Study to identify and assess relevant instruments and incentives to reduce the use of single-use and other items, which impact the marine environment as marine litter

Prepared for

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Executive Summary

Marine litter is a serious and global environmental problem that is amongst the most challenging to address. This challenge arises from the various types of marine litter, the range of sources and the inadequacy of single options to address the problem. Regionally, the composition of marine litter varies, but its sources can be sea-based, coastal or exist well inland with litter carried by rivers to the sea where ocean currents transport it around the globe without respect for national borders. The ocean is a free access resource as regards its capacity to act as a sink for waste. Therefore, just as liquid pollutants have been piped out to sea without cost to the polluter, so marine litter can be associated with poor regulation or policing of the fishing, marine transport and cruise ship industries. However, marine litter is also a product of our consumer society and so is a problem that increases in severity with economic growth, development and wealth. This problem presents significant economic and environmental costs in terms of the evident and potential impacts to wildlife, tourism, functioning ecosystems, fish catches and human health.

This report examines the particular contribution of single-use consumer items to marine litter. In beach surveys, these items are very prevalent and include bottle tops and caps, bottles, cans, food containers, crisp packets, sweet wrappers, sanitary products and balloons, amongst other identifiable items. The small size, colour and durability of these items means that they each present distinct environmental and ecological costs. One characteristic of this litter is that a very high proportion is comprised of plastic, typically different types of plastic polymers with varying levels of additives. Another characteristic is that much of this litter is represented by packaging, including its use as containers for food and drinks.

There are measures that can be taken to address marine litter. These include some obvious candidates such as raising awareness of the problem and its environmental cost, enlisting the support of coastal communities to deal with the problem, and providing a sufficient number of bins to reduce the temptation to littering. These measures can be targeted to locations where there is a particular risk of litter finding its way into the marine environment, namely coastal resorts, but also areas beside rivers.

The report also discusses the options that are available from regulatory and economic instruments. Both can include the use of *extended producer responsibility* where manufacturers and distributors are encouraged to take responsibility for a share of the environmental costs of the products they produce. By comparison, economic instruments provide market incentives or disincentives on the use of products that have a particular risk of becoming marine litter. Economic instruments can include taxes or levies to reduce consumption of specific types of products such as lightweight plastic carrier bags, or alternatively, incentive structures such as the use of *deposit refund systems* that reward consumers for returning bottles or other packaging. Some of these economic instruments can be more effective in changing consumer behaviour than the alternative of commend-and-control type regulation.

Policies, backed by political will, will be needed to implement measures, including regulatory and economic instruments. For example, the problem of marine litter is already addressed by various maritime agreements and policies. These have led to positive developments in terms of the management or waste and litter produced by the maritime transportation industry or the fishing sector. However, while the EU Marine Strategy Framework Directive supports the use of targets and measures to reduce marine litter, progress has been inhibited by the contribution of terrestrial

sources of marine litter. More significant reductions in marine litter will require improvements in the way that most waste is managed on land. In this respect, the EU Waste Framework Directive has encouraged major investment in the management, collection and processing of waste. It also seeks to pursue a *waste hierarchy* as the basis of how waste is perceived. The waste hierarchy prioritises waste reduction in the first instance, following by re-use, recycling, recovery and, finally, best practice disposal. Ultimately the objective is to decouple waste production from economic growth. In addition, the EU has just produced a new Plastics Strategy to deal specifically with this ubiquitous material and its use in packaging in particular.[1] This strategy will represent a step towards the realisation of the *circular economy*, where materials that are currently perceived as waste attain a marketable value based on a high potential for re-use. Once these products and materials have a value, so the risk of their becoming marine litter is substantially reduced.

However, the circular economy will also take many years, if not decades, to achieve. For now, there are opportunities to address particular strands to the problem relating to consumer behaviour and the infrastructure available to collect and manage waste. This report examines the merits of the different approaches available. It finds that these strands need to be addressed by more than one approach and recommends an integrated strategy that can simultaneously deal with behaviour and awareness, litter collection and the wider issue of waste management generally.

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[1] This report was prepared just before the publication of the EU Plastics Strategy (while being informed by the preceding Green Paper). The strategy can be reviewed at http://ec.europa.eu/environment/circular-economy/pdf/plastics-strategy.pdf

Chapter 1: INTRODUCTION

1.1 The problem of marine litter

This report examines the problem that single-use consumer items present as a proportion of the marine litter to be found in the oceans or washed up on coasts and beaches. It looks at the nature and scale of the problem, its environmental cost and the economic cost this type of litter presents. It considers the various measures that are available to deal with the problem, including regulatory instruments that control actions or behaviour, and economic instruments which provide incentives or disincentives to influence the behaviour of consumers, producers and waste processors. It looks both at measures that could have a direct impact on reducing single-use items in marine litter, and at wider measures of waste management whose impact may be more indirect, but which could ultimately significantly reduce the amount of material that is either produced or categorised as waste. It evaluates the effectiveness of individual measures, the costs and practicalities, the opportunities for targeting either locations or particular types of litter, and the links with other measures that can reinforce effectiveness.

Marine litter is a pervasive human impact and, given the undiscriminating nature of oceans and ocean currents, an international problem that will inevitably get far worse as material accumulates and poorer countries develop and consume more. The impact is far more than aesthetic, although this is serious enough given the implications for pristine seascapes and quality of life. There is an immediate economic impact on tourism, a competitive nature of the sector and its importance for employment. Marine litter is also having a serious impact on marine life and the natural environment as materials entangle - or are ingested by - marine wildlife. Entanglement is thought to cause the death of 100,000 mammals each year in the North Pacific alone, a rate that appears to be increasing [1, 2]. This impact on biodiversity can affect human food sources too when fish, shellfish or crustaceans are caught in lost or abandoned nets in so-called 'ghost fishing', or through the disguised and enduring impact on fish stocks due to the damage done to the underlying supporting ecosystem services provided by marine habitats such as reefs and deep-sea corals. There is a further direct impact on the fishing industry sector itself as marine litter is caught in nets or damages fishing gear. Mouat et al (2010 [2]) report that, on average, almost one such incident is reported by each boat per year in Scotland which has approximately 2,000 registered vessels. This impact also extends to the marine transport sector when litter becomes wrapped around propellers or sucked into inflow valves. In one of the worst reported cases in 1993, 292 passengers aboard an overloaded Korean ferry died when the vessel capsized after its propellers become entangled (Cho, 2005 cited in Macfadyen 2009 [3]).

Single use items include many of the familiar throwaway items that are found as general litter in our towns and countryside, namely drinks cans, glass bottles, plastic bottles and tops, cigarette stubs, newspaper and alike. Many of these same items are carried to the sea by rivers, but single-use sanitary items such as cotton buds and hygiene products from wastewater and sewage systems have become a problem too, particularly following storms. Other items such as plastic bags, plastic film,

agricultural wrapping and fragments of string are picked up by the wind and blown out to sea. A distinction of many single -use items is that they are often light and buoyant, at least initially, and can be carried out to sea. Plastic in particular, is light and durable and a very familiar material used in the manufacture of single-use consumer items. Plastic is resistant to natural decomposition, but can degrade in response to ultra-violet light and be ground down into ever smaller pieces, eventually becoming microplastics similar to the very small beads released into wastewater systems from cosmetics, deodorants and exfoliates. These plastic particles can survive for very long periods of time, accumulating on beaches, on the sea bed or in the water column. For example, it has been estimated that plastic bottles or bottle fragments could potentially survive for 450 years in the ocean [4], although nobody really knows or has been around long enough to tell. The small size, and colour of much plastic waste also makes it potentially attractive to foraging wildlife who can mistake it for food.

There is a further, and as yet little understood and unquantifiable, but potentially major risk, to human health. Marine litter already presents a serious physical risk to swimmers, divers and anybody engaged in water-borne activities. A potential health risk is also presented by discarded personal care and hygiene products which represent a distinct proportion of marine litter along some coastlines, with the problem having been highlighted by surfers in particular. There are less obvious risks too, for example from toxins and pollutants, including from chemicals used as additives in plastic, for example for colours or in paints. The problem of chemicals found in microplastics has recently received much attention for this reason [5]. However, larger plastic single-use litter is little different in that the product is very durable and can be broken into ever smaller pieces by attrition in the ocean. There is a risk that constituent chemicals will leak into the marine environment or otherwise be consumed by fish or other creatures, absorbed within the body oils or fat of these animals and then ultimately passed to us. Plastic can also absorb chemicals from the surrounding environment, including persistent organic pollutants (POPs) which do not easily break down in the natural environment.[2] These chemicals are toxic to both humans and other marine life. For example, PCBs, are still prevalent in marine litter, especially on the ocean floor, despite having been banned decades earlier. .

"On average, a plastic bag takes one second to make, is used for roughly 20 minutes and takes up to 400 years to degrade naturally". www.thelocal.fr

1.2 Study objectives

The Study has the following objectives:

- to provide an overview of the policy framework associated with single-use items from litter, general waste and other aspects of waste management,
- link this framework to actions being taken on the marine environment under OSPAR and national monitoring,
- collate a non-exhaustive list of incentives and sector specific agreements to promote resource efficiency and to reduce waste and litter,
- outline the costs associated with these instruments and incentives, and how these costs are managed and transferred

[2] https://cen.acs.org/articles/90/web/2012/08/Ocean-Plastics-Soak-Pollutants.html

- provide an outline of the outcomes achieved and the effectiveness/cost-effectiveness of these instruments and incentives.

1.2.1 Approach

The approach has been to review the literature that exists on marine litter, specifically reports that relate to single-use items and to the product material types that contribute significantly to marine litter of this sort, in particular plastics.

Evidence is provided in **Chapter 2** on the scale and composition of marine litter based on data mainly from beach surveys, but with some examples of sea and sea-bed surveys too. Such data is collected by most EU countries possessing coastlines, and by international agencies, but particular emphasis is placed on OSPAR's own regional sea data. Information on the wildlife, ecosystem service, health and economic impacts of this marine litter, is presented, again with particular reference to single use items. Policy measures are discussed in **Chapter 3** beginning with conventions and other agreements related to the quality of the marine environment and its protection from pollution of all sorts, with specific discussion of where marine litter is addressed. Within the OSPAR region, marine litter is implicitly addressed by the Marine Strategy Framework Directive and the Waste Framework Directive and the nature and relevance of these and other EU directives and regulations are discussed. At a national and local level, particular strategies intended to increase public awareness and to collect, process or address items of litter, particularly in coastal communities, are also relevant.

In **Chapter 4** various direct measures, including awareness raising, are introduced along with regulatory instruments. **Chapter 5** introduces the role of economic instruments. We illustrate these chapters with short case studies to demonstrate the factors that make for successful schemes or which act as potential barriers to reducing marine litter. Such schemes can provide useful feedback on the effectiveness of different measures, the costs of implementation and the practicalities and logistics of implementation. **Chapter 6** brings the review together with proposals for an integrated strategy linking direct measures, regulatory and economic instruments, and wider waste management.

The assessment has been informed by discussion and communication with other OSPAR members with responsibility for Action 43 and the reports they have been able to provide, including strategies adopted within each country. Discussions have also been held with the managers of the schemes, waste policy administrators and experts, and with other stakeholders such as industry producer organisations and representatives.

Chapter 2: SOURCES AND TYPES OF MARINE LITTER AND THE PREVALENCE OF SINGLE USE ITEMS

2.1 Sources of marine litter

In Europe, 42% of beach litter has been found to be recreational or beach related [6]. This type of litter is overwhelmingly single use in nature, namely drinks bottles, bottle caps, food packaging, plastic cups, drinks stirrers, etc. Wind is clearly a factor in this material becoming litter, but many of these items are also deliberately or carelessly left on the beach. The high proportion represented by this figure is certainly disputed, not least because of the often significant contribution made by fishing waste. It would also be subject to much regional variation. The remaining proportion from land-based activity arrives as wind deposited debris, for example from poorly managed landfills, or via pathways such as rivers, often from poorly managed waste water treatment works, especially those with inadequate capacity, and often following floods and storms.

Of other litter, worldwide, Ocean Conservancy estimate illegal dumping to account for around 2% of total waste. Fishing litter also accounts for a significant proportion of around 20% of marine litter. Of floating debris, counted from various international locations, 20% by number and 70% by weight tends to be fishing related [7]. Eunomia [8] estimates that, within the European Economic Area (EEA), between 1,700 and 12,000 tonnes of fishing waste and 3,000 to 41,000 tonnes of aquaculture waste is lost each year. The higher estimates for aquaculture are notable. Aquaculture activities occur on the water surface or just below and are subject to winds, tides and storms. The sector also makes much use of plastic lines and expanded polystyrene. Of fishing activities, studies have found that shark and crustacean fisheries had the highest gear losses. These economic losses have prompted some countries to impose regulation which can often have a positive outcome on productivity given that it has sometimes led to subsequent gains to the industry as populations recover and catches rise [9]. Other proposed solutions include better regulation, the compulsory logging of lost gear and the re-design of nets and floats.

Litter from marine shipping is a comparable problem. Material is often washed overboard during storms, including entire freightliners sometimes full of plastic packaging pellets or containing items hazardous to other boats. Marine freight transport is the principal source, but cruise ships have also been implicated. As well as general waste from cruise ships, the common practice of releasing balloons during events on board has been known to impact on turtles who ingest the litter mistaking it for jellyfish. A considerable amount of litter from the sector as a whole is believed to have been deliberately discarded.

2.2 Impact

2.2.1 Wildlife impacts

Each year, it is estimated that 130,000 small cetaceans get caught in abandoned nets and that around 100,000 mammals die (US EPA, 1992). Birds, seals, cetaceans and turtles are especially vulnerable. Up to 50% of humpback whales in the United States are reported to show evidence of encounters with fishing nets and gear [10] while marine litter generally is thought to be responsible for 15% of mortality of young fur seals in the North Pacific (FAO, 2003). Fishing line and nets are major causes, but single-use plastic bags, utensils and balloons have all been implicated [11]. Young gannets, for example, frequently become entangled in the plastic string used for nesting material [12]. In addition, hazardous chemicals, including PCBs, have been found in the bodies of dead porpoises and other marine mammals [13, 14].

Small and micro plastic particles have been found to have wedged themselves in the gut of shellfish, affecting the growth and development of wild and commercial species. Cole et al (2013 [15]) have even found microplastic pieces in the guts of zooplankton along with reduced consumption of algae by affected samples. Similarly, Frias et al (2014 [16]) found microplastics in 61% of plankton samples from the Portuguese coast. In the North East Atlantic, fulmars are known to be particularly vulnerable to the ingestion of small pieces of plastic debris. This impact is of an extent that OSPAR has been using the plastic content in the birds' stomachs as an indicator of marine litter in the North Sea. Between 2007-2011, 95% of 796 sampled fulmar carcasses had plastic in their stomach and 62% exceeded the 0.1 gram OSPAR objective. On average, each bird's stomach contained 33 particles of plastic weighing 0.38 grams. The long term goal is that less than 10% of fulmars should have a plastic content in their stomachs which exceeds 0.1g. Fortunately, these figures have remained fairly stable for the most recent ten year period [17].

Seabird and marine litter ingestion

Marine litter may also be having other impacts on the marine ecosystem, potentially causing pressures on native ecology in distant locations. For example, items such as fishing gear, but also single-use products such as plastic bags, cause physical damage to sensitive environments such as reefs. Floating debris can also act as a substrate on which jellyfish planulae can develop [18]. Likewise, marine litter can also carry invasive species to new locations, including isolated islands with resident endemic species far more quickly than would ever occur under natural conditions [19, 20]

2.2.2 Ecosystem service loss

Although the wildlife impacts are dispiriting and serious in their own right, this wildlife also provides human beings with crucial ecosystem services benefits. As well as the benefits that we enjoy from our attachment, awareness and direct experience of the marine environment, wild fisheries are obviously an important source of economic activity, employment and, of course, food, a very valuable source of protein that comprises the largest element of people's diet in many locations. Fishing provides the basis for a way-of-life in many coastal communities whose economic survival depends on this industry. Direct damage arises from ghost fishing from abandoned nets, but significant damage is also caused to the supporting marine ecosystem such as sea bed habitat, deep sea reefs, and nursery areas, including from single-use items such as plastic bags. Were fish to ever be implicated in health risks to human beings, the damage to the industry would be seismic. Shellfish have already experienced the reputational damage that can be done from health concerns following issues with untreated sewage or pollution flows, and are possibly equally vulnerable to microplastic pollution. Shellfish are also extremely important for filtering pollutants from the water and make a distinct contribution to this regulating ecosystem service in some estuarine waters that could otherwise be classified as poor quality and a potential location for algal blooms.[3] This service, and the localised turbulence such beds provide, assist with the survival of shellfish larvae and by providing food for other species which inhabit such reefs. Shellfish beds also protect shorelines from coastal erosion [21, 22], a service that could become yet more important with climate change. Both fish and shellfish, and zooplankton, are of course key elements of the diet of predatory fish, marine mammals and birds and the contribution they, in turn, provide in suppressing numbers of potentially troublesome species such as jellyfish.

2.2.3 Health impacts

Plastic is not a uniform product. Plastics can comprise synthetic polymers, mostly polyethylene (high and low density), polyethylene terephthalate (PET), polypropylene (PP), polyvinyl chloride (PVC), polystyrene (PS) and polyurethane (PUR) (NEP, 2016). Additives are often the source of potential toxins and include colours, fire retardants, softeners and chemicals providing UV-resistance. This mix provides many opportunities for a cocktail of hazardous chemicals to leach into the environment. Levels of toxic POPs, including carcinogenic PTCBs such as phenantrene and tPAH, tPCD and rDDT, were recorded for Portugal and international locations by Frias et al [23]. In principle, those POPs which are known to be toxic are controlled by the Stockholm Convention of 2004. Around 225,000 tonnes of additives are thought to leak into the ocean each year, and while not yet at harmful levels, could indicate the potential for greater concentration. There is no evidence yet of an impact on human health, but some monomers used in the production of certain plastics contain bisphenol A (BPA), a synthetic oestrogen that some suspect of having an impact on human fertility. Male fertility rates have been falling globally for some decades, not just in Western countries, but with distinct reductions in rural populations the Far East too. A range of reasons have been put forward for these reductions of which contamination from plastic products, including food wrapping is just one. These chemicals are not of a concentration in the oceans to be a concern directly, but could be a problem if ingested by fish which are subsequently caught as food. Like other chemicals they can potentially concentrate higher up the food chain.

[3] For example the River Slaney estuary in Ireland Pers comm Dr. Shane O'Boyle, Irish Environmental Protection Agency

2.2.4 Impact costs

The nature of costs

Essentially, the ocean acts as a sink for waste. The sea is a free access resource with no direct private costs to disposal, but for the slight risk of being caught and fined. The economic cost is a social one in that it is experienced by all users. In economic terms, it is an externality cost that prevents the maximisation of social wellbeing. This cost is, though, not shared equally, being experienced most significantly by fishermen, water sports enthusiasts and beach lovers. The complexity of the problem is evidenced by the fact that some of these users, i.e. fisherman, as a group, can be both polluters and the impacted party.

Some costs can be estimated using market prices, e.g. loss of fish catch, while others are more difficult to quantify, e.g. biodiversity losses. Clearly, there is great uncertainty about health costs, but potentially the social costs are substantial. The wildlife or aesthetic costs could be assumed to be intangible, before it is realised that these can present very significant costs in terms of losses of personal sense of well-being or losses of ecosystem service benefits, including tourism. What perhaps we can say is that these social costs are likely to be greater the more people are impacted by them. Consequently, health costs, although possibly slight in themselves, have the potential to affect very large numbers of people, but especially where fish is a major element of people's diet. Tourism losses are likely to be greater in tourism destinations. Even the mortality of fulmars in the near Arctic can have a high non-use value if enough people value these birds' existence, as they invariably do when one species is seen as being indicative of the health of the natural environment generally. In these respects, understanding what constitutes marine litter is important because each material, indeed each item type, has its own particular externality cost related to the impact that it has on wildlife, ecosystem services or health depending on the volume of material, where it is deposited and its potential degradability.

There is a wide variation in estimates of the economic cost of marine litter which range from $8 billion per year (Arcadis, 2013) to $40 billion per year (World Economic Forum, 2016) depending on what is, or is not, included. Tangible costs include those associated with physical clean-up costs due to damage to ships or fishing gear, and rescue costs where propellers have been fouled (between €830,000-€2.2m). There are foregone costs due to losses of marketable catches and loss of tourism income.

Beach clean-ups

Beach clean-up costs are a direct expense. Costs are also incurred in removing litter from harbours and installations. For example, the cost of removing debris from Esbjerg Harbour in Denmark in 2010 was estimated at €96,695 [24]. In the UK, the average cost of harbour clean-up is reported to be around €8,000 per year with most vessel damage being caused by floating fishing gear. Figures of seven times this amount are reported for Spain [2]. For beaches, clean-ups are undertaken to protect tourism and health often to meet the criteria needed to attain Blue Flag status and to raise a town's profile as a tourism or amenity destination. Unfortunately, much beach litter is sent for landfill or incineration, partly because the litter is contaminated by dirt or sand. Overall, the UK spends €18-€19m each year removing beach litter or €146,000 per municipality on average. Sums of around €10.4 million per year are spent in the Netherlands and Belgium where a longer length of total coastline is cleaned than in the UK [2]. Clean-ups costs for the more popular destinations around the North Sea are between €28,000 and €35,000 per year and. Even for less popular beaches, the costs have been estimated at between one quarter and third of these amounts. On

average in the EU, the annual clean-up of a single beach is estimated at €8,171. Although typically €7,300 might be spent per kilometre, this expenditure can amount to €82,000 in popular locations and amounts to €300,000 per year in Barcelona [25]. Furthermore, these costs can be an underestimate of the total value of the economic resources invested. For instance, for voluntary clean-ups, it would really be necessary to include estimates of volunteer time input based on the opportunity cost of the time that people could spend doing other things, including paid work. These are referenced by Mouat et al (2010) as an average contribution of €16.23 or an aggregate value for just two of the largest UK beach clean-ups of around €131,287.

Impacts on fishing

Fishing losses have been estimated at €17,200 and €19,200 per boat in Scotland and €62 million per year [2]. In areas that are heavily dependent on this industry, the impact can be substantial. For the Scottish economy, the impact has been estimated at €11.7-€13 million per year [2]. In Portugal, Mouat et al (2010) report lower damage to catches due to the prevalence of long-lining, although fisherman reported average losses of €2,930 per year and a higher incidence of propeller fouling.

In addition to the damage to vessels, fish and crustaceans may continue to be captured by lost traps and other fishing gear. New regulations introduced to reduce litter in Chesapeake Bay in the USA had the effect of increasing landings of crustaceans by 27%, earning an extra $2.5 billion per year for the local fishing community [26]. Similarly, abandoned fishing gear in Puget Sound caused losses of 175,000 crabs worth $586,000 per year, or 5% of the value of the fishing catch [9]. The cost of damage to fishing and non-fishing vessels is difficult to quantify as many incidents are not reported, but has been estimated at $279 million per year globally (APEC, 2009). For the fishing industry, the cost has been estimated at €33 million per year in the UK alone (MPMMG, 2002) or €66 million across the EU, equivalent to 0.9% of total revenue [2]. Costs to the aquaculture sector are relatively lower, due to the shorter distances travelled by vessels, although as noted above, the sector is thought to be a major contributor of marine litter. Hall [24] estimated that an average of one hour per month is spent removing debris from cages or propellers.

Loss of fishing catch and damage to vessels mostly arises from discarded gear and nets or other large items rather than single-use products. Nevertheless, single-use products can also impact on fishing as with the example of large amounts of personal wipes having to be removed from ropes 8km off the coast of an urbanised area of the east coast of Ireland.[4] In addition, many habitats are important for the nursery stage of commercial fish and shellfish species, but rather little is understood of their role in these life cycle stages [27]. Holt [28] estimates the cost of eradicating the smothering alien carpet sea squirt (*Didemnium vexillum*) from Holyhead Harbour in Wales at €670,000 over ten years without which the local fishing industry could have been severely impacted by as much as £6.9 million over the same period. The cost of removing alien species elsewhere could be excessive so that the full costs of impacts are passed onto local wildlife or commercial activities.

Tourism

Amongst the more overt economic impact from marine litter is the impact on tourism. The European tourism industry's direct economic impact is upwards of €560 million and is responsible for employing 12.3 million people (WTTC, 2015; EuroStat, 2017). The global Loss of tourism income from marine litter has been estimated to be between €259 million and €630 (€695m) million per year. Removal of beach litter is undertaken in recognition of the need to avoid these economic losses and the aforementioned costs of litter removal provide some measure of the perceived

[4] https://greennews.ie/wet-wipes-are-wreaking-havoc-in-sewers-and-rivers-and-washing-up-on-irish-beaches/

benefit of avoiding these losses [2]. Although local authorities might step in before littering becomes too bad, significant losses have occurred where substantial material has been washed up following storms and flooding. For the popular destination of Goeje Island in Korea, such an event in 2011 was credited with causing losses of tourism expenditure of between €23-€29 million due to the absence of 500,000 visitors [29]. This event could be described as an exceptional and not a habitual example of marine litter. Nevertheless, on-going gradual losses of tourism income arise where coastal litter is a persistent problem. Using a survey of regional tourism bodies in the UK, Mouat [2] records that up to 90% of tourism visits to some locations were specifically attracted to visit by the presence of a beach or coastline. Marine litter can therefore particularly affect the image of beach resorts which claim to be up-market or of high quality. Sandy beaches can be cleaned mechanically reasonably cheaply on a daily basis in tourist areas, but rocky beaches and coves are more difficult to clean.

In South Africa, Ballance et al. [30] found that 40% of foreign tourists and 60% of domestic tourists would be deterred by the presence of more than 10 items for metre of beach. At an average tourist spend per day (in Ireland) of €89 for overseas holidaymakers or €71 per day for domestic overnights, such a loss at a popular destination attracting 100,000 such visitors per year could amount to €6.1 million per year.[5] In Sweden, it has been estimated that marine litter has led to annual loss of €22.5m of tourism income along the Skagerrak coast. The problem is taken very seriously in Hawaii and Maldives where there are strict rules on disposal of waste or the use of certain types of fishing gear [31].

Unquantified social losses arise from the aesthetic impact and indirect losses of utility from experiencing or an understanding of the damage to wildlife. Even otherwise pristine environments are not unaffected by marine litter. The loss of individual utility experienced in some of these places is likely to be higher than for busier locations where rather the absolute costs are higher. Economic impacts follow from mortality experienced by wildlife and fish populations due to marine litter and from the smothering or scouring of habitats for biodiversity [32, 33]. This damage impacts also on habitats supporting commercial species.

Health

Human health costs have the potential to be very significant given the importance, and value, we place on our physical health. Certainly, many plastics contain chemicals of potential toxicity, including bioaccumulative substances and endocrine disrupters. Typically, this toxicity is only realised at high concentrations, but this becomes an issue when these toxins are absorbed by food species such as shellfish. The growing and relentless accumulation of micro and nano pieces of plastic and their uptake within the marine environment will increase the risks over time. Although the evidence is unsubstantiated at present, and the current risk is argued to be minor [34], the possible impact is of a scale that would invoke the precautionary approach.

2.3 The scale and composition of marine litter

2.3.1 Composition of litter

[5] Failte Ireland. Tourism Facts 2016. A beach such as Tramore would receive around this number of such visitors.

An understanding of the composition of marine litter is relevant to knowing how to address its sources and the manner in which it has been used, and can therefore inform the appropriateness and effectiveness of policy. Through surveys and beach clean-ups, we have a good understanding of the broad composition of marine litter. However, these surveys only provide samples of a proportion of this litter as much other litter drifts in the water column or has settled on the sea bed. Only around 15% of marine litter is assumed to be washed ashore [2, 35]. International clean-up data collected by Ocean Conservancy (2016) identifies cigarette stubs as comprising, on average, 29% of marine litter, plastic bottles 14%, plastic bottle tops 12%, plastic bags 11%, and food wrappers 12%. Each of these items can be defined as single use. Metal cans and glass bottles are still commonly washed up, but have reduced as a proportion of collected items over time due to changes in consumer packaging, although a high proportion probably sinks to the sea bed. Of material composition, recent OSPAR surveys report 82% of litter as being plastic or polystyrene, with much smaller contributions from wood, rubber, glass and other materials (see Table 2.1). Much of the plastic derives from external packaging, including wrapping and string, but also internal packaging such as pellets. Sanitary products account for 5.8% of the total and metals for 2.7%. The most recent trends do reveal some relative reduction in plastic items, although these remain dominant (see example of Southern North Sea in Table 2.1). Otherwise, the data indicates that no overall trends are apparent for the entire OSPAR area, but demonstrate significant variations in the abundance of individual items at different locations.

Table 2.1 Material composition for Northern North Sea 2009-2014

item type	Median number per 100m	Average per 100m coast	% total number of items	Trend (no. per year)	Relative trend (% change per year)
plastic/polystyrene	339.6	400.2	88.60%	-30.3	-7.6
wood	9.8	12.2	2.70%	-0.6	-5.1
rubber	7.7	8.2	1.80%	0.4	5.3
metal	4.6	7.5	1.70%	-0.9	-12.0
glass	5.8	7.2	1.60%	0	0.2
paper/cardboard	3.2	6.4	1.40%	-1.1	-17.5
sanitary	4.4	6	1.30%	-0.3	-5.7

item type	Median number per 100m	Average per 100m coast	% total number of items	Trend (no. per year)	Relative trend (% change per year)
cloth/textile	2.9	3	0.70%	-0.4	-12.2
ceramic/pottery	0.4	0.6	0.10%	0	-2.3

Based on surveys at 25 beaches in UK, Norway, Sweden and Denmark

A survey of fishermen reported by Mouat et al [2] provides evidence of the type of litter found in the water itself or on the sea bed that can be compared with the OSPAR beach data. As noted above, this litter could potentially account for 85% of the total. The survey found that the most common type of litter recovered or caught in nets was string or rope (generally now made of plastic polymers), followed by plastic consumer items, bottles, wire, nets and tyres. Tourist related waste was less prevalent at sea, but still reported by more than 10% of boats.

This broad summary data on marine litter can alternatively be presented by volume or weight rather than number of items. When this is done, the proportion of litter accounted for by items from the fishing and marine sector tends to rise as these items are often large whereas count data are influenced by the large number of small single-use items such as metal lids, bottle tops or cigarette stubs. Large items such as barrels or nets are likely to be around for a long time, to become engulfed permanently within beaches or dunes, or to float on the ocean surface or within the water column where they present a physical threat to swimmers, fishing, fishing boats or shipping or a risk of ghost fishing. By comparison, small items can smoother beaches, are more likely to be ingested by animals or birds, or broken into ever smaller pieces whose chemicals may leach into the ocean. It is an issue of producing quantified estimates of the cost of this damage based on these two categories and deciding on both the practicality and cost-effectiveness of how to deal with the problem.

