# UNWRAPPED

## HOW THROWAWAY PLASTIC IS FAILING TO SOLVE EUROPE'S FOOD WASTE PROBLEM

## (AND WHAT WE NEED TO DO INSTEAD)

**UNWRAPPED: HOW THROWAWAY PLASTIC IS FAILING TO SOLVE EUROPE'S FOOD WASTE PROBLEM (AND WHAT WE NEED TO DO INSTEAD)**

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RETH!NK PLASTIC

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Rethink Plastic is an alliance of leading European NGOs with one common aim: a future that is free from plastic pollution. It represents thousands of active groups, supporters and citizens all across the Europe, and is part of the global Break Free From Plastic movement, consisting of over 1000 NGOs and millions of citizens worldwide.

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All report documents, including the three fact sheets,
the Annex and the Life Cycle Assessment analysis are available at:
foeeurope.org/unwrapped-throwaway-plastic-food-waste

## LIST OF ACRONYMS USED

| | |
|---|---|
| B2B | Business to Business |
| CATL | Ceinture Aliment-terre Liégeoise |
| CSA | Community Supported Agriculture |
| DEFRA | Department for Environment, Food and Rural Affairs |
| EASME | Executive Agency for Small and Medium-sized Enterprise |
| EEA | European Environment Agency |
| EPA | Environmental Protection Agency |
| EPR | Extended Producer Responsibility |
| FAO | Food and Agriculture Organization of the United Nations |
| FEBA | European Federation of Food Banks |
| GAS | Gruppo Acquisto Solidale (Ethical Purchasing Group) |
| GPP | Green Public Procurement |
| HoReCa | Food Service Industry (Hotels Restaurants Catering) |
| IMEB | Istitut Municipal d'Educació Barcelona |
| INCPEN | Industry Council for Research on Packaging and the Environment |
| LCA | Life Cycle Assessment |
| MAP | Mediterranean Action Plan |
| NIAS | Non-intentionally Added Substances |
| OVAM | Public Waste Agency of Flanders |
| PPWD | Packaging and Packaging Waste Directive |
| RFID | Radio-frequency Information Technology |
| SFSC | Short Food Supply Chain |
| SME | Small and Medium Enterprise |
| STREFOWA | Strategies to Reduce Food Waste |
| UBA | Umwelt Bundesamt |
| UNEP | United Nations Environment Programme |
| WRAP | Waste & Resource Action Programme |

# EXECUTIVE SUMMARY

Food waste and plastic waste are two major economic, environmental and social challenges facing Europe.

- **Food waste represents a major failure of our economy.** The associated costs of food waste in the EU was estimated at EUR 143 billion in 2015, equivalent to the operational budget of the EU.
- **Plastic packaging is often heralded as a means of avoiding food waste but it has not provided a comprehensive solution.** Growth in the application of plastic packaging has increased alongside the growth in food waste, with Europe's total demand for plastic rising to 49 million tonnes per year, of which 40% is used for packaging.
- **Plastic packaging remains highly problematic for waste management and the environment.** Europeans, on average, throw away more than 30kg of plastic packaging per person per year. Landfilling and incineration are the dominant approaches to managing post-consumer plastic waste (at 31% and 39%, respectively) and rates of littering and environmental leakage of plastics remain unacceptable. Less than 30% of plastic waste is collected for recycling, with most of this either exported out of Europe or destined for low value applications.
- **Most food packaging remains at odds with the objectives of the circular economy.** The majority of plastic packaging is used only once, with 95% of its value lost to the global economy after this first use (worth an estimated EUR 100 billion annually). The United Nations estimate global annual natural capital costs from plastics in the food industry at EUR 15 billion.


- There is growing evidence that **many single-use food contact materials, including plastics, may pose health risks to consumers due to chemical migration.** Harmful chemicals such as endocrine disruptors have been shown to migrate in plastic packaging and other materials, such as recycled card. There is a pressing need for greater understanding of the health impacts of these chemical transfers and subsequent development of appropriate policies.

**The combined challenges of food waste and plastic packaging waste** must be **tackled together**, starting with the role of plastic packaging in the food system:

- **Food waste has complex drivers** – while some packaging has a role to play in protecting food and extending shelf-life, many packaging practices increase wastefulness of both food and packaging. The drivers of food waste are diverse, and include the oversupply and undervaluing of food. Tackling these requires systemic change to our food system, changes in which packaging has limited potential.
- **Producers** – in Europe's industrialised and globalised food system (characterised by long supply chains and multiple intermediaries), cosmetic specifications and packaging standards can lead producers to waste edible food. Rethinking supply chains can help to recognise the value of agricultural produce, simultaneously reducing food and packaging waste. Short food supply chains (SFSCs) can bring consumers closer to local farmers and facilitate waste prevention, together with higher rates of packaging reuse and recycling.
- **Processors and packagers** – estimates suggest that by 2020 Europe will consume more than 900 billion items of packaged food and drink annually. Packaging serves multiple purposes, of which food preservation is just one. More comprehensive research and debate is needed, given the limitations of existing analyses of packaging's contributions to reducing food waste, particularly industry-led LCA studies.
- **Wholesale and retail** – many packaging practices used by the food industry and retailers (e.g. multipacks) are implemented to support economic efficiencies and marketing and brand objectives rather than to preserve food. These practices can drive food waste throughout the value chain. For many products, zero or reusable packaging represents a viable and sustainable solution, and this is reflected in the growing number of retailers focusing on reducing the use of unsustainable packaging. More transparency and research is needed on how retailers operate and perform on waste.

- **Households** – products that come wrapped in plastic packaging do not necessarily help citizens to reduce household food waste. Diets and purchasing behaviour, as well as knowledge on safe food preparation and preservation at home, can be more effective and less wasteful than simply adding more plastic to products. Reusable packaging and traditional approaches to preserving food can deliver all of the functionality of single-use packaging.
- **Food services** - many food services, such as fast food and delivery services, waste both food and plastic packaging. Some businesses are demonstrating how integrating their services into local supply chains, using reusable materials and alternative delivery systems, can overcome these challenges and create competitive advantage. All of the actors in the food supply chain can participate in recovery and redistribution of safe and nutritious food for human consumption.
- **Municipalities** – local authorities are key actors in the procurement of food services and the management of food and packaging waste. Many cities are taking action to reduce waste and its associated negative socioeconomic impacts, while generating value from inedible food waste by enhancing composting infrastructure. Innovative cities are exploring the regional development opportunities offered by SFSCs and urban agriculture, as well as providing support for sustainable diets.

## RECOMMENDATIONS FOR ACTION

The challenges of food and plastic packaging waste are elements of the **EU's Circular Economy Package**, as well as many national and local initiatives, policies and strategies. More needs to be done, however, to link these discussions. At EU level, this could be done as part of the recently published **EU Strategy on Plastics in a Circular Economy**, as well as in the forthcoming 2018 **food package initiative**, which is expected to include a legislative proposal on the EU food supply chain. Key actions for policymakers and stakeholders will be to:

- **Develop a holistic, evidence-based approach to the role of plastic packaging in the food system**, identifying the underlying drivers of food waste and its interaction with plastic packaging. This should include conducting more comprehensive assessments (including LCAs), and integrating knowledge on marine litter and the health impacts of chemical migrations.
- **Review legislation to assess and address gaps** in order to tackle the dual challenge of food waste and plastic waste. This includes single-use plastic packaging reduction targets, scaling up reusable packaging and reviewing eco-design criteria, cosmetic standards and labelling.
- **Use market-based instruments to prompt behavioural change** towards avoiding food and plastic waste and keeping resources in the economy. This includes using green public procurement (GPP), extended producer responsibility (EPR) schemes, deposit refund schemes and progressive taxation on virgin plastics.
- **Provide greater investment and funding for waste prevention systems**, including zero and reusable packaging systems and better integrated SFSCs between rural and urban areas, with a focus on retailers and SMEs.

