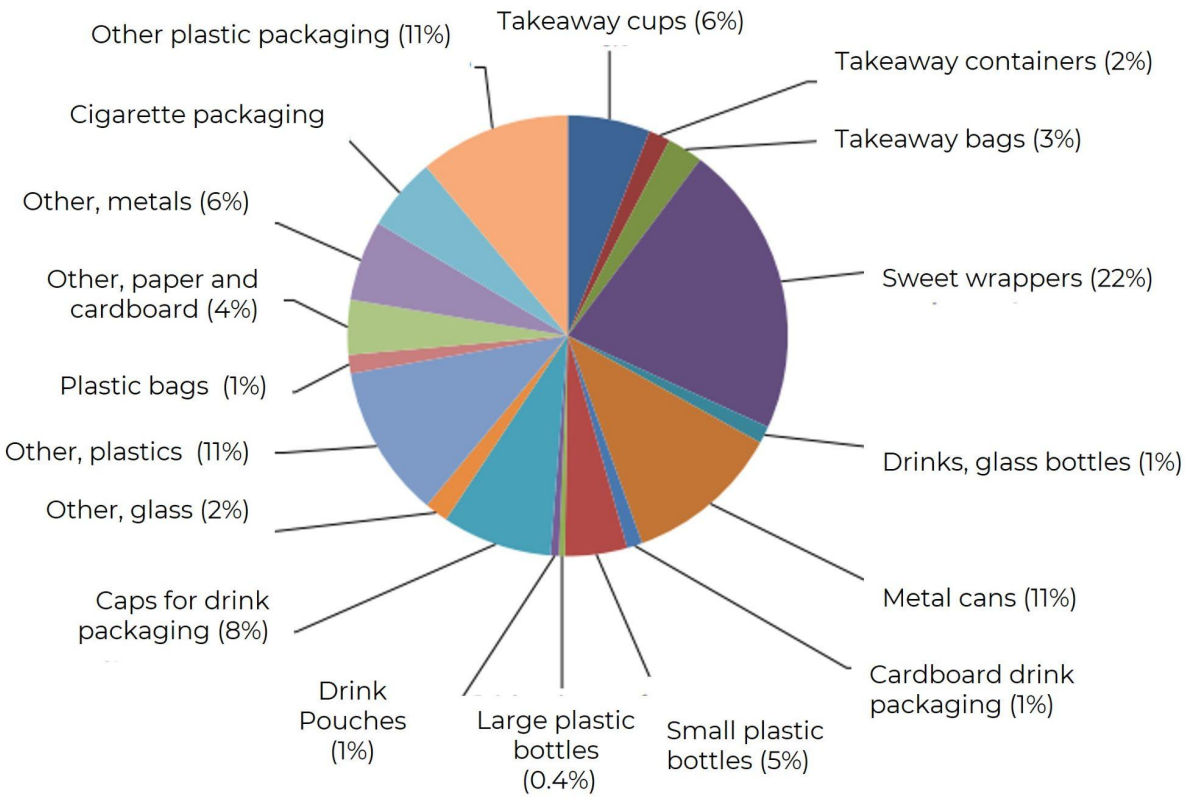
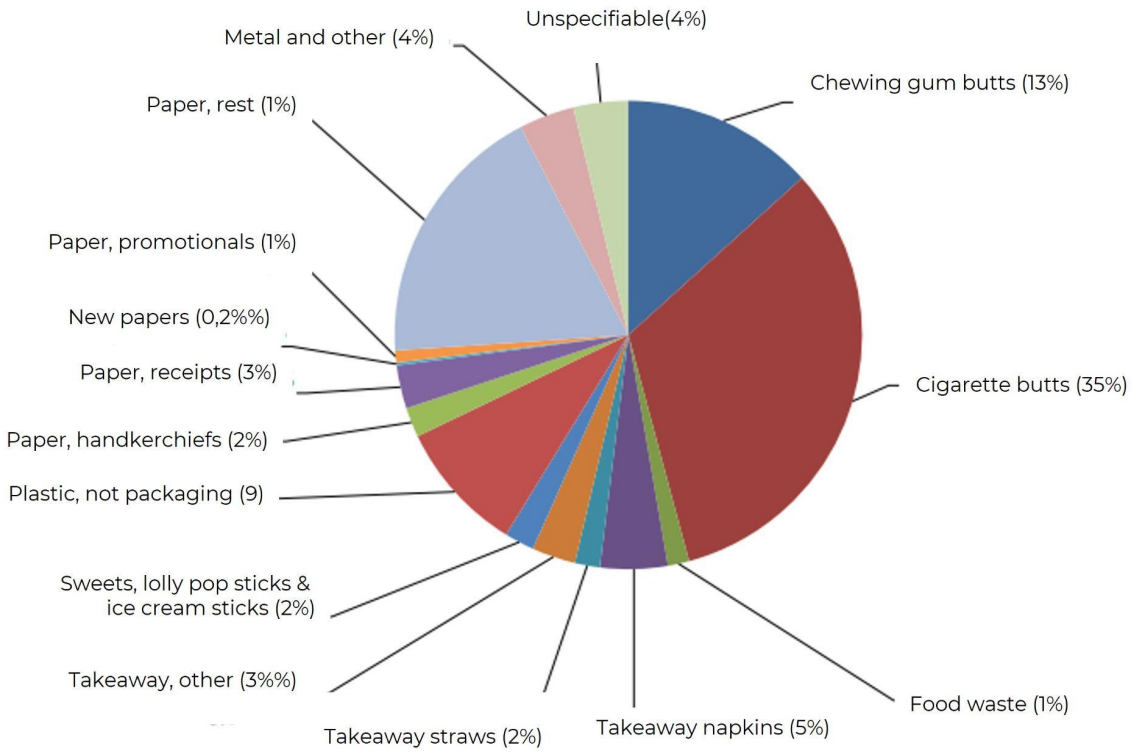


Figure 11: Overview littering of other packaging, small organic waste and other materials in the Netherlands (in number of items) (Lieverse & Ter Beek, 2020)



3. Results and discussion Part 2 (Steps 6-8)

Chapter 2 summarises the overall results of the quantification of the 20 selected products and their disposable packaging in the first part of the iterative collaborative research. These overall results were the basis to identify seven products qualifying as potential ELPs (Section 3.1), next qualitatively assessing these products on their prospects for shifting from disposable to reusable packaging (Section 2.3) as input to finally identify the five products qualifying as ELPs (Section 3.3.).

3.1 Identifying seven products qualifying as potential ELPs

The first part of the iterative collaborative research, as described in Chapter 2, has selected and quantified 20 products in terms of their consumption, the weight of their disposable packaging and materials in these packaging, and the related environmental pressures and rates of waste recycling and littering. This information, together with the same criteria as used for selecting the 20 products in the first part (see Section 2.1), has been used to identify seven products to qualify as potential ELPs.

The selection criteria to select the 20 products in Part 1 and the products qualifying as potential ELPs in Part 2 were:

- Existence of a reusable alternative for the currently common disposable packaging of a given product or for similar products.
- Considered feasibility of replacing a currently common disposable packaging of a given product by a reusable alternative.
- Main type of material from which the packaging of a given product was expected to be made (products with assumed plastic packaging were prioritised).

- The potential impact of a given product based on its market share and/or share in total household expenditure.

Similarly, as for the selection of the 20 products in Part 1, ZWE and RNB came up with a proposal for the seven products to identify as potential ELPs. This proposal has been presented to, and discussed with, the core stakeholders in a second workshop for the iterative collaborative research. This has resulted in cleaning agents, dry food, postal services, soda drinks & water, take-away warm drinks, take-away & delivery meals, and wine as the products qualifying as potential ELP.

3.2 Qualitatively assessing prospects for reusable packaging (or none)

The seven products qualifying as potential ELPs were qualitatively assessed for their prospects of shifting from disposable to reusable packaging (or none). For this purpose, RNB, in interaction with ZWE, put together the main (sub-)aspects of influence on the prospects for such a shift. These aspects were processed into a table with a cell for each (sub-)aspect (as in Table 3).

Table 4: The (sub-)aspects that the core stakeholders qualitatively assessed for each product qualifying as ELP on their prospects to influence the shift from disposable to reusable packaging (or none) in their country

Comparative **practical ease** to shift a substantial part of the market to reusables
Availability of reusable alternatives for disposable packaging (e.g. alternatives implemented or being developed, alternatives for similar products).
Level of implementation of reusable alternatives (e.g. availability and suitability of return/collection systems, scale, and for large scale applications).
Availability of technology needed to use this packaging (e.g. already existing or being developed, maybe similar technology for other products).
Capital intensity of solutions & availability of such capital (economic feasibility).
Other practicalities potentially facilitating or blocking reusable packaging.

Comparative **socio-political easiness** to shift a substantial part of the market to reusables
Identification of stakeholders and their relevance (e.g. industry, retail, consumers).
Readiness of identified stakeholders to shift to reusables.
National and EU policies (existing and in development) for the promotion of reusables (to be completed for the country or EU Member State to which this template relates).
Possibility that a shift to reusables takes place **simultaneously** in several countries, whether through enforcing policies, standardisation, and/or transferability.
Strategic importance of the product and its packaging (current or new), not least from a socio-economic view point (e.g. large/small or growing/declining market, competitiveness of market).
The level of **innovation** and policy intervention required
The extent to which this ELP may teach us something relevant for replacing other products' disposable packaging by reusable ones (or none) (e.g. about its reverse logistics, or how to get specific stakeholders on board).
Any other aspect you consider relevant, but not yet covered above.
Relevant additional information sources.

