Wheelabrator TECHNOLOGIES

# Deadline 3: Applicant's Response to the Examining Authority's Further Written Questions (ExQ1A)

## Appendix 1.15b - Our Waste, Our Resources - A Strategy For England 2018 – Evidence Annex

Wheelabrator Kemsley (K3 Generating Station) and Wheelabrator Kemsley North (WKN) Waste to Energy Facility Development Consent Order

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HM Government

# OUR WASTE, OUR RESOURCES: A STRATEGY FOR ENGLAND

## EVIDENCE ANNEX

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# Contents

# About this document

This Annex sets out the evidence underpinning the Resources and Waste Strategy. It is positioned within the policy analysis framework provided by HM Government's Green Book[1]. Its primary purpose is to explain the rationale for intervention and provide transparent evidence behind the actions in the Resources and Waste Strategy. It will be a source of information for policy makers as they develop specific policy proposals and have a wide range of applications external to government. For these reasons it focuses on:

- Why is the current situation problematic? What is the case for change?
- What is the rationale for Government intervention? Why are markets or social processes not working?
- What could be done to achieve the policy objectives set out in the Resources and Waste Strategy? What policy instruments could be deployed?

This Annex does not attempt to:

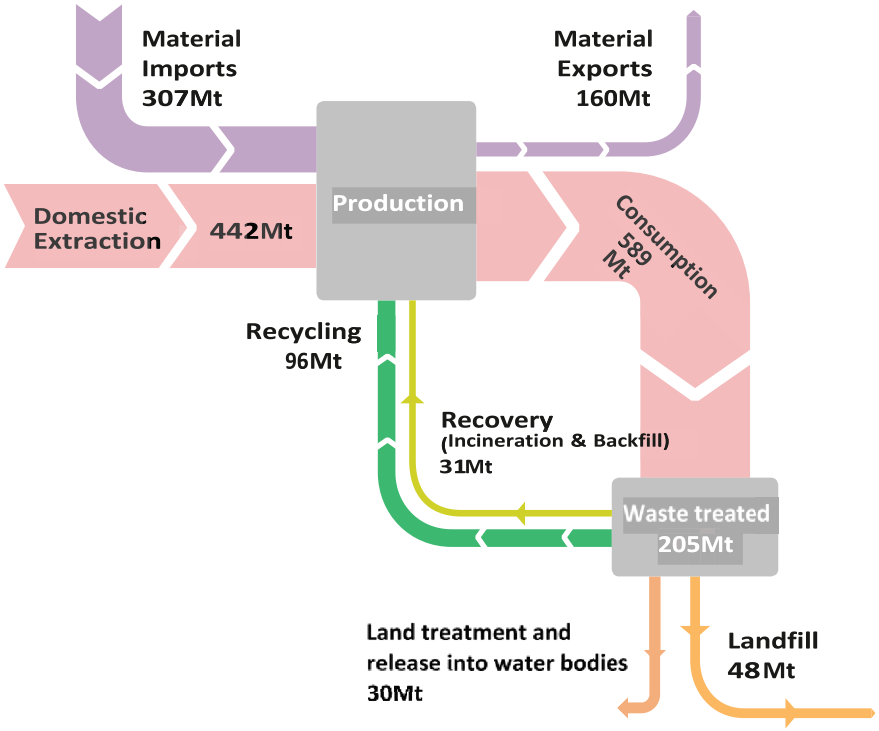
- Set out all facts, figures and insights relevant to resources and waste policy. It does signpost to relevant sources of information.
- Describe comprehensively the current situation in resources and waste, but it does focus down on relevant particulars.
- Set out the history of waste policy, except where relevant to assess the current situation.

[1] HM Treasury (2018) The Green Book: Central Government Guidance on Appraisal and Evaluation

# 1 Introduction

Material resources flow constantly throughout our economy in vast quantities. Consuming these materials provides social value, generating economic growth as well as meeting basic human needs and wellbeing. However, not all of the value of these resources is fully exploited. In England, latest estimates showed 41.3m tonnes of waste were sent to landfill in 2014. A further 27.7m tonnes goes to energy recovery, incineration or backfill[2,3]. This wastes valuable material resources, some of which cannot be replaced. Waste also imposes social costs such as environmental impacts. For example, landfilling of biodegradable material results in the generation of harmful greenhouse gases and transport of waste materials around the country causes local disamenity and atmospheric pollution.

**Figure 1: The flow of material resources around the UK economy 2014[4]**




[2] Backfilling means 'a recovery operation where waste is used in excavated areas (such as underground mines, gravel pits) for the purpose of slope reclamation or safety or for engineering purposes in landscaping and where the waste is substituting other non-waste materials which would have had to be used for the purpose.'

[3] UK Statistics on Waste

[4] Defra analysis. Figures for material flows relate to 2014 (imports/exports/consumption/domestic extraction). England figures not available. Figures for recycling, recovery, waste treatment and landfill relate to 2014.

Some of the materials and products we dispose of have not even been used. For example, WRAP (2018) estimate that 41% of household food waste occurs because it was not used in time[5]. Many products are owned but are rarely used. For example, the average European car is parked 92% of the time[6].

This challenge is often described as 'making the economy more circular'. This means products and their component materials stay in use for as long as possible before entering the least environmentally damaging waste management route.

There is evidence that the UK is gradually becoming more resource efficient. Between 2000 and 2010 this improvement was measurable. For example, WRAP and Green Alliance (2015) estimate that despite the economy expanding by 20% and the population increasing by 6% in this timeframe, by 2010 the UK was using 30 million tonnes fewer resources, had reduced the amount of this wasted by 10 percentage points and had more than doubled production of secondary raw materials[7]. Between 2007 and 2015, household food waste fell by 13%[8].

There is some evidence that the rate of change towards a more circular economy has slowed. For example, in 2012, England's recycling rate for waste from households waste was 44.1% but by 2017 this had only increased to 45.2%[9,10]. Similarly, household food waste has not continued to decline and there are some indications that it actually increased from 7 million tonnes in 2012 to 7.3 million tonnes in 2015[11].

A growing body of research over the last five years has demonstrated that using resources more efficiently is not necessarily a threat to growth and could in fact create significant opportunities and economic benefits[12]. For example, Oakdene Hollins (2017) found UK businesses could realise resource efficiency savings of at least £3bn per year at low or no

[5] WRAP (2018) Household food waste: restated data for 2007-2015
[6] Ellen MacArthur Foundation, SUN and McKinsey Centre for Business and Environment (2015) Growth Within: A Circular Economy Vision for a Competitive Europe p.12
[7] WRAP, Green Alliance (2015) Employment and the circular economy Job creation in a more resource efficient Britain
[8] WRAP (2018) Food Surplus and Waste in the UK – Key Facts
[9] Local authority collected waste: annual results tables
[10] 2017 figure includes metals reclaimed/recycled from incinerator bottom ash, whereas the 2012 figure does not. This accounts for 0.8 of a percentage point in the 2017 recycling rate.
[11] Environment, Food and Rural Affairs Committee (2017) Food waste in England Eighth Report of Session 2016–17 paras 27ff
[12] The work of the Ellen MacArthur Foundation provides a good overview of the concepts, benefits and challenges of moving towards a more circular economy https://www.ellenmacarthurfoundation.org/

cost[13]. The Ellen MacArthur Foundation (2015) found resource efficiency could deliver 0.8–1.4% additional GDP growth for Denmark[14].