***The way forward:*** *Europe has an opportunity to reposition our approach to the production, delivery and consumption of food and food packaging. While plastics have some role to play, real reform must be broader in scope. This report shows the need to better examine the limits of plastic packaging in reducing food waste overall, and identifies real innovation among those who eschew all forms of waste. Policymakers must now turn successful initiatives into everyday practice. Europe's high rates of per capita waste should not be viewed as an inevitable by-product of economic development and convenient lifestyles: today's environmental realities oblige us to approach food, plastic and all resources in a way that ensures a good life for all within the planetary boundaries. Similarly, Europe wants a food system that values agricultural produce and supports its producers, thus supply chains should be used to foster regional development and allow the food system to reduce, reuse and recycle materials, including packaging.*

# 1 THE FOOD SYSTEM AND FOOD WASTE

**Abundance of food and its low cost relative to overall household expenditure are, arguably, successes of Europe's industrialised food system, yet these benefits have come with high levels of food waste and inefficiency.**

Food waste[1*] represents an economic and social loss with far-reaching environmental consequences [1]. To put it in context: if global food waste were a country, it would be just behind the USA and China in terms of annual greenhouse gas (GHG) emissions. In 2012, the EU-28 wasted an estimated 88 million tonnes of food at different stages of the supply chain (see Annex) [2]. Associated costs of food waste for the EU are estimated at EUR 143 billion, equivalent to the operational budget of the EU [3].

Food waste has increased sharply over the last half-century in Europe, from a few percent in the 1930s to current global levels where one-third of food produced is lost or wasted [1, 4, 5]. Accounting for trade, most European countries now have between 150% and 200% of the food needed to feed their populations based on calorific demand [5]. With supply larger than demand, a high level of food waste is likely [6].

The relatively low cost of food in Europe creates little economic incentive for consumers to avoid waste. Table 1 compares household expenditure on food with food waste, indicating how food is valued in different countries. Expenditure on food in Europe is particularly low as a proportion of income: the UK, Switzerland, Ireland and Austria all spend less than 10% of their income on food. By contrast, the top three countries spending the most on food are Nigeria, Kenya, and Cameroon [7], where more than 45% of income is spent on food. Notably, Sub-Saharan Africa also has the lowest levels of household food waste [1].

| COUNTRY | INCOME SPENT ON FOOD | HOUSEHOLD FOOD WASTE |
|---|---|---|
| UK | 8.2% | 95-115kg/yr. per capita consumer food waste (Europe/N-America) |
| Switzerland | 8.7% | |
| Ireland | 9.6% | |
| Austria | 9.9% | |
| Cameroon | 45.6% | 6-11kg/yr. per capita consumer food waste (Sub-Saharan Africa) |
| Kenya | 46.7% | |
| Nigeria | 56.4% | |

*Table 1 – Comparison of income spent on food and consumer food waste (FAO, 2011; Gray, 2016)*

Food waste is one of several inefficiencies in Europe's food system. While global food systems have the potential to meet the food security demands of current and future generations [8], nutritional needs are often poorly matched by consumption patterns and agricultural land use [9]. This is evident in Europe where, for example, 72% of the land used to feed European citizens goes towards animal-based products [10]. In addition, around half of Europeans are overweight, with one-in-six being obese [11]. Using nutrients and resources efficiently, including avoiding waste, are central to developing sustainable food systems [12-14].

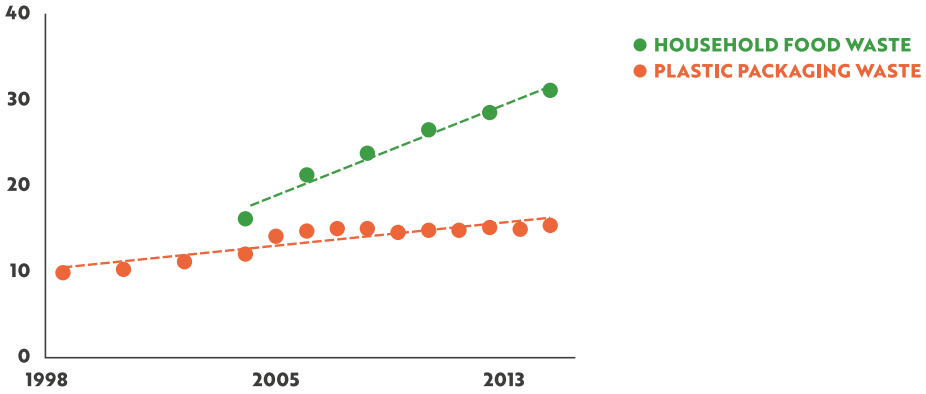
*[1*] A list of definitions are given in the Annex.*

# 2 THE EMERGENCE OF PLASTIC PACKAGING IN THE FOOD SYSTEM

**Plastic packaging waste is another symptom of inefficiency in the food system. The use of plastic packaging, particularly single-use plastic, underpins convenience, supports an on-the-go culture and, in some cases, extends shelf-life. But packaging waste has grown alongside food waste, challenging its potential to contribute to reducing food waste.**

Since the use of plastic packaging for food became common in Europe in the 1950s, the levels of plastic packaging and food waste per capita have grown simultaneously, with annual levels in excess of 15 million tonnes or 30kg plastic packaging waste per capita, and of 31 million tonnes or 70kg household food waste per capita (Figure 1). While both food and packaging waste have started to level off in recent years (party due to an increasingly saturated market for fast moving consumer goods, as well as slow economic growth in Europe), per capita levels remain among the highest globally [15]. In general, national and EU-wide data on food and plastic packaging waste streams suggest that increased levels of plastic packaging have not reduced food waste.

**FIGURE 1 – HOUSEHOLD FOOD AND PLASTIC PACKAGING WASTE IN THE EU-28 (MILLION TONNES)**




*Source: [16]; [17].*

Approximately 42% of the plastics produced globally since 1950 have been used for packaging [18], which, at 40%, continues to be the biggest market for plastics in Europe today [19]. Data on the amount of plastic packaging used specifically for food is difficult to obtain, with one source stating that global food packaging constituted 41% of all packaging used in 2007 [20]. Europe's market for packaging is highly developed, with per capita packaging waste levels (for all types of packaging) among the highest in the world, in excess of 200kg per year in some Member States [16].

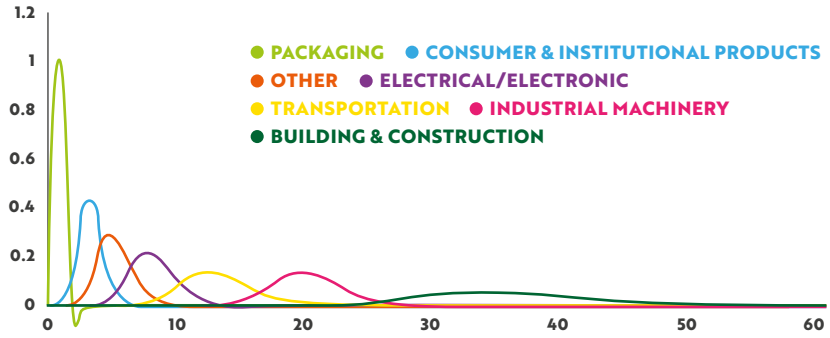
Well-designed packaging can contribute positively to the food supply chain [1], e.g. by facilitating transport and reducing distribution losses [22]. Traditional approaches to packaging, such as using jars and tins, can give access to produce out of season [22]. Much research has focused on the contribution of plastic packaging to extending product shelf-life, but concerns persist in relation to how these benefits are presented (see page 8 and Life Cycle Assessment analysis document). Some packaging may be beneficial for products such as beef, where the environmental impact of a single product unit can be substantial [23]. Many contemporary packaging applications, like those used by takeaway services and pre-prepared foods, are linked to the emergence of an on-the-go culture and declining household sizes, and are often linked to higher levels of waste [24]. The convenience offered by single-use plastic should be understood in the context of growing awareness of the impact of packaging waste and the wider need for an absolute reduction in the use of all resources.

# 3 PLASTIC PACKAGING WASTE AS A GLOBAL CHALLENGE

**Most food packaging remains at odds with the objectives of the circular economy, illustrated by low rates of reuse and recycling, as well as significant levels of environmental leakage. The export of plastic waste from Europe, as well as a growing global market for packaged foods, has seen the socioeconomic and environmental impacts of plastic packaging waste rapidly globalised.**

300 million tonnes of plastics are produced globally every year, with production expected to double in the next 20 years. By 2050, the plastics industry could account for 15% of the global carbon budget. Europe's total demand for plastic has risen to 49 million tonnes per year, of which 40% is used for packaging. The majority of this plastic packaging is used only once, with 95% of its value lost to the economy after this first use, a loss with an estimated value of EUR 100 billion globally [24]. Compared to other plastic applications, packaging tends to have a significantly shorter product lifetime. Most products become waste in the same year in which they were produced (see Figure 2).