The table with one (sub-)aspect per cell was multiplied so that there was one for each product qualifying as a potential ELP in all countries covered and the EU28 (resulting in 42 tables). Next, for the represented country or the EU28, the core stakeholders were asked to qualitatively assess each (sub-)aspect in the table for each product qualifying as a potential ELP.

The qualitative assessment involved colouring the cell for that (sub-)aspect, and explaining why that colour was applied, to indicate its influence on the prospects for shifting from disposable to reusable packaging (or none) for the addressed product. In other words, the colouring of, and explanation in, each cell expresses whether the addressed product on that aspect qualifies (green), possibly qualifies (orange), or does not qualify as an ELP to be taken

up in Phase 2 of the RSVP project for working on the actual transition (see Chapter 1).

The tables were processed by RNB in overviews per country and the EU28 for all products (see Figure 11 for an example), and in overviews per product for all countries and the EU28 (see Figure 12). In the third and final workshop for the iterative collaborative research, there was a discussion about the final identification of those products qualifying as ELP to be addressed in Phase 2 of the RSVP project, but the core stakeholders also reflected on the process of colour-scoring the tables per product qualifying as a potential ELP for their country. It was a shared experience that the colour-scoring was influenced by their own knowledge and involved subjectivity about the product and its disposable packaging being qualitatively assessed. It was also observed that green colouring for a given product depended on the implementation level of reusable packaging alternatives for that product as this was addressed by most (sub-)aspects. The subjectivity and differences in implementation stages between countries involved make simple comparisons of the colour scorings between countries and the EU28 difficult.

Only the final aspect did not address the level of implementation for the given product, but instead what a trajectory for implementing reusable packaging for that product might teach us about other products: 'The extent to which this ELP may teach us something relevant for replacing other products' disposable packaging by reusable packaging (or none) (e.g. about its reverse logistics, or how to get specific stakeholders on board)'. All core stakeholders considered this to be an important aspect in the final identification of the products qualifying as ELPs.

Figure 12: Overview of the colour-scoring for the EU28 of all aspects for each product qualifying as a potential ELP

EU28	Comparative practical ease to shift a substancial part of the market to reusables					Comparative socio-political ease to shift a substantial part of the market to reusables			Possibility of simultaneously shifting to reusables in several countries, be it through enforcing policies, standardisation, and/or transferrability	Strategic importance of the product and its packaging (current or new), not least from a socio-economic point of view	The level of innovation and policy intervention required	The extent to which this ELP may teach us something relevant for replacing other products' disposable packaging by reusable ones (or none)	G	Y	R
Product category	Availability of reusable alternatives for disposable packaging	Level of implementation of reusable alternatives	Availability of technology needed for using those pacakagings	Capital intensity of solutions & availability of such capital	Other practicalities potentially facilitating or blocking reusable packaging	Identification of stakeholders and their relevance	Readiness of identified stakeholders to shift to reusables	National & EU policies (existing and in the making) for the promotion of reusables							
Wine													6	6	0
Cleaning agents					No information provided				No information provided				3	7	2
Dry food									Hard to access			No information provided	2	8	2
Postal services									No information provided				4	7	1
Soda drinks & water													8	4	0
Take-away & delivery meals							No information provided						7	4	1
Take-away warm drinks									Hard to access				7	4	1
Green	6	3	6	1	1	3	0	4	0	7	1	6			
Yellow	1	4	1	6	5	4	6	3	3	0	6	0			
Red	0	0	0	0	1	0	1	0	4	0	0	1			

3.3 Identification of five products qualifying as ELPs

Identification of the five products qualifying as ELPs for Phase 2 of the RSVP project was carried out in the third and final workshop for the iterative collaborative research. For this purpose, the core stakeholders started to present for their country or the EU28 the results for the qualitative assessment for each product qualifying as potential ELPs, and their preferred products to be finally identified as an ELP. Next, Figure 12 with an overview of the colour scoring for each product qualifying as a potential EPL in each country was presented to kick off the discussion concerning which products to finally identify as qualifying as an ELP.

The discussion about which products to identify as an ELP started with regard to which criteria to use for this. Section 3 already mentioned as criteria

the level of implementation of reusable packaging for a given product versus what such an implementation trajectory might teach us about other products. The final criterion was reiterated in the discussion by pointing to productive synergies that may exist across products. Postal services did not comply with any of those criteria, but were put forward as being of interest because all stakeholders needing to implement reusable packaging alternatives are the same as those now in charge for package delivery.

Deliberating all pros and cons, the following products were identified as ELPs to be addressed in Phase 2 of the RSVP project: take-away warm drinks, take-away & delivery meals, soda drinks and water, wine, and postal services.

Figure 13a: Overview of the qualitative assessment of cleaning agents qualifying as potential ELP to replace disposable by reusable packaging

Cleaning agents	Comparative practical ease to shift a substancial part of the market to reusables					Comparative socio-political ease to shift a substantial part of the market to reusables			Possibility of simultaneously shifting to reusables in several countries, be it through enforcing policies, standardisation, and/or transferrability	Strategic importance of the product and its packaging (current or new), not least from a socio-economic point of view	The level of innovation and policy intervention required	The extent to which this ELP may teach us something relevant for replacing other products' disposable packaging by reusable ones (or none)	G	Y	R
Country	Availability of reusable alternatives for disposable packaging	Level of implementation of reusable alternatives	Availability of technology needed for using those pacakagings	Capital intensity of solutions & availability of such capital	Other practicalities potentially facilitating or blocking reusable packaging	Identification of stakeholders and their relevance	Readiness of identified stakeholders to shift to reusables	National & EU policies (existing and in the making) for the promotion of reusables							
NL					No information provided			No information provided					7	3	2
BE													2	9	1
DE				No information known	No information known								0	3	9
FR	Some initiatives	No information available	No information available	No information available	No information available	No information available	No information available	No information available	No information available	No information available	No information available	No information available	0	0	12
ES													10	2	1
EU28					No information provided				No information provided				3	7	2
Green	4	1	2	1	0	2	2	1	2	3	2	2			
Yellow	1	4	3	3	1	3	4	1	2	2	3	3			
Red	1	1	1	2	4	1	1	3	2	1	1	1			

Figure 13b: Overview of the qualitative assessment of dry food for its qualifying as a potential ELP to replace disposable by reusable packaging

Dry food	Comparative practical ease to shift a substancial part of the market to reusables					Comparative socio-political ease to shift a substantial part of the market to reusables			Possibility of simultaneously shifting to reusables in several countries, be it through enforcing policies, standardisation, and/or transferrability	Strategic importance of the product and its packaging (current or new), not least from a socio-economic point of view	The level of innovation and policy intervention required	The extent to which this ELP may teach us something relevant for replacing other products' disposable packaging by reusable ones (or none)	G	Y	R
Country	Availability of reusable alternatives for disposable packaging	Level of implementation of reusable alternatives	Availability of technology needed for using those pacakagings	Capital intensity of solutions & availability of such capital	Other practicalities potentially facilitating or blocking reusable packaging	Identification of stakeholders and their relevance	Readiness of identified stakeholders to shift to reusables	National & EU policies (existing and in the making) for the promotion of reusables							
NL					No information provided			No information provided		No information provided			2	5	2
BE													0	8	4
DE				No information known									6	4	2
FR		No information available	No information available	No information available	No information available	No information available	No information available		No information available	No information available	No information available	No information available	0	0	12
ES													9	4	2
EU28									Hard to access			No information provided	3	7	2
Green	2	1	3	1	1	1	1	1	3	3	1	1			
Yellow	3	3	1	2	3	3	2	3	2	1	3	3			
Red	2	2	2	3	2	1	3	2	2	1	2	2			

Figure 13c: Overview of the qualitative assessment of postal services for its qualifying as a potential ELP to replace disposable by reusable packaging

Postal services	Comparative practical ease to shift a substancial part of the market to reusables					Comparative socio-political ease to shift a substantial part of the market to reusables			Possibility of simultaneously shifting to reusables in several countries, be it through enforcing policies, standardisation, and/or transferrability	Strategic importance of the product and its packaging (current or new), not least from a socio-economic point of view	The level of innovation and policy intervention required	The extent to which this ELP may teach us something relevant for replacing other products' disposable packaging by reusable ones (or none)	G	Y	R
Country	Availability of reusable alternatives for disposable packaging	Level of implementation of reusable alternatives	Availability of technology needed for using those pacakagings	Capital intensity of solutions & availability of such capital	Other practicalities potentially facilitating or blocking reusable packaging	Identification of stakeholders and their relevance	Readiness of identified stakeholders to shift to reusables	National & EU policies (existing and in the making) for the promotion of reusables							
NL					No information provided			No information provided	No information provided		No information provided		4	4	0
BE													1	4	7
DE													2	7	3
FR									No information provided		No information		0	1	11
ES							XXXXXXXXXXX						6	3	3
EU28									No information provided				4	7	1
Green	1	0	2	1	1	2	3	0	0	5	1	2			
Yellow	3	2	2	2	2	3	2	1	3	0	3	3			
Red	2	4	2	3	2	0	3	3	2	1	1	1			