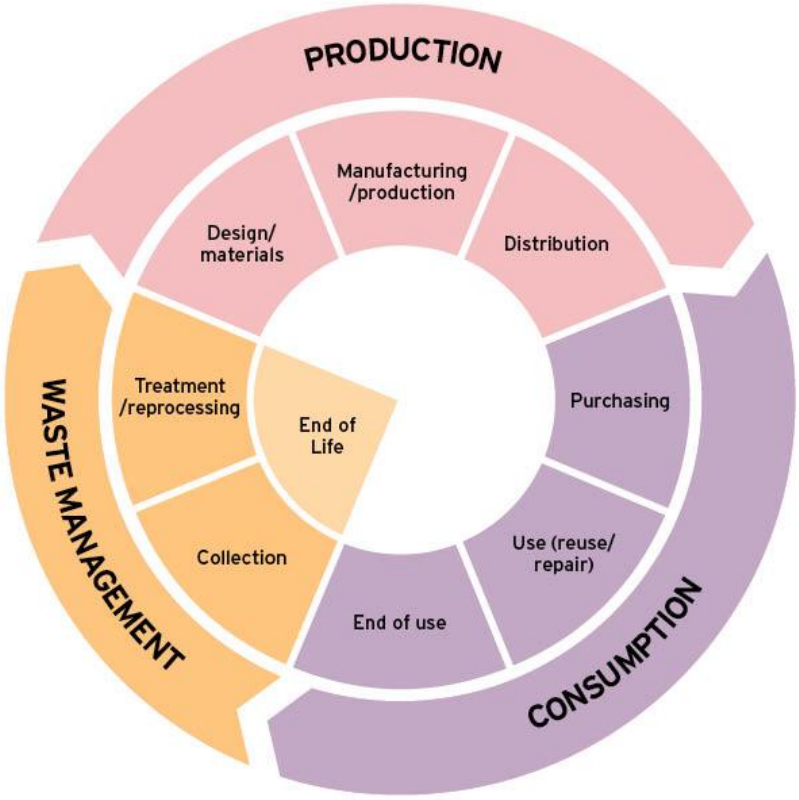
There is emerging evidence that improving resource efficiency is popular with the public. CIE-MAP and Green Alliance (2018) found most people see the need to shift towards a society that uses resources more efficiently. The study also found 60% were supportive of a 'drastic shift' towards a resource efficient society even if that changed the way they live[15]. People tended to favour approaches that were carried out by others (e.g. redesigning packaging) or were not too restrictive (e.g. a collaborative economy).

There is also evidence that resource efficiency can lead to job opportunities. The Ellen MacArthur study estimated 7,000–13,000 jobs could be created[14]. The European Commission also recognises the potential[16]. In the UK, WRAP and Green Alliance (2015) estimated that under a scenario of transformative rather than incremental change towards circularity, 102,000 net jobs could be created, accompanied by a 0.28% fall in the unemployment rate[17]. Importantly, the study found that many of the jobs could be skilled or professional (for example in remanufacturing and bio-refining) and that more jobs could be created in areas of high unemployment. The reuse and repair sector has traditionally created jobs and work experience opportunities for those who find it difficult to access employment. Estimates suggest that it could create 75 jobs for each 1,000 tonnes of goods handled[18].

The environmental benefits of resource efficiency are reasonably well established. The Ellen MacArthur study estimates carbon footprints could be reduced in Denmark by 3–7%. A 50% reduction in virgin resource consumption for certain materials could be achieved[14]. WRAP (2010) estimates that adopting six low cost strategies to tackle inefficient resource use could reduce Britain's environmental footprint by between 5 and 7%[19].

[13] Oakdene Hollins for Defra (2017) Business Resource Efficiency Quantification of the no cost/low cost resource efficiency opportunities in the UK economy in 2014
[14] Ellen MacArthur Foundation (2015) Delivering the Circular Economy: A Toolkit For Policymakers: Executive Summary
[15] Green Alliance and CIE-MAP (2018) By popular demand: What people want from a resource efficient economy
[16] European Commission (2014) Green Employment Initiative: Tapping into the job creation potential of the green economy COM(2014) 446 final
[17] WRAP, Green Alliance (2015) Employment and the circular economy: job creation in a more resource efficient Britain
[18] RREUSE (2015) Briefing on job creation potential in the re-use sector
[19] WRAP (2010) Securing the future: the role of resource efficiency

**Figure 2: A simplified depiction of the circular economy[20]**




Whether framed in economic, broader social or purely environmental terms, inefficient use of material resources causes harm to current and future generations. Rethinking the way products are designed, restructuring the way they are provided and increasing reuse, repair, remanufacture and recycling will create societal benefits. There are a whole range of challenges to overcome to achieve this goal. This Annex provides the evidence which underpins how Government proposes to tackle them, as set out in the Resources and Waste Strategy.

## 1.1 Rationale for intervention

We can assess barriers to change through the lens of markets, innovation and disruptive transition[21] and behavioural insights[22]. We focus primarily on challenges as a result of

[20] Source Defra graphic
[21] UCL (2018) Resource efficiency and the circular economy, concepts, economic benefits, barriers and policies
[22] Based on rigorous research, behavioural insights are a more realistic model of human decision-making, which take account of individuals' inherent biases and preferences. This helps us understand what motivates, incentivises or discourages certain behaviours among people and organisations.

market failure[23]. These occur where markets do not deliver an efficient outcome. Better use of resources could improve the situation for society as a whole. Evidence suggests levers such as regulations, fiscal incentives and the provision of information to allow the market to deliver a more efficient outcome. We seek to use the polluter pays principle to guide our policy development (see Box 1 below).

Care has been taken throughout the Annex to draw on the growing recognition that people do not always assess the costs and benefits of their actions rationally[24]. This applies especially in the Consumption chapter. This does not just apply to individual citizens; the very biggest businesses are staffed by people. As a result, the government is increasingly turning to behavioural insights to complement conventional environmental policy tools[25,26].

**Box 1: The polluter pays principle**

In the Strategy, the overarching market failures we are seeking to correct are the negative environmental 'externalities' generated through the raw materials we extract and the waste we create. These environmental impacts are felt by society, not just those who produce or consume a particular product, so market forces acting on individuals alone will not deliver the right environmental choices for society.

Where possible we apply the polluter pays principle so those who produce pollution bear the costs of managing it, to prevent damage to human health or the environment. This not only puts the cost of managing environmental damage onto the polluter, but also puts the incentives in place to change behaviour of polluters. By charging polluters (producers and consumers) the full cost of their environmental damage, economic theory dictates they will reduce pollution to the level where there is an efficient outcome for society.

The polluter pays principle is part of a set of broader principles to guide sustainable development worldwide (formally known as the 1992 Rio Declaration). It underpins most of the regulation of pollution affecting land, water and air.

[23] As is consistent with HMT Green Book guidance HM Government (2018) The Green Book: Appraisal and Evaluation in Central Government

[24] Dual process theories of human behaviour are described in Kahneman, D (2011) *Thinking Fast and Slow* New York: Macmillan

[25] Since the original Behavioural Insights Team was established in the Cabinet Office in 2010, many Government Departments, including Defra, now have their own behavioural insights teams. The original Behavioural Insights Team is now an independent organisation.

[26] The 2018/19 Government Communication Plan commits the service to "work harder to master the techniques of behavioural science and start considering audiences by personality as well as demographic".

## 1.2 Structure of the annex

We divide challenges into production and consumption chapters according to whose behaviour we are primarily trying to influence rather than how an action is delivered. For example, although product labelling is the responsibility of producers its role is to provide information to consumers. Plastics and food waste have their own chapters, as priority materials. Although plastics does not have a separate chapter in the Strategy document, for this annex it is helpful to draw evidence on plastics together.

Challenges switch from consumption to end of life as soon as materials are discarded. We categorise recycling and the supply of recycled material as End of Life. However, once reprocessed it becomes a secondary raw material, which is a factor of production. And so completes the circle.

We recognise that compartmentalising a complex resources and waste system into lifecycle stages is to some extent artificial; this is because there are close economic and behavioural interplays between them. An intervention in one area will ripple through the system to impact other actors.

# 2 Production

## 2.1 Introduction

Producers make decisions on their business models as well as the type and amount of material used in production processes and product design. A “linear” business model typically refers to a situation where natural resources are extracted and transformed into material goods that are then placed on the market. This is where the producers’ concern ends and their products eventually enter the waste management system for recycling or waste treatment.

Circular business models, on the other hand, modify the traditional flow of resources through a number of changes and are often defined as:

- ***Product life extension models*** extending the life of products through reuse, maintenance and repair, refurbishment and remanufacturing. For example Caterpillar manufacture and remanufacture construction and mining equipment. Its brand “Cat®Reman” sells exclusively remanufactured products and currently employs around 4,000 people in 17 locations worldwide[27].

- ***Circular supply models*** substitute virgin input materials with renewable and/or recyclable input materials and preparing products for recycling[28]. For example Advance Nonwoven, is a Danish manufacturer of insulation material which specialises in selling certified cradle-to-cradle renewable products made from natural fibres, waste or recycled material.

- ***Sharing models*** involve using under-utilised consumer assets more intensively, by providing shared use, access or ownership. For example, online platforms like ZipCar facilitate transactions between the owners of under-utilised assets and individuals seeking to use them.

