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# Preventing single-use plastic waste: implications of different policy approaches– Environment Working Paper No. 182

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# Abstract

Single-use plastics constitute approximately half of global plastic waste generation. Their use in consumer goods and packaging has been the focus of recent waste prevention policy due to the importance of the volumes of waste generated and the frequency with which these materials are littered. To address several externalities that emerge across the life-cycle of single-use plastics, multiple policies can be combined to constitute an effective policy mix. Specific policy instruments include market-based and regulatory instruments and voluntary approaches. An extensive literature review of case studies where these policy instruments have previously been implemented is the basis for policy recommendations and comparison of the selected instruments in terms of their behavioural, environmental, and economic implications.

In several markets, market-based policy instruments and policy bans have helped to curb waste generation and littering of single-use plastics. However, the effectiveness of these interventions depends to an important extent on whether environmentally preferable substitute materials or products are available, as well as on whether the measures are effectively enforced. Effective policy intervention requires a policy mix that covers single-use plastics, as well as their substitutes, and that includes an emphasis on monitoring and enforcement, in order to help minimise burden-shifting of environmental impacts.

**Keywords:**

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# Résumé

Les plastiques à usage unique constituent environ la moitié de la production mondiale de déchets plastiques. Leur utilisation dans les biens de consommation et les emballages a fait l'objet d'une politique récente de prévention des déchets en raison de l'importance des volumes de déchets générés et de la fréquence à laquelle ces matériaux sont jetés. Pour traiter plusieurs externalités qui émergent tout au long du cycle de vie des plastiques à usage unique, plusieurs politiques peuvent être combinées pour constituer un ensemble de politiques efficace. Les instruments politiques spécifiques comprennent les instruments réglementaires et ceux fondés sur le marché ainsi que les approches volontaires. Une analyse de la littérature approfondie des études de cas où ces instruments politiques ont déjà été mis en œuvre constitue la base des recommandations politiques et de la comparaison des instruments sélectionnés en termes d'implications comportementales, environnementales et économiques.

Sur plusieurs marchés, les instruments économiques et les interdictions de mise sur le marché ont contribué à réduire les déchets plastiques à usage unique. Cependant, l'efficacité de ces interventions dépend dans une large mesure de la disponibilité de substituts écologiquement préférables, ainsi que de l'application effective des mesures. Une intervention politique efficace nécessite une combinaison de politiques qui couvre les plastiques à usage unique, ainsi que leurs substituts, et qui met l'accent sur la surveillance et l'application, afin de minimiser le transfert de charge des impacts environnementaux.

**Mots clé:**

Pollution plastique, économie circulaire, gestion des déchets, responsabilité élargie des producteurs, gestion responsable des produits, utilisation efficace des ressources, consommation durable.

**Classification JEL:**

H23, L15, Q53, Q58

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# Executive Summary

Single-use plastics are typically used only once before being disposed of as waste. Single-use plastic applications include consumer goods (e.g. carrier bags, toiletry items), packaging items (e.g. food containers), as well as inputs in the medical (e.g. blood bags, syringes) and agricultural (e.g. grain bags) sectors. In 2015, plastic packaging constituted 141 million tonnes of waste, corresponding to 46.7% of global plastic waste generation. This paper focuses on single-use plastic consumer goods and packaging, which have been the focus of recent waste prevention policy initiatives both for their importance in terms of volumes of waste generated, and because this type of waste is frequently littered.

Globally, plastics were responsible for roughly 1.7 Gt [CO2e] of greenhouse gas emissions in 2015. However, the environmental impact of plastic waste depends on whether it undergoes formal waste management (e.g. through reuse, recycling, incineration or landfilling) as opposed to being illegally incinerated, littered or dumped, potentially resulting in air, soil and water pollution.

In recent years, increasing public awareness of the issue of plastics pollution has led to the implementation of numerous waste prevention policies across the world. According to UN Environment, as of July 2018, 127 countries worldwide had adopted national legislation concerning plastic bags and 56 countries had banned or taxed other single-use plastic goods (e.g. cutlery, bottles, food packaging) or specific polymers.

The complexity of the plastics value chain calls for the application of multiple policy instruments to address all the environmental externalities emerging across the life-cycle: market-based instruments, regulatory instruments and voluntary approaches. This report discusses the environmental, economic and behavioural implications of different policy approaches to prevent the generation of single-use plastic waste, building upon evidence about the impacts of such policies where possible. Given most policies so far have addressed frequently-littered single-use plastic goods, with particular attention to packaging, this is the core focus of this report and of its policy recommendations.

### *Market-based policies and bans on single-use plastics can help curb waste generation and littering*

The implementation of taxes or mandatory charges has generally led to an important decrease in the sales of single-use plastic bags, particularly where the price signal has been set to exceed average consumer willingness-to-pay for plastic bags. For example, the Irish tax on single-use plastic carrier bags reduced their use by 90%.

Similarly, bans on single-use plastic bags have reduced littering of these goods. For example, after a state-wide ban on single-use plastic bags in California, plastic bag litter recovered during yearly clean-up operations was reported to have dropped by 76%.

It is not always possible to compare estimates across jurisdictions, partly due to data and methodological differences. As such, additional research can help to confirm the applicability of the findings of impacts from the studies on early adopters of market-based policies and bans.

*However, their effectiveness depends on a number of contextual features*

The effectiveness of policies aimed at preventing the generation of single-use plastic waste depends on multiple features of the context within which they are implemented: consumer preferences, the availability and environmental footprint of alternatives to plastics, competitiveness and employment effects, as well as the capacity of authorities to effectively enforce these policies. The response to a policy depends on the elasticity of demand for the targeted good or material, on the frequency of purchases and on the availability of alternatives.

For example, in Belgium a tax on single-use plastic foil and cutlery introduced in 2007 had limited impacts on consumption and was eventually discontinued. This may have been due to an inelastic demand, infrequency of purchase, or limited availability of alternatives.

To ensure they affect consumption choices, price signals should be set based on a combination of factors: the environmental externality cost of single-use plastics products, consumers' willingness to pay for the product, and the sensitivity of their demand to price changes.

Policies can be introduced at several stages of the plastics life-cycle, with different implications for administrative costs, specificity of the policies to single-use plastics, and public reaction. Upstream policies target intermediate inputs or refined materials, final product policies apply to consumers, and waste policies target end-of-life waste generation. Upstream policies affect fewer actors, can especially influence design choices, and have relatively low administrative costs. However, these policies do not isolate single-use plastic inputs from those for durable plastic products, as can be done with final product policies. As well, the impacts of upstream policies on a relatively concentrated group of actors increases the likelihood of their resistance to these measures.

*Bans are less flexible than market-based policies, but effective at targeting leakage by specific products*

Based on economic theory, taxes and charges may be best suited to maximise economic efficiency because they enable a flexible behavioural response both from consumers and producers and provide greater innovation incentives. However, if the policy objective is to target specific single-use plastic goods because of their leakage into the environment through littering, bans may be more appropriate to ensure their complete removal from the market and substitution with reusable products or alternative materials. This is the approach taken by the EU with its ban on frequently-littered plastic goods that can be easily manufactured with other materials (e.g. single-use cutlery, straws). If the objective is to limit the use of specific polymers in order to achieve better recyclability of a waste stream, material content regulations or upstream taxes (at the level of producers) may be preferable. For example, multiple local jurisdictions in the United States have a ban on polystyrene food containers. The EU has banned the use of expanded polystyrene in certain products (e.g. food and beverage containers) and oxo-degradable plastics in all products.

*There are also numerous voluntary initiatives, but their effectiveness to reduce plastics use remains to be determined*

Among the wave of initiatives on single-use plastics implemented in recent years, there has been a significant increase in voluntary approaches led by governments, NGOs and private businesses. Initiatives such as the New Plastics Economy Global Commitment led by the Ellen MacArthur Foundation have helped raise the profile of the issue of plastics pollution, resulting in numerous businesses pledging to achieve voluntary waste prevention objectives. For example, retailers and producers of packaged goods adhering to the Global Commitment aim to increase average recycled content in plastics packaging from 2.5% to 25% by 2025.

However, due to cost considerations and the problem of free-riding (i.e. when an actor benefits from the efforts of another actor without contributing), voluntary commitments may not be sufficiently ambitious. More research and information is needed to evaluate the effectiveness of the voluntary initiatives that are ongoing, and it also remains to be seen if the level of ambition might be taken at a level that is sufficient to achieve real results. If costs and free-riding do become problematic in such cases, voluntary approaches may not be able to be used as substitutes but rather could be complementary to regulatory intervention.

*Plastics waste prevention policies should be designed as a comprehensive policy package to minimise environmental burden-shifting*

Waste prevention policies should be designed to avoid environmental burden shifting between single-use plastics and other disposable options such as paper or bio-plastics. Manufacturing single-use goods with alternative materials may not change their disposable nature and, with it, the associated littering practices and risk of leakage into the environment. Alternative materials may also have an overall larger environmental footprint. Thus, waste prevention policies should be designed as a policy package that targets all disposable goods which are frequently littered or otherwise illegally disposed of, rather than solely single-use plastics. This would incentivise the reuse of single-use plastic goods whenever possible (e.g. carrier bags), and promote a shift towards goods that are designed to be reusable whenever these warrant a lower environmental footprint. For example, following the implementation of a charge on all single-use carrier bags (made of plastics, bio-plastics and paper) in Wales, consumption of the bags dropped by 71% in three years. In their place, own bags and reusable, returnable 'bags for life' usage increased. A 2015-2016 survey identified some confusion by respondents about the recyclability, return-ability, and durability of 'bags for life' in Wales.

*Administrative complexity and imperfect enforcement may jeopardise policy impact of both market based and regulatory policies to reduce single-use plastics*

Policy effectiveness relies on all stakeholders complying with regulatory standards and bans, and on price signals to be effectively implemented and tax or charge revenues collected. Sparse enforcement may jeopardise policy impact. Competitiveness and employment concerns may act as political barriers to policy action in jurisdictions with strong dependence on plastics manufacturing, chemical, upstream oil and gas, and ancillary industries.

Both market-based and regulatory policies may have "indirect" unintended consequences such as time and administrative burdens for consumers, producers, retailers as well as regulators: as behavioural responses are affected by these burdens, policies should be designed in order to minimise them. For example, the more exceptions are carved into a policy (e.g. in terms of materials, products and retailer categories to which a policy applies), the more administratively complex it might be to enforce it.

*Stepping up monitoring and evaluation efforts is also fundamental to assess the impacts of policy initiatives targeting single-use plastic goods beyond carrier bags*

Evidence on the impacts of policies aimed at preventing single-use plastic waste is encouraging. However, policy has overwhelmingly focused on single-use plastic carrier bags, and initiatives addressing other goods are only gradually coming into force: as such, the evidence on the impact of waste prevention measures on other goods is limited. Because behavioural and production responses to policies in different product value chains are likely to vary, it is not possible to generalise results available so far. As new policies addressing broader sets of single-use plastic goods come into force, it is important to monitor their results to inform the policy-making process and to allow policy design corrections to be made where necessary. For example, in recent voluntary initiatives such as the Plastics Pacts, signatories are required to regularly provide both quantitative data and qualitative information on their innovation efforts to replace single-use plastics. Indicators to track the outcomes of waste prevention efforts could include the number or weight of single-use plastic products sold, as well as that of product alternatives, be they reusable or disposable, and the volume or weight of the relative waste streams.

# 1. Introduction

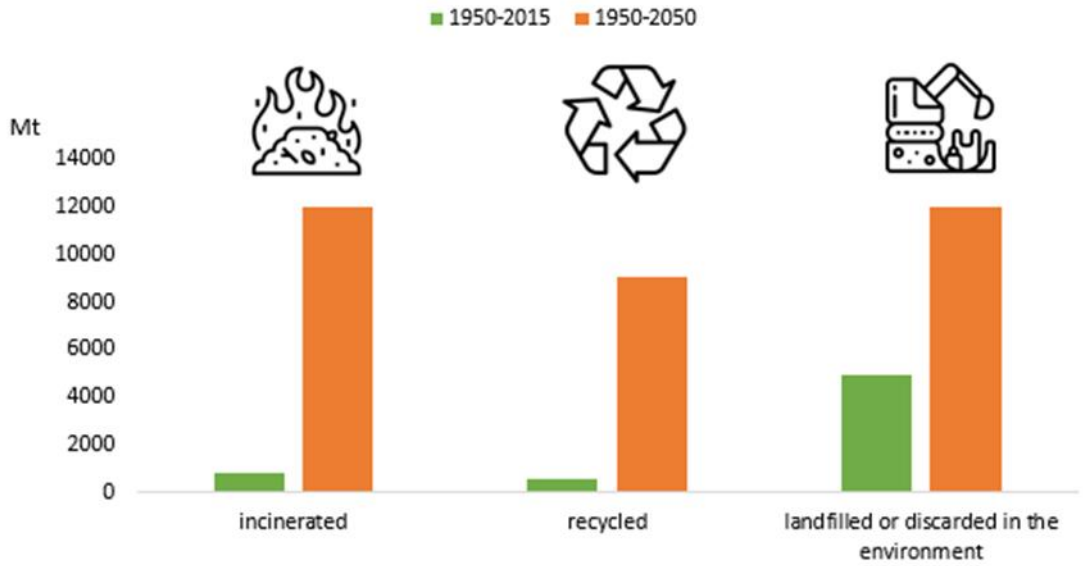
Plastics have many beneficial characteristics related to their lightness, resistance, durability and cost, among other desirable qualities. They enable increased fuel efficiency in aviation and road transport, can help prevent food waste in the agriculture and retail sector, and provide hygienic tools in the medical sector. However, while some of their applications have a long lifespan, others quickly transition to the end-of-life phase.

Single-use plastic goods are typically used only once before being disposed of (UN Environment, 2018[1]). These include consumer goods (e.g. carrier bags, toiletry items), packaging items (e.g. food containers), as well as applications in the agricultural (e.g. grain bags and bale wrap, or "single-season" plastic film for mulching) and in the medical sector (e.g. blood bags, intravenous tubing, syringes).

This paper focuses on single-use plastic consumer goods and packaging, which have been the focus of recent waste prevention policy initiatives both for their importance in terms of volumes of waste generated, and because this type of waste is frequently littered. In fact, packaging makes up for a considerable share of single-use plastics goods and plastics production overall: in 2015, plastic packaging constituted 141 million tonnes of waste, corresponding to 46.7% of global plastic waste generation (OECD, 2018[2]). Arguably, single-use plastic items used in the agricultural and medical sector respond to different needs, undergo different waste collection procedures and thus are less often littered in the environment: incentivising the prevention of plastics waste from these sectors would require different, appropriate policy initiatives.

If recent trends continue, cumulative plastics production is estimated to reach 26 billion tonnes in the next 30 years: this would bring cumulative plastic waste incinerated to 12 billion tonnes, cumulative recycled waste to 9 billion tonnes and cumulative waste landfilled or leaked in the environment at 12 billion tonnes (Geyer, Jambeck and Law, 2017[3]), as illustrated in Figure 1.

**Figure 1. Cumulative plastic waste generation in indicated period, by fate (million tons)**




Source: Data from (Geyer, Jambeck and Law, 2017[3]). Icons made by monkik (left and middle) and Smashicons (right) from www.flaticon.com.

The environmental impact of single-use plastic goods is multi-fold, ranging from the emissions due to their production from petrochemical derivatives, to waste generation. Additionally, the impact of single-use plastic waste differs according to whether plastics are gathered and treated through formal waste management (e.g. through recycling, incineration or landfilling) as opposed to being littered on land or in the ocean, intentionally or unintentionally, dumped or illegally incinerated.[1]

Global plastics were responsible for about 1.7 Gt [CO2e] of greenhouse gas emissions (GHG) in 2015 (Zheng and Suh, 2019[4]).[2] Further, whenever plastic waste is not properly collected and disposed of, it can leak and accumulate into the environment: 32% of global plastics waste is currently estimated to follow this fate (World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company, 2016[5]). Recent evidence indicates that inert plastics exposed to ambient solar radiation can emit GHG emissions (Royer et al., 2018[6]).

Improperly disposed waste can have severe environmental impacts: uncontrolled incineration can generate toxic air pollution emissions; dumping can pollute both soil and ground water, and foster the spread of infectious diseases (UNEP / ISWA, 2015[7]). Further, leaked plastics may degrade in smaller fragments, i.e. microplastics. As terrestrial and marine wildlife ingest microplastics, such fragments may travel upstream of the food chain and possibly impact human health. While there is evidence that microplastics are present in several categories of food and drink, their impact on human health is not yet well understood (GESAMP, 2015[8]) (GESAMP, 2016[9]).[3] For these reasons, plastic waste is best addressed at source, aiming to prevent leakage and its potential impact on ecosystems as well as human and animal health.

The above-mentioned environmental externalities due both to plastics production (e.g. greenhouse gas emissions) and end-of-life (e.g. leakage) have an estimated global cost of USD 40 billion (World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company, 2016[5]). Further, the short life cycle of single-use plastics entails substantial economic losses, as valuable materials are sent to waste after a single-use rather than being recovered and reused: it is estimated that 95% of the economic value of plastic packaging is lost every year in Europe, generating losses for EUR 105 billion (Veolia Institute, 2019[10]).

The environmental externalities due to single-use plastics production, consumption and waste generation should be addressed with a policy package building upon several complementary approaches:

Preventing single-use plastics waste generation, for example by encouraging the uptake of reusable products where these have a lower environmental impact over their lifetime or reducing the default provision of plastics (e.g. plastic cutlery or straws in the restaurant industry);

Substituting plastics with alternative materials characterised by lower aggregate environmental impacts;

Improving the design of plastics to make the material itself as well as plastic goods more consistent with sustainable development objectives, e.g. through research and development (R&D) facilitating recyclability or dematerialisation, as well as the integration between new material features and existing waste management systems;

[1] Informal waste management is also prevalent in many countries, but its' role usually relatively small in OECD countries (OECD, 2016[119]). The impacts and benefits of the informal sector is context dependent. In some countries, it helps recycling efforts for high-value materials, while in others it has raised concerns of illegal dumping and undermining the effectiveness of formal waste management (OECD, 2019[117]).

[2] The 2015 "global life-cycle" estimate includes emissions from resin production, conversion, and EoL processes (Zheng and Suh, 2019[4]).

[3] An ongoing OECD project focuses on the sources, pathways, sinks and impacts of microplastics waste. The aim of this project is to provide recommendations to prevent and mitigate microplastics leakage into the marine and freshwater environment.

Minimising material leakage into the environment through better plastic waste collection and treatment (including recycling) and through awareness-raising and educational programmes on littering prevention;

Reverting to clean-up and remediation as a final option, in case it has not been possible to prevent plastics leaks into the environment.

Additionally, such a policy package should be paired with long-term plans for infrastructure development and maintenance, bearing in mind macroeconomic and demographic trends, evolving lifestyles and their impact on waste generation. The prioritization of the above approaches will differ according to the baseline situation of a given country. For example, where basic waste collection and management infrastructure is lacking, its development would be a priority concern to ensure the environmentally sound disposal of all waste streams, thus preventing the environmental and public health impacts associated with uncontrolled incineration and dumping.

This report focuses on policy approaches to prevent waste generation from frequently-littered single-use plastic goods and packaging, which have been the focus of public policy initiatives. These include regulatory policies such as bans, market-based policies such as taxes, voluntary measures taken by specific private sector actors and other policy approaches such as information campaigns and behavioural interventions.

As public attention to the environmental consequences of plastic waste has increased,[4] many countries across the world have recently implemented or are planning a range of policies aimed at preventing single-use plastic waste.

The policy approaches to pursue this effort have varied widely across the world. A recent global overview of all laws and regulations addressing single-use plastic waste (UN Environment, 2018[11]) indicates that plastic bags have been at the centre of policy efforts. This may be due to their salience in the waste stream, both in formal waste treatment and in littering.

For example, in the United States, plastic bags, wraps and sacks constituted 4140 thousand tons of waste in 2017: this amounted to over 28% of total plastic packaging waste (which includes also bottles, jars and other containers) and over 11% of total plastic waste (US EPA, 2019[12]). As indicated by data gathered from clean-up efforts worldwide, plastic bags are also among the most frequently littered items, together with cigarette butts, food wraps, plastic bottles and caps, straws and stirrers, and plastic or foam take-away containers (Ocean Conservancy and International Coastal Cleanup, 2018[13]).

According to a recent UN Environment study, as of July 2018, 127 countries worldwide have adopted national legislation concerning plastic bags: the regulatory approach abounds, with bans in 91 countries, whereas only 27 countries impose taxes on their import or production and 30 countries impose levies or fees on their consumption (UN Environment, 2018[11]).[5] Conversely, only 27 and 29 countries have respectively banned or taxed other single-use plastic goods (e.g. cutlery, bottles, food packaging) or specific materials (e.g. polystyrene). Microbeads, an intermediate good with critical implications for marine pollution, have been explicitly addressed only in eight countries.

In the European Union, national action has been paired with regional efforts spearheaded by the European Commission, which released its European Strategy for Plastics in a Circular Economy in 2018. The Strategy, further discussed in Box 2, reiterates the role of waste prevention policies as priority in the waste hierarchy (European Commission, 2018[14]). As such, waste prevention efforts across EU countries have been numerous and varied: in a recent report, the European Environment Agency indicates that

[4] In discussing reasons for this sudden surge in public interest, the Guardian newspaper has pointed to the impact that the documentary Blue Planet II, which in December 2017 made salient the impact of plastic pollution on marine wildlife (Buranyi, 2018[116]).

[5] The study covers 192 countries and is up to date until July 2018 (UN Environment, 2018[11]).

information provision has been the preferred approach, affecting 69 of 173 surveyed waste prevention initiatives, followed by 36 market-based instruments, 30 voluntary agreements, 25 regulatory instruments, and 3 financing measures (EEA, 2019[15]). Most initiatives have aimed to reduce the amount of waste generated (*quantitative* waste prevention), whereas only five initiatives aimed to reduce the amount of hazardous substances contained in plastics (*qualitative* waste prevention).