**FIGURE 2 - PRODUCT LIFETIME DISTRIBUTIONS (IN YEARS) FOR PLASTICS FROM DIFFERENT SECTORS (LOG NORMAL PROBABILITY DISTRIBUTION FUNCTION) [18]**




In Europe, landfilling and incineration are the dominant approaches to managing plastic waste, at 31% and 39% respectively [25]. Less than 30% of post-consumer plastic waste is collected for recycling, most of which is either exported out of Europe or destined for low value applications.

The exported plastic waste (3.05 million tonnes in 2015) is mostly transported to China and other Asian countries, causing unquantified environmental impacts [26, 27]. However, with China announcing a ban on all plastic waste imports from 2018, Europe will need to better manage its plastics at local level, as well as changing the ways we produce and consume plastics in all sectors of the economy.

Littering and environmental leakage of plastics impact biodiversity and bring significant socioeconomic costs [28]. Most of the litter found on beaches in Europe [29] and across the globe [30] can be associated with the food, beverage and tobacco sectors. Plastics make up 85% of beach litter worldwide, 61% of which are single-use plastics such as crisp packets and sweet wrappers, food containers and cutlery [30]. Each day, an estimated 700 tonnes of plastic flows into the Mediterranean alone [31, 32]. The United Nations Environment Programme (UNEP) estimates global annual natural capital costs from plastics in the food industry at EUR 15 billion, the highest impact from plastic in any consumer goods sector (Figure 3). The main natural capital costs from plastics include GHG emissions, water extraction, terrestrial land and water pollution, and ocean pollution.

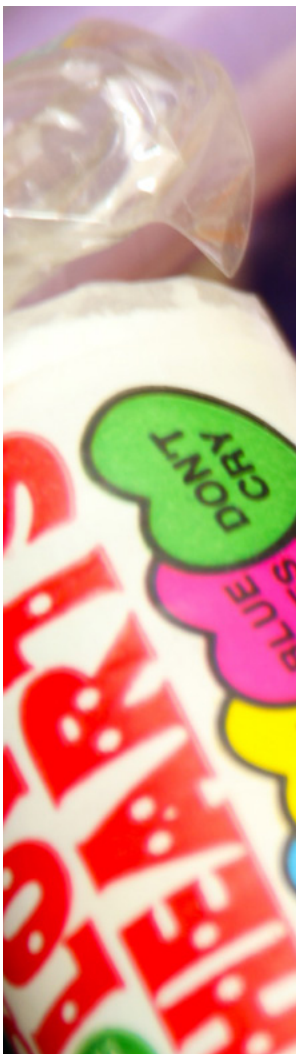
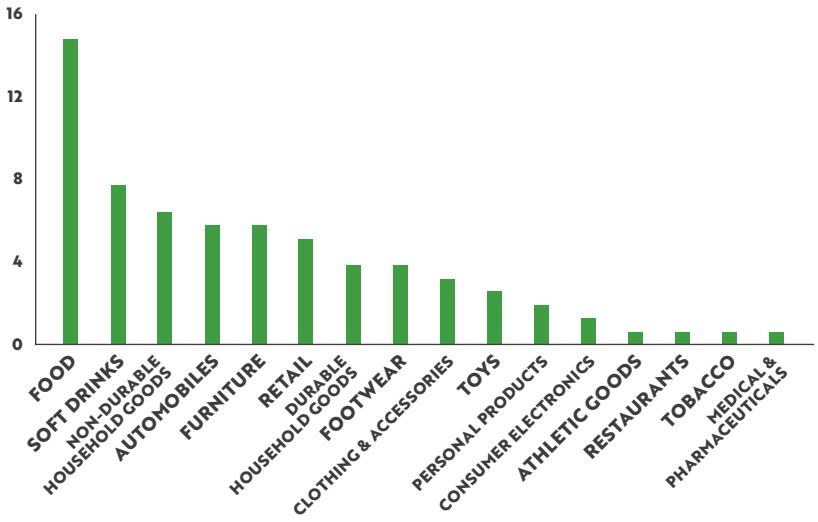


**FIGURE 3 - GLOBAL ANNUAL NATURAL CAPITAL COST OF PLASTIC - CONSUMER GOODS SECTORS (IN EUR BN) [33]**




Efforts by governments and industry to limit the impact of plastic packaging or curtail over-packaging have had limited or unforeseen consequences. For example, packaging designers often focus on light-weighting, in order to reduce emissions and economic contributions to EPR schemes [34]. While some evidence suggests that the average weight of plastic packaging has fallen since 2004 [35], this, together with trends towards multi-material, flexible packaging and a growing demand for convenience goods, has resulted in packaging which is increasingly complex and difficult to recycle [24, 36] and has not led to a decrease in absolute quantities of plastic packaging by weight.

# 4 PRODUCERS

**Much of Europe's food is transported vast distances and supply chains typically involve numerous intermediaries. In these supply chains, packaging plays a role in facilitating intermediate processing and eventual sale to final consumers. Packaging practices themselves also cause produce to be wasted by farmers and producers. There are opportunities, however, to reduce both food waste and the use of packaging by changing retail and packaging practices and by using shorter supply chains.[2]**

An estimated nine million tonnes (or 20kg per capita) of food is wasted in the agriculture sector in the EU-28 each year [2]. Although some waste can be linked to natural factors, much of the food wasted by the agricultural sector is edible and avoidable [6]. Retail practices further down the supply chain remain key determinants of the percentage of produce which makes it to market. In the case of fresh produce, pre-determined packaging formats and sizes restrict the produce deemed suitable or desirable for retailers. At worst, these practices lead to edible food being rejected by retailers, driving agricultural waste. At best, such practices create cosmetic hierarchies of food based on neither nutrition nor taste [6, 37, 38].

## TRIMMED BEANS - PACKAGING SPECIFICATIONS LEADING TO FOOD WASTE

Food waste NGO, Feedback, published a report on Kenyan horticultural exports to Europe, illustrating that the practice of top and tailing French beans for packaging resulted in average wastage of 30-40%. Farmers grow longer varieties of beans in order to carry out the practice, with large amounts of the bean then wasted in order to fit beans into the packaging. Feedback successfully encouraged Tesco, one of the world's largest food retailers, to change their buying practices and length specifications to uncut products [38]. This change of practice was expected to save 135 tonnes of edible crop each year [39].

Research has shown that retailers routinely flex cosmetic standards on fresh fruit and vegetables in order to match supply and demand, applying their standards more strictly in times of surplus and being more lenient during periods of scarcity [40]. Other examples of buyer specifications which give rise to unnecessary loss include contract requirements for a minimum number of items rather than a minimum weight, with producers trimming vegetables in order to fit a greater number into the crate [37].

Modern supply chains make it normal for food to be made from ingredients which have been transported over vast distances, whether in processed or raw form [41]. Such transportation is difficult to achieve without packaging. However, packaging may then be used for marketing purposes (e.g. the neat row of trimmed beans in the example above) and to achieve economies of scale. This can create unfair and wasteful trading relations between retailers and producers both in Europe and in third countries [40].

**Packaging has been shown to play a role in determining the grading standards for food, thus contributing to food waste. Changing retail and packaging practices offers opportunities to recognise the value of agricultural produce and simultaneously reduce food and packaging waste. In addition, shortening supply chains can bring consumers closer to farmers and facilitate sustainable approaches to packaging.**

Alternative production and retail models, particularly those which embrace the concept of short food supply chains (SFSCs) and the wider principles of agroecology, demonstrate that it is feasible and economically viable to develop food supply chains which are less dependent on cosmetic standards, unsustainable packaging practices and unfair trading relations with farmers [42].

