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Preliminary Research to Assess the Impacts of a Ban or Restrictions in Sale in Wales of Items in the EU's Single Use Plastics Directive

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Glossary

Term	Definition
BBIA	Bio-based and Biodegradable Industries Association
Biodegradable plastic	A plastic capable of undergoing physical, biological decomposition, such that it ultimately decomposes into carbon dioxide (CO2), biomass and water, and is, in accordance with European standards for packaging, recoverable through composting and anaerobic digestion (definition source: EU SUP Directive)
BSDA	British Soft Drinks Association
CEN	European Committee for Standardisation
Defra	Department for Environmental, Food and Rural Affairs
DRS	Deposit Return Scheme
ECHA	European Chemicals Agency
EPR	Extended producer responsibility
EPS/XPS	Expanded / extruded polystyrene
Global warming potential	A measure of how much heat a greenhouse gas traps in the atmosphere up to a specific time horizon, relative to carbon dioxide
HDPE	High-density polyethylene (a plastic polymer)
LCA	Life cycle analysis
LEAMS	Local Environmental Audit and Management System
Masterbatch	A mixture of additives and chemicals, unique to the manufacturer, that gives the final product certain desired properties (flame-retardant, oxo-degradable, etc)
MCS	Marine Conservation Society
MLAP	Marine Litter Action Plan
MU	Multi-use (as opposed to single-use)
NOAA	National Oceanic and Atmospheric Association (USA)
n.d.	No date –used for references without a publication date
ONS	Office for National Statistics
Oxo-degradable plastic	Plastic materials that include additives which, through oxidation, lead to the fragmentation of the plastic material into micro-fragments or to chemical decomposition (definition source: EU SUP Directive)
PE	Polyethylene (a plastic polymer)

Term	Definition
PET	Polyethylene terephthalate (a plastic polymer)
PLA	Polylactic Acid (a plastic polymer)
Plastic	A material consisting of a polymer…to which additives or other substances may have been added, and which can function as a main structural component of final products, with the exception of natural polymers that have not been chemically modified (definition source: EU SUP Directive)
PP	Polypropylene (a plastic polymer)
Problematic and unnecessary plastic	Single-use plastic items where consumption could be avoided through elimination, reuse or replacement and items that, post-consumption, commonly do not enter recycling and composting systems, or where they do, are not recycled due to their format, composition or size (definition source: WRAP)
SGMA	Sol-Gel Coatings & Advanced Materials
Single-use plastic product	A product that is made wholly or partly from plastic and that is not conceived, designed or placed on the market to accomplish, within its life span, multiple trips or rotations by being returned to a producer for refill or re-used for the same purpose for which it was conceived (definition source: EU SUP Directive)
SME	Small and medium-sized enterprises
SUNP	Single-use non-plastic alternative
SUP	Single-use plastic
VAT	Value added tax
WRAP	Waste and Resources Action Programme

1. Introduction

Policy and research context

1.1 The EU's Single-use Plastics (SUP) Directive (European Commission, 2019), adopted by the European Parliament on 5 June 2019, sets out the environmental impacts of SUPs and fishing gear and measures for Member States to reduce their impact. The SUP Directive notes that in the EU 80 to 85 % of marine litter, measured in beach litter counts, is plastic, with SUP items representing 50 % and fishing-related items representing 27 % of the total (see paragraph 5 of EU SUP Directive). Specific products are targeted in the Directive, largely based on their prevalence in beach litter surveys (these products are among the 10 SUP products most often found on Europe's beaches and seas), as well as lost and abandoned fishing gear. A summary of the products and measures outlined in the Directive is shown in Table **1**.1.

1.2 One of the measures (Article 5 in the Directive) is a restriction on placing certain SUPs items on the market, stating that “Member States shall prohibit the placing on the market of the products listed in Part B of the Directive’s Annex and of products made from oxo-degradable plastic”. This effectively forms a ban on the import and sale of these products. The SUP Directive Annex Part B lists nine categories of SUP products earmarked for prohibition from the market, all of which are consumer products or packaging which have readily available non-plastic alternatives. Fishing gear, carrier bags and other products covered in the SUP Directive but not subject to a ban are out of scope of this review.

Table 1.1. Products and measures in the EU SUP Directive

	Market restriction	Consumption reduction	Extended producer responsibility	Product design requirement	Marking requirements	Separate collection	Awareness raising measures	Product innovation
Cotton bud sticks	●							
Cutlery, plates, straws, stirrers	●							
Balloon sticks	●							
EPS beverage containers and cups (including caps, covers & lids); and EPS food containers	●							
Oxo-degradable plastic products	●							
Food containers		●	●				●	
Beverage cups (including covers & lids)		●	●		●		●	
Beverage containers and their caps & lids			●	●		●	●	
Flexible food packets and wrappers			●				●	
Wet wipes			●		●		●	
Menstrual / sanitary products					●		●	
Balloons			●				●	
Tobacco product filters			●		●		●	●
Fishing gear			●				●	
Carrier bags			●				●	

1.3 Table **1**.1 shows that the ban covers the majority of products for which there is a readily available non-plastic alternative. For other products other measures are proposed, such as extended producer responsibility (EPR), product design and marking requirements (i.e. labelling on the packaging or the product itself).[1]

1.4 The ban is not specifically targeted to address other key issues commonly discussed around plastics and single-use such as waste reduction, low recycling rates, poor quality recycling (downcycling), climate change, and illegal waste exports. It is important to consider these issues and other potential impacts of a ban to identify opportunities and unintended consequences, but it is out of the scope of this research to look at measures that would reduce overall use of the items covered by the Directive.

1.5 The Welsh Government is considering a ban that prohibits placing these products on the market in Wales, in alignment with the SUP Directive, or a restriction in sale of these products with exemptions and conditions for specific points of sale, such as via a pharmacy to cater for specific groups. The proposed ban or restriction in sale also relates to the wider policy context in Wales and the UK, as described in the following sections.

Welsh policy context

1.6 In 2017, the Welsh Government developed a Marine Litter Action Plan for Wales (MLAP) and this encourages all sectors in Wales to act on marine litter issues through the 'Clean Seas Wales Partnership' (Business Wales, 2018). The MLAP is strongly aligned to the principles of the Wellbeing of Future Generations Act[2].

1.7 The Wellbeing of Future Generations Act provides the context in which the Welsh Government and the public sector works by setting out seven goals to ensuring the wellbeing of future generations. This Act gives a legally binding common purpose for all public bodies in Wales. Under the 'Journey to a Globally Responsible Wales', topic 4 (using "Our fair share of natural resources") specifically lists adopting a SUP-free policy as an example to accomplishing this priority. Within this, Marine litter can

[1] More details regarding the nature of the 'non-ban' measures set out in the SUP Directive are summarised at https://zerowasteeurope.eu/wp-content/uploads/2019/05/ZWE_Unfolding-the-SUP-directive.pdf

[2] Shared Purpose: Shared Future Statutory guidance on the Well-being of Future Generations (Wales) Act 2015

be considered an issue of global responsibility, not least because litter can be carried great distances on ocean currents and wash up far from its origin, as evidenced by the Pacific garbage patch (National Geographic, 2020). Action is, therefore, required by Wales and other nations to tackle the issue in a comprehensive manner.

1.8 Within this context, legislative measures targeting SUPs have already been taken by the Welsh Government. For instance, in 2011 Wales was the first UK nation to introduce a 5p charge for single-use supermarket carrier bags to restrict their use. Bans for microplastics beads in wash-off personal care products have recently come into force and other measures for reducing single-use products are being considered across Wales.

1.9 Wales has also jointly consulted with the UK Government and other devolved administrations on reforms to the packaging regime, including reforms to the "Extended Producer Responsibility" scheme and a Deposit Return Scheme (DRS)[3]. Other measures include a tax on plastic packaging with less than 30% recycled content, as well as a new litter programme, "Wales Litter Prevention Plan" which will draw upon the expertise and knowledge of a wide range of sectors to identify long lasting, sustainable solutions to littering (Welsh Government, 2019).

1.10 Finally, the Welsh Government has a longstanding commitment to achieve zero waste by 2050 and has invested heavily in the collection of materials, including plastic, from every household in the country, leading to globally recognised rates of recycling. In December 2019, it launched a consultation on a new circular economy strategy – Beyond Recycling. The consultation includes a significant focus on plastic, including an ambition to see a Wales free from unnecessary, single use and problematic plastics. Specifically, there is a proposal to phase out SUP, which will see Wales become the first country to send zero plastic to landfill. It also proposes game-changing reforms including introducing Extended Producer Responsibility for

[3] Consumer research to inform the design of an effective deposit return scheme

packaging and a Deposit Return Scheme for drinks containers. The Welsh Government will publish the final strategy later in 2020.

Policy and voluntary industry agreements across the UK

1.11 The UK Government's 25 year Plan (HM Government 2018a) and Resources and Waste Strategy (HM Government 2018b) is determining a strategic direction for plastics in England. The 25 year plan has a target of working towards eliminating avoidable plastic waste by the end of 2042 and significantly reducing and where possible preventing all kinds of marine plastic pollution – in particular, material that came originally from land.

1.12 With this strategic direction in mind, the Department of Environment, Food and Rural Affairs (Defra) has published draft legislation for a ban on cotton buds and stirrers and restrictions on the availability of plastic drinking straws that is set to come into force in England in April 2020 (Lets Recycle, 2019). The draft includes some exemptions for medical and scientific uses.

1.13 Other jurisdictions have also been active on tackling SUPs. The Scottish Government has committed in principle to introducing a charge for single-use cups, the so-called "latte levy" with a 20p to 25p levy mooted to encourage more use of reusable alternatives (BBC, 2019). Due to the principle of full net cost recovery, extended producer responsibility reforms within UK Government and Devolved Administrations will impact on how waste collections and street cleansing costs are financed, and further consultation is expected during 2020. (HM Government, 2019).

1.14 Several voluntary agreements are also concentrating on phasing out "problematic" plastic. Members of the "Plastics Pact", which includes retailers, manufacturers, and organisations such as the Food Packaging Association, have pledged to eliminate problematic or unnecessary SUP packaging through redesign, innovation or alternative delivery models (such as reuse) by 2025. In pursuit of this goal, eight items have been identified by the Waste and Resources Action Programme (WRAP) as needing to be eliminated from circulation by 2020 (Resource, 2019). WRAP has also defined the terms 'problematic' and 'unnecessary' as "single-use

plastic items where consumption could be avoided through elimination, reuse or replacement and items that, post-consumption, commonly do not enter recycling and composting systems, or where they do, are not recycled due to their format, composition or size".

Research aims

1.15 The aim of this preliminary research study is to identify potential economic, social, and environmental impacts in Wales of a ban or restrictions on the sale of items in the SUP Directive ban.

1.16 This preliminary research presents findings on the potential impacts of the ban (or restriction in sale) to inform the Welsh Government and other stakeholders. It is not a full policy impact assessment. The report is intended to be used as an evidence base to inform stakeholders and support responses to any future public consultation.

2. Definitions and Scope

2.1 The SUP products covered in this research relate to those in the SUP Directive Article 5 and Annex Part B which states, “Member States shall prohibit the placing on the market of the single-use plastic products listed in Part B of the Annex and of products made from oxo-degradable plastic”.

2.2 The SUP Directive defines plastics as “a material consisting of a polymer…to which additives or other substances may have been added, and which can function as a main structural component of final products, with the exception of natural polymers that have not been chemically modified”. A SUP is defined as “a product that is made wholly or partly from plastic and that is not conceived, designed or placed on the market to accomplish, within its life span, multiple trips or rotations by being returned to a producer for refill or re-used for the same purpose for which it was conceived”. The authors of this report understand this to mean that products listed in Part B of the Annex to the SUP Directive made from bio-based plastics such as PLA, ‘compostable’ or ‘biodegradable’ plastics, and/or include a plastic lining, would be considered a SUP product within scope of the market restriction. However, the Directive’s definition of plastic includes an exemption for “natural polymers that have not been chemically modified”. A recent report has highlighted that this exemption may cause ‘loopholes’ whereby certain products (such as wet wipes) made from unmodified natural polymers (namely cellulose-based materials such as viscose and lyocell) could be challenged to be out of scope of a ban (Eunomia and Reloop, 2020). The report closely examines the potential legal definitions of “natural polymers” and “not chemically modified”, and makes a series of recommendations for actions that can be taken to close these loopholes, such as requiring that products placed on the market would have to demonstrate significantly lower environmental impact than conventional plastics. The question of which natural polymers are covered by the term ‘plastic’ and which may be exempt is an important consideration in working towards implementing the Directive.

2.3 We define each product below as stated in Article 5 and Annex Part B of the SUP Directive and include any notes as to the scope of our research related to the product. Each item will be further described, including its uses, available alternative materials, sales volumes, price, and common disposal behaviour in Section 5.

Cotton bud sticks

Figure 2.1. Plastic-stemmed cotton buds

2.4 Cotton buds are single-use products used most commonly in the home for hygiene purposes such as ear cleaning, first aid and make-up application and arts and crafts. Cotton buds can also be used outside the home, primarily in medical contexts to take microbiological cultures and DNA samples (also called ‘swab sticks’ in these contexts). Cotton buds are also useful to apply or selectively remove substances and medicines to a targeted area. Plastic stem cotton buds have a polypropylene straw stem and use a plastic-based adhesive to attach a small ball (bud) of cotton wool to each end of the stem. The SUP Directive states that single-use, plastic-stemmed cotton bud sticks should be included in a ban, except if used for medical purposes (i.e. “if they fall within the scope of Council Directive 90/385/EEC or Council Directive 93/42/EEC” concerning medical devices).

Cutlery (forks, knives, spoons, chopsticks)

Figure 2.2. Plastic fork

2.5 Cutlery is not further defined within the SUP Directive, besides the examples given. It is taken in the research to mean SUP, disposable serve ware, often supplied 'for free' at the point of sale for foods in catering and takeaway businesses, as well as items sold with convenience/ready meal foods and as items sold direct to the consumer in supermarkets to be used in the home (for events, parties, barbeques, etc.).

Plates

Figure 2.3. SUP plates

2.6 The SUP Directive does not define SUP plates; however, it does define other food containers (see paragraph 2.13), thereby narrowing down the definition of what could be considered a 'plate'. We believe there are three main types of single-use 'disposable' plates (and bowls), on the market:

- Plates, including serving plates, dinner plates, side plates, saucers - and in different shapes from standard round to square or oval.

- Trays and platters: for service – intended for hors d'oeuvres, canapes, appetizers, desserts, takeaways - again available in many shapes and sizes.
- Bowls, e.g. soup bowls, salad bowls and dessert bowls; bowls for ice cream and large capacity bowls for serving.

2.7 In this research, 'plates' is therefore defined to include plates, trays and bowls[4] supplied 'for free' at the point of sale alongside foods in catering and takeaway businesses, as well as items sold with convenience/ready meal foods and items sold direct to the consumer in supermarkets to be used in the home (for events, parties, barbeques, etc.).

Straws

Figure 2.4. Plastic drinking straw

2.8 Disposable plastic drinking straws can be rigid or flexible in nature, plain or coloured and may come wrapped in film for hygiene purposes. An array of straws is produced for both domestic and commercial uses. Our definition of straws also includes the small drinking straws that are commonly wrapped in plastic film and attached to beverage cartons.

2.9 As with the exemption for medical uses plastic-stemmed cotton bud sticks, the SUP Directive also exempts straws for medical uses. 'Plastic medical-enabling straws' are used to administer (durably and safely) pre-dosed granular medicines in hospitals and care settings.

[4] Some foods are packaged for sale in bowls with lids, which would be considered food containers rather than equivalent to a plate.

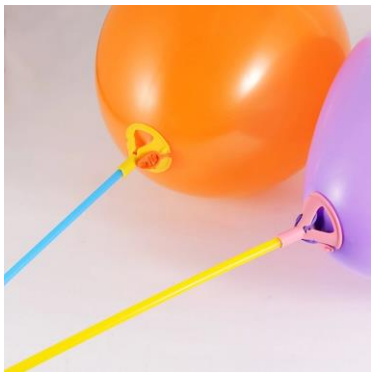
Beverage stirrers

Figure 2.5. Plastic beverage stirrer

2.10 Stirrers are rigid single-use products used to help sugar dissolve into hot drinks or to mix drinks (hot and cold).

Balloon sticks

Figure 2.6. Plastic balloon stick



2.11 Balloon sticks are products which are attached to latex air-filled balloons to support them to give an impression that they are floating. Hence, these balloons do not require gas filling points (as do helium gas balloons which require string and may require weights). Each ‘maxi stick and cup’ contains a stick element (resembling a straw) and a cup which attaches to the balloon without puncturing it.

2.12 The SUP Directive includes some exemptions regarding “balloons for industrial or other professional uses and applications that are not distributed to consumers, including the mechanisms of such sticks”. Considering these exemptions, we understand the balloon sticks included in this research to be those given directly to consumers with the balloon.

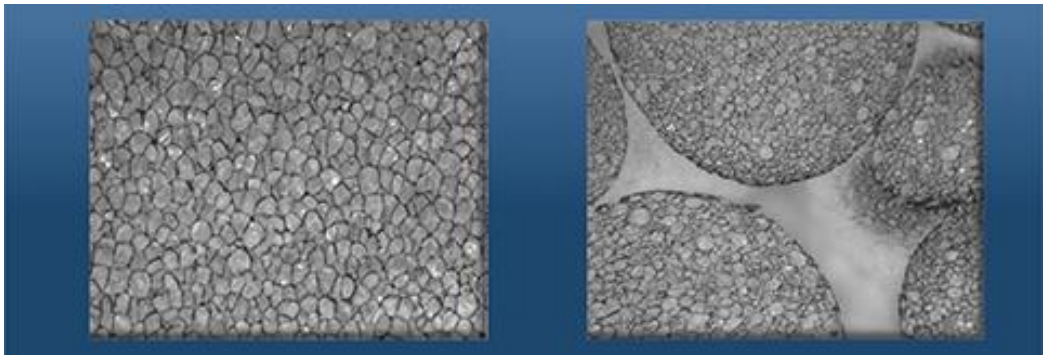
Food containers made of expanded (or extruded) polystyrene

Figure 2.7. EPS/XPS take-out containers, food trays, chip cones, and portion pots

2.13 The SUP Directive defines these items to be: “Food containers made of expanded polystyrene, i.e. receptacles such as boxes, with or without a cover, used to contain food which: (a) is intended for immediate consumption, either on-the-spot or takeaway, (b) is typically consumed from the receptacle, and (c) is ready to be consumed without any further preparation, such as cooking, boiling or heating, including food containers used for fast food or other meal ready for immediate consumption, except beverage containers, plates and packets and wrappers containing food”.

2.14 There has been some debate among industry stakeholders regarding whether the SUP directive also covers extruded polystyrene (XPS), as the Directive definition clearly only states expanded polystyrene (EPS). Clarification on this issue was sought with DG Environment at the European Commission, who clarified that “extruded polystyrene should be considered a subcategory of expanded polystyrene. Both are non-solid polymers, not the normal form of styrene, but rather a foam. Due to their uses in SUP items, they are often found in the marine environment. Marine litter counting does not distinguish between the two categories.” For the purposes of this research, and considering the above view, our definition of EPS food and drink containers will also include XPS.

Figure 2.8. 25x close-up of XPS (left) versus EPS (right)



Source: Construction Specifier, 2015

2.15 XPS may be less prone to crumbling than EPS, but it is still a brittle material that can fragment into macro and microplastics when released into the environment. The purpose of a ban is to cover those products that are associated with environmental damage, not to facilitate loopholes. The European Commission will provide SUP Guidelines covering the descriptions above, expected to be published in July 2020.

2.16 The SUP Directive also provides examples of food containers to be considered as SUP products: “fast-food containers or meal, sandwich, wrap and salad boxes with cold or hot food, or food containers of fresh or processed food that does not need further preparation, such as fruits, vegetables or desserts.” Hence, under the Directive definition we believe there are two main types of single-use ‘disposable’ takeaway containers, on the market (HM Treasury, 2018), as follows:

- To contain food that is intended for immediate consumption,
- For service – intended for hors d’oeuvres, canapes, appetizers, desserts, takeaways.

Each of these two main types are available in many shapes and sizes.

2.17 In this research, ‘takeaway container’ is defined to include containers supplied ‘for free’ at the point of sale alongside foods in catering and takeaway businesses, as well as ready to consume single portion foods sold in supermarkets. We therefore include EPS/XPS food trays and cones and small EPS/XPS portion pots used for foodstuffs (hot and cold) among the items considered in-scope in this research.

Beverage containers made of expanded polystyrene, including their caps and lids

2.18 Annex Part B of the SUP Directive does not provide a definition of beverage containers, but they are described elsewhere in the Directive as “Beverage containers with a capacity of up to three litres, i.e. receptacles used to contain liquid, such as beverage bottles including their caps and lids and composite beverage packaging including their caps and lids”. Furthermore, “Examples of beverage containers to be considered as SUP products are beverage bottles or composite beverage packaging used for beer, wine, water, liquid refreshments, juices and nectars, instant beverages or milk, but not cups for beverages as these are a separate category of SUP products for the purposes of this Directive”.

2.19 No examples of a beverage container constructed from EPS or XPS were identified during the course of the research. Clarification was sought from DG Environment at the European Commission, who pointed towards the descriptions given in the Directive and added that “the difference between the ‘cups for beverages’ and ‘beverage containers’ would be that a cup is used for drinking, while a beverage container is used for packaging and transport and can be closed”. However, DG Environment declined to provide an example of an EPS beverage container.

2.20 Since no EPS/XPS beverage containers were identified on the market, the impacts of banning them cannot be investigated further.

Beverage cups made of expanded (or extruded) polystyrene

Figure 2.9. EPS beverage cup and lid

2.21 The Annex Part B of the SUP Directive lists “Cups for beverages made of expanded polystyrene, including their covers and lids” without specifically mentioning extruded polystyrene. The same arguments presented for the EPS/XPS food containers exist for EPS/XPS beverage cups, however both online research and stakeholder engagement have been more aligned, indicating that the type of single-use beverage cups shown in Figure 2.9 are typically EPS, not XPS. We will nonetheless include both EPS and XPS beverage cups in the definition of this research, as the littering impacts of both materials are the same.

2.22 Covers and lids of EPS/XPS beverage cup lids are included in the SUP Directive. Most commonly, the lids are either flat, vented lids or ‘sip’ lids, usually made of polystyrene (Dart, 2019).