The wave of policies implemented with the aim of curbing consumption of single-use plastics raises several questions. While these policies have a common objective, their behavioural, environmental and economic implications are different. Consequently, because these policies differently affect consumers, producers and regulators, their aggregate impact and effectiveness is likely to vary.

Most policy initiatives implemented thus far have targeted specific single-use plastic goods, such as carrier bags and on-the-go consumption items such as cups and straws. However, single-use plastics also include other categories of goods such as other forms of packaging, medical plastics, as well as product components such as microbeads. For this reason, this report also discusses to what extent policy measures currently in place could be expanded to target other goods where needed.

This report has multiple objectives:

- First, it aims to discuss the features of the most common policy approaches adopted thus far to prevent single-use plastics waste generation, and their expected behavioural, environmental and economic implications building upon what we know from the theory of environmental policy and upon evidence across jurisdictions with heterogeneous policies in place.
- Second, it aims to present examples of each policy approach, indicating how they are implemented. The objective is to summarise the lessons we can draw from available evidence on their impact. Box 1 provides some considerations on the methodologies adopted in the studies reviewed.
- Third, it aims to conclude by providing recommendations for designing policies aimed at curbing single-use plastics waste, according to each good's characteristics and environmental impact, to the specific polymers involved and to behavioural mechanisms that need to be addressed and the needs and conditions of the applying economy.

### Box 1. Evidence and methodology

While policy actions focusing on single-use plastics are relatively recent across OECD countries, an increasing number of academic papers and policy reports analyse their environmental and economic implications, with most of the evidence coming from policies focusing on plastic bags. These studies span from assessment of national policies to analyses of local-level interventions, reflecting the heterogeneity in the administrative setup of waste prevention efforts across OECD countries.

Most research efforts have focused on policies targeting single-use plastic carrier bags. With the aim of quantifying the environmental impact of such policies, a number of academic and policy studies have analysed variation in the amount of carrier bags sold in the retail sector, both in aggregate terms and across different social groups. Certain studies have also sought to pin down the impact of policies penalising consumption of plastic bags on the uptake of alternative options, from paper carrier bags to reusable bags.

Empirical evidence on the environmental and economic impacts of market-based policies aimed at preventing single-use plastics waste is for the most part based on before/after comparisons of performance indicators. Such indicators vary from the (estimated) number of plastic bags sold by retailers in a given lapse of time, as reported by businesses, to statements made by consumers in the context of focused surveys investigating policy appreciation, changes in habits as well as the perception of littering.

Besides not being strictly comparable, before/after comparisons do not isolate the impact of a given policy from the confounding effects of additional factors affecting consumer behaviour (e.g. evolving social norms). As a consequence, they should be interpreted as rough upper bounds on potential policy impacts.

Few exceptions instead adopt empirical approaches aimed at controlling for potential confounding effects (Homonoff, 2018[16]) (Homonoff et al., 2018[17]) (Taylor, 2019[18]) (Taylor, 2019[19]), thus providing a more precise estimate of policy impacts.

These studies exploit rich observational data on consumer purchases of carrier bags at checkout level in supermarkets. This is an important difference with respect to studies based on aggregate statistics or survey data. While surveys can shed light on policy perception and acceptance, relying on self-assessed consumption patterns can deliver biased estimates. On the contrary, observational data can provide information with a greater degree of certainty, also when compared to aggregate statistics.

The next sections discuss the behavioural, environmental and economic implications of the different approaches adopted in policy actions aimed at curbing single-use plastics waste across the world. Policy approaches are categorised as market-based, regulatory or voluntary; other less common approaches, such as information campaigns and behavioural interventions are discussed more briefly.

The implications of these different policy approaches are discussed from an ex-ante perspective, detailing what we can expect from their implementation given collective knowledge from the theory of environmental policy, as well as from an ex-post perspective, presenting evidence from academic and policy reports analysing relevant policy interventions.

While the next sections provide examples of specific policy instruments, these have often been implemented as part of broader, high-level national initiatives on plastics waste, which are also connected to international co-ordinated actions: Box 2 summarises some of these recent high-level national and international initiatives on plastics waste.

### Box 2. Recent high-level national and international initiatives on plastics waste

In the past five years, marine plastics litter and single-use plastics waste have been the focus of several high-level national and international initiatives. Some initiatives, discussed below, are entirely focused on these topics; other countries instead have included their plans for addressing plastics waste in more general strategic documents. The latter has been the case in the United States, where the current strategic plan for Sustainable Materials Management addresses the sustainability of all packaging, including plastic packaging, across its entire life cycle, or in the United Kingdom, which has pinned down objectives to e.g. incentivise demand for recycled plastics in the resource efficiency and waste-related commitments included in its 25 Year Environment Plan.

While some of the most recent strategic initiatives are not yet operational, others have already translated into concrete targets for plastics waste prevention, and followed-up by the implementation of policy instruments to address the related externalities. Because of their recent implementation, it is too early to be able to draw an assessment of the impacts of these initiatives.

**EU: Strategy for Plastics in the Circular Economy and the Single-Use Plastics Directive**

In January 2018, the European Commission published its Plastics Strategy, laying out a roadmap for a transition to a circular plastics value chain. Its pillars are: (i) improving the economics and quality of plastics recycling, through e.g. design for recyclability and improved waste collection and sorting; (ii) curbing plastic waste and littering, by investing in waste prevention and addressing crucial issues such as microplastics leakage and biodegradability criteria; (iii) driving innovation and investment towards circular solutions, through e.g. specific EU research funding; (iv) harnessing global action, by engaging in international initiatives and fora (European Commission, 2018[14]).

This has already translated into legislative action: the Single-Use Plastics Directive (Directive (EU) 2019/904[20]), approved in June 2019, addresses the 10 single-use plastic goods most commonly littered on beaches, which include both plastic consumer goods and packaging as well as fishing gear. Some single-use plastics goods are required to be phased-out by mid-2021 (e.g. cotton buds, cutlery, plates, straws and stirrers). For goods which are currently less easily substituted (e.g. food containers, cups for beverages), objectives are set for reduced consumption and greater producer involvement in awareness-raising, clean-up, collection and waste treatment through measures such as new extended producer responsibility schemes.

In July 2020, the European Council suggested that an EU-wide tax of 0.80 EUR per kg on non-recycled plastic packaging waste be introduced as of January 2021 (European Council, 2020[21]).

**G7: Ocean Plastics Charter**

At the G7 Summit held in 2018 in Charlevoix, Canada, leaders “recognise[d] the urgency of the threat of ocean plastic waste and marine litter to ecosystems and the lost value of plastics in the waste stream” (G7, 2018[22]).

The leaders of Canada, France, Germany, Italy, the United Kingdom, and the European Union issued an Ocean Plastics Charter, expressing their commitment “to move toward a more resource-efficient and sustainable approach to the management of plastics” (G7, 2018[22]). The building blocks towards this effort are actions to foster (i) sustainable design, production and after-use markets, (ii) collection, management and other systems and infrastructure, (iii) sustainable lifestyles and education, (iv) research, innovation and new technologies, and (v) coastal and shoreline action. The Charter includes quantitative objectives to be attained through co-operation with private actors, e.g. for recycled content of plastics packaging.

Since its publication, the Charter has been endorsed by additional countries beyond the G7, as well as businesses and organisations (Environment and Climate Change Canada, 2020[23]).

**Canada: Zero Plastic Waste Strategy and Action Plan**

In November 2018, the Canadian Council of Ministers of the Environment approved the *Strategy on Zero Plastics Waste*, followed by an *Action Plan* published in June 2019. The latter identifies the following priorities, together with a timeline to address them: 1) facilitating the development of extended producer responsibility programs for plastics; 2) identifying single-use and disposable products most likely to be leaked into the environment or pose other end-of-life management challenges, and identifying sustainable substitutes; 3) developing national performance requirements and standards for recycled content, certified compostable items, and for repair, remanufacturing and refurbishment; 4) putting in place incentives for a circular economy, such as e.g. regulatory, economic and fiscal measures; 5) supporting infrastructure and innovation investments; and 6) updating public procurement criteria to incorporate best practice principles for plastics management (Canadian Council of Ministers of the Environment, 2019[24]).

**Japan: Resource Circulating Strategy for Plastics**

In May 2019, Japan adopted its *Resource Circulating Strategy for Plastics*. The strategy sets out milestones and quantitative objectives for reduced usage of single-use plastics (i.e. waste prevention), better separation and collection of plastics, also building upon improved design, and promotion of recycled materials and recyclable resources as alternatives to single-use plastics (e.g. paper, biomass plastics).

In parallel, an action plan targeting marine plastics litter has also been approved (Ministry of the Environment of Japan, 2019[25])**.**

Actions undertaken by G20 countries in the context of the G20 Resource Efficiency Dialogue and G20 Implementation Framework for Actions on Marine Plastic Litter are summarized on the following webpage: https://g20mpl.org/

# 2. Market-based policies

Market-based policy instruments, such as environmental taxes and mandatory charges, are economic incentives to curb pollution emissions through production adaptation and behavioural change. Examples of product-oriented market-based instruments aimed at preventing the generation of single-use plastic waste are taxes or mandatory charges on single-use plastic products such as plastic bags, cutlery, bottles or other packaging items. Further upstream, taxes on specific polymers aim to reflect the environmental damages associated with their end-of-life management. Instead, further downstream, wide-ranging instruments such as weight-based or volume-based waste fees for generic household waste may prevent waste generation and foster higher recycling rates, whenever recyclable goods are subject to lower waste collection fees.

Exploiting market-based instruments can deliver environmental improvements, preventing single-use plastic waste, at a lower economic cost than inflexible regulations (i.e. *static efficiency*), enabling behavioural and production adaptation. At the same time, economic instruments can induce innovation in pollution prevention and abatement technologies in the longer run (i.e. *dynamic efficiency*), as producers innovate to curb their plastics emissions and the associated fiscal burden.

A range of economic instruments are required to address market failures and misaligned incentives along the plastics value chain, both in the petrochemical and plastic sector, and in the manufacturing and consumption of specific single-use plastic goods (e.g. packaging). For example, as greenhouse gas emissions from plastic production are largely unpriced, the prices of plastic polymers do not reflect the environmental impact associated with their manufacturing process.

Besides the application of revenue-raising instruments to plastic waste prevention, other price signals have been applied to single-use plastic goods long before the recent surge of attention towards this specific waste stream. For example, deposit-refund schemes for plastic bottles were introduced at the state level in the United States in the 1970s (Walls, 2013[26]), and across Northern Europe starting in the late 1980s (ACR+, 2019[27]), either as part of an extended producer responsibility scheme or as private initiatives. Box 3 explains the rationale for the following analysis to focus solely on taxes and charges levied on single-use plastic goods.

### Box 3. Extended producer responsibility, deposit refund schemes and single-use plastics

Extended producer responsibility policies aim to apply the polluter-pays principle by ensuring that producers, rather than municipalities and taxpayers, bear the financial burden of end-of-life waste treatment for their products (OECD, 2016[28]). EPR policies have been applied to a range of single-use plastic goods, mainly through deposit-refund schemes for plastic containers (e.g. Germany[6], Norway).[7] In other countries (e.g. United States), deposit-refund schemes are instead a private initiative, without being necessarily connected to producer responsibility for managing their products' end of life. Such private deposit-refund schemes may also focus on more specific market segments (e.g. reusable beverage containers, in Germany).

In deposit-refund schemes (DRSs), consumers pay a deposit at the point of sale of the product, while the refund is only received if the product is returned to an authorized recipient. Unlike with a standard Pigouvian tax, the deposit paid upon purchase is cancelled out by the refund obtained upon returning the product: as such, DRS are a peculiar economic instrument. At the same time, deposit-refund schemes are usually implemented following regulatory take-back obligations for producers to ensure certain recycling rates for their packaging, thus also incorporating a command-and-control element.

This policy approach can be applied to reach two different objectives: on one hand, to increase collection rates of specific packaging, thus ensuring higher recycling of given materials and curbing littering; on the other hand, to increase material reuse whenever possible. While recycling-focused DRS are not strictly speaking waste prevention instruments, as they do not avoid the generation of waste, they can help minimise residual waste by providing recycling facilities with uncontaminated feedstock for materials that have maintained value for an extended period of time. Reuse-focused DRS can provide waste prevention incentives and help close material loops.

However, from a general perspective, EPR policies such as deposit-refund schemes have not managed to significantly curb the generation of single-use plastics waste that has come with the rise in consumption of one-way containers. There is evidence that recycling-oriented DRSs can successfully increase recycling rates (OECD, 2015[29]). However, countries that have adopted DRS to preserve the market share of refillable containers (e.g. Germany, Denmark) have not succeeded in containing the replacement of refillable containers with single-use items (ACR+, 2019[27]).

The "eco-modulation" of EPR fees is a policy feature aimed at prompting greater efforts for eco-design.For example, while in Europe it is common for EPR schemes to set different fees for different packaging materials (e.g. plastics, aluminium, cardboard), there are only few instances of differentiated fees for different plastic polymers and even fewer schemes which differentiate fees according to the presence of disruptive additives, to the reusability or recyclability of packaging (as is the case e.g. in France and Italy) (Watkins et al., 2017[30]). As such, by rewarding eco-design efforts, eco-modulation can contribute to facilitating recycling, minimising residual waste generation.

This practice is likely to gain further traction in the European Union, where the recently revised EU waste framework directive requires member states to put in place financial incentives aimed at achieving EU waste prevention and recycling objectives: this includes EPR as well as landfill and incineration taxes and pay-as-you-throw schemes. The revised directive explicitly recognizes the need for EPR fees to be "modulated on the basis of the real end-of-life cost of individual products or groups of similar products, notably by taking into account their re-usability and recyclability" ***(European Commission, 2015[31])***.

[6] More specifically, Germany's deposit-refund scheme for beverage containers affects not only plastic packaging, but also cans.

7 Advance-disposal fees for non-packaging plastics (applied e.g. in Korea) are another example of EPR approach applied to the plastics waste stream.

## Policy target: life-cycle stages

Designing market-based policies to target plastic waste, as opposed to materials, intermediate goods (e.g. monomers, virgin resins) or final goods made fully or partly of plastics has different behavioural, environmental and economic implications. While these options are not equally common in current policy, different types of taxes can be envisioned (Zero Waste Europe, 2018[32]) (New Economics Foundation and Zero Waste Europe, 2018[33]):

- *Tax on intermediate goods or materials*, e.g. monomers or resins: this can apply to the sale or purchase of inputs and refined materials.
- *Tax on final single-use plastic products*: this can apply either to consumers or to producers and importers.
- *Tax on plastic waste*: this can be implemented through pay-as-you-throw schemes for households. While technically not taxes, fees associated with extended producer responsibility schemes can provide similar price signals to producers.

An upstream tax on monomers or resins has the advantage of addressing relatively few taxpayers, encouraging resource efficiency at the design and production stages. Because of this, the administrative costs of a tax on producers are likely to be lower than for a tax applying to a larger set of economic actors, like customers. However, such a policy approach may face well-organised lobbying efforts at the industry level, given the group of targeted taxpayers is limited and with homogeneous interests. Further, this approach does not immediately allow to clearly differentiate policy actions between single-use and durable plastic goods, as some polymers may be used both in durable and disposable applications. Additionally, it does not differentiate between different single-use plastic goods (i.e. carrier bags and medical plastics).

Levying an upstream tax on the sale or purchase of inputs or materials can prompt respectively a “supply push” or a “demand pull” for alternative materials: if such a tax explicitly targeted virgin resins, it would incentivise the use of alternative materials, including recycled plastics, thus reducing landfilled and incinerated plastic waste (Zero Waste Europe, 2018[32]). At the same time, recycled plastics may not be appropriate in all uses of virgin materials or require approval for specific uses, such as food-contact packaging.

Instead, introducing price signals downstream on the production or consumption of specific single-use plastic products allows policy makers to target goods characterised by particularly harmful environmental impacts, recognising the specific nature of single-use products as opposed to durable plastic goods. A product tax may be more salient to the public than a tax on intermediate goods or materials, which may be either absorbed along the value chain or trickled down onto product prices. However, a downstream tax entails higher transaction costs, as it requires the involvement of an extremely large number of agents, with the resulting administrative complexity (Zero Waste Europe, 2018[32]).

More generally, while upstream taxes present the advantage of targeting fewer economic agents, their implementation would require complementary trade arrangements (i.e., tariffs on imports and exemption of exports for all stages of the value chain downstream for the one where the tax falls) in order to preserve competitiveness of domestic industry (Zero Waste Europe, 2018[32]).

One example of an upstream tax on a specific polymer is the Danish tax on PVC (polyvinyl chloride), aimed at reducing its landfilling or incineration (Skræp Svenningsen et al., 2019[34]). The tax was in place between 2000 and 2019: it was discontinued based on the claim that it was not inducing significant behavioural effects, given it did not vary by the amount of PVC contained in products (Chemical Watch, 2017[35]).

Putting a downstream price signal on plastic waste, levied on either customers or producers, would translate into efforts towards eco-design, waste prevention, and use of alternative materials. In practice, most economic instruments designed to curb single-use plastic waste focus on final products rather than materials or intermediate goods. This includes taxes on manufacture and import of single-use plastic

goods, and mandatory charges, whereby retailers are mandated to put a price on these goods rather than provide them for free to customers. If manufacturing of a certain good accounts for an important share of demand for a specific resin, a tax levied at manufacturing or retail sale may have a significant impact on the entire value chain.

Mandatory charges collected by retailers generate the same price signal as taxes, thus it is reasonable to expect they drive the same behavioural response from consumers. This may be the case, unless consumers have a negative perception of taxes, drawing a greater disutility from a tax than from a price increase of the same magnitude.

The recent wave of policy efforts has mainly focused on a specific single-use plastic product: carrier bags. In fact, 27 countries impose taxes on the manufacture and production of plastic bags, and 30 countries impose national-level consumer fees on the same product. At the same time, taxation targeting other single-use plastic goods (e.g. cutlery, bottles, food packaging...) is present only in 29 countries (UN Environment, 2018[11]).

Most of the available evidence relates to taxes or charges levied on consumers: this may be because such policies directly affect the majority of the population, as opposed to production-focused taxes, thus prompting greater oversight and research efforts to assess their outcomes.

## Policy coverage: products and materials

Certain market-based policies are characterised by a narrow focus on specific single-use plastic products (e.g. plastic carrier bags), whereas others have adopted a broader approach, applying a price signal to all single-use goods with the same purpose, regardless of the material they are manufactured with (e.g. paper or bio-plastics carrier bags).

The production and consumption of single-use goods manufactured in different materials comes with different environmental externalities: as a consequence, the aggregate environmental impact of a tax on single-use plastic goods will depend on the substitution effect it induces, both among producers and among consumers. This is discussed in further detail in Section 5, which addresses the implications of demand and input substitution.

Policy design choices can mitigate the potential adverse effects of material substitution: in Wales, Scotland and Northern Ireland, for example, the mandatory charge on single-use carrier bags applies both to plastic bags and to biodegradable and most paper bags (for further details on policies implemented in the United Kingdom, see Box 4). In Wales, the rationale underlying this design choice was grounded in a 2011 life-cycle assessment of the environmental impacts of carrier bags manufactured in different materials (Environment Agency, 2011[36]). This and additional evidence on the life-cycle footprint of different types of carrier bags is summarised in Box 5.

### Box 4. Carrier bag policies. Case studies from the United Kingdom

In the United Kingdom, the implementation of economic instruments targeting single-use plastic bags has been gradual and differentiated across the four countries (England, Northern Ireland, Scotland, Wales), while the economic signal is homogenous, at 5 pence (GBP 0.05) per carrier bag (Priestley and Sutherland, 2019[37]). The main difference across the four regions is that, while Wales, Northern Ireland and Scotland have opted to charge for the purchase of all carrier bags, regardless of the material (e.g. encompassing plastics, paper, biodegradable plastics), England has instead designed a policy entirely focused on fossil-based plastics.

In October 2011, Wales was the first country in the United Kingdom to introduce a mandatory charge on all carrier bags, regardless of their material, in order to curb their consumption beyond what had been achieved through a voluntary agreement with supermarkets. The charge applies to single-use bags made fully or mainly from plastic, paper and plant-based starch which are not intended for multiple reuse. The charge has successfully contributed to curb carrier bag consumption, which has been estimated to drop by 71% between 2011 and 2014 (Priestley and Sutherland, 2019[37]). In their place, own bag usage increased from 61% to 82% in 2012 (Smith, Sutherland and Priestley, 2020[38]). A 2015-2016 survey study commissioned by the Welsh government identified some confusion by respondents about the recyclability, return-ability, and durability about 'bags for life' (Winning Moves and Icaro Consulting, 2019[39]). The findings raise concerns that the 'bags for life' may not be re-used in all instances with enough frequency to offset the environmental impacts of their production vis a vis a single-use carrier bag (Smith, Sutherland and Priestley, 2020[38]).

In April 2013, Northern Ireland introduced a levy on all single-use carrier bags. In 2015, the levy was extended to all carrier bags priced below GBP 0.2, applying both to single-use and reusable bags, regardless of their material. This design choice aims at ensuring that cheaper reusable bags are used to their full potential rather than prematurely discarded. While the levy has contributed to reducing the consumption of all carrier bags with respect to pre-policy level, recent years have seen an upward trend in consumption: bag consumption dropped by 72.8% in the first year of operation relative to 2012, and only by 67.1% in its fifth year. This has nonetheless prevented an estimated 1 billion bags from being sold during the first 5 years of application of the levy (Department of Agriculture, Environment and Rural Affairs of Northern Ireland, 2018[40]).

In 2014, a mandatory charge on carrier bags was introduced in Scotland, thus setting a minimum price of GBP 0.05 for new single-use bags supplied at point of sale and made of plastics, paper and certain plant-based materials. Zero Waste Scotland estimated that the charge contributed to reducing carrier bag use by about 80% across the 7 main retail chains in its first year of application, amounting to at least 650 million fewer bags (Zero Waste Scotland, 2015[41]).