Other parameters that can be used to understand the composition of marine litter, the risk it presents and as pointers on how to deal with it, include product life-cycle phase, use category, originating sector, packaging type (e.g. primary, service packaging, ship based), durability, source activity (i.e. consumer, industry), fragmentation and risk [36]. Arcadis (2013) reports that items which would be collected as municipal waste account for 63% of the marine litter in European regional seas and industrial material for 20% (with the rest unassigned). Of items corresponding to municipal solid waste, the principal items are packaging and these are overwhelmingly plastic at 83%.

2.3.2 Regional variations

Regionally, figures vary considerably. The fact that the composition of litter varies between sites (hence the use of median and arithmetic averages) and between collections in the Northern and Southern North Sea, the Celtic Seas, Bay of Biscay and Iberian Coast, indicates that regional patterns of use and disposal play a part as well as the effect of major ocean currents such as the Gulf Stream. The proportion of fishing nets and ropes is, for example, higher in the Northern North Sea relative to

some plastic consumer items, but not others. The Northern North Sea also has the highest quantities of litter with plastics being dominant, but also a higher proportion of sanitary items than other seas.

As OSPAR has common recording guidelines, these differences could be due to the local prevalence of particular industries, beach recreation, the proximity of large population centres, or just the effect of ocean currents and winds. Other surveys have found between 425 and 900 items per km^2 of coastline [7, 37], with up to 1,000 items per 100m of coastline in some places [38]. Survey data collected by Arcadis [7] identify 53% of litter as being of terrestrial origin and constituting mostly items which were transported short-distances, but with 27% having undergone longer-distance transportation. Single use items have been found to account for 47% of the total here, but as much as 89% in the Mediterranean.[6] The composition of litter will obviously vary depending on the location of the sea and how enclosed it is by land. The North Sea, for instance, has busy shipping lanes and off-shore gas and oil exploitation, but is also bordered by coastal tourism resorts.

Table 2.2 provides an example of the types or use or categories of materials recovered in the OSPAR surveys from coasts of the Southern North Sea. It shows the prevalence of plastic items, including unidentified small pieces, as well as an equal representation of nets, ropes and plastic foam, most likely originating with fishing. It also reveals a high frequency of crisp and sweet wrappers.

Table 2.2 15 most recorded items making up at least 80% of total in Southern North Sea 2009-2014

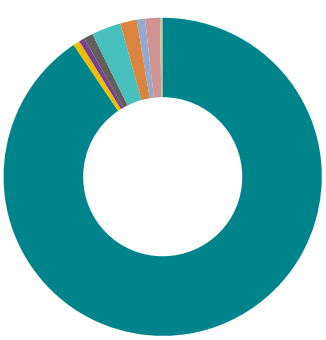
[6] High representation of cigarette stubs in the Mediterranean.

Item	Median number per 100m	Average per 100m of coast	% total number of items	Trend (num / yr)	Relative trend (% change per yr.)
Plastic/polystyrene pieces < 50 cm	103.5	135.9	30.10%	-6.1	-4.5
Nets and ropes	125.7	135.8	30.10%	-6.4	-4.7
Plastic: Caps and lids	26.5	31	6.90%	0.6	1.9
Plastic: Drinks bottles and containers	11.9	11.9	2.60%	-1.3	-11.1
Plastic: Foam sponge	8.1	11	2.40%	-1.4	-12.3
Plastic: Other items	6.1	8.9	2.00%	-1.9	-21.0
Plastic: Crisp/sweet packets/lolly sticks	7.7	8.1	1.80%	0.3	3.9
Plastic: Tangled nets/cord/rope/string	7.3	7.2	1.60%	0.2	2.4
Rubber: Balloons	5.5	6.1	1.40%	0	0.5
Plastic: Food containers incl. fast food	5.3	5.9	1.30%	-0.4	-7.6
Plastic: Indus packaging, plastic sheeting	6	5.7	1.30%	-0.5	-9.4
Wood: other items < 50 cm	3.8	5.7	1.30%	0.2	3.5
San: Cotton bud sticks	3.2	4.9	1.10%	-0.1	-2.8
Glass: Other items	3.5	4.5	1.00%	0	-0.7
Plastic: Plastic/polystyrene > 50 cm	2.6	4.5	1.00%	0.1	1.1

Based on surveys at 37 beaches in UK, France, Netherlands and Belgium

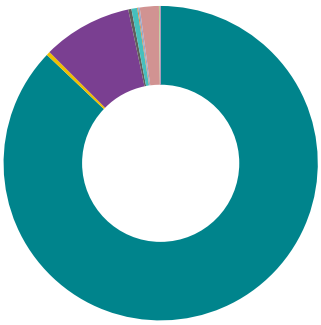
Figure 2.1 provides an illustrative comparison of beach litter composition for the Southern North Sea and Northern North Sea, along with the Celtic Sea and Bay of Biscay/Iberian Coast. Plastic items are dominant in all seas, but a wider relative range of items is apparent in the latter two seas with greater evidence of sanitary items and, in the Bay of Biscay/Iberian Coast in particular, more paper and cardboard. By comparison, the Arctic Sea is almost wholly dominated by plastic items with some appearance of wood.

Figure 2.1 Composition of marine litter



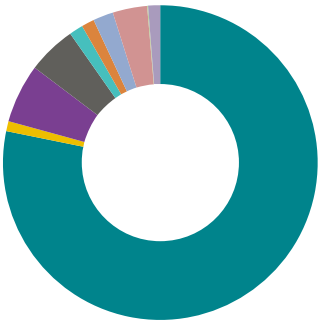
plastic/polystyrene
paper/cardboard
sanitary
metal
wood
glass
cloth/textile
rubber
medical waste
ceramic/pottery

Southern North Sea



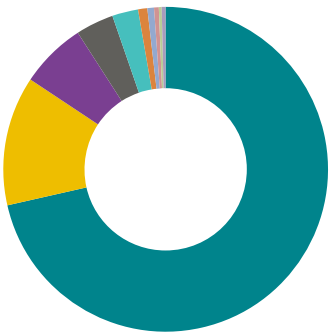
plastic/polystyrene
paper/cardboard
sanitary
metal
wood
glass
cloth/textile
rubber
medical waste
ceramic/pottery

Northern North Sea



plastic/polystyrene
paper/cardboard
sanitary
metal
wood
glass
cloth/textile
rubber
medical waste
ceramic/pottery

Celtic Sea



plastic/polystyrene
paper/cardboard
sanitary
metal
wood
glass
cloth/textile
rubber
medical waste
ceramic/pottery

Bay of Biscay & Iberian Peninsula

Table 2.3 summarises the data collected by the Marine Conservation Society for OSPAR. The surveys are undertaken along beaches around each coastline, including many of lower popularity. They reveal the predominance of single-use items, but also how the composition of marine litter varies between the different OSPAR seas with consumer plastic items such as plastic bottle caps and drinks

containers appearing amongst the top items in most seas bar for the Northern North Sea and Arctic Sea where there is a greater predominance of fishing and industrial items. Although the survey counts all items, including those of very small size, it is worth noting that crisp packets and fragments or plastic string are high on each list despite rarely being discussed relative to caps and bottles.

2.4 Single use items

2.4.1 Types of single use items

The particular focus of this report is single-use items of marine litter that are commonly found in beach litter surveys. These include many of the familiar consumer products from our modern society, i.e. drinks cans, glass bottles, plastic bottles, plastic bags, cigarette stubs, newspaper and alike. A high proportion of these items is represented by packaging, namely cans, bottles, bottle tops, carrier bags and food wrapping. Indeed, bottle caps appear in higher numbers than the bottles themselves. An increasing proportion of the material used in this packaging is plastic which, as described, is often buoyant, durable and potentially hazardous to wildlife, and perhaps also to human beings. Consequently, a particular issue to be addressed is the combined problem of plastic packaging, although this packaging may take many forms, for example, as containers or for holding items together, and may consist of several different types of plastic. Packaging may be of consumer products or from industrial processes and transport, including plastic wrapping film. Other single items include cigarette stubs and sanitary items, the latter of which comprise a high proportion of marine litter items in some locations. The prevalence of sanitary items commonly arises from storm water flow and a failure to collect floating material from rivers as well as from inadequate wastewater treatment. Although the occurrence of these items is proportionately less in the Southern North Sea, many of the same pathways are present. For example, debris collected from eel nets strung across the River Thames has included up to 20% of sanitary items. Surveys indicate that one in three adults in Ireland admit to having flushed items such as cotton buds, baby wipes, tampons and sanitary pads, and even nappies, down the toilet.[7]

In this study, we define single-use items as consumer items and packaging designed for one purpose and use, and generally disposed of in the terrestrial environment. However, some single use items, such as large container bags, may be lost overboard from fishing vessels or blown off shore from farms. Potentially, the term single use can be applied to waste collected or lost from marine shipping and even to some types of fishing activity, e.g. a proportion of the counts of string. The common release of balloons from cruise ships is an example of single use waste. The detailed report produced by Eunomia [8], commissioned to inform the proposed EU Directive on waste from ocean sources, addresses these issues and proposes a variety of new and improved mechanisms to address the problem. The issue is also being addressed by a separate OSPAR initiative.

2.4.2 Plastics

In 1964, world plastic production was 16 million tonnes. By 2014, that figure had reached 311 million tonnes [39]. There is some evidence of this production levelling off in Europe, but in most developing countries output is continuing to rise. Around 4-6% of oil and gas production is used in

[7] An Taisce. wwwthinkbeforeyouflush.org

plastics manufacture, an amount roughly equivalent to fossil fuel use within the aviation sector. This reliance could become 20% by 2050.

In the EU, the plastics sector has a turnover of €340 billion. A total of 52m tonnes were produced in 2015, of which 39.5% was used for packaging [40]. Indeed, plastic packaging accounted for the greater part of growth between 2008 and 2015 [41]. Despite Directives on waste reduction and the recycling of packaging, long-term growth in plastic production is still being forecast to rise at 4% per year [5].

Plastics are very commonly used for single use items due to their light weight, versatility and strength. Indeed, much of the popularity of plastic for single use items is due to its durability. However, the very qualities that make plastic so popular in manufacturing and packaging, makes it a particular problem in the oceans. While an item such as a plastic bottle is likely to be used only once, it could survive in the marine environment (as noted earlier) for 450 years. Indeed, it has been estimated that monofilament fishing line could survive for 600 years [1]. The very durability of plastics, means that a considerable uncertainty applies to the quantity and ultimate fate of this litter. While many plastic products are buoyant, other types are denser than water and will ultimately sink to the sea floor out of sight of beach or surface surveys.

Around 32% of plastics are lost to the waste collection system. Although plastics only accounts for 10% of all waste, globally they represent between 50%-80% of marine litter [1, 42]. Table 2.3 clearly reveals just how prominent plastic single-use items are in the different monitoring activities undertaken for OSPAR. As well as plastic caps and bottles, there is a high frequency of plastic -based fragments or string and crisp packets. Metal cans are, however, surprisingly absent. Only in the Arctic Sea does the prevalence of consumer items diminish slightly as a greater proportion is accounted for by larger items and fishing litter, although, here too, plastic single-use items, sanitary items and cigarette stubs still appear high on the list, illustrating the role of ocean currents.

Of the 322 million tonnes of plastic produced each year, it has been argued that between 5-13 million tonnes enters the oceans each year [43][19], of which perhaps 150,000-500,000 tonnes accumulates in EU waters.[8] Of this amount, 9 (4.8-12.7mt) million tonnes per year is thought to arrive from coastal sources, 0.5 million tonnes from inland terrestrial sources, 1.75 from sea-based sources and 0.95 million tonnes of primary microplastics, of which road tyre dust, followed by pellet spills (often single-use packaging), form the largest components. The large variation in these estimates reveals, once again, that the full scale of the problem is tremendously difficult to estimate and varies considerably for different seas and locations. On average across the world, based on studies by Jambeck et al (2015 [43]) and Ocean Conservancy (2012), Eunomia (2016 [11]) report 2 tonnes of plastic litter per km^2 of beach, 70kg per km^2 of ocean bed, but just kg per $1km^2$ on the sea surface. It is argued that these amounts could double by 2025 [15]. Although the amount of plastic material thought to be on the sea bed is lower per square kilometre than for beaches, the area is vast making the sea bed an eventual sink for most plastic litter.

On the other hand, while being a significant problem for the marine environment, the durability of plastics also points to an opportunity for recycling or re-use. Energy and oil based resources go into the manufacture of plastics and these embedded inputs are largely wasted if the product is only used once. Of the oil resources which go into plastics production, there is a split of roughly 50% energy and 50% raw materials. Plastics provide for a finished product that is potentially a reusable,

[8] http://ec.europa.eu/environment/marine/good-environmental-status/descriptor10/pdf/MSFD%20Measures%20to%20Combat%20Marine%20Litter.pdf

rather than single use asset which can be reconstituted or shaped for many uses over a long period of time without high further significant demands on energy resources or raw materials.

Table 2.3: Representation of single-use items (yellow) in OSPAR beach litter surveys 2016

Southern N Sea		Celtic Seas		Biscay		Iberian Peninsula		Northern N Sea		Arctic	
Plastic small	16835	Plastic small	5897	Plastic small	5956	Plastic small	5145	Plastic String	37633	Plastic String	7751
Plastic large	15658	Plastic large	4225	Plastic large	4403	Plastic large	4598	Plastic large	31920	Plastic large	3564
Plastic Other	6004	Plastic String	4140	Paper: Cig stubs	1277	Paper: Cig stubs	3271	Plastic small	22077	Plastic small	2430
Plastic String	5213	San. Buds	3022	Plastic String	1031	Plastic String	2985	Plastic Caps	6949	Plastic Caps	516
Plastic Caps	3989	Plastic Crisps	3020	Plastic Drinks	939	San: Buds	1710	San: Buds	4708	Wood: small	265
Plastic Crisps	2811	Plastic Other	2771	Plastic Caps	752	Plastic Caps	1605	Med: Other	4189	Rope	251
Paper: Cig stubs	2755	Plastic caps	2636	San: Buds	538	Plastic Other	1254	San: Other	3695	Shotgun pellets	192
Rubber: Other	1617	Rope	1496	Plastic Crisps	485	Plastic Crisps	858	Plastic Crisps	3456	Strapping	160
Fishing net small	1239	Plastic drinks	1020	Plastic Food	439	Plastic Drinks	480	Plastic very large	2411	Glass: Other	143
Plastic Food	1227	Wood small	711	Foam sponge	254	Plastic Cutlery	384	San: Towels	2311	San: Other	142
Foam sponge	1112	Medical: other	694	Glass: Other	221	Small bags	322	Rubber: Balloons	2103	San: Buds	140
Plastic Drinks	1024	Plastic Cutlery	677	Wood: small	197	Bags	280	Plastic Other	1782	Plastic Other	107
Plastic Cutlery	970	Fishing line	530	Metal: Drink	173	Foam sponge	277	Shotgun	1359	Foam sponge	106
Plastic very large	856	Food	470	Cups	153	Plastic Food	246	Strapping	1353	Small bags	104
Plastic Tangled	850	Fishing net small	388	Plastic Tangled	123	Oyster nets	219	Plastic Cutlery	1218	Wood: large	93
San: Buds	845	Foam sponge	381	Plastic Other	119	Paper: Other	206	Fishing net small	1054	Industrial	86
Oyster nets	821	Clothing	371	Bags	113	Plastic Tangled	193	Plastic Tangled	804	Fishing net small	79
Rope	744	Plastic bags	352	Paper: Other	108	Rope	166	Pollutants: Wax	733	Floats	58
Glass: Bottles	537	Plastic tangled	347	Cloth: Other	106	Fishing net small	158	Plastic Food	736	Plastic Crisps	55
Floats	518	Plastic strapping	330	San: Towels	104	Glass: Bottles	142	Plastic Drinks	707	Plastic v. large	54
Metal: Caps	514	Glass bottles	316	Wood: large	103	Cups	135	Paper: Cig stubs	680	Bags	53
Glass: Other	503	Small bags	313	Fishing line	95	Glass: Other	135	Wood: Other small	675	Plastic Food	51
Small bags	446	Toys	313	Toys	90	Metal: Plastic Caps	131	Small bags	579	Plastic Drinks	48
Rubber: Balloons	440	Glass: Other	304	Rope	87	Floats	128	Rope	560	Wood: Pallets	47
Shotgun cartridges	438	Plastic V. Large	297	Metal: Foil	80	Wood: small	117	Cups	515	Pottery	41
Plastic bottles	403	Shotgun cartridges	290	Plastic bottles	79	Metal: Foil	113	Foam sponge	469	Fish boxes	37
Med: Plastic Other	397	Plastic gloves	286	Plastic Cutlery	79	Plastic Cleaner	99	Glass: Other	455	Rubber: Other	35
Plastic Industrial	373	Metal foil	257	Plastic Cleaner	73	San Towels	97	San Tampons	432	Plastic Cups	32
Wood: small	373	Plastic: Industrial	251	Plastic v large	73	Toys	88	Bags	422	Oil small	31

2.5 Summary

Beach litter surveys reveal a wider range of different types of marine litter. Fishing litter has at least equal representation to consumer and industrial items when measured by weight or volume. Measured by number, the largest proportion of litter (where recognisable) consists of single-use items. Of these plastic items comprise by far the main component and consist mainly of packaging material or containers. This material is predominant in most OSPAR sea, with smaller, but significant contributions from paper and card, sanitary items or cigarette stubs in some seas. Regionally, OSPAR counts reveal broadly expected variations given the respective representation of major population centres, beach activity and the fishing industry, but also illustrate how ocean currents have a role in transporting litter long distances to even such pristine environments as the Arctic Sea. Much marine litter is believed to derive from coastal sources, including beach recreation. Most of it is of a type that should be collected as municipal solid waste. Fragments of mainly plastic string, plastic bottles, bottle topics, crisp packets and sweet wrappers, are amongst the most common item types. There is also a high representation of polystyrene foam, sanitary items and cigarette stubs. These items can have a significant impact on wildlife, ecosystem services, potentially human health and on the tourism and fishing industries with costs in some cases impacting severely on businesses and economic and social well-being. However, while the costs are significant and the impacts of much concern, the potential scale of these impacts, including those for human health, should provide an incentive for the international community to address the problem, while the composition and material base of the materials involved, provides pointers on the measures that can take to deal with the problem.

Chapter 3. INTERNATIONAL, EU & REGIONAL POLICIES RELEVANT TO MARINE LITTER

3.1 Marine policies

3.1.1 International marine conventions with global scope

Four international conventions are relevant to marine litter, namely

- UN Convention on the Law of the Sea (UNCLOS)
- International Convention for the Prevention of Marine Pollution from Ships (MARPOL 1973/78,). Annex V (revised 2013) of the convention specifically addresses on board generated waste, requires signatories to provide port reception facilities and includes a prohibition on the discharge of solid waste and litter into the sea;
- Convention for the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention 1972 and the London Protocol 1996);
- Convention on the Transboundary Movements of Hazardous Wastes and their Disposal (Basel Convention).

These four conventions outline signatories' obligations in relation to shipping and the marine environment and address marine litter in combination with pollution and dumping at sea. They are, however, primary directed at the marine transportation and fishing sectors.

Other international actions and commitments of relevance to marine litter include:

- The Global Programme of Action for the Protection of the Marine Environment from Land-based Activities, led by the UN Environment Programme (UNEP) and adopted in 1995. Litter is one of nine sources of pollution identified by the Programme;
- The Sustainable Development Goal No. 14 to conserve and sustainably use the oceans, seas and marine resources, specially Target 14.1 aims to significantly reduce marine pollution of all kinds, including marine debris;
- The Honolulu Commitment to improve international collaboration and coordination on marine litter agreed in 2011;
- The Global Partnership on Marine Litter, managed by UNEP and launched in June 2012 at Rio +20 which includes seven specific objectives of marine litter.
- G7 Action Plan on Marine Litter of June 2015 which is closely aligned with the OSPAR Action Plan.
- G20 Action Plan on Marine Litter of July 2017, which includes specific commitments to single-use items and microplastics.

3.1.2 OSPAR

The obligation of addressing and reducing marine pollution is central to the OSPAR convention. This commitment extends to marine litter too for which a general objective is set down in the Strategy for the Protection of the Marine Environment of the North-East Atlantic for the years 2010-2020. This

objective aims "to substantially reduce marine litter in the OSPAR maritime area to levels where properties and quantities do not cause harm to the marine environment".

A Regional Action Plan (RAP) for Prevention and Management of Marine Litter in the North East Atlantic was adopted on June 27th 2014. This is characterised by a need to:

a) Focus on the specific sources of items of most concern;
b) Develop regional measures, taking into account socio-economic aspects, including cost effectiveness;
c) Regional coordination of SMART[9] targets, including those linked to sources, and the Marine Strategy Framework Directive (see below) targets;
d) Monitoring to assess progress, taking into account outputs from EU Technical Group on marine litter;
e) Cooperation with relevant regional and international organisations such as Regional Seas.

While most actions address land-based sources and the responsibilities of Ports Authorities, one action has been the "fishing for litter" measure which provides an opportunity for fishermen to collect material from the water column itself or from the sea bed and to dispose of this litter using collection facilities in ports. The action could be described as unique in gathering marine litter after its deposition at sea. The initiative has been trialled in various OSPAR states and remains active around parts of the UK. The OSPAR Marine Litter RAP has recommended a strengthening of the existing recommendation 2010/19 to encourage wider uptake within the OSPAR Region. Using 500 vessels, OSPAR (2007) believes it would be possible to collect 2000 tonnes of material each year, equal to 10% of the estimated 20,000 tonnes in the North Sea.

3.1.3 EU Maritime Law

In Europe, almost 90% of the EU's trade is seaborne with short sea movements representing one third of all intra-EU trade in tonnes/kilometres. The European Commission's objectives for the maritime sector are to prevent sub-standard shipping, to reduce the risk and accidents, to protect the livelihoods of people working in the industry, and to minimise the environmental impact of marine transport.[10] The Ship Source Pollution Directive transposes MARPOL into EU law. The EU Directive on Port Reception Facilities for Ship-generated Waste and Cargo Residues (2000/59/EC) places obligations on ports to provide waste facilities and on ships' captains to notify whether they are carrying waste or litter and to deliver that waste to the port reception facility before leaving EU waters unless it can be demonstrated that there is sufficient storage capacity to reach a port with adequate facilities. Ports are required to have cost recovery systems to encourage the delivery of waste.

The Marine Strategy Framework Directive

The EU Marine Strategy Framework (MSFD) (2008/56/EC) has the objective that EU coastal and marine water should be of good environment status (GES) by 2020 based on a set of eleven criteria or "descriptors". Descriptor 10, defines GES as requiring that the "properties and quantities of marine litter do not cause harm to the coastal and marine environment".[11] The descriptor is

[9] Specific, Measurable, Achievable, Realistic or Results-orientated and Time-based, tangible or trackable.
[10] https://ec.europa.eu/transport/modes/maritme
[11] Annex 1 Directive 2008/56/EC http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0056 Member States may apply a consistent specific definition in their Programme of Measures.

matched by the objective on marine litter set by OSPAR. The MSFD thereby represents the legal instrument for the assessment, monitoring and setting of targets for reductions in marine litter to achieve GES. However, the choice of measures to address marine litter is delegated to Member States. In the case of Ireland, for example, the Programme of Measures (POMs) contains 20 such measures, which deal with waste that could find itself to the marine environment, and one (19), which addresses marine litter specifically [44]. Marine litter, in the MSFD, is defined by amounts, characteristics and spatial distribution, and by the impact on marine life (EC, 2011). Indicators for the purpose of establishing GES, may be defined for the amount of litter washed ashore, litter remaining in water column, litter deposited as micro-particles and the impact on marine life.

The MSFD places special emphasis on regional coordination. Technical guidance has been provided on implementation and monitoring, but does not contain common targets. However, while the attention given to marine litter is welcome, several smaller states have failed to prepare their own proposals and targets for the management of marine litter [36]. A lack of harmonised data to form a baseline against which targets can be set has been described as a barrier in this regard [36].

The Directive also refers to the Regional Action Plans of bodies such as regional sea area conventions such as OSPAR, but has been criticised from some quarters for lacking the commitments itself to support the delivery of targets [45]. It has also been argued that the MSFD remains unclear on how trends towards GES are to be measured, specifically in addressing the varying types of litter recorded at different sites and the multiple sources that give rise to this litter. Given the lack of baseline information, it has been difficult to combine the indicators defining GES with specific quantitative targets. Eunomia [8] links this issue with an over-reliance on regular surveys which, though necessary, are also expensive and could be providing an illusion of action to support the formulation of targets that look good, but are not backed by effective measures. For example, a review for the Joint Research Centre [46] found that while 15 Member States had set targets, many of these did not address the full range of indicators required to demonstrate GES. Eunomia gives the example of the UK as one Member State which has acknowledged that its own initiatives on marine litter are unlikely to be successful. This conclusion arises, in part, from the inevitable lack of control any one state has over marine litter which is carried by currents from numerous origins.

Despite these observations, the EU is committed to “take action by 2025” to meet the Sustainable Development Goals agreed at Rio+20. The EU Environmental Action Programme (7th EAP) also requires quantitative headline reduction target for marine litter supported by source-based measures to reduce the quantities of litter finding its way to the marine environment.

3.2 General waste policy

A weakness of marine-focused initiatives is their capacity to address marine litter is largely restricted to the shipping and fishing industries and not to the terrestrial environment. It is for the terrestrial environment where wider initiatives to deal with waste management, resource efficiency and the circular economy are now being progressed.

Over 2.5 billion tonnes of waste was generated in the EU (28) in 2014. EU waste statistics [47]reveal that most of this waste was produced by the construction (34.7%) and the mining/quarrying sectors (28.1%) and is classified by Eurostat as “mineral waste” (2017). While the household and primary industry sectors account for most marine litter, they were responsible for just 8.3% of the total

waste stream in 2014. Indeed, total household waste in 2014 amounted to 204 million tonnes, a 0.7% fall on the levels produced a decade earlier.

Nearly half (47.4%) of the waste collected in the EU-28 in 2014 was treated, and over one third, i.e. 36.2%, of total waste was recovered through means other than incineration. Incineration with energy recovery accounted for 4.7% and without for 1.5%. The highest recycling rates were recorded for Belgium (73.9%) and Italy (76.9%). Sweden and Finland were amongst the countries with the highest rates of landfill (84.4% and 80.9%), although these figures include relatively large amounts of mineral waste. Incineration with energy recovery accounts for a relatively high amount of waste treatment in some northern European states, being 35.8% in Norway, 20.7% in Denmark and 10.5% in Germany.

3.2.1 The EU Waste Framework Directive (2008/98/EC)

The Waste Framework Directive presents EU Member States with legally binding obligations on waste management. It establishes the concepts and criteria associated with waste management, including the definition of waste, recycling and recovery. It requires that waste is managed without impact on human health and the environment, particularly water, air, soil plants and wildlife. It also sets out the relevance of the 'Polluter Pays Principle' and 'Extended Producer Responsibility'.

The current Waste Framework Directive succeeds earlier directives such as the Landfill Directive (1999/31/EC) which set technical requirements for landfills and the management of their impacts and raised the prospect of restricting access to landfill to support the separate collection of recyclables. By comparison, the current Directive is more comprehensive and stipulates the measures to be taken by Member States in relation to all stages of waste management, including waste reduction and recycling. The Directive has been influential in directing Member States towards a more comprehensive approach to the management of waste and, in particular, an emphasis on the decoupling of waste generation from economic growth and moves towards materials recovery. Article 4 of the Waste Framework Directive sets out the concept of a 5-tier 'waste hierarchy' to encourage waste minimisation through, successively, prevention/reductions in use, re-use, recycling or reprocessing of constituent materials, the recovery of the embedded energy in the manufacture of the original products, and with appropriate disposal as the final option.

The Directive sets the framework, standards and targets for the proper management of waste. It is guided by the call for greater coherence and integration of environmental policies into wider EU policy contained in the 7th EAP and the Europe 2020 Strategy for a Resource Efficient Europe. The Directive does not contain specific actions on marine litter, but is very relevant to this issue given that it emphasises the proper collection and management of waste at source. Hitherto, there has been a lack of incentives for the segregation of recyclable waste and for the best practice management of landfills across Europe [48, 49]. The result is that much waste is collected as mixed material, escapes from the waste stream and associated infrastructure for disposal to unlicensed facilities, or is dispersed as wind-blown waste. This situation does not apply in its entirety to every Member State or OSPAR signatory, but is relevant to those for whom there has still been inadequate past investment in waste and water infrastructure. Article 36 also addresses the abandonment, dumping or uncontrolled management of waste and illegal dumping, although the more prevalent problem of general littering remains.

The Directive sets out a range of principles, regulatory frameworks and targets which are to be supported by performance criteria, an improved knowledge base and higher standards for waste collection and resource efficiency. Additionally, the Waste Framework Directive obliges Member States to

- Take measures to prevent the abandonment or improper disposal of waste;
- To establish an integrated network and infrastructure for self-sufficiency in the management of waste (reducing the export of waste);
- To have an enforceable system of permits and registration for those collecting and managing waste;
- To ensure that these bodies maintain detailed records of the quantity, origins and nature of waste.

The Waste Framework Directive proposes to ultimately eliminate as far as possible the use of landfill as a destination for waste. Landfill can be perceived as wasteful and also presents a threat to environmental quality from methane emissions, uptake of contaminants by seagulls and crows, and the possible leakage of leachate into the water table/watercourses where the management of facilities is inadequate. In addition, poorly managed landfill can add to marine litter, particularly at coastal sites, as material can simply be blown away. Higher standards, set down by the Directive, are minimising instances of these problems, but it is still intended that Member States move away from a dependence on landfill towards waste reduction in line with the 5 tier EU waste hierarchy.

The Directive asserts the importance of reducing society's reliance on finite resources while also identifying the material value of the waste itself and how this can be captured for reuse, recycling or, as a minimum, recovered as energy during incineration. A guiding principle of the Directive of relevance is the Polluter Pays Principle (PPP) which seeks to ensure that those who produce waste also carry responsibility for the cost of its appropriate management. This principle places responsibility both on consumers to not litter and to dispose of waste properly where facilities exist, and on producers to design products that have a minimum risk of becoming waste and to accept producer responsibility for a share of the costs involved in the after-use management of their products. It is especially relevant to single use products that are easily discarded by consumers without cost and to producers, of whom many such products do not conform to the needs of the waste hierarchy.