Products made from oxo-degradable plastics

2.23 The SUP Directive defines ‘oxo-degradable plastic’ as “plastic materials that include additives which, through oxidation, lead to the fragmentation of the plastic material into micro-fragments or to chemical decomposition”. Oxo-degradation is defined by CEN (the European Standards authority) as “degradation resulting from oxidative cleavage of macromolecules”.

2.24 Products made with this additive-technology and available on the market include film applications such as carrier bags, agricultural mulch films and, most recently, certain plastic bottles (European Bioplastics, n.d.). Other uses include packaging applications, with products such as blister packaging, labels and caps (Ellen MacArthur Foundation, 2019).

2.25 The impacts of a ban on oxo-degradable plastics were not modelled in this research as ‘oxo-degradable plastics’ could encompass several different types of products but no significant market was identified in Wales.

3. Methodology

3.1 Resource Futures undertook this research for the Welsh Government between October 2019 and January 2020. The overall research methods used were:

- Literature review
- Market mapping in Wales
- Stakeholder interviews
- Development of impact model

Literature review and market mapping

3.2 Evidence gathered for this research built upon three previous research studies undertaken by Resource Futures for Defra on different groups of products within the SUP Directive ban (Resource Futures, 2018a , Resource Futures, 2018b, Resource Futures, 2019a). All product prices were updated to reflect the current market, using an average of current prices investigated from three UK wholesalers. Product sales figures were updated as well to represent the Welsh market using a proportion of the previously identified sales figure estimates for England and the UK. A record of price data and assumptions for each of the products is provided in Annex D. Desk-based research was undertaken to identify the most common non-plastic products that might replace SUPs in Wales by reviewing products sold by main brands and retailers, and through discussions with stakeholders.

3.3 Additional sources were investigated to understand Welsh end of life management and disposal pathways. Particularly, Welsh terrestrial litter composition studies (conducted by Keep Wales Tidy and Resource Futures), and Welsh marine litter composition studies (provided by Marine Conservation Society from the Great British Beach Clean) were analysed. Other bodies of literature on Welsh littering behaviours and policies were analysed, providing a robust understanding of potential pathways for the products and the associated costs. These literature sources are cited throughout this document with references provided as end notes. Further context was provided by (Keep Wales Tidy, 2019; Keep Wales Tidy et al., 2019a; Keep Wales Tidy et al., 2019b; Keep Wales Tidy et al., 2019c).

3.4 A market mapping exercise was conducted to identify manufacturers in Wales for the SUP products and their non-plastic alternatives. Manufacturers were identified via desk-based research, the literature review, and interviews with stakeholders. Desk-based research and stakeholder engagement provided insight into companies in Wales relating to these products, as described further in Section 6.

3.5 Finally, a body of literature was examined on the 'disamenity' impacts[5] associated with terrestrial and marine litter and transferrable findings identified for use in the quantitative model (Keep Britain Tidy, 2014; Eftec, 2002; ZWS, 2017). These impacts, along with greenhouse gas impacts per material, were compiled to indicate the relative production and end of life impacts of materials.

Stakeholder interviews

3.6 Telephone interviews were conducted with a selection of stakeholders. The Welsh Government provided a list of 40 paper and plastic based manufacturers located in Wales who were already known to the Welsh Government as they had either requested or received business support. The Welsh Government wrote to these companies bilingually to offer them the opportunity to participate in the study. Four manufacturers responded to the invitation and agreed to contribute to the research. It is not clear whether the other companies didn't respond because they felt they would be unaffected by the ban, for example as they were not manufacturing or handling any of the products within the ban scope, or if they simply decided not to participate at this stage.

3.7 Repeated efforts were made to engage the Welsh Local Government Association, however, no response was obtained therefore Local Authority costs used in the modelling such as street cleansing and enforcement via Trading Standards offices, could not be verified.

3.8 A further 45 stakeholder organisations were contacted bilingually by Resource Futures and Miller Research and invited to participate in the work. These stakeholders were identified via desk-based research, from previous work by the

[5] Disamenity costs are any measures that can be used to represent a range of societal costs, such as wellbeing, health, ingestion/entanglement of wildlife, etc.

researchers, and by other stakeholders during interviews. These organisations were chosen to participate in the research if they satisfied at least one of the following criteria:

- their organisation dealt directly with the products in question, or
- their organisation dealt with plastic and/or substitute materials / products generally and had the potential to be affected by, or have pertinent views on, the ban or restriction in sale, or
- they might otherwise help inform the research, e.g. on the potential environmental, social and economic impacts in Wales.

3.9 Organisations based in Wales were prioritised for stakeholder engagement. Organisations from elsewhere in the UK were invited to participate particularly when seeking to address a knowledge gap, or where few relevant organisations in Wales were identified for a specific area of the research, or they chose not to participate.

3.10 The stakeholders targeted represented a full range of actors, including trade associations, the food and drink sector, manufacturers, retail, packaging and plastics experts, environmental organisations, and social impact representatives. In total, 29 of these organisations contributed to the research via telephone interview or email correspondence, depending on their preference, with Resource Futures and Miller Research. All stakeholders contributed to the qualitative aspect of this research, except for the two statistics organisations, who provided quantitative data. Table 3.Error! *No text of specified style in document.**1. Organisations contributing to the research***provides the full list of participating stakeholders, all of which consented to being named as contributors to this research.

3.11 A topic guide was drafted to guide each interview and facilitate consistency of approach. This generally covered detail on the organisation's activities in relation to the products in question, the organisation's thoughts and interest in the subject, their opinions on the impact and timing of the ban, changes in use of packaging to date, the evidence-base/significant gaps and impacts and unintended consequences of a ban. A spreadsheet proforma was prepared to collect key quantitative data relating to unit price, weight and sales estimates in Wales, but

none of the stakeholders contacted were able to provide this information. This may be due to the short project timescales, which meant there was little time for stakeholders to collect relevant data, and a general lack of comprehensive market data for these products in Wales. All stakeholders were given the opportunity to correspond and conduct the interview in Welsh.

Table 3. Error! No text of specified style in document.**1. Organisations contributing to the research**

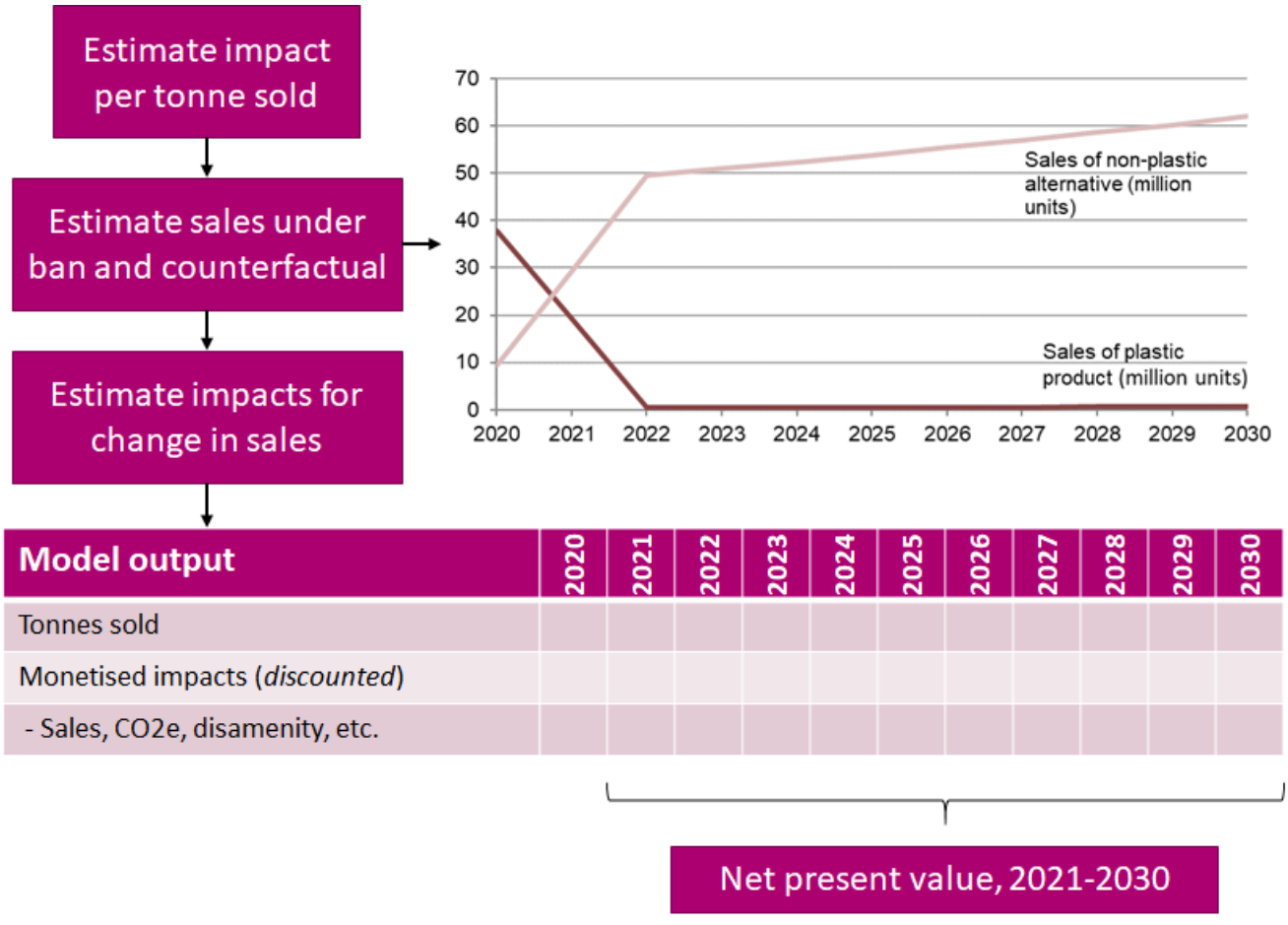
Organisation Name	**Type**
Cywain	Food and drink
Food and Drink Federation	Food and drink
Food and Drink Industry Board	Food and drink
Foodservice Packaging Association	Food and drink
Jack & Amelie	Food and drink
Project Helix	Food and drink
The Nationwide Caterers Association	Food and drink
Chevler Ltd	Packaging
Huhtamaki	Packaging
(Individual) Packaging Technologist	Packaging
SGMA	Packaging
Transcend Packaging	Packaging
Symphony Environmental	Packaging
Dart	Packaging
Seoil UK Ltd	Packaging
Wells Plastics	Packaging
AB Group Packaging	Packaging
Vegware	Packaging
ASDA	Retail
Association of Convenience Stores	Retail
British Plastics Federation	Plastics / materials
Bio-based and Biodegradable Industries Association	Plastics / materials
BioComposites Centre	Plastics / materials
RECOUP	Plastics / materials
Keep Wales Tidy	Environment
Marine Conservation Society	Environment
ONS	National statistics
Stats Wales	National statistics
DG Environment (via Europe Direct)	Government

Development of the impact model

3.12 A product demand impact model was developed in MS Excel to provide a preliminary indication of the quantitative impacts (financial, environmental and social costs and benefits) of two potential product use scenarios each having a time scale of 10 years.

3.13 In each scenario, the sales and market share of a 'typical' SUP product relative to the share of alternative non-plastic items is modelled. Figure provides a presentation of the main calculations of the model for a scenario.

Figure 3.1. Schematic indicating the main calculations in the impact model for a scenario



3.14 The two scenarios that were compared were:

- **No Ban:** Under this scenario the Welsh Government would continue to support current voluntary market change towards readily available non-plastic alternatives and an overall reduction in use. Retailers, wholesalers and manufacturers could still produce and sell SUP products if they wished to do so. Given the scope of the study and the intrinsic difficulties of forecasting future government policy and associated impacts, this 'do nothing' scenario does not consider the impact of other potential policy measures, which may or may not come to fruition in future. For example, changes to the extended producer responsibility system for packaging and potential fiscal measures for reducing the use of SUPs being jointly investigated by the Welsh Government and HM Treasury. In short 'business as usual' is assumed unless there is clear evidence that a change in government policy will take place.
- **Ban:** Under this scenario a legislative ban would be introduced. SUPs would be substituted with alternative materials. The alternative materials and their relative costs are described in Section 4.

3.15 Baseline demand for 2020 was represented and sales were forecast for both SUP and non-plastic alternatives over a 10-year period (from 2021). An array of different impacts were estimated and monetised in the modelling. The majority of impacts are estimated from the number and nature of each product and the resulting waste tonnage.

3.16 The sources of model data and assumptions are listed in Annex D, and explained in detail below.

3.17 Impacts were discounted over the modelling period according to HM Treasury's Green Book[6] e.g. costs were kept at constant prices applying the standard Treasury discount rate of 3.5%.

3.18 Transfers of resources between people (e.g. gifts, taxes, grants, subsidies or social security payments) were excluded from the analysis. These types of transfers pass

[6] The Green Book: appraisal and evaluation in central government

purchasing power from one person to another and do not involve the consumption of resources or make society better or worse off as a whole, hence their exclusion. Since VAT collection and payments are entirely of a distributional nature, VAT was a key transfer excluded from the assessment. In the model the assumed headline product sale price is including VAT and VAT at 20% is removed to estimate the subsequent impacts.

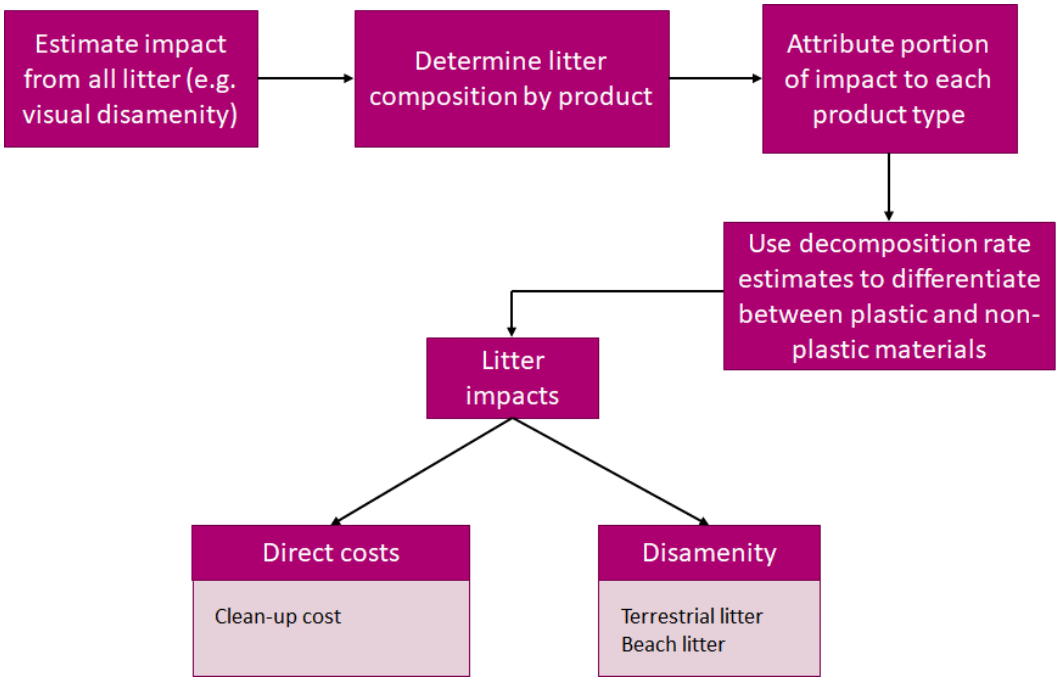
3.19 Tariffs are received by HMRC for some imported products[7]. These tariffs are either absorbed by the manufacturer and/or paid for by UK consumers within the sales price of products. So, they are considered as a transfer and their redistribution is not separately estimated in this assessment.

3.20 A central estimate for the impacts of the Ban relative to the No Ban scenario was estimated using the impact model. Sensitivity analysis was also undertaken to investigate the significance of data uncertainties and assumptions, providing a range (lower and upper impact values) from the central estimate.

3.21 An allocation approach was taken in the research to estimating litter disamenity impacts, as illustrated in Figure 3.2. To estimate litter impacts, the total impact from all items of observed litter in the terrestrial and marine environments was estimated from the research. The best data for relative abundance of different products comes from litter surveys. The survey data was used to allocate a proportion of the total disamenity costs to the products in question.

[7] Duties vary between products and markets and will change following the UK's departure from the EU. A duty of 6.5% is presently applied to many of the products considered here which are imported from outside the EU (e.g. plastic sacks and bags, plastic bottles and lids, take-away cups, flasks etc). Trade Tariff: look up commodity codes, duty and VAT rates

Figure 3.2. Description of the calculated litter impacts



Terrestrial and beach litter modelling

3.22 The model assumptions around the composition of terrestrial and beach litter are based on the best available data for Wales, as detailed below, but not all of the products in the ban are counted and reported as separate categories in marine litter surveys and so some assumptions were used to disaggregate categories where necessary.

3.23 Several sources were identified to inform the model estimates. Litter surveys were used to estimate potential impacts on terrestrial litter. Terrestrial litter also relates to marine litter where SUP products are littered on land and then transferred to the marine environment e.g. by surface water drains.

3.24 Terrestrial litter composition was informed by Keep Wales Tidy LEAMS Survey 2019. The LEAMS Survey contained specific data on many of the SUP products, with data collected in 11 of Wales' 22 Local Authorities from Wales April 2019 – November 2019. The composition analysis of litter waste in Wales study (Resource Futures, 2019b) also provided data. This analysed litter picked up manually from the

ground and from litterbins, however, the latter was excluded from our analysis for this study. A total of 885kg of material was sorted from 37 samples of litter pick waste from four Welsh Local Authorities. The composition by item count was calculated using the count of items of each material divided by the total of all items.

3.25 Beach litter composition was informed by analysis of ten years of survey data from the Marine Conservation Society (Nelms et al., 2017), the latest MCS beach survey data from the Great British Beach Clean 2019 (analysis of data specific to Welsh Beaches kindly provided by MCS for this study) and the impact assessment for the proposed EU SUP Directive (European Commission, 2018a).

3.26 The model assumes there is no change in public littering behaviour across the 10-year period and so the same proportion of items will be littered. However, the non-plastic products decompose at a much faster rate than plastic and so the observable beach litter impacts are reduced. This difference between the materials used is an important factor in estimating the beach litter impacts.

3.27 Table 3.2 shows decomposition rate estimates for common types of marine debris. This data is widely used in the literature and popular articles on marine litter. However, we were unable to find the original source of the data, and so we cannot be certain it is originally derived from a study by the US EPA, as stated in the Ocean Conservancy and NOAA documents most commonly cited, nor can we check the methods used to estimate the decomposition rates. We cannot verify the accuracy of this data and therefore this may reduce the accuracy of the findings of this model. As noted in the footnote to the table, decomposition rates for plastics are estimates only. Complete decomposition cannot have been measured yet as the polymers used in these products have been used in manufacturing for less time than the hundreds of years shown.

Table 3.2. Decomposition rates for common types of marine debris [8]

Item	Decomposition rate
Paper towel	2-4 weeks
Newspaper	6 weeks
Wax carton	3 months
Plywood	1-3 years
Plastic grocery bag	10-20 years*
Styrofoam cup	50 years*
Plastic beverage bottle	450 years*
Fishing line	600 years*
Apple core	2 months

Source: Ocean Conservancy & NOAA Marine Debris

3.28 Given the uncertainty in decomposition rates, particularly plastics, we conservatively assume that plastic decomposes 100 times slower than paper. This method recognises the distinction between degradability of different materials. The assumptions are used to estimate the relative decomposition of materials, e.g. that to whatever degree the plastic products have degraded in that period, the non-plastic products made from paper, wood or bagasse will have degraded much more. Whilst fracturing and dispersal of plastic products is undesirable, for non-plastic products such as paperboard products this is likely to hasten decomposition and reduce disamenity impacts when products are no longer recognisable. Future work could look to incorporate more sophisticated decomposition rates when estimating impacts, e.g. recognising that the distinction between non-plastic and plastic is likely to be small at first but more significant in longer timeframes. Another area of interest concerns decomposition rates for other alternatives such as bagasse[9]. The main NOAA data sources did not cover this type of packaging. An unverified data source

[8] 'Wax carton' is thought to refer to a Tetra Pak-style container of card with laminates of plastic film and aluminium.
[9] Bagasse is the dry pulpy fibrous residue that remains after sugarcane or sorghum stalks are crushed to extract their juice. It is used as a biofuel for the production of heat, energy, and electricity, and in the manufacture of pulp and building materials.

indicates the decomposition rate for bagasse could be of the order 30-60 days[10], similar in length to the paper-based materials described above.

Limitations of the data and model estimates

3.29 Key limitations in the data and model estimates centre around:

- **Market growth rates** (or reductions) for the single-use products - as projections of any market are inherently uncertain.
- **Sales units placed on market** in Wales - as comprehensive and accurate market data was not available.
- **Unit weight and price** of products - particularly as regards future projects, as a variety of products are currently available on the market and the design and cost is likely to change as the market develops in the next 10 years.
- **Speed of a shift** (i.e. voluntary action) from SUP to non-plastic alternatives in the No Ban scenario - as projections of product choice are inherently difficult and particularly for products such as these that are the subject of public and media interest.
- Proportion of market served by **imports into the UK** – as comprehensive and accurate import/export data is not available for these products, and the trade balance may change in the next 10 years as UK manufacturing sector responds to any implemented legislation.
- **Decomposition rates of SUPs** and their non-plastic alternatives – due to a lack of accurate field-tested data on the composition rates of these products in the marine environment and as terrestrial litter.
- **Visual disamenity value** of terrestrial and beach litter in Wales – as a range of visual disamenity values were found in the literature.
- The number of **items littered** found in terrestrial and beach surveys – due to a combination of factors, which are described in the following paragraphs.

3.30 Regarding litter impacts, there is not sufficient evidence available on littering behaviours for these products to estimate with any accuracy what percentage of

[10] Information obtained from Nature House Green Webpage

items are transferred to become terrestrial litter or beach litter, or indeed what the total tonnage may currently be lost each year through these various pathways. The picture is further complicated by the difference between the volume of items littered each year vs. the stock of items accumulating as litter, particularly in the marine environment and on beaches.

3.31 A proportion of litter items found on Welsh beaches is likely to have been transported from overseas on marine currents. As mentioned in the introduction section, this reinforces the need for global action. This adds additional uncertainty when estimating the impacts of a ban or restriction in sale in Wales.

3.32 The data limitations were considered when producing the central estimates within the economic model, erring on the side of caution to produce conservative estimates of the potential benefits of switching from plastic to alternative materials. Sensitivity analysis was conducted to test the effect of data uncertainty upon the model impact estimate results, as described below.