While voluntary agreements between the government and certain retailers successfully reduced plastic bag sales in England in 2009-2010, their end reverted this trend: plastic bag consumption increased by over 21% between 2010 and 2014 (Priestley and Sutherland, 2019[37]). This trend, together with the positive results obtained by neighbouring nations with the application of charges and levies, motivated the introduction of a mandatory charge on single-use plastic bags in October 2015. Three years after its launch, DEFRA reported that plastic bag sales in the seven largest retail chains had dropped by 86% (DEFRA, 2018[42]).

In summer of 2020, DEFRA announced that the charge on plastic carrier bags in England would increase from 5p to 10p in April 2021, and that it would apply to all retailers, ending the exemption for small retail shops (with fewer than 250 employees) ***(DEFRA, 2020[43])***.

### Box 5. The environmental impacts of carrier bags: evidence from life-cycle analysis

Life-cycle analysis (LCA) is a useful tool to assess and compare the aggregate environmental footprint of different products, compiling the environmental impacts they entail at each stage of their life cycle. While policy actions on single-use plastics usually aim to prevent waste generation and littering, LCA studies analysing single-use plastics production take a broader perspective to assess a larger set of environmental impacts.

Prior to implementing legislation on carrier bags, Wales commissioned an LCA study assessing the environmental impacts of the production, use and disposal of carrier bags made of different materials, including high-density polyethylene, low-density polyethylene, biopolymers (i.e. starch-based biodegradable plastics), paper and cotton. The study focused on global warming potential as well as resource depletion, acidification, eutrophication, human toxicity, ecotoxicity and smog formation. It did not consider the environmental impacts of different materials when littered.

The study indicates that "the paper, LDPE, non-woven PP and cotton bags should be reused at least 3, 4, 11 and 131 times respectively to ensure that they have lower global warming potential than conventional HDPE carrier bags that are not reused" (Environment Agency, 2011[36]). Additionally, biodegradable bags made of starch-polyester blends are shown to have a "higher global warming potential and abiotic depletion than conventional polymer bags, due both to the increased weight of material in a bag and higher material production impacts" (Environment Agency, 2011[36]).

This indicates that conventional lightweight plastic carrier bags retain the lowest global warming potential across the alternatives mentioned above: replacing them with other materials requires additional reuse efforts from the consumer side, in order to keep their aggregate environmental footprint constant.

A more recent life-cycle assessment of carrier bags from the Danish Environment Agency takes a broader approach, considering additional environmental impact indicators beyond climate change: this includes ozone depletion, human and ecosystem toxicity, eutrophication (terrestrial, freshwater, marine), resource depletion. Taking as benchmark LDPE carrier bags, which are always available in Danish supermarkets, it finds that, according to most environmental indicators (i.e. including but not limited to climate change), this type of bag provides the overall lowest environmental impact related to the production and disposal stages (Danish Environmental Protection Agency, 2018[44]).

While these LCAs provide useful insights into the potential substitution effects and on their environmental implications, they should be interpreted with some caveats in mind. First, each LCA reflects the specificities of a given market (i.e., Wales or Denmark in these cases), and their findings may not be generalizable across countries. Second, the choice of the specific environmental impacts to assess may change the picture and final ranking of alternative material options: for example, neither of the LCAs discussed in this box considers the potential impact of littering. Third, assumptions on the source of materials used in manufacturing may also have an important impact (e.g. primary vs recycled materials): for example, the Welsh LCA does not consider carrier bags made with recycled material, as at the time of the assessment bags with recycled content constituted a small proportion of the carrier bag market.

Overall, the studies focusing on Wales and Denmark that are analysed in this box indicate that common single-use alternatives to conventional, single-use plastic carrier bags – such as paper bags and biodegradable bags – do not necessarily yield a lower environmental impact when considering the multiple environmental impacts (including but not limited to waste disposal) which may arise throughout

their lifecycle. At the same time, it is important that LCAs of single-use items consider the potential environmental impact of improper disposal choice such as littering: this type of consideration has been largely missing thus far.

LCA can help inform policy design and avoid the risk of environmental burden-shifting (i.e., in this case, an improvement in terms of one environmental impact being offset by an increase in another environmental impact), by considering all the environmental impacts arising throughout the material and product lifecycle.

In the United Kingdom, the government has proposed a plastic packaging tax aimed at incentivising the use of recycled materials, alongside extended producer responsibility regulation. The proposed tax would apply to businesses producing or importing plastic packaging containing less than 30% recycled content, and it would enter into force in April 2022 to allow production adaptation. The government will perform a second round of consultations on the specifics of tax design, given the first round gathered numerous suggestions, reinforcing the tax on filled packaging imports as opposed to exempting them, and to revise the recycled content threshold (HM Treasury, 2019[45]).

Through the 2020 Budget Law (Law n. 160/2019), Italy has also recently introduced a tax of EUR 0.45 per kilogram of plastic material applying to single-use goods made fully or partly of plastics and aimed at containing, protecting, manipulating or delivering products or food (i.e., mainly focusing on packaging and containers). Biodegradable and recycled plastics are excluded from the application of the tax, as well as medical devices. The liability arises at the time of production or import into the national territory. The tax will become operational in July 2020.

Further, the Budget Law has introduced a tax credit on biodegradable plastic in order to facilitate the conversion of the industrial sector to biodegradable plastics. Consistent with the goals that will be fully outlined in the National Plan on Sustainable Plastics, companies operating in the plastics sector that produce single-use products are granted a tax credit of 10% of the expenses incurred during 2020 for technological adaptation for the production of biodegradable products.[8] Belgium, Denmark and Finland have adopted a broad policy approach, simultaneously instituting taxes on a product category rather than a specific product: their taxes on packaging and other single-use plastic goods are described in Box 6.

While the taxes implemented in the United Kingdom and in Italy focus on plastics, the policy initiatives described in Box 6 have the merit of recognizing the environmental externalities associated with the production and consumption of packaging as a whole, addressing such externalities with integrated policy actions. At the same time, the limited impact of the Belgian tax on the consumption of goods other than carrier bags might be partly due to the fact that such products are generally a rare purchase: in this circumstance, a small price signal may be insufficient to prompt an alternative choice. However, because of very limited evidence on the outcomes of environmental taxation on packaging consumption, it is not possible to discuss in detail their realised environmental and economic impacts.

Limited evidence might also be due to the fact that, for policies implemented in the early 2000s, it may be difficult to obtain reliable time series on e.g. the sales of certain single-use plastic goods covering the pre-policy period. This should be less of an issue in the digital era, as scanner data from retailers potentially enable a rather precise observation of the evolution of consumption patterns.

Finally, taxes and charges on single-use plastic goods other than plastic bags are less widespread than policy initiatives that focus on plastic bags. Implementation of policy for more than just plastic bags has largely been concentrated in Europe, and is relatively rare in the rest of the world.

[8] The law describes biodegradable products as those abiding by according to the standard EN 13432:2002, and sets an upper bound of EUR 20 000 on the yearly subsidy that a single beneficiary can obtain.

### Box 6. Taxes on packaging

In 2007, Belgium instituted an "environmental tax" at federal level, with differentiated rates across four categories of products: single-use plastic carrier bags (EUR 3/kg), single-use plastic foil (EUR 2.70/kg) and aluminium foil (EUR 4.50/kg), and single-use plastic cutlery (EUR 3.60/kg) (Eunomia and IEEP, 2016[46]). Because of its focus on household plastic items, the tax was dubbed "pic-nic tax". It remained in place from July 2007 to January 2015, when it was dismantled based on the claim that it had successfully prompted behavioural change: as a result, tax revenues barely covered policy implementation costs (Muelenaere, 2014[47]).

Consumption of single-use plastic carrier bags dropped by over 3000 tonnes between 2006 and 2008. However, this was part of a downward consumption trend which had started ahead of the tax implementation, prompted by a voluntary agreement between the government and a subset of retailers to price single-use plastic carrier bags instead of providing them for free. As a consequence, consumption of single-use plastic carrier bags dropped by 86% between 2003 and 2010 (IBGE, 2011[48]).

Policy effects on consumption of other targeted single-use plastic goods have been limited: tax revenues relative to sales of plastic cutlery as well as plastic and aluminium foil increased between 2008 and 2010 (IBGE, 2011[48]). This indicates that the price signal provided by the "pic-nic tax" may have been insufficient to curb consumption of these goods, which are likely to be relatively infrequent purchases for most households.

While Denmark has taken a similar approach, targeting a range of plastic containers through a broader set of packaging taxes, in place since 1999, some of them have recently been discontinued. The tax on paper and plastic carrier bags, disposable dishes and cutlery and PVC for food products is weight-based (10 – 20.35 DKK per kg, roughly EUR 1.34 – 2.74, according to the product). Conversely, weight-based taxes on other packaging items were discontinued in January 2014 because of the administrative burden they posed for businesses. Similarly, the former packaging tax on beverage containers included in the Danish deposit refund system was abolished starting in July 2019 (Skræp Svenningsen et al., 2019[34]).

Evidence on the effectiveness of the Danish packaging tax in curbing packaging waste generation is limited: a 2001 study indicated that carrier bag consumption (both paper and plastic) dropped by an estimated 70% after the introduction of the tax (ECOTEC, 2001[49]). However, no estimates seem to be publicly available for the impact of the packaging tax on other types of packaging: it is thus not possible to fully assess its environmental impact.

In Finland, packaging affected by approved deposit-refund schemes (both aimed at recycling or refilling) is exempt from packaging taxes, which vary according to the packaging material and volume ***(Skræp Svenningsen et al., 2019[34])***.

## Stakeholders: governance, focus and coverage

In several countries across the OECD and beyond, market-based policies targeting single-use plastics have been implemented at subnational (e.g. state, county or city) rather than national or federal level.

While the regulatory approach has been more popular at the national level, in the United States some plastic bag levies have been implemented at city-level (e.g. Chicago; Washington, DC) or county-level (e.g. Montgomery county, Maryland) (UN Environment, 2018[11]). Producers of single-use plastic goods are going to be differently affected according to the economic importance of the local market characterised by a tax or charge.

In some countries, specific categories of stakeholders may be exempted from taxes or charges. For example, certain jurisdictions have mandated charges on single-use plastic goods to apply solely to large-scale retailers, or allowed a longer period for small retailers to comply with legislation. This is the case in England, where small and medium-sized retailers (i.e. with less than 250 employees) are not required to implement the mandatory charge on single-use plastic carrier bags in place since 2015; however, a consultation on a potential revision of this norm is ongoing (Priestley and Sutherland, 2019[37]).

There can be several motivations for this type of exemption: one is to ease the administrative burden that revenue collection and compliance reports might pose on smaller retailers. The flip side to this is that enforcing compliance among many small and medium-sized enterprises (SMEs) also poses a considerable administrative burden on regulators. A potential way to circumvent these challenges would be to encourage the creation of a voluntary agreement among small retailers, including stores and market stalls, to voluntarily price plastic carrier bags.

The behavioural and environmental implications of this policy design choice depend on the market share of small retailers relative to large-scale chains. However, allowing for asymmetric practices in different sectors of the retail sector may hinder behavioural change: one steady price signal applying across shopping locations might help instead.

## Price signal

The level of a tax or a charge on single-use plastic products may be set (a) following the estimation of the economic cost due to the environmental externalities caused by production and consumption of the product in question, (b) following the estimation of consumer's willingness and ability to pay for it, or (c) on an ad-hoc basis.

The first approach, typical of environmental taxation at large, ensures that the price signal is set to equalise the marginal external cost associated with the environmental damages caused by plastics production and/or consumption. This prompts behavioural change from consumers, who are expected to demand fewer single-use plastic goods, following an increase in their price, thus rebounding on alternative products. In the longer run, this is expected to alter production patterns, as manufacturers of single-use plastic goods recalibrate their production and possibly opt for alternative materials.

The second approach ensures that, if the price signal is higher than the average willingness to pay, most consumers will be prompted to change their behaviour and, as indicated above, to reduce their consumption of single-use plastics while opting for alternatives. If the tax is set to be lower than the average willingness to pay, the price signal may be insufficient to prompt behavioural change across most consumption groups.[9]

How an ad-hoc price signal compares to a price signal based on estimates of key market parameters will depend on how elastic the demand and supply of single-use plastic goods is relative to variation in their price.[10] In practice, among the market-based policies discussed in this report, only the Irish tax on plastic carrier bags has been set based on estimated willingness to pay for these goods, and none has been set based on estimated cost of environmental damages.

[9] An average willingness to pay (WTP) is a composition of many individual WTPs. Some individual WTPs can be expected to be higher than other individual WTPs. An individuals will be expected to reduce their consumption when the price signal is higher than their individual WTP, which will occur at a lower level for an individual with a lower WTP. For example, one previous study has found statistically-significant differences in WTP for a pack of six plastic water bottles based on income level, age and importance attached to environmental protection (Orset, Barret and Lemaire, 2017[118]).

[10] For example, evidence from the impact of a tax on bottled water applied in the state of Washington (United States), indicates that demand for bottled water is inelastic (Berck et al., 2016[115]).

Among the first OECD countries to institute a country-wide policy in this sector, Ireland introduced a EUR 0.15 plastic bag levy in 2002. The tax, levied on consumers, applies to bags made wholly or partly of plastic, sold at any sales outlet (supermarkets, service areas…). The government set the tax at this level following a survey indicating that average consumer willingness to pay for plastic bags hovered around EUR 0.024. The price signal was thus set at EUR 0.15, more than 6 times higher than the average maximum willingness to pay. This led to an immediate 90% reduction in the use of plastic bags (Convery, McDonnell and Ferreira, 2007[50]).

However, willingness to pay is not constant over time and is not equal across a range of products: consumers may adapt to a higher price for single-use plastic goods, which may lead to a rebound in demand for such goods. The plastic bag levy in Ireland is an example of such a gradual rebound in usage over time. A EUR .15 per bag levy was first introduced in 2002 and led to an immediate drop in per capita, per annum consumption from 328 to 21. However, usage gradually increased to 31 bags per capita, per annum in 2006. The levy was subsequently increased to EUR .22 per bag in 2007 (OECD, 2010[51]). As of 2014, the per capita, per annum usage had fallen again to 14 and the levy rate has remained at EUR .22 (OECD, 2021[52]).

In order to provide producers with an incentive to adopt greener production practices, price signals on single-use plastic goods may be modulated according to additional criteria. This is the case in Norway, where the level of tax on plastic bottles decreases with an increasing collection rate, to incentivise material recovery.

More specifically, in Norway, manufacturers and importers of recyclable bottles in PET plastic are subject to an environmental tax of NOK 3.50 (about EUR 0.36) per bottle since 1994. This adds to a basic tax (NOK 1.19, about EUR 0.12) applying to bottles and cans if they cannot be reused in their original form (ACR+, 2019[27]).

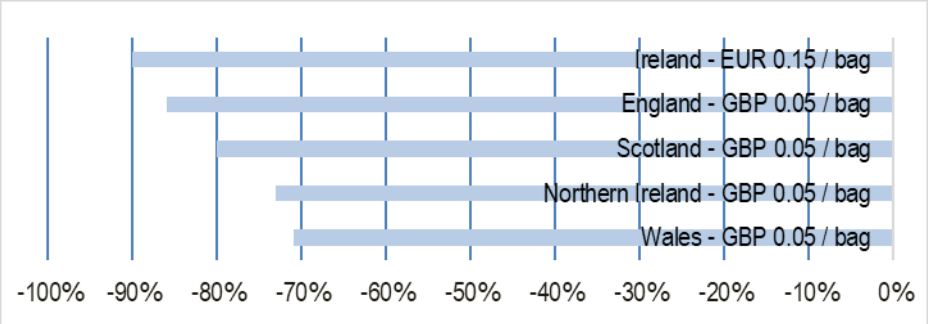
The environmental tax aims to internalise the damages associated with littering plastic containers in the environment (Skræp Svenningsen et al., 2019[34]). It is inversely proportional to the return rate (i.e., number of bottles collected individually or as a group under EPR): tax reductions start with a 25% return rate, and the tax ceases to apply above a 95% return rate (UN Environment, 2018[11]). Because of this feature of tax design, this policy goes hand in hand with the deposit-refund scheme, as manufacturers have a clear incentive to engage in EPR schemes to boost collection and return rates thus benefiting from tax credits. In 2011, the recycling rate for plastic bottles surpassed 95% (ACR+, 2019[27]).

Price signals targeting single-use plastic goods can be set with different units of application, i.e. by weight (as was the case e.g. in the Belgian “pic-nic tax”) or by piece sold or produced (as is the case for most taxes and charges on plastic carrier bags). The unit of application of price signals, be they taxes or charges, can have different implications for producers: for example, taxes levied by weight of plastics used in production may prompt eco-design efforts, for instance by inducing design and development of lightweight plastic goods (i.e. lightweighting). This may not necessarily be the case with a fixed market-based instrument applying to each single-use plastic product produced or sold: such a policy design may instead encourage material substitution in the longer run. As a consequence, the relative performance of taxes set by weight or by unit will differ according to the extent of lightweighting and material substitution, and to their environmental impact.

Market-based policies may also differ according to who establishes the price signal they aim to introduce. While the relevant regulatory authority sets the tax level, this need not be the case with mandatory charges: policy makers may require that retailers charge consumers for the purchase of a certain good, without indicating how much. Certain single-use plastic bag policies, for example, enable retailers to freely set the price, but impose a certain minimum price level to be respected. In China, the price for plastic bags may vary across shops, as long as it covers the cost of purchase of plastic bags incurred by retailers (He, 2012[53]).

Figure 2 summarises the quantitative impact of different taxes and charges on the consumption of plastic carrier bags.

### Figure 2. Consumption impacts of selected plastic bag taxes/charges




Note: estimates relate to consumption adjustments over different periods of time, hence they are not comparable. They aim to provide an indication of the magnitude of the impact of each policy intervention.
Source: Convery et al. (2007); Priestley and Sutherland (2019); Zero Waste Scotland (2015).

## Destination of revenues from taxes and charges

Whether a market-based policy entails a tax or a charge, revenues may accrue to different entities: tax revenues are typically collected by the government, whereas charges collected by retailers do not have a default destination.

As a consequence, for policy makers and regulators, a practical difference between taxes and mandatory charges collected by retailers is that the former have the advantage of generating public revenues, with obvious implications for public budgets. For example, in Ireland annual tax revenues from the levy on plastic bags have been estimated in the order of EUR 12-14 million / year in the first two years of operation of the tax (Convery, McDonnell and Ferreira, 2007[50]).[11]

Certain jurisdictions provide indications on the use of revenues raised through mandatory charges and taxes, encouraging their donation to charities and local causes, sometimes with a focus on environmental protection.

In Ireland, tax revenues from the levy on plastic bags are transferred to a fund dedicated to environmental issues controlled by the Minister for the Environment, Heritage and Local Government: while earmarking is not the most efficient approach for revenue recycling, directing revenues towards environmental protection causes has helped ensure policy acceptance (Convery, McDonnell and Ferreira, 2007[50]). Similarly, in Northern Ireland tax revenues are collected by the Department of Agriculture, Environment and Rural Affairs (DAERA) on a quarterly basis and devoted to financing local environmental projects (Priestley and Sutherland, 2019[37]).

When it comes to mandatory charges, in England, Wales and Scotland, legislation strongly encourages donations to “good causes” (Priestley and Sutherland, 2019[37]). Certain retailers in these regions have, as a consequence, set up programmes to invite customers to express their preferences regarding the destination of proceeds from plastic bag charges. In England, around 60% of retailers, accounting for about

[11] Tax revenues more than offset the cost of implementation, collection and administration. In fact, introducing the tax required a EUR 1.2 million investment inter alia in new IT systems, and EUR 358 000 for developing and running a broad information campaign. Annual operation costs were estimated at EUR 350 000 (Convery, McDonnell and Ferreira, 2007[50]). Implementing the Irish tax has been relatively easy, since retailers have integrated the revenue collection and reporting with the value added tax system.

80% of carrier bag sales, voluntarily reported figures on their charity donations: in 2017-2018, these amounted to GBP 51.6 million (DEFRA, 2019[54]).

While charity donations and environmental protection are noble causes, such revenue earmarking may have unintended consequences: it may induce consumers to justify their purchase of single-use plastic goods as a way of financing charitable donations, which can bring a "warm glow". This may hinder behavioural change, preventing a shift to e.g. reusable options: as such, it is a question that deserves to be empirically analysed.

## Accompanying measures

In certain administrations, market-based policies targeting single-use plastics are accompanied by complementary measures: these might be aimed at ensuring awareness, buy-in and compliance, or at tilting consumption choice towards specific product alternatives deemed to be preferable from an environmental point of view.

For example, the Irish tax on single-use plastic carrier bags has been particularly successful at reducing bag consumption partly thanks to the important information campaign which, explaining policy objectives and tax revenue destinations, paved the way for widespread awareness and buy-in. A telephone survey performed among 100 consumers a year after implementation of the Irish tax indicated that 87% of surveyed consumers had a positive or neutral perception of the impact of the tax at checkout, and 90% of them reported the tax had a positive impact on the environment (Convery, McDonnell and Ferreira, 2007[50]).[12]

Sometimes pricing policies are paired with regulatory constraints such as material requirements. For example, in January 2018 Italy mandated retailers to price small plastic bags used to wrap loose fruits and vegetables in supermarkets rather than provide them for free to consumers. The mandatory charge was associated with a requirement that all such bags be made of biodegradable and compostable plastics, with a certain proportion of renewable (plant-based) material fixed by law. As discussed in Box 5, several studies have indicated that plant-based biodegradable plastic bags are characterised by a higher life-cycle footprint with respect to conventional plastic bags. Further, their degradability is ensured only in optimal treatment conditions, which may require adaptation of organic waste treatment plants (Environment Agency, 2011[36]) (Danish Environmental Protection Agency, 2018[44]).