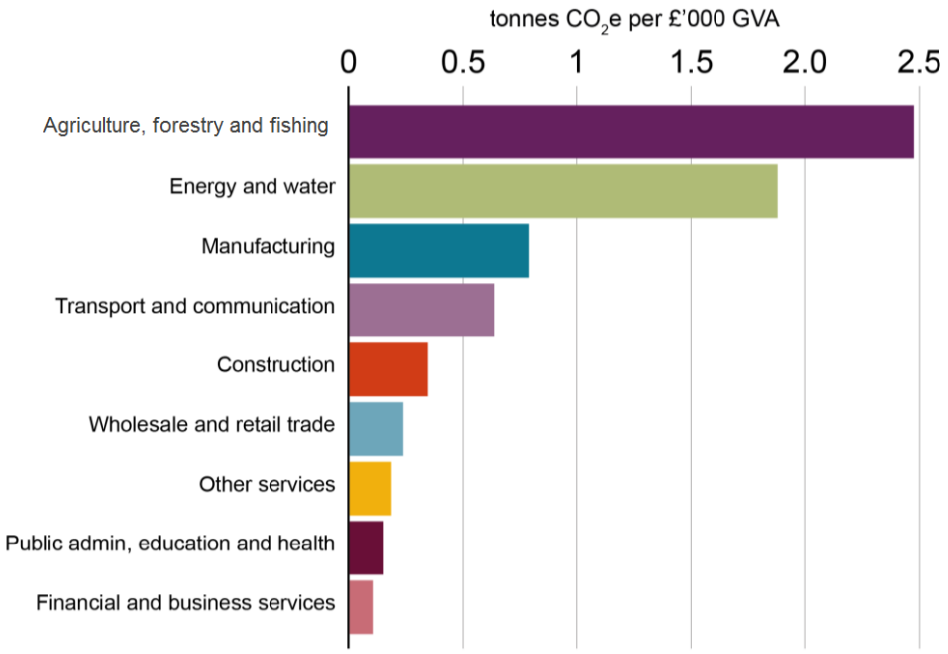
- ***Product service systems models*** combine a physical product with a service component. They offer product access rather than ownership where the supplier take responsibility for product lifecycle management. For example, online platforms like Netflix, Spotify and Coursera allow film, music and literature to be consumed without ownership.

[27] OECD (2018) *Business Models for the Circular Economy*.
[28] This type of circular supply model is dealt with in the end of life section of this document.

Resource productivity[29] in the UK is among the highest in Europe and is 1.5 times the EU average. The UK's global material footprint (raw material consumption, accounting for imports and exports of materials) fell 27% from 630 million tonnes in 2000 to around 460 million tonnes in 2013 while over the same period GDP rose by 18%. Raw material consumption per unit of GDP continues to fall, meaning that the UK economy generated around £3.90 of GDP output per kilogram of raw materials in 2013 when compared to £2.30 per kilogram in 2000[30]. Note that raw material consumption here includes raw material used to make products that are manufactured abroad and imported into the UK as well as removing any materials that were further exported in final products.

One reason the UK benefits from a high resource efficiency calculation is due to the significant contribution of services to GDP, which is less resource intensive than manufacturing. The University of Leeds (2018) found that the 30 sectors accounting for 80% of the total carbon footprint in 2014 also represented around 62-85% of the material footprint[31]. Thus, tracking key sectors and products will help improve understanding of resource efficiency and carbon reduction. Figure 3 below summarises the UK sectors' material intensity in terms of the tonnes of materials used per £ of GVA.

**Figure 3: Tonnes of material used p**er £'000 of Gross Value Added by Sector[32]




[29] Described as the relationship between economic activity and material consumption, e.g. comparing the size of UK domestic Gross Domestic Product to the UK raw material consumption, excluding exports and including imports.
[30] ONS, UK Environmental Accounts
[31] Centre for Industrial Energy, Materials and Products (2018) *Resource efficiency metrics*.
[32] Ibid.

Current official statistics do not report comprehensively on the economic activity of more resource efficient activities. For example, there is no clear definition for remanufacturing as a sector. In the absence of ONS classification, WRAP (2016) classifies remanufacturing as a sub-sector of manufacturing[33].

The ONS does however group together the sectors where remanufacturing activity most commonly takes place: repair, maintenance and installation.

The 2015 report by the European Remanufacturing Network estimated the UK annual turnover of remanufacturing in 2014 to be £2.5bn, excluding the aerospace sector which accounted for an additional £2bn[34].

In 2016, the UK repair sub-sector generated turnover of £41m and £17m in GVA[35].

The UK's increasing resource efficiency is the result of a number of factors, including economic restructuring, change in consumer patterns and genuine improvements in material efficiency. These improvements are often adopted by first movers who take advantage of new innovative production approaches and technologies. At an economy-wide level, evidence shows the first-mover advantage, in particular, can lead to positive macroeconomic effects on economic growth, employment and competitiveness[36].

A number of studies identify the UK can benefit further from increased resource efficiency. We recognise the following as the key challenges to achieve that[37]:

1. Improving resource efficiency through provision of necessary information and economic incentives.
2. Accounting for environmental impacts in production.
3. Ensuring the fate of products are included in product design.

In the remainder of this chapter, we set out barriers and possible solutions to achieving a) resource efficiency, b) environmental benefits and producer responsibility and c) better product design.

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[33] WRAP (2016) *Extrapolating resource efficient business models across Europe*.
[34] The European Remanufacturing Network (2015) Remanufacturing market study
[35] ONS (2017) Annual Business Survey-Sectors GVA 2016
[36] UCL (2015) *Investments in Resource Efficiency costs and benefits, investment barriers, intervention measures*.
[37] For example, Ellen MacArthur Foundation, SUN and McKinsey Centre for Business and Environment (2015) *Growth Within: A Circular Economy Vision for a Competitive Europe*; WRAP, Green Alliance (2015) *Employment and the circular economy Job creation in a more resource efficient Britain*; McKinsey (2017) 'Mapping the Benefits of the Circular Economy' McKinsey Quarterly June 2017;

## 2.2 Resource efficiency: barriers, potential and evidence on possible solutions

The literature on resource efficiency provides a wealth of potential barriers to increased resource efficiency for industry and businesses. Eunomia's (2018) literature review and industry engagement concluded the main barriers were the following[38]:

- Based on the respondents, the key barrier is the lack of alignment of economic drivers with environmental priorities.
- Further, a lack of readily available and good quality data undermines the case for change.
- Businesses often lack awareness of key resource efficiency opportunities, related techniques and technologies.
- There might be upfront capital and managerial costs for implementation of solutions with payback periods longer than the often required two years.

Overall, there is a general lack of focus on resource efficiency, with the priority mainly being the production throughput. The following provides evidence on the resource efficiency potential and, then, evidence on some of the measures that could help to overcome relevant barriers and unlock the resource efficiency potential.

Oakdene Hollins (2017) estimate the resource efficiency savings that UK sectors could make at no or low cost to businesses once overcoming relevant barriers[39]. In this study, 'no-cost/low-cost' interventions referred to 'quick-win' savings opportunities with a payback of less than one-year[40]. The savings opportunity is estimated to be worth between £3.2 and £4.7 billion per year from increased waste prevention and waste diversion measures. While these estimates imply substantial opportunity when added together, they should be seen in comparison to the overall size of the UK economy. Thus, in many cases, the savings per business are relatively small, often not fully understood or not seen as a priority. Table 1 summarises these estimated savings by sector and subsector.

[38] Eunomia for Defra (2018) *Material Resource Efficiency Opportunities and implications within the UK construction, chemicals and metal sectors*.
[39] Oakdene Hollins for Defra, 2017. Business Resource Efficiency *Quantification of the no cost/low cost resource efficiency opportunities in the UK economy in 2014.*
[40] These include interventions such as the following: wholesale and retail sector – waste prevention measures with respect to food waste and reusable packaging; hospitality and foodservice sector – food waste prevention quick wins; remaining quick wins in food and drink manufacturing (e.g. improved temperature control, better stock control procedures, improvements to forecasting and changes to orders); chemicals sector – optimal valorisation of industrial waste and recycled end-of-life materials as feed; construction sector – reduced over-ordering and onsite damage.

**Table 1: Business savings through no/low cost resource efficiency measures by sector**

| Sector | Sub sector | Savings per year (£millions) |
|---|---|---|
| **Services** | Wholesale and retail | 87 |
| | Hospitality and foodservice | 250 |
| | Other | 166 |
| | **Total** | **503** |
| **Manufacturing** | Food and drink | 192 |
| | Chemicals | 583 to 1,166 |
| | Basic metals | 388 to 776 |
| | Other | 610 to 1,149 |
| | **Total** | **1,773 to 3,283** |
| **Construction** | | 911 |
| **Mining & quarrying** | | n/a |
| **Total** | | **3,187 to 4,697** |

*Source: Oakdene Hollins (2017) Business Resource Efficiency Quantification of the no cost/low cost resource efficiency opportunities in the UK economy in 2014.*

Given the narrow focus of this research on low and no cost opportunities, the total potential economic benefits of greater resource efficiency to the UK economy could be significant. This requires further research. Interventions include capital expenditure projects with a payback of over one year and technical solutions using techniques such as 'lean' manufacturing. It also includes opportunities to expand 'servitisation' type business models offering remanufacture, refurbishment or repair.