3.33 When interpreting the model impact estimate results, it is also important to consider a number of methodological limitations:

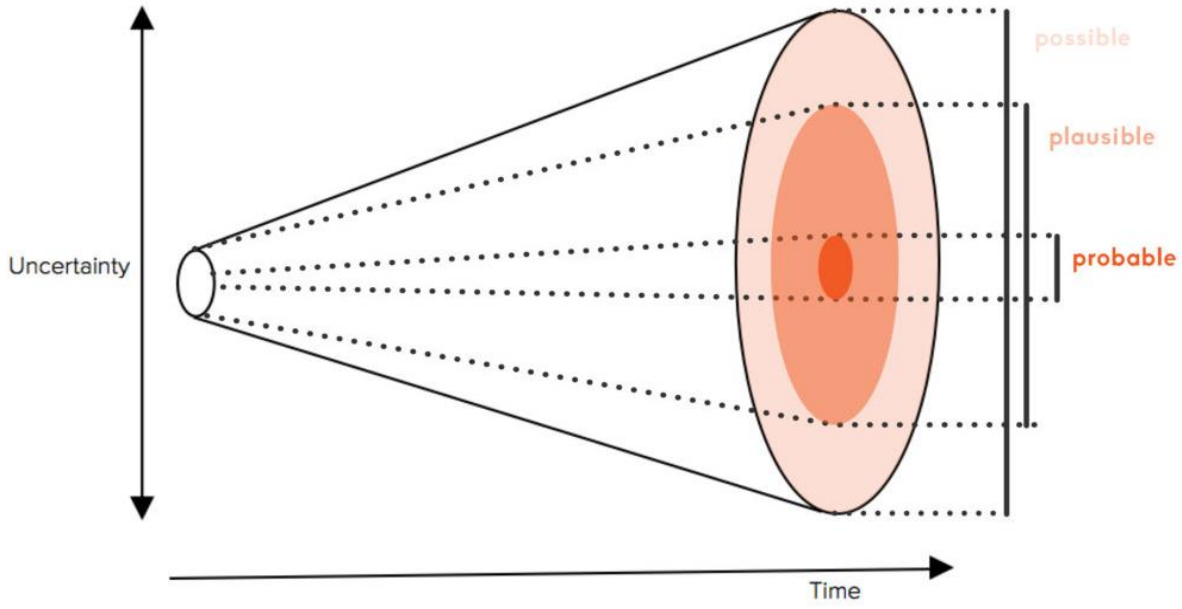
- Full investment and transition costs for businesses in Wales could not be estimated due to a lack of available data.
- The impacts on revenues to manufacturing are estimated for the UK, but the specific impacts in Wales could not be estimated due to a lack of data.
- The full impacts of marine litter are not yet understood and the visual disamenity cost estimate only represents part of the wider impacts.
- There is no standard method to estimate impacts associated with specific products based on visual disamenity for litter as a whole.

Sensitivity analysis

3.34 The sensitivity analysis tested upper and lower values for data that were identified as having the greatest uncertainty and that could have the greatest effect upon the model impact estimate results.

3.35 Figure 3.3 illustrates the cone of uncertainty, as applied in impact modelling and forecasting. The values used in the sensitivity analysis test the range of plausible values in the model, and as impacts are forecast into a ten-year period the estimated results vary accordingly. In the sensitivity analysis a group of assumptions are varied together. However, it is unlikely that all values will in reality be at the extremes of the values tested, and thus the sensitivity results represent the boundaries of plausible impacts.

Figure 3.3. Cone of uncertainty



3.36 The sensitivity analysis is presented in two stages. First, uncertainty around market growth estimates, particularly testing the potential effects of a ban or reduced consumption of single-use products regardless of their material composition. These sensitivity analysis values are presented in Table 3.3.

Table 3.3. Market growth rate uncertainty – sensitivity analysis values

Scenario	Product types	Central Value	Lower value	Upper value
Ban	Plastic straws, cotton bud sticks, stirrers, plates, cutlery and balloon sticks	-2.0%	-5.0%	0.6%
No ban	Plastic straws, cotton bud sticks, stirrers, plates, cutlery and balloon sticks	-1.0%	-4.0%	0.6%
Ban	SME food and beverage containers and cups	3.0%	-1.5%	3.0%
No ban	SME food and beverage containers and cups	3.0%	-0.5%	3.0%

3.37 For single-use straws, cotton bud sticks, stirrers, plates, cutlery and balloon sticks, the sensitivity analysis tests a further 3 percentage point reduction relative to the central scenario, or a very small market growth in the upper sensitivity. It is recognised that it is currently a challenge to reduce consumption of SME food and beverage containers and cups and reusable systems are difficult to implement. Nevertheless, many companies are innovating in this area and so sensitivity tests of a 1.5% annual market reduction is tested in the Ban scenario and a 0.5% annual reduction in the No Ban scenario.

3.38 Further model sensitivities were tested, varying values where there was the greatest uncertainty and which had the greatest effect on the overall results. The number of product units placed on the market each year is varied by +/-25% to account for data uncertainty in the central estimates, as comprehensive and accurate market data was not available. The unit weight and price were varied for the non-plastic alternatives to explore variability in products and future developments as this market develops and new or improved products are introduced. Unit weight and price for SUP products were not varied as these products are well established and so less likely to change dramatically. In addition, it is the difference between the SUP and non-plastic alternative in weight and price that is a key driver in the impact estimates. Details of all sensitivity analysis values are presented in the tables below. Variables scaled relative to the central value are presented in Table 3.4., and other specific values used in the sensitivity analysis are presented in Table 3.5.

Table 3.4. Plausible upper and lower range analysis around the central estimate

Model variable	Product types	Lower as % of central value	Upper as % of central value
Sales units placed on market p.a.	All	75%	125%
Unit weight (g)	All non-plastic products	75%	125%
Unit price (£)	All non-plastic products	50%	200%
Speed of shift - No ban	Straws, cotton bud sticks, stirrers, plates, and cutlery	Same	33% faster
Items littered	All	50%	200%
Visual disamenity value - terrestrial and beach litter	All products - Range derived from Eunomia (2014, adjusted for Wales); Marine: Eftec (2002)		

Table 3.5. Further variables tested for plausible upper and lower range analysis

Model variable	Product types	Central est.	Central value	Lower value	Upper value
Speed of shift - No ban	All EPS/XPS products	1 point drop in EPS/XPS % market share each year, e.g. 50% to 49% to 48%	1%	1%	10%
% imports into UK	Plastic straws, cotton bud sticks, stirrers, plates, cutlery and balloon sticks	90% imports, 10% domestic production	90%	80%	100%
% imports into UK	EPS/XPS food and beverage containers and cups	5% imports, 95% domestic production	5%	5%	50%

4. Findings - Market failure and the case for intervention

4.1 Litter is a form of pollution and reflects failures both to manage resources and waste responsibly and to limit end of life impacts. In economic terms, litter creates an external cost known as a 'negative externality'. A negative externality exists when the activity of one agent (such as the producer and/or end user of a product) cause a loss of welfare to another agent, which is not compensated. In these circumstances, because of the negative externalities associated with the product, the marginal societal costs of producing the product exceed the private costs faced only by the producer/supplier of the product, and a 'market failure' is said to have occurred. Without government intervention the good or service will be under-priced, or over-produced, or both, and the negative externalities will not be taken into account. Overall, there is a loss of economic welfare.

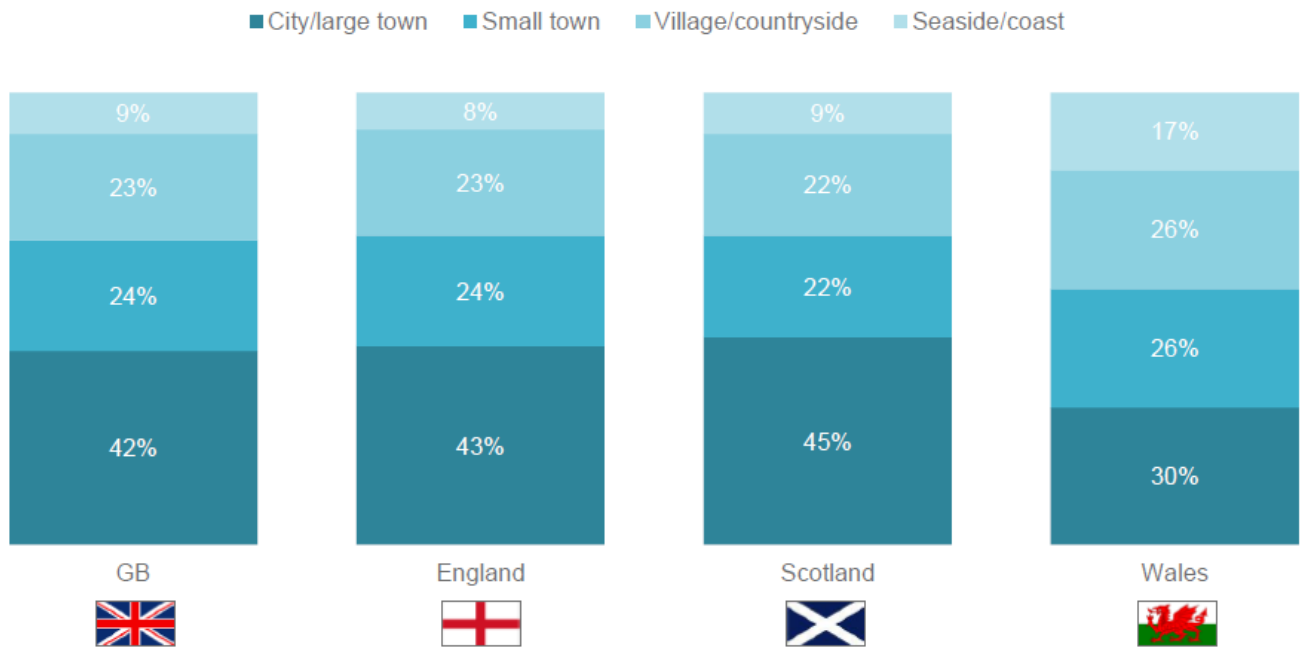
4.2 Single-use products are typically sold to consumers at a low price or provided 'for free' as part of a general product or service, such as drinking straws provided in fast-food restaurants and disposable plates at outdoor events. The external cost created by litter is not reflected in the product market price, and receptors and people affected by the litter (including the public and wider environment) are not compensated for these costs. The free market does not lead to an efficient outcome, so there is an economic rationale for some form of government intervention to address this market failure. The implementation of a legislative ban or restriction in sale is one of the key options available. Further details of the costs of marine litter in Wales and the case for intervention are explored below.

4.3 The products in scope of this research and outlined in the SUP Directive are commonly used, highly visible, ubiquitous items. They are frequently flushed, discarded and/or littered, with a direct pathway to the marine environment through surface water drains and sewage systems. For instance, street litter is often washed into surface water drains, which typically discharge directly into waterways, and many items pass through the simple screens. This is especially so for small items (such as straws) and materials that are easily crumbled or fragment into small pieces, such as expanded polystyrene (EPS). During rainstorms, sewers can be

also overwhelmed and discharge directly into rivers and the sea, bypassing sewage treatment plants.

4.4 Coastal tourism is particularly strong in Wales, which has a higher percentage of coastal visits than other UK countries (***Figure 4.1***). Seventeen million people visited the Welsh coastline in 2017 on day visits alone, spending £615 million (Kantar, 2017). Marine litter has potentially significant economic impacts on tourism in coastal areas, making them less attractive to visitors, and therefore has a disproportionate economic and tourism impact in Wales (Keep Wales Tidy, 2011).

Figure 4.1. 2017 main destination type on Tourism Day Visits by destination country



Source: Kantar, 2017

4.5 Plastic items are thought to represent 50-80% of shoreline debris (ISWA, 2017). The Marine Conservation Society's (MCS) Great British Beach Clean, conducted 437 beach cleans and litter surveys over one weekend in September 2019. The league table of items found on UK beaches by their prevalence per 100 meters of shoreline shows that plastic/polystyrene pieces are the most common items found in beach litter across the UK (Marine Conservation Society, 2019).

4.6 Welsh-specific data from the Great British Beach Clean was requested from the MCS for this research. The MCS provided data on the litter survey categories most relevant to the products considered in the ban. The percentage composition of relevant items from the Welsh beach litter surveys (taken from 30 beach cleans in Wales) is compared to the total UK figures (from a total of 437 beach cleans in the UK) in Table 4.1. The data shows that these categories are similar in Wales and the rest of the UK.

Table 4.1. Beach litter items and findings from the Great British Beach Clean 2019 in Wales

Litter item	% total in Wales	% total in UK
Cotton bud sticks	1.2	1.8
Plastic/polystyrene cutlery/trays/straws	1.7	1.5
Plastic/polystyrene food containers	0.6	0.7
Plastic/polystyrene cups	0.3	0.8
Paper/cardboard cups	0.1	0.1
Plastic/polystyrene foam	1.3	0.8
Plastic/polystyrene piece 0-2.5cm	18.0	18.7
Plastic/polystyrene 2.5- 50cm	7.7	6.9
Plastic/polystyrene 50cm+	0.7	0.8

4.7 Not all of the products in the ban are separately categorised and recorded in marine litter surveys. Of the products recorded, MCS found that cotton bud sticks, and plastic/polystyrene cutlery, trays, straws, food containers and cups account for 3.8% of beach litter. By far the most common beach litter problem is small plastic or polystyrene pieces (18%), which are the result of plastic products degrading and fragmenting into small pieces.

4.8 It is important to note that the most prevalent items found in both UK and Welsh beaches are plastic/polystyrene pieces, together making up over 25% of the total debris found in the Welsh beach clean ups. Once polystyrene pieces have broken off from their original product it is very difficult to determine what the original product was. Litter in this category could come from a variety of sectors, including food

service packaging, fishing and aquaculture (e.g. fish boxes and floats), construction, other product packaging. However, of all types of litter that were identifiable and assigned to specific categories, the MCS identified that about 30% of the items found came from public litter i.e. “litter that the public has not disposed of correctly”.

4.9 For most municipalities, one of the principal motivations for removing beach litter is the potential economic impact of marine litter on tourism (Mouat et al, 2010). Research by KIMO international on the economic impacts of marine litter concluded that regularly removing beach litter costs less than the potential reduction in revenue for local businesses that could result from taking no action (Mouat et al, 2010). The study brought together research from municipalities throughout the UK and the Northeast Atlantic region.

4.10 The impact of plastic litter on marine wildlife and ecosystems is not yet fully understood. However, there is growing evidence on the impacts of marine plastic related to marine natural capital (i.e. the worlds’ stock of natural assets). On a global scale, it has been estimated that for 2011, marine ecosystem services provided benefits to society approximating £38 trillion in 2011[11] (Costanza et al., 2014). One report postulated that on a global level, marine plastics could cause up to a 5% reduction in marine ecosystem service delivery in 2011, which equates to an annual loss of £380 - £1,900 billion[12] in the value of benefits derived from marine ecosystem services (Beaumont et al., 2019). There are numerous other negative economic impacts of litter, such as negative impacts on consumer confidence in fish and seafood, reduced property investment due to the presence of street litter, use of finite resources, etc[13].

4.11 Regardless of any monetised cost estimate, concern for marine litter and the perceived impact on the well-being of individuals is rising. As the profile of marine litter is raised, more people become aware of the issue (BBC, 2019a).

[11] Valued at US $49.7 trillion in 2007
[12] Valued at US $500-$2500 billion in 2007
[13] The full range of direct and indirect associated costs of discarded plastics is explored in the preliminary impact assessment of a ban on plastic straws, stirrers and plastic-stemmed cotton buds by Resource Futures: A preliminary assessment of the economic, environmental and social impacts of a potential ban on plastic straws, plastic stem cotton buds and plastics drinks stirrers

5. Findings - The market for each single-use product

5.1 This section presents detailed information regarding each of the nine researched products, defined in Section 2. Key findings are presented below relating to:

- Product use and market prices,
- The market for plastic-free alternatives and reusables,
- Indications of waste and recycling behaviours,
- The presence of products in terrestrial and marine litter, and
- Sales estimates for SUPs and plastic-free alternatives.

5.2 Comprehensive and accurate market data was not available to determine the quantity and price of each product placed on the market each year. Estimates have been made based on published data, market research, stakeholder and industry information, and previous research, as described in paragraph 3.2. These estimates were varied in model sensitivity analysis by +/-25% to account for data uncertainty, as described in earlier sections of this report.

Cotton buds

5.3 Cotton buds materials and common uses are described in Section 2. Cotton buds are sold in packs of varying sizes; common pack sizes are 100, 200 and 300 units in each pack, although they may be as small as a pack of 5 sterile cotton buds, up to packs of 500 units. Prices therefore vary as well, ranging from £0.95 to £1.28. An average price per unit was estimated to cost £0.005, rounded up to £0.01. Plastic and paper-stemmed cotton buds were found to be comparable on price.

5.4 Plastic-free alternatives already exist in the market. Johnson & Johnson, the UK market leader, was the first manufacturer to agree to replace their plastic cotton bud stems with paper in 2016 (Knapton, 2017). The retailer Waitrose made the same commitment at the same time. Since then, other major UK retailers have also changed their sourcing and/or production to phase out plastic stems (Cotton Bud Project, n.d.). A leading own brand retailer (Sainsbury's) is now also offering a plastic-free adhesive to attach the cotton bud to the stick (Sainsbury's, 2017).

5.5 A global market research report lists the top 10 global manufacturers of cotton buds as having their main manufacturing base outside Wales (predominantly located in South-East and Southern Asia) (Orian Research, 2018). The UK retail market is overwhelmingly dominated by own brand products from the main retailers Tesco, Sainsbury, Asda and WM Morrison, with Johnson & Johnson the leading non-supermarket brand (<5% by value) (Euromonitor, 2017). Health and beauty retailers such as Boots and Superdrug also have significant market share.

5.6 Detailed product sales information was not available for Wales, so estimates were made based on a range of sources. The BBC, in a news article reporting on Scotland's ban of plastic-stemmed cotton buds, estimated that 1.8 billion cotton buds are sold every year. Vogue used the same figure in an online op-ed (Morosini, 2019), however the WWF reported a much larger figure, at 13.2 billion plastic cotton buds consumed in 2018 (Elliott and Elliott, 2018). Waitrose has estimated that removing plastics from their cotton buds could save 21 tonnes of plastics per year (BBC, 2019).

5.7 The most common alternative to plastic cotton bud sticks are made of rolled paper. As mentioned previously, the paper alternative is readily available at most retail shops. Other readily available alternative materials are sticks made of bamboo. While these are more expensive (between £1.99 and £2.60 for a 200-pack, average of £0.011 per unit), some individuals prefer them for their supposed increased sturdiness compared to the paper stems.

5.8 Some reuse options exist for cotton buds. LastSwab claims to be the world's first reusable cotton swab; they offer a cotton swab that has a nylon stick, with the tips made from "TPE, a material often used for healthcare applications" (Last Swab, n.d.). While reusable options exist, they likely make up a niche market share compared to paper and plastic single-use alternatives.

5.9 A limited evidence base was available regarding how cotton buds are purchased, used and disposed of in the home. A UK-based study said 6% flushed buds down the toilet in the last 3 years (Envirotec Magazine, 2017). A survey by Anglian water revealed cotton buds are 'commonly flushed items'. A World Wildlife Fund (WWF)

study recently estimated UK litter rates for different types of terrestrial and marine litter (including cotton buds with a litter rate of 13.5%) although the ultimate source was not published at the time of writing (Elliott and Elliott, 2018).

5.10 Cotton bud sticks accounted for 1.7% of beach litter in Wales in the MCS Great British Beach Clean weekend, September 2019, and were found on 4.2% of streets surveyed in the LEAMS Survey 2019 (Keep Wales Tidy - visual surveys of a 50m length of one side of a street).

5.11 No sales data for Wales was identified in this research. Sales volumes for all products were therefore based on methodologies previously outlined in our research for Defra on the potential impacts of a ban in England, and scaled based on a ratio of Welsh to English population of 6% (Resource Futures, 2018a). However, as detailed above, much of the market has now switched from plastic to paper stemmed cotton buds and so the market share estimate was updated for this research. One hundred million cotton bud sticks were estimated to be sold per year in Wales, 30 million plastic, and 70 million paper[14].

Cutlery

5.12 There are three different situations where single use cutlery might be used, where food and drink establishments provide them to customers (European Commission, 2018a):

- for use on the premises mainly to save costs of washing reusable cutlery e.g. at events/conferences;
- taken out with food which cannot be hand eaten for consumption on-the-go, at barbeques/ picnics/parties/takeaways/with ‘food to go’ meals; or
- to avoid a security risk associated with metal cutlery e.g. in prisons, aircraft, festivals.

5.13 Cutlery is normally supplied for free at the point of sale alongside a purchase of takeaway/café food, or alongside within food to go meals (e.g. from sandwich

[14] Market split estimates were updated in light of major manufacturers and retailers who have since switched to non-plastic products, subsequent stakeholder comments and our understanding of the market, but as comprehensive and detailed market data is not available there is inherent uncertainty.

shops, with supermarket convenience/on-the-go items). Hence, most cutlery is thought to be bought business-to-business and supplied to caterers, takeaway businesses, restaurants, pubs, hotels and retailers. A minority of items are sold direct to consumers at supermarkets (e.g. for picnics, barbeques etc). In the foodservice sector some may make a charge (e.g. 5 pence chip fork). Disposable cutlery can come in a variety of forms, including (according to Webstaurant Store, an industry wholesaler, 2019):

- Standard-sized cutlery (occasionally individually wrapped, such as on aircraft) which may be consumed in the home, in workplaces, or 'on-the go';
- 'Petite', e.g. mini tasting forks and spoons, such as those sold with ice-cream tubs or served with hors d'oeuvres catering; or
- 'Sporks', i.e. short combined forks and spoons with lunchtime pasta/salads.

5.14 Regarding the sales price of each product, disposable cutlery is sold in economy, midweight and heavy grades with the former two dominating the market. Online research revealed a range of prices for both plastic product and paper-based plastic-free alternatives. However, when taking an average, both the plastic and the wooden alternative have the same average price.

5.15 Wooden cutlery was identified in the research as the typical non-plastic SUP alternative. SUP cutlery is predominantly and increasingly imported from the Asia-Pacific region into Europe (European Commission, 2018a). Based on previous research, we have assumed in the modelling 90% of cutlery is imported from outside the UK for both plastic and non-plastic products, of which 20% of plastics and 50% of wood is assumed to be imported from Europe and the rest of the imports come from outside Europe. The plastic and the wooden cutlery alternative have similar prices per unit, at about £0.04.