Figure 13d: Overview of the qualitative assessment of soda drinks & water for its qualifying as a potential ELP to replace disposable by reusable packaging

Soda drinks & water	Comparative practical ease to shift a substancial part of the market to reusables					Comparative socio-political ease to shift a substantial part of the market to reusables			Possibility of simultaneously shifting to reusables in several countries, be it through enforcing policies, standardisation, and/or transferrability	Strategic importance of the product and its packaging (current or new), not least from a socio-economic point of view	The level of innovation and policy intervention required	The extent to which this ELP may teach us something relevant for replacing other products' disposable packaging by reusable ones (or none)	G	Y	R
Country	Availability of reusable alternatives for disposable packaging	Level of implementation of reusable alternatives	Availability of technology needed for using those pacakagings	Capital intensity of solutions & availability of such capital	Other practicalities potentially facilitating or blocking reusable packaging	Identification of stakeholders and their relevance	Readiness of identified stakeholders to shift to reusables	National & EU policies (existing and in the making) for the promotion of reusables							
NL													6	6	0
BE													5	7	0
DE					No information provided								8	3	0
FR													2	6	4
ES							xxxxxxxxxxx						6	4	1
EU28													8	4	0
Green	4	3	5	2	1	3	1	1	4	4	4	4			
Yellow	2	4	1	4	5	2	5	4	2	0	2	0			
Red	0	0	0	0	0	0	2	0	0	1	1	0			

Figure 13e: Overview of the qualitative assessment of take-away and delivery meals for its qualifying as a potential ELP to replace disposable by reusable packaging

Take-away & delivery meals	Comparative practical ease to shift a substancial part of the market to reusables					Comparative socio-political ease to shift a substantial part of the market to reusables			Possibility of simultaneously shifting to reusables in several countries, be it through enforcing policies, standardisation, and/or transferrability	Strategic importance of the product and its packaging (current or new), not least from a socio-economic point of view	The level of innovation and policy intervention required	The extent to which this ELP may teach us something relevant for replacing other products' disposable packaging by reusable ones (or none)	G	Y	R
Country	Availability of reusable alternatives for disposable packaging	Level of implementation of reusable alternatives	Availability of technology needed for using those pacakagings	Capital intensity of solutions & availability of such capital	Other practicalities potentially facilitating or blocking reusable packaging	Identification of stakeholders and their relevance	Readiness of identified stakeholders to shift to reusables	National & EU policies (existing and in the making) for the promotion of reusables							
NL									No information provided	No information provided	No information provided	No information provided	3	5	0
BE													6	6	0
DE													6	6	0
FR													5	5	2
ES											No information provided		9	2	0
EU28							No information provided						7	4	1
Green	6	1	6	2	1	6	1	1	3	5	0	4			
Yellow	0	5	0	4	5	0	4	5	2	0	3	0			
Red	0	0	0	0	0	0	1	0	0	0	1	1			

Figure 13f: Overview of the qualitative assessment of take-away warm drinks for its qualifying as a potential ELP to replace disposable by reusable packaging

Take-away warm drinks	Comparative practical ease to shift a substancial part of the market to reusables					Comparative socio-political ease to shift a substantial part of the market to reusables			Possibility of simultaneously shifting to reusables in several countries, be it through enforcing policies, standardisation, and/or transferrability	Strategic importance of the product and its packaging (current or new), not least from a socio-economic point of view	The level of innovation and policy intervention required	The extent to which this ELP may teach us something relevant for replacing other products' disposable packaging by reusable ones (or none)	G	Y	R
Country	Availability of reusable alternatives for disposable packaging	Level of implementation of reusable alternatives	Availability of technology needed for using those pacakagings	Capital intensity of solutions & availability of such capital	Other practicalities potentially facilitating or blocking reusable packaging	Identification of stakeholders and their relevance	Readiness of identified stakeholders to shift to reusables	National & EU policies (existing and in the making) for the promotion of reusables							
NL					No information provided								6	5	0
BE													4	8	0
DE													6	6	0
FR			No information available	No information available	No information available	No information available	No information available	No information available	No information available	No information available	No information available	No information available	0	0	12
ES											No information provided		5	6	0
EU28									Hard to access				7	4	1
Green	4	1	3	0	1	4	0	2	3	5	1	4			
Yellow	1	4	2	5	3	1	5	3	1	0	3	1			
Red	1	1	1	1	1	1	1	1	2	1	1	1			

Figure 13g: Overview of the qualitative assessment of wine for its qualifying as a potential ELP to replace disposable by reusable packaging

Wine	Comparative practical ease to shift a substancial part of the market to reusables					Comparative socio-political ease to shift a substantial part of the market to reusables			Possibility of simultaneously shifting to reusables in several countries, be it through enforcing policies, standardisation, and/or transferrability	Strategic importance of the product and its packaging (current or new), not least from a socio-economic point of view	The level of innovation and policy intervention required	The extent to which this ELP may teach us something relevant for replacing other products' disposable packaging by reusable ones (or none)	G	Y	R
Country	Availability of reusable alternatives for disposable packaging	Level of implementation of reusable alternatives	Availability of technology needed for using those pacakagings	Capital intensity of solutions & availability of such capital	Other practicalities potentially facilitating or blocking reusable packaging	Identification of stakeholders and their relevance	Readiness of identified stakeholders to shift to reusables	National & EU policies (existing and in the making) for the promotion of reusables							
NL								No information known					0	6	6
BE													1	10	1
DE				No information known				No information known					0	9	3
FR													5	5	2
ES													9	3	0
EU28													6	6	0
Green	3	0	4	1	1	3	1	0	2	2	1	3			
Yellow	3	4	2	4	2	3	4	4	3	2	5	3			
Red	0	2	0	1	3	0	1	2	1	2	0	0			

4. Conclusions

The iterative collaborative research described in this report has deciphered the EU's disposable packaging landscape. The research was performed in two parts. In the first part of the iterative collaborative research, 20 products were selected and quantified in terms of their consumption, the weight of their disposable packaging and materials in this packaging, and the related environmental pressures and rates of waste recycling and littering. The second part qualitatively assessed the prospects for shifting from disposable to reusable packaging (or none) for seven products identified from the 20 products covered in the first part.

The quantified consumption for a third of the twenty products is considered good, and the quantification of their disposable packaging is good for about half of the twenty products (see Table 2 for an overview). The quality for the other products was either reasonable or mediocre. Reasonable or mediocre quality does not imply that it is (easily) possible to improve the quality for these products. The quantified product consumption and packaging data represent the best quality currently achievable. Most of them have not been quantified before.

Main findings of Part 1:

- Per capita consumption diverges strongly between products, although consumption data across products is often not simply comparable due to different units being used (e.g. 125 ml plastic cups for yoghurt versus 1 l cardboard boxes for milk).
- Also national consumption diverges strongly between products, but this is more influenced by the different number of inhabitants than per capita differences across countries.
- There appeared to be a large variation in the weight of (self-acquired and weighed) disposable packaging for some products, such as plastic covers around magazines or grape clamshells, which indicates a

substantial improvement potential for making this packaging more materially efficient.

- Regardless of the improvement potential for some disposable packaging, no packaging at all or reusable packaging has environmental priority over recycling disposable packaging (the latter still being close to a linear economy).
- National total disposable packaging weight is strongly influenced by differences in weight between packaging materials (for example, the weight of bottles for wine and jars for conserved vegetables stand out because of the relatively large weight of glass).
- Differences across products in national disposable packaging weights do not translate one to one into similar differences in energy use for producing these packaging materials (e.g. 16 MJ/kg glass compared to 211 MJ/kg aluminium).
- The pattern of environmental pressure contributions from the packaging materials for the selected products roughly follows the pattern of energy use for producing these packaging materials.

The second part has qualitatively assessed the prospects for changing from disposable to reusable packaging (or none) for cleaning agents, dry food, soda drinks & (sparkling) water, postal services, take-away & delivery meals, take-away warm drinks, and wine. Even though subjectivity influenced the results per country and per product, the additional qualitative assessment was instrumental in identifying five products as so-called Ecosystemic Leverage Points (ELPs). Particularly cleaning agents and dry food were assessed to have fewer prospects for achieving the desired move away from disposable packaging (see Figure 12). The prospects for postal services were also less well evaluated, but nevertheless selected as ELP, because of their deviating supply chain and therefore the potential to learn from this (even if a transition would not be achieved.) The other six products selected as ELP are soda drinks & (sparkling) water, take-away & delivery meals, take-away warm drinks, and wine.

The whole purpose of the iterative collaborative research was to contribute to RSVP's identification of necessary logistic, legislative, media, and economic

conditions to successfully shift three to five product and market segments, referred to as 'Ecosystemic Leverage Points' (ELPs), from disposable to reusable packaging (Phase 1). The collaborative research did indeed serve this purpose. The actual transitions for the five identified ELPs are to take place in RSVP's Phase 2.

References

(in body text & annex)

All 'download here' links below can be used to download the given reference. They were still accessible in January 2022 (occasionally access requires a username and password). If those links nevertheless expired, or when reading this document on paper, a reference can usually be found by typing its title in a web browser.

ABN-AMRO (2017). Meal delivery: A growth market full of possibilities. Internet-publication of ABN-AMRO (no longer available on the internet; in Dutch).