Similarly, China introduced a mandatory charge on single-use plastic carrier bags in 2008, coupled with a ban on thin plastic bags (with thickness below 0.025 millimetres) (He, 2012[53]).

[12] Litter surveys reinforce this sentiment, as respondents reported that, between January 2002 and April 2003, the number of areas clear of plastic bag litter increased by 21% and the number of areas without any traces increased by 56%. While plastic bags accounted for 5% of the national litter composition prior to the introduction of the tax, this figure fell to 0.22% in 2004. This has contributed to reinforce the positive consumer response to the new tax (Convery, McDonnell and Ferreira, 2007[50]).

### Box 7. Market-based policies: key insights

- Most of the market-based policies aimed at preventing single-use plastics waste target final goods rather than materials or intermediate goods.
- Evidence on the impact of taxes and mandatory charges on plastic carrier bags is encouraging: generally, the implementation of taxes or mandatory charges has led to an important decrease in the sales of plastic bags, particularly where the level of the tax/charge has been set to exceed average consumer willingness-to-pay for plastic bags. However, estimates vary across countries partly due to data and methodological differences.
- Evidence on the impact of taxes on other single-use plastic goods, such as containers and other packaging, is more limited and not as clear-cut. The effectiveness of a price-signal in preventing single-use plastics waste may also depend on the frequency of consumer purchases.
- Based on the available evidence, the impact of market-based policies targeting single-use plastic goods is expected to be maximised if alternatives to plastics are readily available and if exemptions (e.g. for specific materials or groups of stakeholders) are minimal.
- If single-use plastics are replaced with alternatives characterised by larger overall environmental footprints (as is the case e.g. when single-use paper carrier bags replace plastic carrier bags), the environmental impact of a policy may be diminished. As such, the focus and scope of market-based policies addressing single-use plastics should be motivated by evidence from life-cycle analysis.
- Directing price signals at consumers may make them more salient than if directed upstream, inducing a stronger behavioural response.
- Earmarking revenues from taxes and mandatory charges may not be the most efficient way to manage them, but it may support policy acceptance if revenues are directed to environmental protection projects.
- Exploiting market-based instruments can deliver environmental improvements (in this case, single-use plastic waste prevention) at a lower economic cost than inflexible regulations, enabling behavioural and production adaptation, as well as technological innovation. However, if consumer sensitivity to prices of single-use plastic goods is low, market-based policies may result in lower environmental effectiveness than regulatory policies.

# 3. Regulatory policies

Regulatory policy instruments, also known as command-and-control instruments, aim to constrain polluting consumption and production practices by instituting legal limits on pollution emissions or requirements of sustainable practices.

In the single-use plastics sector, this has translated into two main kinds of regulation: bans on specific products, intermediate goods or materials, and standards mandating the use of certain materials or production techniques. These regulations are discussed in detail below.

## Policy coverage: products and materials

### *Bans*

We can distinguish different categories of bans related to single-use plastics:

a) bans on specific *final goods*, e.g. single-use plastic carrier bags, specific packaging types, straws, cutlery;

b) bans on *goods with specific features*, e.g. plastic carrier bags with certain thickness attributes;

c) bans on *specific materials*, e.g. biodegradable plastics, oxo-degradable plastics;

d) bans on *intermediate components*, e.g. plastic microbeads used in the manufacturing of cosmetics.

Worldwide, the application of regulatory policies to single-use plastics has mainly taken the form of bans on specific single-use plastic products: 91 countries have implemented bans on plastic carrier bags, while 27 countries have limited the production or consumption of other specific single-use plastic goods (e.g. straws, cutlery) or materials (e.g. polystyrene). After plastic bags, the most banned products are plastic plates, cups, stirrers and cutlery (12 bans), followed by packaging and plastic bottles (6 bans each) and take-out food packaging (5 bans): this indicates that the magnitude of policy action differs importantly across single-use plastic goods (UN Environment, 2018[11]). Box 8 presents an example of a product ban and of the range of actions put in place to support its implementation.

### Box 8. Case study from Belgium: the Flemish ban on disposable cups at public events

Starting in 2020, organisers of events in the region of Flanders, Belgium, will no longer be allowed to offer disposable cups for beverages, unless over 90% of them can be separately collected for recycling.

This policy initiative has been motivated by a study assessing the aggregate environmental footprint of different drinkware and tableware options for events (cups, mugs, glasses, plates, bowls and cutlery), considering different material and disposal options. Drawing upon 22 life-cycle analyses, the study presents evidence that reusable tableware products always deliver a lower environmental footprint relative to single-use ones; for drinkware, the only single-use option with a comparable environmental footprint to reusable ones is using recycled PET cups. Building on this set of evidence, a handbook (OVAM, 2017[55]) and an online tool (OVAM, 2019[56]) addressing event organisers have been developed to explain the rationale of the policy initiative and to support and simplify product choice considering specific needs and contextual features.

A similar measure has been put in place within public institutions: starting in 2020 and 2022, disposable packaging (in plastic, glass, paper) can no longer be used respectively to serve drinks and prepared foods.

Source: personal communications with OVAM; (OVAM, 2017[55]).

Empirical evidence on the effectiveness of such bans is limited: aside from certain pioneering efforts implemented in the early 2000s, most of these policies have been implemented in the past 5 years: data on their outcomes is thus relatively limited.

While the environmental effectiveness of a tax or charge in preventing waste generation depends both on the variation in demand for targeted and for substitute goods, the impact of product bans depends entirely on the substitution effects they entail, i.e. on the environmental footprint of goods they are substituted with. As such, assessing the behavioural and environmental impact of bans requires the observation of consumption patterns of substitute goods.[13] As the set of substitute goods may be considerably large, a complete evaluation of substitution patterns may be complex: this could be an explanation for the limited number of studies empirically assessing the impacts of bans.

The environmental effectiveness of many such product bans has been measured through the lens of reduced littering, which has often been the lead motivation for their implementation, alongside objectives for waste prevention: some evidence is presented in Box 9. In contexts where single-use plastic waste is incinerated outside specialised plants, incineration leads to toxic air pollution emissions: bans on single-use plastic goods, reducing this stream of waste, indirectly contribute to curbing such emissions (UN Environment, 2019[57]).

### Box 9. The impact of product bans on littering. Evidence from California

If a product ban is appropriately implemented, it will stop the littering of banned products by removing them from the market. However, if these products are replaced with single-use items made of other materials, a ban will not prevent waste generation nor littering altogether.

Certain bans have successfully curbed littering: following the implementation of a ban on single-use plastic bags in 2011, the city of San Jose, California, reported litter reduction by "approximately 89 percent in the storm drain system, 60 percent in the creeks and rivers, and 59 percent in City streets and neighborhoods" (Scientific American, 2014[58]) compared to pre-ban levels.

On a larger scale, after California implemented a state-wide ban on the sale of single-use plastic bags in January 2017 (CalRecycle, 2019[59]), plastic bag litter recovered during yearly clean-up operations was reported to drop by 76% compared to 2010, with plastic bags accounting for less than 1.5% of total littered items, compared to 7.4% in 2010 (Ocean Conservancy and International Coastal Cleanup, 2011[60]; 2018[13]).

However, there are also examples of bans leading to rebound effects in littering: waste audits indicated an important increase in the littering of substitutes of expanded polystyrene foam cups following their ban in the city of San Francisco in 2007. While the waste audit indicated a 34% reduction in littered polystyrene cups in 2009 relative to the 2007 baseline, littering of paper cups for hot beverages and of plastic cups increased respectively by 141% 72% ***(HDR / BVA Engineering and MGM Management, 2009[61])***.

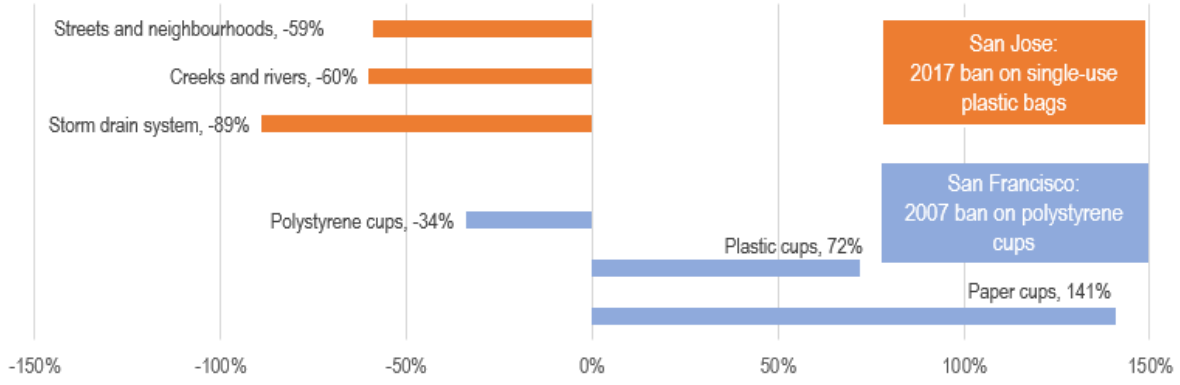
Considering the full environmental impact of bans is complex: in the case of plastic bags, evidence presented in Box 5 indicates that the life-cycle environmental footprint of the most common alternatives (i.e. paper or bioplastic bags) may be greater than that of plastic bags. Thus, unless bans induce shifts to other, more sustainable substitute goods, they may have an overall negative environmental impact.[14]

[13] This relies on the assumption that bans are perfectly enforced, or banned products may still leak on the market.

[14] The efficacy of bans is often measured through their impact on littering. However, the LCAs considered in this study (Box 5) have not considered littering in the system boundary. Instead, the studies modelled impacts based on more formal waste management.

Figure 3 provides a visual depiction of the littering effects of bans implemented at local level in California, United States.

## Figure 3. Littering impacts of selected bans on single-use plastic goods




Note: estimates relate to the impacts of different bans on littering over different periods of time, hence they are not comparable. Estimates from San Francisco refer to littering of polystyrene cups and their substitutes in plastics and paper. Estimates from San Jose report the effect of the ban on littering of plastic bags in different milieus.
Source: (HDR / BVA Engineering and MGM Management, 2009[61]), (Scientific American, 2014[58]).

Nonetheless, in certain cases bans may be justified to prevent and counter specific environmental hazards: for example, bans on plastic microbeads can be justified in order to avoid the risk these particles pose to ecosystems, animal and human health. Such bans focus on a specific intermediate good, which reaches the market as part of other more complex products (e.g. cosmetics). As of July 2018, microbeads bans exist in Canada, France, Italy, Korea, New Zealand, Sweden, the United Kingdom, and the United States. While most regulations only concern cosmetics and toiletries, the ban in New Zealand also applies to abrasive cleaning products and car or industrial cleaning products (UN Environment, 2018[11]).

Product bans implemented thus far have rarely encompassed the entirety of a specific sector, even in the case of plastic bags. Certain bans apply to goods with specific characteristics, such as lightweight bags,[15] which are particularly fragile and thus harder to reuse and more prone to littering and clogging pipes: varying thickness restrictions have been implemented in 38 countries worldwide (UN Environment, 2018[11]).

Conversely, certain categories of use are often exempted from plastic bag bans: examples include bags used to wrap fresh, perishable food, dry-cleaned garments or items purchased at duty-free shops in airports.

Goods manufactured with *specific materials* (e.g. recycled plastics or biodegradable plastics) have at times been exempted from bans, similarly to the approach taken with some taxes and charges. For example, Italy banned non-biodegradable plastic carrier bags in January 2011: this measure has effectively made biodegradable compostable carrier bags the new default options available for sale at major retail chains (Corriere della Sera, 2011[62]). As indicated in Box 5, this change in materials use may entail environmental burden-shifting.

[15] Some countries specify the thickness of bags concerned by regulation (e.g. below 50 microns), but the definition of thin or lightweight bags varies across countries.

Bans on specific plastic polymers, such as polystyrene, are common in Pacific islands (UN Environment, 2018[11]) and, at city and county level, in the United States, where several local-level bans on polystyrene in the restaurant sector have been implemented in the past 10 years (Wagner, 2020[63]). The state of Maine, for example, recently passed a law introducing a ban on polystyrene food containers, which will become operational in 2021 (Del Valle, 2019[64]).

Oxo-degradable plastics, or oxo-plastics, are another material category that has attracted the attention of regulators. These are "conventional plastics that contain additives which promote the oxidation of the material under certain conditions" (ECHA, 2018[65]), potentially disintegrating into microplastics. They are used in single-use items such as carrier bags and food packaging, but also in agricultural film and landfill covers. At the EU level, the EU Plastics Strategy has requested the European Chemical Agency to assess the scientific basis on oxo-plastics for taking regulatory action at EU level (European Commission, 2018[14]). Certain countries have already taken regulatory action: for example, partly or entirely oxo-degradable packaging or bags have been banned since 2015 in France (JORF, 2015[66]) and the EU has banned the use of oxo-degradable plastics in all products (EU Lex, 2019[67]).

Material-specific bans are likely to elicit different behavioural responses with respect to bans on intermediate goods or on products with specific features. Banning a specific material or an intermediate good puts the onus on producers, who need to opt for alternative inputs into their production process in order to deliver a final good with the same features. As the development of suitable alternatives may require time, consumers' welfare may be reduced in the short term. Conversely, a ban on specific product features (e.g. thin plastic bags) need not necessarily reduce consumer welfare, as suitable alternatives are likely to be more promptly available. If producers have a portfolio of goods with, for example, different thickness features, they may be able to swiftly put alternatives on the market.

Likewise, different regulatory exemptions and requirements entail different environmental impacts. The impact of a ban on a good manufactured with specific materials or features depends on the environmental footprint of the alternatives which will replace it. For example, if single-use plastic bags are banned and mainly replaced with biodegradable plastic bags, the life-cycle analyses discussed in Box 5 have shown the overall environmental impact may be negative. Further, littering habits may not necessarily change with similar goods manufactured with different materials, but bans may still visibly reduce single-use plastic litter. Box 10 provides further evidence on the environmental footprint of other single-use products when manufactured in plastics as opposed to paper or wood.

### Box 10. Environmental impact of different materials for single-use products: evidence from LCA

In order to assess the potential implications of a large-scale EU ban on a range of single-use plastic items, the Danish Environmental Protection Agency commissioned a life-cycle analysis comparing the impact of single-use plastic and non-plastic (paper, wood) goods such as cotton buds, cutlery, food containers, straws and stirrers (Takou et al., 2018[68]). Biodegradable plastics and reusable options are not considered. The focus is on the environmental impacts of production and end-of-life management (recycling and incineration), excluding transport to market and use. The impact categories considered include climate change, human and ecosystem ecotoxicity, eutrophication, acidification and resource depletion. The geographical area of reference is Denmark.

For all products considered aside from food containers, single-use non-plastic options performed on average better or on par with single-use plastic options. Product weight matters for the definition of preferable options whenever indirect land use changes are an issue: nonetheless, for average product weight, the wooden option performed better than the plastic option in cutlery and stirrers. Conversely, the polypropylene cotton buds performed better than the paper ones.

The lower weight of plastics packaging with respect to equivalent packaging manufactured with other materials is an important driver of their difference in environmental footprint. A 2016 report commissioned by the American Chemistry Council quantifies the environmental cost of consumer goods and packaging manufactured in plastics as opposed to alternative materials (e.g. aluminium, paper, glass, steel and tin plate), considering GHG emissions, air, water and land pollution, water depletion and ocean impacts (Trucost, 2016[69]). While for most materials, the environmental cost per kg is lower than that of plastics, alternative materials are generally needed in larger quantities (on average, up to 3.8 times more) to perform the same function, increasing the environmental footprint of the same product. However, the report does not compare plastics-manufactured packaging with similar packaging produced with an alternative material, but rather considers a weighted average of alternative materials available on the US market, complicating comparisons.

The report also notes that 80% of the environmental cost of consumer plastic products and packaging is associated with resin production, product manufacturing and transport to market. Costs associated with potential littering are disregarded.

A recent study by Zero Waste Europe and Friends of the Earth Europe for the Rethink Plastic Alliance provides a critical assessment of selected LCA studies focusing on food and beverage packaging. By generally ignoring littering as a potential disposal mode of packaging, studies tend to downplay end-of-life environmental impacts. Associating a relatively greater weight to GHG emissions than to end-of-life environmental impacts of packaging may have contributed to the popularity of food and beverage packaging options which are harder to reuse and recycle (e.g. pouches) ***(Schweitzer, 2018[70])***.

### *Standards: material requirements*

Material requirements are standards imposed on the use of specific materials for the manufacturing of certain goods. Such regulatory tools can be modulated to require goods to be manufactured fully or partly according to certain standards (e.g. requirement to include a certain percentage of plant-based plastics or recycled plastics in manufacturing of specific products).

The Italian mandatory charge on bags used to wrap fruits and vegetables in the retail sector has been paired with a requirement that such bags be manufactured with biodegradable, compostable plastics. Similarly, the city of Seattle, in the United States, implemented a ban on expanded polystyrene in 2009 and a ban on non-recyclable, non-compostable disposable food packaging and service ware in 2010. A further ban in 2018 was implemented on single-use plastic utensils and straws (Seattle Public Utilities, 2021[71]). Therefore, businesses must opt instead for compostable or recyclable products. The city has issued approved product listings to ensure that compostable products are compatible with technology used in local composting plants (Seattle Public Utilities, 2019[72]).

Material requirements can be leveraged to support markets for secondary plastics: in the region of Flanders, Belgium, waste bags will need to include a minimum of 80% recycled plastics as of 2021, reaching 100% in the longer run.[16] The feasibility of such standards depends on the characteristics of the goods it applies to: products without strict hygienic requirements might be lower-hanging fruits.

As they affect technology choices for producers by limiting their input choice, material requirements are a special type of technology standard. They ensure both relatively higher adoption and compliance incentives with respect to price signals, and certainty over the type of materials used by each producer and over the associated emissions. On the other hand, mandating the use of certain materials under the assumption they are preferable for their end-of-life impacts allows no flexibility over the choice of technologies to minimise waste generation: as a consequence, this type of standard provides no incentives to innovate and cannot be easily adapted as the context evolves. Further, monitoring compliance with

[16] Source: personal communications with OVAM.

material requirements may be costly, when these can be mixed in certain proportions with other materials (OECD, 2011[73]).

According to the cost of the mandated material relative to that of materials currently used in production, the material requirement is going to alter production costs for single-use plastic goods and, as such, their market price. As a consequence, the behavioural response of consumers will depend on their sensitivity to price variation as well as on their preferences for specific materials.

In terms of environmental impacts, as the production of virgin polymers is more energy-intensive than the recycling of secondary plastics, the latter process has the potential for reducing an important share of the greenhouse gas emissions associated with the plastics lifecycle (Michaud et al., 2010[74]). The environmental impact of biodegradable plastics has been discussed in Box 5 for the use case of carrier bags; similar lifecycle analyses should be performed prior to mandating such material requirements.

## Policy target: life-cycle stages

Bans can be designed to target the manufacture, import, or retail stage, thus applying to different actors along the value chain of the same good. However, about half of the countries banning single-use plastic bags or other single-use plastic goods have jointly addressed all market entry options (manufacture, importation and retail). Countries regulating microbeads generally ban them from sale, with few also including bans on manufacturing and imports.

The choice of policy approach varies somewhat across regions: when it comes to the regulation of plastic bags, for example, African countries have opted for broad restrictions, covering both manufacture, retail distribution and import, whereas European countries have mainly acted through bans at the retail distribution level.

For consumers, bans on the production or sale of single-use plastic goods lead to the same effects: as these regulatory interventions effectively remove a consumption option from the market, bans do not provide multiple margins for behaviour to adapt. The only behavioural response for consumers is to choose among the available alternatives.

In presence of a ban on sales of single-use plastic goods, producers need to shift production processes towards alternative inputs while maintaining the same product features, if they are to preserve their market share or remain in business. However, this might be difficult or impossible for certain goods: maintaining their performance may require additional R&D efforts. Alternatively, products could be exported to markets where single-use plastics are allowed – which is not possible if the ban addresses manufacturing rather than sales.

## Stakeholders: governance, focus and coverage

Bans on single-use plastic goods have been implemented both at national and sub-national levels, with several cities, counties and provinces taking regulatory action e.g. in the United States and Canada. In the United States, some states have passed laws preventing counties and cities to implement policies constraining the consumption of single-use plastic goods (NCSL, 2019[75]).

When it comes to the stakeholder coverage of regulatory policies, specific categories of stakeholders can be temporarily or permanently exempted from the application of single-use plastic bans, for feasibility or equity reasons.

For example, while Chile has implemented a ban on plastic bags at checkout in supermarkets in February 2019, small shops have been granted an additional two years to adapt to the policy (El País, 2018[76]). As discussed in the case of tax exemptions for specific categories of shops, such exemptions may hinder behavioural change, as consumers are faced with asymmetric commercial practices across the retail sector.

Bans can also involve exemptions for vulnerable consumer categories: in the city of Seattle, United States, the ban on single-use plastic straws does not apply to people relying on them because of a medical condition (Seattle Public Utilities, 2019[72]). This type of exemption has the objective of enabling a small number of users with particular needs to still benefit from goods which are generally prone to littering, protecting these social groups from disproportionately negative policy impacts.

### Accompanying measures

In certain jurisdictions, bans on single-use plastic goods have been implemented together with mandatory charges, generating hybrid market-based and regulatory policies.

The joint impact of such hybrid policies has been assessed, for example, in the context of three Californian cities which have banned single-use plastic bags while mandating that all reusable bags be priced at least USD 0.05 as of January 2014 (Taylor and Villas-Boas, 2016[77]). Even when a ban on plastic bags is coupled with paper bag charges, the demand for the latter, which become the default single-use option, generally undergoes a significant increase. However, single-use paper bag consumption increases less at stores providing cheap, reusable options: the addition of an affordable reusable carrier bag seems to be crucial in preventing the shift from a single-use, plastic-based option to an alternative single-use option.

As a consequence, the availability of different reusable and single-use options at a range of affordable prices is determinant for the aggregate environmental impact of the policy, as each type of bag as a different environmental footprint.