*[2]* This chapter looks at the impact of packaging on the production of food by land-based agriculture in Europe. Significant waste also occurs in fisheries although there are sometimes different drivers, such as the catch quota system which incentivises the discarding of fish at sea.*

Community Supported Agriculture (CSA) is one model which can reduce or eliminate the need for food to be packaged. Under a typical CSA scheme, customers pay at the beginning of the year for a share of the harvest. Food is either distributed by the producer via a system such as regular produce baskets, or customers come to the farm to collect it. Either way, packaging is minimal, e.g. using reusable baskets to display or deliver produce. Comparable models, such as the French Jardins de Cocagne and Italian Gruppi di acquisto solidale (GAS), also aim to make direct links between farmers and consumers and, often, to reduce levels of packaging [43].

The EU-funded Foodlinks project examined 20 initiatives across Europe which aimed at implementing SFSCs [42]. For example, the Italian GAS San Zeno, based in Pisa, links 10 producers within a 40km radius of the city to its members, providing them with vegetables, fruit, juices, jams, cereal and eggs. It has developed guiding principles for its operations, including the reduction of packaging overall and a preference for reusable packaging. Foodlinks notes that SFSCs use less packaging than supermarkets because:

- Many products, such as bread and vegetables, are sold without packaging.
- Short distribution distances mean that reusable packaging (such as glass jars for yoghurt) becomes viable, and facilitates sustainable transportation options such as walking and cycling (soft mobility).
- Local produce is sold fresh and in season, removing the need for processing and refrigeration in transit.

In 2015, more than 6,000 initiatives across Europe aimed to facilitate the consumer-farmer connection, providing food to more than 1 million people [43].

## COMMUNITY SUPPORTED AGRICULTURE IN LUXEMBOURG

Terra is a CSA farm operating on 1.5 hectares in the centre of Luxembourg city. It uses an organic agroforestry system based on fruit trees and permaculture in which vegetables and plants are grown. Annual subscriptions provide members with a weekly share of produce, which they themselves collect from the farm, and they are encouraged to play an active part in its production and harvest. The Terra team provides customers with advice on how to store produce to minimise waste and how to maximise its nutrition in cooking. Seasonality means that there are times when there is more produce than the regular customers can handle, during which times the excess is either sold to local organic retailers or given away to farm volunteers or local charities. With a few exceptions, produce is not processed on-site, although regular customers occasionally make processed products for distribution to the farm's supporters. No cosmetic standards are applied. Terra's system involves minimal packaging and minimal use of plastics, with plastic netting used to protect growing produce and reusable plastic crates for displaying fruit and vegetables.

Policies to support a dietary shift towards more seasonal and locally produced food have the potential to bring about significant resource savings. One industry group estimated that 95% of supermarket products currently comes from processors rather than directly from farmers, while just 15% of farmers sell more than half of their produce directly to consumers [44]. In 2013, Europe had net imports of around 27 million tonnes of soybeans and soybean products for oil production and animal feed. And while many everyday products, such as bananas, coffee and cocoa cannot be produced in Europe, efforts should be made to reduce the number of intermediaries and ensure a fair deal for local producers [9].

# 5 PROCESSORS AND PACKAGERS

**By 2020 it is estimated that Europe[3] will consume more than 900 billion items of packaged food and drink annually [45]. Packaging serves multiple purposes, including food preservation. Most existing analysis which promote plastics, including LCA analyses, fails to take a systemic approach to the role of packaging. Similarly, the focus on light-weighting, alongside growing markets like pre-prepared foods and smart-packaging, drive waste while appearing to offer consumer convenience.**

The processing sector is the second largest contributor to food waste in the supply chain (after households), accounting for 19% (17 million tonnes) of the food wasted in the EU-28 annually [3]. Losses during food processing and packaging can be linked to over-production, logistics, equipment defects, human error, residues, cleaning, reduced stock turnover and quality demands from retailers [22, 45]. Processing and packaging practices are also important determinants of food waste in other parts of the value chain, as the nature of packaging design can help to determine a product's lifecycle [47].

Packaging design is generally based on the characteristics of the product, marketing needs, shelf-life, logistics, transport distance, storage and handling, as well as environmental and economic costs [23]. The environmental performance of packaging is difficult to ascertain, given the complex trade-offs and competing interests. However, some approaches to food packaging are clearly problematic for packaging waste and/or food waste. At worst, packaging is used to mislead consumers about product content e.g. practices such as slack-filling/selling air, attaching gifts, and downsizing. These can result in unnecessary packaging and may increase food waste [48].

## JUSTIFYING PLASTICS? GAPS IN EXISTING LCA RESEARCH ON PACKAGING

Life Cycle Assessment (LCA) is a methodology applied to assess the environmental impact of different products, which has been widely used to assess food packaging. As part of this study, 21 LCA packaging studies were reviewed (see Life Cycle Assessment analysis document). Key conclusions and recommendations based on this analysis were:

- LCA analyses are increasingly used to inform policy discussions on food packaging. In the context of food and packaging waste, LCA has both strengths and weaknesses.
- An emphasis on GHG emissions in existing LCA studies, has resulted in food packaging decisions made at the expense of material efficiency, with too much focus on carbon emissions and too little on end-of-life impacts. The result is complex packaging design, such as pouches, which are impossible to recycle and lead to 'mixed residues destined for landfill' or incineration [36].
- Existing LCA studies consider waste management scenarios which often ignore environmental leakage of packaging. Studies could better consider the waste treatment realities of specific markets in order to develop measures to reduce marine litter and other forms of pollution.
- As the knowledge base on chemical migrations from food contact materials is strengthened, these considerations should be better integrated into the assessment of packaging design and material choice, otherwise the precautionary principle should be adopted
- LCA analysis should be better combined with knowledge on food waste drivers in order to understand the extent to which packaging can reduce waste of the product, as many food waste drivers (e.g. over-purchasing and preparation techniques) are not linked to packaging, and some packaging practices (e.g. trimming and multipacks) can increase food waste.
- Where LCA is applied, more studies should investigate systemic solutions such as short food supply chains, as well as package-free retail and reusable packaging.

Overall, these conclusions suggest the need for more comprehensive approaches to understanding the extent to which packaging supports a sustainable food system and circular economy objectives.

*[3]* Report covers: Belgium, the Netherlands, Scandinavia, Poland, Spain, Italy, France, UK, Germany and Russia.*

## PRE-PREPARED FOODS AND CONVENIENCE

Pre-prepared and convenience foods are also problematic. Products such as pre-cut fruit and vegetables, pre-packaged sandwiches, sushi and wraps are one of the fastest growing segments in the food industry, reflecting urban lifestyles which favour food on-the-go and reduced time for preparing meals [49]. Even seemingly fresh foods such as bagged salads are highly processed, e.g. chlorine may be added to keep cut lettuce fresh for longer. Some evidence suggests that this level of processing and packaging reduces the nutritional content of salads [50, 51]. In the UK, 37,000 tonnes (178 million bags) of prepared salad are thrown away each year [52]. A combination of short shelf-lives, high packaging to product ratios, and dependence on refrigeration make ready-to-eat foods vulnerable to waste and inefficiency [53]. In addition, food poisoning has been associated with some ready-to-eat packaged products [54, 55]. One study showed that bagged salads provide the ideal conditions for salmonella [56], demonstrating that processing and packaging may create as many hygiene problems as they solve.

## PROBLEMATIC PACKAGING DESIGN

Flexible packaging, multi-layered materials and small format items are waste-intensive [36], e.g. sachets and pouches used to package processed foods such as crisps, condiments and coffee. Hundreds of billions of sachets are sold each year across the globe [57]. Small format packaging represents 10% of the packaging market by weight but such items are very vulnerable to leakage into the environment and are disproportionately present as marine litter [24, 30]. A report for the plastics industry estimated these plastics to have zero recycling potential [58]. Current approaches to quantifying the sustainability of packaging design account poorly for the end-of-life of packaging or for circular economy objectives (see box above). There is a growing demand for increasingly complex smart-packaging solutions, such as moisture absorbers, oxygen scavengers, active date labels and anti-microbial coatings. These products invariably increase the number of materials used in packaging, further reducing recyclability [24, 59]. Finally, while bio-based and biodegradable plastics may represent sustainable packaging alternatives in certain circumstances (where they provide added value and the correct waste management infrastructure is in place), their impact on marine litter and plastic pollution is no less reduced.