5.16 Single-use cutlery can be made from a variety of materials (Webstaurant Store, 2019), including: plastic (typically polystyrene or polypropylene), wood (commonly birch), polylactic acid, plant starch (often corn starch), bamboo, sugarcane/bagasse, and paper (Maxwell, 2015).

5.17 Reusable cutlery is also available made from metal, bamboo and thicker plastic. There has been some increase in consumer popularity for reusable cutlery sets, often made of bamboo and sold in foldable travel pouches, however this reusable model remains a niche market.

5.18 Cutlery is used both indoors and outdoors. In terms of waste and recycling behaviours, our assumption for the research is that because cutlery is lightweight and predominantly used in restaurants, fast food outlets, workplaces, or at events or parties, it is typically discarded to general waste rather than recycled due to the effort required to segregate and clean them and to sort and send to recovery (composting or recycling).

5.19 Resource Futures recently undertook a study for the Welsh Government (June 2019) that involved a detailed compositional analysis of the litter waste in Wales. The study found that dense plastic non-packaging items made up 3.6% of the total items, of these, plastic cutlery was most common and made up 1.3% of the total. 'Plastic/polystyrene cutlery/trays/straws' accounted for 1.7% of beach litter in Wales in the MCS Great British Beach Clean weekend, September 2019.

5.20 Sales volume estimates for cutlery were based on methodologies previously outlined in our research for Defra scaled based on a ratio of Welsh to English population of 6%. The market share of plastic and non-plastic has been updated to reflect a shift in the market away from SUPs. Market share estimates for all products have been triangulated from stakeholder consultation and pieces of market intelligence around major players that have shifted from SUP products, but as comprehensive and detailed market data is not available there is inherent uncertainty. For cutlery, 226 million units were estimated to be sold per year in Wales, 159 million plastic, and 68 million wooden[15].

[15] Where numbers do not correlate with the total market sum it is due to rounding of figures to the nearest million for presentation.

Plates

5.21 The uses of single use plates are varied and include:

- Household use (purchased at retail outlets), e.g. for parties; and outdoor eating such as that occurring during garden BBQs, picnics and camping.
- Commercial contract use (purchased at wholesale outlets or direct from manufacturers) with the aim of: reducing staff time, cleaning chemicals and space/equipment required for washing reusable plates; and to provide convenience for end-user not wanting/intending to return the plate, such as at music festivals, street food vendors.

5.22 Previous research identified that the main manufacturing base for plates is outside the UK (predominantly South-East Asia and North America), but comprehensive market data was not available. Based on previous research, we have assumed in the modelling 90% of SUP and plastic and paper plates made from other materials are assumed to be imported, of which 20% is from Europe. Most are bought business-to-business and supplied to caterers, takeaway businesses, restaurants, pubs, hotels and retailers. The items are sold to consumers via the foodservice sector and via supermarkets.

5.23 Regarding the sales price of each product, online research revealed a range of prices for both the plastic product and the paper-based alternative modelled. For the modelling central estimate, a single unit price of £0.06 has been used to represent plastic and items and £0.07 for paper items.

5.24 Plates can be made from a variety of materials. Plastic plates tend to be made from ‘food grade’ unexpanded polystyrene and acrylic, or EPS/XPS. Plastic plates have low levels of absorbency and insulating properties, making them hygienic and ideal for conserving hot food.

5.25 The main alternative to plastic is paper. ‘Paper’ plates may be made from compressed or layered card and are biodegradable and microwaveable. Uncoated paper can absorb grease and can collapse under the weight of heavier food. Paper plates can thus be laminated with a plastic or ‘biodegradable’ coating to decrease its absorbency; these types of laminated paper plates are also considered as SUP

in this research. Other non-plastic materials include bagasse, bamboo, aluminium foil, and palm leaf. Thicker ceramic, metal, bamboo and plastic reusable plates are also readily available.

5.26 No specific evidence base was identified in the research on behaviours regarding how plates are used and disposed of.

5.27 The impact assessment for the SUP Directive ban states that the proportion of littered single use plates on beaches (by item count) is very low relative to other types of litter items at 0.02% of the total which is “not seen as significant at the EU level” (European Commission, 2018a). However, it is not known what proportion of plastic plates could be degraded into the smaller unspecified plastic fragment categories in beach litter counts.

5.28 By value (not volume) the global market for disposable plates in 2017 has been estimated at 2.2 billion USD (Future Market Insights, 2017). In the USA, it has been estimated that nearly 29 billion pieces of disposable plates are sold per year (Green Restaurant Association, n.d.), which amounted to 89 pieces per person.

5.29 Sales volumes estimates for plates were based on methodologies previously outlined in our research for Defra and scaled based on a ratio of Welsh to English population of 6%. For plates, 59 million units were estimated to be sold per year in Wales, 29 million plastic, and 29 million paper[16]. This equates to an average of 19 disposable plates per person per year, half of which are SUP.

Straws

5.30 Straws are used for a variety of uses, both domestically and commercially. Most are bought business-to-business and supplied to restaurants, pubs, hotels, retail and schools. A minority proportion of the large straw market is business-to-consumer and online sales (for home use/parties).

5.31 Straws are also used in a medical context in order to safely administer pre-dosed medicines. This usage context is listed as an exemption in the SUP Directive, as

[16] The modelled split of SUP to paper plates remains the same as previous Defra research. Where numbers do not correlate with the total market sum it is due to rounding of figures to the nearest million for presentation.

described in paragraph 2.9. Flexible plastic straws are also used to assist/enable drinks and liquid food consumption in medical assistance situations.

5.32 Regarding the sales price of each product, online research revealed a range of prices for both plastic product and paper-based plastic-free alternatives. For the central estimate, using the methodology described in paragraph 5.2, a single unit price of £0.004 was estimated for plastic drinking straws, and £0.014 for paper drinking straws.

5.33 Plastic-free single-use alternatives already exist in the market for some types of products. For example, paper-based straws are available for certain types of drinking straws, and these can be laminated to improve their strength or be made thicker and heavier weight. A developing market for single-use bioplastic straws made of bio-based materials such as polylactic acid (PLA) is present and these items are primarily being sold to the catering sector. In addition to disposable drinking straws, reusable and durable straws are also sold (cocktail straws, refillable sports drinks bottles, reusable non-plastic straws). Metal, glass, bamboo and silicone straws are also being offered to the market as reusable alternatives, primarily for use in the home. Alternatives to small plastic straws attached to beverage cartons/juice pouches are not readily available, as the straw needs to be rigid enough to pierce a film to access the drink.

5.34 Straws are commonly used both indoors and outdoors. In terms of waste and recycling behaviours, our assumption for the research is that because straws are lightweight and predominantly used in restaurants, pubs, fast food outlets, schools or workplaces, or at parties, they are typically discarded to general waste rather than recycled due to the effort required to segregate and clean them and to sort at recovery facilities. A recent Eunomia report estimated 150 tonnes of straws are generated as waste (via municipal recycling, municipal residual, and litter) in Wales (Eunomia, 2018a). ‘Plastic/polystyrene cutlery/trays/straws’ accounted for 1.7% of beach litter in Wales in the MCS Great British Beach Clean weekend, September 2019.

5.35 Sales volume estimates for straws were based on methodologies previously outlined in our research for Defra and scaled based on a ratio of Welsh to English population of 6% (Resource Futures, 2018a). The drinking straw market has shifted significantly in recent years away from SUP. While precise data is not available, we estimate around 40% of the large single-use drinking straws market is now served by non-plastic items. Beverage carton straws is a smaller market, and predominantly plastic. We estimate around 95% of this market is SUP. For both types of straw, 256 million units were estimated to be sold per year in Wales, 173 million plastic, and 83 million paper.

Beverage stirrers

5.36 Beverage stirrers are used to mix or stir hot or cold drinks, e.g. to help dissolve sugar. Like straws, the predominant market for stirrers is the hospitality sector and this largely appears to be supplied from outside the UK by importing wholesalers. A small market exists for decorated party cocktail stirrers. These may be used in pubs, clubs and restaurants, or in the home and are heavier in weight and more reusable.

5.37 The most common alternative to plastic drink stirrers is made from wood. A few plastic-free, reusable alternatives for cocktail stirrers exist which tend to be made from glass.

5.38 In terms of price, both plastic stirrers and the wooden alternative were found to have a negligible price difference in our online research. Plastic items have been modelled at £0.004 per unit, and paper items £0.003.

5.39 As with straws, in terms of waste and recycling behaviours it is assumed that stirrers are disposed of as waste rather than being recycled due to the effort required to segregate and clean them. Only a fraction of stirrers are used outdoors, littered and not street cleansed. These stirrers have much higher likelihood of eventually become marine litter than those consumed indoors.

5.40 Sales volume estimates for plastic stirrers were based on methodologies previously outlined in our research for Defra, and scaled based on a ratio of Welsh to English

population of 6% (Resource Futures, 2018a). For stirrers, 11 million units were estimated to be sold per year in Wales, 5.7 million plastic, and 5.7 million paper[17].

Balloon sticks

5.41 Balloon sticks are used to support air-filled balloons, so that they give the impression that they are floating without filling the balloon with helium. They are mainly used outdoors (often by children). Wholesale consumers include restaurant chains, charities and the party sector. These products are largely sold business to business, rather than business to consumer, however the end users are often individuals, and mainly children.

5.42 Regarding the sales price of each product, a unit price of £0.07 was used for the plastic balloon stick, and £0.18 for the card alternative. Where they are sold, the specific cost of the stick is not visible and is included within the overall cost of the balloon.

5.43 As these products are mainly used outdoors and by children, it is anticipated that a proportion will be littered. However, it must be noted that litter studies often group balloons, strings and sticks together, so we could not isolate litter from balloon sticks.

5.44 Sales volume estimates for balloon sticks were based on methodologies previously outlined in our research for Defra and scaled based on a ratio of Welsh to English population of 6%. For plastic balloon sticks, 1 million units were estimated to be sold per year in Wales. Most balloon sticks were identified in the research to be made from plastic, typically polypropylene. There are a few examples of bio plastic and card alternatives, however they make up a niche proportion of the market.

Food containers made of expanded (or extruded) polystyrene containers

5.45 EPS/XPS food containers are predominantly used at takeaway premises (high street vendors, and street food vendors such as burger/chip shops and kebab shops). Some are used by the hospitality sector in hotels and pubs and in food takeaway delivery businesses. Some events also use EPS/XPS food containers,

[17] The modelled split of SUP to paper plates remains the same as previous Defra research.

although these are increasingly moving toward alternative products. The items are sold to consumers via the foodservice sector and to businesses via foodservice wholesalers.

5.46 As EPS/XPS food containers vary greatly in size and shape (including clamshells, chip cones, and sauce pots as demonstrated in Figure 2.7), and the sales price varies as well. For the modelling, we have used a combined weighted average based on EPS/XPS food container's proportion of total sales figures, provided by a major producer claiming significant share of the market. An average price of £0.03 per unit was used for EPS/XPS containers and £0.08 for non-plastic alternatives.

5.47 Many of the large high street foodservice businesses have already replaced EPS/XPS food containers with paper alternatives, since these can be printed upon to brand the packaging whilst also meeting food hygiene standards. Another popular alternative, particularly among high-street businesses, are bagasse food containers. Bagasse is made from sugarcane, and thus many producers claim it is compostable, which is popular among consumers. It looks and feels like its paper/board alternative, however it provides better insulation and strength, which makes it particularly suitable for heavy and greasy foods. Other alternatives include other food-grade plastic (such as PET), and reusables (using a variety of materials such as ceramic, aluminium, PET and bamboo). Paper/board (with and without a polymeric lining) was found to be the most common alternative on the market based on online research and stakeholder engagement as described in paragraph 5.2.

5.48 While EPS/XPS is technically recyclable, this is often not practical to do for food containers given their propensity to be heavily contaminated with food leftovers. Nonetheless, Recoup (a charity providing expertise on the plastics recycling value chain) has demonstrated recycling is feasible in principle, by conducting an EPS recycling trial at an event in Swansea, supported by Dart Europe, Klöckner Pentaplast, and Plastipak. The event attendees were given the possibility to separate their food waste from their EPS/XPS cups and trays. The food was sent for composting and the EPS/XPS was washed, then sent to Moulded Foams in Blackwood to be incorporated into thermal flooring blocks for the construction industry (Packaging News, 2019). Recoup was contacted regarding this trial. They

indicated that the trial (and other, similar trials conducted in Wales) was largely successful in demonstrating the recyclability of EPS/XPS. However, they admitted that, practically, it is not cost-effective, due to a) the need to wash the containers, and b) there was comparatively small output material, given that EPS/XPS is largely made up of air.

5.49 Single-use non-plastic food containers are readily available on the market, made from bagasse, paper, and other materials. Bagasse food containers also pose problems in terms of disposal. While they are technically compostable, in actuality, there are few facilities in Wales that can compost the containers, meaning that bagasse containers are often sent to landfill or EfW instead (BBC Wales, 2019). Paper/board food containers made of fibre pulp (without a polymeric lining) are the only known container that can be composted with other organic waste. However, uncoated paper can absorb grease and boxes can collapse under the weight of heavier food. Therefore, plastic laminated paper, i.e. a paper food container with a PE or PLA lining, may be used to avoid the container absorbing grease, although material scientists are developing new non-plastic solutions to this issue. Once a polymeric lining is used, it is often not recycled due to the difficulty of separating the lining from the paper packaging.

5.50 Sales volumes for EPS/XPS food containers were estimated using methodologies previously outlined in our research for Defra, and scaling to Welsh population based on a ratio of Welsh to English population of 6%. For food containers, 47 million units were estimated to be sold per year in Wales, 38 million EPS/XPS, and 9 million paper.

Beverage cups made of expanded (or extruded) polystyrene

5.51 EPS/XPS cups are typically used (like other disposable catering products) to save on costs of washing reusable cups, e.g. at community fairs/events/conferences. They are particularly suited for hot drinks given EPS/XPS's insulation properties. They are also commonly used in in prisons, hospitals and care homes to avoid security risks associated with glass or other materials. They are normally supplied to the customer free of charge, although some foodservice establishments are now

beginning to charge a small fee to customers when supplying disposable cups for beverages. The lids to cover the cups are made from non-expanded polystyrene and provide the necessary functional performance required for hot beverages on-the-go.

5.52 For the central estimate in the modelling, a single unit price of £0.03 was applied for the EPS/XPS item and £0.04 for the paper alternative, identified through online research and stakeholder engagement.

5.53 Single-use beverage cups can be made from a variety of materials. Other than EPS/XPS, this could be non-expanded plastic (such as PS, PET and PP), rigid paper (typically reinforced with either an air pocket insulation or with a polymer lining), PLA, and various other materials designed for re-use (such as aluminium, bamboo, and thicker plastic).

5.54 EPS/XPS and paper cups will likely be disposed in the same way described for EPS/XPS food containers in paragraph 5.48. The same complications arise regarding its recyclability, in terms of contaminated EPS/XPS and the polymeric lining for paper products complicating its recyclability, resulting in most cups presently being disposed of with general residual waste.

5.55 Sales volume estimates for EPS/XPS cups were based on methodologies previously outlined in our research for Defra and scaled based on a ratio of Welsh to English population of 6%. For cups, 33 million units were estimated to be sold per year in Wales, 26 million EPS/XPS, and 7 million paper.

Products made from oxo-degradable plastics

5.56 Uses of oxo-degradable plastic products are described in Section 2. Oxo-degradable plastic plastics are themselves promoted as alternatives to the conventional plastics and so no common ‘alternative’ to oxo-degradable plastic was identified.

5.57 Our research found that there are divergent views amongst some stakeholders regarding the current market for oxo-degradable plastics in Wales. Most stakeholders consulted were not aware of any oxo-degradable plastic products

used in the market, and one stakeholder close to the oxo-degradable plastics industry stated that few are sold in the UK. In contrast, a packaging manufacturer (note: not a manufacturer of oxo-degradable products) reported that oxo-degradable products are widespread and prevalent in the foodservice sector both in Wales and the UK, offering several examples of cutlery, straws, and cups using oxo-biodegradable technology, and this view was supported by another manufacturer. A report for the European Commission found that oxo-degradable plastic in the UK was (in 2016) restricted to plastic bags only, with all recovered post-consumer bags being sent outside the EU for reprocessing mostly in China (Hann et al, 2016). We were unable to verify this claim in our research as stakeholders provided differing views on the use of oxo-degradable plastic in the UK, as detailed in Section 7.

5.58 The SUP Directive specifically lists oxo-degradable plastic as one of the products that should be considered for a ban "as that type of plastic does not properly biodegrade and thus contributes to microplastic pollution in the environment, is not compostable, negatively affects the recycling of conventional plastic and fails to deliver a proven environmental benefit". However, members of the oxo-degradable industry dispute these claims and have criticised the European Commission's decision to include oxo-degradable plastics, arguing that it was done so hastily before scientific research into the potential harms had been completed. They believed the move ignored "established science" and was, instead, "politically motivated" (Hird, 2019). Members of the oxo-degradable industry were particularly displeased with the Commission's request for the European Chemicals Agency (ECHA) to withdraw from preparing an Annex XV restriction dossier concerning the placing on the market and use of oxo-degradable plastics (Recycling Magazine, 2019). The oxo-degradable plastics industry believed including oxo-degradable plastic in the SUP Directive without considering ECHA's evidence was premature.

5.59 The oxo-degradable industry also raises the distinction between 'oxo-degradable' and 'oxo-biodegradable' technology, whereby oxo-biodegradable plastics break down into biodegradable materials over a much shorter timeframe (Barret, 2019). The industry is seeking clarification on the definition of oxo-degradable plastics in the SUP Directive and whether oxo-biodegradable plastics are subject to the ban.

The UK manufacturer, Symphony Environmental, reports that if their oxo-biodegradable material is littered it “will degrade and biodegrade in a continuous, irreversible and unstoppable process until there is nothing left” leaving “no toxic residues and no microplastics” (Symphony Environmental, n.d.).

5.60 However, oxo-degradable plastics have come under criticism by other organisations. The Ellen MacArthur Foundation and European Bioplastics industry association have expressed the view that oxo-degradable plastics do not provide a solution to the littering problem, and indeed contribute to microplastic pollution (Ellen MacArthur Foundation, 2017; European Bioplastics, n.d.). The Ellen MacArthur Foundation wrote that “Oxo-degradable plastics are being produced and sold in many countries, with society being led to believe that they completely biodegrade in the environment within relatively short timescales. Yet compelling evidence suggests that oxo-degradable plastics take longer than claimed to degrade and that they fragment into small pieces which contribute to microplastics pollution” (Ellen MacArthur Foundation, 2017). European Bioplastics also stated that they are “falsely marketed as a solution to the plastic waste and littering problem” (European Bioplastics, n.d.).

5.61 The Ellen MacArthur Foundation reports that oxo-degradable plastics are also problematic in terms of reuse, recycling and composting (Ellen MacArthur Foundation, 2019). The report states that they are not suitable for reuse, as they are designed to start fragmenting within a few months of use, and they negatively affect the quality and economic value of plastic recyclate. Also, that they do not fulfil the requirements of relevant international standards for composting, as their biodegradation takes too long, and plastic fragments can remain in the compost.

5.62 One manufacturer interviewed stated that their oxo-biodegradable technology will biodegrade in an industrial composting unit, doesn’t cause problems if mixed into plastics recycling streams, and only needs a short exposure to UV light to biodegrade in the open environment (the timescales of biodegradation are subject to environmental factors).

5.63 A common concern relating to biodegradable plastics is that labelling a product as ‘biodegradable’ will increase the public’s inclination to litter, but the UN found that there was limited evidence to support this assumption (United Nations, 2015).

6. Findings - Market mapping in Wales

6.1 A preliminary ‘market mapping’ is presented below to understand the scale and scope of current businesses and industries that are operating in Wales, in order to better understand the context and how a ban or restriction in sale may impact this landscape. Paragraph 3.4 provides detail on the methodology used for the market mapping exercise.

Manufacturers

6.2 Manufacturers of the SUP products are likely to incur loss of revenue resulting from a ban or restriction in sale and/or transition costs if existing production lines are converted to producing other products. However, the ban or restriction in sale also creates an opportunity for growth in manufacturing of non-plastic products to serve the market following the ban. Initial online research, described in paragraph 3.4, shows a presence of manufacturers of both plastic and non-plastic products in Wales.

6.3 The market mapping identified major manufactures of SUP products and their non-plastic alternatives (see section 3.4 for methodology). Of the market leaders identified, only one manufacturing facility was identified in Wales and it is not clear whether this site manufactures products in scope of the ban or other items produced by the company. Further details on the market leaders identified are given in Annex B.

6.4 A broader mapping of manufacturers in Wales, including SMEs, identified other companies that could be affected by a ban or restriction in sale. In total, 12 manufacturers producing plastic products within scope of this research and/or their non-plastic alternatives were identified in Wales and could be either directly or indirectly affected by a legislative ban (see Table 6.1). Specifically, these manufacturers produce SUPs in the form of PET-lined card trays, plastic food packaging products and single-use non-plastic products in the form of paper plates and cups, compostable food trays and containers, and paper straws. The manufacturers were invited to participate in this research and insights from those

that responded are provided in the stakeholder consultation findings section in this report.