#### Box 11. Regulatory policies: key insights

- The most common regulatory policy for plastic waste prevention is the plastic bag ban. The empirical evidence on the impacts of plastic bag bans is limited and very circumstantial; many studies have focused on bans applied to local communities.
- The environmental impact of a ban entirely depends on the alternatives available to consumers and producers and on their behavioural and technological response: if other single-use goods replace single-use plastics, the environmental effectiveness of these regulatory policies may be limited.
- Material requirements are a special type of technology standard, mandating producers to adopt certain materials in specific proportions (e.g. biodegradable or recycled plastics). Such standards have at times been paired with market-based policies, in order to support alternatives to virgin plastics.
- When aiming to reach a certain pollution abatement target (in this case, a given objective for plastic waste prevention), the inflexible nature of regulatory policies may cause them to be a costlier option for the economy as a whole than market-based policies. However, implementing stringent regulatory policies may be justified by the precautionary principle, in jurisdictions where this is relevant, as is the case e.g. for bans on microbeads.

# 4. Voluntary approaches and other policy measures

Voluntary approaches towards environmental preservation (in this case, waste prevention) through the discussion between policy makers and industry are commitments to improve environmental performance beyond legal requirements, often designed with the participation of third parties such as environmental NGOs. Their objective is to provide a prompter and more flexible solution to emerging environmental issues than by designing, implementing and enforcing other policy measures such as market-based and regulatory instruments (OECD, 1999[78]).

The speed at which the topic of plastics has gathered high attention into the public sphere has generated the momentum for voluntary approaches, with industry keen to show efforts to curb the negative externalities associated with plastics production, littering and with improper disposal. Because of this combination of phenomena, many voluntary initiatives have sprung up in the past five years.

### Table 1. Voluntary approaches for environmental policies

| | Typology of voluntary approaches | | |
|---|---|---|---|
| | Definition | Parties involved | Example related to single-use plastics prevention |
| *Public voluntary programmes* | Commitments devised by a public institution (e.g. environmental agency, ministry of environment, NGO) in which firms are invited to participate ("optional regulations")[17] | Public authority (e.g. environmental agency, ministry); individual firms or sectoral associations | New Plastics Economy Global Commitment (led by the Ellen MacArthur Foundation);<br>Netherlands Plastics Pact (led by Ministry of Environment) |
| *Negotiated agreements* | Commitments for environmental protection developed through bargaining between a public authority and the industry | Public authority (e.g. environmental agency, ministry); individual firms or sectoral associations | UK Courtauld Commitment (funded by UK governments, monitored by WRAP) |
| *Unilateral commitments* | Commitments set independently by the industry, without any involvement of a public authority | Individual firms or sectoral associations | Alliance to end plastic waste.<br>Initiative of the French retail association (FDD) to reduce single-use plastic bags.<br>Company-level commitments within the New Plastics Economy Global Commitment (led by the Ellen MacArthur Foundation)[18] |
| *Private agreements* | Negotiated between a firm or sectoral group and those who are harmed by its pollution emissions | Individual firms or sectoral associations; affected social groups | |

Source: (OECD, 1999[78])

[17] This definition expands upon the one included in OECD (1999[45]) by recognising the role played by charities (e.g. WRAP) and NGOs (e.g. Ellen MacArthur Foundation) in spearheading the voluntary approach to environmental protection.

[18] The New Plastics Economy Global Commitment contains features of both public voluntary programmes (whereby firms sign national-level commitments connected to the broader Global Commitment, such as the UK Plastics Pact) and unilateral commitments (whereby firms make their own pledges, without connections to national policy frameworks).

Table 1 summarises the typology of voluntary approaches developed in OECD (1999[78]), providing examples of different types of agreements in the context of prevention of single-use plastics waste. Most voluntary approaches in the context of single-use plastics are public voluntary programmes, whereby businesses adhere to voluntary commitments proposed by a coordinating institution – most commonly, the Ministry of Environment, environmental regulatory agency or an NGO focusing on waste and circular economy.

Unilateral initiatives have also been popular, whereby businesses set independently more ambitious objectives than required by environmental regulations, either as an individual institution or as a sectoral association. Table 2 summarises the main features of voluntary approaches, which concern their set-up, scope, governance and enforceability. The implications of such features are discussed in the next section, with reference to specific voluntary initiatives.

Voluntary standards can help to establish requirements at the product or process level (Rousset et al., 2015[79]) and can take the form of public voluntary programmes or unilateral commitments and are typically developed by industry associations and firms (OECD, 2006[80]). For example, the European Commission co-financed the development of a certification scheme for post-consumer plastic recyclers (EU CertPlast) tied to European Standard EN 15343:2007 (EU Certplast, 2018[81]). Product and process specific requirements for certification help to inform participant recyclers' customers about their supply chain and facilitates the customers' fulfilment of commitments for recycled content in single-use plastic applications.

### Table 2. Main features of voluntary approaches

| | Main features of voluntary approaches (VAs) | |
|---|---|---|
| Individual / collective | Individual VAs involve single firms. Collective VAs involve multiple firms from the same industry, sector or value chain, | Most VAs in this sector are collective, but specific private actors (e.g. retail chains) may put in place individual, unilateral commitments. |
| *Local / … / global* | VAs can be negotiated at the local level, between an environment agency and a specific firm to solve a specific environmental issue. For broader environmental problems, VAs can be negotiated and implemented at regional, federal, national or global level. | Local VA: Netherlands Plastics Pact.<br>Global VA : Ellen MacArthur Foundation Global Commitment |
| *Binding / non-binding* | With binding VAs, contractual obligations lie with the industry, while public authorities may be in charge of specific tasks (e.g. set up a database to monitor baseline situations and evolving efforts, facilitate knowledge-sharing). Enforcement can rely on a body specified in the contract (e.g. arbitration committee) or on contract law litigation. | Binding VA: Netherlands Plastics Pact. |
| *Open / closed access to third parties* | VAs may be open or closed to third parties such as green NGOs or academic experts. | VA open to third parties: the New Plastics Economy Global Commitment includes governments, industry, research groups, NGOs. |
| *Target-based / implementation-based* | Target-based VAs set specific pollution abatement objectives.<br>Implementation-based VAs establish the implementation measures needed to reach objectives set in legislation. | Most VAs in this field are target-based. |

Source: (OECD, 1999[78])

Over the past five years, the number of international and national voluntary initiatives has increased, brokered by both public institutions and specialised NGOs. These initiatives are very important for their scope and ambition, as they set quantitative objectives affecting a number of economic actors and single-use plastic goods, but because they are very recent initiatives, evidence on their impacts is very limited.

However, some evidence can be drawn from longer-lived agreements implemented in the 1990s or in the early 2000s, often with a national geographical coverage and a narrower product focus (e.g. plastic bags).

Previous OECD work on voluntary approaches in environmental policy making can also help shed light on the economic effects of VAs (OECD, 2003[82]): because of the flexibility characterising such approaches, it is unlikely that they will achieve maximum economic efficiency by equalising the marginal costs of pollution abatement – in this case, of curbing the generation of single-use plastics waste.

Voluntary approaches can effectively deliver environmental improvements beyond business-as-usual levels if they push forward ambitious objectives. This depends on a credible threat of additional regulatory action to ensure concrete additional efforts from involved parties. If voluntary targets are not sufficiently ambitious, because of excess caution or uncertainty regarding pollution abatement costs, VAs may not provide a substantial incentive in terms of environmental improvements, while still allowing participating businesses to claim such abatement efforts as additional. As such, investing in background work, including the understanding of background levels of single-use plastics production, consumption and waste generation, together with the relative costs, is fundamental in order to design realistic yet ambitious voluntary approaches (OECD, 2003[82]).

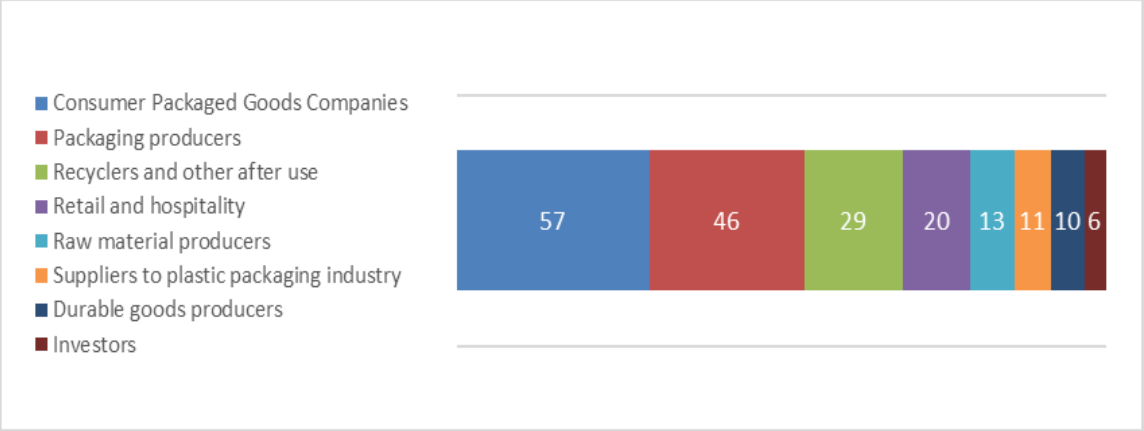
## Policy target: life-cycle stages

Voluntary initiatives focusing on single-use plastics can separately or jointly address the different stages of the plastics life cycle: plastics production, manufacturing of consumer goods and packaging, retail and end-of-life (including e.g. actions to support recycling and actions to limit littering).

The New Plastics Economy Global Commitment, described in detail in Box 12, is arguably the plastics-related voluntary initiatives with the broadest coverage in terms of stakeholders involved. More specifically, the Global Commitment brings together producers of raw materials, manufacturers (producers of consumer goods, packaging, durable goods as well as their suppliers), retailers as well as investors.

As shown in Figure 4, while manufacturers and retailers are numerous among the signatories and make up for over 20% of the global packaging market, recent progress report states that "[t]he step in the value chain currently least represented by the signatories to the Global Commitment is raw material producers" (Ellen MacArthur Foundation, 2019[83]).

### Figure 4. Business signatories to the New Plastics Economy Global Commitment




Source: data from (Ellen MacArthur Foundation, 2019[83]).

### Box 12. The New Plastics Economy Global Commitment

The New Plastics Economy Global Commitment is a voluntary initiative spearheaded by the Ellen MacArthur Foundation, a leading NGO in the circular economy sector, in collaboration with UN Environment. It contains features of both public voluntary programmes (whereby firms sign national-level commitments connected to the broader Global Commitment, such as the UK Plastics Pact) and unilateral commitments (whereby firms make their own pledges, without connections to national policy frameworks).

The Global Commitment lays out a vision for a circular economy of plastics. More specifically, for *plastics packaging*, this vision is described by the six following characteristics:

1. Elimination of problematic or unnecessary plastic packaging through redesign, innovation, and new delivery models is a priority.
2. Reuse models are applied where relevant, reducing the need for single-use packaging.
3. All plastic packaging is 100% reusable, recyclable, or compostable.
4. All plastic packaging is reused, recycled, or composted in practice.
5. The use of plastics is fully decoupled from the consumption of finite resources.
6. All plastic packaging is free of hazardous chemicals, and the health, safety, and rights of all people involved are respected.

This vision sets the tone for specific commitments for all signatories, which include businesses, governments as well as research institutions and NGOs. Business commitment include quantitative objectives with the time horizon of 2025: the 123 consumer packaged goods, retail, and packaging producing signatories have pledged to making 100% of their plastic packaging reusable, recyclable, or compostable. Consumer packaged goods and retailers have committed to a material requirement which will bring the average recycled content in plastic packaging from an estimated 2.5% to 25%.

While there is no formal monitoring or enforcing authority in a voluntary agreement, mutual peer pressure and transparency are the keys to advancing towards voluntary goals: in this case, adhering businesses commit to reporting annually and publicly on progress towards their objectives and pledges.

The governments of Chile (June 2019), France (February 2019) and the United Kingdom (April 2018) have already launched national Plastics Pacts building upon the Global Commitment, with more specific quantitative objectives and standards (see Table 3).

A similar agreement developed at a larger scale, the European Plastics Pact, is being led by France, the Netherlands and Denmark: it is a coalition network of companies, governments and NGOs whose aims are to cooperate along the value chain of single-use plastic products and packaging, share good practices and harmonise actions across borders (European Plastics Pact, 2020[84]).

Source: (Ellen MacArthur Foundation, 2019[83]).

The Netherlands Plastics Pact led by the Ministry of Infrastructure and Water Management counts 75 signatories, including businesses, foundations and sectoral associations. Among them are 37 plastics-using companies in the manufacturing of consumer goods or packaging (i.e. food, beverage and packaging industry) or in operations (i.e. retailers, hospitality industry, logistic providers, caterers and event organisers). Conversely, only 17 plastics-producing companies are represented (including producers of virgin, bio-based and recycled plastics in the chemical industry, in the fossil-based and bio-based plastics industry and/or in the waste processing and recycling industry).

The possible reason behind this relative under-representation of raw material producers is due to the fact these voluntary initiatives have recently explicitly focused on packaging – such explicit focus is present both in the Global Commitment, in the British, French and Dutch Plastics Pact. As such, it is natural that manufacturers have responded in greater numbers to the call to action. Further, the market segment of plastic production tends to be more concentrated than that of packaging manufacturing, presenting fewer economic actors. These policy initiatives, government commitments supported both by voluntary agreements with businesses and with other policy actions, are schematically described in Table 3.

### Table 3. National Plastics Pacts: a comparison of objectives

| | France<br>By 2022 / 2025 | UK<br>By 2025 | Netherlands<br>By 2025 |
|---|---|---|---|
| **Avoidance** | End the use of PVC in household, commercial and industrial packaging by 2022, and take steps to eliminate other problematic or unnecessary plastic packaging by 2025, starting with EPS. | Eliminate problematic or unnecessary single-use packaging through redesign, innovation or alternative (reuse) delivery models.<br>Note: this includes broad categories such as oxo-degradables, PVC and polystyrene packaging. | Avoid unnecessary use of plastic materials through reduced use, more reuse and/or use of alternative, more sustainable materials, resulting in a 20% reduction in the amount of plastics (in kg) relative to the total amount of single-use products and packaging placed on the market in 2017. |
| **Features of packaging** | Reusable and 100% recyclable by 2025 | 100% should be reusable, recyclable or compostable | All are reusable where possible and appropriate, and in any case 100% recyclable. |
| **Recyclability or compostability** | 60% recycled by 2022 | 70% should be effectively composted or recycled | At least 70% (by weight) are recycled to a high standard |
| **Recycled content** | 30% average recycled content across all plastic packaging | 30% average recycled content across all plastic packaging | Highest possible percentage of recycled plastics (in kg), with each company achieving an average of at least 35%. The plastics used will as much as possible be sustainably produced biobased plastics, in order to reduce the use of virgin fossil-based plastics. |

Source: (Ministère de la Transition Écologique et Solidaire, 2019[85]) (WRAP, 2019[86]) (Ministry of Infrastructure and Water Management of the Netherlands, 2019[87])

Other voluntary initiatives have focused on collecting single-use plastic products: an example is the implementation of the American Chemistry Council's Wrap Recycling Action Program in the United States. This program has helped states and municipalities partner with grocery and other retail stores to introduce collection points for plastic bags, wraps, and other films, as well as to increase consumer awareness of these recycling opportunities and of products containing recycled content film materials. While these types of programs do not necessarily reduce the volume of single-use plastics being produced and generated as waste, they do contribute to the prevention of littering of these products as well as the incorporation of recycled content into future products.

## Policy coverage: products and materials

As mentioned in the previous section, recent voluntary approaches aimed at preventing the generation of single-use plastic waste have explicitly focused on packaging goods. Thus, this type of policy approach has recently taken aim at specific products while specific materials (in this case, polymers) have not been as central in discussions.

This marks an important development with respect to recent market-based and regulatory actions, which have predominantly focused on specific products, largely plastic bags: in fact, the coverage of recent voluntary approaches is substantially broader, reflecting the complexity of plastics as a multi-purpose material.

As indicated in Table 3, the UK Plastics Pact aims to eliminate problematic or unnecessary single-use packaging. Such products are defined as problematic or unnecessary if their use is avoidable, if reusable alternatives are available, if they are not recyclable or hamper the recycling process (due to their format, composition or size) or if they pollute the environment (WRAP, 2019[86]). The eight categories of plastic products which are to be phased out by the end of 2020 are: disposable plastic cutlery, cotton buds, stirrers, straws, disposable plates and bowls, oxo-degradables, all polystyrene packaging and PVC (polyvinyl chloride) packaging. The list includes both specific products and broader polymer applications (i.e. PVC and polystyrene for packaging) (WRAP, 2019[88]). Similar references to PVC and EPS (expanded polystyrene) are included in the French Plastics Pact (Ministère de la Transition Écologique et Solidaire, 2019[85]).

While the UK Plastics Pact has identified eight goods as priority for business commitments, it has also pinned down a broader set of 19 problematic and unnecessary single-use items and materials to be further investigated, proposing key actions for Pact members to consider in order to start addressing their adverse impacts (WRAP, 2019[88]). A progress report (WRAP, 2019[89]) published a year after the launch of the Pact highlights the achievement and planned actions of 45 adherents with respect to the four objectives listed in the Pact (see Table 3). While it is not mandatory for signatories to follow specific guidelines for reporting, some of them attempt to quantify the waste prevention impact of their initiatives. Overall, the report states that these concrete actions have prevented tons of plastics waste generation thanks to packaging optimisation, removal of single-use plastics options from sale, as well as resource-efficient design innovations and shifts towards recyclable materials (WRAP, 2019[89]).

Previous national voluntary initiatives, such as the 1991 Covenant on Packaging in the Netherlands and the 2005 Courtauld Commitment in the United Kingdom focused on packaging as a whole, thus covering both plastics and other materials such as plastics, cardboard, glass. Box 13 and Box 14 provide some evidence on the effects of these older agreements.

### Box 13. The Dutch Covenants

In the Netherlands, covenants (voluntary agreements negotiated between industry and governments) have been long established as a useful policy instrument to engage relevant stakeholders early in the decision-making process for new environmental policies. This approach can help minimise any opposition to proposed measures at later stages.

The prevention and recycling targets for packaging, established in the 1988 Memorandum on the Prevention and Recycling of Waste, were:

- no increase in the amount of packaging generated;
- elimination of landfilling of packaging waste;
- an increase in recycling from an estimated 25 per cent of packaging in 1986 to 60 per cent in the year 2000;
- qualitative waste reduction by removing hazardous materials (e.g. heavy metals, PVC) from the waste stream.

This was followed by a specific Packaging Covenant, which was signed in 1991 and which set the following goals for the year 2000:

- to substitute hazardous packaging materials with less hazardous materials by the year 2000. Beyond 2000, packaging should not contain any hazardous substances, e.g. heavy metals;

- to reduce the total amount of packaging to the 1986 level and, if possible, strive for an additional 10 per cent reduction;
- to promote re-usable packaging, with a target of 60 per cent recycling of disposable packaging, and prohibit packaging disposal in landfills.

Although companies voluntarily sign up to the collectively negotiated objectives included in the Packaging Covenant, they are legally bound by its conditions. If these are not met, they would be enforceable under civil law.

While the Packaging Covenant included specific, more ambitious objectives for paper, cardboard and glass packaging, it did not specifically address plastics packaging. An intermediate review of progress indicated that all of the targets set for packaging waste reduction in 1994 were met. All the goals for product and material re-use for specific waste streams were met, except for plastics.

Source: (OECD, 1998[90]).

### Box 14. The Courtauld Commitment

Between 2005 and 2015, the Courtauld Commitment brought together grocery retailers and suppliers with the objective of reducing food packaging waste (including but not limited to plastics) and household food waste. The agreement involved quantitative objectives along three phases (2005-2010; 2010-2012; 2013-2015), indicating the increasing and renewed ambition of signatories (WRAP, 2019[91]).

The industry agreement was designed and negotiated by WRAP, the Waste and Resources Action Programme, a UK charity focusing on resource efficiency. WRAP also collects waste data from signatories and publishes annual reports, which assess both collective and individual progress with respect to baselines (Ellen MacArthur Foundation, 2019[92]).

Phases 1 of the agreement included objectives to limit the increase in primary packaging waste, and Phase 2 also discussed secondary and tertiary packaging. Quantitative targets involved both the weight and carbon footprint of grocery packaging.

For example, the Commitment aimed to stop growth in packaging waste by 2008 (relative decoupling) and to achieve absolute reductions in packaging waste growth by March 2010 (absolute decoupling). Packaging growth was successfully halted in 2007 despite 1.8% growth in the grocery sector (BIO Intelligence Service, 2009[93]). Further, the agreement successfully prompted packaging innovation, both reducing the material intensity of packaging (e.g. through light weighting) and improving food conservation thus curbing household food waste (e.g. through re-sealable packs).

A new phase of the Courtauld Commitment, launched in 2016, includes objectives to 2025 and focuses on food waste prevention. The UK Plastics Pact instead pushes forward voluntary action concerning plastic waste prevention.

## Stakeholders: governance, focus and coverage

As summarised in Table 2, the governance of voluntary approaches can be diverse (OECD, 1999[78]). According to the number and categories of stakeholders involved as signatories or observers, voluntary initiatives can be individual or collective, and open or closed to parties other than governmental institutions and private firms. According to the geographical scope of their ambition, voluntary approaches may be local, national or global. According to the governance structure of the agreement, they might be binding or not, and signatories may have to report progress and provide data and information to a public overseeing institution or NGO appointed as "broker" of the agreement by the government.

Voluntary approaches can be distinguished, inter alia, according to their geographical scope of ambition. From the local and national initiatives implemented in the 1990s and early 2000s, booming public attention to the issue of plastics pollution has motivated the emergence and implementation of global-level voluntary initiatives.