Article 8 of the Directive therefore aims for Extended Producer Responsibility (EPR) in line with the PPP. This involves placing environmental impact management obligations on producers, including making producers cognisant of downstream impacts associated with the use and disposal of products, and reflected in the costs incurred at different stages in their lifetime. EPR provides for incentives to address waste reduction through improved product design, by minimising packaging and supporting measures for the collection and reuse of materials or their recycling. In the first instance, producers can be encouraged to take effective voluntary actions so as to avoid the introduction of new regulations backed by penalties or other economic instruments. Producer can join Producer Responsibility Organisations (PROs) or conform with legal obligations that require non-participating companies to self-comply. However, there are opportunities for producers to reduce their resource costs by reducing or reusing raw materials and to benefit from being seen to demonstrate greater corporate social responsibility.

For private households, there is a need to raise participation in the proper collection of waste, its reduction and segregation into recyclables and non-recyclables. The Directive encourages the use of incentives, e.g. variable charges, by weight and for the segregation of materials. The support of the waste collection sector for such incentives is ensured through the use of landfill levies (e.g. currently €75 tonne in Ireland). A strong correlation has previously been identified between increases in the levy and the amount of waste being disposed of at landfill (EPA, 2010). The levy essentially obliges

waste collection operators to invest in alternative recycling and recovery programmes to minimise their costs.

Case study example: Ireland

In Ireland, as in other EU countries, waste policy is based around the waste hierarchy of prioritising prevention and reuse ahead of recycling, recovery and landfill of waste. The National Waste Prevention Programme has been in effect since 2004 with the most recent strategy set out in 'Towards a Resource Efficient Ireland 2014-2020'[12]. Irish waste policy in general is outlined the document 'A Resource Opportunity – Waste Management Policy in Ireland' (2012)[13]. The policy and programmes accord with the Waste Framework Directive by focusing on resource efficiency, prevention and reuse, and by fostering a more coordinated approach to waste management. Management and enforcement had already been improving following a critical 2005 European Court of Justice judgement and the subsequent prioritisation of investment in the infrastructure for waste and landfill to meet European standards. In practice, this has required, as a minimum, for modern landfills to have impermeable membranes for the protection of the underlying water table and the use of netting to prevent fly-blown waste.

Waste policy is set out by the relevant Government department. Local authorities are required to make waste management plans and enforcement is undertaken by the Environmental Protection Agency (EPA) which also oversees implementation at the strategic level. A regional approach to waste management has been employed with the country divided into three waste regions. For household waste, it is the private sector which is rather the service provider and is required to satisfy a regulatory regime that includes mandated service levels, the management of waste in accordance with the waste hierarchy, and the adoption of incentivising pricing structures to encourage sustainable household behaviour. Waste infrastructure is largely owned and operated by private waste operators who also now undertake most collection.

At present, flat rate charges for households' general waste are being phased out over the period Sept 2017 to Sept 2018 and replaced by payment by weight or variable charges in line with the waste hierarchy. To pursue the waste reduction and recycling at producer level, a Review of Extended Producer Responsibility in Ireland was conducted in 2014 (DECLG), including the potential for reductions in unnecessary waste, such as packaging. Various initiatives had already been put in place prior to the review in relation to electrical goods, batteries, end-of-life vehicles, tyres, farm plastics and packaging waste. Many of these have been quite successful in facilitating the diversion of waste from landfill, allowing Ireland to meet EU and national recycling targets. Indeed, in 2011, Ireland had the highest recycling rate for packaging in the EU. The plastic bag levy, introduced in 2002 and now set at 22c per bag, has successfully incentivised a significant reduction in plastic bag use. Together with the income from the landfill levy, the revenue is paid into an Environment Fund which promotes awareness of waste management and other aspects of environmental sustainability.

Overall, waste management policy, planning and legislation has been successful in reducing the amount of municipal waste going to landfill from 92% in 1995 to 42% in 2013. It has been reinforced by initiatives at business and community level to reduce the total volume of waste or to reuse materials, including the Green Business Programme, Community Reuse Network Ireland and Free Trade Ireland [50]. For packaging, the latest EPA statistics (Nov 2017) report 91% packaging waste recovery by weight (target 60%), 68% recycling by weight (target 55%), 88% recycling of glass, 80% recycling of paper and board, and 34% for plastics. There are still challenges, for example waste production per person is significantly above the EU average at 586kg compared with 481kg, although this has decreased significantly.

[12] Environmental Protection Agency.
[13] Department of the Environment, Community and Local Government.

3.2.2 EU Packaging and Waste Packaging Directive

The EU Packaging Waste Directive (94/62/EC) (currently under review) requires Member States to introduce harmonised systems for the reduction of packaging waste and for its increased collection and return. Packaging includes all product packaging, including single-use carrier bags, food packaging, wrappers and drinks containers. By its nature, almost all packaging becomes waste and so the Directive directly targets a major source of both general waste and marine litter. At present, the Directive (like the Waste Framework Directive) does not specifically address marine litter, despite the prevalence of packaging waste in beach litter surveys. It does, though, include objectives to reduce the weight and volume of packaging, to design reusable and recoverable packaging, and to manage the composition of packaging, prioritising reductions in the use of hazardous substances. These objectives could have an impact by reducing marine litter or its impacts. The Directive also sets recycling and recovery targets for different types of packaging such as paper and board, glass, plastics, metals and wood. It sets out the role of extended producer responsibility and encourages manufacturers to join PROs who generally fund collection and recycling operations.

Eurostat figures show that the Directive has had a significant impact on recovery and recycling, although progress towards reduced packaging and recovery has proceeded more modestly in the last ten years. The levels of recovery and recycling in the best performing states are 25% higher than those towards the bottom of the scale and provide a rationale for higher targets given that these figures demonstrate what can potentially be achieved. In 2014, the average per person weight of packaging waste in the EU-28 was 143kg. Most of this packaging was represented by paper and cardboard, equal to 34 million tonnes (see Figure 3.1). In Ireland, for example, paper and board accounted for 47% of packaging waste, followed by glass and plastics at 19% each, wood at 12%, and metals at 3% (DECLG, 2014). Despite the Directive, producer and consumer habits are not easily changed and the quantity of packaging waste produced per person in the EU has remained fairly static between 2005 and 2014, but for short lived reductions during the recession. Similarly, the relative contribution of materials has remained similar between 2005-2014, although the share of glass and metals decreased slightly over this time. The average level of recycling has, however, increased from 54.6% in 2005 to 65.5% in 2014. Total recovery rates are also higher, although reveal a high dependence on incineration in some countries. In the OSPAR region in 2012, the average recovery rate was 82.7% and the recycling rate was 60.0%. Recycling was highest in Belgium and Germany at 81% and 71% respectively, with Germany and Ireland having the highest rates of packaging recycled per person at 156.7kg and 132.7kg.

Figure 3.2 Share of packaging waste generated in the EU 2014

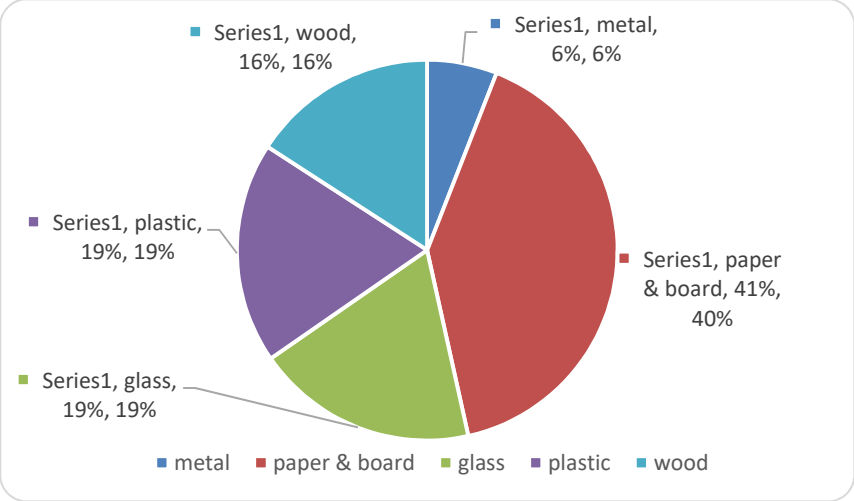
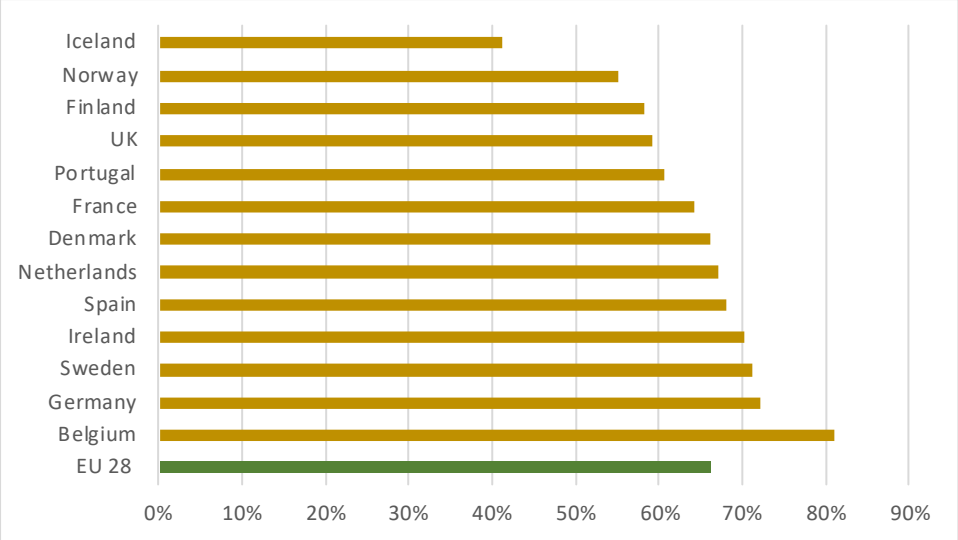


Figure 3.3 Level of recycling for all packaging in OSPAR States (Eurostat, 2014)



3.2.3 Directive on consumption of lightweight plastic carrier bags

This directive on plastic bags (2015/720) is an amendment to the Packaging Directive which requires Member States to set reduction targets for these bags such that per person consumption should not exceed 40 bags in any one year by 2025. Reduction targets are to be reinforced by a levy and/or other economic instruments to be decided by each Member State, beginning with a prohibition on the provision of bags free of charge to the consumer by 2018 unless equally effective measures can be implemented.

3.2.4 Eco-design Directive

The Eco-Design Directive (2009/125/EC) is a framework directive that provides general requirements for encouraging product designs that minimise impacts on the environment from manufacture, use or disposal. Currently, the Directive only addresses the environmental performance of energy-using products and not packaging. Its impact on waste generation is small at present, although the target groups are due to be reviewed in 2020.

3.2.4 Ecolabel Regulation

The Ecolabel Regulation (66/2010) allows an ecolabel to be awarded to goods and services that have a low environmental impact. The regulation requires labelling to take into account the full life-cycle impact of products and services. There is potential to include the prospect of a product becoming marine litter in the criteria for the award of the Ecolabel.

3.2.5 Landfill Directive

The Landfill Directive sets strict criteria for landfills to minimise negative impacts on health and the environment, including surface water, groundwater, air and soils. It requires that landfills can only be operated on receipt of a license from the competent authority and be managed within the scope of a regional waste management plan. Inadequate landfill management has been implicated in marine litter, particularly following losses to rivers or wind. While the Directive has been in effect for 14 years, there continues to be numerous cases of infringement, including illegal sites and dumping, although these issues are less prevalent in the OSPAR states, despite some increase in cases following the implementation of landfill levies. These levies have been successful in reducing the proportion of waste going to landfill. It has been proposed that the disposal of plastics, glass and metals to landfill could be prohibited as part of the measures to be implemented under the circular economy package (see below) [36].

3.2.6 Green Public Procurement

This communication (COM (2008) 400) sets out a process whereby public bodies can encourage reductions in waste and a move towards the circular economy by seeking only to procure goods and services that can demonstrate a reduced environmental impact. The Commission identifies ten priority areas for green pubic procurement (GPP) of which paper and printing services and cleaning products have relevance to the continued use of single use items.

3.2.7 Water Framework Directive

The Water Framework Directive (2000/60/EC) is relevant to the problem of marine litter in that a distinct proportion of material arrives via waterways. The Directive set a target for 60% of the EUs waterways to achieve Good Ecological Status by 2015. Member States are required to establish river basin districts and associated management plans. Assessment of overall waterbody status is based on biological and chemical status. The Directive provides an over-arching framework for directives such as the Bathing Waters Directive (2006/7/EC) and Urban Waste Water Treatment Directive (01/271/EEC). The former requires the monitoring of inland and coastal bathing waters to ensure that they meet standards set for the protection of human health. These standards to not specifically refer to litter, but could potentially do so, particularly is items such as sanitary products are present.

The UWWTD sets standards for the collection, treatment and discharge of waste water from urban centres with higher standards applying for receiving waters which are environmentally sensitive. It requires that treatment works serving over 10,000 people include at least secondary treatment. The Directive is relevant to marine litter given the tendency for poorly performing plants to fail to capture items such as personal hygiene products that can easily be carried by rivers into the marine environment. Wastewater treatment networks and plants in some Member States still do not have the capacity to deal with high inflows during storm water events with the result that these flows are simply diverted into rivers or estuaries without removal of litter or other pollutants. As an example, in Ireland, 43 urban agglomerations are still discharging effluent without treatment, with 80% of this released into estuarine or coastal waters.[51] Irish Water, the national water utility, has been set a target of eliminating 40 of these discharges by 2020. It is during storm events, though, that most

both litter and sewage, including sanitary items, finds its way into watercourses. The situation in Europe is improving, but the level of capital investment needed for adequate wastewater treatment is substantial. Massive investments have been made in this area, including €1.38 billion in Ireland alone between 2011-13. However, the public good benefits extend beyond marine litter, to include human and environmental health.

3.3 EU Action Plan for the Circular Economy

"*Closing the loop", the EU Action Plan for the Circular Economy* (COM/2015/614), builds on previous initiatives such as the Roadmap for a Resource Efficient Europe (COM 2011 571) and is based on two key guiding principles. The first of these is to retain the value of products, materials and resources within the economy. Thus, it is envisaged, the circular economy will provide for competitive advantage and protect European industry against future resource scarcity and the price volatility associated with raw materials. The second principle is to provide a direct public good by minimising waste generation, reducing water pollution and moving towards the more sustainable use of materials and energy. The Action Plan contains a legislative package and a broad list of actions.

The Action Plan proposes:

- A target for recycling of 65% of municipal waste by 2030;
- A target for recycling 75% of packaging waste by 2030;
- A binding landfill target to reduce landfill of municipal waste to a maximum of 10% by 2030;
- A ban on the landfilling of separately collected waste;
- The promotion of economic instruments to discourage landfilling;
- Simplified and improved definitions and harmonised methods for the calculation of recycling rates throughout the EU;
- Concrete measures to promote re-use of materials by converting one industry's by-product into another industry's raw material;
- Economic incentives for producers to put greener products on the market and support recovery and recycling schemes (e.g. packaging, batteries, electric and electronic equipment, vehicles, etc).

These targets are currently under negotiation and a final outcome is expected in late 2017 or early 2018.

The Action Plan also sets out the infrastructure and approaches that will be needed to make the circular economy an achievable objective. These include steps to 1) improve product design to maximise the longevity and reusability of the composite materials , 2) to address the primary and secondary impacts arising from production processes that do not allow for recycling and re-use, 3) to provide the information and infrastructure to allow households to make informed choices on the composition and potential recyclability or reusability of the products they purchase, 4) to minimise waste through adherence to the waste hierarchy, 5) to transform waste into potential resources, and 6) to provide the horizontal or supporting measures to encourage relevant research, foster product innovation and to make funding available.

Each of these approaches has relevance to marine litter which is specifically mentioned in the Action Plan as being amongst the Sustainable Development Goals to be achieved by 2030. As consumer behaviour plays a large part in the question of whether an item is at risk of becoming marine litter, most especially of single-use items, the inclusion in the Action Plan of proposals to increase the

relevance of product information to consumer decision making presents an opportunity to communicate awareness of product content, recyclability and the impact of inappropriate or premature disposal, including the impact on the marine environment discussed in Chapter 2. The Action Plan emphasises the potential role that economic instruments can have in making consumers aware of these impacts and by changing purchasing and use behaviour. It also refers to the potential of Green Public Procurement to spearhead changes in use and consumer behaviour.

The Action Plan contains proposals to embed the waste hierarchy in the management of waste in Europe by providing for a common waste infrastructure that discourages the use of landfill and funding support for incineration. This section of the plan discusses the virtue of higher targets for the recycling of single use packaging waste and the role of EPR by making manufacturers responsible for addressing a share of the impact of premature disposal by contributing to the cost of waste infrastructure. The proposals with regard to transforming waste into a usable resource are intended to demonstrate how a combination of regulation and economic instruments can stimulate a market for reusable materials, for example by reducing uncertainty as to the composition and continued availability of materials.

The section on product design discusses how products can be designed to increase their usability (or repair), their durability and recyclability. Reference is made to the existing EU Eco-design Directive and to the potential use of economic instruments to encourage EPR by differenting product costs based on their durability and end-of-life impacts.

In its first report in 2016 on the implementation of the circular economy, the Commission noted examples of actions on food waste, eco-design and innovation. To date, however, the concept has mainly been understood in terms of better waste management and a disconnect still applies to resource efficiency objectives [52]. A report by technopolis [53] identified several barriers including mixed waste collection, legislation which inhibits the use of recycled materials in new products, and a lack of enforceable product requirements.

3.4 EU Plastics Strategy

3.4.1 Present situation

At present, there is no specific provision in the Waste Framework Directive to address plastic waste despite its popularity for single-use products and its prevalence in marine litter. Only the packaging Directive contains specific recycling targets. The average per capita consumption of plastics in the EU- 28 in 2008 was 30.6kg. Of the 24.9 million tonnes of plastic waste generated in the EU at this time, around 60% was designed for long service life and 40% for short term or single use. The relatively short life span reflects the fact that packaging accounts for a higher proportion of plastic use than for other materials at 63%.

Plastic waste recovered goes mainly to incineration, of which energy recovery accounted for 30% in 2008. Plastic recycling and recovery is highest in Belgium and the Nordic states (>85%) and lowest in Spain, Portugal and the UK (25%-32%). Those countries with the highest rates of recovery already tend to have restrictions on the plastic waste entering landfill, but also make much use of incineration. Incineration can be a means to deal with mixed plastic waste, but an over-reliance is potentially counter-productive in that it would undermine the market for plastic recycling. Slovenia has the highest rate of recycling plastic packaging at 69.4%. In Germany, the rate is 50.2%. However,

recycling rates vary depending on the product and its composition. Around 40% of bottles and industrial film was mechanically recycled in 2008 compared with less than 10% for mixed plastics. Much of the packaging waste recovered is from commercial sources for which high levels of compliance occur. Municipal solid waste (MSW) accounted for between 40-50% of total plastic waste.

Table 3.1 Plastics recycling in most OSPAR countries

Country	Level of plastics recycling
Germany	50.2%
Netherlands	49.8%
Sweden	47.5%
Spain	42.5%
Belgium	41.8%
Portugal	40.0%
UK	36.9%
Norway	36.1%
Ireland	35.4%
Denmark	30.4%
Finland	24.6%

3.4.2 A strategy for plastic waste

A European Strategy on Plastic Waste in the Environment was published in 2013. The strategy looked at production, use, waste management, recycling and resource efficiency and provided several studies for new legislation on plastic bags and several follow-on studies. Plastic is precisely the type of material that must be addressed by the circular economy given its value as a potentially recyclable resource and the embedded energy left from its manufacture. Major constraints on the reuse and recycling of plastic have been the varying types of plastic manufactured, the combination of these plastic types within single products, and the presence of potentially toxic substances used as additives in both the product or from the residue of the contents of bottles or other containers.

The EU Action Plan for the Circular Economy contains specific actions on plastics amongst its "Priority Areas", including the need to address potentially hazardous additives and the practicalities and logistics of biodegradability. A Directive to reduce the use of light weight plastic bags was adopted in 2015 as an amendment to the Waste Framework Directive. However, the EU is currently working towards a Plastics Strategy as part of the Action Plan on the Circular Economy. This proposed strategy builds on the publication of a Green Paper on Plastic Waste in 2013 (A European Strategy on Plastic Waste in the Environment (COM 2013 123) and the Study on Plastic Waste in the Environment (Bio Intelligence Service) commissioned in 2011. Unlike some previous policy documents, the Green Paper does discuss the problem of plastics in marine litter and this will be addressed within the forthcoming Plastics Strategy too.[14] It remarked that the current Waste Directive does not specifically address plastic waste, but does acknowledge that it contains relevant tools to deal with this waste, for example through EPR. Rather, it identifies that plastics are currently only addressed directly by the Packaging Directive. Packaging, it notes, accounts for 40% of the

[14] The new EU Plastics Strategy was produced in Dec 2017 and recommended, in particular, improved design of plastics products, expansion of the separate collection of plastic waste, expansion and modernisation of sorting and recycling, and the creation of viable markets for recycled plastics.

plastics converting industry's production, but is described as the "low-hanging fruit" for policy initiatives as it accounts for 63% of total plastic waste that is generated. The Green Paper quotes studies that argue that 162,000 jobs could be created through the management of plastic waste materials, equivalent to 15.6 jobs per 1,000 tonnes recycled. At present, as noted above, only 28% of plastic waste in the EU is recovered with much of this accounted for by waste-for-energy incineration. Around half of the remainder goes to landfill.

The Green Paper remarks that regulations (i.e. REACH 1907/2006/EC) do exist to manage the chemicals used in the manufacture of plastics, including potentially toxic additives, and that the Classification, Labelling and Packaging Regulation (1272/2008/EC) addresses issues of information and labelling. It comments that much could be achieved if these existing regulations were implemented and supported by satisfactory landfill management. However, it also acknowledges the challenges that must be met, for example overcoming the legacy of existing waste infrastructure which is largely designed to deal with mixed waste or to direct plastics towards incineration or waste-for-energy. Over-reliance on incineration can discourage the provision of recycling infrastructure, partly because of the high locked-in investment in incineration plant [39]. In addition, the Green Paper raises the question of how to deal with bio-based plastics (plastics from natural plant materials) and biodegradable waste. The latter might only be degradable under controlled conditions that are not typical of oceans. This usually involves exposure to UV radiation or composting temperatures in excess of 50˚C. Oxo-degradable plastics which include a metal additive may break down more quickly, but only to the extent of becoming microplastics [54]. These materials could undermine existing efforts at modifying consumer behaviour including the segregation of waste [55].

A Roadmap for an EU Strategy on Plastics in the Circular Economy was released at the beginning of this year (2017) with a view to negotiation following a planned conference in September. The Commission has issued a letter of intent that a strategy be developed to provide for all plastic packaging being recyclable by 2030. A target of 65% is being discussed for the reuse and recycling of all packaging waste by 2025 and for plastic bottles recycling of 55%. The principal aims of the roadmap are to decouple plastic production from a reliance on virgin oil-based feedstock, to improve the economics of reuse and recycling, and to reduce the leakage of plastic waste into the environment. The Roadmap sets out a strategy, potentially supported by economic instruments, that could stimulate innovation in the plastic industry to reduce the propensity of single use products. It remarks also on the need for integration with existing regulations that deal with the treatment of chemicals and to push forward with the development of secondary markets for plastics. The absence of secondary markets is identified as a particular impediment and part of the reason why, until recently, around 50% of plastic waste is still being exported to third countries and why the EU's own plastic recycling sector accounts for only 4%-6% of plastics demand in Europe at present. The other major challenge identified by the Roadmap is the poor recyclability of plastic waste given that most products are designed for single use. The Roadmap makes the case for increasing consumer awareness, but has been criticised for not discussing a further extension of producer responsibility.

3.5 Summary

A range of targets and undertakings have been discussed over the years to address the problem of marine pollution and waste. The UN Convention on the Law of Sea (1984), The MARPOL Convention (1973/78 and 2013), the Convention for the Prevention of Marine Pollution by Dumping of Wates and Other Matter (1992 & 1996 London Protocol) and the Convention on the Transboundary

Movement of Hazardous Waste, have all addressed the problem of waste in the oceans, including marine litter. Marine litter has also been specifically addressed by the UNEP The Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (1995), the Honolulu Commitment (2011), the Rio +20 Sustainable Development Goals (2012) and the G7 Action Plan on Marine Litter. As a component of marine pollution, litter has risen as a policy priority as awareness has grown of the dangers marine litter presents to the marine ecosystem, the activities that depend on it, and the threat presented by the remorseless accumulation of much of this litter. The uptake of common monitoring and reporting methods is progressing, but specific and comprehensive actions to deal with the problem have not been set out or agreed. The EU Marine Strategy Framework Directive, for instance, specifically addresses marine litter along with other threats to the marine environment, but leaves it largely to Member States and the Regional Seas Conventions to decide how to address this problem.

The management of the marine litter is complicated by the international nature of the problem and varied sources of litter, by its mixed composition of products and materials, by the many different types and stages of use of the products which become litter, by the contribution of different economic sectors and consumers. At the European level, improved waste and litter management represents the principal means to deal with more than half of the quantity of marine litter which arrives from terrestrial sources. Single use items are not specifically addressed except through support for recycling and re-use generally. In essence, the problem of marine litter is one of inadequate waste management generally with the front end of the problem being careless or deliberate littering and dumping. The EU Waste Framework Directive has begun to address the problem of inadequate waste management, but is largely silent on the downstream problem of marine litter. A range of other directives such as the EU Packaging Directive, the Eco-design Directive, the Water Framework Directive, the Bathing Waters Directive and the Urban Waste Water Treatment Directive together provide the means to address waste that is at risk of becoming marine litter.

The eventual implementation of the Action Plan for the Circular Economy and agreement on a forthcoming Plastics Strategy will do much to manage the problem of single use marine litter by creating a market for essentially valuable products that are currently destined to become waste. It will also include measures to enshrine the waste hierarchy in legislation so that disposal becomes the last resort. These are laudable objectives, but actions and targets will require that existing local examples of best practice waste management that address single use items become the norm and that policy is backed by effective regulatory and economic instruments. Aside from legislation and investment in infrastructure, the need remains to influence consumer attitudes away from the disposable culture towards a more sustainable system where the longevity and reusability of a product is valued.

Chapter 4. MEASURES

4.1 Types of marine litter, the legal framework and governance

Marine litter derives from a variety of sources. These can be broadly categorised as marine activities, beach/coastal activities and other terrestrial. Deliberate dumping or littering is one of the causes of marine litter and is likely to be significant at some locations. Most loss is accidental, although carelessness is a large contributory factor, be this by individuals, businesses or within waste management systems. Both producers and consumers have a responsibility for marine litter, but this responsibility can sometimes only be made explicit through the use of measures that cause either party to become aware of the environmental cost. Communicating this responsibility can be achieved through awareness raising or promotion of best practice at one end of the scale or otherwise by making consumers and producers share in the cost, i.e. internalising the cost, including through EPR.

Only a certain number of measures are available to deal with marine litter directly, namely local collection infrastructure, beach collections, at-sea/port collections and initiatives such as Fishing for Litter. Reductions in litter derived from terrestrial sources require indirect measures. Inevitably, this dilutes the capacity of any one measure to achieve a distinct quantifiable reduction in the quantity of marine litter. Furthermore, there are many sources and types of marine litter that, to be effective, a variety of measures will be necessary. These need to be comprehensively linked to one another so that a single measure reinforces another. This, in turn, requires research, modelling of outcomes and careful design, backed by strategies for implementation, monitoring and evaluation. It also requires commitment and enforcement, because if a single measure is poorly implemented, or if its effectiveness is undermined by the poor implementation of another measure, this will not only reduce the capacity to achieve targeted reductions in marine litter, but could also undermine public confidence or compliance with the result that the potential cumulative benefits of a mix of measures are never realised.

Enforcement requires a comprehensive legal framework to be in place. The same is required for private companies to make the changes in products and investments in waste infrastructure. In the first instance, this will require public investment in an effective infrastructure for waste management. It also implies good governance characterised by political commitment and the capacity to provide the infrastructure to administer and implement measures, and to police infringements or illegal activity. Good governance extends to being able to identify and engage a range of stakeholders, to engender not just stakeholder compliance, but their participation and input, including through the use of public-private partnerships. This increases the likelihood that policies will be understood, will be deemed credible, and will achieve a high level of public buy-in, increasing the prospect of behavioural change.

4.2 Integrated waste management

The prevalence of single-use items of marine litter is ultimately determined by the production of such disposable items, the behaviour of consumers and the management of waste streams generally. Under the EU Waste Framework Directive, targets have been set for recycling. The Arcadis report (2013)[36] presents scenarios that indicate a 4.6% reduction in marine litter is possible between 2015 and 2020 with full compliance with the Directive compared with a 4.4% increase under a 'business as usual' scenario. It notes that several Member States have already achieved full compliance. However, while the report acknowledges the high contribution of packaging litter, it argues that packaging recycling targets cannot account for all sources of marine litter, remarking also on the role of non-packaging industrial material. Therefore, an integrated array of measures is needed to address waste as a whole.

Waste management consists of five stages from source, collection, transport, processing and output. Waste is collected from households/offices, commercial/industrial and bring banks/recycling centres. Regulation can be used to set targets for recoverable or recyclable waste, to prescribe collection systems and the separation of different kinds of waste. Indeed, Arcadis assumes that the average level of recycling in the EU would amount to 26% (30% is composting is used) if the targets of the Waste Framework Directive were met. The setting of increasingly rigorous targets is a factor that has led, in Ireland for example, to an increasing transfer of direct responsibility from local authorities to private operators. The former are required to have a detailed waste management plan and to demonstrate that there is sufficient waste infrastructure, including the collection and management of waste according to the waste hierarchy. The latter can be subjected to increasing restrictive licensing obligations, but may have greater flexibility to achieve these obligations through new working practices, innovation and economies of scale related to the level of competition and household fees they feel able to charge. Landfill levies can be set at a rate that encourages these companies to invest in segregation of waste types.

Hitherto, there is no reference to marine litter in the Waste Framework Directive and regulation has been designed with a view to affecting the overall quantities and type of waste and not in relation to the relative risk that these materials will end up in the marine environment. Rather, marine litter will feature in the forthcoming Plastics Strategy. Only in a few instances can normal waste management procedures address the problem of marine litter directly. However, improved waste collection and management is fundamental to reducing the amount of waste that becomes marine litter. Targets for re-use and recycling should mean that less waste is disposed to landfill. Firmer measures can also be taken in coastal localities to ensure that litter does not find its way to the marine environment. Indeed, the Waste Framework Directive requires that landfill is not sited in exposed locations and that waste is covered against wind and protected from seagulls or crows.