Table 6.1. List of identified Welsh manufacturers

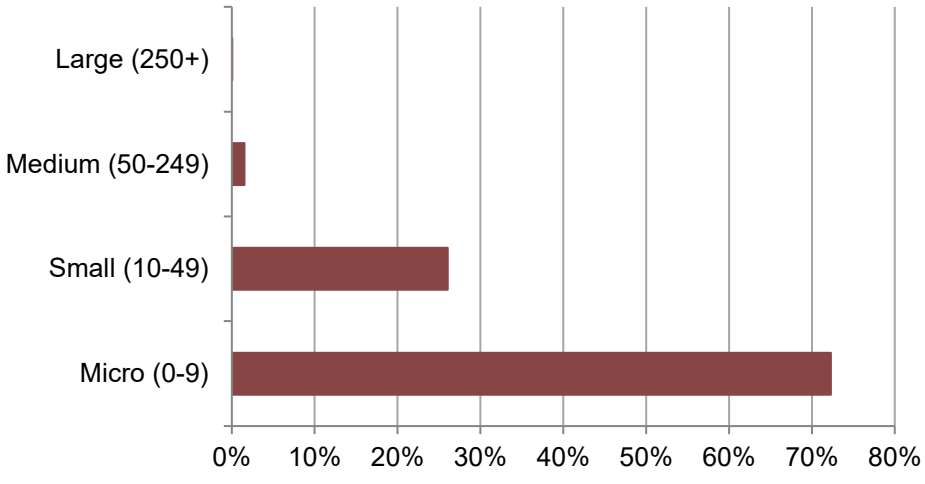
Company Name	Manufacturing type	Details	Area
Berry Global / RPC	Plastic	Containers and cups	Port Talbot, Llantrisant, Glamorgan, Gwent
The Cup Folk	Plastic, PLA, Paper	Cups	Wrexham
Klockner Pentaplast	EPS	Clam boxes and trays – but unconfirmed if manufactured at Newport site or elsewhere	Newport
Beatus Cartons	Paper and plastic	Broad use in packaging	Porth
Chevler	Paper and plastic	trays, food liners	Hengoed
Boardlink	Paper	Plates, PET-lined card trays	Flintshire
Transcend Packaging	Paper	Straws	Caerphilly
Benders Paper Cups	Paper	Cups	Wrexham
Seda UK Limited	Paper	Paper cups, containers and plastic lids for hot and cold drinks and dairy products, as well as folding cartons	Blackwood
Biopaxium	Various pulp fibres	Food containers and trays	Wrexham
UPM Kymmene (UK) Ltd	Paper	Broad use in packaging	Wrexham
Glatfelter Caerphilly Ltd	Aluminium	Food containers	Caerphilly

Compiled via desk-based research and stakeholder engagement or provided by the Welsh Government. Note this is not an exhaustive list of all Welsh manufacturers within scope of this research.

Rest of the supply chain

6.5 Other stakeholders that will be impacted by a legislative ban or restriction in sale on SUP products in Wales will be Welsh businesses in the foodservice sector, as these provide much of the takeaway products that are within scope of a ban (namely EPS/XPS food containers, plastic cutlery, plates and straws). According to data provided by the ONS Business Register and Employment Survey (UK Business Counts - local units by industry and employment size band), small and micro businesses account for 98% of the businesses engaged in the 'food and drink service' in Wales (see Figure 6.1). Businesses in the 'food and drink service' sector shown in the data include restaurants and mobile food service activities, event catering activities, beverage serving activities, and 'other' food service activities. Representative organisations for this sector were interviewed to inform this research (see Table 3.Error*! No text of specified style in document.**1. Organisations contributing to the research***).

Figure 6.1. Welsh businesses in the food and drink service by employment size band [18]

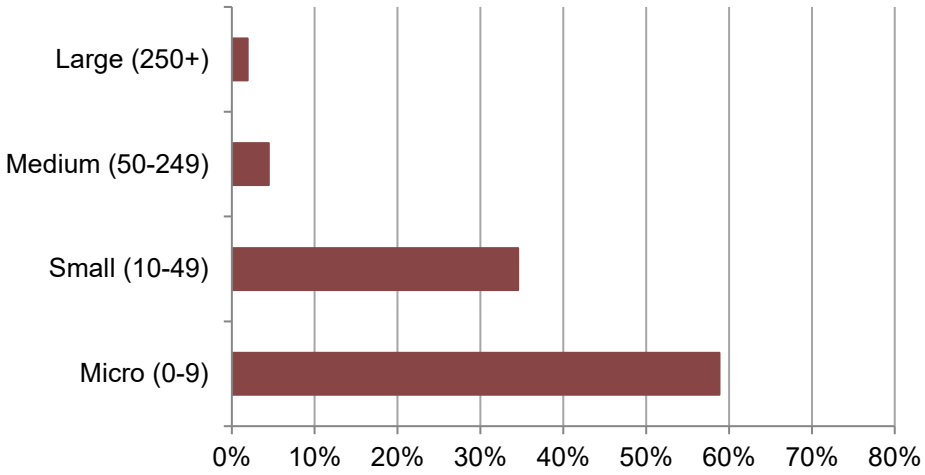


Data source: ONS Business Register and Employment Survey

[18] Local units by employment size band. Comprising SIC codes: 5610 : Restaurants and mobile food service activities; 5621 : Event catering activities; 5629 : Other food service activities; 5630 : Beverage serving activities

6.6 Welsh retailers will also be affected by a ban. Large retailers engaged in this research indicated that they have already begun phasing out the SUPs in scope of this research. For this reason, as for the food and drink service sector, small and micro business in the retail sector will likely be most affected by a ban; these make up 94% of businesses in the retail sector. While retailers sell most of the plastic items within scope of this research directly to customers (for personal use in barbeques, parties, and other events), some retailers also provide items such as straws, cutlery, plates, and EPS/XPS cups to customers and employees in-house, such as in their cafés or canteens.

Figure 6.2. Welsh businesses in food retail industry by employment size band[19]



Data source: ONS Business Register and Employment Survey

6.7 Finally, it is also interesting to note that the takeaway/delivery market is increasing. According to a report by Just Eat, spending on takeaways increased from £7.4 billion in 2009 to £9.9 billion in 2016 in the UK, roughly 3% per annum after adjusting for inflation. In Wales alone, it has brought in £400 million in revenue and employed over 11,000 people since 2014 (Just Eat, 2017). As an increasing number of restaurants open their services to the takeaway market, products such as food and beverage containers, cutlery and straws will need to be sourced in such a

[19] Local units by employment size band. Comprising SIC codes: 4711 : Retail sale in non-specialised stores with food, beverages or tobacco predominating; 4781 : Retail sale via stalls and markets of food, beverages and tobacco products

way as to accommodate this growing market while complying with a legislative ban on these products. While there are generally readily available alternatives on the market, this takeaway/delivery economy is another important market to consider when considering the impacts of ban on SUPs. Further investigation of the Welsh takeaway market will be required in order to confirm these findings from the Just Eat report referenced above.

7. Findings - Stakeholder consultation

7.1 A summary of the main findings uncovered from the interviews and from other correspondence with stakeholders engaged in the research is provided in this section of the report. Comments are categorised by: key findings; economic impacts; environmental impacts; social impacts; and implementation risks.

Key Findings

7.2 Of the 21 stakeholders providing an opinion on whether their organisation would be likely to support a ban on the proposed products, 14 indicated that they would generally be supportive of a ban. The main reasons cited was that it was "inevitable", as the SUP Directive was already agreed and passed in June, requiring all Member States to comply with the Directive by July 2021. Others supported a ban in the general sense because the products proposed did not pose major problems for them, as there are readily available alternatives on the market. Finally, stakeholders suggested a ban would level the playing field and support the industry for non-plastic alternatives, making them cheaper for all to use.

7.3 Three stakeholders supported the ban but provided some remarks to qualify their response. These remarks centred around doubts that the full range of implications to business (and manufacturers particularly) had been considered, and that these businesses need expert support when going through the process of changing product lines. These (and several other) stakeholders believed that the alternatives have not been adequately and independently studied regarding the full life-cycle analysis in a way that is directly comparable to the plastic product. Stakeholders also agreed that the proper treatment of the alternatives needs to be secured before banning the currently recyclable plastic product. For example, one stakeholder from the food and drink industry said that their organisation and their members would generally agree to pay a premium for the alternative product, but they would want to ensure that the product will be disposed of properly, and not end up in landfill. They added that investment in industrial composting and other facilities needs to be made before paper (or other) products become mainstream.

7.4 Two stakeholders indicated that they would not support a ban, on the grounds that the products in question make up a small proportion of the quantities of plastic waste in the terrestrial and marine environment. They lamented the fact that the ban would further “demonize” plastic, taking attention away from the fact that the root cause of the problem is littering and using single-use items generally. Two stakeholders said they would not support a ban if it included oxo-biodegradable plastics.

7.5 Stakeholders provided some specific comments about individual products on the ban list. These views are summarised below:

- Spoons (within cutlery): There are several manufacturers in Wales that use plastic spoons for bespoke applications, such as single-portion ice-cream pots. Requiring these manufacturers to invest in new machinery to support wooden spoons could be very costly, particularly as this is not their primary product.
- Plates: One stakeholder believed that plates should not be on the list, as these are not used or intended for takeaway purposes, and because the alternatives are not functionally suitable (e.g. paper plates not suitable for heavy food).
- Straws: Stakeholders in favour of an exemption or grace period for beverage carton straws argued that plastic straws attached to carton beverage containers, such as juice boxes for children, have no readily available alternative. This situation requires more time and support to investigate alternatives, and whether these alternatives have a bigger environmental impact (e.g. changing beverage carton container to use plastic caps would use more plastic).
- Balloon sticks: One stakeholder in the environmental sector explained that balloon sticks are not a highly littered item; the paraphernalia surrounding the balloons (e.g. ribbon, plastic string, etc) are more commonly found littered items. Banning balloon sticks will not address the problem of balloon litter.
- EPS or XPS polystyrene food containers: Notwithstanding the inclusion (or not) of XPS under a ban, there is some debate as to which material is more common in the context of food containers. Some stakeholders were not aware of any XPS used in this context, and argued that it is used mostly in the building and construction industries, while others maintain that XPS is widely used for food

containers and preferred over EPS as it does not crumble as much when broken. Our desk-based research found examples of both EPS and XPS food containers.

- Expanded polystyrene beverage containers: Correspondence with EPS/XPS manufacturers revealed that, using the SUP Directive definition of a “beverage container” (see paragraph 2.18), they cannot think of any products of this nature in EPS or XPS.
- Oxo-degradable plastics: Nine of the stakeholders interviewed offered views specifically relating to a ban on oxo-degradable plastics. As stated above, two stakeholders would not support a ban if it included oxo-biodegradable plastics. Seven stakeholders stated that they would support a ban on oxo-degradable plastics, most of whom cited adverse environmental impacts and that the technology is “highly uncommon”, stating that they are not aware of any oxo-degradable products used in the UK or Wales. Nonetheless, some stakeholders indicated that their customer base did not know if this included biodegradable or compostable packaging and said that more clarity on this is needed. One oxo-biodegradable producer agreed with this sentiment of consumer confusion, further arguing that the confusion extends to the highest levels of EU government. They added, for example, that their oxo-biodegradable (not to be confused with oxo-degradable) products do indeed biodegrade, and that a ban will stifle the opportunity for development of this technology.

Economic impacts

7.6 When asked about the possible financial impacts imposed on the sector, stakeholders cited the potentially steep economic costs of a ban, although most of the impacts discussed were anecdotal; none provided specific figures or estimates of costs to their business. The discussion of economic impacts centred around costs to manufacturers, particularly regarding replacing machinery to support the alternative products. Questions were raised regarding how the businesses would be able to finance this change, and what the consequences would be for end consumers.

7.7 Economic impacts in terms of human capital were also cited. These were raised both in terms of job losses, and job gains. Job losses would occur in factories that are unable to pay for the machinery costs cited above – one manufacturer anecdotally added that the closure of an EPS factory led to 400 job losses (the factory location was not provided). Job gains would occur in terms of more resources (i.e. dedicated personnel) spent internally to investigate alternative technologies and products. One retailer added that their entire sustainability team did not exist until January 2019. Further jobs would be created if manufacturing in Wales responded to the anticipated increase in demand for non-plastic alternatives. An example of this is shown in the case study below, in which Transcend Packaging, manufacturer of paper straws in Wales, created 170 new jobs in recent months, including highly skilled and technical jobs with high salaries, and expects to continue to grow at a fast rate.

7.8 Other economic impacts cited were the higher cost to consumers (although preliminary market research for this study found many of the SUP and non-plastic products to be comparable prices at wholesale value), and higher transportation costs due to the alternatives being heavier. One industry group referred to Defra's summary of responses to the consultation on plastic straws, cotton buds and drink stirrers, as this provides a wealth of information on financial impacts. The major financial impacts from this summary report were provided by Tetra Pak and the British Soft Drinks Association (BSDA). Tetra Pak indicated that in the UK there are approximately 10 production facilities which produce drinks filled in cartons with straws on approximately 20 production lines. They estimated the capital equipment investment to produce alternatives to be tens of millions of pounds in the next five to seven years. The BSDA estimated that switching from a carton with on-pack straws to a plastic bottle with a cap would require investment of £250k to £1.5 million per production line, plus redesign costs.

7.9 Stakeholders indicated that smaller businesses would be disproportionately affected by a ban, as these operate in a highly competitive market and are very price conscious and lack space for washing facilities to support reusable products. Another stakeholder added that the third sector (e.g. community groups, churches,

Scouts, etc.) would be disproportionately affected as well, as they have limited financial resources and many times must choose the cheapest option available.

7.10 Nonetheless, many stakeholders believed that the overall impact (to these disproportionately affected groups and to larger companies alike) will be negligible, as the price differential between the plastic product and the alternative is relatively small or non-existent in many cases. They furthered that as the market for alternative products becomes more competitive (driven, perhaps, by a ban on the plastic products), more businesses will enter this space, driving down the price and thereby financial impact to retailers and other businesses.

Case Study: Transcend Packaging

Transcend Packaging is a Welsh paper straws manufacturer that has grown out of a shift in demand for an alternative to plastic straws. When McDonalds announced it would phase out plastic straws in all UK stores in June 2018, Transcend was one of two manufacturers selected to supply paper straws to the fast food chain. Starting as a small facility employing 20 people, it more than doubled to cater to this new demand. In the last few months alone, 170 new jobs were created, and they anticipate further growth, with plans to expand their headquarters in Wales by adding more executive positions. Transcend Packaging will begin production in early 2020 of straws for carton juice boxes and hopes to become market leaders for this product. They are an example of the opportunity created for the Welsh manufacturing industry to respond to the SUP issue, creating growth and jobs in emerging green markets.

Environmental impacts

7.11 Both positive and negative environmental impacts were raised by stakeholders. The positive impacts related to the fact that the proposals eliminate the reliance on products made from finite resources (i.e. fossil fuels). The alternatives derive from natural and renewable sources. For example, Chevler Packaging Ltd produces a natural greaseproof paper, with no added chemicals, created by the intense beating of fibres when making the paper itself. This paper can be used to line food

containers or ready meals to avoid grease damaging the outer packaging. Another innovative and natural technology was developed by Sol-Gel Coatings & Advanced Materials (SGMA) (more detail below).

7.12 However, while the positive effects of the alternatives to SUPs on the environment are “relatively self-explanatory” (according to one stakeholder, given the fact that they are plastic-free), stakeholders argued that the negative consequences are more nuanced and multifaceted, yet no less important. For example, many stakeholders raised the issue that an increased reliance on fibre products will increase the use of paper and thus deforestation. For this reason, an LCA is needed to understand the full impact of alternatives to SUPs. This includes investigating treatment options; if the plastic-free alternatives can only be recycled in select locations, the logistics and fuel costs to transport this waste to these locations must be considered as well.

Case Study: SGMA

SGMA has developed a natural coating solution that can be applied to paper food and drink packaging products to make them 100% water (and 60% oil) repellent. The treated paper is 100% recyclable and compostable. The coating does not contain any plastic polymers or harmful chemicals, and thus does not interfere with the paper’s ability to be recycled and does not require any special treatment to be composted. The coating solution is not applied as a lining and is instead absorbed by the fibre to give it a glass-like finish. It is made from molecules extracted from sand; when it degrades, the molecules revert back to their original sand form. SGMA is in the process of getting the technology food-grade certified and hopes to conclude the certification by mid-2020.

A ban will stimulate demand for new solutions and drive innovation. First movers and successful technologies will have a potentially large market as similar bans are implemented across the EU.

7.13 One stakeholder was particularly concerned about polymer linings on paper products. They raised the risk that biopolymer coatings, such as PLA, will break down into microplastics when processed at a paper recycler, slipping through filters

and eventually contaminating water streams. Traditional plastic coatings, they commented, “come off in big chunks” and can be recovered.

7.14 The topic and possibility of reusable products was also discussed. Two different types of reusable models were identified. The first is the classic model whereby an individual invests in reusable products (such as bamboo cutlery, metal straws, etc), retains ownership of the product and must plan to bring it with them when ordering food or drink. This model can be supported by financial incentives that reward a customer for using a reusable item instead of a single-use item, as is seen in many high street coffee shops with discounts for reusable coffee cups. Reuse can be facilitated by apps, such as ‘Refill’, which identifies businesses that will provide free water refills. These types of campaigns were said to be successful in decreasing the stigma around drinking tap water, which has also helped increase reuse. One major retailer shared that sales for these types of reusable products have increased 96% from last year in their stores. The growth and demand for these products has prompted the development of a major plan around reusable products in their stores, planned for 2020. One issue related to this model, however, relates to liability and health and safety. Notably, if a customer uses their own container for food or drink and becomes sick, there is no way to prove whether this was from the contents or the packaging.

7.15 Other stakeholders think that it is not ideal or practical to carry numerous products throughout the day. Due to this limitation, a second reuse model involves a system whereby reusable products are part of a scheme managed by the retail or business, a model already extensively used in South Korea (Business Insider, 2016). For example, a trial by Deliveroo will allow customers to ask for their containers to be picked up by Deliveroo workers so that restaurants involved in the trial can wash and reuse the containers for future use. While this would solve the issue of convenience, stakeholders raised various other issues, such as food safety on a wider scale, and requiring significant amounts of energy to wash the products.

Social impacts

7.16 When asked about potential social impacts of a ban, stakeholders raised issues particularly regarding impacts to vulnerable groups such as people with disabilities or decreased mobility. When discussing exemptions to a ban, there was overwhelming support for exemptions for such groups and for medical applications. While some argued for an exemption if food safety issues could be proven, others believed that no exemptions (except for medical applications) should be allowed to avoid loopholes and distortion of the market.

7.17 One stakeholder raised the concern that any guidance issued by the Welsh government involving changes to rules and regulations affecting them must be provided in several languages. Their concern was related to the many small, independent shops currently using SUP products, many of which are run by people who may not have high levels of English and/or Welsh reading skills.

7.18 Finally, one major retailer reported that a proportion of their customer base continue to prefer the SUPs, and they receive daily complaints from these customers regarding its alternatives, particularly their disapproval of wooden cutlery. The retailer anecdotally added that when they announced they would stop selling plastic straws, one customer came to a shop and purchased the entire shelf of plastic straws to prepare for its future limited availability.

Implementation risks

7.19 Two major implementation risks were raised by stakeholders. The first was to do with issues of uniformity across Wales and England. Stakeholders argued that particularly amongst retail, supply chains for these products are interwoven and complex, and so policy amongst the two nations must be uniform in order to avoid further costs and complications to business. One major retailer reported that they have a great number of stores that are located near the England/Wales border, and that are often serviced from the same depot. A misaligned ban could pose complications in this context, e.g. home service deliveries from an English store into a Welsh home and vice versa. For this reason, they argued that any legislation in

this area would have to be pragmatic in terms of the business realities of an open border and a complex, highly integrated UK supply chain.

7.20 The second implementation risk centred on clear definitions of the products in question and what a SUP product is, generally. This was a sentiment felt by a majority of stakeholders consulted. Key questions to consider in terms of definitions include:

- What is the threshold for considering a plastic item single use? If manufacturers move from producing thin/flimsy spoons, for example, to heavier and machine-washable plastic spoons, is that still single use? There is no industry standard for this consideration.
- Confusion around oxo-degradable, biodegradable, oxo-biodegradable, and compostable, and which of these will and won't be affected by a ban on SUPs.
- The EU Directive states that a SUP is anything in which plastic is a main structural component of the product. Does this include a polymer barrier/coating? Other queries, such as what is considered a "natural polymer not chemically modified" (see paragraph 2.2) may be important to clarify as well.

7.21 While the SUP Directive provides a definition of 'plastic' and 'single use plastic' (see Section 2), it may be useful to provide examples and guidance for those stakeholders still struggling to understand the limits and definitions of what is in scope of a ban. DG Environment is also expected to provide guidelines on the Directive in July 2020.

8. Findings – Considerations in implementing legislation

Timing of a ban or restriction in sale

8.1 The SUP Directive states that Member States shall apply the ban from 3 July 2021, along with the laws, regulations and administrative provisions necessary to comply with this Directive. For many products in the ban there are readily available alternatives on the market, which perform functionally well in the most common applications, and so the ban is expected to result in a switch in most cases from the SUP product to a non-plastic alternative. The dates of announcing and enacting a ban should allow sufficient time for SUP products to work their way through the supply chain and for organisations to change their purchasing behaviour.

8.2 A staged approach was proposed by the BBIA (Bio-based and Biodegradable Industries Association) in the Defra consultation (Defra 2019). The BBIA gave an example from the Seychelles, which banned straws and EPS food containers with two stages: from a certain date, the import or manufacture of straws was banned; there was then a 6-month period to use up the straws already in circulation, during which straws were allowed to be used.

8.3 Whilst non-plastic alternative products are available, they do vary in their functional properties and price, as outlined in the research findings. As demand for non-SUP products rises in response to the ban, functional issues may be improved through product and material innovation, and prices may drop due to economies of scale.

8.4 A draft version of the SUP Directive was first proposed by the European Commission in May 2018 with a ban on the same products, excluding EPS food and drink containers, EPS cups and oxo-degradable plastics, which were added later. The final Directive was adopted in June 2019 and asks that the ban come into force in July 2021. By July 2021, three years will have elapsed since the ban was first proposed, and two years since the list of banned products was finalised.

8.5 For many products this is sufficient time for the market to respond, and an EU-wide ban should be viewed as a priority for any business directly affected, especially

manufacturers. However, some stakeholders say that a longer lead-in time is needed, specifically for beverage carton straws. Tetra Pak, makes the case for this clearly in a response to the Defra consultation (Defra 2019), stating that alternative paper-straw production technologies are currently not suited to high volume production in food-safe environments, and that significant R&D investments of over £30 million would be needed to develop alternatives, which they hope to offer by 2025. The Foodservice Packaging Association and Innocent requested at least 3 years to find a suitable environmentally friendly alternative for on-pack beverage carton straws.

Effects of a ban or restriction in sale

8.6 Based on our discussions with stakeholders and online research, we have identified three major effects that legislative bans can have on society. Firstly, announcing a ban raises the profile of the items considered for a ban, leading to higher coverage in the media of their negative effects (e.g. on the environment) and can subsequently reduce demand for these products (see 4.11). Secondly, it serves as a signalling effect to business to invest in other products that will not be under scope of a ban (see 7.2). Thirdly, it spurs innovation to design and develop alternative products and materials that can replace the banned item (see 7.10).