ACM (2021). Post and Package monitor 2020. Case no.. ACM/21/050334. The Hague (the Netherlands): Dutch Authority for Consumer & Markets (ACM) (download here; in Dutch).

Bergsma, G., G. Warringa & E. Schep (2017). Costs and effects of deposit on small bottles and cans. Delft (the Netherlands): CE Delft (download here; in Dutch).

Brouwer, M.T., I.W. Smeding & E.U. Thoden van Velsen (2019). Verkenning effect verschuiven meetpunt recycling kunststofverpakkingen. Wageningen (the Netherlands): Wageningen University & Research (download here; in Dutch).

CBI (2021). The European market potential for table grapes. Internet-publication of the Centre for the Promotion of Imports from developing countries (CBI) of the Dutch Ministry of Foreign Affairs (download here).

CBS (2019). Consumer prices; average prices consumer products, 2000-2018. Internet-publication on statline of the Dutch Bureaus of Statistics (CBS) (download here; in Dutch).

CBS (2022). Companies and economic sectors. Internet-publication on statline of the Dutch Bureaus of Statistics (CBS) (download here; in Dutch).

CBS (2021). Private households according to composition and size, 1 January. Internet-publication on statline of the Dutch Bureaus of Statistics (CBS) (download here; in Dutch).

Dealroom & Prioritydata (2017). Food Delivery Tech: Battle for the European Consumer. Internet-publication of Dealroom (download here).

Deloitte (2020). Foodservice Market Monitor New frontiers for the Italian Foodservice considering the impact of COVID-19. Internet-publication of Deloitte (download here).

Dutch Dairy Organisation (2020). Dairy in numbers 2019. The Hague (the Netherlands): Dutch Dairy Organisation Zuivel.nl (download here; in Dutch).
EC (2018). Directive (EU) 2018/852 of the European Parliament and of the council of 30 May 2018 amending Directive 94/62/EC on packaging and packaging waste. Official Journal of the European Union, L 150/141 (download here).

EC (2019). Commission implementing Decision (EU) 2019/665 of 17 April 2019 amending Decision 2005/270/EC establishing the formats relating to the database system pursuant to European Parliamentand Council Directive 94/62/EC on packaging and packaging waste. Official Journal of the European Union, L112/26 (download here).

Eurostat (2022a). European Classification of Individual Consumption according to Purpose. Internet-publication of Eurostat (download here).

Eurostat (2022b). Sold production, exports and imports by PRODCOM list (NACE Rev. 2) - annual data. Internet-publication of Eurostat (download here).
Eurostat (2022c). Population on 1 January. Internet-publication of Eurostat (download here).

Eurostat (2022d). Recycling rate of packaging waste by type of packaging. Internet-publication of Eurostat (download here).

FAO (2022). Food Balances (2014-). Internet-publication of the Food and Agriculture Organization (FAO) of the United Nations (download here).

FSIN (2021). FSIN File Delivery 2019. Internet-publications of the FoodServiceInstitute (FSIN) (download here; in Dutch).

GlobalTrade (2020). The EU Canned Food Market Picks Up the Momentum. Internet-publication of GlobalTrade (download here).

Huijbregts, M.A.J., L.J. A. Rombouts, S. Hellweg, R. Frischknecht, A.J. Hendriks, D. van de Meent, A.M.J. Ragas, L. Reijnders and J. Struijs (2005). Is Cumulative Fossil Energy Demand a Useful Indicator for the Environmental Performance of Products? Environmental Science & Technology, 40(3): 641–648 (download here).

IndexMundi (2022). European Union (EU-27) Fresh Table Grapes Fresh Domestic Consumption by Year. Internet-publication of IndexMundi (download here).

KVNW (2015). Sustainability plan. Internet-publication of the Royal Dutch Society for Wine traders (KVNW) (download here; in Dutch).

Kauertz, B., S. Schlecht, S. Markwardt, F. Rubik, J. Heinisch, P. Kolbe & Y. Hane (2019). Research of the ecological meaning of single use cups in out-of-house consumption and possible measures to reduce the use. Dessau-Roßlau (Germany): Umwelt BundesAmt (download here; in German).

Lieverse, R. & G. ter Beek (2020). National litter monitor. Measuring cleanness and litter composition. Veenendaal (the Netherlands): Eco-Consult - Groen, Milieu & Management (download here; in Dutch).

Nutricia (2022a). With love for your baby and the planet, Internet-publication of Nutricia (download here; in Dutch).

Nutricia (2022b). [No title, but overview of Olvarit baby food in jars]. Internet-publication of Nutricia (download here; in Dutch).

NVC (2020). Annual Report 2019. Zeist (Nederland): Dutch Cosmetics Organisation (download here; in Dutch).

Paardekoper (2022). Pizza box, vegetale, corrugated cardboard, 32x32x3cm, white. Internet-publication of Paardekoper (download here; in Dutch).

Potting, J., A. Hanemaaijer, R. Delahaye, J. Ganzevles, R. Hoekstra & J. Lijzen. Circular economy. Circular Economy: what we want to know and can measure. Framework and baseline assessment for monitoring the progress of the circular economy in the Netherlands. The Hague (Netherlands): PBL Netherlands Environmental Assessment Agency (download here).

RIVM (2022). Consumption of food products. Internet-publication of the Dutch National Institute for Public Health and the Environment (RIVM) (download here; in Dutch).

RNB (2019). The waste-reduction potential of shampoo bottles. Internet-publication of Recycling Netwerk Benelux (RNB) (download here; in Dutch)

Slecht & Wellen (2020). Comparative Life Cycle Assessment of Tetra Pak® carton packages and alternative packaging systems for beverages and liquid

food on the European market. Final report. Heidelberg (Germany): Institut für Energie- und Umweltforschung Heidelberg (IFEU) (download here).

Statista (2015). Volume of pasta consumed per capita in the European Union (EU) in 2015, by country (in kilograms). Internet-publication of Statista (download here).

Statista (2019). Estimated annual consumption of single-use coffee cups in Europe (EU-28) in 2015, by country (in millions). Internet-publication of Statista (download here).

Statista (2020). Consumption of table grapes in Belgium from 2006 to 2016 (in 1,000 ql). Internet-publication of Statista (download here).

Trouw (2006). Baby food, an appealing multi-million market. Trouw, 15 october 2006 (download here; in Dutch)

The Daily Milk (2022). Milk-boxes belong to plastic waste. Internet-publication of The Daily Milk (download here).

Thuiswinkel.org (2015). Sector sustainability plan packaging Thuiswinkel.org. Ede (the Netherlands) (download here; in Dutch).

Thuiswinkel.org (2018). Monitoring of results sustainability plan packaging Thuiswinkel.org. Ede (the Netherlands) (download here; in Dutch).

Van Duin, R. & A. van Duin (2019). Towards enforcement of policy focused on preventing packaging. Case 2: plastic bottles for textile softeners (download here; in Dutch).
Van Velzen, E.U.T., I.W. Smeding & M.T. Brouwer (2019). Verkenning effect verschuiven meetpunt recycling verpakkingen. Wageningen (the Netherlands), Wageningen University & Research (download here; in Dutch).

Verburgt, T. (2021). Life Cycle Assessment of reusable and single-use meal container systems. Utrecht (the Netherlands): Utrecht University (download here).

Wilcox, J. & J. Mackenzie (2021). What we waste. Tracking 20 years of growth in international drinks container wastage, and how refillables and deposit return systems can reverse this trend. Brussels (Belgium): Reloop (download here).

Annex

Quantification consumption, packaging & materials

Baby food in pouches - if 100% were in plastic pouches

FAO (2022) provides data for the per capita consumption of baby food up to 2018 for all selected countries and the EU28. However, the reliability of the country data is questionable. Therefore the average 0.22 kg per capita consumption in the EU28 has been used to calculate total baby food consumption in the countries covered and the EU28 by multiplication by the number of inhabitants in 2019 in the countries covered and the EU28 from Eurostat (2022c).

The shares of baby food sold in disposable pouches or jars is unknown. So therefore the total packaging weight has been quantified as if all baby food were 100% in either the one or the other. Here the focus is on pouches.
There are several baby food brands on the market. One major brand is Olvarit from Nutricia (part of Danone specialising in baby food). In the Netherlands, for example, Nutricia has roughly a 60% share in the baby food market (Trouw, 2006).

Olvarit pouches for babies from 6 to 12 months contain 90 grams of baby food (Nutricia, 2022a). Three self acquired and weighed Olvarit pouches plus cap weighed respectively 6.75, 7.03, and 6.84 grams (including 2.89, 2.90, and 2.79 grams for the caps). These three pouches were from a non-specified plastic, presumably polypropylene (PP). The total weight of pouches for baby food has been calculated by dividing the total consumption of baby food by the 90 grams as contained in an Olvarit pouch, and next multiplying the resulting number of pouches by 6.9 grams as the assumed typical weight for a baby food pouch (including cap).

See below for the results of the calculations. Except for the variation in weight of the Olvarit pouches, pouches from several other brands are also made from other materials, among which laminates of aluminium and plastic. The numbers below are therefore expected to give a mediocre indication.