## REUSABLE PACKAGING

Reusable packaging for processors and packagers is viable for SFSCs and is already widely used in Business to Business (B2B) distribution. At present, environmental impact assessments focus on the transport emission impacts of long supply chains, based on the weight of a produce, including its packaging. One German assessment of asparagus consumption demonstrated that produce air-freighted from Peru had almost 10 times the environmental impact of locally grown produce harvested in season [60]. In shorter supply chains, reusable packaging becomes preferable [61], with factors such as transport mode and rate of return becoming important [62]. Gaining an understanding of how to systemically implement reusable packaging solutions should be a top priority of the packaging and food industry.

## REUSABLE CRATES REDUCING EMISSIONS AND SPOILAGE

Reusable packaging for distribution between producers, suppliers and retailers can be effective in reducing both packaging and food waste [53]. Reusable crates have been shown to reduce spoilage of mangoes by improved ventilation and reduced bruising [21]. One French retailer has implemented 1.8 million reusable packaging crates for fruits and vegetables. Reverse logistics on crates are supported with radio frequency identification (RFID) technology, which tracks the crates and produce throughout the distribution chain. A product-service model is used, with the cases rented by the retailer, saving 150 tons of waste and 30% of emissions annually compared to previous practices [63].

# 6 WHOLESALE AND RETAIL SECTOR

**The retail sector's impact on food waste is not fully understood and is therefore potentially underestimated. Retail in Europe is dominated by a few large companies, with limited transparency on either food or packaging waste data. Packaging practices used by wholesalers and retailers often target economic efficiencies, marketing and brand objectives, rather than the prevention of food and packaging waste. Practices in the retail sector can drive waste throughout the supply chain.**

The retail sector has been estimated to generate about 5% of total annual food waste in the EU [2]. However, closer analysis reveals that retailers also influence waste indirectly both up and down the supply chain, primarily through a variety of marketing practices which encourage over-purchasing and lead to household waste [64, 65] but also by imposing arbitrary grading standards on produce (see Chapter 4). Most retailers do not disclose waste flow data for food or packaging waste, while those who do often use different methods of monitoring and reporting, making it difficult to determine the sector's actual impact [66, 67].

Retailers hold considerable power compared to other parts of the supply chain. In Europe, five retailers account for 50% of the market, with higher concentrations in individual countries. In each of Austria, Finland, Germany and Portugal, over 80% of the market is covered by four retailers [68-71]. The retail sector has the greatest interaction with, and impact on, consumers, making it central to reduction of food waste and plastic packaging waste downstream [67, 72, 73] since households are estimated to generate more waste than other parts of the food value chain [73-75].

Estimates of plastic packaging placed on the market by retailers in Member States with high packaging intensities (such as Germany, France and the UK) suggest supermarkets alone are responsible for around 900,000 tonnes of plastic packaging per country each year (see Annex). A lack of publicly available data or transparency requirements limits the incentives for major retailers to reduce packaging waste. For retailers, packaging serves as an important marketing tool [76] to create competitive advantage and increase sales. In self-service supermarkets, in particular, packaging plays a central role in product sales [77, 78] and marketing considerations [79]. While effective marketing can increase retail sales, it can also lead to over-purchasing by consumers, an important driver of food waste [1].

Multi-packs, for instance, use packaging to increase sales while also increasing the risk of food waste. Packaging which groups products restricts consumer choice and forces greater purchasing. The widespread practice of selling citrus fruits, onions and garlic in plastic mesh nets, and bananas and potatoes in plastic bags, for example, have been shown to cause consumers to buy more than they need [80]. A survey showed that 76% of Germans prefer package-free fruit and vegetables [67]. The packaging industry currently promotes smaller portion sizes with higher packaging ratios as a solution to over-purchasing. For many products, a less wasteful solution might be to serve loose products and allow customers to buy only the amounts they need.

## LASER MARKING ON FRUIT AND VEGETABLES, SPAIN

Spanish company, Laser Food, has developed food labelling technology. This 'laser marking' provides information such as origin and barcodes without the need for packaging or stickers, saving resources and reducing emissions (laser marking generates 1% of the carbon emissions of a typical sticker on an item of fruit). To date, the technology has been used on melons, oranges, and avocados, with the practice adopted by several large retailers across Europe, including Carrefour (France), ICA (Sweden), REWE (Germany) and M&S (UK) [81, 82].

Similarly, promotions used by retailers to increase product turnover (e.g. '3 for 2' campaigns) can lead to over-purchasing. As the general demographic trend in Europe is towards smaller households, this can amplify food waste [83]. A survey of over 4,200 consumers in the UK showed that 91% would prefer a single item at a reduced price rather than multi-buys [84]. In 2008, one Danish retailer phased out multi-buy offers, seeing an initial drop in sales transform into greater brand loyalty over time [72].

**For many products, zero packaging represents a viable and more sustainable packaging solution. Many fresh foods are naturally wrapped in their own skin and, under the right conditions, can be safely transported and consumed without single-use plastic packaging. The growing number of retailers focusing on reducing the unnecessary use of packaging demonstrates increasing consumer demand for less packaging. The growing number of food banks and redistributors of food are also indicative of the failures of food retailers and packaging companies to reduce waste.**

Traditional farmers' markets are common across Europe, many of which operate with low levels of packaging, selling fruit and vegetables loose, and meat and dairy products in paper. A key challenge for traditional independent retailers, including farmers' markets, is to encourage the use of reusable bags and containers, as many of them still continue to use single-use plastic bags and other packaging. 100 billion plastic bags are consumed in the EU each year [85], all of which can be replaced by reusable bags, representing an achievable objective for policymakers in the short-term.

## KOOPERATYWA DOBRZE – WARSAW, POLAND

Although large retailers in Warsaw are banned from using single-use plastic bags, small retailers and farmers' markets are exempt. Dobrze, a Warsaw food retailer, aims to achieve zero waste in its two stores and encourages its customers to reuse their own packaging. However, Dobrze faces a number of challenges: For some products, plastics are difficult to avoid as they are used by manufacturers, in distribution, or line other packaging materials (e.g. heavy duty paper bags). While Kooperatywa Dobrze do not apply grading standards, cosmetic standards continue to drive food waste, as 'customers have grown accustomed to fruit and vegetables looking a particular way and being larger in size'. The store is also committed to developing a thriving and inclusive food system in the region, working with 10 small-scale organic producers, and with 200 members guiding its decision-making.

As well as traditional markets, a growing number of European food retailers are renouncing packaging. Package-free, or 'zero waste' stores sell loose produce and promote the use of reusable containers. Many package-free stores also source local and organic produce, thereby supporting SFSCs and the (potentially) associated lower food wastage. Some achieve additional savings by processing and serving unsold food in snack bars or catering [86, 87].

While the pros and cons of package-free retail need further research, these stores can demonstrate how low-impact, small-scale farming and the circular economy may be mutually supportive and lessen the trade-off between packaging and food waste. Package-free retail solutions may result in more attractive prices for consumers by reducing marketing and packaging-related costs. The website bepakt.com provides an (non-exhaustive) index of package-free stores across Europe.

A growing number of initiatives sell and/or voluntarily distribute food that would otherwise go to waste (see a list of initiatives on the FUSIONS and FoodWin websites). The existence of these initiatives indicates the level of wastefulness in today's food retail sector and they have become an essential input to Europe's food banks and charities combatting food poverty [88]. Food distribution does not address the underlying causes of food waste or hunger and faces several practical challenges, such as supermarkets' reluctance to redistribute own-brand products because of concerns over brand reputation [40].

# 7 HOUSEHOLDS

**The use of plastic packaging does not necessarily help people to reduce household food waste. Diets and purchasing behaviour, as well as knowledge of correct preparation and preservation of food at home, can be more effective and less wasteful than simply adding single-use plastics to food. For most products, reusable packaging and traditional approaches to preserving food at home can deliver all of the functionality of single-use plastic packaging. Research on the health risks associated with food contact materials remains a grey area but permanent materials (such as glass and metal) present clear advantages for use with food.**

Households are the main contributors to food waste, accounting for 53% (47 million tonnes) of waste in the EU-28 per year [3]. Many of the drivers of waste at household level relate to practices further up the supply chain. Drivers include [89]:

- Poor storage/inappropriate use of packaging leading to spoilage.
- Poor packaging design leading to residues.
- Incorrect application of dates.
- Low price of food relative to income.
- Consumer behaviour – preference for variety.
- Dietary guidance (lack of food knowledge).
- Municipal waste collection infrastructure.