8.7 These effects are already happening for many of the SUPs in scope of this research. For example, in the past year alone, the market for plastic straws has experienced some significant changes. McDonalds UK began switching its plastic straws to a paper alternative in September 2018 (BBC, 2018). The fast food chain reportedly makes up approximately 15% of the total market for large drinking straws in the hospitality sector[20], meaning that at least 15% of that market has already shifted to using alternative materials. However, other high-street retailers have also started to take action, including Waitrose, Costa Coffee, Wagamama, JD Wetherspoon pubs, and Pizza Express, as well as more than 60 independent British festivals (BBC, 2018). These changes have occurred even before the legislative

[20] Using figures from a 2018 BBC report: BBC News Reality Check: Do we use 8.5 billion straws a year in the UK?

ban has gone into effect, which demonstrates the signalling effect a ban can have on businesses.

8.8 Legislative bans also can spur technological innovation. For example, as we have seen (see paragraph 7.11) SGMA, based in the UK, is in the process of bringing to market a coating solution that can be applied to paper products to make them 100% water impermeable (and 60% oil impermeable) without impacting the container's ability to be recycled. This coating technology could have major impacts to the food packaging industry. The company is already actively engaged in a programme to help Starbucks, McDonald's, Coca-Cola, Yum! Brands and the Worldwide Fund for Nature. A ban on EPS/XPS food and beverage containers may bring this technology, and others like it, to market quicker as demand increases for alternative products. Other innovations, such as a reusable beverage cup rental service specifically targeting event and festival locations, are being developed as well (Green Goblet, n.d.).

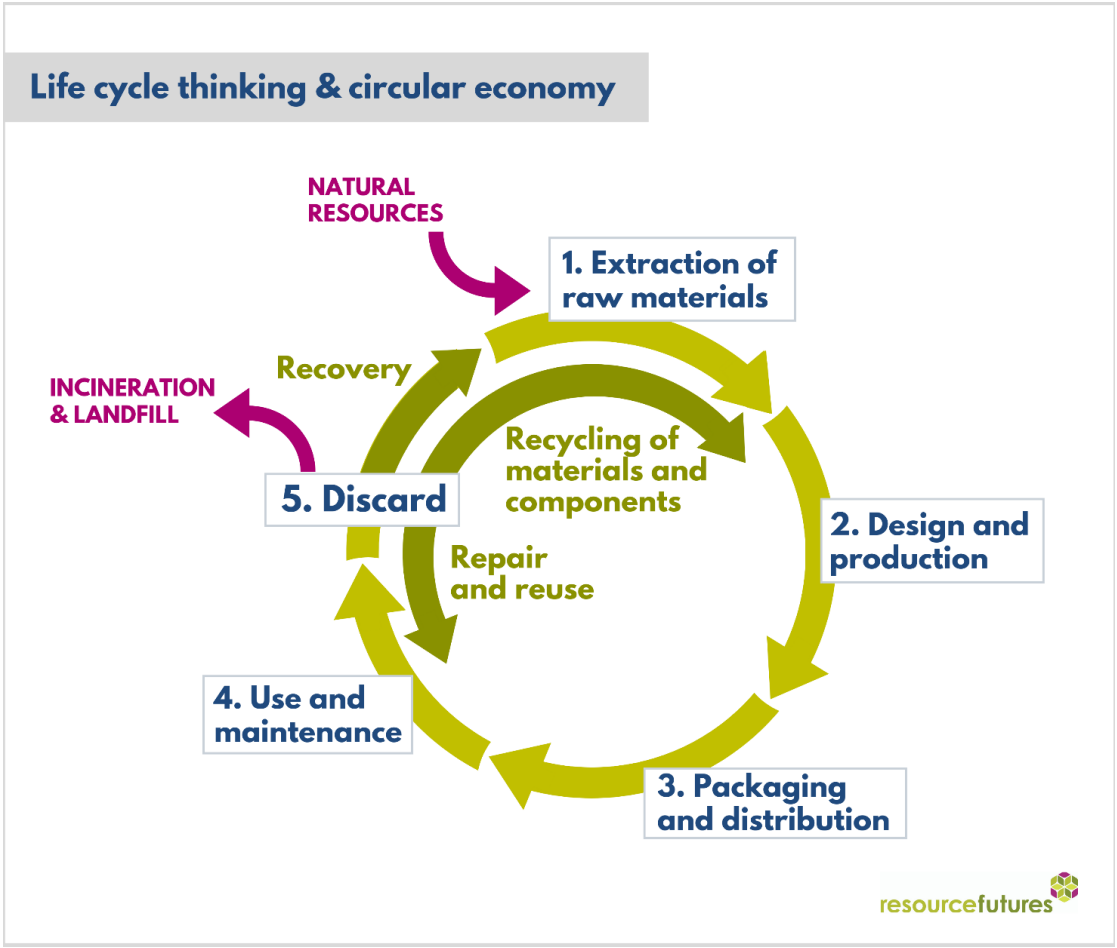
9. Findings – Life cycle thinking and life cycle analysis

Life cycle impacts and risks

9.1 Unintended consequences could result from the ban or restriction in sale if, in switching away from plastic products, alternative materials and behaviours themselves cause an effect of greater magnitude elsewhere at a different life cycle stage. The risk of unintended consequences must be carefully considered, and the text of a ban carefully drafted to mitigate or minimise any such risk.

9.2 Life Cycle Thinking can be used to assess some of these risks and inform decision making to reduce the overall risk to the environment. In assessing risks across the entire life cycle of a product it can help prevent potential ‘burden-shifting’ from one impact area to another, e.g. reducing marine litter but increasing greenhouse gas emissions or shifting impacts from end of life to the production or use phases.

Figure 9.1. Relationship between life cycle thinking and circular economy



Source: Adapted from Genselective webpage

9.3 Life Cycle Thinking may be applied qualitatively to identify and better appreciate the risks of product substitution resulting from a product ban. Life Cycle Assessment studies (LCAs) can provide detailed quantitative analysis to estimate the scale and severity of the impacts of different product alternatives at each life cycle stage cradle to cradle and show their effects on different types of environmental pollution impact. Figure 9.1 summarises the main life cycle stages involved in supplying a product such as packaging. It shows the relationship between life cycle thinking and LCA and circular flow of resources in a circular economy.

Life cycle thinking

9.4 An important question when considering impacts across the full life cycle, is to compare the functional performance of SUP products and their non-plastic

alternatives i.e. are the products comparable in terms of strength/ durability/ application during its intended use? Is it functionality equivalent? Or is it adequate/ fit for purpose? Many of the products in the ban have multiple uses and markets and each must be carefully considered to avoid unintended consequences.

9.5 The EU SUP Directive provides exemptions to the ban for cotton buds and straws in medical uses. The literature review identified that there are specific medical needs with regards to straws, in which non-plastic disposable straws are thought to be lacking in suitable functionality. Professional and industrial use of balloon sticks is exempt in the SUP Directive where they are not distributed to consumers.

9.6 Stakeholders consulted in this research also indicated that plastic cutlery is often used in prisons, aircraft, and other security critical environments to avoid risks associated with other materials. These markets should be considered for exemption if it is found that the non-plastic alternative products are not suitable.

9.7 A follow-on question in life cycle thinking regards the number of products or weight of material that is needed to fulfil the same function. There is a risk that non-plastic alternatives will not perform as well or more material is needed to match the performance of plastic resulting in increased environmental impacts. For example, stakeholder consultation previously indicated that EPS/XPS exhibits particular properties which are difficult to match (Resource Futures, 2019a). It is lightweight and has high insulation benefits, being 93% air, is impermeable and retains its shape and strength. Non-plastic fibre-based cups and trays are typically double walled or thick to match functionality of EPS/XPS. Whilst the fibre-based products might be more environmentally benign from a marine litter perspective, they are heavier and manufacturing and distribution impacts in the supply chain will be different.

9.8 Furthermore, consumer groups have raised concerns over alternative materials containing substances potentially harmful to human health, particularly for food-contact packaging, e.g. reports that aromatic amines (carcinogens) have been found in paperboard-based food packaging (BEUC, 2019), Polyfluoroalkyl

substances (PFAS) have been found in bagasse packaging (CEH, 2018), and formaldehyde resin used in bamboo packaging (Wessling, 2019).

9.9 A very basic life cycle comparison of the impact associated with the different product weights was undertaken in the modelling for this research based on product weight and disposal impact using UK Government Greenhouse Gas (GHG) Conversion Factors for Company Reporting. The modelling shows that the GHG impacts of SUP products and their alternatives are small as the products are comparatively lightweight and the total tonnage of material placed on market is relatively small. The analysis did not account for the effect of weight differences on transport impacts in the supply chain. However, the risk of contributing significant and adverse global warming impact is low - and very low compared with other societal choices.

Life cycle analysis studies

9.10 LCA studies assess a wide range of environmental impacts and can assist in a holistic comparison of two competing products or systems. They do not measure the impacts for reducing litter or reducing consumption, but when policies have been assessed against these aims an LCA can be used to highlight other impact areas and avoid transferring risk to other areas of the environment.

9.11 There is often a compromise or trade-off between products, with one performing better against one impact area (e.g. global warming potential) and worse in others (e.g. NOx air pollutants). LCA results must be interpreted in terms of which impact areas are a priority. Climate change is a political and scientific priority, and LCA allows us to balance this impact against other environmental concerns, such as air quality, water and land-use. It is important not to prioritise one environmental concern at the cost of all others, as the petrol vs. diesel debate illustrated in recent years. The findings from two key LCA studies are discussed below.

9.12 An LCA study for the European Commission (European Commission, 2018b) assessed some of the SUP products proposed for a ban. An extract of the key results is reproduced in Annex A. The single-use non-plastic products assessed were paper cotton bud sticks, wooden cutlery, paper straws, wooden stirrers, and

paperboard/wax containers. Multi-use items were assumed to have between 500 to several thousand uses, and so the impact of manufacturing and raw materials is very small per use. The impacts of washing multi-use items was also included in the LCA and dominates the results.

9.13 The study found that the single-use non-plastic alternatives are comparable in many of the impacts assessed, outperforming SUPs in some areas and having greater impacts in others. Typically, fossil CO2 and methane emissions are reduced by avoiding plastic, whereas non-fossil CO2 is increased. The multi-use products are assessed in best- and worst-case scenarios. Best-case is comparable to impacts of single-use for many of the products, whereas worst-case shows significantly increased impacts. The exception to this is a food container, which present much lower impacts in multi-use in both the best- and worst-case scenarios than the SUP item (a polystyrene clamshell).

9.14 The European Commission LCA suggests that washing systems for reusable products need to be carefully considered and performance improvements sought where possible. Further decarbonisation of the grid will also reduce these negative impacts. The Impact Assessment for the EU SUP Directive (European Commission, 2018a) comments that the main parameters in the LCA "show a decrease in impacts, though for some options, there might be a minor increase in land use due to a switch to paper and wood".

9.15 Following the publication of the EU SUP Directive, the Danish EPA published an LCA study focussing on SUPs and single-use non-plastic alternatives (Takou et al., 2019). The products assessed were cotton buds, cutlery, plates, food containers, straws and stirrers. The study assumed a global production supply chain and waste management in Denmark, with paper and wood products incinerated at end-of-life. Climate change, particulate matter, fossil resource depletion and element resource depletion were identified as the categories with the largest potential impacts.

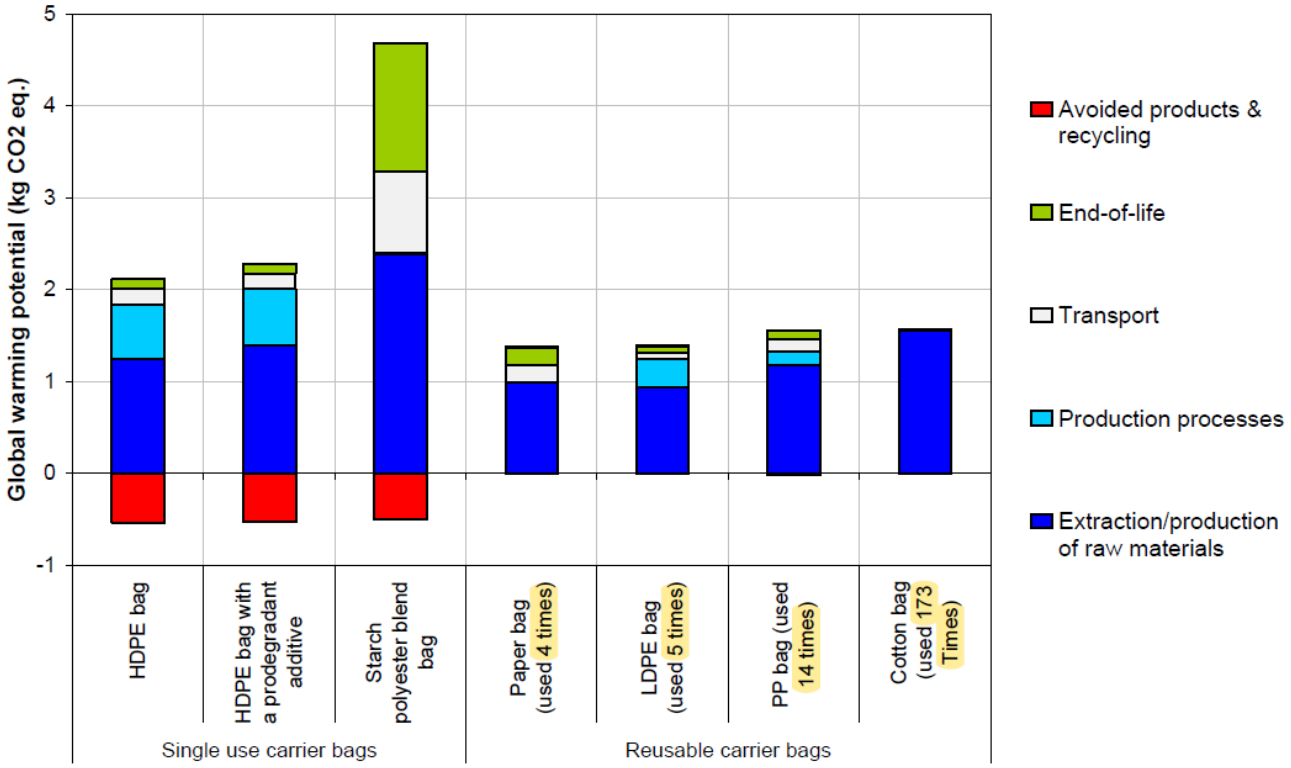
9.16 In the Danish LCA study, single-use non-plastic products performed better or on the same level as SUPs, on the whole. In sensitivity analysis which considered indirect land use changes from paper and wood production the benefit of non-plastic

alternatives was reduced, although this typically depended on the weight of the non-plastic product as to whether it outperformed SUP or not. This highlights the need to optimise and lightweight non-plastic products wherever possible whilst maintaining the functional performance of the product. The authors further add “it is important to keep in mind, that using biomass as raw material for the single-use non-plastic products can also have environmental impacts, due to the indirect land use changes that their procurement can include. This stresses the fact that non-plastic options can be problematic as well”.

9.17 An American LCA study on EPS was inconclusive as to which material was preferential: EPS, Paperboard or PLA (American Chemistry Council, 2016). Modelling undertaken by Biopack indicated that bagasse has roughly half the manufacturing carbon footprint of EPS, but a full LCA study is recommended to account for impacts across the entire supply chain (Resource Futures, 2019a).

9.18 Carrier bags are one of the current applications for oxo-degradable plastics. An Environment Agency LCA (Environment Agency, 2011) compared carrier bags in terms of disposable HDPE bags, disposable oxo-degradable HDPE bags (termed a prodegradant additive), disposable biopolymer (starch-polyester blend) bags, and reusable bags. Overall, the oxo-degradable bag was found to have very similar impacts to the conventional HDPE bag. The results for global warming potential are shown in Figure 9.2, with results for reusable bags shown for the number of times they must be reused in order to outperform a conventional HDPE bag.

Figure 9.2. The global warming potential impacts of each type of carrier bag assuming each is reused to outperform a conventional HDPE bag with no reuse



Source: Environment Agency, 2011

9.19 If the disposable HDPE bag is reused once as a bin liner or multiple times, e.g. to carry shopping, then the impacts per use are reduced. A summary of the main study findings is presented in Table 9.1**Error! No text of specified style in document.**, comparing reusable paper, plastic and cotton bags to a disposable HDPE bag used once or up to 3 times. The global warming potential impacts of the disposable oxo-degradable HDPE bag were very similar to the conventional HDPE bag and so it is assumed that the results also broadly serve as a comparison to this type of bag.

Table 9.1 Error! No text of specified style in document.**. The number of times bags need to be used to result in the same CO2eq emissions as single-use HDPE**

Type of carrier	HDPE bag (no secondary use)	HDPE bag (40.3% reused as bin liners)	HDPE bag (100% reused as bin liners)	HDPE bag (used 3 times)
Paper bag	3	4	7	9
LDPE bag	4	5	9	12
Non-woven PP bag	11	14	26	33
Cotton bag	131	173	327	393

Source: Environment Agency, 2011

9.20 Overall, in the case of carrier bags, the results suggest that switching from oxo-degradable HDPE to conventional HDPE reduces the GHG emissions slightly, but 'reusable' products must be reused many times to achieve similar performance. Paper bags, which are often perceived to be more environmentally friendly, need to be used three to nine times before they outperform disposable HDPE bags. Cotton bags must be used several hundreds of times to overcome the benefit of using a lightweight HDPE disposable bag.

9.21 LCA studies typically consider a simple material-product substitution and so results must be considered in the light of behaviour change aspects that may result from a ban. As already discussed, switching materials in single-use products can result in changes in functionality, such as the strength and durability. Conversely, consumers may choose to use fewer products once the environmental impacts are highlighted, and so a ban may reduce overall consumption. Future behaviour change is difficult to predict and outside the scope of this research study.

9.22 As discussed, LCA studies assess impacts across a large number of environmental areas. Results should be interpreted according to of which impact areas are considered a priority, and priorities may vary by location and stakeholder group. On the whole, the LCA studies discussed above suggest that the SUPs they assessed

generally have a similar scale of environmental impacts to single-use non-plastic alternatives. Overall, these studies did not show that significant impacts have been shifted to another impact area or part of the value chain.

10. Findings – Model impact estimates

Assumptions made regarding the scenarios modelled

10.1 Following stakeholder discussions, further qualitative and quantitative analysis was undertaken to understand the potential magnitude of the impacts of a ban. For EPS/XPS food containers and EPS/XPS cups, a specific proportion of the market was modelled to reflect activities of small and medium sized business and organisations, as the predominant uses of EPS/XPS products.

10.2 The model baseline described the estimated quantity of products placed on market each year and the % market share held by SUP products. Non-plastic alternatives are readily available for all products within the scope of the ban, and currently have differing proportions of the market share. For example, most cotton buds sold now use non-plastic sticks. For modelling purposes, we assume 30% of the market remains plastic. Similarly, a large proportion of the market for drinking straws has now shifted to paper straws. On the other hand, EPS/XPS still dominates in parts of the small and medium-sized (SME) food container and cup market, e.g. for food vans and fast food outlets.

10.3 Implementation profiles were represented in the impact model for both 'Ban' and 'No Ban' scenarios. These were informed by the discussions with stakeholders. The scenarios modelled for a central estimate are described in this subsection. Two scenarios are modelled:

1) Ban scenario: legislative ban
2) No Ban scenario: voluntary change/do nothing

10.4 The Ban scenario assumes that a legislative ban will be implemented and come into force by 3 July 2021 in accordance with EU SUP Directive Article 5. It is assumed that by 2022 the market for these products will have shifted to non-plastic alternatives, with a very small proportion of the market still using SUP products under the exemptions in the Directive and small-scale imports unaware or not adhering to the ban.

10.5 The No Ban scenario represents the anticipated change in markets in the absence of a policy intervention. In this scenario leading businesses and organisations continue to reduce avoidable product use and find non-plastic alternatives. The government would also continue to provide support measures – engagement with trade associations and bodies to promote the desired product and behavioural changes and innovation support could be provided to Welsh product suppliers and manufacturers to help them to innovate and invest where alternatives were not already present in the market. The rate at which the market voluntarily shifts away from SUP products and the depth of that shift is based on the accumulated research for each product. Any such forecast of behaviour change and market response carries a level of inherent uncertainty.

10.6 Figure 10.1 and Figure 10.2 show the projections of market share for SUP products in Wales in the Ban and No Ban scenarios. The grouping of products is purely for presentation purposes to make the figures easier to read. Figure 10.1 shows projections for group 1 – cotton bud sticks, beverage stirrers, drinking straws, and beverage carton straws. Figure 10.2 shows projections for group 2 – plates, cutlery, balloon sticks, and SME food containers and cups (i.e. the market modelled for EPS/XPS food containers and cups).