Baby food	NL	BE	DE	FR	ES	EU28	Unit
Baby food consumption	3.8	2.5	18.3	14.8	10.3	112.9	kton[1]
No. of pouches (90 grams)	42.2	28.0	202.9	164.2	114.7	1,254.2	mln
Plastic (PP?)	0.3	0.2	1.4	1.1	0.8	8.7	kton

Baby food in glass jars - if 100% were in glass jars

(Nutricia, 2022b). A self acquired and weighted 200 gram olvarit jar was 124.02 grams for the glass body, and 6.16 grams for the metal lid. Based on this single jar, the total weight of jars for baby food has been calculated by dividing the total consumption of baby food by 200 grams as contained in an Olvarit jar, and next by multiplying the resulting number of jars by the weights for the above single jar as the assumed typical weight for a baby food jar.

See below for the calculation results. Since the numbers are based on the weight of a single baby food jar, and for one brand only, they give a mediocre to good indication (glass jars from different brands are more alike than pouches for baby food).

[1] A **kiloton** or metric ton (**kton**) is standard indicator base unit for mass is the kilogram. 1 kton is equal to 1,000,000 (1 million) kilograms.

Baby food	NL	BE	DE	FR	ES	EU28	Unit
Baby food consumption	3.8	2.5	18.3	14.8	10.3	112.9	kton
No. of jars (200 grams)	19.0	12.6	91.3	73.9	51.6	564.4	mln
Glass body	2.4	1.6	11.3	9.2	6.4	70.0	kton
Metal (iron) lid	0.1	0.1	0.6	0.5	0.3	3.5	kton

Beer in disposable glass & plastic bottles and aluminium cans

GlobalData is a data analytics and consulting company that, amongst others, produces annual databases about beer packaging entering the European market. The database contains packaging by type (e.g. bottles or cans), volume (e.g. 33 cl or 50 cl), materials (e.g. glass or plastic), and whether it is disposable or reusable packaging. The focus here is on disposable beer packaging.

The step of quantifying beer consumption has been omitted, because the number of used disposable beer packaging in 2019 could be directly taken from the GlobalData database. Weight and material composition for each packaging by type, volume, and materials have been taken from open literature, are provided by producers, or have been based on multiple self acquired and weighed packaging with the same specifications. The number of used beer packaging from Global.data, i.e. glass & plastic bottles and aluminium cans, has been multiplied by the weight of the packaging parts to arrive at the total weight of beer packaging in the countries covered and the EU28. Plastic beer bottles consist of the plastic PolyEthylene Terephthalate (PET).

GlobalData requires their data to be used so that these are not traceable from published results. Therefore the numbers below are based on, but do not directly reflect, consumption data, and only show the total packaging weight. The packaging weights are presented in two volume intervals, i.e. volumes smaller than 1 litre (a size suitable for on-the-go consumption), and volumes

of 1 to 3 litres of packaging. The results are presented below. The numbers are considered to be of good quality.

Beer	NL	BE	DE	FR	ES	EU28	Unit
Glass bottles < 1l	28.9	8.8	47.3	765.4	403.4	2,890.5	kton
& metal caps	0.3	0.1	0.4	8.2	4.5	26.0	kton
Glass bottles ≥ 1l			2.8	1.5	198.3	200.8	kton
& metal caps			0.0	0.0	0.6	0.6	kton
PET bottles < 1l		0.0	17.0	0.2	0.0	24.8	kton
& metal caps		0.0	2.1	0.0	0.0	3.1	kton
PET bottles ≥ 1l				0.3	0.7	56.8	kton
& metal caps				0.0	0.1	3.9	kton
Small cans	14.1	7.1	15.9	19.1	48.0	258.1	kton
Large cans			0.4			0.5	kton

Cleaning agents in plastic bottles

No data about the consumption of cleaning agents was found in publicly available sources. Therefore an 'educated guess' of the total Belgium consumption from a producer of surface cleaning agents has been used. The total Belgium consumption has been extrapolated to the Netherlands, Germany, France, Spain, and the EU28 with the help of the number of inhabitants in 2019 in the countries covered and the EU28 from Eurostat (2022c).

No data about disposable plastic bottles for cleaning agents was available. The bottle weight for textile softeners. i.e. made from the plastics PolyEthylene Terephthalate (PET) or High Density PolyEthylene (HDPE), has been used instead. Multiplying this weight by the results for total cleaning agents consumption resulted in the estimated total bottle weight for

cleaning agents. Below are the results of the calculations, which are of mediocre quality.

Cleaning agents	NL	BE	DE	FR	ES	EU28	Unit
Consumpt. cleaning agents	89.9	59.6	431.7	349.3	244.1	2,668.1	mln litres
PET bottles	4.4	2.9	21.3	17.2	12.0	131.5	kton
HDPE bottles	1.8	1.2	8.9	7.2	5.0	54.8	kton

Conserved veggies in metal cans

Total consumption of conserved vegetables in disposable cans for Germany and France and per capita consumption for the Netherlands in 2019 have been taken from GlobalTrade (2020). According to GlobalTrade (2020), Dutch per capita consumption was the second highest in Europe. Therefore the average per capita consumption for Germany and France has been calculated and extrapolated to Belgium, Spain, and the EU28 with the help of the number of inhabitants in 2019 in the countries covered and the EU28 from Eurostat (2022c). In this way the total consumption of conserved vegetables in cans in those countries has been calculated.

Some cans are (partly) made of aluminium, but the majority is made of steel. They are also available in different sizes with unknown market shares. Therefore, calculations have been made with a medium size can with 400 gram content and 55% drained weight of conserved vegetables (based on canned green beans). A self acquired medium size steel can has been weighted at 52 grams.

The total number of cans for conserved vegetables has been calculated by first dividing the total consumption of canned vegetables by the drained weight of conserved vegetables, and then with the overall content weight contained in a medium size can. The resulting number of cans is next multiplied by the weight of a medium can to arrive at the total weight of

metal in the cans. The calculated results below give a mediocre to good indication.

Conserved vegetables	NL	BE	DE	FR	ES	EU28	Unit
Canned veggies consumpt.	161.2	63.1	445.0	380.0	258.5	2,826.3	kton
No. of metal cans (400 grams)	732.9	286.8	2,022.7	1,727.3	1,175.2	12,847.0	mln
Steel (~iron)	38.1	14.9	105.2	89.8	61.1	668.0	kton

Conserved veggies in jars - if same consumption as for canned veggies

Data for the total consumption of conserved vegetables in disposable glass jars have not been found. Assuming a similar consumption of vegetables in jars as vegetables in cans, the total number of jars for conserved vegetables has been calculated by first dividing the total consumption by the drained weight of conserved vegetables, and then by the overall content weight contained in a medium size jar. A medium size jar contains 340 grams, of which 55% drained weight of conserved vegetables (based on canned green beans).
A self acquired medium size glass jar has been weighed at 171 grams for the glass body and 11 grams for the lid. The total weight of glass and metal in the jars has been calculated by multiplying their number by the weight of glass for the body and of metal for the lid. The calculated results are below. The numbers are expected to give a reasonable to good indication as glass jars from different brands are fairly alike.

Conserved vegetables	NL	BE	DE	FR	ES	EU28	Unit
Jarred veggies consumpt.	161.2	63.1	445.0	380.0	258.5	2,826.3	kton

No. glass jars (340 grams)	862.3	337.4	2,379.7	2,032.1	1,382.6	15,114.1	mln
Glass body	147.4	57.7	406.9	347.5	236.4	2,584.5	kton
Iron lids	9.5	3.7	26.2	22.4	15.,2	166.3	kton

Fruit juices, nectars, and (fruit) flavoured still drinks

Total disposable packaging for fruit juices, nectars and (fruit) flavoured still drinks has been established in the same way as for beer, and the same comment applies to it (i.e. the numbers below are based on but do not directly reflect consumption data, and only show total packaging weight). The results are presented below. The numbers are considered to be good.

Possible straws and their packaging that regularly accompany small cardboard boxes, pouches, and cups have been quantified, but are not reflected in the table below as their quantities are very small. The same applies to pouches made from the plastic PolyEthylene Terephthalate (PET) that are used in other EU28 countries than the countries covered here.

When unclear, the caps of bottles are assumed to be made from the same plastics as the bottles themselves are made from, i.e. caps of PolyPropylene (PP) for PP bottles.