Eunomia (2018) suggests that, in the construction, chemicals and metals sectors, resource efficiency measures with short and long term payback periods could result in financial savings of £3.5bn per year for these three sectors[41]. This research used a wide range of evidence sources, such as the database of resource efficiency opportunities maintained by the Greater Manchester Growth Company. This includes tens of thousands of opportunities identified and implemented across a wide range of companies in the north-west of England over the last ten years. Table 2 shows the overall saving per sector and for the top five sub-sectors[42].

[41] Eunomia for Defra (2018) *Material Resource Efficiency Opportunities and implications within the UK construction, chemicals and metal sectors*.
[42] Note that this shows only a median of five different estimates with a wide range savings.

**Table 2: Resource efficiency savings potential in chemicals, construction and metals[43]**

| Sectors and top five sub-sectors | Financial savings (£m per year) |
|---|---|
| **Chemicals (whole sector)** | **453** |
| *Other plastic products* | *105* |
| *Pharmaceuticals* | *93* |
| *Soap, detergents, perfumes* | *48* |
| *Plastic plates, sheets, tubes* | *29* |
| *Plastic packaging goods* | *31* |
| **Construction (whole sector)** | **2,123** |
| *Installation of building services* | *796* |
| *Development of building projects* | *254* |
| *Commercial buildings* | *213* |
| *Residential buildings* | *167* |
| *Other specialised construction* | *159* |
| **Metals (whole sector)** | **955** |
| *Manufacture of products* | *260* |
| *Manufacture of motor vehicles* | *212* |
| *Vehicles and transport equipment* | *204* |
| *Metal structures and equipment* | *100* |
| *Machining* | *81* |
| **Total** | **£3,531** |

*Source: Eunomia research and consulting for Defra (forthcoming) Material Resource Efficiency Opportunities and implications within the UK construction, chemicals and metal sectors.*

WRAP (2016) estimates that the economy-wide adoption of resource efficient business models, such as remanufacturing, repair, leasing and recycling, could deliver a potential net GVA gain of €86bn, 21Mt of materials avoided and 37Mt of materials diverted by 2030[44].

[43] Table shows savings of top five sub-sectors only. Thus, whole sector's savings are higher than the sum of top five sectors.
[44] WRAP (2016) Extrapolating resource efficient business models across Europe.

These studies, however, have made clear that there is a wider range of barriers to achieve this potential. The following sub-sections will explore how these challenges can be tackled to increase resource efficiency. Related to that, Box 2 indicates our areas of future research interest.

**Box 2: Area of Research interest 1: Circular Economy/Resource Efficiency**

Throughout this document, a number of evidence gaps have been identified and following on from the 2015 Nurse Review of the UK Research Councils and our previous strategic approach, we want to provide a clear steer regarding our future research needs in the form of Areas of Research Interest (ARIs). For this area we want to focus on:

1. Sector definitions
2. Metrics including carbon measures and natural capital accounting
3. Potential costs/benefits
4. Impacts of meeting targets
5. Engagement of SME clusters
6. Secondary market improvement
7. Definitions of reuse, recycling and remanufacture
8. Design for durability
9. Design for recyclability

Circular economy infrastructure

### 2.2.1 Resource efficiency in construction sector – a case study

The construction sector has achieved significant improvements in diverting waste from landfill, with the recovery rate for non-hazardous construction and demolition waste of 89.9% in 2014[45]. But whilst the sector has come a long way in terms of waste diversion it is still one of the highest contributors to UK waste arisings. Previous research makes the following recommendations:

[45] UK waste statistics, Defra 2018 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/683051/UK_Statisticson_Waste_statistical_notice_Feb_2018_FINAL.pdf

- Oakdene Hollins (2017) recommend policy should focus on reducing over-ordering and on-site damage[46].
- Eunomia (2018) consider a number of policies, including improving on-site waste reduction, increased offsite construction, improved recycling and reuse through improved waste segregation on site, increased recycled content of construction materials, designing buildings for deconstruction, increased refurbishment rather than demolition and application of lean design[47].
- CIE-MAP and Green Alliance (2018) recommend that policies should focus on higher substitution towards low carbon materials, increased reuse of construction materials and reduction in material inputs through increased design optimisation. Among other recommendations, they suggest a much more prevalent use of whole life carbon assessments in construction projects than at the moment. This could contribute to the reduction in GHGs emissions by 67 $MtCO_2e$ in the fourth carbon budget period and 92 $MtCO_2e$ in the fifth[48].

### 2.2.2 Industrial symbiosis and sectors' best practice

At present the typical linear business model, such as produce – use – dispose, still dominates the production process. In recent years Government has led initiatives such as the Industrial Strategy to promote resource efficiency and a more circular economy. One aim of the industrial strategy is to encourage businesses to adopt models that facilitate resource resilience, resource efficiency and promote a more circular economy. Encouraging businesses to move away from disposal-led business models to value-led ones could reduce waste and primary material consumption while promoting material reuse.

The uptake of circular business models like the ones mentioned in Chapter 2 are still the exception rather than the norm. Some barriers to the uptake of more resource efficient business practices are founded in lack of connectivity and collaboration within and across value chains; a lack of readily available, good quality data and a lack of awareness of key opportunities and related techniques and technologies. Simply put – many businesses are unaware of what secondary materials are available, in what quantities and where.

The simple sharing of readily available data and information would provide a crucial link between supply and demand. Collaborative consumption initiatives could help unlock the untapped potential of secondary material use in the production process. Such initiatives are typically distributed networks of connected individuals and communities like knowledge

[46] Oakdene Hollins for Defra (2017) *Quantification of the no cost low cost resource efficiency opportunities in the UK economy in 2014*.
[47] Eunomia for Defra (2018) *Material Resource Efficiency Opportunities and implications within the UK construction, chemicals and metal sectors.*
[48] CIE-MAP and Green Alliance (2018). Less in, more out

sharing platforms which provide data and information on the quantity, type and location of available unused materials and under-utilised assets.

Initiatives such as *"Find a fuel"* and the *National Industrial Symbiosis Programme* **(***NISP)* ha*ve* shown how the flow of data and information through resource sharing platforms have delivered efficiency savings to businesses in the past. One of the most critical roles played by Government in the NISP programme was to actively facilitate the connections between interested parties[49].

Such models can help improve resource efficiency by extracting more value from materials than if they were treated as waste. They provide information on locally available secondary materials and active platforms for industry to exchange and re-use materials.

- The NISP launched in 2005 was a regionally based, 'independent material exchange facilitator' aimed at helping local businesses come together to find uses for unwanted materials. The programme evaluation showed it diverted more than 7 million tonnes of waste from landfill and generated more than £176m in material sales and £156m in cost savings for participating companies, within its first five years[50].

- SMILE (Saving Money through Industry Links and Exchanges) Resource Exchange is Ireland's National Program for industrial synergies. The program assists companies in reusing unwanted materials. After six years, the program has about 1400 members, completed over 300 successful synergies and diverted 8000 tons of material from landfill. These transactions have translated into €2.1 million of cost saved for businesses, in addition to environmental savings that have not been monetized.[51]

- In the United States, the Materials Marketplace Pilot ran from June to August 2015. Initial results showed: 23 participating companies, 78 facilities engaged, 150 materials—2.4 million tonnes total—uploaded to the marketplace, 59 materials being sought, 68 recommended matches and 19 transactions in development, with another 49 possibilities that were still pending action at the close of the pilot. This pilot has led to several Material Marketplaces now running across the USA, Turkey and Vietnam.

Similarly, incentivising and supporting such initiatives as Local Enterprise Partnerships (LEPs) and industry-led clusters in the UK can help businesses learn from best practice, provide benchmarking and obtain advice to improve resource efficiency. This could include facilitating materials sharing platforms or materials brokerage services.

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[49] Find a fuel and NISP Factsheet; (2016)
[50] National Industrial Symbiosis Programme (2016) NISP Economic Valuation Report,
[51] https://marketplacehub.org/case-examples/

To support local initiatives Government has proposed the development of a mandatory electronic waste tracking system. An integrated waste tracking system will provide the necessary infrastructure and access to connect businesses with available materials to those seeking them. LEPs and industry-led clusters could facilitate this at a local level.