Figure 10.1. Market share of SUP products in Wales in Ban and No Ban scenario – Group 1 SUP products

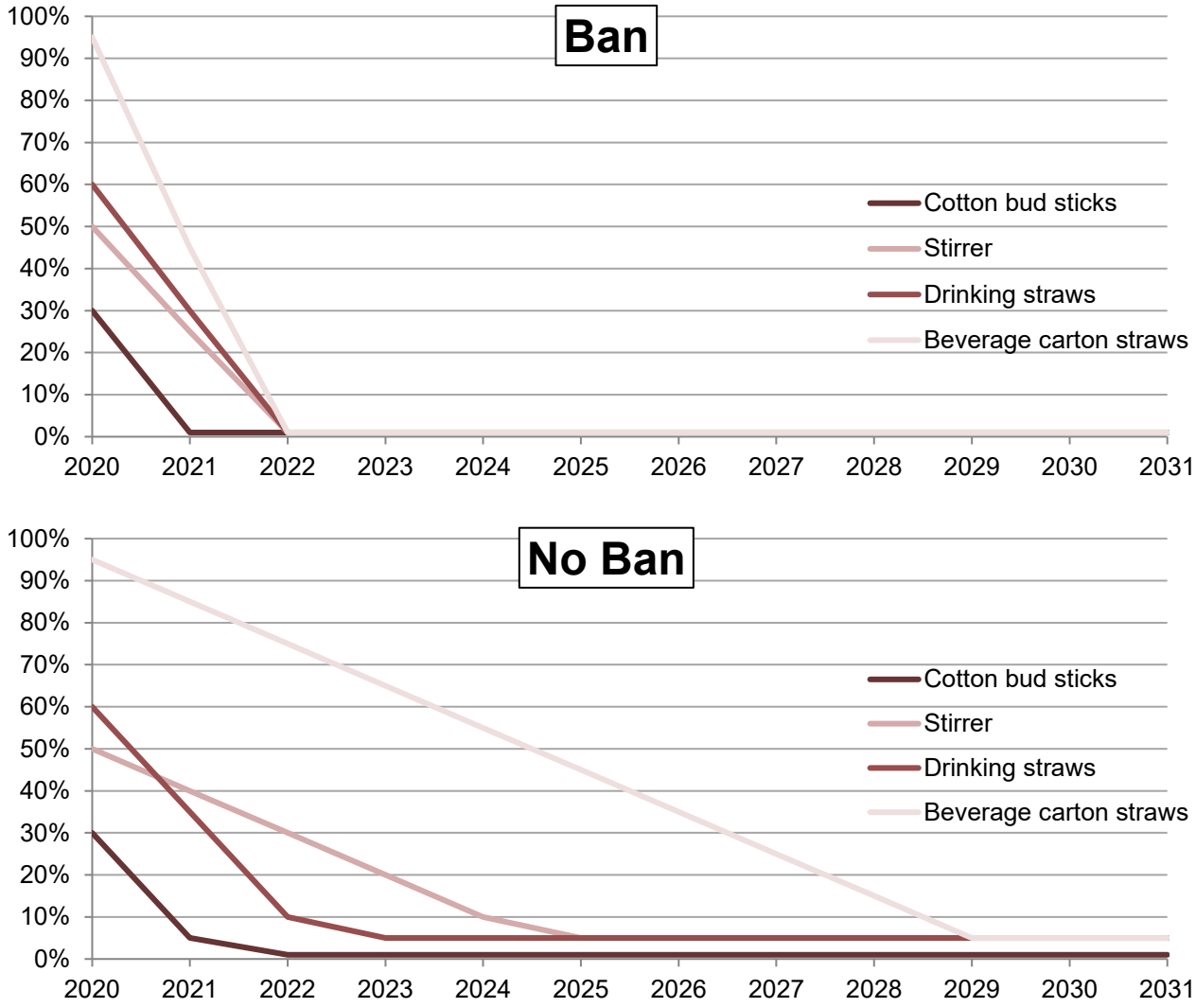
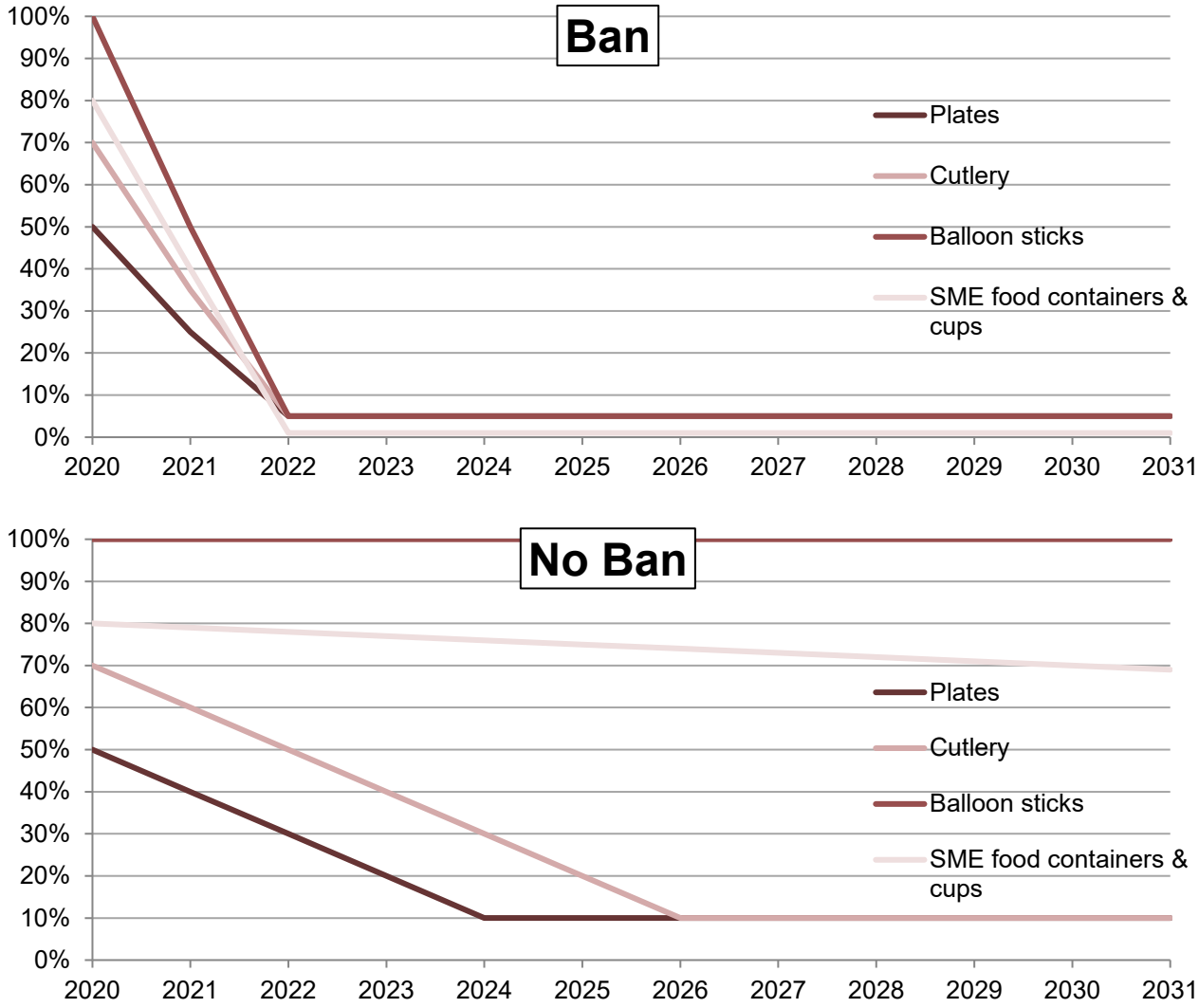


Figure 10.2. Market share of SUP products in Ban and No Ban scenario – Group 2 SUP products



10.7 Table 10.1 shows the volume estimates of the individual units placed on market, and the plastic and non-plastic share of the market, as relates to the baseline year of 2020 in Figure 10.1 and Figure 10.2 The background to these estimates is given in Section 5 above.

Table 10.1. Baseline assumption of volumes placed on market in Wales, millions of units

	Plastic	Non-plastic	Total
Cotton bud sticks	30	70	100
Stirrer	6	6	11
Drinking straws	120	80	199
Beverage carton straws	54	3	57
Plates	29	29	59
Cutlery	159	68	226
Balloon sticks	1	0	1
SME food containers	38	9	47
SME takeaway cups	26	7	33

10.8 The main effect of the ban modelled is that consumption will shift dramatically to non-plastic products, as described above. We also assume that a ban will affect the market growth rate, i.e. the total volume of single-use products sold in future years irrespective of whether they are plastic or not. The markets for single-use straws, cotton bud sticks, stirrers, plates, cutlery and balloon sticks are assumed to be shrinking by 1% per annum, as public awareness around these products is already relatively high. In many markets, these products are not deemed ‘necessary’ by consumers. Whilst increasing the utility of an experience, such as drinking a soft drink, eating outside, or enjoying a celebration, increasingly consumers and businesses are looking to reduce consumption or find reusable solutions. In other instances, their use is habitual or involuntary, such as being provided a small straw with mixed alcoholic drinks, and increasingly cultural shifts and environmental considerations are reducing use. Under a ban this is assumed to shrink at 2% per annum, due to additional public and media attention.

10.9 The markets served by the EPS/XPS products in scope, SME food and beverage containers and cups, is assumed to be growing roughly in line with the takeaway market (Just Eat, 2017). In these markets, containers and cups are deemed necessary and reusable systems are more difficult to implement, and so it is assumed the single-use market is less likely to shrink for these products.

10.10 Enforcement costs would be incurred by Local Authorities' trading standards bodies, and other regulatory costs would include ongoing management costs for Government and one-off costs of advertising the ban and introducing the legislation. Parallels can be drawn from previous legislation. A regulatory impact assessment was conducted before measures on single-use carrier bags were introduced in Wales (Welsh Government, 2010). The study considered a ban as one option and estimated one-off costs of £400,000 advertising the ban and £180,000 introducing the legislation, with ongoing annual costs for Government of £180,000 management costs and £500,000 enforcement costs. A charge rather than a ban was implemented, and a post-implementation review reported £80,000 per annum staff costs (i.e. management) (Welsh Government, 2016).

10.11 The Welsh Government took a light-touch approach to introducing the carrier bag charge. Local Authorities were not asked to actively seek infringements of the legislation, instead responding to public reports of non-conformance. Trading standards adopted an education and support role, working with companies to help them comply with the law. As a result, cases were resolved without prosecution and enforcement costs were kept low.

10.12 Regulatory implementation costs will depend on the approach taken. For the purposes of the model we have assumed £100,000 one-off costs to introduce the ban and £100,000 ongoing annual management and enforcement costs based in part on the expected scale of markets and stakeholders affected and assuming a similar cost-efficient, light-touch approach is taken to enforcement. These costs should be revisited once more detailed stakeholder consultation has taken place.

10.13 There is expected to be a small additional business burden estimated for each product associated with transition costs on suppliers and retailers, which is represented in the business costs. The exact costs and the period they were incurred over would need to be confirmed in formal stakeholder consultation regarding a ban.

Economic impacts

10.14 Table 10.2 provides a summary of the impact estimates of the ban, i.e. a sum of combined impacts for all products. The estimates are net present value (NPV) over a ten-year period from 2021 to 2030 and rounded to **three significant figures**. Due to rounding values differences between the scenarios may not sum exactly. All figures **exclude VAT**. The impact estimates relate to products placed on the market in Wales.

Table 10.2. All products, financial impact estimates, NPV 2021 to 2030 (£m)

	Ban (Column A)	No Ban (Column B)	Difference - Ban over No Ban (C = A – B)	Difference - % change from No Ban
Financial costs to the economy				
Regulatory implementation cost	0.9	none	0.9	n/a
Business implementation cost	0.7	0.5	0.2	+43%
Waste treatment cost	1.6	1.4	0.3	+19%
Clean-up cost	11.6	11.8	-0.2	negligible
Cost to fishing industry	negligible	0.1	-0.1	-91%
Economic growth impacts				
Sales value	144.0	130.0	14.1	+11%
Revenues to UK manufacturing	27.5	18.9	8.6	+46%
Environmental and social impacts				
UK - Value of traded CO2e	0.3	0.6	-0.3	-44%
UK - Value of non-traded CO2e	0.2	0.2	negligible	negligible
EU - Value of traded CO2e	0.1	0.2	negligible	negligible
EU - Value of non-traded CO2e	negligible	negligible	negligible	negligible
RoW - Value of CO2e	0.3	0.4	-0.1	-28%
Terrestrial litter visual disamenity	23.6	24.0	-0.4	negligible
Beach litter visual disamenity	0.2	2.6	-2.4	-91%

10.15 The relative impact of the ban can be seen in column C, showing the difference of the Ban scenario over the No Ban scenario. This difference is primarily a product of the speed and depth of change that is modelled in the market for each scenario,

and for some products a signalling effect from a ban reducing overall consumption of both plastic and non-plastic products.

10.16 The greatest economic impacts are seen in the increased sales value which increased by 11% (£14 million) across the product group as a whole, driven by the price difference between plastic and non-plastic products. It is not clear the degree to which the increased costs will be absorbed by Welsh businesses and the degree to which it will be passed on to the consumer; nor indeed the price elasticity of demand for the products (in the absence of reliable information, we have simply assumed that consumers will be willing to pay more for higher priced alternatives where necessary). However, it must be born in mind that the products in the ban are often served as part of food and drink service and would constitute a small portion of the total cost irrespective of whether plastic or non-plastic products are used. If demand for non-plastic products increases dramatically following the ban then the sale price could reduce as manufacturers take advantage of economies of scale, and these increased cost impacts would reduce. As the price elasticity of these products is unknown the estimates above assume that the product price for non-plastic products remains constant.

10.17 The revenue to UK manufacturers is the second most significant economic impact, being closely related to the sales value, which increases by 46% (£9 million). This revenue could be retained in the Welsh economy if Welsh manufacturers respond to the demand for non-plastic products. Indeed, as these products are also likely to be banned across the EU there are significant opportunities for an export market. However, manufacturers of plastic products will lose revenue, and these losses are accounted for in the estimated impacts.

10.18 Companies in Wales will incur costs where investment is needed to transition from SUP to alternative products (see, for example paragraphs 7.8 and 8.5 above). One major EPS manufacturer estimated that a one-off capital investment would be needed to convert existing EPS packaging manufacturing capacity, or establish new packaging production capacity for EPS-free products in the UK (Resource Futures, 2019a). This manufacturer does not have any plants in Wales, but another company was identified manufacturing EPS food containers (clamshells and trays). In total

the market mapping identified five manufacturers of SUP products that may be affected in Wales. It is hoped that these companies and others engage in public consultation on the ban and can provide further information on the investment costs needed. Although the net impact on revenue from sale of products is estimated, until further detail is provided, the investment costs are not estimated in Table 10.2.

10.19 The most significant environmental and social impact shown relates to the visual disamenity cost of beach litter. The terrestrial visual disamenity costs were highest (£24 million) but the impact of the ban was relatively small (£0.4 million reduction in costs) because most terrestrial litter is cleaned up quicker than the decomposition time of the non-plastic materials. Beach litter visual disamenity costs are smaller (£2.6 million) but a ban could reduce this by 91% (£2.4 million reduction in costs).

10.20 Switching from plastic to materials that degrade quicker in the marine environment will reduce the amount of litter accumulating over time and therefore reduce these impacts. Any overall reduction in consumption of the products (irrespective of whether plastic or non-plastic) will also contribute to this benefit as fewer items will be littered in general. However, there is a large degree of uncertainty in the litter costs and benefits, not least because litter survey data does not provide granular detail on most of the individual products in question, and these are counted and reported in broader categories as well as the many pieces of plastic and EPS/XPS found that cannot be identified as coming from a specific product. A sensitivity range is explored in the report section below due to the uncertainty around this estimate.

10.21 The visual disamenity is one element of litter that can be estimated in economic terms. However, it does not necessarily reflect the full impact of plastic pollution on the marine environment, wildlife and ecosystems, which is not yet fully understood. The threat of microplastic pollution, as plastic litter breaks down into smaller and smaller pieces, is a current knowledge gap that needs to be filled. The fragmenting of plastic litter is illustrated in the marine litter survey data, which consistently counts unidentified plastic pieces as the most common type of litter.

10.22 Unlike for beach litter, which remains in situ more than urban/street litter, the switch in materials is not anticipated to deliver significant benefits to terrestrial litter problems, as in most instances litter is cleaned up faster than paper and wood can biodegrade. Overall consumption reduction resulting from a ban may provide some small benefits, e.g. as consumer and businesses choose to use fewer items, and the potential for reuse and product innovation.

10.23 Clean-up costs are based on an estimate of £70m per annum for all litter in Wales (UK Parliament, 2017)[21]. Stat Wales reports a net cost of £53m[22], which encompasses sweeping and removal of litter from land, litterbins etc., but excludes highways, countryside, schools and other services, and so the £70m estimate is considered more representative of the total clean-up cost. A proportion of the total clean-up cost is attributed to the products in the ban on the basis of terrestrial litter surveys. However, any small reduction in litter volumes is unlikely to translate to cost savings as street cleansing efforts are likely to require the same resources to maintain the frequency of clean-up activities.

10.24 Carbon emission impacts are on the whole minimal, with a small reduction in traded CO2e emissions in the UK as the result of a ban, and an even small reduction in global emissions outside of the EU.

10.25 Analysis of key economic impacts for individual products is presented in Annex C.

Sensitivity analysis

10.26 Two rounds of sensitivity analysis were conducted to test upper and lower values for data identified as having the greatest uncertainty and that could have the greatest effect upon the model impact estimate results. The data limitations and the approach to sensitivity analysis is described in Section 3.

10.27 The sensitivity analysis tested uncertainty in the market growth rate assumptions. The sensitivity analysis values used are presented Table 3.3. in Section 3. The results of this sensitivity analysis are presented in Table 10.3 and Table 10.4 below.

[21] Estimated cost of sweeping and removal of litter from land, litterbins, rubbish/litter on highways (e.g. carriageway sweeping) and also clean-up costs incurred by leisure, schools, countryside and other services.
[22] 2018-19, Street cleansing (not chargeable to highways), Revenue outturn expenditure summary, by service

Table 10.3. Market growth rate uncertainty - lower sensitivity results, all products, NPV 2021 to 2030 (£m)

	Central - Ban (£m) (Column A)	Central - No Ban (£m) (Column B)	Central - Difference - Ban over No Ban (C = A – B)	Lower - Ban (£m) (Column D)	Lower - No Ban (£m) (Column E)	Lower - Difference - Ban over No Ban (F = D – E)	Lower Difference - % change from Central Difference (C and F)
Financial costs to the economy							
Regulatory implementation cost	0.9	none	0.9	0.9	none	0.9	none
Business implementation cost	0.7	0.5	0.2	0.7	0.4	0.3	+22%
Waste treatment cost	1.6	1.4	0.3	1.3	1.1	0.2	-43%
Clean-up cost	11.6	11.8	-0.2	9.4	9.9	-0.5	-162%
Cost to fishing industry	negligible	0.1	-0.1	negligible	negligible	negligible	+27%
Economic growth impacts							
Sales value	144.0	130.0	14.1	117.0	110.0	7.0	-50%
Revenues to UK manufacturing	27.5	18.8	8.6	21.1	15.8	5.3	-39%
Environmental and social impacts							
UK - Value of traded CO2e	0.3	0.6	-0.3	0.3	0.5	-0.2	+13%
UK - Value of non-traded CO2e	0.2	0.2	negligible	0.2	0.2	negligible	-16%
EU - Value of traded CO2e	0.1	0.2	negligible	0.1	0.1	negligible	negligible
EU - Value of non-traded CO2e	negligible	negligible	negligible	negligible	negligible	negligible	-44%
RoW - Value of CO2e	0.3	0.4	-0.1	0.2	0.3	-0.1	negligible
Terrestrial litter visual disamenity	23.6	24.0	-0.4	19.2	20.2	-1.0	-162%
Beach litter visual disamenity	0.2	2.6	-2.4	0.5	2.2	-1.7	+27%

Table notes: Cumulative range impact estimates for all products combined; absolute values in ban and no ban for central and lower estimates, and comparison of difference between ban and no ban - calculated values and percentage change from the central estimate. Note that high percentage change figures may not be significant where absolute values are low.

Table 10.4. Market growth rate uncertainty - upper sensitivity results, all products, NPV 2021 to 2030 (£m)

	Central - Ban (£m) (Column A)	Central - No Ban (£m) (Column B)	Central - Difference - Ban over No Ban (C = A – B)	Upper - Ban (£m) (Column D)	Upper - No Ban (£m) (Column E)	Upper - Difference - Ban over No Ban (F = D – E)	Upper Difference - % change from Central Difference (C and F)
Financial costs to the economy							
Regulatory implementation cost	0.9	none	0.9	0.9	none	0.9	none
Business implementation cost	0.7	0.5	0.2	0.7	0.4	0.3	+22%
Waste treatment cost	1.6	1.4	0.3	1.7	1.4	0.3	negligible
Clean-up cost	11.6	11.8	-0.2	12.1	12.1	none	+100%
Cost to fishing industry	negligible	0.1	-0.1	negligible	0.1	negligible	+12%
Economic growth impacts							
Sales value	144.0	130.0	14.1	154.0	138.0	16.1	+14%
Revenues to UK manufacturing	27.5	18.8	8.6	27.1	19.3	7.8	-9%
Environmental and social impacts							
UK - Value of traded CO2e	0.3	0.6	-0.3	0.4	0.6	-0.3	negligible
UK - Value of non-traded CO2e	0.2	0.2	negligible	0.2	0.2	negligible	+32%
EU - Value of traded CO2e	0.1	0.2	negligible	0.1	0.2	negligible	+4%
EU - Value of non-traded CO2e	negligible	negligible	negligible	negligible	negligible	negligible	negligible
RoW - Value of CO2e	0.3	0.4	-0.1	0.3	0.4	-0.1	-10%
Terrestrial litter visual disamenity	23.6	24.0	-0.4	24.6	24.6	none	+100%
Beach litter visual disamenity	0.2	2.6	-2.4	0.5	2.6	-2.1	+12%

Table notes: Cumulative range impact estimates for all products combined; absolute values in ban and no ban for central and upper estimates, and comparison of difference between ban and no ban - calculated values and percentage change from the central estimate. Note that high percentage change figures may not be significant where absolute values are low.

10.28 The market growth sensitivity analysis highlights the impact that the signalling effect of a ban could have, i.e. if overall consumption of these single-use products is reduced. In relative terms, the most pronounced effect is on terrestrial litter impacts such as cleanup costs and visual disamenity (estimated benefits increase by 162%). In absolute terms, the greatest impact is on sales value (reduced by £7.1 million) and revenues to UK manufacturing (reduced by £3.3 million) as the size of the single-use market for these products is affected.

10.29 The second sensitivity analysis tested other areas identified as having the data limitations that could significantly impact upon the overall results. This sensitivity analysis varies assumptions around the volume of sales units placed on market, unit weights and prices, the speed at which the market will shift voluntarily without a ban, the proportion of the market served by imports into the UK, and the litter impacts associated with these products. The sensitivity values tested are presented in Table 3.4., and Table 3.5. in Section 3. The results of this sensitivity analysis is presented in Table 10.5. and Table 10.6. The results reflect the combined effect of sensitivity values tested, which do not act in the same direction for all impact areas.