Fruit juices, nectars & (fruit) flavoured drinks	NL	BE	DE	FR	ES	EU28	Unit
Glass bottles < 1l	4.6	1.7	19.1	9.4	15.0	212.1	kton
& metal caps	0.1	0.0	0.5	0.2	0.5	6.3	kton
Glass bottles ≥ 1l	3.8	1.1	2.4	30.5	10.5	57.2	kton
& metal caps	0.1	0.0	0.0	0.4	0.1	0.8	kton
PET bottles < 1l	2.2	1.7	7.7	8.1	2.4	41.0	kton
& HDPE caps	0.2	0.1	0.6	0.7	0.2	3.4	kton
PET bottles ≥ 1l	1.0	1.3	30.4	17.0	4.8	78.2	kton
& HDPE caps	0.0	0.1	1.3	0.7	0.2	3.1	kton

HDPE bottles < 1l	0.1	0.0			0.0	0.9	kton
& HDPE caps	0.0	0.0			0.0	0.0	kton
HDPE bottles ≥ 1l	0.4	0.0	0.4	0.0	0.0	1.2	kton
& HDPE caps	0.0	0.0	0.0	0.0	0.0	0.0	kton
PP & bottles & cups	0.0			0.0	0.0	0.0	kton
& PP caps for bottles	0.0			0.0	0.0	0.0	kton
& Aluminium lid for cups				0.0	0.0	0.0	kton
& PP caps for cups						0.0	kton
& Paper straws for cups						0.0	kton
& PP straws for cups						0.0	kton
& PP foil around straws						0,0	kton
PP bottles ≥ 1l	0.0					0,0	kton
& PP (?) caps	0.0					0,0	kton
Cardboard boxes < 1l	3.1	1.2	2,4	3.4	12.2	39.3	kton
& aluminium lid	0.0	0.0	0.1	0.0		0,1	kton
& Paper straws for cups	0.1	0.0	0.1	0.1	0.4	1.3	kton
& PP straws for cups	0.1	0.0	0.1	0.1	0.4	1.3	kton
& PP foil around straws	0.0	0.0	0.0	0.0	0.1	0.2	kton
& Overwrap multiple boxes	0.2	0.1	0.1	0.2	0.7	2.1	kton
Cardboard boxes ≥ 1l	9.7	2.0	25.9	18.7	10.8	128.6	kton
& PP (?) lid	1.0	0.2	2.6	1.8	1.0	12.6	kton
Aluminium foil pouches < 1l	0.2	0.2	2.7	1.2	0.0	0.4	kton
& PP (?) caps	0.0	0.0	0.1			0.2	kton
& Paper straws for cups	0.0	0.0	0.2	0.1	0.0	0.3	kton

& PP straws for cups	0.0	0.0	0.2	0.1	0.0	0.3	kton
& PP foil around straws	0.0	0.0	0.0	0.0	0.0	0.1	kton
LDPE Foil pouches ≥ 1 l			0.0	0.0	0.0	0.0	kton
& PP (?) cap			0.0	0.0	0.0	0.0	kton
Metal (aluminium) cans < 1l	0.2	0.2	0.0	4.4	0.4	6.1	kton
Metal (aluminium) cans ≥ 1l						0.0	kton

Hair care products in plastic bottles

According to the 2019 annual report of the Dutch Cosmetics Organisation (NCV, 2020), Dutch consumers spent €364.7 mln on hair care products in that year. According to CBS (2019), the average price of a 400 ml bottle of shampoo was €2.90 per bottle in 2019. The Dutch consumption of hair care products has been calculated by dividing consumer spending by the average shampoo price.

RNB (2019) provides weights and material composition of disposable shampoo bottles of 300 ml (weights including caps). The total number of shampoo bottles bought by Dutch consumers has therefore been based on a 300 ml instead of a 400 ml content.

RNB (2019) identified bottles made from High Density PolyEthylene (HDPE), and bottles made from PolyEthylene Terephthalate (PET), each from two major brands and a category 'others'. HDPE bottles are 32.5 grams for Andrelon, 33.0 grams for Head & Shoulders, and 30.0 grams for 'others'. PET bottles are 36.0 grams for L'Oréal, 35.7 grams for Schwarzkopf, and 29.0 grams for 'others'. The total number and weight of HDPE and PET bottles has been calculated by assuming equal market shares for all four brands and the

category ‘others’, i.e. 20% each (64% HDPE and 36% PET in the category ‘others’).

The Dutch consumption of hair care products, the number of bottles needed to pack them, and the materials they are made of are extrapolated to the other countries covered and the EU28 with the help of their number of inhabitants in 2019 from Eurostat (2022c). The table below gives the calculated results. The numbers are considered of good quality.

Hair care products	NL	BE	DE	FR	ES	EU28	Unit
Consumption hair care prod.	50.3	33.3	241.6	195.5	136.6	1,493.5	litres
No. of bottles	167.7	111.1	805.5	651.8	455.4	4,978.2	mln
HDPE bottles	2.8	1.9	13.6	11.0	7.7	84.1	kton
PET bottles	2.7	1.8	13.2	10.7	7.4	81.4	kton

Milk - If 100% were in 2 litre plastic jugs

The consumption of milk for all countries covered except Spain, and for the EU28, has been taken from the Dutch Dairy Organisation (2020). The Dutch Dairy Organisation (2020) does not include Spanish milk consumption, and this has therefore been put on a par with the per capita Italian consumption as it’s culturally assumed to be similar to Spanish consumption. The milk consumption in kg has been converted to litres with the help of the ‘milk density’ of 1.035 litre/kg.

The shares of milk sold in disposable cardboard milk boxes or plastic jugs is unknown. So therefore the total packaging weight has been quantified as if all milk were 100% in either the one or the other. Here the focus is on jugs. A self acquired jug made from the plastic PolyEthylene Terephthalate (PET) has been weighed at 50 grams (including cap). The total weight of the jugs has

been calculated by multiplying their number by their weight. The table below gives the calculated results. The numbers are considered of good quality.

Milk	NL	BE	DE	FR	ES	EU28	Unit
Milk consumption	751.3	554.9	4,588.4	3,295.7	2,307.5	32,234.8	mln litre
No. of milk jugs	375.6	277.4	2,294.2	1,647.8	1,153.8	16,117.4	mln
PET	18.8	13.9	114.7	82.4	57.7	805.9	kton

Milk - if 100% were in 1 litre cardboard boxes

The same total milk consumption as for disposable jugs has been used to calculate the total number and weight of cardboard boxes if they packed 100% of all milk consumed. The number of 1 litre cardboard boxes in mln equals the milk consumption in litres.

A weight of 31.6 grams for a 'TBA Edge LC 30' cardboard milk box as provided by Slecht & Wellen (2020) has been used to calculate the total weight of cardboard milk boxes, and for the materials from which they are made. Cardboard milk boxes consist of 75% cardboard, 4% aluminium, and 21% of the plastic Low Density PolyEthylene (HDPE). Similarly as for jugs, the results in the table below are considered of good quality, except for the unknown shares of milk in plastic jugs or cardboard milk boxes.

Milk	NL	BE	DE	FR	ES	EU28	Unit
Milk consumption	751.3	554.9	4,588.4	3,295.7	2,307.5	32,234.8	mln litre
Weight. of cardboard boxes	23.7	17.5	145.0	104.1	72.9	1,018.6	kton
Cardboard (coreboard)	17.8	13.2	108.7	78.1	54.7	764.0	kton
Aluminium	0.9	0.7	5.8	4.2	2.9	40.7	kton

HDPE	5.0	3.7	30.4	21.9	15.3	213.9	kton

Yoghurt - if 100% were in 1 litre cardboard boxes

RIVM (2022) provides survey data about the daily per capita Dutch consumption of dairy products in the period between 2012 and 2018. Milk (42%), yoghurt (15%), and cheese (9%) are the most consumed dairy products in the Netherlands. The yoghurt consumption of 53.7 grams per capita-day has been divided by the daily milk consumption of 147.4 grams per capita-day from RIVM (2022). The ratio has been applied with the milk consumption in the above table to calculate the total yoghurt consumption in the countries covered and the EU28.

The shares of yoghurt sold in cardboard milk boxes or disposable plastic containers is unknown. The total packaging weight has been quantified as if all yoghurt were 100% in either the one or the other. The cardboard boxes used to pack milk are assumed to be the same as the ones for yoghurt, and also the total weight of cardboard boxes for yoghurt has been calculated in the same way. The results are presented below. The numbers are considered to be reasonable to good.

Yoghurt	NL	BE	DE	FR	ES	EU28	Unit
Yoghurt consumption	273.7	202.2	1,671.6	1,200.7	840.7	11,743.6	mln litre
No. of cardboard boxes	273.7	202.2	1,671.6	1,200.7	840.7	11,743.6	mln
Weight. of cardboard boxes	8.6	6.4	52.8	37.9	26.6	371.1	kton
Cardboard box (coreboard)	6.5	4.8	39.6	28.5	19.9	278.3	kton
Aluminium lining of box	0.3	0.3	2.1	1.5	1.1	14.8	kton
HDPE lining of box	1.8	1.3	11.1	8.0	5.6	77.9	kton

Yoghurt in plastic containers

The same total yoghurt consumption as for disposable cardboard boxes, but in kton instead of in litres, has been used to calculate the number and total weight of disposable plastic containers for yoghurt if they packed 100% of all yoghurt consumed.

Yoghurt in plastic containers is available in a wide range of volumes, different designs, and (probably) made from different types of plastics. A single self acquired 4x125 gram Danone pack of yoghurt containers has been weighed at 17.5 grams for the four container bodies of an unidentified plastic (possibly polypropylene; PP), 1.0 gram for the four aluminium 'lids', and 10.7 grams for the cardboard overwrap. The weight of the container bodies also includes a glued, inseparable paper wrap.

The total number of yoghurt containers has been calculated by dividing total yoghurt consumption by the Danone container's volume of 125 grams. Next the total packaging weight has been calculated by multiplying the total number of containers with the weight of four containers divided by four. The table below provides the calculated results that are of mediocre quality.