Improving resource efficiency could also help businesses to increase their Gross Value Added per tonne of material they use. There are differing levels of productivity across geographical regions and sectors. Benchmarking sector performance and sharing best practice could help businesses to identify and capitalise on resource efficiency opportunities[52]:

- The Institute for Manufacturing estimate that improving the resource efficiency of manufacturers to the level of the best in their sector would yield an additional £10 billion per annum in profits for UK firms and a 4.5% reduction in carbon emissions. These mirror the savings we have observed with respect to improving labour productivity[53].
- Green Alliance advocate a role for government to facilitate a sector-specific approach to improving resource efficiency. Government supported manufacturing upgrade programmes could help businesses identify and capitalise on resource efficiency opportunities, share best practice and stimulate investment and innovation[54].

Increasingly, resource efficiency improvements in small and medium-sized enterprises (SMEs) have been a focus for policy makers across the world. It is not yet clear to what degree these policies have been successful as there do not seem to be readily available evaluation studies.

- Under the German Resource Efficiency Programme (ProgRess II), a centre for resource efficiency (VDI ZRE) offers sector specific practical tools and guidance that can be used by manufacturing SMEs. It also provides tools that support lifecycle assessment and methodologies for eco-design in product development.
- The EU is planning to set up a Resource Efficiency Excellence Centre that will provide information, advice and support on: (i) actual SME resource efficiency performance, compared to the sector benchmark; (ii) technological options to increase this resource efficiency (iii) cost-effectiveness of options, with a view to financing them.
- In Scotland, the SME Implementation Fund was opened in 2014 to assist with barriers that prevent improving efficiency of raw material, water and energy use.

[52] Alliance (2017) Lean and clean, Building manufacturing excellence in the UK,
[53] Institute of Manufacturing(2015) Industrial Evolution
[54] Alliance (2017) Lean and clean, Building manufacturing excellence in the UK,

The Government has provided up to £100,000 loans for resource-efficient projects.

- The Environment and Sustainability Partnerships 2016 pilot research finds a longer-term solution could entail employing a Shared Resource Efficiency Manager (SREM) who embeds good practice for a group of SMEs[55]. The group of SMEs could be in the same sector, along a supply chain or just have similar resource efficiency challenges. In its first year, the pilot achieved cost savings of £125k with ongoing savings of £105k per year, for participating businesses. The pilot employed two shared resource efficiency managers (£70k overall costs) across two regional clusters (Rolls-Royce supply chain and EEF in Bristol).

Overall, there is emerging evidence that industrial clusters, sectoral benchmarks and SME-focused initiatives can help to increase business resource efficiency but, at least for some of them, it is too early to say to what degree these policies are robustly delivering a high level of value for money. Given the status of the current evidence base and ongoing activities both in the UK and internationally, Defra has asked WRAP to lead on research that will review the effectiveness of resource efficiency clusters in improving practices. This research will inform future policy development.

## 2.3 Environmental benefits and producer responsibility

Producers currently have little incentive to account for the environmental costs of their production decisions. For example, consumer and industry packaging placed on the market do not fully reflect the environmental impacts of raw material extraction, greenhouse gas emissions and costs associated with its treatment at the end of its life.

Current producer responsibility schemes have been designed to meet existing EU recycling targets for packaging, waste electrical and electronic equipment (WEEE), end of life vehicles and batteries. But for packaging and WEEE in particular, they do not sufficiently incentivise businesses to design products with their end of life in mind. This imposes unnecessary costs on society.

Further, there are barriers limiting the increased supply of, and demand for, secondary materials, whose use could reduce the environmental pressures of production. WRAP's Market Knowledge Portal reports the following levels of recycling activity across the secondary raw materials markets[56]:

- Total **glass packaging recycled** (including remelt and aggregate) totalled 347kt in Q2 2018. Glass Producer Responsibility Notes prices have slowly risen throughout the year to £14.50 per tonne in June 2018, the highest price since June 2015.

[55] Environment and Sustainability Partnerships for Defra, 2016. *Encouraging and supporting SMEs to improve their resource efficiency (Shared Resource Efficiency Managers).*
[56] http://www.wrap.org.uk/content/market-knowledge-portal-1

- Total **plastic packaging recycled** increased by 15% in the year to Q2 2018 to 285kt. UK plastic packaging recycled was 95kt in Q2 2018, broadly the same as the previous year. Plastic packaging recycling exports were 190kt in Q2 2018.
- Around 25kt of **aluminium packaging was reprocessed** in the UK or exported in Q2 2018, relatively unchanged from a year previous. The amount of recovered **steel packaging** being reprocessed or exported fell by 6% over the year to 109kt in Q2 2018.
- UK **exports of recovered paper** fell by 16% over the past year to 365kt in June 2018. Exports fluctuated throughout the year, peaking at 438kt in March 2018. UK mill usage of recovered paper fell by 4% to 264kt in May 2018.
- Approximately 120kt of **WEEE** was collected in Q1 2018, a fall of around 10% over the previous year. Small WEEE collected increased marginally over the year to 33kt in Q1 2018.

Through an extensive literature review and industry interviews, Anthesis research for WRAP (2018) identified a large number of complex barriers deterring increased supply of and demand for secondary raw materials. Table 3 below highlights the key areas where the barriers are for each secondary material[57].

**Table 3: Key barriers at UK secondary raw material markets**

| Barrier | Paper and card | Glass | Plastics | Metals | Clothing | WEEE |
|---|---|---|---|---|---|---|
| Material quality issues from household kerbside collections | | | | | | |
| Quality of exports | | | | | | |
| Lack of innovation in UK infrastructure and reprocessing capacity | | | | | | |
| Cost and investment constraints | | | | | | |
| Cost differential of primary and secondary materials | | | | | | |
| Labour and skills | | | | | | |
| Legislation and policy reforms | | | | | | |
| Enforcement | | | | | | |
| Manufacturers' barriers | | | | | | |
| End market barriers | | | | | | |
| Consumers | | | | | | |

*Source: Adapted from WRAP (2018)*

OECD (2018) also reports other barriers to increased use of secondary materials. In particular, one of the key environmental barriers associated with recycling plastics is the

[57] Anthesis for WRAP (2018), Characterising Supply and Demand within Secondary Material and Goods Markets.

presence of hazardous additives in primary plastics. These chemicals can be hazardous to human health or the environment and, despite being in restricted use or recently banned, can possibly end up in products ready to be reprocessed as there is currently a limited transparency in the use of additives in plastics production. This is mainly relevant to products such as toys and food packaging that must be made of non-hazardous plastics, including secondary materials[58].

In line with the polluter pays principle, we want to incentivise producers to use materials that take into account the environmental impacts of products and services over their lifecycle while keeping pace with changing customer requirements. Below we present evidence on policy approaches that can help achieve this outcome.

### 2.3.1 Extended Producer Responsibility

Extended Producer Responsibility (EPR) is an environmental policy approach that requires producers to take further responsibility for their product's end-of-life stage. It often involves producers taking responsibility for collecting end-of-life products, their sorting before the final treatment and recycling. EPR schemes can either require producers to provide necessary financial resources and/or to set up their own collection schemes instead of the municipal sector (e.g. local authorities or wider municipal sector generating household-like waste)[59]. The following sub-sections describe the key producer responsibility areas.

#### *2.3.1.1 Packaging Producer Responsibility reform*

In the packaging sector, the existing Producer Responsibility Packaging Recovery Note (PRN) system was designed to meet EU targets at the lowest compliance cost to obligated businesses.

To date, it has been successful in ensuring that the UK meets the targets set by the EU at minimal cost to business. However the current system has many shortcomings and will not be capable of meeting our core principles for Extended Producer Responsibility (EPR), as set out in the Strategy. The following is a list of the main shortcomings of the current system. The reforms will look to solve these problems.

- Less than 10% of the costs of managing household packaging waste are currently covered by industry, so producers are not taking full responsibility for their packaging at end-of-life as would be expected under the polluter pays principle[60].

[58] OECD (2018), Improving Markets for Recycled Plastics: Trends, Prospects and Policy Responses, OECD Publishing, Paris.
[59] OECD (2016), *Extended Producer Responsibility: Updated Guidance for Efficient Waste Management*, OECD Publishing, Paris.
[60] Defra, forthcoming, Consultation on Reforming the Packaging Producer Responsibility System – Impact Assessment.

- The system as it stands could provide greater incentives to individual producers to redesign packaging for greater reuse and recyclability.
- Demand among reprocessors for collected materials has not increased as intended.
- Local authorities have seen little financial incentive from the PRN system for collection of packaging waste.
- There has not been any significant increase in investment in recycling capability, communications or research and development.
- There are concerns that the current system favours exporting low-quality packaging waste rather than retaining it for reprocessing in the UK.
- The PRN market is largely opaque, and the vendor or buyer may possess more information than their counterpart. This leads to PRNs not realising the optimal value that might be obtained if information on the pricing and volumes of PRN trades was widely available. Overall, the market lacks price transparency and those obligated to purchase evidence do not see how their contributions to the system are spent.