The high profile of the issue of plastics pollution in public debate has also mobilised attention of different stakeholders. This has reflected in varied leadership of public voluntary initiatives, which have been led not only by governments (e.g. Dutch Plastics Pact), but also by NGOs (e.g. New Plastics Economy Global Commitment, led by the Ellen MacArthur Foundation) and private firms (e.g. Alliance to end plastic waste).

Rather than including only environmental regulatory agencies and private firms, it is the norm for voluntary approaches to be open to third parties as well: for example, research institutions and academics, civil society groups and financial institutions have been included in recent Plastics Pacts. The presence of civil society associations in voluntary approaches can increase pressure to comply with commitments and report on progress.

National governments leading voluntary initiatives have often sought the support of NGOs or other public institutions to negotiate deals (e.g. UK Plastics Pact and Courtauld Agreement, brokered by WRAP) and to monitor progress and compliance (e.g. Dutch Plastics Pact, monitored by the National Institute of Public Health and the Environment).

In Costa Rica, a National Strategy aims to encourage voluntary interventions to shift from single-use plastics to renewable and compostable alternatives. The Strategy explicitly mentions municipalities as another key actor to involve in this effort, alongside public institutions, businesses and civil society (Ministerio de Salud de Costa Rica, 2017[94]).

Voluntary approaches can have binding features: for example, the Dutch Plastics Pact requires signatories to make available baseline data as well as regular data updates to the National Institute of Public Health and the Environment in order to enable consistent monitoring and reporting. Parties to the 1991 Packaging Covenant (see Box 13) were legally bound by its conditions, which were enforceable under civil law.

When voluntary approaches are not legally enforceable, peer pressure from other signatories and observers, together with civil society's scrutiny of regular progress reports, can provide signatories with a strong incentive for compliance and transparency. For example, in the Global Commitment, businesses have agreed to make public both their commitments, action plans and regular progress towards common objectives. Further, 40 businesses have disclosed sensitive information such as annual volumes of plastic packaging production and use, some of them for the first time (Ellen MacArthur Foundation, 2019[83]).

## Policy set-up: target-based and implementation-based agreements

Voluntary approaches can be target-based, setting specific pollution abatement objectives, or implementation-based, establishing the implementation measures needed to reach objectives set in legislation.

Most voluntary approaches on plastic waste appear to involve quantitative targets, such as those listed in Table 3: recently launched Plastics Pacts involve targets both on waste prevention (e.g. through avoidance of unnecessary single-use plastic items) and on increased recycling.

Previous approaches also involved commitments on the reduction of single-use plastic waste, stated either by weight or by number: for example, in a unilateral commitment launched in 2003, the French retail federation (FCD, Fédération du commerce et de la distribution) committed to cut by 15% the number of single-use plastic bags issued at checkout between 2003 and 2006. This objective was attained in one year. More broadly, this number dropped from over 10 billion in 2002 to 500 million in 2015 (BFM Business, 2016[95]).

Recent agreements also include some general implementation-based elements: for example, the Global Commitment recognizes that eliminating problematic or unnecessary plastic packaging requires efforts in redesign, innovation, and new delivery models. As such, government signatories of the Commitment agree to set up incentives for e.g. reuse models in order to support the achievement of quantitative objectives.

## Accompanying measures

Voluntary approaches aim to mainstream the uptake of more stringent standards or the implementation of more ambitious initiatives than required by environmental legislation. These can include market-based initiatives, regulatory initiatives but also information provision and behavioural interventions.

For example, retail chains can voluntarily introduce market-based initiatives: as discussed in Box 15, this can involve the introduction of price signals such as charges on single-use plastic bags or discounts for customers opting for their own reusable bags or mugs.

### Box 15. Voluntary price signals

In order to provide customers with an incentive to shift to reusable options and thus curb single-use plastic waste, businesses may voluntarily introduce price signals such as charges on single-use plastic goods and bonuses for reusable ones.

In theory, these two types of signals, if set at the same level, should result in the same incentive and thus prompt the same behavioural change in customers, provided the cost of behavioural change is perceived as lower than paying such a charge, or higher than receiving such a bonus. However, this may not always be the case because of a behavioural bias known as loss aversion, whereby individuals perceive losses more strongly than gains (Kahneman and Tversky, 1979[96]).

In order to investigate whether loss aversion affects consumption choices even when it concerns very small amounts, Homonoff (2018[16]) analyses the effects of a 0.05 USD tax on disposable bags and a 0.05 USD bonus for using reusable bags, implemented in neighbouring US counties. She finds that only 40% of consumers exposed to the tax used at least one single-use bag per shopping trip, compared to 82% prior to the tax. Conversely, the same-sized bonus for reusable bags, voluntarily implemented by some businesses, had virtually no impact on the use of disposable bags.

Another example of a voluntary price signal is the 0.05 GBP charge on single-use plastic-lined paper cups tested by Starbucks in a subset of its London cafés for three months in year 2018, in collaboration

with NGO Hubbub. This added to a pre-existing 0.25 GBP discount for consumers using a reusable mug. The charge led to increased uptake of reusable cups: more specifically, in the stores trialling the charge, the average percentage of beverages served in reusable cups increased from 2.2% before the trial to 5.8% ***(Hubbub, 2018[97])***. Following this pilot, Starbucks announced it would trial the charge on disposable cups across all its 950 cafés in the United Kingdom ***(Restorick, 2018[98])***.

Recent voluntary initiatives de facto include bans and standards. For example, the UK Plastics Pact includes a commitment of businesses to rule out specific categories of problematic and unnecessary plastic goods (e.g. cotton buds). The Dutch Plastics Pact includes a standard for recycled material content, which requires signatories to include an average of 35% recycled plastics in single-use plastics products and packaging goods.

Information provision can help in supporting the momentum for voluntary commitments from businesses, but also increase the environmental awareness of the public and the acceptance for policy measures requiring behavioural change. Information initiatives can take multiple forms, from public information campaigns, to publications for targeted groups, to mandatory or voluntary product labels.

As part of the UK Plastics Pact, WRAP has produced guidebooks with recommendations on best in class polymers (WRAP, 2019[99]) and eco-design tips for manufacturers (WRAP, 2018[100]), to support the achievement of objectives on recycled plastics content. As part of the Dutch Plastics Pact, the development of a raw materials information system is under consideration.[19]

Finally, businesses and public institutions can put in place voluntary initiatives building upon behavioural insights in order to prevent single-use plastics waste generation. In fact, many behavioural biases affect individual choices surrounding waste generation, sorting, recycling, as well as the choice between single-use and reusable products: Box 16 discusses some of these biases from the perspective of behavioural insights.

An example of a voluntary business initiative building on behavioural insights is food delivery company Deliveroo's shift to offering single-use cutlery on demand rather than by default (Deliveroo, 2018[101]). As discussed in Box 16, because of the so-called status-quo bias, consumers tend to opt for default options built-into transactions rather than to exert effort to opt out of them: if disposable cutlery is offered by default with meal orders, it might be provided also to consumers who do not need it and might throw it away directly. Conversely, asking consumers to explicitly opt in to obtain this kind of meal feature requires a conscious effort, albeit small, thus potentially reducing waste generation. Changing the default policy to a "greener" option is a way to leverage status-quo bias to nudge consumers towards a more sustainable outcome.

### Box 16. Behavioural biases and waste generation

Multiple behavioural biases affect individual choices surrounding waste generation, sorting and recycling, as well as product reuse:

- When it comes to product choice, consumers subject to status-quo bias will naturally opt for standard, default options: if retailers offer by default (and, perhaps, for free) single-use options such as bags, cups or cutlery, consumers are less likely to exert effort and turn to reusable options.

[19] While this initiative is not connected to a voluntary initiative but rather to the ban on disposable cups at public events (see Box 9), the Flemish agency OVAM has developed an information handbook and an online tool to simplify product choice of tableware for event organisers.

- Correct sorting and recycling is hindered by the often-unintuitive design of waste bins. Their framing (design) is often the by-product of complex waste sorting regulations; thus, correctly sorting waste requires a conscious effort rather than an automatic, effortless act.
- Littering is influenced by attitude-behaviour gaps (whereby individuals mindful of environmental issues do not recognise correct waste disposal as a fundamental contribution to the preservation of the environment), by miscalculation of the consequences of littering (both personal, e.g. being fined, and public, e.g. generating an environmental externality) and by negative social norms.

Alongside behavioural biases, various market features hinder the implementation of policies aimed at closing the loop in the plastics sector. At the product choice stage, there is obvious information asymmetry between producers and consumers regarding the possibilities to recycle different materials. In the case of plastics, confusion about compostable or biodegradable plastics may also mislead consumers to think that such materials may biodegrade if abandoned in the environment.

When it comes to household waste generation, consumers rarely receive feedback regarding the amount, type and end-of-life treatment of the waste they generate. Furthermore, it may be complex to connect waste generation to the cost of waste collection, which may be billed to households by their municipality as part of a generic residence tax.

Providing feedback on the amount of waste produced – both in absolute terms and relative to meaningful benchmarks – would make the cost and benefit of waste collection more salient, and could be paired with commitment devices to help households stick to waste prevention objectives.

Source: Adapted from (OECD, 2017[102]).

### Box 17. Voluntary approaches: main insights

- A wide variety of voluntary approaches address single-use plastics waste and plastics pollution at large: these include public voluntary programmes led by governmental institutions or NGOs, negotiated agreements between government and the plastics industry, and unilateral commitments from private businesses.
- After national initiatives in the 1990s and early 2000s, more recent voluntary actions have a global scope, bringing together multiple governments and multinational firms. Such initiatives have mainly focused on plastic packaging, involving more manufacturers and retailers than raw material producers.
- Some voluntary approaches can have binding features. When they are not legally enforceable, however, the credible threat of additional regulation, peer pressure and civil society's scrutiny of regular progress reports can provide each signatory with strong incentives for compliance and transparency.
- Previous voluntary approaches, focusing on all packaging rather than single-use plastics only, have effectively prevented waste generation to a certain extent. Such agreements most often included medium and long-term quantitative objectives for waste prevention, recyclability features of products and recycling rates. However, voluntary approaches are unlikely to achieve maximum economic efficiency, and thus are best accompanied by additional policy incentives.
- Other than objective-setting, voluntary approaches can also involve the implementation of voluntary price signals, such as charges and discounts; regulatory measures, such as bans and standards; information provision, or behavioural interventions.

# 5. Conclusion and policy recommendations

## Comparing alternative policy approaches

This section compares different policy approaches aimed at preventing single-use plastic waste – market-based policies, regulatory policies and voluntary approaches. It synthesises the evidence on their environmental effectiveness and economic efficiency, and explains how these relate to the way consumers and producers react to their introduction. Next, it discusses the environmental and economic implications of features of the context in which such policies are applied. It concludes by discussing areas for future work.

### *Environmental effectiveness*

Most available evidence on the environmental effectiveness of *market-based policies* in curbing single-use plastic waste relates to taxes or charges on carrier bags. These policies have been shown to successfully curb consumption of single-use plastic carrier bags – and, therefore, waste – by 70% to 90%.[20] Evidence on the impact of price signals as applied to other single-use plastic goods (e.g. containers and other packaging) is scarce, as their application has been limited to a handful of cases.

Concerning *regulatory policies*, there is evidence that some *bans* have effectively reduced the littering of targeted single-use plastics in the environment. For example, following the implementation of the San Francisco ban on polystyrene cups in 2007, their littering dropped by 34%. Similarly, following their 2011 ban in San Jose, littering of plastic bags was reduced by 59% to 89%, according to locations.

Because market-based policies and regulatory policies induce different behavioural responses, the type of evidence available on their outcomes and environmental effectiveness is different. Taxes and charges on single-use plastic goods leave consumers free to adapt their consumption levels or shift to alternative options: policy effectiveness is measured by observing the reduction in sales of targeted goods. Conversely, when fully enforced, bans remove from the market specific single-use plastic goods: their environmental effectiveness is measured through the reduction in single-use plastic waste generation and littering.

Data availability on sales and disposal of single-use plastic products is critical to monitor policy effectiveness. Data on product sales can be readily available from retailers and producers, and at times, its disclosure has been built into policy requirements. However, data on waste generation and littering tends to be less detailed and not as readily available: even where plastics are collected separately from other waste streams for recycling purposes, data on specific products ending up in the waste stream may not be available. As such, tracking impacts of bans may rely on bespoke efforts such as waste audits and littering surveys.

In the context of single-use plastics, *standards* have been implemented as material requirements, mandating the use of, for example, biodegradable plastic film or recycled polymers in the manufacturing of specific goods. The environmental effectiveness of these standards relies on producers complying with

[20] Reports on environmental effectiveness often refer to different baselines and time horizons: as such, while still indicating a positive policy impact, figures on policy outcomes are not perfectly comparable. See Figure 2 for further details.

material requirements. Monitoring compliance with technology standards is relatively straightforward when they require the installation of a specific production system or tool. However, when it comes to enforcing the use of materials that can be mixed with alternatives, as is the case with polymers, compliance checks can be more complex and costly.

Most *voluntary approaches* discussed in this report are very recent and, as such, lack a formal evaluation of their environmental effectiveness. However, previous evidence signals that the voluntary approach can successfully curb waste and, to some extent, support eco-innovation efforts, particularly when the regulatory threat is credible, when commitments are monitored and reporting is public.

Critically, during the negotiation of voluntary approaches and ahead of their approval, the regulator may have very limited knowledge of firms' marginal costs of pollution abatement (in this case, waste prevention).[21] As such, medium-term and long-term quantitative objectives risk being set at suboptimal levels (OECD, 2003[82]).

Across all policy approaches, the focus has been on products rather than intermediate goods, materials (e.g. specific polymers) or waste. Whether this is the optimal approach to foster waste prevention is discussed in the next section on policy recommendations.

The environmental effectiveness of waste prevention policies focusing on a specific waste stream, in this case single-use plastics, rests on their capacity to curb their consumption and quick turnover into waste. However, the policies discussed can also have a range of indirect effects with important environmental implications.

Indirect effects of waste prevention policies in this sector include the shift to product or material alternatives with higher environmental footprints (e.g. biodegradable plastics, paper). Such policies may also induce spill-over effects on other environmentally-relevant behaviours (e.g. recycling practices) or on the acceptance of other environmental policies.

### *Economic efficiency*

When discussing the economic efficiency of voluntary approaches, market-based and regulatory policies, a number of broad considerations apply across markets and across pollution issues. Table 4 summarises the strengths and weaknesses of different policy approaches.

Generally, market-based policies such as environmental taxes are more economically efficient than regulatory policies: this is due to multiple reasons (Smith, 2014[103]) (OECD, 2011[104]). First, taxes provide producers with continuous incentives to innovate, in order to reduce their fiscal burden – this is not the case with bans and standards.[22] This means that, when facing a tax on a certain material or product, producers have an incentive to continuously invest in R&D solutions exploiting alternative, untaxed materials: this allows them to meet the same consumption needs with a different product design, with the ultimate aim of paying an ever-smaller amount in taxes. Second, taxes enable consumers to adapt their behaviour in different ways, either reducing their consumption of the taxed good (or of the good at the source of taxed pollution emissions) and shifting to alternatives they consider acceptable, or by keeping

[21] While asymmetric information may hinder the implementation of any policy instrument, this issue may be more acute under voluntary approaches, as coaxing information from voluntary adherents may be more complex than within e.g. a regulatory requirement. On the other hand, if the regulatory threat is credible, adherents to voluntary approaches may be willing to share information in order to avoid more stringent standards.

[22] Most taxes in this context are levied on *products* manufactured with specific materials rather than on *pollution emissions*. Product taxes provide producers with an incentive to change the material with which they manufacture their goods in order to dodge the tax altogether. Conversely, a tax on pollution emissions would encourage continuous innovation: installing progressively more effective pollution abatement technologies would continuously reduce the tax burden.

their consumption steady and paying the corresponding taxes. Conversely, bans remove goods from the market, leaving consumers and producers with the sole possibility of searching for alternatives, with the welfare costs this entails. Once they find a suitable alternative that complies with regulatory restrictions, producers have less of an incentive to innovate to reduce their tax liability. Third, taxes minimise total abatement costs of pollution: they effectively provide a "safety valve" to producers facing excessive costs of pollution abatement (e.g., costs of modifying product design with alternative materials), while incentivising producers who can easily and inexpensively adapt their product design (e.g. by reducing or avoiding single-use plastics) to undertake greater pollution abatement (Smith, 2014[103]).

Thus far, the vast majority of policy actions for single-use plastic waste prevention (be they market-based, regulatory or voluntary) have focused on final products rather than inputs or materials. However, additional policies exist or can be envisioned, targeting different stages of the plastics life cycle: extraction and refinement of raw materials, manufacturing (resins, intermediate inputs, and final goods), waste generation and recycling.

A different policy focus also translates into different levels of economic efficiency: taxing plastic goods is a proxy for taxing plastic waste, which entails lower efficiency relative to the latter. Taxing materials would restrict the number of economic agents subject to taxation relative to taxing goods, potentially simplifying compliance checks and lowering administrative and implementation costs. A similar consideration applies to regulatory tools: banning specific materials rather than products would also target a smaller number of economic actors, while potentially affecting a greater proportion of plastic goods (i.e., all goods manufactured with the same material).

Further, while this report focuses on the end-of-life externalities connected to single-use plastic goods, their production and consumption entail additional environmental externalities, such as the emissions of greenhouse gases associated with fossil fuel refinement and resin production. As such, multiple policy approaches should be combined to address all the externalities related to single-use plastics, straddling multiple life-cycle stages. The choice of policy tools for each life-cycle stage should be motivated by environmental effectiveness and economic efficiency considerations, and should address the potential detrimental distributional impacts they may cause on specific social groups.

Environmental policies addressing single-use plastics could also generate unintended consequences both for producers and consumers. According to available alternative materials and goods, producers and consumers behavioural responses may entail different environmental impacts. These would range from pollution emissions connected to the manufacturing of alternative materials to those associated with the management of related waste. Additionally, adapting to new fiscal and regulatory constraints requires time and effort, generating additional administrative burden, both for producers and for regulators. These aspects are further discussed in the next section on contextual features.

## Table 4. Strengths and weaknesses of different policy approaches

| | *Strengths* | *Weaknesses* |
|---|---|---|
| **Market-based policies: taxes and charges** | | |
| ***On plastic waste*** | • Tend to equalise pollution abatement costs across polluters, i.e. the cost of plastic waste prevention.<br>• Both taxes and charges can raise revenues, which will accrue to government / retailers / producers according to design.<br>• Continuous incentives to innovate to reduce abatement costs and hence the tax burden.<br>• For taxes, implementation can be done through existing national institutions. | • Potentially high monitoring costs<br>• Uncertainty about level of waste prevention achieved.<br>• Incentives to adopt alternatives to single-use plastics are lowered by costs to producers / consumers<br>• Concerns of competitiveness and potential distributional impacts |
| ***On final single-use plastic goods*** | • Lower monitoring and administrative costs (relative to direct taxes on plastics waste)<br>• Can be implemented through adjustment to existing taxes levied on e.g. manufacturers of single-use plastic goods.<br>• More salient to the public than a tax on intermediate goods or materials, thus potentially triggering larger behavioural response. | • Taxing plastic goods is a proxy for taxing plastic waste, which causes a loss of static and dynamic efficiency relative to introducing a price signal for the pollution source.<br>• Potentially higher number of subjects (i.e. manufacturers of single-use plastic goods) with respect to taxes on intermediate goods or materials. This is associated with administrative complexity.<br>• If implemented in isolation, it does not provide incentives for recycled resins upstream. |
| ***On intermediate goods or materials*** | • Monitoring and administrative costs may be lower than taxes on final single-use plastic goods, thanks to the potentially lower number of subjects (i.e. plastics producers).<br>• A tax on non-recycled resins or monomers reduces demand for virgin feedstock while providing incentives for recycled plastics. | • Requires complementary trade arrangements to ensure that imported goods or materials cannot undercut those produced domestically<br>• A fossil fuel tax may be preferable to a tax on monomers.<br>• If including exemptions for recycled plastics, this will entail greater administrative complexity.<br>• Alternatives may not be readily available for all inputs or materials. |
| **Regulatory policies** | | |
| ***Bans*** | • Can address pollution hotspots (e.g. littering hotspots) or specific materials or goods that are prone to littering or cannot be economically recycled. | • Do not provide continuous innovation incentives.<br>• Effectiveness depends on compliance checks. |
| ***Standards*** | • Technology standards generally imply low monitoring costs<br>• High adoption and compliance incentives (relative to pricing instruments)<br>• Certainty over pollution emission levels (at individual units level) | • In the case of material requirements in certain minimal quantities, monitoring costs and complexity may be substantial.<br>• Provides no flexibility to search for cheaper abatement options<br>• Cannot be easily adapted in response to new information about costs and benefits<br>• No continuous incentives to innovate |
| **Voluntary approaches** | • Contribute to information gathering and dissemination on abatement costs and benefits<br>• High (political) adoption incentives | • No intrinsic mechanism to encourage adoption of least-cost abatement options<br>• Uncertainty about outcomes as effectiveness varies with perceived benefits of participants<br>• Risk of collusion among participants |

Source: adapted from (OECD, 2011[104]) (New Economics Foundation and Zero Waste Europe, 2018[33]) (Zero Waste Europe, 2018[32])

## The importance of contextual features

### *Alternatives to single-use plastics and consumer preferences*

Behavioural reactions to policies vary according to the availability, popularity, price and perceived convenience of alternatives, as well as to the preferences of consumers for such alternatives. Consumers may exhibit preferences for specific materials, which may affect their behavioural response to the introduction to material-specific policies. These elements affect the sensitivity of demand for single-use plastic products (and for their alternatives, ranging from bamboo cutlery to biodegradable carrier bags or paper cups) to changes in their price, thus driving the total impact on demand for these goods. Alternatives to single-use plastic goods may include other disposables as well as reusable options –Box 18 summarises the benefits and challenges associated with recent business models aimed at providing consumers with a range of goods in reusable containers.