Yoghurt	NL	BE	DE	FR	ES	EU28	Unit
Yoghurt consumption	273.7	202.2	1,671.6	1,200.7	840.7	11,743.6	mln litre
No. of containers	2,189.5	1,617.2	13,372.9	9,605.3	6,725.4	93,949,0	mln
Plastic body (PP?)	9,6	7,1	58,5	42,0	29,4	411,3	kton
Aluminium	0,6	0,4	3,4	2,4	1,7	23,7	kton
Coreboard overwrap	5,8	4,3	35,7	25,6	17,9	250,6	kton

Olive oil in plastic bottles

The total consumption of olive oil for the countries covered and the EU28 has been taken from FAO (2022). Olive oil is sold in multiple brands that usually

have their own olive oil bottles. A single self acquired 1 litre olive oil bottle has been weighed at 47.43 gram. The bottle is made from the plastic PolyEthylene Terephthalate (PET). Total packaging weight has been calculated by multiplying total olive oil consumption by a bottle weight of 47.43 grams. The results are in the table below, and are of mediocre quality.

Olive oil	NL	BE	DE	FR	ES	EU28	Unit
Olive oil consumption	19.6	16.3	70.7	126.1	671.7	2,013.0	mln litre
No. of bottles	19.6	16.3	70.7	126.1	671.7	2,013.0	mln
PET	0.9	0.8	3.4	6.0	31.9	95.5	kton

Pasta & rice - if 100% were in plastic bags

The total consumption of rice has been taken from FAO (2022). Statista (2015) provides per capita consumption of pasta in 2015 that has been used to calculate total pasta consumption in the countries covered and the EU28 by multiplication by their number of inhabitants in 2019 from Eurostat (2022c).

Both pasta and rice are available in many volumes in either disposable cardboard boxes or plastic bags, each with an unknown market share. For each a self acquired plastic bag has been weighed. The 1 kg rice bag of an unidentified plastic, but assumed to be polypropylene (PP), weighed 7.68 grams. The 0.5 kg pasta bag of PP weighed 6.13 grams. Total packaging weight for rice and pasta has been calculated by multiplying their total consumption by the weight of the bags, and dividing the result by the content of the bag. The results in the table below are of mediocre quality.

Olive oil	NL	BE	DE	FR	ES	EU28	Unit
Rice consumption	110.0	141.0	405.0	659.0	727.0	2,344.8	kton
Pasta consumption	76.0	61.9	664.2	537.4	234.7	4,593.2	kton

PP (?) rice bags	0.8	1.1	3.1	5.1	5.6	18.1	kton
PP pasta bags	0.2	0.2	2.0	1.6	0.7	13.8	kton

Postal services - Letters in paper envelopes

The number of letters in paper envelopes has been derived from the Post and Packages monitor of the Dutch Authority on Consumers & Markets (ACM, 2021). According to ACM (2021), 2,052 million pieces of postbox items, i.e. post, from business senders were delivered in 2019.

For post items, ACM (2021) distinguishes between letters, periodicals (like magazines), and addressed promotional material. ACM (2021) does not provide numbers for each post stream, but does quantitatively distinguish between post streams to be delivered within the next day (time-critical post) and to be delivered within two days or more (non-time-critical) after being sent for shipping. This information has been used to estimate the number of post items in each stream.
ACM (2021) does not distinguish between post items from business to other businesses or from business to consumers. In 2019, however, the Netherlands counted 1.7 mln companies in the first quarter (CBS, 2022) and 7.9 mln households at the first of January (CBS, 2021). This ratio was used to calculate the number of post items for consumers; 1,163 mln letters and promotionals assumed in paper envelopes, and 364 mln periodicals in assumed plastic covers sent to Dutch consumers in 2019. These numbers were extrapolated to the other countries covered and the EU28 by multiplication by their number of inhabitants in 2019 from Eurostat (2021c).

The focus here is on letters and promotionals sent in paper envelopes. During a period of time, 23 delivered paper envelopes of A5 size were collected and weighed at 166.87 grams. The resulting average weight of 7.3 grams has been multiplied by the total number of post items in paper envelopes. The results are presented below, and considered of good quality.

Letters & promotionals	NL	BE	DE	FR	ES	EU28	Unit
No. of items	1,316.0	872.3	6,321.7	5,115.4	3,574.2	39,071.0	mln
Paper envelopes	9.5	6.3	45.9	37.1	25.9	283.5	kton

Postal services - Plastic covers for periodicals

During a period of time, 15 plastic covers for delivered magazines have been collected and weighed at 59.2 grams, leading to an average weight of 4.56 grams per plastic cover (typically of Low Density PolyEthylene; PE). The plastic covers varied strongly visibly in thickness and have therefore also been weighed individually. Their weights ranged from less than 2.0 grams to more than 6.0 grams, the median being 4.15 grams.

The median weight has been multiplied by the total number of periodicals (see previous section) to arrive at the total weight of plastic covers for periodicals. The results are below, and they are estimated to be of good quality.

Periodicals	NL	BE	DE	FR	ES	EU28	Unit
No. of items	364.0	241.3	1,748.6	1,414.9	988.6	10,806.9	mln
HDPE covers	1.5	1.0	7.3	5.9	4.1	44.8	kton

Postal services - Cardboard shipping boxes

According to ACM (2021), the total number of packages was 577 mln. ACM (2021) distinguishes between inland packages (sent by Dutch senders to inland addressees), and crossborder packages (sent by Dutch senders to an addressee abroad, or vice versa).

For inland packages, ACM (2021) specifies those sent from business to business, from business to consumers, and from consumers to other

consumers or businesses. The part for Dutch consumers at the border was calculated with their share in the inland stream calculated at 318 mln. Based on a sample of 150 packages, 75% is sent in cardboard shipping boxes (240 mln), 19% is sent in plastic shipping bags (i.e. 240 mln), and 6% in other shipping packaging (Thuiswinkel.org, 2015). These numbers for packages sent to Dutch consumers were extrapolated to the other countries covered and the EU28 by multiplication with their number of inhabitants in 2019 from Eurostat (2022c).

Thuiswinkel.org (2015) provides data about volumes of products and degree of filling of the cardboard shipping boxes in their sample. This data has been used to calculate the volume of cardboard shipping boxes. Via a number of mathematical manipulations, those volumes have been translated into weights on the basis of cardboard shipping boxes of corrugated board as offered on the websites of a number of large providers. The result applies to the Netherlands, and has been extrapolated to the other countries covered and the EU28 with the help of their number of inhabitants in 2019 from Eurostat (2022c). The table below provides the results, which are evaluated as good.

Packages in cardboard boxes	NL	BE	DE	FR	ES	EU28	Unit
No. of packages in shipping boxes	240.0	159.1	1,152.9	932.9	651.8	7,125 .4	mln
Corrugated board	84.1	55.7	403.8	326.7	228.3	2,495.4	kton

Postal services - Plastic shipping bags

The number of packages in plastic shipping bags has been multiplied by the estimated weight of shipping bags. According to Thuiswinkel.org (2015), these are plastic shipping bags of 57.2 mu thick, and which are of Low Density PolyEthylene (HDPE). Assuming that a plastic shipping bag has a size of 4 A4

sheets, this leads to 13.3 grams per bag. The results are in the table below, and are considered of good quality.

Packages in plastic bags	NL	BE	DE	FR	ES	EU28	Unit
No. of packages in shipping bags	62.0	41.1	297.8	241.0	168.4	1,840.7	mln
LDPE	0.8	0.5	4.0	3.2	2.2	24.5	kton

Soda drinks, sparkling water, and water

Total disposable packaging for soda drinks & sparkling water has been established in the same way as for beer, and the same comment applies to it (i.e. the numbers below are based on, but do not directly reflect, consumption data, and only show total packaging weight). The results are presented below. The numbers are considered to be good (see Table 2 on page 14 for an evaluation of the data quality).

Cardboard packaging has been quantified, but is not reflected in the table below as their quantities are very small, and only used in EU28 countries other than the countries covered here. When unclear, the caps of the plastic bottles are assumed to be of the same plastics as the bottles themselves, i.e. PolyEthylene Terephthalate (PET).

Soda drinks	NL	BE	DE	FR	ES	EU28	Unit
Glass bottles < 1l	1.9	6.8	25.0	22.1	58.8	291.3	kton
& metal caps	0.0	0.1	0.2	0.2	0.7	3.3	kton
Glass bottles ≥ 1l			43.2	0.0	0.8	50.8	kton
& metal caps			0.1	0.0	0.0	0.2	kton
PET bottles < 1l	3.6	7.6	64.8	6.7	6.4	150.2	kton
& HDPE caps	0.5	1.0	8.2	0.9	0.8	18.9	kton
PET bottles ≥ 1l	14.3	10.0	92.8	36.3	36.2	367.4	kton

& HDPE caps	1.0	0.7	6.9	2.6	2.3	25.2	kton
Metal (aluminium) cans < 1l	8.1	10.9	13.8	24.5	34.4	149.1	kton

Sparkling water	NL	BE	DE	FR	ES	EU28	Unit
Glass bottles < 1l	1.5	0.2	0.5	16.6	9.9	154.7	kton
& metal caps	0.0	0.0	0.0	0.1	0.1	1.1	kton
Glass bottles ≥ 1l	0.0	0.0	2.9	1.5	15.2	32.4	kton
& metal caps	0.0	0.0	0.0	0.0	0.1	0.1	kton
PET bottles < 1l	3.0	3.9	24.5	5.9	0.9	251.8	kton
& HDPE caps	0.4	0.5	3.1	0.7	0.1	10.7	kton
PET bottles ≥ 1l	3.8	5.7	106.5	37.0	2.7	352.5	kton
& HDPE caps	0.3	0.4	7.5	2.9	0.2	24.8	kton
Metal (aluminium) cans < 1l	0.1	0.0	0.0	1.6	0.1	3.2	Kton