In line with the polluter pays principle (see Box 1), a reformed packaging producer responsibility system could result in the full net costs of managing packaging waste being paid by obligated producers. This could incentivise improvements in product design, recycling collections and investment in recycling and reprocessing infrastructure. A number of reforms have been already suggested by the industry such as:

- Valpak (2017) argue for a mandatory UK-wide, competitive market-based system to be maintained. Producers would share responsibility with an independent regulator to improve resource efficiency in household and commercial and industrial packaging. They claim this would improve the quality and quantity of materials collected, increase consumer awareness, strengthen UK recycling capabilities, reduce material price spikes, increase producer access to recycled material and improve distribution of producer funds[61].
- ESA (2016) make the case that the system needs to allow for meeting whatever recycling targets are set by legislation. It should strive for the reprocessing of packaging waste to take place in the UK, as long as it is economically and environmentally feasible, and should keep the overall costs of the UK's collection and recycling system minimised[62].

A number of design options will be presented in the forthcoming consultation and assessed against aspects such as cost efficiency and the ability to meet long-term recycling targets.

[61] Valpak (2017) Packflow 2025 – Full Report.
[62] ESA (2016) A discussion of the UK PRN/PERN system for packaging waste and possible alternatives.

#### *2.3.1.2 Producer Responsibility for Waste Electrical and Electronic Equipment (WEEE)*

The introduction of the 2013 WEEE Regulations in January 2014 sought to remove inefficiencies and reduce the cost of compliance for producers of electrical equipment compared to the 2006 Regulations. The Impact Assessment estimated a reduction of £10 million per year over 10 years. The Post Implementation Review due to be published by 1 January 2019 will re-assess those costs and consider areas for improvement.

Since 2014 producers have financed the collection of between 500Kt and 600kt of WEEE annually. Collections have been stable at around 40% of products placed on the market annually. That figure rises to around 56% of products placed on the market when account is taken of large household appliances that are collected and recycled with scrap metal and data provided by specialist treatment facilities[63]. However the collection rate for small items that can be readily disposed of with residual household waste dropped to only 35%.

It is for this reason that when considering options for encouraging increased collections we will look particularly at small mixed WEEE. This will include the role of the "Distributor Take-back Scheme" (DTS) which currently has 859 members, including the majority of major retail chains. The DTS allows members to avoid collecting WEEE in store from customers and instead provides funding to support collections at Household Waste Recycling Centres. We will seek to gather evidence on the environmental impacts that could be achieved through amending the WEEE Regulations to reward producers of better designed products with lower compliance costs.

#### *2.3.1.3 Producer Responsibility for Batteries*

Batteries are categorised as either industrial, automotive or portable. Industrial and automotive batteries are subject to a landfill and incineration ban. 2017 data published by the Environment Agency shows that a 45% collection rate applies to portable batteries, based on a rolling three year average of batteries placed on the market[64]. This target is in line with EU legislation embedded in the Batteries Directive 2006/66/EC which required 29 EEA countries including the UK to achieve minimum collection rates for portable batteries of 25% by September 2012 and 45% by September 2016.

The industrial and automotive batteries market is presently dominated by lead-acid chemistries, which have a positive value at end of life and a long-standing collection, treatment and recycling infrastructure exists. Industrial and automotive battery producers are required to register with the Secretary of State, unless they are also portable battery producers. There is no charge for registration. Producers are also required to report

[63] These facilities process WEEE through routes other than those established by producers under the WEEE Regulations.
[64] Environment Agency (2018) 2017 UK Portable Batteries Data Summary: Final.

annually on the tonnage of batteries they have placed on the market, the tonnage of batteries they have taken back and the tonnage of batteries delivered for treatment. Producers are obligated to take back on request batteries from final holders, but in practice the majority of batteries continue to be collected and treated by the existing, competitive infrastructure without calling on the battery producers.

2017 figures provided by industrial and automotive battery producers show that some 78% of industrial batteries placed on the market were lead-acids and for automotive that figure was effectively 100%. They also show battery producers taking responsibility for collecting 7% of industrial batteries and 5% of automotive batteries as a share of those placed on the market. There are some 21 Approved Battery Treatment Operators (ABTOs) in the UK handling industrial and automotive batteries and 21 Approved Battery Exporters (ABEs).

Portable battery producers are required to join a compliance scheme unless they are classed as a small producer. Small producers are those placing less than 1 tonne of portable batteries on the market each year, and are required to register directly with their relevant environment agency and report annually on the batteries they have placed on the market. There is a £30 annual fee. There are over 1,500 small battery producers.

Compliance schemes act on behalf of producers and ensure the producer is registered with the appropriate environmental regulator. There is a £600 fee for each compliance scheme member together with an annual compliance scheme subsistence charge of £90,000. There are five Battery Compliance Schemes. In 2017, these five compliance schemes had some 582 large producers between them. The compliance scheme secures battery evidence notes to cover off the obligations of their producer members and ensures that the regulator is provided with information on both the tonnage of batteries placed on the market and batteries collected for treatment and recycling by or on behalf of their members. Retailers and distributors supplying more than 32kg of portable batteries a year are required to provide a collection point in their premises where batteries can be deposited. Battery Compliance Schemes will then collect those waste batteries from the business premises free of charge. There are 21 ABTOs for portable batteries and 12 ABEs.

#### *2.3.1.4 Producer Responsibility for End of Life Vehicles (ELV)*

ELV follows an individual producer responsibility approach where each manufacturer has responsibility for the vehicles they produce. Vehicle manufacturers and importers are required to register with the Secretary of State as producers. There are no fees for doing so. Producers are required to maintain a convenient network into which last owners can deliver vehicles at end of life at no charge. Producers are then responsible for ensuring the vehicles are treated to appropriate standards and that the 95% reuse, recycling and recovery rate is met.

In contrast to the producer responsibility schemes for batteries, packaging and WEEE, there is no provision for compliance schemes under ELV although most vehicle manufacturers have contracted with one of two service providers to physically deliver their ELV obligation.

An entirely commercial treatment infrastructure also operates in parallel, where permitted treatment facilities choose to accept vehicles outside the network maintained by producers. In doing so, these facilities take on the legal responsibility for the recycling and recovery target. Most vehicles have a positive value at end-of-life due to the materials, particularly metals, used in their construction.

In October 2018, three companies quoted £60, £120 and £250 respectively, to be paid to the last owner, for the collection and treatment of a mid-range saloon based in London. In 2016, some 1,440 Authorised Treatment Facilities handled over 1.1 million vehicles achieving an overall recovery rate of 92%. This was 3% points below the 95% target.

#### *2.3.1.5 The case for new EPR schemes*

WRAP research for Defra[65] suggests other products which could be brought into producer responsibility schemes due to their environmental impacts. For example, removing mattresses and carpets from residual waste treatment could result in up to 143 thousand tonnes of $CO_2e$ emissions reduction per year and a 4.3% reduction in existing amount of household residual waste.

Further research is required to understand the economic and environmental impacts of bringing new products into EPR. Existing evidence on a suite of products is summarised here.

*Tyres*

Reports from WRAP[66], the European Tyre Recycling Association[67], and the British Tyre Manufacturing Association[68] have made the environmental case for increasing tyre recycling, reuse, and re-treading, with potential carbon savings from using recycled rubber. For example, Europe's biggest tyre manufacturer, Michelin, has announced its 2048 ambition to make tyres using 80% sustainable materials and to recycle 100% of the tyres they produce[69]. They plan to use bio-sourced materials like Biobutterfly and more recycled materials in their tyre production. The potential gains once all the targets have been met,

[65] WRAP for Defra (forthcoming) *Difficult to Recycle Products and Materials: Summary Report.*
[66] WRAP, Waste Tyres Case Study Remoulds and Retreads: the re-use of tyres for cars and light trucks.
[67] European Tyre Recycling Association (ETRA) Tyre Recycling in the European Union
[68] Internal report from BTMA (may be published soon, need more information regarding use of document).
[69] Michelin (2018) Michelin's 2048 ambitions; Press information.

include savings of (i) 33 million barrels of oil per year, (ii) a month's energy consumption in France.

To increase participation amongst all manufacturers, EPR can be an effective policy measure. Case studies[70] have indicated that EPR can not only be effective in increasing recycling rates, but can also improve collection rates and fund adequate enforcement to prevent illegal dumping by tyre manufacturers.