4.2.1 The Circular Economy

Integrated waste management involves the implementation of a range of complementary measures at different stages in the product life-cycle from manufacture, to consumption and disposal. It typically draws on the concept of the waste hierarchy which prioritises, in order, reduction/prevention, re-use, recycling and recovery, with disposal as a large resort. The Circular Economy (CE) envisages significant actions to implement the waste hierarchy principle for the management of waste at each stage from production to processing and consumption throughout the economy. The ultimate ambitions of the *EU Action Plan for the Circular Economy* are to decouple production from waste and virgin fossil feedstock, to reduce the production of limited use consumer

products, and to move towards an economy in which a value is realised for what is current considered waste, in turn increasing the uptake of recycling and re-use. Most disposable single-use items are incompatible with this strategy.

However, such a strategy is little short of revolutionary in relation to how we address and manage the relationship between raw materials, products and waste at present. A key element will be pursuing producer responsibility and this will not be accepted easily by the industry lobby. At present, no one EU Member State can impose restrictions and costs on producers that could disadvantage them in relation to producers in other Member States. It will be necessary to demonstrate firstly that implementation of EPR will provide social benefits that exceed the costs, that secondly, the transition can be implemented in such as a way as to minimise up-front costs for producers and any risk to competition, and that finally, there are potential commercial gains to be had from realising a much higher value of the recovered or recycled raw material than is currently the case.

Prevention/reduction

EU member states are required to have a National Waste Prevention Policy which focuses, in the first instance, on waste prevention or reduction in line with the waste hierarchy. There is some evidence from Eurostat that some decoupling of material consumption from economic growth has occurred since the return to growth. Minimisation is the most efficient means of dealing with waste. Reductions in use directly reduce the quantity of material available to become litter and marine litter. Waste minimisation also provides more output per unit of input, minimises resource use and energy use. Much reduction can be achieved at process/manufacturing level by managing inventories and modifying production processes to maximise use of inputs, reduce the volume of reject products and reduce the need for cleaning products. At a consumer level, removing planned obsolescence minimises waste and equates to improved product redesign, but may have some trade-offs as for example where new products are more energy efficient. For single-use products, household reduction can be achieved by replacing weighty liquid cleaning products with more traditional powdered products or by simply supplying goods in larger containers. For single-use items, the most distinctive element of reduction would be the elimination of unnecessary packaging. Packaging accounts for a significant proportion of single-use product waste. Excess packaging is annoying for consumers, especially where they are faced with disposal costs. It also adds to manufacturing and transportation costs. Nevertheless, we have become accustomed to products arriving with large amounts of packaging, often as a form of brand differentiation or superficial evidence of quality. Streamlined distribution systems can also help to reduce the amount of packaging that is used between initial producers, manufacturers and retailers. Polystyrene and polymer film are both products that are difficult and expensive to recycle and which often turn up as marine litter.

Re-use appears next in the waste hierarchy. This process ensures that the maximum value is extracted from a product following its initial or previous use, postponing the time at which disposal may ultimately be necessary. Re-use often occurs within the manufacturing plant, but can also be encouraged between producers. It can potentially be undertaken by consumers too. Reusable coffee cups are an example which has become vogue and which can begin to stimulate more sustainable behaviour by consumers away from the disposable society to which we have drifted. Similarly, products such as bottles can be put straight to other uses. Some refillable products, e.g. washing products have become available as producers have realised that there are also benefits to be had in reducing transportation costs. Re-use can also be achieved directly through deposit-refund systems,

particularly for glass bottles, although most such systems aim to collect products for recycling rather than reuse

Recycling is a strategy that has been pursued for twenty years or more, but it is only recently that we have begun to see serious efforts to apply variable pricing to segregate waste and to charge consumers varying incentives for recycled and other waste. Recycling offers an opportunity for raw materials to be reused after being reconstituted, although there are limits on the frequency with which materials can be recycled and costs involved in terms of transportation, sorting and energy. Levels of recycling have risen gradually, if not dramatically, but only around 20-30% of PET products are currently recycled due to the nature of use and limits of the ability to clean the material or presence of more than one polymer [56].

Recovery, for the most part, currently means capturing a proportion of the energy embedded in the product through incineration. This waste management option is most popular in Germany and the Nordic states. Dense plastics contain 55% carbon by dry weight [57]. This is higher than other components of municipal solid waste and assists the products' combustion. The level of energy recovery is highest for district heating and for use in cement kilns, but is around 25% for standard waste-to-energy incineration [58]. However, as a proportion of the original volume of mixed plastic waste, this percentage could be as low as 2.5% due to contamination. The inclusion of additives adds to the cost of incineration and prohibits the incorporation of PVC and polyurethane products due to the danger of toxic emissions. For purer forms, such as PET, incineration for energy recovery is possible without significant harmful emissions. Dioxin emissions are within health standards in modern plants, but CO_2 emissions are unavoidable. Partly for these reasons energy recovery is not being strongly encouraged as moves towards a circular economy.

Chemical-based recycling is also available, but is more expensive, though could become more common in future. New means of breaking down polymers are also emerging, such as for plastic films using micro-organisms and algae. These methods have the potential to consume waste plastics without the same loss of CO_2 and for the organic material to be used itself for energy. The compatibilisers used to bind multi-layer material packaging in the original production process, can be used for recycling too, albeit to produce low value products [39].

Disposal represents the last resort and mostly entails landfill. Landfill denies the opportunity for re-use and recovery. Greenhouse gases are produced and there is also a risk of emissions of methane and leachate. Some energy recovery is possible, but only where landfills are set up to capture these emissions.

4.2.2 Plastic recycling

The Waste Framework Directive could have a significant impact on marine litter if fully implemented in each Member State. Its targets for re-use and recycling would mean that less waste would end up in landfill. However, its impact to date has not been reflected in a significant reduction in the volume of marine litter.

One area is which reduced waste would be highly desirable from a social and economic point of view, and for which there could be a significant impact on the volume of marine litter, is plastics, particularly plastic packaging. At present, in the EU, of the plastic that is not lost to the environment, 26 million tonnes is collected, of which 39% goes to energy recovery, 31% to landfill and 30% is recycled. Around half has hitherto been exported, mainly to China. Nevertheless, there are positive examples of progress in many OSPAR states to reduce dependence on plastics. In France, for example, multi-party support for a source reduction strategy has reportedly achieved a 44% reduction in plastics use between 2007 and 2012, and a 100,000 tonne reduction in all packaging

over this period. With the cooperation of the beverage packaging sector, two-thirds of household packaging was recycled in 2015 along with 40% of plastic bottles. Favourable contribution rates for products design and materials linked to distinct recycling channels are available from the *Eco-emballages* packaging scheme.[15]

Figure 4.1 illustrates the 7 codes used for recyclable polymer resins, although some are more profitably recycled than others. Of the constituent polymers, HDPE, LDPE and PP account for 60% of the plastics found in MSW, although PET (PETE) and PS are also significant. PET and HDPE are used in bottle production and are the main materials recovered from MSW. For some plastics, the recycling situation is positive, if capable of improvement. For instance, it is mandatory in the EU that PET (PETE) bottles are capable of being recycled. Indeed, a large proportion of PET bottles are already recycled, for example the benchmark is up to 80-90% in Germany. Bottles are easily recognisable by the consumer, are of relatively pure composition and are not generally contaminated by food residue. There are also reasonable levels of recycling for HDPE and, in some (but not all) states, for mono-material plastic film too.

The models of potential reductions in marine litter that were used in the Arcadis report [36], assume maximum plastics recycling in the short-term of 24% based on current performance in Belgium, Romania and Austria. However, of the proportion which is recycled, rather little attention is given to what happens to these products. For instance, only 6%-8% of plastic waste in truly recycled back into plastic products. Many plastics are recycled into low grade products such as carpets and pipes which themselves have poor subsequent recycling potential [39]. There is also a problem with other types of plastics for which it is difficult to maintain consistent purity.

Figure 4.1 Polymer resin codes *(www.gbpyrolysis.com)*

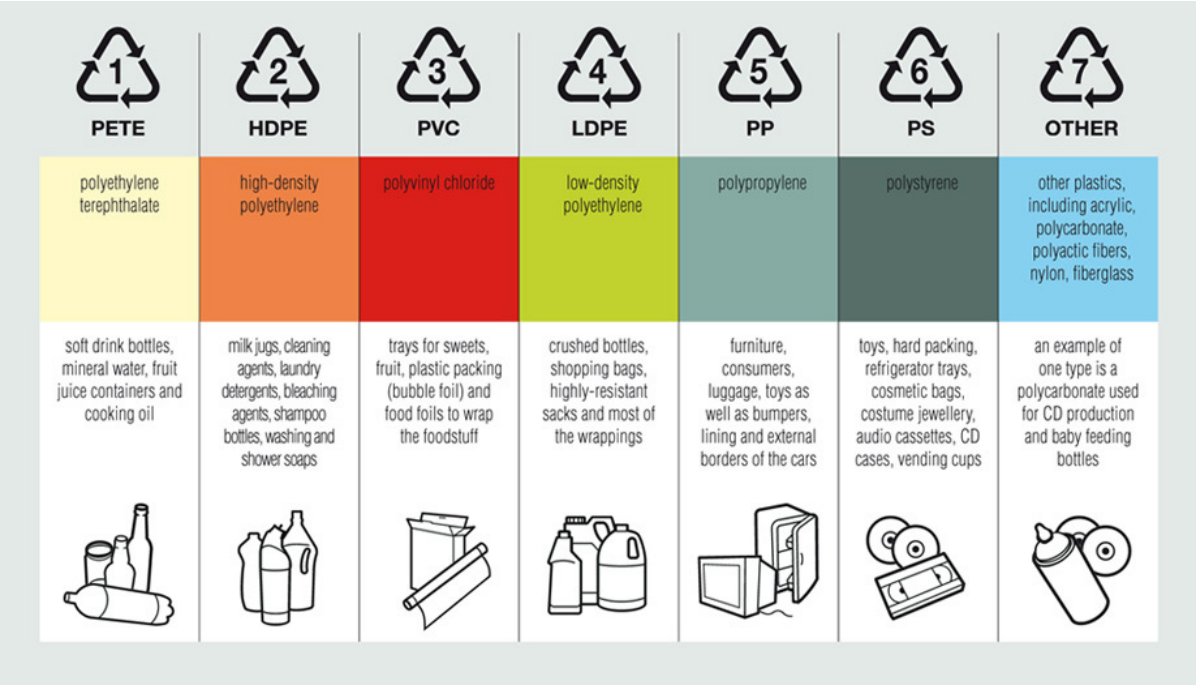


Table 4.1 Share of plastics demand in Europe

PETE	HDPE	PVC	LDPE	PP	PS	Other
7.1%	12.1%	10.1%	17.3%	19.1%	6.9%	26.4%

[15] Now has tender to produce automatic bottle collection machines for use in supermarkets.

Much recyclable material is of mixed composition and must be sorted at some stage. This applies especially to the largest component of waste, namely household MSW. Much of the increased level of recycling claimed to date has been from producers or is due to producer-to-producer exchange of material that is relatively pure and clean. Of household waste, it is relatively easy to remove and recycle glass and metals, including single-use items such as drinks bottles and cans. Glass bottles, where not subject to deposit return, are often collected in bring centres. Steel and, especially, aluminium cans are made of consistent material and have a resale value (e.g. 900 tonne for aluminium and €90-120for steel cans (www.letsrecycle.com, accessed Dec 2017). Consequently, the prevalence of these items in beach litter has fallen over the years. However, much household municipal waste is lower value and more expensive to sort. Sorting also has to extend to the removal of packaging which is contaminated by contents such as drink, milk or food residue. This is expensive, and sometimes impossible to remove. It adds to operational costs and reduces the life of reprocessing machinery. Consequently, the price of recyclate derived from these sources is very low compared with pure forms (see Table 4.2).

In principle, it has been argued that, even today, 53% of plastics output in Europe could be economically recycled. [59] However, much plastic comes in different shapes with tops and collars produced from a range of polymers. A variety of additives can be used to add colour and these additives cannot easily be removed with the result that final products depend on a secondary market for that same colour, further reducing the price relative to pure or transparent alternatives. Black plastic, popular for meat products, has a particularly low value. Bottle tops should ideally be removed and this is costly and labour intensive. These tops, typically made of HDPE, can only be reprocessed with the associated bottles, typically made from PET, if a very low value market price is accepted for the secondary product. Plastic collars are even more difficult and expensive to remove unless designed for easy separation. Again, many of these products are single-use.

Labels may be made of plastic film, typically printed with colour inks, or of paper stuck on with a non-standard range of glues, some of which are very difficult to wash off. The composition of the glue is not described on the bottle and can often be extremely difficult to remove.

This mix, together with the contamination that arises from colourants, other chemicals and container contents, adds significantly to the costs or recycling or reduces the prospect of locating a secondary market unless only low value products and prices are accepted. Multi-layered plastic or multi-material packaging, including materials used, for example, in crisp packets, is even more difficult to separate and is not accepted for recycling in many counties. Crisp packets can be either metallised plastic or foil. The latter products often emphasise “freshness” and can be potentially be recycled. The former fail to remain scrunched up when placed in pockets, can consequently spring out and are, in any case, not recyclable.

Recycling in Ireland

In Ireland, as of 2015, 282,148 tonnes of plastic packaging waste was generated. Of this, 95,890 tonnes was recycled and 92,902 tonnes was sent to incineration for energy recovery. The level of plastic recycling has now increased to 35% which is ahead of the 22.5% target currently required by the Packaging Directive and places Ireland amongst the countries with the higher plastic recycling rates. Plastic bottles account for 42,000 tonnes of plastic waste of which 70% are recycled. However, over 80% of the plastic that is recycled is actually exported for this purpose. Although there is sufficient reprocessing capacity within Ireland, the poor quality of mixed recycling means that the price is so low that it is only economic to export the larger proportion of mixed waste. Plastic from MSW accounts for 85% of the total volume collected. Of this, around one third, or 102,825 tonnes is segregated, while 307,911 tonnes is mixed plastic

waste. Indeed, while over 1.6 billion PET bottles per year in Ireland are recycled into flake or fibre, a proportion of this volume is actually imported due to the poor availability of high quality plastics.

Incineration capacity has recently increased. Before 2017, plastic packaging film from all sources represented the largest component sent to landfill. This was followed by PET and HDPE packaging. Post-consumer plastics are mainly derived from MSW, followed by industrial plastic waste, construction waste, end-of-life vehicles, farm plastics and electrical waste. Of these, single-use products commonly found as marine litter comprise much of the material that should find its way into the MSW stream with a small contribution due to farm plastic. Other materials or items often found in beach surveys, for example polystyrene and crisp packets, are not generally accepted as recyclables. Street bin litter is also not usually sorted for recycling.

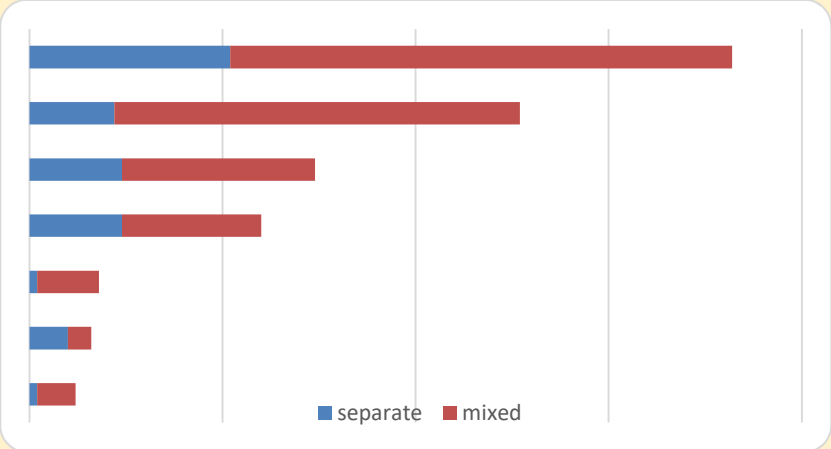


Figure 4.2 Degree of separate and mixed plastics by type collected for recycling or recovery (tonnes)

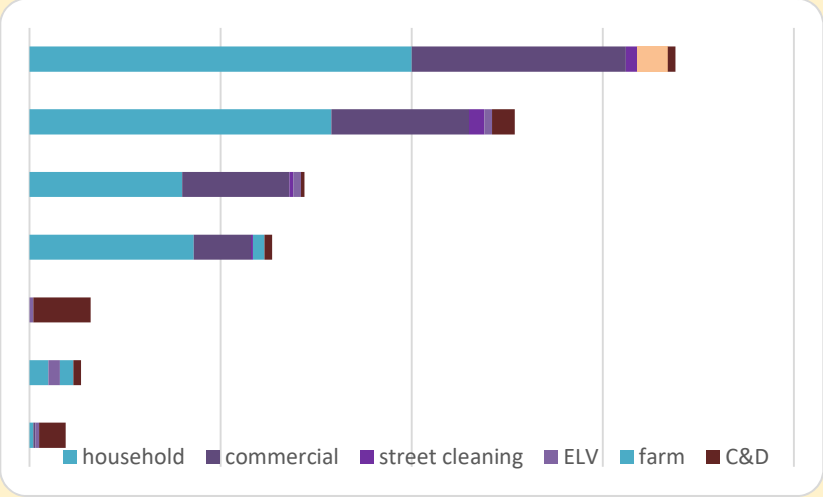


Figure 4.3 Types of plastics collected by source (tonnes)

ELV = end-of-life vehicles, C&D = construction and demolition waste.

Sources: DECLG, 2011; DECLG, 2014

4.2.3 Future prospects

Hitherto, most plastics have been sent to the East Asia for recycling. However, in September 2017, China refused to accept shipments with more than 1% contamination under its "Green Fence" policy. New markets for mixed recycling would need to be found in other developing countries, but this

would be in contravention of the ideals of the Waste Framework Directive. However, these developments could yet have a silver lining by forcing Europe to regulate and invest seriously in the foundations for a circular economy. This would require much greater effort at separation of waste, product redesign, EPR and the development of secondary markets supported by serious restrictions or higher levies on landfill waste. Standards could have a role too. ISO standards 9000 and 14001 can already be applied to waste collection to reassure prospective re-processors of recyclate quality. ISO 15270-2008 provides guidance on plastics waste recovery and end-of-waste criteria exist under the Waste Framework Directive to define the conditions under which plastics can be accepted by re-processors as a resource rather than being dismissed as waste. However, there is no EU end-of-waste criteria for plastics.

Such developments would have positive implications for marine litter. Good quality processed recyclates can cost 40% less than virgin plastics, although prices are very variable as the latter relate closely to the price of oil (Table 4.2). At present, such recycled material is hard to obtain and most waste plastic sold by municipal reprocessing facilities only achieves a very low price in comparison due to the costs of cleaning and sorting. Consequently, inadequate effort is being made by many waste management companies to contain and separate recyclables during collection, transport and processing. Plastic waste has a global market that has hitherto been underpinned by the availability of a market in China, even if this market only offered low prices. For related reasons, little effort has been made by waste collectors to incentivise consumers to diligently collect and self-sort waste, including plastic and other waste. Only a few OSPAR states require households to segregate waste into different types beyond general waste, recycling and organic. Where limited options are available and no variable waste collection pricing applies to favour recycling, it follows that there will be problems with household self-sorting, especially where enforcement is weak. Currently, there is a high proportion of households who do not carefully prepare recycled waste. For example, the mixed recycling found in household 'green bins' in Ireland can be 30%-40% contaminated [60]).[16] Neither are consumers sufficiently financially incentivised to be inclined to avoid purchasing products with excessive packaging or to desist from littering. Price differentials for recycling may exist as waste fees that are lower than for general waste, but positive incentives are needed for consumers to avoid discarding recyclable waste as litter. However, a possible positive outcome of restrictions on the global market acceptance of low quality recyclables, would be higher reclycate values for purer materials that would provide an opportunity for more distinct incentives to recycle and an improvement in the economics of deposit-refund systems. Table 4.2 shows the relatively high price that has been attracted by good quality recyclate in Europe in the past and the potential saving that this can provide over virgin plastic produced directly from the oil-based raw material. Prices have risen since the start of the century, although this price rise has been halved since 2013.

[16] The Department has recently launched a campaign to make people aware of what can, and cannot, be recycled.

Table 4.2 Plastic price range per tonne (DECLG, 2014)

Plastic type	Plastic bottles	Plastic films
Virgin plastic	€1,620-€1,700	€1,450-€1,660
Reprocessed recyclate	€820-€1,070	€650-€1,200
Waste plastic sold by processors	€146-€404	€790-€416
Waste plastic sent to landfill	minus €86 - €111 (including €30 landfill levy)	

By comparison, Table 4.3 shows current price levels prevailing prices. These prices are relatively low, particularly for coloured plastics. HDPE is most valued and achieved prices of £275 (€315) per tonne in the UK in October 2017. LDPE achieved a lower price, but clear bottle PET reached a maximum price of only £168 (€192) per tonne in mid July 2017 and fell to £90 (€103) by October. Prices have been volatile and have ceased to be economic for the recycling of plastic film. The recent closure of the Chinese market for recyclates may be having an impact. Around 760,000 tonnes of plastic was previously exported from the UK 2015, of which around 550,000 was packaging plastic out of total packaging recovered of around 1 million tonnes (www.wrap.org.uk).

Table 4.3 Relative prices per tonne achieved in Europe for different recyclables

Plastic type	Oct 2017 average value	2016 average value
HDPE bottles (natural)	€315	€360
HDPE bottles (coloured)	€114	€150
PET bottles (clear, light blue)	€103	€120
PET bottles (coloured)	€34	€55
Plastic film	€11-34	€55-€104
Aluminium cans	€1,120	€875
Steel cans	€114	€58
Cardboard	€128	€115
Mixed paper	€55	€83

Source: www.letsrecycle.com

4.3 Measures for Marine Litter

It is impossible to separate the problem of marine litter from the subject of waste generally, including integrated waste management and progress towards the circular economy. A proportion of waste inevitably ends up as marine litter and reductions in the volume of waste will have an impact on reducing the amount of marine litter, although some measures will be more relevant than others and are examined below. Some types of waste, as discussed in earlier chapters and below, are more likely to end up as marine litter. Some of this litter is more likely to be deposited in some locations than others or to end up as litter on the sea bed, in the water column or as beach litter. There are direct measures that can be taken to reduce the amount of marine litter, including awareness raising and collection infrastructure, and these are examined below with the help of examples or case studies. However, these measures are to a large extent addressing a wider problem of society's excessive production of waste.

4.3.1 Choice of measures

An understanding of the types of litter, the impacts of this litter and the sources of litter is important to identifying the measures to deal with the problem.

Prioritisation by type of marine litter

Prioritisation can be given to those types of litter that appear most often. Beach surveys provide a database on the types of litter that allows us to identify problem items and so, potentially, where to prioritise and target regulation and enforcement, where to explore the relevance of economic instruments, and to identify products for which EPR, including product re-design or deposit refund systems could be followed through. While wide-ranging and integrated measures are desirable, targeting particular types of litter can focus efforts on its reduction. Plastic litter represents a persistent form of marine litter that can encompass many different uses, but much plastic litter is likely to be represented by packaging of one form of another. As noted above, plastics can comprise many different polymers. By comparison, many metal items are likely to be represented by a limited range of raw materials, typically steel and higher value aluminium. Glass is low value, but relatively easy to recycle.

Plastic-based string fragments appears high on the list of items comprising beach litter (1st in Table 2.3 for the Northern North Sea and Arctic Sea, 3rd in the Celtic Seas and 4th in the Bay of Biscay and Iberian Peninsula), but while often single-use, string is not really as consumer item and is not easy to replace, although alternatives have always existed. Plastic-based foam is a similar common type of marine litter, as likely to derive from the fishing or marine transport sector as from consumer products. Cigarette stubs are a very common item of single-use marine litter, made from cellulose acetate that is only slowly biodegradable and with some toxicity derived from the tobacco product. Cigarette stubs appear third on the list of items found in the Bay of Biscay and Iberian Peninsula in Table 2.3. Many other plastic items are represented by packaging, of one form or another, designed for single use products. Of these, particular attention must be given to detachable small items, especially caps and lids (4th in the Northern North Sea and Arctic Sea, 5th in the Southern North Sea and 6th in the Bay of Biscay and Iberian Peninsula), but also food containers, crisp packets and sweet wrappers. Plastic bottles appear a little lower down the lists (c10th), still common, but not quite the priority that perceptions or their visibility may suggest. Metal cans and drinks cans are much further down on the lists despite their visibility and the association they provoke with images of anti-social littering. There is a high representation of small items of plastic derived from larger, but unknown items.

Prioritisation by impacts

Highest priority must be given to items of marine litter which present a risk to human health. Fishing nets and other gear present a direct threat to swimmers, divers and surfers. Of single-use items, personal hygiene and medical products present an evident health threat to water sports enthusiasts, but also to anybody walking along or playing on beaches. Likewise, broken glass, shorn cans or sharp metal objects are an obvious risk. The impact of microplastics on human and environmental health is unknown, but the prevalence of such items is potentially considerable, noting also that all plastics will experience attrition over time into ever smaller pieces. Toxic substances could well be absorbed by human beings directly or through the consumption of fish products, noting even that microplastics are found in marine life as small as plankton.

A comparably high priority must also be given to marine litter that has an environmental impact. Fishing gear presents a direct risk of entanglement and ghost fishing as has already been discussed. Single use items such as plastic bottle caps and plastic bags present an evident environmental risk to

the marine environment and wildlife. The bouyancy of items such as plastic bottles means that they can be carried a long way by tides and currents. Smaller pieces of plastic or small shiny metal items can be ingested by marine mammals and birds with a direct environmental impact.

High priority should also be given to items that present direct economic costs, for example the impact of floating fishing gear on vessels or of ghost fishing on commercial stocks of fish and crustaceans. In this area, there is an opportunity to engage stakeholders in that many of the sectors that are directly responsible for this marine litter, also incur losses, albeit not necessarily by the same actors. Similarly, locations and sectors that benefit from the marine and coastal environment, for example beach resorts or the cruise ship industry, can be encouraged to take responsibility for reducing marine litter and for its collection. Marine litter impacting on tourism includes fishing gear and freight losses, but also single-use items, with plastics, drinks and food cans once again high on the list due to their visibility. More difficult to address are the economic losses that could also follow more indirectly from the impact on ecosystem services, including marine environmental productivity and the marine food chain, including through fear of contaminants that could affect human health.

Impacts on health and the marine environment are often better represented by measures that count numbers of items rather than by size, with type of items being the next most relevant. Fishing nets would be an obvious exception. Personal hygiene items clearly present a risk to human health, but plastic bags, balloons and small items of plastic are evidently a problem for marine wildlife. The situation is as yet unclear on microplastics, although the precautionary principle would apply here.

The precautionary principle is a fundamental principle of the EU relating to environmental, health and food policy. Article 174(2) of the European Community Treaty provides that all EU environmental policy be based on the precautionary principle. After the Nice Declaration of 2000, the principle was extended to health and safety policy too.[17] The Principle is relevant to the health and environmental impacts of marine litter in that it reduces the burden of proof in situations where the ultimate scale of impacts or the sensitivity or receptors is unknown, but could be significant or irreversible. It also features in international treaties such as the Rio Declaration on Environment and Development. A precautionary approach likewise represents an appropriate way to address risk in the absence of scientific evidence. But does not imply the same legal obligation as the precautionary principle, being subject to considerations of local capacity or implementation cost.

Prioritisation by source or pathway

Sources of marine litter include:

- Discarded and lost gear from fishing vessels
- Discarded or lost materials and waste from freight shipping and cruise ships.
- Coastal tourism and amenity
- Loose ground-based litter
- Inadequate landfill management
- Inadequate storm water or wastewater impoundment, filtering or treatment.

Pathways include wind, rivers, tides and coastal activity, fishing and marine transportation, as well as deliberate dumping at sea or from land.

The source of marine litter provides a direct indication of how it could potentially be addressed. Action on fishing nets and gear can be directed at the fishing sector, including harbours, to minimise

[17] www.ecologic.eu/1126

losses with the assistance of stakeholder engagement. Litter from the fishing, shipping and cruise industries can be addressed through regulation, incentives and port reception facilities.

Consumer items, such as many single-use items, can be managed by engaging with manufacturers and with the packaging industry. Where there is evidence that these items have come from recreational beach or coastal activities, there is the potential for local initiatives with resorts, shops and café owners to reduce litter at source through the provision of disposal facilities or regular beach cleaning. Where the source is evidently other terrestrial, there may be a need to improve waste collection and management, including at landfills, and for sewage and storm water. Farm waste collection schemes are also relevant in this regard. This, of course, needs to be backed by the implementation of stakeholder engagement, regulations and incentives for the manufacturers or distributors of specific products and materials.

The likelihood of litter originating from other countries or continents, or from vessels registered in third countries, clearly affects the capacity of individual states to deal with the causes or to impose fines or liability. International agreement and protocols are obviously relevant in this respect. Cross-boundary rules and legislation, such as those applying in the EU, can be directed to facilities management and enforcement. Each sea evidently has its own particular mix of marine litter. The mix of waste in land-locked regional seas such as the Baltic, Mediterranean and Black Sea provide some pointers as to the sources and how one might begin to address the problem. However, the solutions are more challenging in locations such as the North East Atlantic or the English Channel, which are subject to long-distance currents or have busy shipping lanes and where around 25% or more of marine litter can originate from distant sources.

4.4 Prospective measures local and general measures

4.4.1 Litter collection and facilities.

Regular beach cleans are an inefficient means of dealing with litter and, of course, only address beach litter rather than litter arriving at sea from other sources. In Chapter 2 it was noted that North Sea resorts spend between €28,000 and €35,000 each year on beach cleaning. On South Beach in Scarborough, UK, 40,000 people have been counted on a single day, after which the total accumulated waste amounted to $7m^3$ or 1.75 tonnes [25]. Regular beach cleaning is therefore expensive, but clean beaches do encourage more responsible behaviour, reducing the prevalence of the littering in the first place. Under its Zero Waste Scotland strategy, the Scottish Government has plans to spend £500,000 each year of dealing with litter at key locations.