The abundance and low cost of food in Europe, reflected in relatively low levels of household expenditure on food [8], are closely linked to food waste at household level, arguably facilitating a culture of socially acceptable food waste [6]. However, cumulative waste represents a significant burden on households, approximately EUR 200 per capita per year [3]. Trends towards smaller household sizes and ageing populations also contribute to increasing food waste at home. Single households are estimated to waste 45% more food per person than the average larger household [53].

Methods to preserve the shelf-life of food can help to reduce food waste and may include the use of packaging [1]. However, much of the research on food packaging assumes that extending the shelf-life of products will inevitably reduce food waste (see Life Cycle Assessment analysis document). In practice, extending the shelf-life of food extends the window within which an item of food can be eaten, which, in the context of a household with a constantly over-stocked fridge, will not reduce waste [89]. Frequent reference is made to the fact that shrinkwrapping a cucumber can extend its shelf-life from 5 to 15 days compared to unpackaged vegetables [90, 91], but such evidence says nothing about consumer behaviour or, indeed, the implications for nutrition and taste. One study estimated that over one-quarter of avoidable food waste every year is thrown away in its packaging, either opened or unopened [92].

Food contact materials describe any material intended to come in contact with food in the value chain. There is growing evidence that many single-use food contact materials, including plastics, may pose health risks to consumers due to chemical migration. Plastics contain non-intentionally added substances (NIAS) and migration of harmful chemicals such as endocrine disruptors has been demonstrated in both plastic packaging and other materials, such as recycled card [93, 94]. At present, not enough is known about which chemicals migrate from which materials to food and beverages, their impacts on human health, and how policies might be used to address these [93]. The nature of the polymerisation (plastic production) process makes it difficult to ascertain the chemical composition of packaging, even by its producers. In general, packaging made from permanent materials (i.e. glass or stainless steel) provides superior food contact materials, as they are significantly less likely to result in chemical migration or to impair the flavour of the product [95]. Such materials are highly suited to being reused and recycled and can thus be readily integrated into SFSCs and the circular economy more widely [96].

Many European consumers are frustrated with current levels of food packaging. In a survey by UK consumer watchdog 'Which?', 94% of respondents agreed that manufacturers and supermarkets should act to reduce the amount of packaging used in their products, 54% said that they try to purchase products which are not over-packaged and 23% reported excess packaging as a reason to avoid buying a product [97]. Another survey by the Industry Council for Research on Packaging and the Environment showed that 79% of consumers agree that products are over-packaged [98]. In response to the growing levels of packaging on food and heightened awareness of its environmental impact, many people are taking steps towards zero waste lifestyles. Some pioneers in zero waste living have developed books and blogs to advise others on cutting down on waste at home, many of which pay close attention to food waste and packaging. Strategies to Reduce Food Waste (STREFOWA), an EU-funded project in Central Europe, provides tips and strategies on preserving and managing food in European cities [99]. Common tips cited on several zero waste food blogs include:

## PRESERVING FOOD AT HOME WITHOUT PLASTIC PACKAGING

- Use reusable bags, mason jars and containers when food shopping and storing food at home.
- Store bread in a cloth bag inside a wooden bread bin, as it absorbs moisture (unlike a plastic bag) and prevents bread from moulding quickly.
- Choose retailers which use minimal packaging and allow food to be bought in bulk.
- Store the stems of leafy vegetables and herbs (e.g. lettuce, celery, parsley, coriander) in water to keep them fresh.
- Understand which fruit and vegetables should be stored at room temperature (e.g. tomatoes and lemons).
- Understand which foods spoil more quickly when wrapped in plastic (e.g. mushrooms, soft cheeses).
- Store apples with potatoes but separate from other fruits: apples emit ethylene gas which speeds up the ripening process of fruits and vegetables but has the opposite effect on potatoes, preventing them from sprouting.

There is a risk of losing oral traditions and food knowledge when our food system becomes dependent on convenience food and single-use packaging, e.g. crop varieties and origin (country and ecosystem), food preparation and associated cultural heritage. Likewise, while there is a temptation to look to innovation to 'solve' sustainability issues, much of the knowledge needed to reduce waste already exists. A study of 60 families, half of which were given environmental food education, explored the impacts of packaging on food waste. The study found that the educated group wasted on average 5kg less of food each week and were more critical of the role of packaging, which was associated with 20% to 25% of food waste [100]. Cultural norms can also shape how we waste food. A common example is seen in restaurants, where Europeans typically do not ask to take home their unfinished food, unlike in the US. [101]. Portion sizes in restaurants vary across countries, which can also have an impact on food waste. In the US, for example, portion sizes are typically much larger than those in Europe.

# 8 FOOD SERVICES

**Many food services are wasteful in both food and plastic packaging, with fast-food and delivery services being particularly packaging intensive. However, many successful businesses are now integrating their services into local supply chains and using reusable materials, demonstrating that these challenges can be overcome and can even create competitive advantage.**

In Europe, food waste associated with the food services sector amounts to an estimated 12 million tonnes, accounting for 12% of all food waste and making it the third most wasteful food sector [3]. A lack of data on food waste among businesses, however, makes this estimate somewhat unreliable. Drivers of waste from food services include [102, 103]:

- Storage losses, as a result of damaged or out-of-date products.
- Preparation losses, due to fruit and vegetable peels, spoiled or dropped food.
- Serving losses, food that did not end up on the customer's plate because it remained in the kitchen or in the buffet.
- Plate waste, food that remained on the customer's plate.

Data from the UK and Sweden suggest that plate waste is the biggest source of food waste in the sector [102, 104]. A study of restaurant food waste in Italy showed that such waste could be reduced by using local and fresh food, stored and prepared on-site. In addition, limiting menus and plate sizes was found to reduce food waste. The study acknowledged the challenges faced by restaurants, such as the seasonal demands and the high-pressure working environment [105].

Small format packaging, such as condiment sachets and single-serve containers (e.g. for butter, milk and spreads), are common items in the food services sector. These items generate packaging waste because they cannot be recycled, and generate food waste as they are often left unfinished by customers or disposed of unopened by businesses [24, 58]. Heinz reportedly manufactures 11 billion single-serve ketchup sachets alone each year [106]. In order to reduce food and packaging waste, the US Environmental Protection Agency (EPA) advises the food services sector to serve condiments in dispensers rather than individual packets and to use refillable containers to serve milk and sugar [107]. Plastics are also disproportionately used in services such as the airline industry, healthcare and hospitality catering. One study estimated that airline in-flight waste amounted to approximately 500kg per flight (including paper, plastic, metal and food) [108].

## FAILED REGULATIONS ON BANNING REUSABLE BOTTLES FOR OLIVE OIL

In 2013, the European Commission withdrew controversial legislative proposals to ban restaurants from serving olive oil in reusable bottles. The initial proposal, designed to improve hygiene and prevent restaurants from refilling bottles with lower grade oil, was widely criticised and deemed to be excessively invasive from the European institutions. Many argued that the legislation, which would have obliged restaurants to use single-use and labelled bottles, would promote mass-produced oil and punish local and artisanal producers [109]. The ban was, however, kept by the Spanish government [110].

Takeaway and delivery services offer convenience but also have the potential to be highly wasteful. The on-the-go nature of takeaway food increases the risk of littering, with the majority of the items most commonly found in beach clean-ups being linked to food services. In 2016, more than 350,000 polystyrene takeaway containers and 400,000 straws were collected in beach clean-ups organised by just one NGO [30]. A key challenge for food services will be to transition to sustainable alternatives to single-use plastics without disrupting their businesses. Even where food services opt for recyclable materials, efforts to recycle that packaging are often lacking. One study of McDonalds restaurants in Finland showed that even though 93% of the packaging was recyclable, only 29% was being recycled in practice [111]. Meal kits are a growing segment in the food services sector, delivering ingredients to prepare specific recipes at home. The market for meal kits is already estimated to be worth EUR 2 billion. Ingredients are measured according to portion sizes but packaging intensity is very high, with one American article showing that each meal included at least 24 items of packaging [114].