*Fishing gear*

The proposed EU 'single-use plastics' directive has highlighted the need for Member States to act on plastic marine litter. The Commission's impact assessment shows that fishing gear presents a particular issue; accounting for 27% of all marine litter, and harming marine wildlife and commercial fish stocks[71]. EPR offers the opportunity to incentivise better recycling collections, and encourage better management of waste fishing gear. There has been some initial scoping work by Circular Ocean[72] on potential policy interventions, including EPR, emphasising the need for regulatory support to help ensure compliance from producers.

*Clothing*

WRAP estimates clothing has the fourth largest impact on the environment, after housing, transport and food[73]. This is caused by waste, greenhouse gas emissions and use of water through the whole production, consumption, use and end-of-life process.

- In terms of carbon footprint, the highest contributor is the production of fibre through polymer extrusion or agriculture and other fibre preparation adds to the carbon footprint.
- Water impacts are overwhelmingly from the production stage, with cotton production accounting for 69% of the water footprint of fibre production and 65% of the total water footprint.
- Waste occurs throughout the supply chain, although more prominent at the production stage.

However, operating in line with best practice, including recycling, can generate environmental savings. A report led by WRAP estimates that adopting best practice can

[70] OECD case study on tyre EPR in Flanders the case for EPR
[71] Impact assessment Single-use plastic directive
[72] Circular Ocean Mechanisms to support the recycling/reuse of fishing gear and the prevention of gear becoming lost/abandoned at sea.
[73] All WRAP figures in this section come from WRAP (2017) *Valuing Our Clothes: The Cost of UK Fashion* http://www.wrap.org.uk/sites/files/wrap/valuing-our-clothes-the-cost-of-uk-fashion_WRAP.pdf

reduce carbon emissions by 10–15%, water by 13–15%, product lifecycle waste by 1–3.5% and reduce the amount of clothing in household residual waste by about 15%[74].

EPR will aim to extend participation across the whole sector, delivering greater benefits, as opposed to just covering a few signatories. Through an assessment of the French EPR scheme for textiles, WRAP have also looked at how EPR might deliver on environmental objectives in the UK[75]. They have found there is scope to incentivise more sustainable, more recyclable materials, to increase reuse, encourage innovation in recycling markets and increase durability.

For clothing the in-use phase has a significant impact, so it is important for consumers to understand how to take better care of their clothing. Washing larger loads less frequently and at lower temperatures reduces water and energy impacts and may extend their life.

Recycling will also play a role; by recycling polyester, for example, 25 to 75 percent of carbon emissions can be cut, compared to virgin raw material use[76].

Many consumers already embrace re-use and recycling options for clothing. The largest amount is taken to charity shops (39%), while charity bags (18%) and bring banks (13%) remain important. A growing number of high street retailers such as Marks and Spencer (M&S), Hennes and Mauritz and TK MAXX also incentivise customers to return old clothing for recycling, in exchange for vouchers (e.g. £5 per bag of clothing). Re-sale is another popular route for used clothing and 7% of unwanted second-hand clothes were sold, but 6% of the time, clothes are still disposed of in general rubbish collections. Some of these may be contaminated beyond use and as such their value is lost.

*Furniture, mattresses and carpets*

For bulky waste, including furniture, mattresses and carpets, a WRAP study found that, on average, approximately 36% of bulky items being taken for disposal at HWRCs are fit for reuse[77]. EPR could be a policy measure to increase both reuse and recycling rates, by improving collection rates, encouraging investment in reprocessing capacity and incentivising producers to engage in the better management of their products. For mattresses, a National Bed Federation report indicates the current recycling rate of 16% could be improved if there was a greater availability and capacity of compliant

[74] WRAP Valuing Our Clothes: The Cost of UK Fashion
[75] WRAP (2018) *UK Textiles EPR: How could a textiles EPR system help prevent textile waste and divert used textiles from landfill in the UK?*
[76] Shen L., Worrell E., Patel M.K. (2010) 'Open-loop recycling: A LCA case study of PET bottle-to-fibre recycling' *Resources, Conservation and Recycling* 55:1 pp.34-52
[77] WRAP, Study into the re-use potential of household bulky waste, 2012

reprocessing facilities[78]. For carpets, a lack of end markets, and issues with financing collection and reprocessing infrastructure, have acted as a barrier to recycling[79].

Most carpets contain materials which are not recyclable or reusable. Moreover, materials are often mixed, making recycling even more difficult as they cannot be easily separated and the associated costs may not make it economically viable to do so. Additionally, hazardous substances used in the manufacture of carpets make recycling even more difficult[80]. Hence, the majority end up in landfill. To create an end market for carpet recycling, EPR can encourage producers to use more recyclable materials in their production by requiring them to bear the full cost of disposal. The more recyclable products used and the less cross-contamination at the production stage, the lower the cost of disposal to producers and vice versa.

*Construction materials*

For construction materials, WRAP (2008) conducted a life-cycle assessment and where there was sufficient data found that on average construction projects that adopted a higher recycled content typically reduced their overall environmental impacts[81]. This included through waste reduction, diversion from landfill and carbon savings. EPR could incentivise producers and retailers to increase the availability of recovered products or products containing recycled content, using clear signals such as a 'recyclability efficiency metric' to make it easier when setting procurement requirements and providing a basis for EPR fee modulation[82]. The Building Research Establishment has estimated that by following best practice, waste from new houses could be reduced by *at least* 15%, with landfilled waste reduced from 7% to 4%. EPR could complement other waste reduction policy measures to achieve these goals[83].

Box 3 summarises our long-term research interests in Extended Producer Responsibility.

[78] National Bed Federation End of Life mattress report
[79] WRAP Flooring Resource Efficiency Action Plan report
[80] Changing Markets (2018) Detoxing Carpets: Pathways towards safe and recyclable carpets in a truly circular economy.
[81] WRAP, *Life-cycle assessment of construction product data*: Environmental impact of higher recycled content in construction projects, 2007.
[82] WRAP recyclability efficiency metric report for the construction industry
[83] Building Research Establishment (with Defra) Developing a Strategic Approach to Construction Waste

**Box 3: Area of Research Interest 2: Extended Producer Responsibility**

Throughout this document, a number of evidence gaps have been identified and following on from the 2015 Nurse Review of the UK Research Councils and our previous strategic approach, we want to provide a clear steer regarding our future research needs in the form of Areas of Research Interest (ARIs). For this area we want to focus on:

- UK market issues
- Issues around PRN system
- Cost and benefits
- Extending to cover other products and the role of incentives
- Increasing reuse

### 2.3.2 Incentivising use of secondary materials – a case study on metals, textiles and plastics

Improving resource efficiency through the use of recycled materials remains one of our key objectives. This is because the extraction and processing of primary raw materials generally leads to higher environmental pressures than when using secondary materials.

This section will explore the environmental impacts associated with the use of primary and secondary materials in production. It will focus on a number of selected materials such as metals, textiles and plastics.

#### 2.3.2.1 *Secondary metals*

Some of the most commonly used metals include aluminium, copper, lead, zinc, nickel, iron and manganese. Due to their extensive use, their scraps are usually recovered and recycled. However, the production and processing of these metals result in several negative environmental externalities.

Van der Voet et al. (2018) assessed the environmental impacts related to seven selected metals (Iron, Aluminium, Copper, Zinc, Lead, Nickel and Manganese). Using a life cycle type methodology, they found that the environmental impacts related to primary metal production are expected to rise steeply. Hence, the most environmentally effective option for all metals is to increase the share of secondary material production. Figure 4 below shows primary and secondary production of the seven metals and their impacts on energy demand, GHGs emissions, land use, water pollution and natural resource depletion[84].