By comparison, beach litter collection *events* provide for direct public involvement as well as supplying useful data. Ideally, these collections should be complemented by an integrated approach that also aims to reduce (and remove) fishing litter given the high presence of such debris in beach counts. Large items of fishing-related waste or sightings of nets engulfed in dunes cannot fail to have a demotivating effect on volunteers collecting small items of single use litter and gives the impression of government neglect at volunteers' expense.

Beach litter collections can be used to encourage community engagement with the local environment and the problem of marine litter. Awards based incentives such as Blue and Green Flag Awards can be used to strengthen the inherent willingness of communities to improve their local

environment. In Ireland, for example, the Ocean Hero Awards[18] acknowledge the contribution made by local communities to awareness of the coastal environment and to beach litter collection. The Global Citizenship Marine Environment[19] theme has been added to the Green Schools programme to raise the next generation's awareness of pressing global issues such as marine ecosystems, marine litter, energy use and climate change.

Clean Coasts

Clean Coasts is managed in Ireland by the environmental NGO 'An Taisce'. The organisation runs various initiatives and campaigns including the Big Beach Clean linked to Ocean Conservancy, an annual event in line with other identical activities in 112 other countries which together removed 8 million kilograms of litter in 2016. In addition, it manages the 2 Minute Beach Clean, the Green Coasts Award, Think Before you Flush, a 'Roadshow' of awareness events around the country, and Corporate Volunteering to engage companies and their employees. The Clean Coasts network includes 500 local groups around Ireland. It does not have the resources to actively manage these groups, but rather encourages groups to set their own goals and provides them with support, materials and networking. It is also a requirement of the programme that groups work in tandem with Local Authorities. Local participation includes Green Coasts, a community-based beach management initiative that forms a bottom-up alternative to Blue Flag and now includes 63 beaches around Ireland.

A total of 16,500 volunteers have been involved in these events in Ireland, spending 17,550 hours of their own time. Other Clean Coasts campaigns may be timed to coincide with local events such as the annual *Fleadh*, a national Irish culture and music festival, during which busy hotels and guest houses are encouraged to adopt the Think Before You Flush campaign. There is some corporate support of national campaigns, but core support is provided by the Department of Housing, Planning and Local Government, the Ministry responsible for marine policy, and Fáilte Ireland, the Irish tourist body.

The Department of Housing, Planning and Local Government regards this programme as having been so successful and has included it as a Measure under its Marine Strategy Framework Directive programme of Measures (descriptor 10 Marine Litter) .

In addition, national charity groups have often instigated national plastics collections. For example, *France Cancer* encourages people to collect plastic to provide funds for the cancer care. This procedure permits the self-sorting of the materials by donors, providing a fairly pure supply of plastic that can attract a relative high recycling value. Another French charity, *Bouchon d'Amour*, (http://www.bouchonsdamour.com) collects plastic bottles to provide facilities for disabled people in Madagascar. In 2016, it collected 1,669 tonnes raising funds of €399,200.

However, litter collections are still only deal directly with the end result and not with causes located earlier in the process. They are unlikely to carried out along an entire coastline and fail to address that proportion of litter which will be carried out to sea, will remain in the water column or sink to the sea bed. They cannot be expected to collect small or micro-particles or, at the other end of the scale, sacks and fishing nets which have become embedded in sand and dunes. Furthermore, it is also difficult to recycle much of the material collected due to its corrosion or degradation and contamination by dirt or sand.

[18] http://cleancoasts.org/our-initiatives/ocean-hero-awards/
[19] https://greenschoolsireland.org/themes/global-citizenship-marine-environment/

Litter collections do demonstrate the contribution made by beach recreation activities. Such activities have been shown to account for as much as 42% of the total count of litter [6], although this is disputed by other organisations who have argued that most litter has been washed up from other sources with the exception of take-away packaging and drinks cans.[20]

Assessment - beach litter collection:

Targeting: ★★★★ Beach litter collections can be targeted at specific locations, but greater engagement at population centres and resorts.

Effectiveness: ★ Beach collections do not on the whole combat sea or sea-bed litter and omit much of the coastline and islands. High on awareness/citizen engagement

Links: ★★★★ Can be linked to awareness campaigns, provision of facilities.

Costs: ★★ Voluntary engagement reduces cost, but regular and continuous collections necessary.

Outcome: ★★★★ Addresses marine litter, aesthetic and wildlife impact directly. Good for promoting awareness and public engagement.

4.4.2 Awareness

As well as beach litter collections, other steps can be taken to increase awareness of the problem of marine litter and to foster responsible behaviour. The sizeable contribution made by beach and coastal recreation, and the visibility of the marine litter problem, means that coastal awareness campaigns can be very effective. A complementary contribution can be made by information signage and by the provision of simple infrastructure such as bins. However, just as many coastal resorts in OSPAR countries fail to provide the infrastructure of bins or recycling facilities at the coast, so too do many fail to provide any signage to encourage beach-goers to dispose of their litter properly. This omission is rather curious given the strong emotional impact that information and pictures of marine litter impacts can have.

Various awareness campaigns have originated with specific interest groups, but have often expanded their activities and appeal to a wide population. The 'Butt FREE Australia' campaign has attracted sponsorship from tobacco companies. In Britain, 'Surfers Against Sewage' originated in response to health risks presented by untreated sewage and the presence of sanitary items in the water, but has extended to other types of marine litter as demonstrated by its 'No Butts on the Beach' campaign. Cigarette stubs, like crisp packets, sweep wrappers, bottle tops and balloons, are items which people may regard as small and environmentally benign, but which appear near the top of the list of beach litter. They are items well-suited to awareness raising, but can be addressed by few other measures.

Awareness campaigns can involve considerable effort and promotion. However, Arcadis (2014)[36] reports a 43% reduction success for campaigns on both cigarette stubs and cotton buds. The international Blue Flag campaign has an especially high profile. Blue Flag status requires named beaches to achieve high environmental quality based on criteria such as water quality and litter. The campaign is successful in highlighting locations, including resorts, that have high quality beaches and so acts as a promotional tool for some, but a shaming device for others, placing consequent pressure on local government authorities from concerned local citizens and businesses who might be affected by any loss of tourism.

[20] Keep Britain Tidy Group

Too many products are simply discarded or allowed to accidently blow away in the wind. Human behaviour is often rightly described as difficult to change, but this does not apply in all instances. Sometimes, awareness can stimulate just small changes in behaviour such as a switch from flushing away single use sanitary items to disposal in the bin. In the UK, awareness campaigns have been successful in reducing the prevalence of cotton buds in marine litter by 43% (ref p136). The EU FP7 project MARLISCO (2012-15) showed that people were concerned with problem of marine litter and recognised the link with consumption, but underestimated the contribution of land-based sources and plastic. The project gathered information on public awareness of marine litter, reporting strong support for facilities, including bins, high profile clean-ups and deposit refund schemes as well as for enforcement and producer responsibility.

In Ireland, the *RelayRisk* project funded by the Environmental Protection Agency examined the communication strategies needed to address the problem of rural septic tank registration and maintenance [61]. While marine litter does not present the same health risk as septic tanks, it does have significant environmental impacts. *RelayRisk* concluded on the importance of advancing voluntary compliance and building public trust in relevant institutions through stakeholder and community engagement and collaboration. Health and community responsibility were found to be stronger motivating factors than regulatory obligations.

The problem of single use items in marine litter would be a far less prevalent issue if changes in consumer behaviour towards waste generally can be achieved through increased awareness. Economic instruments are increasingly being adopted to encourage greater segregation of waste. However, it is remarkable how little recycling information appears on the labelling of single-use products such as plastic bottles. Generally, nutritional information is far more prominent than recycling information. The latter commonly depicts a mixture of non-standard and standard symbols to encourage responsible disposal or recycling, but does not specify the benefits of removing and separating bottle tops or labels, or of washing out contents. Although the name of a specific polymer of the bottle (not the cap) may be listed, this name has little meaning to consumers and is not associated with impacts. Furthermore, this information is printed on the label, but not on the bottle itself, diminishing the information available to waste processors once the label is removed. Ideally, a behavioural chain could be communicated by a set of symbols advising on the successive need to remove or wash out contents, to separate bottles and tops, to remove labelling, and to segregate from other forms of recyclable waste where possible.

Summary Assessment - awareness:

Targeting:  National campaigns can be targeted at specific population groups and litter items. Local campaigns can be more directed at beach recreation, be cost-effective and include communication via hotel policies, posters and beach signage

Effectiveness:  National and local campaigns may need to be sustained, but effectiveness can be good

Links:  Can be linked to beach clean-ups, collection and local bans.

Costs:  May need to be sustained. National campaigns can be expensive, but local and coordinated campaigns can be very cost-effective.

Outcome:  Not guaranteed, but can be effective and may be only way to deal with some litter items.

4.4.3 Coastal facilities, disposal infrastructure, bins, etc.

In economic terms, the outdoor environment is a free access resource as regards littering. External costs are placed on other users of the environment due, in the first instance, to the aesthetic impact and people's awareness of impacts to wildlife and health. At the level of individual items, there is a distinction between the composition of general litter and marine litter. Cigarette stubs and chewing gum dominate the general litter tables, with bottle caps representing just 1.9% and bottles 1.6%. Plastic packaging accounts for just 0.4% and feminine hygiene products for 0.02%. However, cigarette stubs ultimately degrade and gum remains in-situ.

The provision of adequate collection bins and complementary infrastructure such as advisory signage are preventative measures and an obvious means of directly addressing marine litter. Keep America Beautiful (2009) refers to the success of dedicated ashtrays for cigarette stubs relative to regular bins. However, while bins are an obvious solution, a survey by APSE[21] in the UK found that only 24% of local authorities had a strategy for the siting of bins and that over 60% of authorities did not have an accurate register of where bins were located. [22] Furthermore, it is common for many popular beach destinations in OSPAR member countries to have no such facilities. One reason for this omission is that responsibility for collection costs falls back on the local government authority who may argue that much of the litter is not originating from local sources or residents and so should be addressed by other means or more responsible behaviour by beach-goers themselves.

This dismissal of responsibility applies also to other waste reception facilities. For example, the capital costs of "civic amenity" recycling facilities in Ireland are covered by REPAK the PRO for packaging waste, which also covers servicing cost against the value of materials collected. Even so, local authorities have been reluctant to accept additional facilities due to additional costs, space requirements and liability issues. However, a brief web search is sufficient to reveal the extent of frustration felt by local people who are often forced into a position of voluntary collections. In some locations, the economic impacts on local tourism businesses may be significant enough to force the authorities' hand. Under the Waste Framework Directive, local authorities are required to draw up a litter management plan. Recent surveys have indicated a reduction in the amount of litter due to better management despite budget cuts. However, the introduction or raising of waste charges has stimulated some increase in the incidence of illegal dumping which, in the UK, rose by 5.6% in 2014/15 to 900,000 reported incidents. Some success has been achieved by working directly with communities to reduce litter and report fly-tipping [62].

By comparison, a report produced for Keep Britain Tidy (2014) found poor buy-in for litter initiatives by businesses. *Rijkswaterstraat*, the Dutch Ministry of Infrastructure and Environment, has reportedly had more success. Once again, producer responsibility should be extended to this area by encouraging businesses to participate or contribute in lieu of possible regulation. Pro-active

[21] The Association for Public Service Excellence
[22] Briefing 17 (4 January 2017). www.apse.org.uk

measures to reduce litter, to reduce dumping or to support litter collection should be a key element of corporate responsibility.

Disposal infrastructure in Bray, Ireland

Bray is a small town and coastal resort just south of Dublin. The town has a shingle beach, a pleasant promenade and coastal walks. Being so close to the city, the beach can receive 10,000 visitors on warm summer's days and this clearly presents problems of beach litter. To address the problem, the local authority has installed 15 large wheelie bins and also 30 solar compacter bins at a cost of €4,500 each. These bins help to decompose waste and also alert the authority of when they are close to being full. The local authority also employs two people to clean the beach five days per week with additional staff employed six days per week from June to September. The cost of this service is €165,000 per year. Nevertheless, litter can still accumulate during the night, particularly from fast food outlets over which the authority has limited powers, although one food outlet is required to collect nearby litter under the conditions of its planning permission. In other cases, the authority can only hope to instil good practice on the basis of the common beach resource. There is no direct reimbursement from central government for these activities.

Summary Assessment – disposal facilities:

Targeting: ★★★★ Facilities can be targeted at specific locations, but collections of litter easier at population centres and resorts.

Effectiveness: ★★ Facilities reduce the risk of terrestrial coastal litter finding its way onto beaches or the sea, but do not otherwise combat sea or sea-bed litter and will omit much of the coastline and islands. Good for awareness/citizen engagement

Links: ★★★★ Can be linked to awareness campaigns, beach collection, local bans.

Costs: ★★★★ Voluntary engagement reduces cost, but regular and continuous collections necessary. Issues with who bears the cost.

Outcome: ★★★ Addresses marine litter, aesthetic and wildlife impact directly. Good for promoting awareness, but does not counter disposable society significantly.

4.4.3 Local product bans

There is also the potential to complement local provision of facilities with voluntary local product bans or measures in coastal resorts or beside rivers. Local initiatives, such as encouraging retailers and food outlets not to use single use packaging, cutlery, cups, coffee stirrers or straws can contribute to effectiveness directly and raise awareness. ,

Light-weight plastic carrier bags have been banned at a local level in several parts of the world, beginning with some stores in San Francisco and followed by local bans in Mexico City, Rangoon and various Indian cities. A ban was introduced Sydney Harbour largely to reduce the risk to the seascape given its association with the city and importance for amenity and tourism. Bans on plastic straws and utensils have also been proposed in Seattle.

Bans cannot easily be implemented in public destinations in the EU. However, the Isle of Wight, on the south coast of England, is included in the Marine Conservation Society's list of local authorities supporting bans on the release of balloons. The MCS's website lists 62 local authorities across the UK which have bans on balloons or sky lanterns. However, bans by local authorities do raise questions of

enforcement. The Isle of Wight's ban on balloons does not feature strongly on the internet compared with companies supplying balloons or events.

Summary Assessment – local bans

Targeting:  Voluntary bans can be targeted at specific locations, but mainly population centres and resorts.

Effectiveness:  Local bans will reduce the prevalence of some types of items, but not all, especially as products will be brought in by visitors themselves. Good for awareness/citizen engagement

Links:  Can be linked to awareness campaigns, beach collections, wider product initiatives

Costs:  Low cost enforcement for public authorities, but requires cooperation and could present legal implications.

Outcome:  Addresses marine litter, aesthetic and wildlife impact directly along with wider aspects of the throwaway society. Good for promoting awareness.

4.4.5 Green procurement

A deliberate policy of avoiding single use items in public procurement policy can make a considerable difference in changing the behaviour of local producers and suppliers. European public spending accounts for 14% of the EU's GDP (EC, 2016). GPP not only increases demand for environmentally-friendly products, but the scale of public spending also means that GPP could be influential in the re-design of products. In addition to the leverage effect of public spending, there is also the argument of leading by example.

The EU Sustainable Development Strategy has the objective that average Green Public Procurement (GPP) should apply to at least 50% of public tenders [52]. Guidance on GPP and the reduced environmental impact on public expenditure is provided by the EU Communication COM (2008) 400. A product's greenness is defined by whether it is 'core green' (addressing most significant environmental impacts or 'comprehensive green' (best environmental products). However, GPP is not confined to the prospect of items becoming waste, neither is marine litter a direct consideration. Criteria exist for 21 product groups, including construction, transport, energy, office machinery and other sectors, but none of these apply to the more persistent forms of single use marine litter, except indirectly for "food and catering services". Specific product criteria on, for example, recycled content, can be difficult for purchasing authorities to verify. Criteria for packaging is also no longer included.

An evaluation of GPP by Price Waterhouse Coopers in 2008 found that, by taking a life cycle approach, actual costs to the purchasing authority could be slightly lower due to reduced operating costs, although avoidance of some single-use items such as paper purchases entailed higher costs of around 15%.[63] Adoption of GPP is voluntary in the EU, but has been widely implemented, including by Hamburg, Barcelona, Copenhagen, Ghent and Vienna. Regional networks are being used to exchange experience among municipalities. The European sustainable procurement network, *Procura+*, also promotes best practice. GPP is a policy that can be adopted by local municipalities, including coastal cities, but also smaller towns such as seaside resorts.

Although GPP is voluntary, the *EC Action Plan for the Circular Economy* contains commitments on GPP. The Circular Economy and GPP are mutually reinforcing and there are also links with the

EcoDesign Directive through the need to demonstrate durability and repairability. The EC has been active in promoting guidance on GPP in response to earlier criticism that a lack of information and tools had been slowing progress. Criteria for the award of EU agreed Eco-labelling have been set out, including absence of hazardous substances, durability/reusability and impact on biodiversity. Several OSPAR states have set GPP targets of 50%, including the Netherlands, Belgium, Ireland, Portugal and Finland [36]. Nevertheless, despite earlier objectives of attaining the best level of GPP currently achieved by any of the Member States, there are at least 12 member States where GPP accounts for only 20% of purchases. The extent to which life-cycle costing has been applied also varies considerably. The EU Directorate General for Internal Policies [52] observes the need to focus on those GPP criteria which would have the greatest environmental impact, to pursue GPP criteria for product types only once both markets and systems of verification are in place and to shift mainstream procurement financing and contracting in favour of GPP.

In principle, GPP could do much to reduce the uncertainty that manufacturers face when considering whether to reuse recycled materials. There are opportunities to encourage product serving system agreements instead of the outright purchase of goods and these arrangements should stimulate more on-going collaboration on sustainability between government purchasers and service providers. However, GPP applies to many different product classes and the link with marine litter is inevitably slight. The exception occurs where purchases of single use items can be avoided in vulnerable areas such as coastal locations.

Green Procurement in Hamburg

The City of Hamburg purchases €250 million of goods each year excluding construction items. Consequently, it has considerable leverage in pushing producers towards a more sustainable agenda. The City's Green Procurement Guidelines contain 150 pages of criteria defining ecological standards for all purchases from paper to cars. The strategy includes requirements that materials be durable, repairable and recyclable where possible, but extends beyond considerations of the circular economy to encompass energy, pollution, water consumption, safety and noise. The leverage effect is greater in those areas for which the city represents the major purchaser.

Purchasing is subject to a certified environmental management system. The guidelines require that city departments carefully evaluate need to decide if new purchases are really necessary, including whether the same products can be obtained from other departments as used or surplus products. If a decision to purchase is agreed, then the producer and product's green specifications are assessed, including possession of any verified eco-labelling, for example Germany's 'Blue Angel' label. The guidelines advise purchasing departments to examine product life cycle costs rather than just the up-front cost and allows them to justify purchasing decisions on this basis, with these costs weighted at 60% in tender assessment. Life cycle costs are also defined as including such exogenous costs as impacts relating to health or climate change. Packaging and suppliers' environmental management systems are also evaluated. Some specific single-use items are prohibited, including single-use bottles (including those for which a deposit refund applies) and disposable crockery and utensils.

Summary Assessment – Green Public Procurement

Targeting: ★★ GPP could be implemented in administrative areas with coastlines or pathways to the sea.

Effectiveness: ★★ GPP can be used to target some items that contribute to marine litter and this could stimulate producers to provide alternatives. However, waste collections from public premises are likely to be quite efficient and more litter is likely to be discarded by consumers following purchases from private businesses.

Links: ★★★ Can be linked to awareness campaigns, beach collections, wider product initiatives

Costs: ★★★ In some instances, can actually save local authorities money, including in reduced waste.

Outcome: ★★ Addresses marine litter only indirectly.

4.5 Summary

Marine litter can only be truly addressed through an integrated strategy of waste management that reduces or removes products at an early stage where these are capable of finding their way to the oceans. The infrastructure for this strategy is already available through the EU Waste Framework Directive which sets out the principles of the waste hierarchy of prevention/reduction, re-use, recycling and recovery, which as it is implemented more effectively over time, will provide the basis for a circular economy in which much waste becomes a valuable resource leaving disposal to landfill as an option for just a small proportion of what currently constitutes waste. In particular, there will be benefits to reductions in marine litter through the improved recycling of *plastics* made possible by improved sorting and cleaning. At present, there is good demand for quality plastic recyclates, but the supply is restricted by the poor quality of material that is available and the willingness of third countries to take this waste, albeit at low prices. This situation is beginning to change and, if new ways can be found to incentive the behaviour of consumers, producers and processors to improve the handling and segregation of used plastics, this in turn will provide for the domestic availability of good quality recyclables and stimulate the market along with market prices for these products.

While an integrated waste strategy will be needed to deal fully with the problem of marine litter, there is nevertheless a range of measures that can be taken that directly address the matter. The choice of measures, and their relative importance, is indicated by the prevalence of different types of litter collected in beach litter surveys. Priorities depend to whether it is thought necessary to act on the basis of the relative types and quantities of litter, or on the significance of the impacts of particular types of litter for human health or the marine ecosystem. This chapter has set out various measures including the role of beach and coastal litter collections, means to increase awareness, litter collection infrastructure, local product bans and green product procurement. Each of these has its merits in terms of its respective availability for targeting, effectiveness, costs of implementation, outcomes and links and complementarity with other measures. The next chapter examines the relative role of regulatory (command-and-control) measures and economic measures that rely on incentives and disincentives to change behaviour.

Chapter 5 REGULATORY AND ECONOMIC INSTRUMENTS

5.1 The effect of Regulation versus Economic Instruments

Marine litter is an example of a market failure in that producers are not confronted with the social cost of its impact. If policy makers are to intervene to bring out a more socially optimal situation, they have a choice of two main strategies, either regulation, i.e. regulatory instruments, or economic instruments, alternatively called market-based instruments. Economic instruments include such measures as charges, levies and taxes or, alternatively incentives or subsidies where behaviour or an activity is judged to be beneficial. Each of these measures can be combined with targets for reductions in marine litter. Regulation is used to set standards which, if practical and well-designed, can be used to achieve quantitative reductions in waste or marine litter. Economic instruments may provide less initial confidence that targets can be reached, but rather influence price, or the market, to bring about a desirable change in behaviour while also potentially collecting revenue that could be used for environmental purposes.

Both regulation and economic instruments require information, but particularly the former because effectiveness depends on the private costs faced by the producers of meeting a targeted change determine the outcome. Ideally, data would be available on the marginal social cost of the impacts too, but in practice it is usually sufficient to have an idea of the significance of these impacts and whether the social cost is currently rising or falling. At the ideal point - the social optimum – the social cost of marine litter could still be positive, meaning that there would be some litter which it would be simply too expensive to prevent or remove. It is usually sufficient to use this limited knowledge to set standards and then to impose regulation or charges on producers to meet them. Each producer will then look to minimise these compliance costs in their own way, but the regulator will need to monitor progress to ensure that sufficient progress is being made, or alternatively, that some producers are not overly disadvantaged

Instinctively, economists prefer economic instruments. For economic instruments, the policy maker does not need detailed information on each company's conformance costs, but only to continuously evaluate how successful the charges are and whether the social costs of the damage are reducing over time, i.e. that reductions in marine litter are being achieved. If the market can evidently absorb the private costs and more progress needs to be made to reduce the levels of marine litter, then the policy maker can gradually increase the charge, or raise the standard to which it applies. This approach is habitually used by the EU to address pollution, greenhouse gas emissions and other environmental impacts.

Both regulatory and economic instruments impose costs on either consumers or producers, particularly at the outset, but both can also contribute positively to consumer welfare or to a competitive market and economic growth in the long term. The object is to internalise the external

cost of litter, i.e. the environmental damage. Regulation imposes costs by, for example, forcing manufacturers to invest in new practices, inputs or machinery or change their product range or packaging. Similarly, waste collectors, be they private or public, can be mandated to use certain methods or achieve particular targets. With economic instruments, the transfer of costs is more overt in monetary terms. However, by being more flexible, economic instruments offer the receiving party opportunities to adapt in their own way, while regulatory instruments have the benefit of setting unambiguous principles to which all should adhere. In practice, a combination of the two may be required, especially for litter which occurs in many different forms and arises from many different sources. Generally, economic instruments are backed by legal infrastructure identifying liability within a regulatory environment with minimum standards. The key criterion is how effective will these measures be in changing behaviour and achieving a quantitative reduction? For marine litter this is complicated by the fact that this impact occurs mainly within a bigger context of waste management, hence the need for this report to cover the context of the Waste Framework Directive and the *Action Plan for a Circular Economy*.

5.2 Regulatory instruments

Regulatory instruments can be used to define the required standards, procedures or technology that local authorities and private businesses must use in producing products or managing waste. These requirements will relate to the targets and objectives set by legislation designed to encourage the choice of design, sustainable production processes and recovery of materials at different stages in the waste cycle. Regulation can be a good means of disseminating new technology and of stimulating technological innovation both with regard to manufacturing and product design. It can encourage the uptake of Best Environmental Practice (BAP) or Best Available Technology (BAT).

Regulation, sometimes called 'command-and-control', has the benefit of being unambiguous in that distinct standards or requirements are set. However, how manufacturers and consumers respond to these standards is another matter. New practices can be more easily implemented by some manufacturers than others, for instance those with relatively new plant. If another manufacturer finds it difficult to adjust, then it will endure higher costs and suffer competitively, or even go out of business. Such disruption is not the objective of the regulation and it is therefore important to ensure fair treatment that does not work against the interest of competition. There is also a need for legislators to be sure that other undesirable responses are avoided, for instance that manufacturers are not encouraged to turn to other materials that could present an equal health or environmental risk or a new prospect of becoming marine litter. Producers might also choose to import rather than manufacture products if the regulation is directed at the manufacturing process rather than the output.

5.2.1 Regulation options

a). National product bans.

Bans are a form of regulatory instrument and can be very effective at addressing certain types of waste, including when preceded by an adjustment phase that allows manufacturers to switch to new safer or benign materials or products. This can encourage innovation through substitution to other more recyclable products. Outright bans are useful in achieving a guaranteed outcome, but need to be justified and can impose varying costs on producers some of whom will be more able to adjust

than others, potentially affecting competition. Economic instruments by comparison maintain a degree of flexibility.

Bans are especially justified when addressing certain types of toxic materials and stimulating their substitution by other, less hazardous products. As well as being undesirable, many such inputs reduce the suitability of products for recycling. One area in which materials switching has been advocated is towards bio-based and biodegradable products. There are opportunities in this area, for example to use biodegradable materials to replace synthetic cigarette filters. However, single-use plastic products made from such materials can also find their way to landfill where the oxygen-less environment fails to promote any more degradation than for other materials. When this occurs, the materials only add to the need for waste segregation without necessarily being recyclable. Even a small amount of biodegradable plastic can contaminate an entire batch of recyclables. There is also some evidence to suggest that labelling a product as biodegradable encourages more wasteful behaviour by consumers [54, 64].

Bans can potentially be directed at particular items that are at high risk of becoming marine litter, such as single-use items or plastic and polystyrene packaging. National bans on plastic carrier bags have occurred in Bangladesh, Rwanda and, most recently, Kenya (August 2017). Plastic bags are so ubiquitous and cheap, that the implications for street litter, health and damage to drainage and sewerage systems means that less developed countries have been amongst the first to instigate bans. Sri Lanka banned plastic bags and other single-use items in September 2017 after the collapse of a rubbish dump killed 22 people. Kenya has imposed strict penalties for the sale of plastic bags. Altogether, Wikipedia lists 20 developing countries where bans have been introduced at either local or national level.[23] A national ban on single-use plastics will come into effect in Costa Rica in 2021.

In the EU, unilateral bans on packaging are not permitted under the Single Market, but an amendment to the Packaging Directive included a target to reduce lightweight plastic bag use by 50% in 2017 and 80% by 2019, with member states free to choose their method of reduction, including either bans or levies.[24] Member States must ensure that, by the end of 2019, no more than 90 of these bags are consumed per person a year (compared with about 200 at present, on average). The Directive requires that by the end of 2025 consumption number should be down to no more than 40 bags per person.

In France, where consumption was around 80 bags per year, a ban on plastic bags was introduced in 2016. An exemption applies to biodegradable bags, although there are problems with the decomposition of these bags as noted above. France has also imposed a ban on plastic cups and plates from 2020. Disposable tableware will still be permitted so long as it contains 50% of biologically sourced and disposable materials. The ban was a subset of the 2015 Energy Transition for Green Growth Act which has achieved some swift environmental measures on the back of the momentum provided by the Paris Climate Conference. Other countries, such as Germany and Finland, have preferred voluntary agreements with the retail sector.[25]

However, outright bans can cause people undue inconvenience. Bans are being fought by retail and packaging businesses, and perhaps ironically, by recycling companies and unions who claim that they infringe the EU's competition laws. Arguments include the fact that plastic bags are potentially recyclable, are low volume if committed to landfill when compared with paper, have low resource

[23] https://en.wikipedia.org/wiki/Phase-out_of_lightweight_plastic_bags
[24] http://ec.europa.eu/environment/pdf/25_11_16_news_en.pdf
[25] http://www.ym.fi/en-us/The_environment/Waste/Green_Deal_agreements

demands in and of themselves and are often used more than once.[26] These are reasonable arguments that return us to the primary issue of behaviour. However, light-weight plastic bags so easily become litter, are so easily lost to wind or drainage, with such potential damaging consequences, that is difficult to envisage any stimuli that changes behaviour to a degree that will be sufficiently effective.

c) Extended Producer Responsibility

One rationale for regulation includes producer responsibility, or adherence to the Polluter Pays Principle through the use of BAT or best management practice. Responsibility can extend to collection, treatment and disposal. EPR has become a feature of attempts to reduce waste generally and of measures for marine litter. If producers can be confronted with a proportion of the life-cycle costs of a product, then they will begin to investigate seriously new eco-design and the re-use of recycled materials.

The first example of an EPR scheme was the Green Dot scheme adopted in Germany in 1991, but EPR is now a key feature of the *Action Plan for a Circular Economy*. EPR assigns responsibility to producers, either physical or financial, for a share of the effort or cost involved in waste management either by taking back and reusing materials or by contributing to the cost of their recycling or disposal. This procedure has the effect of internalising the cost of waste management into the decision making of the producer. Indeed, EPR can be looked upon as an economic instrument, albeit potentially set up by regulation or the prospect of government intervention. By sharing in the costs, producers are stimulated to reduce packaging, to fund or support recycling and to eco-design products.