## TIFFIN BOXES FOR TAKE-AWAY SERVICES

Tiffin boxes are reusable stainless steel lunch boxes widely used in food services across South Asia. In Brussels, one initiative has encouraged uptake of this form of reusable packaging through a number of partner restaurants and bike couriers. Customers are encouraged to wash the boxes in which their food was delivered and these are then picked up with their next delivery. Restaurants in Brussels produce 32,000 tonnes of waste per year, of which one-third is packaging waste [113].

Catering at events can be challenging for waste management, given the dynamic nature of food delivery and service, and the risk of leakage to the environment. Increasingly, large events such as festivals, carry out separate collection of waste streams. There are also opportunities to use biodegradable materials at catered events where waste infrastructure supports industrial composting (particularly if limited access to water or electricity prevents the use of reusables). The German Environment Agency encourages event caterers to take a range of steps, including procurement guidelines, in order to reduce food and packaging waste. Guidelines include [112]:

- Opt for fresh and raw ingredients over processed foods, so as to not lose flexibility
- Opt for reusable or simple packaging
- Avoid packaging boxes which prevent you from freely selecting the unit/amount of food you buy
- Accepting only packaging which is supportive of quality saving, and avoid unnecessary packaging (e.g. film wrapped cucumbers) in order to avoid waste and time wasted unpacking.

In response to consumer demand for food services which demonstrate genuine commitment to sustainability, a number of restaurants now market themselves as 'zero waste'. These restaurants can range from high-end eateries to 'pay as you feel' cafes, serving daily menus based purely on edible food rejected by other restaurants or retailers.

## POCO RESTAURANT - BRISTOL, UNITED KINGDOM

POCO is a Bristol-based tapas restaurant which has implemented sustainability practices to simultaneously reduce food and packaging waste. Restaurant staff complete a waste measurement record for each of their waste streams: general waste, mixed recyclables, compost, plate waste and glass. Targets for reducing waste are updated annually. Chefs comment on problematic or particularly wasteful dishes so that these can be remedied or altered in subsequent weeks. Since 2013, the restaurant has almost halved its levels of mixed and recyclable waste yet has maintained consistent turnover. The restaurant sources the majority of its food from local suppliers, who are discouraged from using plastic packaging. 90% of the produce comes from within a 50-mile radius, with the remaining 10% (such as citrus and chilli) being seasonal and never air-freighted. Produce such as bread, roasted coffee beans, lettuce and gin are supplied by Bristol-based producers. Menus are designed so that surplus purchases are not wasted. Food not purchased daily, such as cheese, is stored in reusable containers. Fruit and vegetables are visibly displayed to customers. Ugly vegetables have 'never been an issue, it's the flavour that counts'. Other packaging materials are upcycled, such as turning olive oil containers into plant pots. Customers are also free to take coffee grounds for their own compost [115].

# 9 MUNICIPALITIES

**Municipalities are key actors in both the procurement of food services and the management of food and packaging waste. Many cities are taking initiatives to reduce food and packaging waste, recognising their negative socioeconomic and environmental impacts. Innovative cities are exploring the regional development opportunities presented by SFSCs and urban agriculture.**

Public authorities are often responsible for the purchase and provision of food in municipally owned buildings, including local government premises and schools. Annual expenditure on catering services for the EU-28 is around EUR 200 billion [116]. Catering services are shared between self-operating public bodies and contract caterers, with around 43% of meals in health institutions and 31% in schools served by contractors [116]. Consequently, public authorities have opportunities to influence the types and quantities of food purchased, for example through (green) public procurement (GPP) measures which promote zero waste and SFSCs.

## PROMOTING LOCAL PRODUCE, SHORT FOOD SUPPLY CHAINS AND THE LOCAL ECONOMY

Started in 2012, the 'Ceinture Aliment-Terre Liégeoise' (CETL) is a Belgian initiative aiming to promote more local, less carbon-intensive food and to revitalise the local economy. It builds on the idea that SFSCs for food can be combined with promotion of the social economy, bringing local economic and environmental benefits. It aims to create credible alternatives to large-scale, long-distance food chains by favouring local and more environmentally friendly agriculture, livestock and food processing. It also aims to create local employment and a link between the city and surrounding countryside [117]. For example, local social enterprises could be contracted to produce meals for schools, businesses and local authorities, using local, seasonal produce [118].

The European Commission has published guidelines on GPP for food and catering services [119]. While these are currently under revision, they already include several criteria to address food and packaging waste, such as:

- Separate collection of waste produced by catering services.
- Training catering staff in waste minimisation, management and selective collection.
- Target percentage of products not supplied in individual portions (single-unit packages).
- Using reusable or renewably sourced tableware and tablecloths.

Several local public authorities in the EU include waste minimisation criteria in their procurement processes for the provision of catering services. Some examples are shown below:

## GREEN PUBLIC PROCUREMENT TO MINIMISE FOOD AND PACKAGING WASTE

In 2013, the City of Turin introduced criteria in school catering contracts to reduce waste. It supported reusable and refillable packaging, separate collection of waste and the redistribution of food waste for social projects. A shift to reusable plates was estimated to save 157 tonnes of plastic per year [120].

In 2013, **Barcelona**'s Municipal Education Institute (IMEB) issued public procurement guidelines for the city's 49 kindergartens, requiring bidders to train their staff on waste reduction and separate waste collection [121].

The **City of Hamburg** has developed 150 pages of green procurement criteria, including the preference for organic, local and seasonal food produce. Food packaging should contain over 45% recycled material or be produced from renewable raw materials, and food should not be supplied in individual portion packaging. Reusable cutlery, tableware, glasses and tablecloths must be used. The criteria also includes a 'negative list' of products that the administration may no longer purchase or use, including capsule-based coffee machines, mineral water in non-returnable bottles and disposable dishes [122].

At the other end of the supply chain, municipalities can also support redistribution of edible food waste and separate collection of organic waste from businesses, households and public institutions.

Food redistribution schemes provide a method for using edible leftover food, with collected food donated to charities, social enterprises and/or food banks. Food redistribution offers an opportunity to keep food waste management at a higher level in the waste hierarchy, ensuring that potential food waste is avoided rather than collected for composting or anaerobic digestion. Although many of these types of project are managed by NGOs or businesses, some examples can be found within municipalities.

## PUBLIC AUTHORITIES AND FOOD REDISTRIBUTION

In Italy, the city of **Turin** (Comune di Torino) and Amiat (a multi-service environmental health company) implemented the Buon Samaritano ('Good Samaritan') project. Uneaten bread and fruit from school canteens and still-edible produce from supermarkets are collected and donated to local charities. In the 2012-2013 school year 11,573 kg of bread and 9,065 kg of fruit were recovered [123]. Up to 150 kg of bread and 50 kg of fruit are recovered each day, enough to prepare around 1,000 meals [124].

At present, most food and packaging waste is accounted for in municipal solid waste collection. Waste disposal to incineration or landfill represent the least preferred options in the waste hierarchy for any form of waste and, as such, are last resorts. However municipalities which support prevention, separate collection, home composting, anaerobic digestion, and recycling programmes can reduce the environmental impacts of waste compared to incineration or landfilling of mixed waste. Waste management practices vary significantly between and within Member States. In 2014, plastic packaging recycling rates in the EU Member States averaged 39.5%, but varied from 25% in France to almost 70% in Slovenia [125]. Meanwhile, the most successful urban food waste collection and recovery schemes can capture 85% or more of the organic waste produced. A city-wide household organic waste collection scheme in Milan has been estimated to save around EUR 30 per tonne of waste in treatment costs [126].

# 10 CONCLUSIONS AND RECOMMENDATIONS

**High levels of food and packaging waste signify inefficiencies in Europe's food system and major failures of the economy. Rapid growth in single-use plastic packaging has not demonstrably reduced food waste in Europe, and most plastic packaging remains difficult to recycle or reuse, presenting a barrier to circular economy objectives. The management of food and packaging waste should not be viewed as a trade-off but, rather, policymakers should look for and implement solutions as part of a holistic approach to the food system.**

Evidence indicates that food surplus in Europe currently goes beyond that which is necessary for food security. An abundance of food makes some level of waste inevitable, while the relatively low cost of food for many consumers has contributed to making waste socially acceptable.

Food and plastic packaging waste in Europe have grown alongside one another, with plastic now the predominant packaging material used for food products. Developing countries, where plastic packaging is less prevalent, have lower rates of household food waste. These data suggest that the use of plastic packaging as a solution to food waste may, in practice, be less true than some existing research claims.