### Box 18. Alternatives to single-use plastics: reuse-based business models

Table 5 summarises the main benefits and challenges for each of the four most common reuse business models providing reusable packaging in business-to-consumer markets (Ellen MacArthur Foundation, 2019[105]).

### Table 5. The four business-to-consumer reuse business models

| | *How* | *Main benefits* | *Potential challenges* |
|---|---|---|---|
| **Refill at home** | Users refill their reusable container at home (e.g. with refills delivered through a subscription service) | Compact products<br>Customisation<br>Brand loyalty<br>Convenience | Refill packs may be less appealing in store<br>Communicating benefits to users<br>Ensuring reusable, recyclable or compostable packaging of refills |
| **Return from home** | Packaging is picked up from home by a pick- up service (e.g. by a logistics company) | Superior design<br>Deposit and reward<br>Shared design<br>Brand loyalty | Local reverse logistics, cleaning and refilling infrastructure<br>Developing a deposit and reward scheme<br>Keeping track of deposits and pay-outs<br>Reducing theft risk<br>Scaling quickly to maintain affordability |
| **Refill on the go** | Users refill their reusable container away from home (e.g. at an in-store dispensing system) | Customisation<br>Smart systems<br>Compact products<br>Improved access | Motivating users to clean and refill containers<br>Easy, safe dispensing systems<br>Brand protection<br>Build-up of distribution network<br>Product safety standards, policies, regulations |
| **Return on the go** | Users return the packaging at a store or drop-off point (e.g. in a deposit return machine or mailbox) | Deposit and reward<br>Shared design<br>Smart systems<br>Superior design | Developing a deposit and reward scheme<br>Ensuring ease of return for users<br>Take-back infrastructure and storage<br>Local reverse logistics, cleaning and refilling infrastructure<br>Keeping track of deposits and pay-outs |

Source: summary of (Ellen MacArthur Foundation, 2019[105]). The report describes the features and advantages of different business models both from the consumer and producer perspective, together with over 60 concrete case studies.

Reusable packaging tends to be characterised by certain features, from compactness to customisation, which can deliver multiple benefits (Ellen MacArthur Foundation, 2019[105]):

- *Compact products* can reduce packaging and transportation costs for producers;

- *Deposit and reward schemes* can incentivise the return of packaging and increase brand loyalty;
- *Superior design* improves product functionality and aesthetics;
- *Smart systems* can help optimise systems and gather information thanks to e.g. digital features of smart packaging;
- *Shared design* can help optimise operations, e.g. by standardising packaging and sharing drop-off points, logistics and cleaning facilities across brands or wider networks. This can translate in more drop-off points for consumers, facilitating uptake;
- *Customisation* is easier with refill schemes and subscriptions.

More generally, reuse-based business models can deliver environmental benefits through reduced plastics littering, in turn cutting the costs required from municipalities to address littering clean-up and waste management. Manufacturing reusable packaging with inert reusable materials (e.g. stainless steel, glass) can reduce the exposure to potentially hazardous substances from single-use plastics alternatives (Miller, Bolger and Copello, 2019[106]). Finally, because of features of their logistical models (e.g. return, collection, washing), reuse-based business models tend to be labour-intensive.

In order to be successfully implemented and taken up, reuse systems require investment in system infrastructure and employee training, the design of durable and universal products (which impacts the number of use cycles), the observance of hygiene requirements. It is also important to account for the minimum viable population density for their economic balance and for their life-cycle environmental impacts to avoid environmental burden shifting (Miller, Bolger and Copello, 2019[106]). Further, certain reuse models may be more appropriate than others according to the context in which they are to operate (e.g. on the go consumption vs. at-home delivery) (Ellen MacArthur Foundation, 2019[105]).

Certain consumer categories may be more willing to exert effort for environmentally friendly choices (e.g. remembering to carry reusable bags), facilitating habit change. Behavioural adaptation may vary with a range of factors, including e.g. income, education, geography, as well as with previous exposure and adherence to environmentally motivated policies targeting consumption goods (e.g. labelling). As such, the impact of the same policy might differ across countries, as cultural and macroeconomic factors might affect behavioural responses. At the same time, general and implicit behavioural mechanisms such as inertia may hinder the shift from single-use to reusable products.

According to the availability and popularity of alternatives to single-use plastic goods subject to specific policies, their producers and importers will be more or less vulnerable to such a policy measure. If consumers opt in large numbers for alternative goods, manufacturers may bear a substantial impact in terms of operation costs and, consequently, in terms of employment and competitiveness. This may pose concerns in jurisdictions where plastic good production employs a substantial share of the population. Further upstream, producers of specific resins and polymers used in the manufacturing of taxed goods may be affected according to the importance such goods have in their order book. In the longer run, if such policy measures persist, they might induce manufacturers to consider the expansion of their production plans: adopting alternative input materials to plastics requires important investments, both in terms of financial and human resources and in terms of time.

When designing policies addressing single-use plastics, it is fundamental to consider the potential behavioural responses and the environmental externalities associated with alternative goods. In order to avoid environmental burden shifting, a range of price signals should reflect the negative external costs associated with different products, particularly when policies addressing a single-use plastic product can result in a demand shift towards other single-use items. This requires alignment between all policies addressing the various environmental externalities associated with the same products (e.g. greenhouse gas emissions, waste generation, littering).

Likewise, to increase consumer awareness and ensure widespread acceptance of such policies, information campaigns should address the relative environmental impact of alternatives to single-use plastic goods, and the importance of reusing disposable plastic goods as much as possible in order to minimise such impacts.

### *Direct effects*

Market-based instruments and regulatory instruments entail a fundamental difference in terms of behavioural and production reactions.

Taxes and mandatory charges provide consumers with an incentive for behavioural change while leaving them free to adapt their behaviour to the extent they prefer and can afford. For example, consumers may react to a price signal on plastic bags by maintaining their consumption steady if they are willing to pay a price for bags, or they may adapt by buying fewer plastic bags, buying single-use bags of other materials (e.g. paper) or opting for reusable bags, according to their preferences for these alternatives. The extent of a demand shift from plastics to alternatives will depend on the elasticity of demand for both goods. Ultimately, the lower the consumer utility associated with single-use plastic goods and the cheaper and more reliable the alternative goods, the higher demand elasticity will be, prompting larger behavioural reactions.

Conversely, because bans entirely remove specific goods or materials from the market, they force behavioural change by inducing consumers to search for alternative options. Following a ban on single-use plastic goods, the demand shift towards alternative goods depends on whether consumers perceive alternative goods as suitable, and on their price and availability.

For consumers with strong preferences for a given good or material, a ban will induce an important utility loss – as may be the case for users who depend on certain single-use plastic goods for health reasons. Conversely, consumers of single-use plastic goods primarily out of convenience (e.g. plastic carrier bags offered for free) may have a more flexible response and thus more limited utility loss. Recent experience of small levies leading to significant reductions in demand for such goods seems to support this.

Behavioural responses to voluntary approaches may resemble those just discussed, according to whether approaches imply collective decisions to ban certain materials or goods or standards on recycled material content, to achieve certain long-term objectives. More generally, the aggregate environmental impact of voluntary approaches will depend on the market share represented by signatories.

### *Indirect effects*

As common, most assessments of policies aimed at preventing single-use plastic waste focus on *direct* policy effects, which relate to consumption of the goods directly targeted by policy measures and their environmental footprint. However, *indirect* policy effects such as substitution and displacement may alter the picture: in order to understand the aggregate environmental and economic impact of these policy measures, both direct and indirect effects should be taken into consideration. An example of the interaction between direct and indirect policy effect of market-based policies is presented in Box 19.

### Box 19. Direct and indirect policy effects. Case study from Scotland

The studies discussed in section 2 point to a considerable reduction in the consumption of single-use plastic carrier bags (and, in certain cases, of carrier bags more generally) following the implementation of taxes and mandatory charges. However, these provide estimates of the upper bound of the *direct* policy effect on consumption of the goods that are directly targeted by the policy measure.

Zero Waste Scotland (2015[41]) estimates the *indirect* effects of the Scottish charge on single-use carrier bags on alternatives to carrier bags such as "bags for life" (thick plastic carrier bags designed to be used over a long period of time) and bin liners.

Building upon historical data and interviews with large grocery retailers, it is estimated that sales of both "bags for life" and bin liners have increased by about 50% in the first year of charge implementation. Based on this, material use and carbon impacts are estimated considering the historical market share of different types of reusable bags (e.g. thick plastic bags, cloth bags) and bin liners. Even recognising increased use of such alternative goods, the charge has been estimated to generate net material savings around 4350 tonnes and net carbon savings of at least 2690 $tCO_2eq$ (tonnes of $CO_2$ equivalent).

#### Shifts in consumer choices

Banning single-use plastic goods to prevent their littering may have unintended indirect effects in contexts in which consumers have found ways to extend their life cycle: for example, single-use carrier bags may be reused as trash bin liners after having served as containers for purchases. Observing data from 139 bans implemented across cities and counties in California between 2007 and 2015, Taylor (2019[18]) shows that, while plastic bag bans reduce carrier bag purchases considerably, this is somewhat offset by the increase in sales of bin liners. Because of this substitution effect, 28.5% of plastic waste reduction is lost due to consumption shifting. Ignoring this type of substitution effect may thus cause to overestimate a ban's environmental impact.

In order to avoid undesirable behavioural responses leading to larger environmental impacts, certain single-use plastics reduction initiatives explicitly state the need to transition towards alternatives with lower environmental footprint than single-use plastics. For example, the Dutch Plastics Pact points to replacing plastics with more sustainable alternatives as a way to limit the carbon footprint of plastics-producing and plastics-using companies (alongside reducing reliance on fossil-based raw materials and increasing reuse): this needs to be assessed with a life-cycle analysis.

#### Additional costs

Whenever they replace give-aways with new transactions, policies such as bans and pricing have concrete socio-economic implications. With taxes and charges, the price signal might disproportionally affect certain segments of the population over others. However, such policies also induce non-monetary costs: Taylor (2019[19]) shows that, in supermarkets, checkout time increases by 3% because of plastic bag bans, and up to 10% if consumers purchase e.g. paper bags instead. The yearly cost of increased checkout time in California, considering half the average hourly wage, amounts to USD 18.9 million. Considering only reduced waste management costs as the primary benefit of this ban, disregarding the cost of time losses would overstate net policy benefits by 32%.[23]

[23] This does not consider the environmental benefits from reduced littering, nor the rebound effects of lower consumption of carrier bags on e.g. consumption of alternative goods such as bin liners.

**Spill-over effects**

Besides direct and indirect environmental impacts, policies targeting single-use plastics may have additional environmental implications if they cause spill-over effects, driving or hindering additional sustainable behaviours.

Analyses of the impact of the Welsh mandatory charge on single-use plastic bags do not provide evidence of spill-over effects on other environmental attitudes and behaviours (Poortinga, Whitmarsh and Suffolk, 2013[107]) (Thomas, Poortinga and Sautkina, 2016[108]). Conversely, a consumer survey indicates that increased support for the English mandatory charge on plastic bags appears to go hand in hand with greater support for other charges targeting plastic waste (Thomas et al., 2019[109]).

If policies translate into trade-offs which consumers perceive as inconvenient, behavioural responses may appear irrational, and may yield worse environmental impacts. An example is the case of the Italian mandatory charge on bags needed to wrap loose fruits and vegetables in supermarkets: such bags arguably respond to a different need (i.e. hygienic food-grade container) than carrier bags, with different potential substitution effects.

In fact, during the first quarter of 2018, sales of loose fruits and vegetables dropped by 3.5% across Italy, while sales of their pre-packaged counterpart increased by 11% relative to the same period in 2017 (ISMEA, 2018[110]). Pre-packaged fruits and vegetables are typically packaged in carton or polystyrene containers, and then wrapped in plastic film: this substitution effect may lead to increased waste generation. Further, pre-packaged fruits and vegetables are often more expensive than loose products: this may indicate the preference of certain consumers to pay more for a product to avoid facing an explicit packaging price. In spring 2018, regulation was updated to allow consumers to reuse their own bags to wrap groceries.

### *Competitiveness and employment concerns*

National policy action addressing plastics pollution may progress with varying coverage, stringency and speed according to the economic importance of plastics manufacturing in the domestic market. If the production of resins and of single-use plastic goods accounts for an important share of employment opportunities in a given market, policy makers may be unwilling to address the environmental externalities caused by plastics production and consumption. This may be due both to the likely stronger lobbying activity of the plastics industry, as well as to concerns for jobs displacement as a potential consequence of aggressive policy action on single-use plastics. However, lack of domestic policy action may not suffice to fully shield local industries, if importing countries implement measures targeting single-use plastic goods.

In order to assess the validity of these concerns, prior to implementing a tax on plastic carrier bags, the Irish Department of Environment and Local Government commissioned a consultancy study on its potential employment effect. The study outlined that only 11% of plastic bags sold in Ireland were produced in four domestic businesses, thus limiting the potential impact on local industry. In the first five years of application of the tax, one of the four domestic producers of plastic bags, employing 26 staff, closed down: however, “it is uncertain whether this would have happened even in the absence of the levy” (Convery, McDonnell and Ferreira, 2007[50]).

In the United States, competitiveness and employment concerns have motivated pre-emptive legislation: 14 states have passed legislation to prevent the implementation of any policy restricting single-use plastic sales and consumption, either at state or local level (NCSL, 2019[75]). Some pre-emptive bills argue that bans on single-use plastics would hurt local manufacturing activities, impose additional administrative burdens on small businesses, and limit individual choice (Rosengren, 2017[111]). As such, laws and regulations concerning single-use plastics vary considerably across states and counties.

Spatially differentiated policies are optimal in presence of spatially differentiated externalities, which can result in the presence of pollution hotspots. In this type of context, sub-national regulation is necessary. Local-level environmental policies may thus emerge as responses to specific emergencies, or as built-in features of legislative systems. For example, in federal countries, central legislation may only set minimum objectives, while decentralised legislation may result in the implementation of more ambitious regulation across the country. While a fragmented regulatory landscape may generate additional administrative burdens for producers and retailers, setting common national objectives may guarantee a common ground for all.

While competitiveness concerns may act as a barrier to environmental policy implementation, competition in affected markets may also vary as a consequence of policy actions. Banning certain materials may indirectly reduce competition by favouring alternatives. Taxes may provide short-term barriers to entry, while prompting innovation investment in order for newcomers to enter the market. Voluntary approaches may be used strategically to prevent entry or even as a platform for collusion: by publicly committing to ambitious sector-level voluntary objectives, well-established producers implicitly raise the bar for entry in a given market for newcomers.

### *Enforcement*

Outside the OECD, China and South Africa have both instituted mandatory charges on single-use plastic carrier bags, respectively in June 2008 and in 2002. However, evidence on the mixed results of these schemes, reported in Box 20, highlights the importance of credible enforcement in ensuring policy effectiveness.

#### Box 20. Enforcement of market-based policies in emerging economies

In China, retailers are obliged to charge for plastic bags, setting the price independently as long as it respects a lower bound defined by the production and transportation cost of the bag. Findings from consumer surveys performed at supermarkets and open markets in two cities (Beijing and Guiyang) indicate that the mandatory charge has reduced the consumption of new plastic bags by 49% within four months of policy implementation (He, 2012[53]).

This policy impact varies along a number of socio-economic variables: consumers supporting the policy and older consumers appear to have a stronger behavioural policy response with respect to males and rural residents. Further, the impact is larger at supermarkets than at open markets, and consumers in Guiyang are less policy responsive than consumers in Beijing. A survey of retailers shows that while all supermarkets are in full regulatory compliance, only 26% of open market stores comply with the obligation to price plastic bags, providing some or all of them for free (He, 2012[53]).

Ten years after the introduction of the tax, civil society organisation Zero Waste Alliance surveyed over 1000 retailers across 9 cities and found a 17% compliance rate with the mandatory charge, with most compliant retailers being concentrated in large-scale supermarkets and very low compliance among small shops. Compliance with other regulatory requirements (e.g. bag thickness constraints) was also found to be extremely low ***(China Development Brief, 2018[112])***.

Bans can be effective in curbing single-use plastic waste provided they are consistently enforced: in case of weak enforcement, banned products may still reach the market. This has been the case e.g. in Kenya, where following the introduction of the ban, plastic bags were illegally imported from Uganda and Tanzania (Parker, 2019[113]).

Spotting banned goods on the market may be simpler than enforcing e.g. material requirements, whereby certain products need to be manufactured using certain materials in given proportions. For example, in Italy, while plastic carrier bags are banned unless they are biodegradable and compostable, a 2015 consultancy report indicated that, four years after the policy launch, 50% of producers were still not complying with biodegradability and compostability criteria (Arcelli, 2015[114]). When banned products and alternatives are difficult to distinguish, as may be the case with biodegradable, compostable or standard plastic bags, important enforcement efforts may be required to ensure the ban is not circumvented.

In voluntary approaches, enforcement of voluntary objectives is by definition based on internally set conditions and only in rare cases on legal action. In these circumstances, peer pressure as well as public attention play an important role in ensuring that the obligations of transparency and commitment to common objectives are met.

## The way forward

Recent policy actions have overwhelmingly focused on specific products rather than polymers or single-use plastics as a whole, and more specifically on carrier bags. Conversely, initiatives addressing other single-use plastic goods are only coming into force. For this reason, while evidence on the impacts of carrier bag taxes and bans is encouraging, data on the impact of waste prevention measures on other goods is currently limited.

Because behavioural and production responses to policies in different product value chain are likely to be different, it is not possible to generalise results available so far. As new policies addressing broader sets of single-use plastic goods come into force, it is fundamental to monitor their results to continuously inform the policy-making process.

All policy initiatives for waste prevention should be accompanied by monitoring efforts in order to track their impact. For example, in recent voluntary initiatives, signatories are required to regularly provide both quantitative data on e.g. quantity of plastics used, and qualitative information on their innovation efforts to transition away from the use of single-use plastics.

Tracking the direct outcomes of waste prevention efforts both upstream and downstream would require designing specific indicators, building data collection provisions into policies to ensure consistency. Some indicators are proposed below:

- *Inputs:* weight of resins measured by polymer type.
- *Products:* number or weight of single-use plastic products sold as well as that of product alternatives, be they reusable or disposable, building upon cashier data from retailers.
- *End-of-life:* total volume or weight of waste generation, including plastics as well as materials commonly used as alternative inputs; volume or weight of waste undergoing different treatments (recycling, incineration, landfilling); weight of littered products (both in single-use plastics and in alternative materials).

Data from this set of indicators would be necessary to quantify both short-term and long-term effects of policy initiatives, understanding the extent to which behavioural responses evolve in time. Further, quantitative assessments should be paired with individual and household surveys to better understand the mechanisms driving behavioural responses. This approach could also shed light on the interaction of such policies with other environmental policy initiatives.

In the medium to long term, waste prevention measures are likely to affect research and development activities, leading to changes in the choice of materials used for single-use products, or potentially to reusable options overtaking single-use ones. Firm surveys would be leveraged to understand the extent

to which policies addressing single-use plastic waste have repercussions on R&D activities among businesses. As not all innovations may necessarily be patented, data from such surveys may complement patent data and provide a more complete perspective on innovation patterns.

### Box 21. Conclusions: key insights

- Most policy actions addressing single-use plastics have built upon regulatory instruments, followed by market-based instruments and lastly by voluntary policy initiatives. Most policies have targeted single-use plastic products rather than materials or intermediate goods.
- Evidence from existing policy measures indicates successful waste prevention outcomes both following the implementation of bans and of price signals (taxes or mandatory charges) on plastic carrier bags: this has translated into reduced consumption of carrier bags and of their littering.
- However, plastic waste prevention policies can indirectly affect the consumption and littering of other goods, according to consumer preferences, to the availability and suitability of alternatives to single-use plastics, and to their relative cost. As such, the aggregate environmental impact of such policies depends on the environmental footprint of plastic substitutes and whether these substitutes are also targeted by policy interventions in order to avoid spill-over effects.
- From the economic efficiency perspective, market-based policies such as taxes and charges are preferable to regulatory policies such as bans and standards, because the former allow consumers and producers to adapt their behaviour to the new policy in different ways, thus providing dynamic innovation incentives.
- The environmental effectiveness of policies aimed at preventing the generation of single-use plastic waste depends on multiple features of the context in which they are rolled out: consumer preferences and alternatives to plastics; competitiveness and employment effects; enforcement capacity.
- Because of a predominant focus on single-use plastic carrier bags, available evidence may not necessarily apply to other single-use plastics. As new policies address other single-use plastic goods, it is important to monitor their impacts to gauge new insights on the economic, environmental and behavioural implications of waste prevention policies.
- Monitoring efforts should be upscaled in order to obtain a better understanding of policy impacts: this will require defining new indicators of policy effectiveness to account both for direct and indirect policy effects, building upon appropriate datasets in co-operation with the private sector.