Still water	NL	BE	DE	FR	ES	EU28	Unit
Glass bottles < 1l	0.6	0.1	8.6	2.7	4.7	92.2	kton
& metal caps	0.0	0.0	0.2	0.0	0.1	1.8	kton
Glass bottles ≥ 1l	0.1		2.3	2.5	1.0	36.8	kton
& metal caps	0.0		0.0	0.0	0.0	0.5	kton
PET bottles < 1l	3.8	5.2	10.3	17.1	26.5	150.4	kton
& PET (?) caps	0.3	0.5	0.9	1.6	2.6	14.0	kton
PET bottles ≥ 1l	2.6	15.9	41.8	124.3	55.7	462.4	kton
& PET(?) caps	0.1	0.7	1.8	5.4	2.3	19.4	kton
Cardboard boxes < 1l	0.2	0.0	0.2			0.4	kton
& aluminium lid		0.0	0.0			0.0	kton
& Paper straws for cups	0.0		0.0			0.0	kton
& PP straws for cups	0.0		0.0			0.0	kton

& PP foil around straws	0.0		0.0			0.0	kton
Cardboard boxes ≥ 1l	1.0		0.1	0.0		1.2	kton
& PP (?) lid	0.1		0.0	0.0		0.1	kton
Aluminium foil pouches < 1l	0.0	0.0				0.0	kton
& PP (?) caps							kton
& Paper straws for cups	0.0	0.0				0.0	kton
& PP straws for cups	0.0	0.0				0.0	kton
& PP foil around straws	0.0	0.0				0.0	kton
Metal (aluminium) cans < 1l	0.0				0.0	0.0	kton

Table grapes in plastic clamshells

The total consumption of table grapes in 2019 has been calculated as own production plus imports minus exports as given by CBI (2021) for all countries covered , except Belgium. Total table grape consumption for Belgium in 2016 has been taken from Statista (2020). Total grape consumption in 2019 for EU27 is taken from IndexMundi (2022) and added together with the table grape consumption of the United Kingdom in 2019 as based on CBI (2021).

Six self acquired disposable plastic clamshells, for the packaging of 500 grams of grapes, have been weighed to be respectively 16, 16, 20, 20, 20, and 22 grams. The number of clamshells has been calculated by dividing total grape consumption by 500 grams. The number of clamshells multiplied by 20 grams resulted in the total clamshell weight for packaging table grapes. The clamshells are made from PolyEthylene Terephthalate PET.

The table below gives the results for table grapes. The results are considered to be of good quality.

Table grapes	NL	BE	DE	FR	ES	EU28	Unit
Table grape consumption	31.0	41.3	187.0	151.0	211.0	2,447.4	kton
No. of clamshells	62.0	82.6	374.0	302.0	422.0	4,894.7	mln
PET	1.2	1.7	7.5	6.0	8.4	97.9	kton

Take-away warm drinks in disposable cups

Statista (2019) provides the use of disposable cups for warm drinks in 2019 for all countries covered. These numbers have been extrapolated to the EU28 with the help of the number of inhabitants in all countries in the EU28 in 2019 from Eurostat (2022c).

The share, weight, and material composition of polystyrene (PS) cups, single and double walled paper cups, and PS lids used for both of them in Germany, have been taken from Kauertz et al. (2019) and applied to the disposable cup use of all countries covered and the EU28.

The results are in the table below, and are considered to be of good quality.

Take-away warm drinks	NL	BE	DE	FR	ES	EU28	Unit
No. of disposable PS cups	228.0	151.0	1,140.0	875.0	638.0	6,970.0	mln
No. of disposable paper cups	333.0	219.0	1,660.0	1,275.0	928.0	10,149.0	mln
PS Cups	0.9	0.6	4.7	3.6	2.6	28.6	kton
PS lids for 15% of PS cups	0.1	0.1	0.5	0.4	0.3	3.3	kton
Paper body of paper cups	3.6	2.4	17.8	13.7	10.0	108.9	kton
LDPE lining of paper cups	0.2	0.1	1.0	0.8	0.6	6.2	kton

PS lids for 70% of paper cups	0.7	0.5	3.7	2.9	2.1	22.7	kton

Take-away & delivery pizza in cardboard boxes

There is a lot of, but inconsistent, information about the number of take-away and deliveries of pizza and other meals. Dealroom & Prioridata (2017) provide data about the number of ordered delivery meals in, probably, 2016 in the countries covered. The quality of this data is questionable, as from other sources, but assumed to be consistent across the countries covered. ABN-AMRO (2016) provides reliable data about the shares of delivery and take-away meals in the Netherlands, whereas FSIN, (2019) provides reliable data about the number of orders in, amongst others, 2016 and 2019 in the Netherlands. This data has been used to extrapolate the number of ordered delivery meals from Dealroom & Prioridata (2017) to also include take-away meals and to relate to 2019. ABN-AMRO (2016) provides the share of pizza in total Dutch orders of take-away and delivery meals. Deloitte (2020) does the same for the other countries covered. The number of orders for the EU28 has been extrapolated from the Netherlands with the help of the number of their inhabitants in 2019 from Eurostat (2022c).

The focus here is on disposable cardboard pizza boxes. Paardekooper (2021) sells pizza boxes used by many pizzerias in the Netherlands. One of these cardboard pizza boxes, i.e. from corrugated cardboard, has been self acquired and weighed at 130 gram. This has been multiplied by the number of pizza orders to arrive at the total weight of pizza boxes in the countries covered and the EU28. The table below gives the results of mediocre quality.

Take-away & delivery pizza	NL	BE	DE	FR	ES	EU28	Unit
No. of pizza orders	45.6	24.3	222.3	130.7	125.4	1,434.9	mln
Corrugated board	5.9	3.2	28.9	17.0	16.3	186.5	kton

Take-away & delivery meals in paper, aluminium, or plastic containers

A wide variety of disposable meal containers is used for packing take-away and delivery meals. Verburgt (2021) provides the weight and material composition of three often used meal containers, one of PolyPropylene (PP), one of paper (coreboard), and one of aluminium. Their market shares are unknown, so their weights were multiplied by the total numbers of take-away and delivery meal orders other than pizza, calculated with the data in the previous section, as if 100% were packed in one or the other. The tables below give the results, which are of mediocre quality.

If 100% of meals other than pizza were to be packed in polypropylene (PP) containers:

Take-away & delivery meals	NL	BE	DE	FR	ES	EU28	Unit
No. of meal orders	524.5	279.7	1,488.0	1,503.6	1,014.8	16,501.5	mln
PP	16.5	8.8	46.9	47.4	32.0	519.8	kton

If 100% of meals other than pizza were to be packed in paper (coreboard) containers:

Take-away & delivery meals	NL	BE	DE	FR	ES	EU28	Unit
No. of meal orders	524.5	279.7	1,488.0	1,503.6	1,014.8	16,501.5	mln
Coreboard	13.7	7.3	38.9	39.3	26.5	430.9	kton
LDPE-lining	0.6	0.3	1.8	1.8	1.2	19.6	kton

If 100% of meals other than pizza were to be packed in aluminium containers:

Take-away & delivery meals	NL	BE	DE	FR	ES	EU28	Unit
No. of meal orders	524.5	279.7	1488.0	1503.6	1014.8	16501.5	mln
Aluminium	4.0	2.1	11.3	11.4	7.7	125.4	kton
Coreboard lid	3.5	1.8	9.8	9.9	6.7	108.9	kton
LDPE-lining of coreboard lid	0.2	0.1	0.4	0.5	0.3	5.0	kton

Textile softeners in plastic bottles

No data about the consumption of textile softeners was found in publicly available sources. Therefore an 'educated guess' of the total Belgium consumption from a producer of surface cleaning agents has been used. The total Belgium consumption has been extrapolated to the Netherlands, Germany, France, Spain, and the EU28 with the help of the number of inhabitants in 2019 in the countries covered and the EU28 from Eurostat (2022c).

Van Duin & van Duin (2019) weighed a large number of PolyEthylene Terephthalate (PET) and High Density PolyEthylene (HDPE) bottles from different brands. Their average weight per 100 grams has been multiplied by the total consumption of textile softeners to arrive at the total packaging weight. The table below gives the results, which are of mediocre quality.

Textile softeners	NL	BE	DE	FR	ES	EU28	Unit
Textile softener consumption	22.5	14.9	107.9	87.3	61.0	667.0	mln litres
PET bottles	1.1	0.7	5.3	4.3	3.0	32.9	kton
HDPE bottles	0.5	0.3	2.2	1.8	1.3	13.7	kton

Wine in glass bottles

The total consumption of wine in the selected countries and the EU28 has been taken from FAO (2022). The average weight of glass bottles, normalised to 1 litre of wine, has been taken from a monitoring report of the Royal Dutch Society for Wine Traders (KVNW, 2015). The results, which are in the table below, are of reasonable to good quality.

Wine	NL	BE	DE	FR	ES	EU28	Unit
Wine consumption	345.0	324.0	1,719.0	3,610.0	2,423.0	15,003.0	mln litres
No. of bottles (0,75 l)	460.0	462.9	2,455.7	5,157.1	3,461.4	21,432.9	mln
Glass	176.0	165.2	876.7	1,841.1	1,235.7	7,651.5	kton