Much of the evidence used to promote the use of single-use plastic packaging for food is based on LCA studies which tend to simplify the drivers of food waste. Studies which assess the environmental impacts of food packaging should aim to integrate knowledge on food waste drivers to better understand the extent to which packaging can reduce waste of the product, as many food waste drivers (e.g. over-purchasing and preparation techniques) are not linked to packaging, and some packaging practices (e.g. trimming and multipacks) can increase food waste. Furthermore, where LCA is applied it should more readily identify key packaging risks, such as marine litter and chemical migrations, but also the potential opportunities that exist in reusable packaging, short food supply chains, and package-free solutions.

Packaging practices in retail can drive food waste up the supply chain by defining grading standards for producers, particularly within unfair trading relationships. Other practices, such as multipacks and fixed portion sizes, can lead to over-purchasing and household waste. Over-packaging or packaging which is problematic for recycling (such as small format or multi-material packaging) is ill-suited to the transition to a circular economy.

The emergence of food waste entities, which use edible portions of food waste as part of their business models or to redistribute food to those in need, are welcome efforts to mediate waste. These initiatives are, however, emblematic of the levels of food waste in Europe today, and such efforts must be coupled with actions to address the drivers of waste and ensure equal access to food.

Across Europe, in all parts of the food supply chain, successful initiatives demonstrate that single-use plastic packaging is not necessary to bring quality food from farmers to consumers. Examples include community-supported agriculture, zero waste retailers, traditional farmers' markets, and zero waste restaurants and households. Municipalities and cities can act to leverage action on plastic packaging and food waste, both as procurers of food and via waste management practices.

Common features within initiatives which successfully reduce food and packaging waste include the use of SFSCs, zero or reusable packaging, and awareness of the role of food within the wider economy, e.g. implementing agroecological methods or supporting local businesses. In general, shortening supply chains has the potential to reduce food loss and waste in the supply chain, as well as making reverse logistics for reusable packaging economically and ecologically viable.

Although technology and innovation can play a role in reducing the application of packaging (e.g. using RFID in reverse logistics or laser marking), many actions are based on simply returning to existing traditional food knowledge and facilitating a social and economic shift away from convenience-driven lifestyles by providing better access to fresh, healthy and nutritious food. A holistic approach is needed, one which also takes account of more sustainable diets, rising hunger and obesity, and developing a food system with packaging that truly works in a circular economy. Growing public demand for a reduction in plastic packaging and food waste present opportunities for businesses and policy makers.

## POLICY RECOMMENDATIONS

The dual challenge of reducing food waste and plastic packaging waste, as well as their impacts on the environment, society and the economy, require urgent attention. Both are elements in the EU's Circular Economy Package and there is potential for their integration into the recently-published EU Strategy on Plastics in a Circular Economy and the forthcoming 2018 food package initiative, which is expected to include a legislative proposal on the EU food supply chain.

Joined-up thinking is needed in the development of these two legislative initiatives and associated follow-up actions, including the need to identify and realise the multiple benefits of simultaneously addressing food and plastic waste.

### THERE IS A NEED FOR A BETTER EVIDENCE-DRIVEN AND HOLISTIC AGENDA ON FOOD WASTE AND PLASTIC PACKAGING

- **Identify the underlying drivers of waste and opportunities for systemic change,** e.g. via the European Platform of Food losses and Food waste, rather than looking for quick fixes or resource-intensive technological solutions.
- **Further research on the interactions between food waste and plastic packaging waste** to develop solutions fit for the circular economy and waste prevention. The management of food and packaging waste should not be viewed as a trade-off.
- Support research (through funding, networking, knowledge exchange, etc.) to **identify the types of food packaging which give rise to the most waste** across the EU and those which are most frequently found outside the formal waste management system (e.g. on beaches).
- **Develop more comprehensive methods for assessing packaging options beyond existing LCA** studies (e.g. by a neutral body such as the Joint Research Centre) to compare single-use packaging with alternative circular economy routes from production to end-of-life.
- **Research the health impacts of chemical migration** from packaging to food and the removal of toxins from plastics to protect human health.
- **Promote improved transparency on food and packaging waste data** throughout the supply chain, particularly at retail level.

## REVIEW LEGISLATION TO ADDRESS THE GAPS IN TACKLING THE DUAL CHALLENGE OF FOOD AND PLASTIC WASTE

- **Reduce the use of single-use plastic packaging** via reduction targets. Support and promote alternatives for on-the-go food services as well as retailers.
- Identify policy measures to **support the implementation of reusable packaging** throughout the food supply chain and develop suitable legislation.
- Develop policies which **incentivise eco-design measures** that support the implementation of the waste hierarchy for packaging.
- **Regulate packaging practices** that drive food waste in the supply chain. This includes **the use of multipacks, unduly strict grading activities, and misleading packaging.**
- Create an EU-wide **right for customers to return any plastic packaging to the point of sale,** e.g. through a revision of the Packaging and Packaging Waste Directive (PPWD), or promote EPR as a criteria for reduced fees for producers.
- Encourage Member States to identify or establish a competent authority with whom **complaints about over-packaging can be registered.**
- Minimise public confusion on issues such as **date labelling, bio-based and biodegradable plastics.**

## USE MARKET-BASED INSTRUMENTS TO PROMPT BEHAVIOURAL CHANGE TOWARDS AVOIDING FOOD WASTE AND PLASTIC PACKAGING WASTE AND KEEPING RESOURCES IN THE ECONOMY

- **Revise EU GPP guidelines for food services,** including in public institutions such as schools and hospitals, to better account for the interactions between food and packaging waste. Use the guidelines to promote using procurement to promote a shift from over-packaging towards reducing packaging in favour of reusable or recyclable alternatives. Promote Member State actions to encourage private sector purchasing patterns that favour zero or reusable packaging, and reduce the social acceptability of waste.
- Under the PPWD, include a **requirement for packaging EPR schemes** with modulated fees, as well as deposit return schemes. Harmonise schemes across Europe to drive packaging design that promotes reduced resource use, reuse, repair and recycling and penalises single-use packaging, especially where alternatives exist.
- Assess the potential to **implement wider economic instruments, including the establishment of progressive taxation on virgin plastic,** to improve the economics of sustainable packaging and reduce the incentive to place plastics on the market.

## PROVIDE GREATER INVESTMENT AND FUNDING TO SUPPORT INFRASTRUCTURE FOR ZERO PACKAGING SYSTEMS AND REUSABLE PACKAGING, AND TO BETTER INTEGRATE SHORT SUPPLY CHAINS BETWEEN RURAL AND URBAN AREAS

- Promote **fiscal incentives to support the transition to zero waste solutions.** A particular focus should be placed on retailers, given their power within the food supply chain, as well as highly wasteful sectors such as airlines, event catering, and food delivery services. Initiatives to establish zero waste or package-free retail should be supported.
- Funding opportunities (including those for agriculture, regional development and SMEs) to **support the implementation of SFSCs and the development of infrastructure that facilitates the return of reusable packaging** (reverse logistics) recognising their benefits in reducing waste and supporting local economic development.
- Invest EU funds to **better integrate food supply chains between rural and urban areas,** including food services, waste management and soft mobility, recognising the opportunities that exist for reducing waste and emissions.
- Support **investments to develop a waste infrastructure** in all Member States that enables separate collection of different waste streams, including plastic packaging and organic waste. However, caution should be taken not to incentivise waste generation or lock-in to technologies lower down the waste hierarchy, such as developing an over-capacity of incineration ahead of packaging waste prevention.

## THE WAY FORWARD

Europe has an opportunity to reposition our approach to the production, delivery and consumption of food and food packaging. While plastics have some role to play, real reform must be broader in scope. This report shows the need to better examine the limits of plastic packaging in reducing food waste overall, and identifies real innovation among those who eschew all forms of waste. Policymakers must now turn successful initiatives into everyday practice. Europe's high rates of per capita waste should not be viewed as an inevitable by-product of economic development and convenient lifestyles: today's environmental realities oblige us to approach food, plastic and all resources in a way that ensures a good life for all within planetary boundaries. Similarly, Europe wants a food system that values agricultural produce and supports its producers, thus supply chains should be used to foster regional development and allow the food system to reduce, reuse and recycle materials, including packaging.

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