In practice, companies often assume responsibility by organising themselves into PROs, although the threat of regulation and economic instruments has been a stimulus to such moves. PROs levy fee contributions amongst members to manage waste. In the Netherlands, for example, the packaging scheme, *Afvalfonds Verpakkingen*, with whom all companies producing more than 50,000kg/yr must be registered, has minimum requirements on recyclability and on criteria to minimise potential contaminants while also offering favourable rates for bio-degradable materials. Pressure is maintained by the agreement reached with Dutch packaging companies to raise recycling targets by one percentage point each year.[27]

Table 5.1: Packaging Waste Management Contribution (*Afvalfonds Verpakkinge)*

Material	**Fee (2016/17 € tonne ex VAT)**
Glass	€56
Paper/cardboard	€22
Plastics	€640
Bio-degradable plastics	€20
Aluminium	€20
Other metals and materials	€20
Beverage cartons	€180
Beverage bottles (in deposit-return system)	€20
Plastic bottles >1l without deposit	€7,500

[26] http://www.bagtheban.com/multimedia/item/the-truth-about-plastic-bags
[27] The Waste Management Contribution Agreement (ABBO) 2013.

Fees can be uniform with respect to the volume, weight or size of products placed on the market by producers. Alternatively, they may be variable depending on the waste management efforts taken by individual members, for example to provide greater durability and therefore to lower the disposal costs. The question arises as to whether these voluntary efforts are sufficient to provide socially optimum outputs? Because EPR typically delegates responsibility to the PROs, the organisation has the temptation to behave like a cartel, engaging in imperfect competition that would not match the costs and obligations of a regulatory regime designed to maximise social welfare. In practice, this might allow PRO's to demonstrate success through increased levels of recycling, although this could still fall short of the ambitious moves needed to minimise waste through product re-use or re-design. More fundamentally, PROs distance individual member companies from the steps that need to be taken to address litter. Companies can essentially buy their way out of difficult decisions regarding packaging type or product design through the fee contributions that they make to the PRO. Proactive actions to re-examine product design or packaging might follow only if companies' respective fees are based fully on the environmental costs of their particular products. If the respective fees are not large enough relative to the marketing advantages of using a particular packaging, then there is insufficient incentive for a company to undertake such a re-examination. In these situations, there may be a need for the regulatory authorities to step in and enforce certain standards or targets [65].

Like waste management generally, EPR addresses the wider issue of waste rather than litter. PROs argue that litter is a consequence of consumer behaviour. However, a relationship nevertheless exists between single-use product types and packaging, their contribution to marine litter, and the potential environmental costs. EPR will be an important factor in the EU's ability to pursue the circular economy and to reduce the prevalence of single-use items and their contribution to marine litter. Beach litter surveys provide the information needed to identify product types for which EPR should be prioritised. As plastic waste is a particular problem, and includes items such as bottles, bottle tops, plastic bags and polystyrene, there is a basis for the regulating authorities to apply continual pressure on producers to address the issue with more ambitious targets for redesign, recycling and re-use.

Table 5.2: Packaging recycling levels in OSPAR States in the EU

	waste generated	recycled	percentage
EU	**80,172,000**	**51,013,000**	**64%**
Belgium	1,702,500	1,364,900	80%
Netherlands	2,748,000	1,977,000	72%
Germany	16,486,200	11,829,600	72%
Ireland	863,600	612,300	71%
Spain	7,146,840	4,602,400	64%
France	12,810,700	7,849,900	61%
UK	10,929,700	6,649,000	61%
Portugal	1,555,800	914,600	59%
Finland	709,600	416,370	59%
Sweden	1,294,800	737,550	56%
Denmark	883,100	479,400	54%

Note: low figures may also be accounted for by incineration/energy recovery

e) Product design

Up to now, the Eco-design Directive has been focused on energy use, including electrical products where design may demand innovation and significant investment. However, most single-use

products are not so complex. Plastic bottles, for example, are produced from a very limited range of polymers. The same considerations apply to glass bottles, drinks cans, plastic bags and plastic food wrapping. Drinks cans were long ago re-designed to remove ring pulls. Plastic bottles can similarly be re-designed to omit removable internal tops, to include collars that can more easily be broken during the processing for recycling, or to contain a more uniform density of PET. Likewise, some personal sanitary products can easily be re-designed to reduce the contribution of persistent plastics, for example by replacing plastics cotton buds stems with paper. Indeed, Johnson and Johnson has agreed to replace the distinctive plastic spine of its cotton buds with a cardboard alternative.

There is here an age-old battle between standards and product differentiation at work where producers are anxious to retain as much differentiation as possible for reasons of product recognition and competitiveness. Eco-design may limit some elements of this differentiation, but does not remove the capacity for producers to brand or distinguish their products. Rather regulations in this area would have the effect of defining the boundaries within which differentiation is possible. For producers, it is important to consult and communicate where those boundaries lie so that they can continue to market distinct products.

e) Development of markets for plastics reuse.

Surveys of producers reveal a potential demand amongst plastic conversion manufacturers for the reuse of plastic materials, but only where all parties in the chain contribute to the maintenance of the quality of the source material. The Irish Recycled Plastic Waste Arisings Study (2011)[66] collected information on the quantity, quality, type, original and destination of waste plastics with a view to supporting development of a waste management infrastructure that could preserve the value of plastic materials. At present, most plastic waste has been exported, but due largely to the poor quality and mix of waste collected. European processors are available to deal with this waste. However, the high cost of sorting and cleaning means that businesses struggle to compete with alternative markets provided by third countries.

Regulation, for example, limiting the amount of plastics which can be delivered to landfill, is one way in which secondary markets could be encouraged to develop. Economic instruments can be used to achieve the same objective. As it is, China has now ceased to accept deliveries of poor quality plastic waste. Such a development now presents European policy with the need for radical action to improve waste segregation and to advance the circular economy. At present, kerbside waste collections of dry recyclables are contaminated by inappropriate waste up to 30% of the total quantity [66]. Often the contamination is of a degree that even good quality recyclable wastes must be landfilled.

Plastic colour is one reason for segregation. Clear PET is currently worth around €103, but coloured PET bottles are only worth €34 (see Table 4.3). However, the main sources of contamination include the different plastics used for tops and labels on PET bottles. Removing mixed plastics from HDPE or PET bottle streams can raise value by 20% (WRAP). PET bottles can be recycled into fleece jackets, duvets, nappies, etc. Clear HDPE has the highest value, but milk bottles are difficult to wash thoroughly are so are regularly contaminated by their contents. Some other plastics are, though, difficult to recycle, including black plastics, plastic film, and black bin plastic. In fact, some OSPAR states are now advising the public to treat this waste are general or non-recyclable waste. Improved consumer awareness of types and condition of recyclables available for collection will be needed if greater separation of household is to be achieved.

For good prices to be realised for recycled plastics, innovation is needed in product reuse and redesign. Regulation may impose costs on producers, but strict environmental standards can also

encourage innovation [67]. It can do this either by placing restrictions on producers , forcing them to look around for other cost minimising methods, or by forcing producers to innovate further to more than offset the costs of the regulation. Both represent a form of EPR. By demonstrating policy commitment, regulation can also reduce the uncertainty and competitive risk that producers might otherwise face in searching for new uses of recycled products. Researching the European waste sector, Manzzanti and Nicolli (2011) have found that regulation has had a positive influence on innovation in product resign and use.

To promote greater recycling, intervention is needed at all stages in the chain. The UK is introducing a Code of Practice whereby waste collectors will need to report on their waste input and output quality so to provide greater transparency on the composition of recycled materials. Relevant factors in this regard include communication/education of householders, good operational procedures and uniform standards in relation to operator training, rejection procedures, vehicle cleanliness, processing conditions and quality management systems. A European recycled plastics certification scheme, *EuCertPlast*, is also in place, but best practice may require new ISO standards to guarantee an appropriate level of Quality Management Systems.

f) Wastewater

Wastewater can be a source of materials that end up as marine litter. In particular, personal hygiene products get flushed into the system and may not be taken out by the treatment process if the standards are deficient. Regulation already exists in principle through the Urban Waste Water Treatment Directive to ensure that processes are present to remove this waste. However, the environmental deficit in Europe's wastewater treatment is considerable and substantial investment is still being made.

In Ireland, for example, wastewater flows occur from 43 urban settlements for which there is still no wastewater treatment (although this situation is now receiving investment). Treatment *capacity* too is a problem with many older plants and sewerage networks. Wastewater treatment plants are generally designed to have a 6 times dry weather storage capacity, or a 3 times dry weather storage capacity backed by a two hour storm capacity. In many towns, though, the drainage and sewerage networks have been historically combined and physical overflows are included in the system to discharge excess water during storm events. Inadequate impounding or filtering of this storm water means that throwaway waste items can end up as marine litter if water is released into rivers. For 212 listed urban agglomerations, there are 1,157 storm water overflows, 29% of which are non-compliant [60](EPA, 2016

There is also an incentive for water utilities to take action themselves against throw-away items entering the wastewater network. Each year, £81 million is spent by UK water companies on cleaning 400,000 sewer blockages, 80% of which are caused by single-use items such as wipes, nappies, cotton buds and tampons. The *Think Before You Flush* campaign and related initiatives in other OSPAR states are therefore not only providing a wider public benefit in helping to change behaviour in relation to this problem, but are also reducing costs for utilities and government.

5.3 Economic instruments

Economic or market-based instruments use price, or other market signals, to bring about a change in behaviour. Although these instruments cannot ensure a definite quantitative outcome in terms of

the quantity or types of waste becoming marine litter, since they work through market incentives, they do have the benefit of flexibility in that they can be adjusted depending on how market actors respond to the incentives, allowing a particular outcome to be reached iteratively. Alternatively, penalties, taxes or charges can be set so that polluters are made aware of the full cost of their negative impact, leading in principle to an efficient level of pollution, including waste.

The effectiveness of market based instruments in terms of achieving a desired response depends on the elasticity of the response (i.e. the extent to which behaviour changes in response to the change in price or other incentive). Market-based instruments have the advantage of allowing market actors to respond in ways that are least costly to them, and therefore tend to involve less deadweight loss than command-and-control restrictions (such as outright bans or quotas). In some cases, they also raise revenues that may be earmarked for associated environmental spending, or used to reduce distortionary taxes, giving a 'double-dividend'.

It should be noted that market instruments can sometimes present potential unintended effects. For example, the landfill tax in the UK increased illegal waste disposal activity. Therefore, all possible impacts need to be considered across the product lifecycle, particularly during the disposal phase, and outside the markets targeted.

Economic instruments can be either:

- Financial disincentives: i.e. penalties, taxes, and charges. These discourage damaging behaviour, but generally do not end it entirely (and thereby provide a continuing stream of revenue).
- Financial incentives: deposit-refund schemes, subsidies, direct payments, price differentiation, or preferential treatments. These can be applied to stimulate behaviour that encourages recycling and reuse of materials, and proper waste disposal.

With reference to the marine litter problem, a number of incentive and disincentive instruments have been proposed. For example, Clean Seas [68] lists the following instruments as having potential to address marine litter:

- Deposit-refund schemes to encourage post-use return of drinks containers and other food packaging, including the potential targeting of such schemes in tourism areas to encourage better disposal.
- Ecotax on single-use food packaging and service packaging to influence product design.
- Packaging tax on drink containers and food packaging to influence design, production, and use.
- Ecotax on single-use items that form sewerage debris.
- Fines for littering to improve waste collection.
- Pay per weight/volume of rubbish disposed to influence consumption and disposal patterns.
- Lower charging of port collection to encourage post-use disposal by ships.
- Incentive-based public-private partnerships to reduce waste in tourism areas.

Policy makers need to consider several criteria when deciding on the suitability of an economic instrument in tackling marine litter, including in particular [69]:

- Effectiveness: the ability to produce a desired result. The magnitude of change in behaviour will depend on the price signal and other features of the instrument's design, and on various cultural, sociodemographic, and economic influences.
- Cost of implementation and other transaction costs (cost-efficiency)
- Additional socio-economic side-effects (positive or negative) (e.g. employment gains or losses in associated economic sectors, changes in competitiveness).

5.3.1 **Deposit Refund Schemes**

Description

Deposit refund schemes (DRS) involve a mandatory deposit on refillable and/or single-use containers in which the deposit previously paid by the consumer is refunded upon return [70]. The refund is usually at a point of sale, but does not necessarily have to be the same retailer where the item returned was bought. Rather, a scheme can be part of a reuse stream (containers are collected by produce manufacturers, cleaned and re-filled) or a recycling stream (containers are processed for materials recovery or energy recovery). A major benefit is that the collection and separate storage of returned items should result in high quality separated waste streams, better enabling their acceptability and value for re-use or recycling. This could also have a potential impact on the recyclability of remaining items, or for their use in energy recovery.

DRS are already used in several OSPAR countries for drinks bottles and so there are more data available on their effectiveness compared to alternative waste management approaches. For example, Germany has a DRS for PET bottles (€0.25) that today encourages the return of 98.5% of refillable bottles [71].

DRS are typically applied as a national scheme, although an alternative option would be to have local schemes which could target high-risk areas (e.g. in coastal communities or those on major rivers). However, defining the boundaries of such schemes could be problematic, for example, if 'high risk' is within a certain distance of a river with tidal influence then this would cover central London. In such coastal cities, locally-defined schemes would thus either result in an arbitrary boundary within the urban area which would be confusing to consumers, or need to cover the whole city (being little different to a national scheme in terms of consumption covered and therefore costs).

A variation would be a national scheme with a higher payment rate in high-risk areas. Such an additional rate would have a boundary effect, so the differential would need to be small enough so as not to create an incentive to bring extra materials to high-risk areas. However, all litter has an external environmental cost and the scheme could still be effective in reducing general litter as well as in encouraging recovery of littered items in high-risk areas.

Effectiveness

Existing DRS usually target single-use consumer goods packaging, in particular plastic packaging. Mandatory deposit systems can contribute significantly to recycling compared to deposit-free beverage packaging. Although consumers face initial costs, these are broadly balanced with the refund. Even with this balance, the incentive still remains to return the items covered. National DRS are permanent in duration and therefore have high effectiveness because a financial incentive is provided to reduce general littering. DRS can influence both terrestrial and marine sources of litter as the incentive created covers not just in-house recycling, but also outside use, including, for example, recreational use at the beach

Deposit rates could also be varied to favour packaging with lower lifecycle impacts. However, as the incentives are generally low (< €1 per item), variations in rates tend to create only modest changes in incentives.

A first target of such schemes is likely to be PET bottles. In the UK in 2014, plastic bottles made up over a third of consumer packaging by weight (WRAP) and so a large undertaking would be needed to collect, reuse, or recycle these items. Under kerbside separation and collection systems in

Germany, 46% to 57% of PET bottles are not collected, but this figure is as little as 1-4% under DRS [70]. Thus, the proportion of litter that is not collected, and which poses a higher risk of becoming marine litter, is reduced by between 91% and 98%. However, Germany, along with Denmark, already had a voluntary system of collection and reuse of containers that preceded kerbside collection and this culture has helped to sustain high levels of return under the mandatory system [72]. Other countries with high levels of plastic recycling, rely on PRO systems rather than deposit refund. Overall, the effectiveness of DRS varies with between 5%, and no more than 20%, not being collected.

DRS in Germany (Albretch, 2014; Helmut Schmitz, pers. comm.)

In Germany, local guidelines are established in the context of the National Packaging Law (updated July 2017) which covers all types of packaging. There is a mandatory DRS for non-refillable containers of €0.25 per item, and there can be local extensions such as levies on single use coffee cups.

For waste covered by the voluntary Green Dot system, collection rates amount to between 43% and 54% for PET single-use bottles, 53% for drinks cartons, and 76% to 82% for single-use glass bottles. The recycling rates relating to the quantity subsequently put into circulation (and including energy recovery) amount to 25% to 31% for PET single use bottles, 39% for drinks cartons, and 76% to 82% for single-use glass bottles. By comparison, mandatory deposit systems show higher collection rates of 96% to 99% and recycling rates of 81% to 98% (depending on the type of packaging material).

The estimated cost of the whole post-consumer plastic collection system is around €12-15 per person per year. For DRS, €5.5bn are paid in deposits/yr, and only €200m (3.6%) go unredeemed. This legislation has created a major industry/sector, as well as a secondary activity of homeless people collecting plastics for refund, but also greatly reducing the contribution of bottles to litter.

On the other hand, beverage containers only account for a small, if visible, proportion of general litter. The proportion is higher for marine litter, but here too, plastic bottles only account for modest percentages. To have a significant impact on the quantity of such litter, DRS could be extended to ensure the return of plastic caps and lids as well as bottles, and also other types of containers (plastic, glass, tins, and other packaging) or food containers. This would, however, increase the complexity and cost of a DRS.

In addition, DRS are not guaranteed to be successful. In some OSPAR countries, such as Norway, return rates are lower than for PRO recycling schemes. The argument has been made that DRS could undermine existing schemes and provide poorer performance, while requiring investment in new collection infrastructure and its maintenance. The diversion of good quality plastics would further reduce the value of mixed dry recyclables in household MSW and the economies of scale that can be achieved through its collection as residual waste would likely consist of a higher proportion of lower value plastics for recycling or materials that can contribute to waste to energy recovery [72].

Costs and savings

The handling of waste items via retailers reduces the costs to local authorities (and hence taxpayers) of collecting them through municipal/kerbside recycling systems. A DRS will, though, result in one-off and on-going costs for business and this can be considered an example of EPR. It is claimed that the distribution of costs would be largely in line with the current contribution of producers to the impact of litter (i.e. satisfying the PPP). Consumers would also face opportunity costs if they do not return their items.

In its most recent report, Eunomia (2017)[73] presents detailed calculations for sources of savings for local authorities (and by extension, local tax/rates payers), breaking estimates for annual savings down into several components:

- Reduced cost of conventional waste collections: *savings* of £0 - £1.65 per household
- Reduced costs of sorting waste streams: *savings* of £0.01 - £3.14 per household
- Reduced revenues from waste processing: *losses* of £0.67 - £1.63 per household
- Reduced costs of incineration/landfill: *savings* of £0.54 - £4.55 per household
- Reduced costs of street cleaning: *savings* of £0 - £0.45 per household for urban authorities of dealing with street litter.

Overall: Eunomia's estimate of the average *net saving* is £1.47 per household, equivalent to £35m per year for England.

There would be a one-off cost to Government of establishing a DRS. There would also be ongoing costs of overseeing the operation of a system, including the need to enforce regulations to ensure compliance. If the DRS covers multiple types of litter, system and collection costs would be increased, but at a decreasing cost per litter type due to economies of scale.

However, initial investment costs may be relatively high for businesses. For retail outlets, including small outlets, there would be a need to invest in deposit collection and refund systems and to provide storage and/or transport facilities. The extent to which retailers can be considered as falling within the realms of EPR would depend on their influence on the consumption, design or type of packaging. This influence would be slight for smaller retail outlets.

Ongoing costs include handling, storage and the transport costs associated with collected items. EPR applies here, but requires a high level of administration to ensure that producers and retailers are treated fairly by avoiding imbalances between deposits paid and refunded. Net costs and revenues will depend on the markets for re-usable or recyclate products. Revenue would also be generated through unredeemed deposits. Often it is this revenue that determines the viability of DRS. Eunomia's modelling of a potential DRS [74] suggested that even with a 90% return rate, unclaimed deposits would cover 70% of manufacturers' costs.

Overall impact

The overall cost-effectiveness of DRS depends on the benefits for terrestrial materials/waste use, essentially the increase in recycling and reduction in littering. There will be environmental and amenity benefits, and also changes in the costs of waste collection, treatment, and recycling.

Although a significant evidence base exists on DRS, an assessment of the effectiveness of such schemes for combatting marine litter requires further information on the:

- Extent of potential savings from coordinating systems across OSPAR countries (compared to separate individual country schemes);
- Impact on collection rates given existing waste collection rates, recycling rates/capacity and markets for separated waste items in OSPAR countries;
- Ability to target high-risk areas for marine litter generation.

There can be unintended negative consequences too, such as:

- Packaging companies switching to materials which are not covered by the scheme, but which have other environmental impacts. This suggests the need for monitoring packaging use and to adapt policies (e.g. by extending the DRS system or other regulations).

- Barriers to trade and innovation. If businesses export to several countries they may need to use different packaging materials for different markets, increasing costs. This can be reduced by harmonising materials between countries. Requirements to use certain materials may restrict innovations in materials use which could be more beneficial to consumers.
- Where kerbside recycling generates a valuable recyclable resource, this benefit could be reduced.

In several OSPAR countries, there is experience of DRS and of the likely impact on waste collection and on marine litter. These show high rates of collection for the items covered. However, the net effectiveness of these schemes depends on the prevalence of returnable items in general and marine litter. This effectiveness must also be judged in relation to the effectiveness of existing recycling schemes, including those managed by PROs. A DRS would need to be supported by investments in retail processes, collection facilities, and by processes/markets for the reuse or recycling of items, stimulating commercial markets for the use of collected packaging.

Summary Assessment - DRS

Targeting: ★★★ Mainly targets bottles, which are high-risk single-use items. Can be applied to other containers, but not suitable for all single-use items.

Effectiveness: ★★ Effective for household and outside use and incentivises higher collection rates, including secondary collection, but net effectiveness depends on contribution to litter and prevailing recycling collection schemes.

Links: ★★★★ Can be linked to awareness campaigns and support green procurement.

Costs: ★★ Fairly high costs, although these partly offset by lower kerbside waste collection costs for taxpayers, and unclaimed deposits retained by retailers.

Outcome: ★★ Addresses recycling, but has weaker link to litter, including marine litter. Is effective in combatting the throwaway society.

Table 5.3: Summary of DRS impact

Instrument	**Deposit refund systems (DRS) have a deposit is paid at point of sale on single-use or refillable containers, that is refunded to the consumer upon return.**
Spatial scale	Usually implemented in national systems. Local schemes are possible but could be complicated due to boundary effects.
EFFECTIVENESS IN TACKLING MARINE LITTER	
Aspects of marine litter targeted (e.g. sources/ types/ stakeholders)	Single-use consumer goods packaging, in particular plastic bottles. Incentive created covers in-household and outside uses.
Scale of impact (spatial, temporal & amount)	National schemes would be permanent in duration and can have high effectiveness. Financial incentive is of < €1 per item.
Clarity – understanding by stakeholders	High collection rates imply clarity is good. Any sub-national variations in DRS would be likely to reduce clarity.
Feasibility – to undertake & enforce	Good – existing schemes operate successfully in several OSPAR states.
Potential for unintended/indirect benefits (to the environment, society, or economy)	Job creation in formal economy by using more labour and less energy/ materials, and in informal economy through waste collection. May increase quality of separated waste enabling recycling, but could undermine existing collection systems. Reduced waste collection costs to local authorities.
Impacts on specific litter types and total litter	Plastic bottles and lids are in total <10% of marine litter, so the impact of DRS on the increase in total litter will be modest

	proportion of this amount.
COSTS	
Private costs (1-off, ongoing)	Once-off costs: Consumers will face initial costs as they pay their first deposits. For business, the costs are from adding the deposit collection and refund system to their retail systems, and facilities for storage and/or transport of items. Ongoing costs: There will be ongoing costs of operating the system at retail/ consumer level and at retail outlets to collect and store items. Revenue may be generated for beverage manufacturers and/or retailers through unredeemed deposits which can mitigate costs.
Public costs (1-off, ongoing)	There is a one-off cost of establishing the policy and DRS, and ongoing regulating its operation (e.g. prevent fraud).
TOTAL costs:	In the UK, Eunomia (2010) estimate net costs of a DRS at £428m (approx. €460m) per year) based on: - Around £84 million to set up if well designed; - Around £700 million per year to run (gross); - Unclaimed deposits fund around 70% of system costs; - Savings to local authorities (and hence, reduce the burden of taxation) of around £160 million.
Potential for unintended costs (including external costs such as on competition)	A DRS may result in packaging changing to materials not covered by the scheme. Requirements to use certain materials may restrict innovation into alternative materials.
Potential for indirect costs (e.g. to jobs, supply chains)	The overall employment effects would be expected to be positive.
Distribution of cost (e.g. individuals, sectors, locations, activities)	Costs are distributed across the whole of society, covering producers, retailers, and consumers at all points of sale. This distribution is in line with current environmental impacts.
Equity of distribution (e.g. polluter pays principle)	Proportionate to polluter pays.
COHERENCE	
Complementary to other instruments/policies?	DRS diverts some waste from kerbside collection. Can also complement green-procurement policies. Deposits are highly visible to consumers and so help communicate the risks of single-use packaging to the marine environment.
Complementary actions and infrastructure	Investments in DRS in retail processes, collection facilities, markets collected items, and regulation against fraud.
Practical evidence – is there a track record/ experience from elsewhere	Yes, schemes operate effectively in several OSPAR member countries.
Logistics needed	Ongoing operation of DRS through retail processes, and operating storage and transport facilities for items collected.
Strength of knowledge base	Good, experience of implementation from multiple OSPAR countries.
Overall effectiveness judgement	High rates of collection for the items covered, but weaker connection to litter and can undermine existing systems.

5.3.2 **Plastic bag levy**

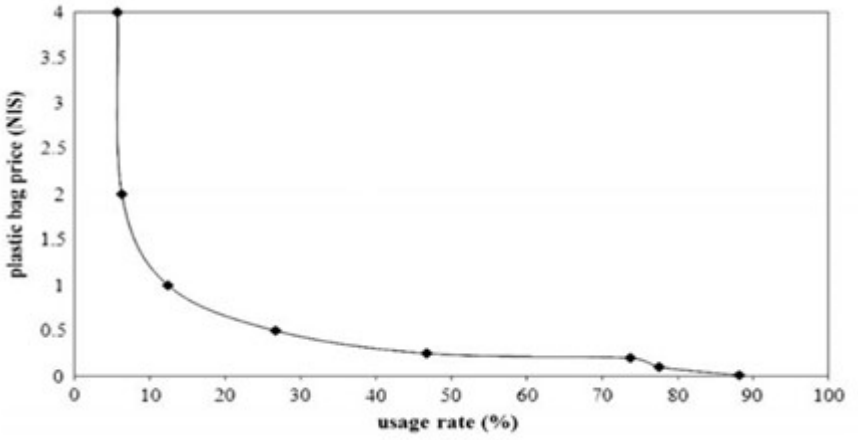
Description

Lightweight plastic bags have been a particular focus of policy effort that is showing positive results in many places. At the EU level, the Plastic Bags Directive (2015/720) obliges Member States to

achieve substantial reductions in single-use bag consumption by putting a price on plastic bags, and/or introducing national reduction targets. The economic instrument of a levy or tax on plastic bags has been the preferred policy measure in many OSPAR countries rather than the use of national bans discussed in Section 5.2.1. The EC is developing a common methodology for calculating how many lightweight bags are consumed per year. Member States must report annual consumption figures to the Commission as of 27 May 2018.

Consequently, in many EU countries, plastic bags are no longer available at grocery stores for free. Some Member States, such as Ireland, Denmark, Finland, and Luxembourg, have already achieved significant reductions in plastic bag use. For example, in 2002, Ireland introduced a plastic bag levy. Initially set at €0.15 (since increased to €0.22), the levy reduced per capita use from 328 bags to 18 bags per year – a reduction of nearly 95%. The UK and the Netherlands have also brought in charges on bags. Here too, a small charge has proved to be equally effective. Effectiveness depends on the elasticity of demand for plastic bags. Demand would appear to be highly elastic at high usage levels (i.e. the situation prior to introduction of any tax/charge), but can be highly inelastic at low levels (i.e. below 10-15% of original usage). Hence, a relatively small tax could result in substantial reductions in plastic bag use, but even quite large price rises might fail to reduce residual use. In some countries, taxes apply to all single-use bags/packaging, including paper, and seek to foster a switch to reusable bags rather than any switch in materials. In Scotland, for example, a charge applies to all single-use bags, including those made of paper, plastic, and some plant-based materials. Indeed, paper bags have a higher environmental impact in many categories (due to pulp and paper production processes and the greater weight of material required per bag). Lewis et al report that "the notable exception is litter. Paper bags would have a reduced impact in litter because of their faster rate of degradation and because of the minimal risk they present to marine wildlife and birds." Thus, to the extent that litter is perceived as the predominant problem, single use paper bags would be preferred to single-use plastic.

Figure 5.1 Demand curve for consumers of plastic bags based on various levies

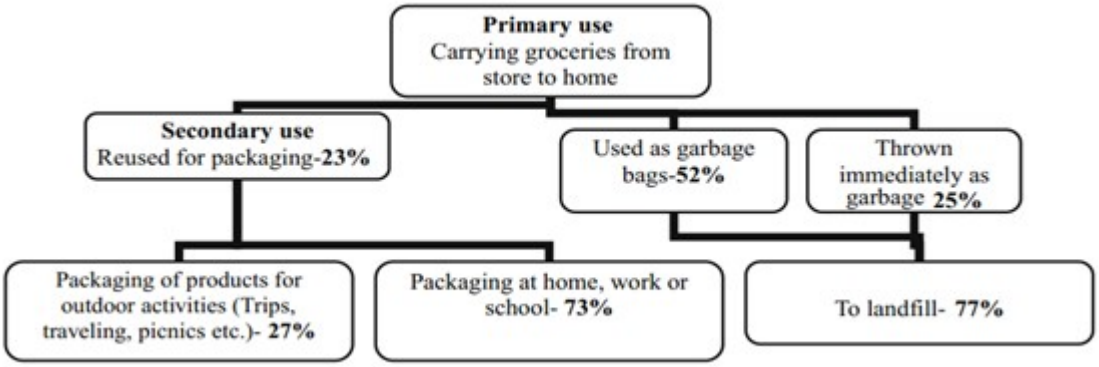


The rationale for cutting back on single-use bags rests on the assumption that the full economic cost (including public and private costs) of alternatives are lower. There is evidence that reusable carrier bags have lower environmental impacts than single-use bags, although the benefits are highly sensitive to usage rates (they assume reuse of 50 times) [75]. There is also a risk of perverse outcomes, for example higher usage of heavier plastic bags which are not necessarily reused and so still find their way into the waste stream [76]. The analysis of sensitivity to reuse rates suggests that consumers should be encouraged to buy reusable bags, and then to keep using those bags over a

considerable period rather than regularly buying new ones [75]. In particular, bags should never be given away free, because this would encourage over-consumption.

There is evidence from Israel that illustrates the importance of considering, in any analysis, the full cycle of use for 'single-use' bags [77]. In many households, these bags are re-used either for packaging or as rubbish bags. To the extent that any tax or ban on single-use bags results in increased consumption to replace these re-uses, the policy may be less effective in reducing total waste and place a higher financial burden on households. On the other hand, there may be a corresponding increase in sales of a more environmentally-friendly (and therefore untaxed/not banned) alternatives (e.g. bags for life, cloth bags). This would coincide with the type of positive behavioural change needed to move away from single use towards waste minimisation and re-use (people ensuring they bring bags with them when shopping to avoid cost of purchasing new bags).