Table 10.5. Other uncertainties around the central estimate - lower sensitivity results, all products, NPV 2021 to 2030 (£m)

	Central - Ban (£m) (Column A)	Central - No Ban (£m) (Column B)	Central - Difference - Ban over No Ban (C = A – B)	Lower - Ban (£m) (Column D)	Lower - No Ban (£m) (Column E)	Lower - Difference - Ban over No Ban (F = D – E)	Lower Difference - % change from Central Difference (C and F)
Financial costs to the economy							
Regulatory implementation cost	0.9	none	0.9	0.9	none	0.9	none
Business implementation cost	0.7	0.5	0.2	0.7	0.4	0.3	+22%
Waste treatment cost	1.6	1.4	0.3	0.9	0.8	0.1	-73%
Clean-up cost	11.6	11.8	-0.2	5.8	5.9	-0.1	+47%
Cost to fishing industry	negligible	0.1	-0.1	negligible	negligible	negligible	+56%
Economic growth impacts							
Sales value	144.0	130.0	14.1	58.4	63.7	-5.4	-138%
Revenues to UK manufacturing	27.5	18.8	8.6	13.0	13.1	-0.1	-101%
Environmental and social impacts							
UK - Value of traded CO2e	0.3	0.6	-0.3	0.2	0.5	-0.2	+6%
UK - Value of non-traded CO2e	0.2	0.2	negligible	0.1	0.1	negligible	+49%
EU - Value of traded CO2e	0.1	0.2	negligible	0.1	0.1	negligible	+12%
EU - Value of non-traded CO2e	negligible	negligible	negligible	negligible	negligible	negligible	-72%
RoW - Value of CO2e	0.3	0.4	-0.1	0.2	0.2	-0.1	+19%
Terrestrial litter visual disamenity	23.6	24.0	-0.4	3.2	3.3	-0.1	+86%
Beach litter visual disamenity	0.2	2.6	-2.4	0.2	0.9	-0.7	+69%

Table notes: Cumulative range impact estimates for all products combined; absolute values in ban and no ban for central and lower estimates, and comparison of difference between ban and no ban - calculated values and percentage change from the central estimate. Note that high percentage change figures may not be significant where absolute values are low.

Table 10.6. Other uncertainties around the central estimate - upper sensitivity results, all products, NPV 2021 to 2030 (£m)

	Central - Ban (£m) (Column A)	Central - No Ban (£m) (Column B)	Central - Difference - Ban over No Ban (C = A – B)	Upper - Ban (£m) (Column D)	Upper - No Ban (£m) (Column E)	Upper - Difference - Ban over No Ban (F = D – E)	Upper Difference - % change from Central Difference (C and F)
Financial costs to the economy							
Regulatory implementation cost	0.9	none	0.9	0.9	none	0.9	none
Business implementation cost	0.7	0.5	0.2	0.7	0.6	0.1	-38%
Waste treatment cost	1.6	1.4	0.3	2.4	2.3	0.1	-64%
Clean-up cost	11.6	11.8	-0.2	23.1	23.5	-0.4	-114%
Cost to fishing industry	negligible	0.1	-0.1	negligible	negligible	negligible	+47%
Economic growth impacts							
Sales value	144.0	130.0	14.1	327.0	313.0	14.6	+4%
Revenues to UK manufacturing	27.5	18.8	8.6	27.3	24.1	3.2	-63%
Environmental and social impacts							
UK - Value of traded CO2e	0.3	0.6	-0.3	0.2	0.3	-0.1	+52%
UK - Value of non-traded CO2e	0.2	0.2	negligible	0.3	0.5	-0.2	-572%
EU - Value of traded CO2e	0.1	0.2	negligible	0.3	0.3	negligible	+74%
EU - Value of non-traded CO2e	negligible	negligible	negligible	negligible	negligible	negligible	-69%
RoW - Value of CO2e	0.3	0.4	-0.1	0.6	0.7	-0.1	+17%
Terrestrial litter visual disamenity	23.6	24.0	-0.4	81.2	82.6	-1.4	-270%
Beach litter visual disamenity	0.2	2.6	-2.4	1.3	2.9	-1.7	+31%

Table notes: Cumulative range impact estimates for all products combined; absolute values in ban and no ban for central and upper estimates, and comparison of difference between ban and no ban - calculated values and percentage change from the central estimate. Note that high percentage change figures may not be significant where absolute values are low.

10.30 The main effect of this sensitivity analysis is upon sales value and revenues to UK manufacturing. For sales value, a key driver is the product unit prices. The preliminary market research presented earlier found non-plastic products are not much more expensive than SUPs for many of the products. In the sensitivity analysis the modelled prices of non-plastic products were halved (e.g. through future market growth, economies of scale and increased competition), or doubled (e.g. if non-plastic alternatives are at least double the price of SUP products and continue to be so for the next 10 years). This represents a very broad range of possible price points. In the lower sensitivity implementing a ban creates a cost saving to consumers and businesses purchasing these products. In the upper sensitivity, the overall market value increases but the impact of the ban is not significantly altered.

10.31 The sensitivity also covered uncertainty in litter data (halving / doubling the proportion of litter made up of these products) and visual disamenity estimates (testing the upper and lower bounds derived from willingness to pay studies). The most profound impact of this is seen in the upper sensitivity results where terrestrial litter visual disamenity costs are increased and the ban creates a greater benefit (270% increase resulting in £1.4 million cost saving).

11. Discussion

Overall findings and conclusions

11.1 This preliminary research assesses the economic, social and environmental impacts of a ban or restriction in sale on particular SUP products, as listed in the EU SUP Directive, with the aim to reduce marine litter. These products contribute towards the issue of marine litter in Wales and negatively impact the natural environment, our enjoyment of it and the economies that rely upon it. Research into marine plastics is ongoing, with new findings revealing the extent of the issue and the harm caused. Whilst the full impact of marine litter is not yet understood, many Governments and stakeholders are taking the precautionary principle and promoting measures to reduce marine litter where possible.

11.2 The environmental benefits are partly represented in the visual disamenity cost of these products when found as beach litter. The visual disamenity reflects the impact that visitors to Welsh beaches feel when responding to visual beach litter. This cost is not borne in market transactions or reflected in the product price and so is considered a negative externality. Having modelled this cost over a ten-year period, we estimate that the cost amounts to around £2.6 million NPV for the products in question. The proposed ban would reduce this by 91% to just £0.2 million NPV if SUP products are substituted for non-plastic ones on a like-for-like basis.

11.3 The visual disamenity is one aspect of marine litter that can be quantified and monetised but it does not encapsulate the full impact which, as stated above, is still being investigated by the scientific community. A key area of concern, identified from the literature review, is the potential threat from microplastics. Plastic can fracture and fragment before fully breaking down (Eunomia, 2018b), and data clearly shows that small pieces of plastic are by far the most common form of beach litter in Wales and the UK (see paragraph 4.8). Such small pieces of plastic are often hidden to the human eye, distributed throughout the marine environment, sometimes termed a ‘plastic soup’ at sea, or buried in layers of sand. As such, they are unlikely to be reflected in the visual disamenity estimate presented above.

11.4 The full cost of marine litter on wildlife, ecosystems and human health is impossible to estimate at this stage, although we know that the visual disamenity is only one part of it. However large this cost may be for the products in this study, it is likely that a Welsh ban, complemented by UK and pan-European bans of these products, will produce a dramatic reduction, potentially similar in magnitude to the 91% reduction estimated in the model for visual disamenity costs.

11.5 Economic and social impacts are also estimated in this study. The main economic impact is an increased cost to those purchasing the products, although as this cost is spread across a very large number of individuals and businesses the marginal impact on each is small. The model estimates suggest that the market for the selected products could increase in sales value by around 11% based on current prices of plastic and non-plastic alternatives. This additional cost would be borne by companies and consumers but could be significantly reduced if the price of non-plastic products is reduced as demand increases.

11.6 Manufacturers of the SUP products, and others in the supply chain, will bear the greatest financial impacts. Conversely, manufacturers of non-plastic alternatives will benefit from an expected increase in demand. The net effect is estimated in the model to be a 46% increase in revenues to UK manufacturing[23], reflecting the relative strength of domestic manufacturing industries for non-plastic products whereas many SUP products are imported from abroad. What proportion of this revenue will be captured by the Welsh economy will depend on how businesses respond to the opportunity presented. The SUP Directive will be implemented by all EU Member States by July 2021, and so the opportunity extends far beyond the Welsh market for these products. The potential for growth has been demonstrated by Transcend Packaging in South Wales who manufacture paper straws and have more than doubled in size in response to changes in demand, creating over 170 new jobs in the last few months of 2019 alone.

11.7 The preliminary research did not find a substantial manufacturing base in Wales for the SUP products, the majority of which are thought be imported from overseas.

[23] Specific impacts in Wales could not be estimated due to a lack of data on manufacturing in Wales and imports into Wales.

The manufacturers in Wales that are affected will bear investment costs to adapting production in response to the new legislation or will suffer revenue losses.

11.8 Other impacts of a ban are estimated to be relatively small. Potential unintentional consequences have been explored and can be avoided with careful wording of legislation and exemptions, e.g. for medical uses of SUP straws.

11.9 The authors of this report recommend that public consultation is undertaken to seek further information from stakeholders on support for the ban, the likely impact on business, and further exemptions that should be considered to protect vulnerable groups and avoid unintended consequences. Communication and engagement around the ban and its setting in the wider context of work on environmental issues will encourage support from businesses and the public.

11.10 Based on the evidence gathered, we believe that a successful ban will contribute towards tackling marine litter in Wales, further enhance the reputation of Wales and its people in taking action to promote sustainability and environmental responsibility, and help protect marine and terrestrial natural environments.

Legislation for implementation of a new ban or restriction in sale

11.11 Several issues must be addressed when writing robust legislation for the ban or restriction in sale in Wales. ‘Plastic’ and ‘single-use plastic’ must be clearly defined in the context of any legislation. DG Environment will publish guidance to accompany the EU SUP Directive in July, and it is recommended that any definitions used in legislation draw upon this resource for clarity and consistency.

11.12 Where possible, definitions should set conditions that can be practicably answered as true or false, and ideally using examples to illustrate how these definitions are applied. Definitions that rely on the supposed intention of the designer or manufacturer of the product lead to weaker legislation that will be more difficult to interpret and enforce. For example, the EU SUP Directive defines single-use plastic as: “a product that is made wholly or partly from plastic and that is not conceived, designed or placed on the market to accomplish, within its life span, multiple trips or rotations by being returned to a producer for refill or re-used for the same purpose for which it was conceived”. Some SUP products can be and indeed are reused

multiple times. Plastic carrier bags are a common example of this, and of the products proposed for a ban, some environmentally minded users reuse plastic cutlery and balloon sticks (Home Talk, 2017).

11.13 The definition of a SUP could relate to the thickness of the material. This approach was used in the plastic carrier bag levy. This leaves the potential to simply make thicker products, using more resources, but still intended to be disposable. However, such a move would likely be seen as poor taste by consumers, who may prefer to avoid buying them, and companies trading or using such products would run the risk of reputational damage.

11.14 The products covered by the ban or restriction in sale must also be clearly defined. The definition of an EPS beverage container was clarified with DG Environment but no examples of these products could be found on the market, nor could key industry stakeholders consulted in this research provide any examples. The definition of this product should be clarified with the European Commission before legislation is written.

11.15 Three types of product manufactured in EPS are subject to the ban in the EU SUP Directive. DG Environment commented that XPS should be considered a subcategory of EPS and is therefore covered by the ban for these products. It would be prudent to be comprehensive in the legislation for these products, providing a definition that encompasses both materials and explicitly listing EPS and XPS as examples for clarity.

11.16 Stakeholder consultation conducted for this and previous studies indicates that companies are looking to comply with the intentions behind the ban rather than simply sticking to the letter of the law and seeking loopholes to exploit. Engagement around the ban, communicating the aims and rationale, will therefore be equally important as the wording of legislation for businesses to support the Government in its goals to restore and enrich the environment in Wales.

Complementary/alternative measures

11.17 The ban seeks to address SUP products commonly found on beaches and where non-plastic alternatives are readily available. Other SUP products are identified in

the EU SUP Directive and a range of measures set out to reduce the likelihood of them becoming marine litter. These measures include EPR, product design and marking requirements (i.e. labelling).

11.18 The most common criticisms of the ban raised by stakeholders consulted in this research are that the products are relatively insignificant and the ban will not address core issues of littering behaviour, single-use consumption, unsustainable resource use, waste and climate change. This further illustrates the importance of well planned communication and engagement to clarify the purpose of the ban as a very targeted measure to address specific marine litter issues and to set the ban in the wider context of other marine litter and environmental action.

11.19 Implementation of the ban and other measures in the SUP Directive should complement the existing framework of environmental legislation and related measures currently being explored such as EPR reform and DRS. The Welsh Government might also consider further opportunities to reduce marine litter, focussing on those thought to be most prevalent or harmful in the marine environment. Wet wipes are commonly highlighted in public consultation, and other products pose a risk when flushed down toilets, such as menstrual products, as this can provide a direct pathway to the marine environment. Fishing gear and microplastics are also key areas of concern. Microplastics come from many sources including tyre abrasion, paint, artificial grass sports pitches and pre-production plastic pellets, as well as the degradation of all other plastic marine litter over time. As such it is a difficult but nevertheless very important issue to tackle.

11.20 It is the view of the researchers that the Welsh Government is recognised as a world leader in waste management and progressive legislation such as the Wellbeing of Future Generations Act provide a framework to developing a healthy and productive society that takes care of the environment. The research suggests there may be an opportunity to further protect the marine environment in Wales.

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Annex A. LCA results comparing single-use plastic and non-plastic products

The key results from a European Commission (European Commission, 2018b) LCA study are shown in Figure A.1. in terms of CO2 and air pollutants. The study compared single-use plastic (SUP) products and their single-use non-plastic alternatives (SUNPs), as well as reusable alternatives (multi-use; MU).

Figure A.1. LCA results for functional unit of one use of a product

Product group	Product	CO2 (fossil)	CO2 (non-fossil)	Methane	NH3	NOx	PM2.5	PM10	SO2	VOCs
Cotton buds	SUP	6.87E-04	-3.43E-05	3.57E-06	2.75E-07	1.68E-06	5.89E-07	1.35E-07	1.78E-06	6.67E-07
	SUNP	4.66E-04	2.19E-04	1.74E-06	2.73E-07	1.43E-06	5.93E-07	1.09E-07	1.11E-06	1.01E-07
	MU, best	1.68E-03	1.42E-03	3.34E-06	7.21E-07	3.35E-06	3.40E-06	6.95E-07	4.14E-06	1.37E-06
	MU, worst	4.20E-03	3.97E-03	8.53E-06	2.23E-06	8.72E-06	8.56E-06	1.85E-06	1.04E-05	3.89E-06
Cutlery	SUP	3.41E-03	-2.26E-05	1.26E-05	2.66E-08	5.15E-06	3.27E-06	6.84E-07	5.70E-06	2.30E-06
	SUNP	7.63E-04	4.18E-03	6.15E-06	1.05E-06	1.27E-05	5.86E-06	7.73E-07	1.23E-06	4.10E-06
	MU, best	1.72E-03	1.44E-03	3.39E-06	7.24E-07	3.42E-06	3.55E-06	7.54E-07	4.20E-06	1.38E-06
	MU, worst	4.23E-03	3.98E-03	8.59E-06	2.24E-06	8.79E-06	8.71E-06	1.91E-06	1.04E-05	3.90E-06
Straws	SUP	1.03E-03	1.22E-04	5.79E-06	4.59E-08	2.21E-06	7.02E-07	2.59E-07	2.88E-06	1.74E-06
	SUNP	1.39E-03	1.56E-03	3.91E-06	1.04E-07	3.84E-06	2.20E-06	4.82E-07	3.70E-06	9.22E-07
	MU, best	1.68E-03	1.43E-03	3.29E-06	7.22E-07	3.35E-06	3.43E-06	7.04E-07	4.14E-06	1.35E-06
	MU, worst	4.19E-03	3.97E-03	8.49E-06	2.24E-06	8.72E-06	8.58E-06	1.86E-06	1.04E-05	3.87E-06
Stirrers	SUP	1.55E-03	1.84E-04	8.68E-06	6.88E-08	3.31E-06	1.05E-06	3.89E-07	4.32E-06	2.61E-06
	SUNP	2.35E-04	1.29E-03	1.89E-06	3.22E-07	3.91E-06	1.80E-06	2.38E-07	3.77E-07	1.26E-06
	MU, best	1.68E-03	1.43E-03	3.29E-06	7.22E-07	3.35E-06	3.44E-06	7.08E-07	4.14E-06	1.35E-06
	MU, worst	4.19E-03	3.97E-03	8.49E-06	2.24E-06	8.72E-06	8.59E-06	1.86E-06	1.04E-05	3.87E-06
Food containers	SUP	2.32E-02	1.73E-03	1.79E-04	3.33E-07	4.49E-05	1.79E-05	4.73E-06	6.06E-05	9.27E-05
	SUNP	1.70E-02	2.34E-02	5.10E-05	2.99E-06	5.58E-05	3.00E-05	6.35E-06	5.05E-05	2.72E-05
	MU, best	2.53E-03	1.43E-03	8.83E-06	7.26E-07	4.96E-06	3.84E-06	8.62E-07	6.01E-06	2.90E-06
	MU, worst	5.04E-03	3.97E-03	1.40E-05	2.24E-06	1.03E-05	8.99E-06	2.02E-06	1.22E-05	5.43E-06

Source: European Commission, 2018b

Annex B. Further details on manufacturer market leaders

Market leaders in the manufacturing sectors relating to the products in the ban were researched to understand the potential impact on the Welsh economy. Tetra Pak is a Swedish company manufacturing beverage cartons that will be affected by the ban on SUP straws. Tetra Pak has a packaging and processing site in Buckinghamshire (Tetrapak, n.d.), a factory in Dorset employing over 90 staff (Food Manufacture, n.d.), and another site in Chester (Packaging Today, n.d.) having previously moved from Wrexham (BBC, 2013). No sites were identified in Wales.

Dart Products Europe is a leading manufacturer of foodservice packaging, including EPS food and drink containers, EPS cups and lids, and plastic plates and cutlery, as well as paper and bagasse alternatives. The company is part of Dart Container Corporation, the world's largest manufacturer of foam cups and containers. Dart Products Europe is based in Cradley Heath in the West Midlands and has several manufacturing sites around the UK. Dart confirmed that they have no sites in Wales. Klockner Pentaplast is one of the world's largest suppliers of plastic films for pharmaceutical, medical devices, food, electronics, and general packaging, and also manufactures EPS food containers in the form of clam shells and trays (Klockner Pentaplast, n.d.1). The company has several locations in the UK, including one in Newport (Klockner Pentaplast, n.d.2).

Symphony Environmental Technologies is a leading producer of oxo-degradable plastics for use by manufacturers. The company headquarters are in Hertfordshire, with a testing centre and laboratory in Norfolk (EcoPolymers, n.d.). No locations were identified in Wales.

Vegware is a manufacturer of more than 300 plant-based single-use compostable catering products (Vegware, 2019). Products include straws, plates, cutlery, and food containers, and cups. Materials used include those in scope of the ban such as bio-plastics and compostable plastics primarily affecting their cutlery and straws range, as well as materials likely to serve as non-plastic alternatives resulting from the ban, such as wood, paper and bagasse[24]. Vegware has offices in Edinburgh and Bristol. No sites were identified in Wales.

[24] Vegware Webpage

Annex C. Key economic impacts for individual products

Economic impacts are predominantly negligible when assessed on a per-product basis. The main impacts are presented below. The collective impact is demonstrated in the 'Economic impacts' section of the report.

Table C.1. Key financial impact estimates of individual products, NPV 2021 to 2030 (£m)

	Ban (Column A)	No Ban (Column B)	Difference - Ban over No Ban (C = A – B)	Difference - % change from No Ban
Sales value				
Cutlery	52.6	55.3	-2.7	-5%
Plates	25.7	26.5	-0.9	-3%
Drinking straws	19.3	19.0	0.3	negligible
Food containers	30.8	16.0	14.7	+92%
Beverage cups	10.5	8.7	1.9	+21%
Beach litter visual disamenity				
Food containers	0.2	2.2	-2.1	-92%

Annex D. Record of data sources and assumptions

The central cost and weight estimates for products are presented below, informed by online research[25].

Table D.1. Model assumptions for plastic products

Product	Sales price per unit (£)	Per unit weight (g)	Material
Cotton buds	0.01	0.25	Plastic
Cutlery	0.04	3.00	Plastic
Plates	0.06	5.00	Plastic
Straws	0.01	0.55	Plastic
Beverage stirrers	0.01	0.32	Plastic
Balloon sticks	0.07	6.00	Plastic
Food containers	0.03	5.14	Plastic
Beverage cups	0.03	2.68	Plastic

Table D.2. Model assumptions for alternative products

Product	Sales price per unit (£)	Per unit weight (g)	Material
Cotton buds	0.01	0.44	Paper
Cutlery	0.04	3.00	Wood
Plates	0.07	10.0	Paper
Straws	0.01	1.18	Paper

[25] Obtained by taking an average of prices found from different wholesaler websites, primarily: Catering24 webpage ; Cater4you webpage ; Nisbets webpage

Product	Sales price per unit (£)	Per unit weight (g)	Material
Beverage stirrers	0.01	1.09	Wood
Balloon sticks	0.10	12.0	Paper
Food containers	0.09	16.5	Paper
Beverage cups	0.04	6.50	Paper

The main data and assumptions used in the model and the uncertainties associated with each of them are presented in **Error! Reference source not found.** below. The impact of uncertainty in these sources was explored through sensitivity analysis.

Table D.3. Sources of data and assumptions used in impact model

Data / assumption	Sources	Level of uncertainty
Sales volume for products	Based on consumption data reported by large companies and ‘bottom-up’ estimates for market share.	High uncertainty
Speed of market change	Based on research insight gained on degree of voluntary change to date, and through stakeholder interviews.	Medium-high uncertainty

Data / assumption	Sources	Level of uncertainty
Littering and waste management	Keep Wales Tidy, 2019, LEAMS Survey. Resource Futures, 2019b, Composition analysis of litter waste in Wales. MCS, 2019, Great British Beach Clean. Nelms et al., 2017, Marine anthropogenic litter on British beaches. European Commission, 2018, Commission Staff Working Document Impact Assessment, Reducing Marine Litter: action on single use plastics and fishing gear. Stats Wales, Annual management of waste by management method. HMRC, UK trade info, import export data. WRAP, 2019, Gate fees report.	Medium-high uncertainty
Item price and weight	Spot values from main manufacturers and from wholesale and retail websites.	Medium uncertainty
Terrestrial and Beach Litter Impacts	Keep Britain Tidy, 2014, Exploring the Indirect Costs of Litter in England. Eftec, 2002, Valuation of Benefits to England and Wales of a Revised Bathing Water Quality Directive and Other Beach Characteristics Using the Choice Experiment Methodology. ZWS, 2017, Deposit Return Evidence Summary.	Medium uncertainty
Carbon emission factors	UK Government GHG Conversion Factors for Company Reporting. Defra/DECC GHG Protocol. Carbon Valuation in UK Policy Appraisal traded and non-traded prices.	Low uncertainty/low significance