# References


ACR+ (2019), *Deposit-refund systems in Europe for one-way beverage packaging*. [27]

Arcelli, P. (2015), *Il mercato italiano dei polimeri compostabili. Dati 2014 - Anticipazioni (presentation)*, Plastic Consult. [114]

Berck, P. et al. (2016), "Measuring Consumer Responses to a Bottled Water Tax Policy", *American Journal of Agricultural Economics*, Vol. 98/4, pp. 981-996, http://dx.doi.org/10.1093/ajae/aaw037. [115]

BFM Business (2016), *Aux caisses des supermarchés, les sacs plastiques, c'est fini pour de bon*, https://bfmbusiness.bfmtv.com/entreprise/aux-caisses-des-supermarches-les-sacs-plastiques-c-est-fini-pour-de-bon-963259.html (accessed on 20 December 2019). [95]

BIO Intelligence Service (2009), *Courtauld Commitment (United Kingdom). Waste Prevention Best Practice Factsheets.*. [93]

Buranyi, S. (2018), "The plastic backlash: what's behind our sudden rage – and will it make a difference?", *The Guardian*, https://www.theguardian.com/environment/2018/nov/13/the-plastic-backlash-whats-behind-our-sudden-rage-and-will-it-make-a-difference. [116]

CalRecycle (2019), *Single-Use Carryout Bag Ban (SB 270)*, https://www.calrecycle.ca.gov/plastics/carryoutbags (accessed on 20 December 2019). [59]

Canadian Council of Ministers of the Environment (2019), *Canada-wide Action Plan on Zero Plastic Waste - Phase 1*. [24]

Chemical Watch (2017), *Denmark to scrap tax on PVC and phthalates. Levy to cease in 2019.*, website, https://chemicalwatch.com/61121/denmark-to-scrap-tax-on-pvc-and-phthalates#overlay-strip (accessed on 20 November 2019). [35]

China Development Brief (2018), *10 Years on from the Ban on Free Plastic Bags*, China Development Brief, http://www.chinadevelopmentbrief.cn/articles/10-years-on-from-the-ban-on-free-plastic-bags/ (accessed on 21 September 2019). [112]

Convery, F., S. McDonnell and S. Ferreira (2007), "The most popular tax in Europe? Lessons from the Irish plastic bags levy", *Environmental and Resource Economics*, Vol. 38/1, pp. 1-11, http://dx.doi.org/10.1007/s10640-006-9059-2. [50]

Corriere della Sera (2011), *Sacchetti plastica non biodegradabili, confermata la messa al bando*, https://www.corriere.it/ambiente/11_agosto_03/bando-sacchetti-plastica_24cf0350-bdf0-11e0-99fd-c37f66002d24.shtml (accessed on 20 December 2019). [62]

Danish Environmental Protection Agency (2018), *Life Cycle Assessment of grocery carrier bags*. [44]

DEFRA (2020), *War on plastic waste stepped up with extension of plastic bag charge*, https://www.gov.uk/government/news/war-on-plastic-waste-stepped-up-with-extension-of-plastic-bag-charge. [43]

DEFRA (2019), *Single-use plastic carrier bags charge: data in England for 2017 to 2018*, https://www.gov.uk/government/publications/carrier-bag-charge-summary-of-data-in-england/single-use-plastic-carrier-bags-charge-data-in-england-for-2017-to-2018#donations-to-good-causes (accessed on 20 December 2019). [54]

DEFRA (2018), *Plastic bag sales in 'big seven' supermarkets down 86% since 5p charge*, Department for Environment, Food & Rural Affairs, https://www.gov.uk/government/news/plastic-bag-sales-in-big-seven-supermarkets-down-86-since-5p-charge (accessed on 20 December 2019). [42]

Del Valle, G. (2019), *Maine just banned Styrofoam food containers*, https://www.vox.com/the-goods/2019/5/3/18528219/styrofoam-container-ban-maine-single-use-plastics (accessed on 20 December 2019). [64]

Deliveroo (2018), *Deliveroo set to dramatically reduce plastic use in UK*, https://uk.deliveroo.news/news/deliveroo-is-to-make-plastic-cutlery-an-opt-in-for-all-uk-customers-which-will-help-dramatically-reduce-wasted-plastic-cutlery.html (accessed on 20 December 2019). [101]

Department of Agriculture, Environment and Rural Affairs of Northern Ireland (2018), *Northern Ireland carrier bag levy annual statistics 2017 / 18*, Department of Agriculture, Environment and Rural Affairs of Northern Ireland, https://www.daera-ni.gov.uk/sites/default/files/publications/daera/stats-carrier-bag-levy-2017-18-report.pdf. [40]

Directive (EU) 2019/904 (2019), *Directive (EU) 2019/904 of the European Parliament and of the Council of 5 June 2019 on the reduction of the impact of certain plastic products on the environment*, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L:2019:155:FULL&from=EN. [20]

ECHA (2018), *ECHA to consider restrictions on the use of oxo-plastics and microplastics*, https://echa.europa.eu/-/echa-to-consider-restrictions-on-the-use-of-oxo-plastics-and-microplasti-1 (accessed on 20 December 2019). [65]

ECOTEC (2001), *Study on the Economic and Environmental Implications of the Use of Environmental Taxes and Charges in the European Union and its Member States (Chapter 12: Packaging)*, ECOTEC in association with CESAM, CLM, University of Gothenburg, UCD and IEEP, http://ec.europa.eu/environment/enveco/taxation/environmental_taxes.htm. [49]

EEA (2019), *Preventing plastic waste in Europe*, European Environment Agency. [15]

El País (2018), *Chile es el primer país sudamericano en prohibir las bolsas de plástico*, https://www.elpais.com.uy/mundo/chile-pais-suramericano-prohibir-bolsas-plastico.html (accessed on 20 December 2019). [76]

Ellen MacArthur Foundation (2019), *New Plastics Economy Global Commitment. June 2019 Report.*. [83]

Ellen MacArthur Foundation (2019), *Reuse, Rethinking Packaging*, https://www.ellenmacarthurfoundation.org/publications. [105]

Ellen MacArthur Foundation (2019), *United Kingdom: Courtauld Commitment*, Ellen MacArthur Foundation, https://www.ellenmacarthurfoundation.org/case-studies/united-kingdom (accessed on 20 December 2019). [92]

Environment Agency (2011), *Life Cycle Assessment of Supermarket carrier bags*, https://www.gov.uk/government/publications/life-cycle-assessment-of-supermarket-carrierbags-a-review-of-the-bags-available-in-2006. [36]

Environment and Climate Change Canada (2020), *Ocean Plastics Charter*, https://www.canada.ca/en/environment-climate-change/services/managing-reducing-waste/international-commitments/ocean-plastics-charter.html (accessed on 21 May 2021). [23]

EU Certplast (2018), *European Certification of Plastics Recyclers*. [81]

EU Lex (2019), *Directive (EU) 2019/904 of the European Parliament and of the Council of 5 June 2019 on the reduction of the impact of certain plastic products on the environment*, https://eur-lex.europa.eu/eli/dir/2019/904/oj. [67]

Eunomia and IEEP (2016), *Packaging taxes in Belgium*. [46]

European Commission (2018), *A European Strategy for Plastics in a Circular Economy*. [14]

European Commission (2015), *Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL amending Directive 2008/98/EC on waste (COM/2015/0595 final)*, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52015PC0595. [31]

European Council (2020), *Special meeting of the European Council (17, 18, 19, 20 and 21 July 2020) – Conclusions*, https://www.consilium.europa.eu/media/45109/210720-euco-final-conclusions-en.pdf. [21]

European Plastics Pact (2020), *https://europeanplasticspact.org/*. [84]

G7 (2018), *Charlevoix Blueprint for Healthy Oceans, Seas and Resilient Coastal Communities*. [22]

GESAMP (2016), *Sources, fate and effects of microplastics in the marine environment: part 2 of a global assessment.*, IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/UNEP/UNDP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection. [9]

GESAMP (2015), *Sources, fate and effects of microplastics in the marine environment: a global assessment*, IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/UNEP/UNDP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection, http://www.imo.org. [8]

Geyer, R., J. Jambeck and K. Law (2017), "Production, use, and fate of all plastics ever made", *Science Advances* July, pp. 25-29, http://dx.doi.org/10.1126/sciadv.1700782. [3]

HDR / BVA Engineering and MGM Management (2009), *The City of San Francisco Streets Litter Re-Audit 2009*, City of San Francisco, San Francisco Environment Department. [61]

He, H. (2012), "Effects of environmental policy on consumption: Lessons from the Chinese plastic bag regulation", *Environment and Development Economics*, Vol. 17/4, pp. 407-431, http://dx.doi.org/10.1017/S1355770X1200006X. [53]

HM Treasury (2019), *Plastic packaging tax: summary of responses to the consultation*. [45]

Homonoff, T. (2018), "Can Small Incentives Have Large Effects? The Impact of Taxes versus Bonuses on Disposable Bag Use", *American Economic Journal: Economic Policy*, Vol. 10/4, pp. 177-210, http://dx.doi.org/10.1257/pol.20150261. [16]

Homonoff, T. et al. (2018), *Skipping The Bag: Assessing the impact of Chicago's tax on disposable bags*, ideas42. [17]

Hubbub (2018), *Disposable cup charge. Impact report*. [97]

IBGE (2011), *Eco-taxation on disposable plastic bags, kitchen utensils, food wrap & aluminium foil (pic-nic tax), Belgium*. [48]

ISMEA (2018), *Ismea, l'effetto "sacchetto" pesa nel reparto ortofrutta: aumento record delle vendite di prodotti confezionati*, Instituto di Servizi per il Mercato Agricolo Alimentare, http://www.ismea.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/10280 (accessed on 20 December 2019). [110]

JORF (2015), *Loi no. 2015-992 du 17 août 2015 relative à la transition énergétique pour la croissance verte*, Journal officiel de la République française, https://www.legifrance.gouv.fr/jo_pdf.do?id=JORFTEXT000031044385 (accessed on 20 December 2019). [66]

Kahneman, D. and A. Tversky (1979), "Prospect Theory: An Analysis of Decision under Risk", *Econometrica*, Vol. 47/2, pp. 263-292, http://dx.doi.org/10.2307/1914185. [96]

Michaud, J. et al. (2010), *Environmental benefits of recycling - 2010 update*, Waste resource action programme. WRAP, https://wrap.org.uk/resources/report/environmental-benefits-recycling-2010-update#. [74]

Miller, S., M. Bolger and L. Copello (2019), *Reusable solutions: how governments can help stop single-use plastic pollution. A study by the Rethink Plastic alliance and the Break Free From Plastic movement.*, 3Keel, Oxford. [106]

Ministère de la Transition Écologique et Solidaire (2019), *National pact on plastic packaging*. [85]

Ministerio de Salud de Costa Rica (2017), *Estrategia nacional para sustituir el consumo de plásticos de un solo uso por alternativas renovables y compostables 2017-2021*. [94]

Ministry of Infrastructure and Water Management of the Netherlands (2019), *Plastics Pact NL 2019-2025*, http://www.plasticpactnl.nl. [87]

Ministry of the Environment of Japan (2019), *Our actions for a resource-efficient future: Following up G7 progress on Toyama framework on material cycles and 5-year Bologna Roadmap, A synthesis report as a follow-up activity of the G7 Alliance on Resource Efficiency, edited and compiled by Aoki-Suzu*. [25]

Muelenaere, M. (2014), *Honnie et jugée piètre gagneuse, la «taxe pique-nique» est morte*, Le Soir, https://www.lesoir.be/art/679195/article/demain-terre/developpement-durable/2014-10-13/honnie-et-jugee-pietre-gagneuse-taxe-pique-nique-est-morte (accessed on 20 December 2019). [47]

NCSL (2019), *State Plastic and Paper Bag Legislation*, National Conference of State Legislatures, http://www.ncsl.org/research/environment-and-natural-resources/plastic-bag-legislation.aspx. [75]

New Economics Foundation and Zero Waste Europe (2018), *The price is right... or is it? The case for taxing plastic*. [33]

Ocean Conservancy and International Coastal Cleanup (2018), *Building a clean swell*, https://oceanconservancy.org/wp-content/uploads/2018/07/Building-A-Clean-Swell.pdf. [13]

Ocean Conservancy and International Coastal Cleanup (2011), *Tracking trash - 25 years of action for the ocean*. [60]

OECD (2021), *OECD Environmental Performance Reviews: Ireland 2021*, OECD Environmental Performance Reviews, OECD Publishing, Paris, https://dx.doi.org/10.1787/9ef10b4f-en. [52]

OECD (2019), *Waste management and the circular economy in selected OECD countries: evidence from environmental performance reviews*, OECD Publishing, Paris, https://doi.org/10.1787/9789264309395-en (accessed on 5 October 2020). [117]

OECD (2018), *Improving Markets for Recycled Plastics: Trends, Prospects and Policy Responses*, OECD Publishing, Paris, https://dx.doi.org/10.1787/9789264301016-en. [2]

OECD (2017), *Tackling Environmental Problems with the Help of Behavioural Insights*, OECD Publishing, Paris, https://dx.doi.org/10.1787/9789264273887-en. [102]

OECD (2016), *Extended Producer Responsibility. Updated guidance for efficient waste management*, OECD Publishing, https://doi.org/10.1787/9789264256385-en. [28]

OECD (2016), *Extended Producer Responsibility: Updated Guidance for Efficient Waste Management*, https://doi.org/10.1787/9789264256385-en. [119]

OECD (2015), *What Have We Learned About Extended Producer Responsibility in the Past Decade? A Survey of the Recent EPR Economic Literature*. [29]

OECD (2011), *Tools for Delivering on Green Growth*, OECD, Paris. [104]

OECD (2011), *Towards Green Growth*, OECD Green Growth Studies, OECD Publishing, Paris, https://dx.doi.org/10.1787/9789264111318-en. [73]

OECD (2010), *OECD Environmental Performance Reviews: Ireland 2010*, OECD Environmental Performance Reviews, OECD Publishing, Paris, https://dx.doi.org/10.1787/9789264079502-en. [51]

OECD (2006), *OECD Glossary of Statistical Terms - Standards Definition*, https://stats.oecd.org/glossary/detail.asp?ID=3313 (accessed on 26 May 2021). [80]

OECD (2003), *Voluntary Approaches for Environmental Policy. Effectiveness, Efficiency and Usage in Policy Mixes*. [82]

OECD (1999), “Voluntary Approaches for Enivronmental Policy: An Assessment”. [78]

OECD (1998), *Extended Producer Responsibility: Phase 2 Case Study on the Dutch Packaging Covenant*. [90]

Orset, C., N. Barret and A. Lemaire (2017), "How consumers of plastic water bottles are responding to environmental policies?", *Waste Management*, Vol. 61, http://dx.doi.org/10.1016/j.wasman.2016.12.034. [118]

OVAM (2019), *Bekers en Bestek Wegwijzer*, online tool, https://www.groeneventscan.be/bekers-en-bestek (accessed on 20 December 2019). [56]

OVAM (2017), *Studie draaiboek drink- en eetgerei op evenementen - eindrapport*. [55]

Parker, L. (2019), *Plastic bag bans are spreading. But are they truly effective?*, National Geographic, https://www.nationalgeographic.com/environment/2019/04/plastic-bag-bans-kenya-to-us-reduce-pollution/ (accessed on 19 September 2019). [113]

Poortinga, W., L. Whitmarsh and C. Suffolk (2013), "The introduction of a single-use carrier bag charge in Wales: Attitude change and behavioural spillover effects", *Journal of Environmental Psychology*, Vol. 36, pp. 240-247, http://dx.doi.org/10.1016/j.jenvp.2013.09.001. [107]

Priestley, S. and N. Sutherland (2019), "Plastic Bags - The Single Use Carrier Bag Charge", *Briefing paper*, No. CBP7241, House of Commons Library. [37]

Restorick, T. (2018), *Starbucks rolls out 5p paper cup charge to all stores across Britain*, Hubbub, https://www.hubbub.org.uk/blog/starbucks-rolls-out-5p-paper-cup-charge-to-all-stores-across-britain (accessed on 20 December 2019). [98]

Rosengren, C. (2017), *Pennsylvania Senate signs off on plastic bag preemption ordinance*, WasteDive, https://www.wastedive.com/news/update-pennsylvania-senate-signs-off-on-plastic-bag-preemption-ordinance/441663/ (accessed on 15 September 2019). [111]

Rousset, S. et al. (2015), "Voluntary environmental and organic standards in agriculture: Policy implications", *OECD Food, Agriculture and Fisheries Papers*, No. 86, OECD Publishing, Paris, https://dx.doi.org/10.1787/5jrw8fg0rr8x-en. [79]

Royer, S. et al. (2018), "Production of methane and ethylene from plastic in the environment", *PLoS One*, Vol. 13/8, p. e0200574. [6]

Schweitzer, J. (2018), *Justifying plastic pollution: how Life Cycle Assessments are misused in food packaging policy. Institute for European Environmental Policy*. [70]

Scientific American (2014), *Do Plastic Bag Bans Work?*, https://www.scientificamerican.com/article/do-plastic-bag-bans-work/. [58]

Seattle Public Utilities (2021), *Food Service Packaging Requirements*, https://www.seattle.gov/utilities/your-services/collection-and-disposal/food-and-yard/business-and-commercial-compostables/food-packaging-requirements (accessed on 21 May 2021). [71]

Seattle Public Utilities (2019), *Current food packaging and serviceware requirements*, http://www.seattle.gov/utilities/businesses-and-key-accounts/solid-waste/food-and-yard/commercial-customers/food-packaging-requirements (accessed on 20 December 2019). [72]

Skræp Svenningsen, L. et al. (2019), *The Use of Economic Instruments in Nordic Environmental Policy 2014-2017*, Nordic Council of Ministers, http://dx.doi.org/diva2:1364822. [34]

Smith, L., N. Sutherland and S. Priestley (2020), *Plastic Bags – The single use carrier bag charge*, UK Parliament: House of Commons Library, https://commonslibrary.parliament.uk/research-briefings/cbp-7241/ (accessed on 21 May 2021). [38]

Smith, S. (2014), *Innovative economic instruments for sustainable materials management*. [103]

Takou, V. et al. (2018), *LCA of Single Use Plastic Products in Denmark*, Department of Environmental Engineering, DTU Environment. [68]

Taylor, R. (2019), "A Mixed Bag : The Hidden Time Costs of Regulating Consumer Behavior". [19]

Taylor, R. (2019), "Bag leakage: The effect of disposable carryout bag regulations on unregulated bags", *Journal of Environmental Economics and Management*, Vol. 93, pp. 254-271, http://dx.doi.org/10.1016/j.jeem.2019.01.001. [18]

Taylor, R. and S. Villas-Boas (2016), "Bans vs. Fees: Disposable carryout bag policies and bag usage", *Applied Economic Perspectives and Policy*, Vol. 38/2, pp. 351-372, http://dx.doi.org/10.1093/aepp/ppv025. [77]

Thomas, G., W. Poortinga and E. Sautkina (2016), "The Welsh Single-Use Carrier Bag Charge and behavioural spillover", *Journal of Environmental Psychology*, Vol. 47/2880, pp. 126-135, http://dx.doi.org/10.1016/j.jenvp.2016.05.008. [108]

Thomas, G. et al. (2019), "The English Plastic Bag Charge Changed Behavior and Increased Support for Other Charges to Reduce Plastic Waste", *Frontiers in Psychology*, Vol. 10/February, pp. 1-12, http://dx.doi.org/10.3389/fpsyg.2019.00266. [109]

Trucost (2016), *Plastics and Sustainability: A Valuation of Environmental Benefits, Costs and Opportunities for Continuous Improvement*, American Chemistry Council. [69]

UN Environment (2019), *Plastic bag bans can help reduce toxic fumes*, https://www.unenvironment.org/news-and-stories/story/plastic-bag-bans-can-help-reduce-toxic-fumes (accessed on 20 December 2019). [57]

UN Environment (2018), *Legal Limits on Single-Use Plastics and Microplastics: A Global Review of National Laws and Regulations*, https://www.unep.org/resources/report/legal-limits-single-use-plastics-and-microplastics. [11]

UN Environment (2018), *Single-use Plastics: A Roadmap for Sustainability*. [1]

UNEP / ISWA (2015), *Global Waste Management Outlook*. [7]

US EPA (2019), *Advancing Sustainable Materials Management: 2016 and 2017 Tables and Figures. Assessing Trends in Material Generation, Recycling, Composting, Combustion with Energy Recovery and Landfilling in the United States*, United States Environmental Protection Agency, https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/advancing-sustainable-materials-management. [12]

Veolia Institute (2019), *Reinventing plastics*. [10]

Wagner, T. (2020), "POLICY INSTRUMENTS TO REDUCE CONSUMPTION OF EXPANDED POLYSTYRENE FOOD SERVICE WARE IN THE USA", *Volume 09 - March 2020, Detritus* 9, pp. 11-26, http://dx.doi.org/10.31025/2611-4135/2020.13903. [63]

Walls, M. (2013), "Deposit-Refund Systems in Practice and Theory", in *Encyclopedia of Energy, Natural Resource, and Environmental Economics*, Elsevier, http://dx.doi.org/10.1016/b978-0-12-375067-9.00035-8. [26]

Watkins, E. et al. (2017), *EPR in the EU Plastics Strategy and the Circular Economy: A focus on plastic packaging*, https://zerowasteeurope.eu/downloads/epr-in-the-eu-plastics-strategy-and-the-circular-economy-a-focus-on-plastic-packaging/. [30]

Winning Moves and Icaro Consulting (2019), *The sale and use of carrier bags in Wales*, Welsh Government, https://gov.wales/research-sale-and-use-carrier-bags-wales (accessed on 21 May 2021). [39]

World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company (2016), *The New Plastics Economy — Rethinking the future of plastics*. [5]

WRAP (2019), *Defining what's recyclable and best in class polymer choices for packaging*, https://wrap.org.uk/resources/report/recyclability-black-plastic-packaging. [99]

WRAP (2019), "Eliminating problem plastics" August. [88]

WRAP (2019), *The Courtauld Commitment*, http://www.wrap.org.uk/content/what-is-courtauld (accessed on 20 December 2019). [91]

WRAP (2019), *The UK Plastics Pact Progress Report. Tracking UK Plastics Pact member progress and future commitments towards the four Pact targets*, https://wrap.org.uk/resources/report/uk-plastics-pact-member-progress-report. [89]

WRAP (2019), *The UK Plastics Pact. A roadmap to 2025*. [86]

WRAP (2018), *Design tips for making rigid plastic packaging more recyclable*, https://wrap.org.uk/resources/guide/design-tips-making-rigid-plastic-packaging-more-recyclable. [100]

Zero Waste Europe (2018), *Research paper on a European tax on plastics*. [32]

Zero Waste Scotland (2015), *Carrier Bag Charge 'One Year On'*, Zero Waste Scotland, https://www.zerowastescotland.org.uk/content/carrier-bag-charge-%E2%80%98one-year-on%E2%80%99-report-0. [41]

Zheng, J. and S. Suh (2019), *Strategies to reduce the global carbon footprint of plastics*, http://dx.doi.org/10.1038/s41558-019-0459-z. [4]