Figure 5.2 Routes of plastic bags use and disposal



Plastic bag levy in Ireland

In Ireland, retailers who supply plastic bags to customers must charge a levy to customers at the point of sale. Currently, the levy is 22 cents per shopping bag which retailers must pass on to the exchequer. The Department of Communications, Climate Action and Environment oversees the levy which is paid into an Environment Fund along with the landfill levy to finance waste management, litter collection and other schemes aimed at protecting the environment.

The levy led to a 90% drop in use of plastic bags, with one billion fewer bags used and significant reductions in roadside litter. This reduction corresponded to a fall from an estimated use of 328 bags per person per year prior to the introduction of the levy, to 21 bags per person by the end of 2002 and a further reduction to an estimated 14 bags per person by the end of 2012 he National Litter Pollution Monitoring System Report 2012 reported that plastic bags constituted 0.30 % of litter arising in 2012, compared with 5% prior to the levy's introduction."[28]

The levy also initially generated €9.6 million for the Environmental Fund. Ironically, with the success of the program, more people are bringing their own reusable carriers to shop with the effect that proceeds from the levy have fallen, resulting in less money available for supporting environmental projects[29]. In addition to the high effectiveness, Convery et al (2007) point out, that the "*Response from the main stakeholders: the public and the retail industry, has been overwhelmingly positive.* [78]

[28] *oireachtasdebates.oireachtas.ie/debatesauthoring/debateswebpack.nsf/takes/dail2013071600106?opendocument#WROO02650*

[29] http://www.irishenvironment.com/iepedia/plastic-bag-levy/

Plastic bag tax in England

In England, the law requires large shops (i.e. retailers with 250 or more employees) to charge 5p for all single-use plastic carrier bags. Charging started on 5 October 2015. The Government reviewed industry standards for the biodegradability of lightweight plastics in December 2015 and found the number of standards for plastic bag biodegradability to be too diverse. In 2014, over 7.6 billion single-use plastic bags were given to customers by major supermarkets in England, equivalent to around 140 bags per person or about 61,000 tonnes in total. Since introducing the scheme, the number of bags used has reduced by more than 80%, or 9 billion fewer plastic bags. Government estimates that over the next 10 years the benefits of the scheme will include: an expected overall benefit of over £780 million to the UK economy, with up to £730 million raised for good causes, £60 million savings in litter clean-up costs and carbon savings of £13 million.

Summary Assessment – Plastic bag levy

Targeting: ★★★ Targets single-use bags/plastic bags, which are high-risk single-use items, but not suitable for all single-use items.

Effectiveness: ★★★★ Significant reductions of use of single-use plastic bags at retail points, of up to 90%. Also good for awareness.

Links: ★★★ Can be linked to awareness campaigns, and supported by green procurement.

Costs: ★★★ Moderate costs which fall rapidly as consumers adapt to the charge.

Outcome: ★★★★ Addresses specific aspect of marine litter, but with high effectiveness.

Table 5.4: Summary of plastic bag levy impact

Instrument	**Levy on lightweight plastic bags, possible extension to all single-use bags/packaging and other items.**
Spatial scale	Usually implemented in national systems. Local schemes are possible but could be complicated due to boundary effects.
EFFECTIVENESS IN TACKLING MARINE LITTER	
Aspects of marine litter targeted (e.g. sources/ types/ stakeholders)	Single-use consumer goods packaging, in particular plastic bags. Incentive created covers in-household and outside uses.
Scale of impact (spatial, temporal & amount)	National schemes would be permanent in duration and can have high effectiveness. Financial incentive is generally a few cents per item.
Clarity – understanding by stakeholders	Very clear for plastic bags, where levy paid at checkout.
Feasibility – to undertake & enforce	Good – existing schemes operate successfully in several OSPAR states.
Potential for unintended/indirect benefits (to the environment, society, or economy)	Job creation in formal economy by using more labour and less energy/ materials. Reduced waste collection costs to local authorities.
Impacts on specific litter types and total litter	Plastic shopping bags form a significant component of marine litter, being the 7th most common item in the 2014 International Coastal Clean-up. An extended scheme covering e.g. other plastic bags, straws and stirrers, and plates and cups) could have a substantial impact.
COSTS	
Private costs (1-off, ongoing)	Consumers will face costs either through paying the levy for bags, or through buying more durable alternatives. For business, the costs relate primarily to collecting the levy, with modest set-up and ongoing costs.

Public costs (1-off, ongoing)	There is a one-off cost of establishing the policy and ongoing regulation of its operation and revenue collection. This should however be more than offset by the revenues. In Ireland, costs of administration have been only about 3% of revenues
TOTAL costs:	Modest, and offset by revenues.
Potential for unintended costs (including external costs such as on competition)	There may be costs of inconvenience, although these are expected to be relatively temporary and minor.
Potential for indirect costs (e.g. to jobs, supply chains)	Some impact through reduced production and sales of single-use bags and any other items covered.
Distribution of cost (e.g. individuals, sectors, locations, activities)	Costs fall almost entirely on polluters, i.e. the levy is paid only by those who choose to use single-use bags/items
Equity of distribution (e.g. polluter pays principle)	Proportionate to polluter pays.
COHERENCE	
Complementary to other instruments/policies?	No conflict with other waste reduction policies. Resource and energy use benefits.
Complementary actions and infrastructure	Levy collection and enforcement.
Practical evidence – is there a track record/ experience from elsewhere	Yes, schemes operate effectively in several OSPAR member countries.
Logistics needed	Ongoing operation of DRS through retail processes, and operating storage and transport facilities for items collected.
Strength of knowledge base	Good, experience of implementation from multiple OSPAR countries.
Overall effectiveness judgement	Excellent, can achieve very high reductions in bag use. May be somewhat less effective for some other items.
Recommendations to research/ develop?	YES

5.3.3 **Extension to ecotax on single-use food packaging and service packaging to influence design**

Based on the evidence of implementation of the plastic bag levy in several countries, consideration can be given to extending a similar levy to other single-use items. However, the costs involved of could differ from those of bags/packaging. It should be noted that there can be some exceptions to the bags/packaging restrictions (such as in wrapping raw meat) and hygiene factors may also affect substitutions of other packaging.

As noted above, the elasticity of consumption in response to price changes of plastic and other bags is fairly high. The same does not apply to many other single-use items, including for food packaging, which make up a large proportion of single-use items and of marine litter.

Policies to reduce the use of all single-use items may be desirable from a resource efficiency perspective. However, from a marine litter perspective, the objective is to reduce single-use items made of specific materials (i.e. plastics) which are damaging when (inappropriately) disposed of. Such policies could be lower-cost because there are single-use items made of alternative materials (e.g. paper plates/cups or wooden cutlery,).

The rate of substitution of plastic items for those of materials that pose less damage to the marine environment depends partly on the awareness of consumers of the risks posed. To this end policies that reduce the use and hence impacts of specific packaging items (e.g. deposit-refund schemes, plastic bag tax) can have, in addition to the environment benefit of reducing the risk of marine litter, there is a benefit of educating the public about the risks of single use plastics to the marine

environment. Further options for instruments on single-use plastics could include a tax on plastic drinking straws and balloons.

Summary Assessment – Levies on food and other single use items

Targeting: ★★★ Targets single-use items such as plates, cups, straws, and packaging. These are high-risk single-use items, but not suitable for all single-use items.

Effectiveness: ★★★ Significant reductions of use of single-use plastic containers and implements could be possible, although for some items substitution may be limited (e.g. balloons, straws) so the levy would encourage reduced consumption not substitution – depending on elasticities, this may mean more revenue raising and less effectiveness.

Links: ★★★ Can be linked to awareness campaigns, and supported by green procurement.

Costs: ★★ Inconvenience costs could be higher than for plastic bags since substitutes may be less convenient.

Outcome: ★★★★ Addresses specific aspect of marine litter, but with high effectiveness.

5.3.4 **Fines for littering to improve waste collection.**

There is limited evidence on the effectiveness of fines:

> "*McIlgorm et al. (2011) discuss the use of financial penalties in discouraging the illegal disposal of marine litter in the Asia-Pacific region and how the effectiveness of such measures is likely to be conditional on the ability to identify the polluter and enforce the penalty.*[79]

Kolodko et al (2016) view fines as

> "*The most direct way to increase the personal cost of littering*" noting that "*Loss aversion is a strong motivating force – people don't like losing what they already have. If people knew that there was a real chance of getting a fine when they dropped litter, they would not do it as often*."[80]

The 'disincentive' effect depends on the expected costs, which is the level of the fine multiplied by the (perceived) risk of being caught and fined. Thus, a higher fine allows the same disincentive effect for less enforcement effort, as well as a greater expected revenue per hour of enforcement. On the other hand, at a broader level it might be thought appropriate that the fine be kept 'reasonable' in proportion to other incentives or disincentives.

Summary Assessment – Littering fines

Targeting: ★★★★ Targets littering, which creates a high-risk of resulting in marine litter. Could be targeted to higher-risk areas (e.g. waterfronts, beaches).

Effectiveness: ★★ Depends on level of enforcement, which in general is low. Fines are more usually applied for fly-tipping that for individuals littering with a single item. However, if fines are substantial and enforcement rigorous, could be highly effective, but more costly.

Links: ☆☆☆ Can be linked to awareness campaigns. Enforcement could be linked to more general cleanliness (e.g. dog waste) and policing/security (reductions in petty crime, vandalism, parking control).

Costs: ☆☆ Variable, but effectiveness is linked to enforcement and fairly high costs of enforcement are needed in order to be effective. Revenues from fines could compensate to some extent.

Outcome: ☆☆☆ Can addresses risk of marine litter, but with high effort/costs. Combats throwaway society. Advantage of being able to focus effort in high-risk areas.

Table 5.5: Summary of Fines impact

Instrument	**Fines for littering**
Spatial scale	Generally local, enacted by local authorities. Effectiveness strongly dependent on enforcement which is likely to be local, and could be strongly local and strategic (e.g. focused on sea front).
EFFECTIVENESS IN TACKLING MARINE LITTER	
Aspects of marine litter targeted (e.g. sources/ types/ stakeholders)	Focus on litter, which is a high-risk part of becoming marine litter.
Scale of impact (spatial, temporal & amount)	Effectiveness dependent on enforcement, which could be localised, varied by season and time of day, and potentially effective in preventing littering.
Clarity – understanding by stakeholders	The basic principle is very clear, if adequately advertised e.g. through signage and information campaigns. The perceived risk of being caught/fined is much more subjective.
Feasibility – to undertake & enforce	Feasible, but resource intensive in terms of manpower for enforcement.
Potential for unintended/indirect benefits (to the environment, society, or economy)	Likely that enforcement would be coupled with other areas of enforcement (dog mess, petty crime, noise, other anti-social behaviour) and could contribute to general increase in amenity/security, potentially resulting in increased attractiveness for visitors, enhanced trade for local businesses.
Impacts on specific litter types and total litter	General impact on reducing litter, with particular impact in areas targeted for enforcement. Could cover litter types that are otherwise difficult to control, such as cigarette stubs.
COSTS	
Private costs (1-off, ongoing)	Very limited – there is an inconvenience cost associated with not being allowed to litter (and therefore having to carry waste to disposal facilities).
Public costs (1-off, ongoing)	Set-up costs are minor, mainly relating to signage, provision of waste bins, and other awareness-raising activities. The main ongoing cost is enforcement, which could be substantial, though partly offset by fines and additional benefits.
TOTAL costs:	Total costs could be substantial, for adequate enforcement, but can be partially offset by fines, and could be reduced by strategic focus of enforcement activities.
Potential for unintended costs (including external costs such as on competition)	Little risk of unintended costs.
Potential for indirect costs (e.g. to jobs, supply chains)	Little risk of indirect costs. If successful, reduced need for litter collection, but this would be more than offset by the enforcement needs.
Distribution of cost (e.g. individuals, sectors, locations, activities)	Costs of the scheme would fall on local taxpayers/ratepayers, partly offset by fines, and compensated by improved amenity and perhaps

	increase trade/visits for coastal areas.
Equity of distribution (e.g. polluter pays principle)	Polluter pays, though randomly – i.e. the polluter caught polluting would pay a fine well in excess of the damage from the pollution, while many other polluters may get away with it.
COHERENCE	
Complementary to other instruments/policies?	Yes, in that the fines target a segment of anti-social behaviour that is unlikely to be reached by provision of collection schemes and disposal facilities alone.
Complementary actions and infrastructure	Requires complementary and adequate provision of litter bins, recycling bins.
Practical evidence – is there a track record/ experience from elsewhere	Yes, fines for littering are widespread, though evidence on effectiveness and enforcement intensity is hard to find.
Logistics needed	Primarily enforcement, which essentially means people on the ground, although CCTV could also play a role.
Strength of knowledge base	Modest, with little evidence on effectiveness at different levels of enforcement.
Overall effectiveness judgement	Effective in reducing littering if adequately enforced with sufficient fines. Could be targeted to high risk areas.
Recommendations to research/ develop?	YES

5.3.5 **Pay per weight/volume of rubbish disposed to influence consumption and disposal patterns**

Pay-As-You- Throw (PAYT) schemes are used in several EU states, and in particular by local authorities in Belgium, the Netherlands and Luxembourg, as a means of encouraging recycling and reducing residual household waste. They differ from other kerbside collection approaches which are financed from general household taxes or charges by linking payments to the amount of material collected. Charging methods vary and involve the payment of a variable fee linked to some aspect of waste volume or mass. Generally, the variable element is applied only to residual waste collection, although in some areas recyclables collection is also charged, at a lower rate.

This variable incentive pricing is being adopted by many EU Member States in line with the PPP principles of the Waste Framework Directive for the kerbside collection of household waste. The difference between the charge for collection or standard waste and recyclables provides an incentive for waste separation. These schemes are not intended to directly address the problem of marine litter.

Possible bases for the fee include:

- The size of collection container used by the household;
- The frequency of collection of a given container;
- A fee per bag used;
- The weight of waste set out for collection; or
- Or some combination of the above

The administrative requirements and costs of these schemes are quite variable. A single fee per bag is straightforward to implement and enforce (only the taxed bags are collected), but charging by weight or by frequency is rather more complex. At the same time, the effectiveness of the schemes varies depending on this same complexity, and schemes based on a one-off choice of container size are less effective than schemes based on volume or (even better, since waste may be more or less compacted) weight [81]. Payments related to the volume or weight of household waste form part of

a coherent suite of waste policies, including other fiscal instruments such as landfill taxes, incineration taxes, and EPR. Typically, revenues from variable fees cover around 30-50% of waste collection costs, partly to avoid exposing the service provider to too much revenue instability, and partly to avoid creating too much incentive for illegal disposals.[82]

5.3.6 **Cross cutting issues**

A cross-cutting question for economic instruments is how they can be targeted towards marine litter. One aspect of this is the degree to which they discriminate against items/materials/activities that pose the highest risk of generating marine litter. Another factor is the point in the lifecycle of products targeted, with disposal habits that avoid collection systems posing the highest risks. These aspects are discussed above.

A further factor is geographical targeting, in terms of locations where generating marine litter is highest risk. These locations include coastal areas, particularly areas of high recreational activity, and settlements along major rivers that can transport litter directly to the marine environment. However, geographical targeting presents a particular challenge for economic instruments applied to market systems that are generally regulated at a national level or similar large scale. National economies generally involve a level playing field for all participants. Furthermore, economic instruments need to be legally defined against a clear point in the market system, e.g. a point of sale. Both these factors mean that local variation of economic instruments brings complexity of regulation and problems of market distortion.

However, there are some aspects of economic instruments and their supporting measures that could be enhanced/targeted towards high-risk areas for marine litter generation. These include:

- Littering fines, through higher fines and/or greater enforcement presence giving a higher risk of those littering being fined.
-
- DRS collection facilities that pay refunds, for example, additional temporary facilities could be provided at points of higher consumption (e.g. tourism beaches in season).

5.4 Summary

This chapter has discussed the wider set of regulatory and economic instruments available to address marine litter. Both can be used to realise targets in relation to re-use and recycling, and marine litter, in different ways. Regulation sets out the requirements which producers must adhere to. National bans on certain products are an extreme form of regulation. They can be very effective, but also need to be used sparingly or to be very targeted to particular products which have a high adverse impact on the environment. Encouraging EPR by, for example, requiring producers and packaging companies to take responsibility for a share of the life-time impact of their products can be very effective at encouraging higher levels of recycling and less waste, but are not always welcomed by industry and need to be carefully monitored and maintained, for instance by gradually making targets more ambitious. As a concept, EPR can also be used to influence product design to minimise the risk from chemical additives or to encourage greater uniformity in the composition product and packaging, including fewer small parts that easily become litter and which can have significant ecological impacts. Ultimately, a more functional market for plastic recyclables would

make the most difference. Regulation to improve sorting and segregation of plastics can help, but economic instruments such as DRS can potentially make a significant difference to the supply of relatively pure plastics with an existing good market value. Economic instruments can also be used to disincentivise behaviour by, for example, placing levies on the use of products such as plastic carrier bags to reduce consumption of items which have a high environmental impact, including on the marine environment.

Chapter 6. A STRATEGY FOR REDUCING SINGLE-USE ITEMS OF MARINE LITTER

6.1 An integrated strategy

Marine litter, and the large contribution of single-use items specifically, arises from a variety of sources and pathways, from deliberate dumping and careless littering, to failures in waste collection and management, or failures in wastewater treatment. Aside from specific actions at the coast, any intervention is going to need to reduce waste first, and marine litter second. Behavioural factors, for example, the propensity to litter, or alternatively to recycle, are a significant factor, but the ability of measures to influence behaviour varies and this adds to uncertainty over effectiveness, especially the response to economic instruments.

So where to begin? No single strategy will alone significantly reduce single-use items of marine litter. This conclusion is evident from the Arcadis report (2013) which contains a range of modelled projections which demonstrate that only modest reductions are possible from any one measure. Arcadis assume a 'business as usual' scenario of growth in marine litter of 4.4% by 2020 and 8.5% by 2025 compared with 2015.[30] A decoupling of future waste generation from consumption, as sought by the *Action Plan for a Circular Economy*, does have an effect, but given the underlying trends towards increased consumption, higher targets for municipal solid waste under the Waste Framework Directive only lead to a 7.4% reduction in marine litter inflow (all marine litter) by 2020 compared with 2015 while limitations on landfill only achieve 2.5%. Higher packaging waste targets are more successful by achieving a reduction of 18.4%, but fail targets to impact on litter that has washed up from further away. However, Arcadis do believe that a 35% reduction could potentially be achieved by 2025 if all EU Member States performed as well as the top three performers. A strategy to address plastic waste would be the major driving force behind significant reductions in marine litter

Alongside these changes in wider waste management, there is a role for targeted measures on such frequently occurring items such as plastic bags, bottle tops, cigarette stubs, crisp packets and coastal consumption of single-use products. Indeed, ideally, an integrated mix of targeted and local measures is needed to address marine litter combined with policies at the higher level of municipal waste management and the move towards the circular economy.

Measures to raise awareness are a first port of call. Awareness raising at all levels is needed amongst all stakeholders, from producers, to households, to individuals, and with respect to marine litter, street litter and waste generally. Marine litter, and particularly microplastics, has recently received much attention, but this publicity does not provide any guarantee of sustained changes in behaviour by everybody. In addition, to support behavioural change, collection infrastructure, specifically bins, but also local authority beach cleaning, is needed at more locations. At present, this infrastructure is markedly absent from many places, including popular coastal walks, and even tourist beaches. There is a role for local regulations too, such as bans on the use of particular products, particularly near the coast where items are vulnerable to becoming marine litter by being swept away by wind or rain. Such measures are straightforward to describe, have low novelty, but a high effectiveness.

At the higher level, the EU need to move forward to ensure that Waste Framework Directive is fully implemented, that waste collectors are properly registered and their performance is regularly

[30] Check this.

assessed, that all landfill sites are registered, properly managed and monitored to avoid losses to wind or watercourses, and that practice moves rapidly towards the proper cleaning and segregation of recyclable materials, especially at household level, but also during processing. Progress in these areas is a pre-requisite to a proper Plastics Strategy that greatly improve the reuse, collection, separation and recycling of different plastics. This strategy should tie in with the principles of the circular economy which would significantly reduce the prospect of materials becoming waste by encouraging reduced use, increased reuse, and active recycling. To stimulate a stronger market and better prices for plastic recyclables in particular, bans or higher levies on the acceptance of some materials into landfill will be needed along with the prohibition of exports of recyclable waste to third countries (a change that might yet occur in any event given China's reluctance to continue to accept poor quality waste). Further supports can be provided through innovation and regulations for the redesign of some items to facilitate reuse and recycling by minimising the combination of different types or plastics, additives or other materials included within a single product.

6.2 The components of an integrated strategy

6.2.1 Awareness and public engagement

Awareness at the coast

Various surveys have been undertaken which demonstrate high public concern with marine litter. Nevertheless, even when beside the sea, many people's behaviour displays little awareness of the severity of the situation. More proactive measures are needed to prevent items from becoming litter once people find themselves in exposed places where bins may not be at hand. Many, if not most, of the items at risk of becoming marine litter in these locations are single-use. Cigarette stubs, drink bottles and caps, food containers, crisp packets and cutlery are all amongst the top five items likely to be found in beach litter collections. People may assume that these are small items have an insignificant impact when, in fact, their contribution can be very damaging. As remarked at the outset to this report, it is possible that many people presume marine litter to be an aesthetic problem, akin to street litter, without knowledge of its particular impacts, especially for wildlife.

Blue Flag beaches are already required to have signage and information on marine litter, but this tends to be more advisory than graphic. Images of injuries sustained by wildlife is an approach that could have a significant impact. While it is unfortunate that so many awareness campaigns now use graphic images (e.g. anti-smoking campaigns, road safety, etc.), the evidence demonstrates that such images are effective in influencing behaviour [83].

Beach clean-ups and campaigns, such as those organised by Clean Coasts, collect large amounts of beach litter each year at locations where this problem is especially visible. These collections can only have a marginal impact on the amount of marine litter, but they do have an influence on awareness, particularly when local people, holidaymakers and children are encouraged to become involved. Awareness raising and environmental education for children can also be undertaken through schools and community events, instilling a lifelong sense of responsible behaviour with regard to litter.

The erection of information signage at beaches, especially if combined with the visible presence of waste bins, can have strong influence on behaviour. Awareness campaigns may be amongst just a few principal approaches available to deal with such items as cigarette stubs, crisp packets, bottle caps, food packaging and cutlery, many of which are discarded

at the beach and away from recycling opportunities which may, in any case, be limited for some of these items. Continued support for beach litter collections provides for public participation and publicity which can be combined with environmental education initiatives to make people aware of the impact of small items of litter, including the problem of crisp packets and drinks bottles discarded by children.

General awareness at national level

Away from coastal locations, general littering in the towns and countryside still contributes to marine litter. There are items that have a high prospect of becoming marine litter, such as the release of balloons or the careless disposal of crisp packets. It is unlikely that people will have considered the risk of many of these single-use items finding their way to the marine environment. For example, it would appear that many people do not consider dropping cigarette stubs as littering [84]. Awareness campaigns can make people aware of this connection and so help to bring about a change in behaviour.

Related public awareness campaigns such as *Think Before You Flush* and the UK campaign *Bag it, Bin it* can make a difference to public awareness and have relevance to marine litter there are pathways such as waste water networks or rivers. Away from the beach, there are several examples of campaigns to raise awareness of the impact - and potential value - of single-use items, including those with a high likelihood of becoming marine litter. For example, the *Blue Lid Campaign* in Turkey was highly successful at collecting 500 tonnes of bottle caps and between 2010 and 2013, raised funds for 2,000 wheelchair purchases. Similarly, there is the example of the France Cancer's *Bouchondamour* bottle top campaign referenced in Chapter 3. In the UK, major retailers were encouraged to have their cotton buds products endorsed by a national campaign with the result that the prevalence of these items in beach litter fell markedly.[85]

However, awareness does not stop at the consumer, but applies to all stakeholders in the product chain. The EU FP7 MARLISCO Project found that a variety of actions can be effective in raising awareness, but that a mixture of approaches is ideally needed to bring about changes in behaviour and that this mixture should apply at all stages, not just at the beachfront, but include preventative measures to be adopted by all stakeholders.[86] Consequently, awareness requires state-sponsored actions to create a sense of co-responsibility among of all stakeholders including consumers (including children), retailers, producers and local councils and councillors. In the MARLISCO project, this involved the establishment of a National Marine Litter Forum which also offered an opportunity for participants to propose solutions.

Support wider awareness campaigns, and anti-litter campaigns, especially where these address single-use items which have a high prospect of becoming marine litter, but which could be overlooked, in particular items such as bottles and bottle caps, crisp packets, sanitary products and balloons. Encourage stakeholder participation with the issue of marine litter to create a sense of co-responsibility and to obtain corporate support and sponsorship as part of extended producer responsibility and in lieu of possible regulation.

Engagement with communities

Local communities can also be part of the solution. If local people become informed of the impact of marine litter, then local pride can be engendered, complemented by wider campaigns to improve beach and water quality such as the Green Flag Awards or the international Blue Flag campaign. The former is particularly suitable for communities in more rural areas as it engages local enthusiasm in locations that lack the facilities for regular litter collection. Information on litter and local initiatives can be included on portals such as www.beaches.ie. This site is sponsored by local authorities in

Ireland, the Environmental Protection Agency (EPA) and the relevant ministry, the Department of Housing, Planning and Local Government. It provides tourists with information on beaches and local activities, but also on beach quality along with advice from information campaigns. As there are potential impacts on the local tourism economy due to excessive beach litter, it should also be possible to get tourism agencies and local businesses involved, directly, or indirectly through support for campaigns or funding. Local groups may also get involved in regular beach cleaning, helping to maintain continual awareness of the issue. Once key members of local communities can be engaged in efforts to address beach litter, an element of behavioural *nudging* can occur whereby the easy option of littering becomes unthinkable and social norms favour responsible behaviour and sustainable practice. Some degree of self-policing can follow, including during hot weather when beaches can be used by larger numbers of visitors.

Engage coastal communities, building on civic pride and existing local neighbourhood initiatives, to include actions on beach litter in their activities and publicity. Appeals to civic responsibility can reduce litter such as cigarette stubs and food items, and encourage fast food outlets to take responsibility for beach litter.

Engagement with local interest groups

Likewise, various interest groups have a direct interest in reducing marine litter, including swimmers, surfers, scuba divers, and birdwatchers. Businesses, especially ecotourism businesses, benefit directly and indirectly from these activities. Interest groups have been very successful in attracting the attention of the wider public through campaigns such as *Surfers Against Sewage* (with its focus including sanitary items) and *No Butts on the Beach*.

Citizen science can contribute too. Phone apps that allow people with a keen interest in the natural environment to report and photograph the location of significant amounts of litter, dumping or large items, and can provide valuable of information, especially if combined with efforts by the relevant authority to collect this litter.

Engaging with local interest groups can draw attention to the hazards or impact associated with such items as sanitary products, plastic bags or cigarette stubs. Examine potential for use of phone apps to further engage citizens with solutions to marine litter.

Labelling

More information on the impact of marine litter and the benefits of recycling is needed generally. Information need to be legislated to appear on the labels of single-use products to encourage at least the product's proper disposal or recycling. At present, when compared with nutritional information, there is remarkably little disposal or recycling information to be found on the labels of consumer products. To improve the prospect of recycling, labelling should also refer to the benefits of emptying of contents, washing and the sorting of separate items. It is possible that many consumers are not aware of the importance of returning clean items and most are probably not aware of the value of separating bottle tops from the bottles themselves. There is also no information in most OSPAR countries on how to dispose of such items properly or of the potential damage that single-use items can create in the marine environment.

Furthermore, non-generic symbols are often present on packaging which fail to provide a consistent message at a level that can be understood by consumers. Indeed, it is common for products to fail to specify the type of material used in product packaging or their true potential for recycling. For plastics, this includes a frequent absence of information on the different types of polymers present.

Provide information on environmental and health impacts on the labelling of items such as sanitary products, balloons or plastic bags where consumers are unlikely to have considered the potential impact on marine life. Move towards a uniform level of required information across the EU and internationally on the benefit of the cleaning, sorting and recycling of single-use items such as drinks and milk bottles, and food packaging. Include symbols and information on the recyclability of all products, including the different polymers present in plastic litter so as to raise consumer awareness and facilitate recycling by both consumers and waste processors.

6.2.2 Green procurement, local and national product bans

Green public procurement (GPP)

As the public sector is a major contributor to the economy and a purchaser of numerous wide-ranging products, GPP can make a significant difference to the production of more environmentally-friendly products. While GPP covers multiple products and services, it can make a difference to uptake of single-use products and could have a distinct impact on marine litter where implemented by local authorities with coastlines.

Although focused largely on more durable items and services, the scale of public procurement means that GPP can stimulate manufacturers to produce more recyclable products. Implementation of GPP in jurisdictions with coastlines could itself have an impact on marine litter.

Product bans

Bans on particular products are amongst measures that can have the most impact on marine litter (Arcadis, 2013). Plastic bags have a high risk of becoming marine litter as they are ubiquitous and provoke throw-away behaviour. They are lightweight and easily caught by the wind. Consequently, bans have been instigated by several coastal cities in the United States and at national level, for example, by France (see Chapter 5). Bans have also been applied to plastic cups and cutlery, again at local level (Seattle) and at national level too (France again). Levies/taxes and voluntary agreements with retailers are the alternative means available to reduce consumption of these single-use products and have been adopted by several EU states. Where taxes or levies on plastic bags have been introduced in EU states they have dramatically reduced consumption, for example to 4 bags per year in Denmark and Finland (see Section 5.3.2).

Product bans can be considered, particularly in local coastal areas to address potential items of litter that have a high impact on the marine environment, including wildlife. This is already occurring for plastic bags, cutlery and balloons.

6.2.3 Disposal and waste infrastructure

Bins

In the UK, most littering (41%) is attributed to pedestrians, but 19% is due to motorists, 10% to retail, 6% to leisure locations and 6% to gathering points.[31] Surveys reveal that cigarette filters account for 55% of the total street litter and packaging for 12%. Both items feature highly in counts of beach

[31] www.dccae.ie/en-.ie/topics/waste/litter

litter. Littering is an offence, punishable by fines. Fines can be conceived as a form of economic instrument and apply to all littering, though in practice they are most likely to be implemented in response to clear disregard demonstrated by significant littering in sensitive environments or to dumping.

In the UK, the cost of litter, including its removal, has been estimated at £1 billion per year. Given these costs, producer responsibility should be extended at least to food outlets in coastal towns who should be required to at least maintain litter facilities and perhaps a physical or financial contribution to the cost of removal of litter included in their operating license requirements.

Disposal bins, although an obvious measure, are absent from many locations, including beaches. All local authorities, especially coastal and riverside towns, should be required to have a minimum density of bins relative to the number of local residents or visitors, with these ideally being labelled for different recycling routes. These can be located at key littering hotspots such as toilet blocks and food stalls. Efficiencies can be achieved by fitting bins with sensors to record how full they are, reducing the risk that bins will overflow. Outside of urban seafronts, there is a risk that bins could be deliberately used to dump household waste that would otherwise incur a charge and could over flow if not emptied regularly. Similarly, the visibility of bins or beach cleaning could cause visitors to be less responsible about their litter if they think somebody else will pick it up. On the other hand, the presence of facilities means that it is at least as likely that people will be encouraged to behave responsibly. While the siting of bins is important, it remains secondary to the need to engender personal responsibility.

Local authorities, especially those in coastal area, should have a litter management plan that can be monitored and evaluated on a regular basis. There should be a minimum density of bins relative to population and the number of visitors, and these can be very useful for collecting litter discarded at the beach such as food packaging, plastic bags and bottles. Pro-active measures, backed by significant fines, should be used to combat dumping. Producer responsibility can be extended to food outlets, especially those in coastal areas.

Management of landfill and waste processing

High quality collection of waste and management of landfill is necessary to reduce leakage of litter to the environment. Good separation of recyclables for processing will provide the basis for functioning secondary markets for recyclables, and for plastics in particular, and is addressed below. However, implementation of regional waste management plans or operation of large modern facilities can improve efficiencies across the board, not only by separating out recyclable items, but by also ensuring the safe containment of waste without risk of fly-blown waste entering the natural environment. Good waste management can also reduce the environmental risk from hazardous waste. Landfill levies can be increased over time to raise the relative value of recyclable materials. Potentially, some materials with a high recyclable capacity could also be subject to higher levies or banned altogether.

Modern well-managed waste collection and landfill sites represent the hub for alternative destinations for discarded materials, including recyclables. They provide the basis for subsequent stages of the circular economy and minimise the threat of leakage, including the loss of items such as plastic bags, bottles, light or small items that can be carried by water or wind into the marine environment.

6.2.4 Water and Wastewater treatment

Rivers as a pathway

Recent research estimates that up to 4 million tonnes of marine litter is transported by rivers. While the range and uncertainty is again considerable, it is argued that 88%-95% of this litter comes from just ten rivers, mostly in South and East Asia. Closer to home, research in Portugal has demonstrated that much beach litter is washed up in the vicinity of rivers where industry or major settlements are upstream.[23] This litter includes single-use items deposited as litter on streets or in the countryside from which it is swept into drains and rivers. However, this problem is not being specifically addressed through targets for EU member states. The Water Framework Directive does not currently address this problem or include litter in its definitions of good environmental status.

Potentially, booms can be extended across rivers to collect floating debris. This would have a significant effect on marine litter, but would also be problematic due to the rapid build-up of natural debris and so require frequent maintenance and removal. Booms might need to be withdrawn during flood events when the problem of litter is greatest. As with beach litter, measures are likely to be more effective if they address the sources of litter and human behaviour rather than pathways or end destinations. Nevertheless, there could be a case for targeting the litter discharge from particular problematic rivers. For example, Rijkswaterstraat in the Netherlands is currently working with Plastics Europe to address the problem of floating litter on the River Maas.

The use of booms should be contemplated across the lower sections of rivers where these can collect significant quantities of buoyant litter such as drinks bottles before they enter the marine environment, but should be capable of regular clearance.

Wastewater treatment

Inadequate water treatment facilities are part of the problem. The Water Framework Directive and the Urban Waste Water Treatment Directive aim to ensure that waste water is treated to a level as to allow surface and groundwaters to achieve 'good environmental status'. Litter is not specifically addressed in the Directives, but can be largely managed through measures applicable to the treatment of waste water generally.

Water borne litter, including items of risk to the environment and public health such as bottles and sanitary products, should be included within the definitions of 'good status' used by the Water Framework Directive. Continued investment in wastewater infrastructure is needed to remove sanitary items, to reduce the exchange between wastewater and drainage systems, and to allow storage of water following storms. This would reduce the risk of items such as sanitary products and light street debris such as crisp packets, bottles, caps and food cartons entering rivers.

6.2.5 Waste reduction, product substitution or redesign

Waste reduction

Waste reduction appears first on the waste hierarchy and could, itself, resolve many of the impacts that pertain to waste management, litter and marine litter. Plastic containers for household cleaning products often turn up as marine litter. Use may not be once-off, but is not sustained beyond a handful of occasions. Liquid products, as opposed to traditional powdered products, are largely comprised of water, producing unnecessary waste, adding to transport costs and the wastewater stream. Manufacturers benefit from product differentiation and by raising prices relative to product performance. However, progress also requires consumers to embrace the concepts of waste

reduction and re-use. The allure of convenience is strong, but there are positive signs as with the example of the popularity of reusable coffee cups. Promoting waste awareness and more sustainable life-styles can help achieve waste minimisation in the household.

Ultimately, waste reduction can be achieved through changes in behaviour towards more sustainable, less consumerist lifestyles. This behavioural change will take time to achieve, but needs to be supported by product offerings that are not reliant on single-use consumption. Moves towards the circular economy will contribute to the achievement of both aims.

Product resign - Environmental impact

Plastic has become the packaging of choice due to cost, weight, strength and versatility. These are all positive features, but substitute materials such as paper or board, though still common in beach litter counts, are clearly less durable and have a much lower environmental impact. Some critical aspects of product design are needed to remove additives, including glues and colourants, that could be harmful to either human beings or marine life. Single-use products should involve the use of water soluble adhesives and omit direct printing onto the product.

Under the precautionary principle these innovations are needed to eliminate potential risks even if these are not proven. Re-design is also needed to reduce the prospect of small items of plastic associated with packaging becoming detached, for example bottle tops and collars, finger pulls or packet rips. These small items present a particular risk of ingestion by birds and other marine animals. In fact, some of these product designs have been deliberately introduced by manufacturers to enhance branding differentiation and to realise higher values. Consequently, redesign to remove them, or at least to ensure that they do not become detached, is likely to be resisted, but should be supported by differentiating the cost of EPR to reflect products' respective environmental impact.

As a minimum to reduce the hazard to human health and the risk to marine life, additives or detachable items that present a known or unquantified risk, should be omitted from the production process where there is no undue impact on consumers. Redesign could reduce the incidence of bottle tops or unnecessary packaging in beach litter or the problem of non-degradable cigarette stubs or sanitary products. It should form a part of EPR incentives and obligations.

Enhancing the potential for recycling

Ideally, products need to be designed to minimise waste and to adapt to the needs of the recycling industry to provide sorted, high quality materials. To date, much of the recycling achievement acclaimed by the recycling and packaging industry has coincided with producers' own needs to reduce weight and transport costs. Plastic bottles, for example, today weigh 30% less than in 1993, and steel 15% less. However, these resource savings do not translate into a reduction in marine litter. EPR in many OSPAR states remains peripheral. Much of the recycling undertaken is commercial or business-to-business relying on high quality clean material. The collective costs returned to producers of recycling or disposing of single-use (or other) items found in household or municipal waste have not been sufficient to force them to consider major product resign. This may eventually change as the EU moves towards the circular economy. In principle, there would also be an economic gain for producers as the volume of high quality plastic recycles would be greater and cheaper than raw materials with less price volatility.

High quality sorting combined with modern manufacturing techniques means that it could be possible for most single or multi-layer PET and HDPE to be used as recyclate [39]. At present, this proportion is not being realised due to product designs that contain combinations of materials, some

of which are difficult to recycle or sort. For example, the use of black plastic for the packaging of some food products greatly reduces its value for recycling. Redesign would make a difference here, but incentives are needed for this to be possible, either regulatory or economic. The PPP principle would suggest that producers should be charged relatively more for the collection of composite or coloured plastics

Among products which could be considered for future re-design are plastic drinks bottles and crisp packets. It is already possible to avoid certain combinations such as the use of PVC labels or seals with PET bottles. It should be possible to avoid tops becoming distinct items of litter by making them less detachable from the PET bottles on disposal, but easy to separate at the recycling stage as the two plastics are different. Crisp packets are light and easily windblown. They are also popular with children, a consumer group who can be reached by awareness campaigns, but who are one step removed from decisions on household waste disposal. The beach survey data reveals that single-use crisp packets show up frequently in each sea. Potentially, all crisp packets could be made of recyclable foil or sold in recyclable containers. Cigarette filters are made of either plastic or cellulose materials. The latter do degrade, but slowly. It should in principle be possible to produce filters with a shorter life once in the natural environment.

Products need to be resigned to meet the needs of the waste hierarchy and to increase their potential for re-use or recycling. This requirement especially applies to single-use consumer products. This redesign needs to be supported by regulation, economic instruments and support for innovation. PRO should charge relatively more for the collection of difficult-to-recycle products made of composite or coloured plastics. This will reduce the "leakage" of potentially recyclable products to the natural environment, including the marine environment, and reduce the incidence of small detachable items becoming litter.

Biodegradable materials

Biodegradable materials, specifically plastics, can be problematic as discussed earlier due to the fact that they only degrade in large-scale compost facilities and not the marine environment. They can also contaminate plastic uniformity within the recycling stream. However, while it would not be the preferred solution, there are opportunities for innovation to produce materials that can degrade more safely in the marine environment.

Although biodegradable plastics can be a contaminate when mixed with normal plastics in the recycling stream, there are also opportunities for *closed-loop* recycling where degradable materials can be used with the assurance that these will be composted. For instance, packaging for food and drinks accounts for 65% of packaging production and is closely tied to branding. Strict regulations on food quality mean that large quantities of food must be removed from the shelves upon reaching its sell-buy date, even though quality might be barely impaired for some time afterwards. Sell-buy dates apply to almost all products including beer and frozen products such as ice cream. Various companies now make biodegradable packaging and utensils that can be composted alongside food waste. Under EU Food Waste Regulations, retailers and restaurants are required to separate this waste for composting or anaerobic digestion for land spreading. However, as much of the waste is packaged, this must be removed at a cost, with a high proportion being too contaminated by proximity to food to be recycled. Potentially, it would be possible to mix in biodegradable packaging with food contents for composting or land spreading [59]. Alternatively, the large volumes of hot water produced by anaerobic digestion can be used to clean packaging. The alternative of a ban on food waste has already been demonstrated in France. There would, though, be less assurance of separation of contaminated and clean recyclables from household waste, and no such assurance where brown bins are not available.

More innovation is therefore needed into biodegradable packaging and the means to separate out contaminated materials. The Polymark project (www.polymark.org) is developing sensors to distinguish packaging that might have come into contact with contaminants food or drinks from clean PET to allow for improved sorting.

There are opportunities for more innovation into biodegradable packing that would be truly biodegradable in the marine environment. There is also potential to use biodegradable materials and plastics in closed-loop recycling, for instance by permitting the combination of biodegradable food packaging and food waste for joint composting where, at present, costly separation is needed. This would reduce the leakage of packaging into the natural environment and enhance the economics of recycling. Food packaging, cups, utensils and straws are already common features of beach litter whose prevalence could be reduced if they could be composted, or were required to be composted, along with food waste.

6.2.5 Economic instruments

Deposit-refund systems (DRS)

DRS can be very effective at reducing the quantity of litter than finds its way into the natural environment, including the marine environment. They are also an effective means of supplying relatively clean and sorted plastic for recycling. On average, DRS can achieve 40% reductions in the amount of marine litter represented by glass or plastic bottles. Some careless littering of these items would continue, but recycling relative to products placed on the market can achieve levels of 80%-90%. Consequently, DRS can be amongst the most effective means of reducing marine litter.

Two reservations are placed against DRS, firstly that it can reduce the amount of valuable plastic available for recycling or energy recovery, and secondly that such schemes are expensive to operate. However, DRS can induce a distinct behavioural change towards recycling that is not restricted just to the types of items included in the scheme, so encouraging the availability of more recyclables. Costs are relative and, if a secondary market for plastics can be stimulated, the collection of such material would compensate for the operational costs. Recent research by Eunomia suggests that, in the current environment (in the UK), DRS would pay for itself in most local jurisdictions.

DRS can be very effective at targeting items such as glass or plastic bottles that can become marine litter. DRS also provides good quality recyclables that can stimulate a secondary market for these materials. These economic incentives are popular and can encourage recycling behaviour and even the direct collection of marine litter. Such schemes can also be extended to drink cans and other items of plastic waste such as some other forms of food packaging.

Disincentives: Taxes and levies

Taxes or levies can be applied to reduce or discourage activities that present negative externalities for public welfare. Applications are many, including landfill levies. The most familiar example in EU and OSPAR states has been the levy on plastic bags. Light weight plastic carrier bags are a very common item of marine litter than can travel far and have a significant negative impact on marine life. They are very much a feature of the disposable society and are usually consumed well in excess of need. Largely as a consequence, in each of the countries where a levy has been implemented, consumption of plastic bags has decreased dramatically despite the typically modest size of the levy. Detractors argue that plastic bags are durable and convenient and that their manufacture has a lower demand on resources than more durable bags or paper bags. However, the benefit of levies is

that they do not prevent consumption. It remains possible for a consumer to purchase a bag where needed. A lower level of plastic bag consumption inevitably results in reduced litter, including marine litter.

Taxes and levies can have a distinct impact on behaviour that has adverse social consequences. Use of plastic bags is one example where there is a very definite link with marine litter and negative impacts on marine wildlife. Significant reductions in this impact can be achieved by relatively modest levies.

6.2.6 The Circular Economy

A Plastics Strategy

At least 14% of Municipal Solid Waste by weight is plastic [36]. Consequently, reducing the amount of plastic in consumer products, and in particular plastic packaging, would be a major driving force for marine litter reduction. The European Parliament has called for binding criteria and targets on the plastic recyclability and the management of waste. At the time of writing, the new EU Plastics Strategy was still under discussion. However, statements from the Commission appear to make it unlikely that taxation will be used to discourage the production or consumption of plastics, at least unless targets cannot be met. Rather, the EC wishes to rely first on measures to encourage producers to reconsider the design of their products and to raise awareness.

The Waste Framework Directive already contains possible tools to incentivise reduced plastic use, including the potential for bans on the landfilling of plastic waste, the means to impose standards on waste collection and sorting, and the means to address inefficiencies in collection. At present, though, even when plastics enter the recycling stream, only around one third of material is recycled for subsequent use, much of which is of low value products with poor subsequent recycling potential [39].

Many of these constrains are reinforced by regulatory or legislative barriers, for example:

- Regulatory barriers that discourage the collection and sorting of homogenous plastic waste and which focus on weight or quantity as opposed to quality;
- Legislation that hinders the use of recycled plastics materials due to health and consumer protection concerns and a lack of harmonised packaging quality legislation;
- Lack of enforceable product requirements for reuse, repair or recycling.

There are clear public benefits to achieving a higher value for plastic waste, not least in providing security of supply and reduced greenhouse gas emissions. There are also private economic benefits from the use of secondary raw materials, which by being generally 10-40% cheaper than primary materials, could save over €700 million under an 80% recycling rate [87]. If plastics were to be recycled on a large-scale, there would be a considerable stimulus to recycling companies and employment which, van Barneveld et al (2016) argue, could be ten times more than for that associated with landfill or incineration. In principle, this would provide the economies of scale for a sustainable market for secondary materials, overcoming the current limitation of low prices. Stronger effort at ensuring materials recyclability would also support innovation and jobs in R&D or product redesign.

Mixed or dirty plastics typical of municipal waste receive much lower prices currently receive low prices, if they can be recycled at all. In small OSPAR states it can be difficult to locate a potential manufacturer willing to take inferior recyclables or a large enough market to sell onto. Nevertheless,

even clean, clear PET is sold as “baled” recycled plastic at low prices of around €150 tonne. Plastic bottle tops, typically foamed polystyrene or polypropylene, and often multicoloured, have almost no value. For most secondary plastics to have a market that rewards sorting and cleaning will also require measures to force manufacturers to accept a proportion of recyclates.

An improved availability of consistent sorted and clean plastic material would provide greater volumes for plastic re-use, and greater demand and higher secondary market prices for plastic recyclates. This, in turn, would provide the basis for incentives to consumers and businesses to take greater care in sorting and cleaning plastic waste. However, demand also needs to be stimulated by requiring manufacturers to use a proportion of recyclates. If plastic waste becomes more valuable to both processors and consumers, this will discourage littering and leakage and therefore the prospect of such materials finding their way into the marine environment.

Moves towards a full Circular Economy

Currently, a lack of standards has led to a proliferation of the use of various plastic types and additives in products whose varied design and composition makes it difficult to recycle products into relatively pure materials that can be reformulated into higher value products. The result has been a “fragmentation” of products along with labelling and recycling processes. Although there are some existing standards for plastics, e.g. WRAP (worldwide responsible accredited production), these are used mainly for plastics used in potentially hazardous circumstances as with the aviation industry, these standards are not universal.

The Ellen McArthur Foundation [39] lists the following objectives to achieve what it describes as the “New Plastics Economy”:

1. Large reductions in losses to natural systems from littering, poor waste collection and management;
2. Steering materials innovation towards products that do not have a negative environmental impact, including so-called “bio-benign packaging”;
3. An increase in the adoption of reusable packaging;
4. An increase in the adoption of compostable plastic materials for targeted closed loop systems;
5. An increase in the economics, quality and uptake of recycling by encouraging a convergence of the types of materials used, improved collection and sorting, and the development of secondary markets of value based on an after-use economy for recycled products;

Relevant supporting measures include

- common and meaningful labelling,
- universal design standards, and
- a phasing out of product design of small elements of packaging such as pouch tear-offs that add to sorting costs and are easily lost to the wider environment.

The economic benefits for Europe have been estimated at €1.8 trillion once the external costs presented by greenhouse gas emissions and litter are included.[88] Policy makers can make a considerable difference by defining standards, by requiring that a proportion of plastic recyclate is used I production, by stimulating the emergence of profitable markets for secondary materials or products, and by supporting innovation.

Advances in each of the numbered areas would contribute to reductions in single-use marine litter. Points 1 and 2 above would do so directly by reducing littering, leakage and the associated impacts. Points 3 and 4, while applicable to waste and litter in all environments, address some forms of packaging that are at particular risk of becoming marine litter. Point 5 would function at the higher level of waste management practice generally, but is the most important in that it will place a higher value on recyclable materials, providing an incentive for proper treatment and sorting by consumers, industry and processors, reducing the amount of waste produced and the associated risk of leakage from collection systems and the impact on the natural environment.

7. A STRATEGY FOR REDUCING SINGLE-USE ITEMS OF MARINE LITTER

There are three principal influences on the amount and composition of marine litter and our ability to reduce this serious environmental problem, namely the ubiquity of items designed for single-use, people's propensity to litter, and leakage from systems of waste management. Each is a consequence of aspects of human behaviour and so responds to our ability to influence this behaviour.

In the first instance, it must be acknowledged that our ability to influence the quantity of marine litter to be found in the OSPAR region is inevitably constrained by whatever is happening in other parts of the world. The world's oceans are a common resource and it is well known that a tremendous volume of litter is entering the ocean in East and South-East Asia as well as from parts of Africa and the Caribbean. However, this does not exclude us from our own responsibilities to clean seas. Furthermore, there is increasing awareness of the problem at international level and a growing determination to address the problem. The realisation that plastic waste of all sorts represents the largest proportion of marine litter and that this plastic can eventually be ground down into small or micro particles has transformed perceptions of the problem into an issue of global concern akin to climate change and ocean acidification. It raises the prospect of this waste being transported long distances and the possibility that it could have a serious impact on biodiversity, global food chains and potentially human health.

The North East Atlantic is a long way from the Pacific Ocean, the Indian Ocean or the Caribbean and it is evident from the composition of beach litter found in the OSPAR region that regional sources make the greater contribution. There are two principal regional sources, namely the fishing sector (and to a lesser extent the marine transportation sector), and terrestrial sources. Of the former, there is clearly much that still needs to done to reduce the quantity of material and fishing gear lost or discarded overboard, some of which can have a significant detrimental impact on wildlife. Of litter deriving from terrestrial sources, much arises from coastal areas and most is small is size and lighter in weight than that from the fishing sector. The vast majority of this terrestrial litter is comprised of the single-use consumer items which are the focus of this report, much of which is packaging and most of which is plastic in composition. The nature and durability of this plastic litter means that it can have a very serious impact on wildlife as is evident from its ingestion by sea birds and mammals. It is unsightly and so presents a significant impact on the welfare of coastal users, the tourist industry and coastal communities. It also presents a potentially serious threat to human health.

The solutions are multiple as discussed in Chapter 6, but are all related to one another so that the only realistic and practical way forward is an integrated strategy that addresses consumer behaviour, littering and waste management.

Increased awareness is one goal of an integrated strategy. At present, marine litter is not being perceived by everybody as a major problem. Much litter derives simply from materials that have been carelessly discarded, mostly single-use items such as food containers, drinks bottles and tops, crisp packets and cigarette ends, a good proportion of which is frequently left at the beach. Raised awareness can be achieved by making people conscious of the link between general litter and marine litter and of the particular environmental problems that marine litter presents. Awareness can be raised through beach signage, publicity campaigns and events such as beach clean-ups. Campaigns on cigarette stubs and the correct disposal of sanitary items have had some success in achieving reductions in the prevalence of these particular items.

While using awareness strategies to change human behaviour is not without its challenges, there are positive interactions with parallel efforts to encourage reductions in the use of consumer products, re-use and recycling. These habits appeal to people's sense of responsibility to each other and to sustainability, whereas avoidance of littering provides positive feedback to quality of life, a desire for clean environment and a sense of stewardship for wild areas and wildlife.

Fundamentally, there is the issue of the attraction of single-use items themselves. It has become the norm for us to purchase food, drinks and other products in these containers. They are light weight, hygienic and convenient. Behavioural change is now needed to achieve reductions in demand for single-use packaging combined with the re-use of containers and materials. The popularity of reusable cups is a positive development. It is a small step of course. It will not be easy to direct behaviour more generally away from our reliance on single-use products in what has become a feature of the "throw-away society". However, it is a step can be nurtured into a more pervasive and acceptable culture of re-use. Changes in behaviour can be further stimulated through the use of economic instruments such as levies on the use of plastic bags or other single-use items that confront people with some of the external costs of litter and marine litter. Incentive schemes such as deposit return systems (DRS), can achieve some of the same, providing also for a relatively pure supply of recyclable materials. Parallel pressure can be placed on manufacturers to support such habits through the supply of refillable containers, etc.

Increased awareness can be complemented though local initiatives that include making communities conscious of the link between beach litter, tourism and local economic development, by engaging these communities directly with initiatives to address the problem and by encouraging a degree of self-policing. One solution is amongst the most obvious, namely of providing a sufficient number of bins for litter disposal. Although obvious, it is surprising how few coastal communities and resorts in some OSPAR member states have an adequate infrastructure for disposal. Given the common property nature of the problem, there could be an argument for making the relevant authorities liable for their failure to provide this infrastructure. If this is not feasible, then local communities should be supported in their efforts to pressure local authorities to provide adequate facilities. Local bans or campaigns against the local use of certain problem products such as single use cups, cutlery, picnic items, plastic straws and balloons in coastal areas can make a difference. There is a connection with wider re-use and recycling efforts where this community engagement influences public authorities to adopt green procurement initiatives.

An overhaul of the waste management infrastructure has a more strategic and less direct influence on the amount of marine litter, but is nevertheless fundamental to reducing the problem. Improvements are already being driven by the EU Waste Framework Directive. In particular, improvements have occurred in the handling and disposal of waste and to the management and siting of landfills. Increasingly, measures are being implemented to incentivise the sorting of material for recycling. To date, the quality of much of the recycled raw material available has been insufficient in some OSPAR states to create a domestic industry to process recycled products, particularly plastics, despite the prices that can be achieved by good quality recyclates. This situation may begin to change following the closure of the East Asian market for poor quality recyclables. In addition, the EU's new Plastics Strategy, along with measures to move towards a *circular economy*, articulated in terms of higher recycling targets and supported by extensions of producer responsibility and innovations in materials reuse and recycling, could yet embed the waste hierarchy and stimulate a market for secondary materials. The key objective here is to achieve a marketable value for the re-use and recycling of the materials currently used for single-use products, providing an incentive for both consumers and producers to re-use or return materials, and so reducing the likelihood that such items ever become litter or marine litter.

The circular economy will take many years and much political determination to achieve. However, in the short term, there are some initiatives that could be taken which would have an impact on the volume and

composition of marine litter. These include much improved information on the labelling of single-use items to communicate the importance of correct disposal by describing the environmental impact of marine litter. This should be combined with unambiguous information on materials composition and recycling potential for both consumers and waste management companies. There is also a need to pursue more sustainable product design with manufacturers to increase the potential for recycling, for example through the use of:

- recyclable containers for products such as crisps or other snacks,
- cardboard, or otherwise more biodegradable, non-plastic materials for products such as cigarette filters or sanitary items, e.g. cotton buds,
- biodegradable labels and glues,
- uniform materials and plastics within a single product, and
- to avoid plastic types or black or coloured plastics that have poor reuse/recycling value.

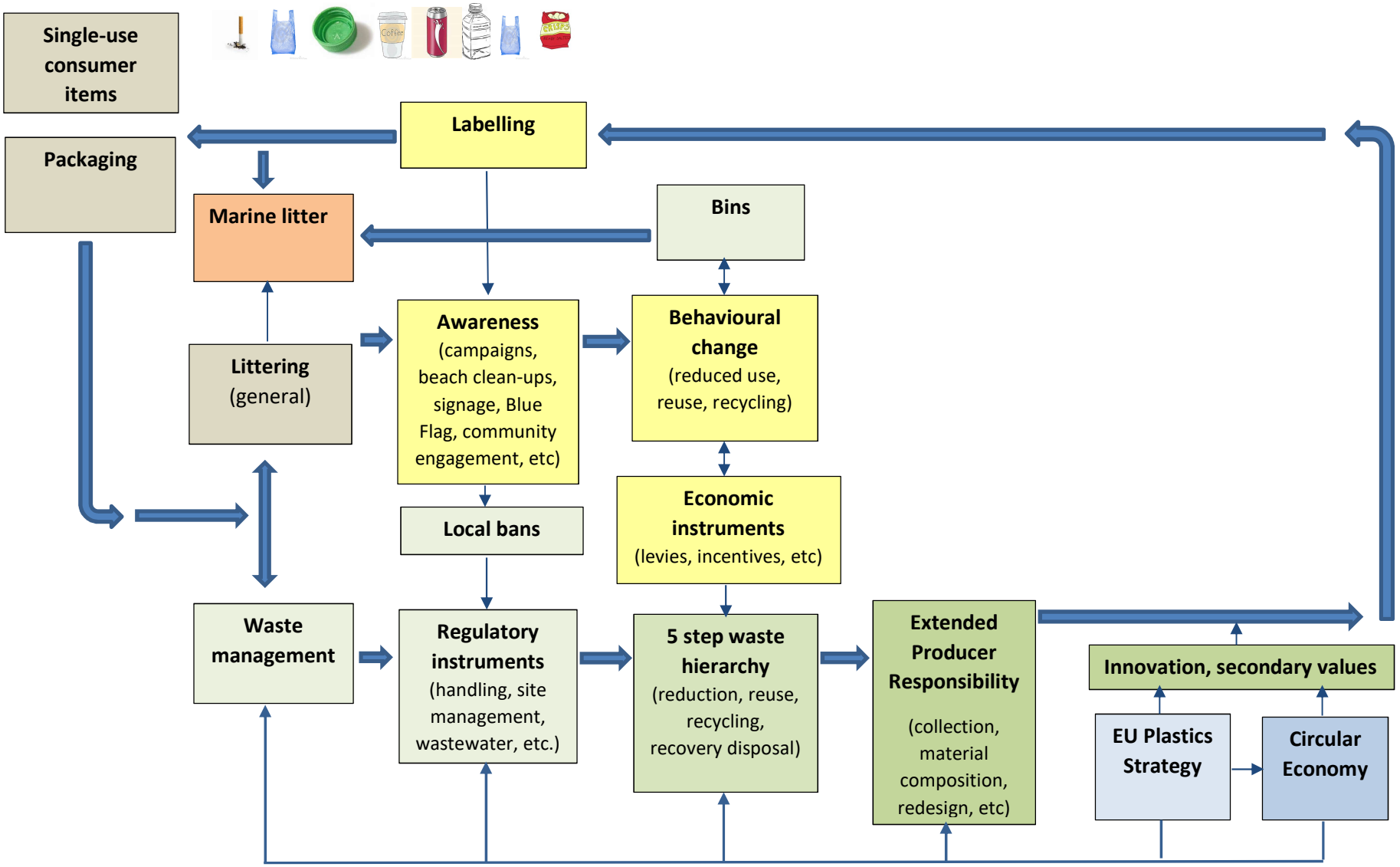
Product redesign should extend to the environmental impact of marine litter by, for example, ensuring that bottle tops and collars can only be easily separated during the waste management process. At present, small items such as bottle tops appear very high on the list of items counted from beach surveys. Further research into the quantification of these externality and environmental costs is needed. This information can be used to support extended producer responsibility by confronting targeted producers directly with levies that account for the relative environmental cost of the current design and material composition of the single-use items they produce.

Investment is also needed in waste water management to reduce the risk that single-use, and especially sanitary items, do not find their way from wastewater networks and treatment plants into watercourses and to the sea. Fortunately, these investments have been prioritised and are being made in Europe under the Water Framework Directive and so the situation should improve. However, it could be some years yet until storm water is adequately contained and managed to remove this litter risk.

Some hopes had been attached to use of biodegradable plastics until it was realised that this decomposition could only be achieved under controlled conditions without which these plastics would be at equal risk of eventually becoming marine litter, including microparticles. However, there remains some potential for the use of closed loop systems to achieve biodegradability, including of material combinations that could otherwise be difficult to recycle, including food packaging, an item type that appears high on the list of litter from beach collections. As its other areas of waste management, innovation in biodegradable materials and in waste processing could potentially be an important factor.

Each step in this **integrated strategy** reinforces the preceding one. These interactions are captured by Figure 7.1. There is, for instance, an interaction between measures that raise awareness of the benefits of re-use and recycling and those that raise awareness of the problem of litter. Messages designed to encourage recycling assist with the retention, sorting and management of waste, while giving value to recycled materials and reducing the prospect of litter. Raising awareness of the environmental problem of litter, and specifically marine litter, at individual and community level, contributes to changes in behaviour and local policies that benefit reuse and recycling.

Figure 7.1 An integrated strategy to address marine litter



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