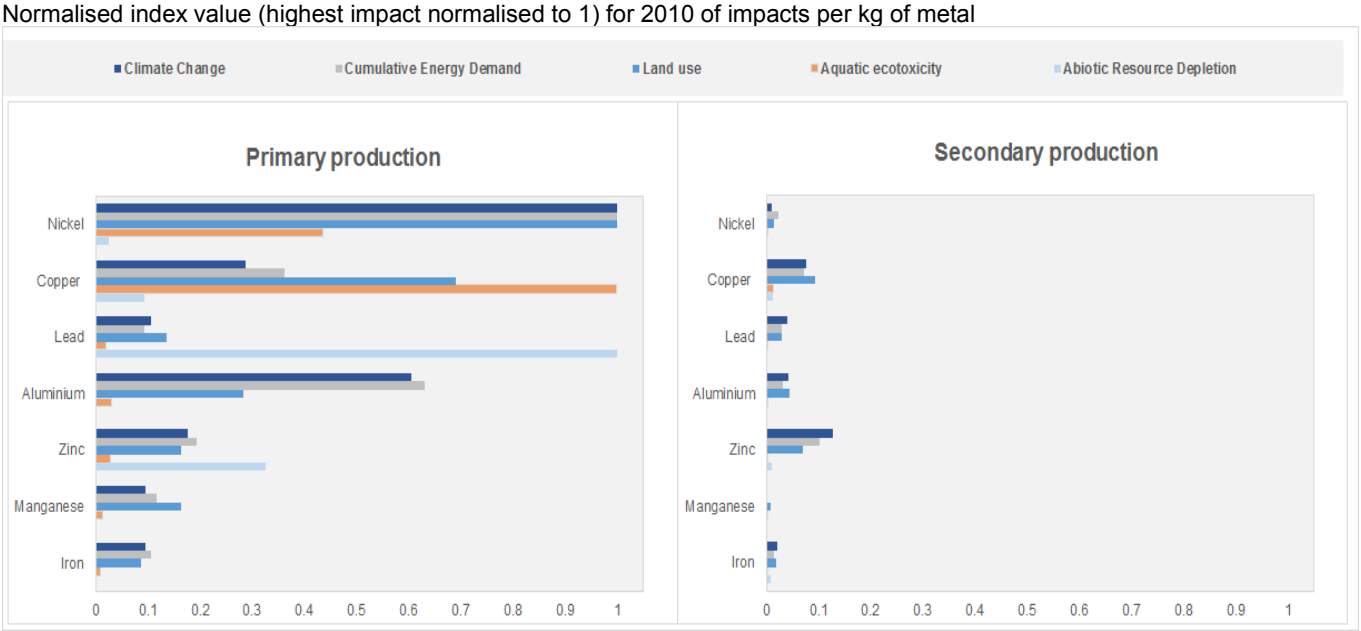
[84] Van der Voet, E., Van Oers, L., Verboon, M., Kuipers, K. (2018), *Environmental Implications of Future Demand Scenarios for Metals*, Journal of Industrial Ecology.

Among the seven metals, primary production of Nickel and Aluminium are more energy intensive relative to the other metals. Primary production of Nickel and Aluminium use close to 3 and 1.8 million joules of energy per kilogram (kg) produced, respectively. As energy use is positively correlated with GHG emissions, Nickel and Aluminium therefore produce the highest GHG emissions. Additionally, the primary production of Nickel has a high impact on water pollution, the second highest after Copper. While primary production of Nickel has the highest energy demand and GHG emissions, secondary production of Nickel has one of the lowest impacts on energy demand (CED), GHG emissions and water pollution.

Secondary metal production, i.e. producing metal products from recycled scrap, accounts for somewhere around 15% to 30% of the global production of the most widely used metals: steel, aluminium and copper[85]. This relatively low share is partly due to the limited amount of available scrap each year and a lack of economic competitiveness that currently constrains increased recycling rates across a number of metals. The OECD highlights the following as key reasons for this: on the supply side, sorting and recycling is labour-intensive and thus can be more costly than primary metals production. On the demand side, there are concerns about the quality of secondary metals for certain applications. Consequently, the secondary metals markets tend to be less well-developed, under relatively higher price volatility and less liquid compared to primary metals markets[86].

**Figure 4: Per-kg environmental impacts for primary and secondary processing**

Normalised index value (highest impact normalised to 1) for 2010 of impacts per kg of metal




*Source: OECD (2018, Forthcoming) and Van der Voet et al. (2018)*

[85] USGS, 2016, Minerals Information Database; World Steel, 2016; Crude Steel Production; ABREE, 2016, Resource and Energy Statistics.
[86] OECD (2018) Business models for the circular economy - opportunities and challenges from a policy perspective.

#### 2.3.2.2 *Secondary textiles*

The textile industry is vital to economies globally. From the clothes we wear to the vacuum cleaner in our homes, textiles are a key component. Flat linens in hospitals and hotels are all made of textiles. Because of the textile industry, farmers can use protective garments to safely and effectively work with chemicals such as pesticides and fertilizers to boost crop yields. The production of textiles involves several stages (e.g. fibre is converted into yarn and yarn into fabric). Cotton is the world's second most important fibre after paper.

The production of these textile materials results in both environmental and economic costs. For example, the cultivation of cotton is believed to degrade soil quality while its production leads to water contamination as many pesticides and fertilisers are used in growing the fibre[87]. Following primary production and consumption, some textiles are recovered and recycled. Textiles that are recovered but not recycled are usually sent to landfill or energy recovery. In landfill, certain textile fibres (e.g. natural fibres such as wool or cotton) decompose while synthetic fibres (e.g. polyester, nylon and acetate) do not. Decomposition in landfill produces GHGs such as methane which contribute to global warming.

Recycling the textiles reduces these impacts and lowers the depletion of virgin resources. WRAP indicates that signatories to the Sustainable Clothing Action Plan saw up to a 10.6% reduction in carbon emissions in the production of clothing between 2010 and 2016. This was 2.3% higher than that of non-signatories (8.3%)[88]. According to The Bureau of International Recycling, of the textiles separately collected, 50% is reused while the other half is recycled[89]. In the UK, the Local Government Association estimates around 360 thousand tonnes of textiles per year are disposed of in residual waste, and reuse of this material could generate approximately £35.4 million of savings to the tax payer[90].

#### 2.3.2.3 *Secondary plastics*

The use of virgin plastics for packaging production have also significant natural capital and environmental footprints. Their production depletes resources and generates greenhouse gas emissions. However, these costs are not reflected in current virgin plastic prices which leads to more being used by producers than is socially desirable. The use of secondary plastics provides a more sustainable approach to production. Government intervention can correct this market failure. The environmental case for increased use of secondary plastics is covered below.

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[87] World Wildlife Fund (2013) Cleaner, Greener Cotton: Impacts and Better Management Practices.
[88] WRAP (2017) Valuing Our Clothes: the cost of UK fashion.
[89] Bureau of International Recycling (2018) Textiles.
[90] Local Government Association (2014) Routes to reuse: Maximising value from reused materials.

A number of policy measures, such as virgin material taxes or minimum recycled content, could strengthen both the supply of and demand for secondary materials, while pricing in the environmental costs of primary materials use.

Initial Defra estimates suggest that, if a Government intervention can incentivise a shift to 30% recycled content by 2030, the GHGs emissions savings would be 17Mt$CO_2$e or £730m of carbon emissions savings in the period of 2019-2032, with possibly up to 80% being UK-based. In terms of the costs to producers, we have assumed that, overall, the producers would face 4% of additional production costs from sourcing recycled plastic. While this is a broad assumption that may need to be revised in future, our evidence suggests that the price of virgin and recycled plastics can be relatively comparable.

## 2.4 Product design

The potential to repair, remanufacture or recycle a product largely depends on its initial product design. If designed using components that cannot easily be replaced and repaired this can reduce a product's potential lifetime. For example, this could be caused by difficulty in accessing spare parts or when new peripheral devices lack interoperability with an existing device. A recent report from the German Environment Agency found that between 2000 and 2010 product lifespans have decreased by:

- 17% in consumer electronics such as LCD monitors and TVs,
- 10% reduction in product lifespan for IT products like PCs, laptops, and mobile phones,
- 7.8% for large household appliances.

The study also examines several reasons as to why product lifespans decline. This trend can be attributed to a number of factors depending on the product group although there are some overlaps. These are summarised in Table 4[91].

[91] The German Environment Agency (2017) *Strategies against obsolescence*.

**Table 4**: **Reasons for declining product lifespan**

| Key causes | | Affected product group |
|---|---|---|
| Material obsolescence | Defects due to lack of performance of materials or components | Large white goods |
| Functional obsolescence | Technical innovation and lack of interoperability of software and hardware | IT products, computer peripherals, LCD monitors, smartphones |
| Economic obsolescence | Cost of a new item is lower than repair cost | Large white goods, small consumer electricals |
| Psychological obsolescence | Consumer desire for the latest gadget with updated technical features | Flat screen TVs, smartphones, tablets |

Source: The German Environment Agency (2017) *Strategies against obsolescence*.

Product repair, such as replacing failed components or even just a single worn part, avoids the entire product turning into waste. Failure to design products for repair reduces their potential lifetime and leads to faster product obsolescence.

These issues can be addressed by designing products using easily replaceable and repairable components. For example, Fairphone, a mobile phone manufacturer, incorporate greater modularity into the design of their smartphones. They then facilitate the repair of existing products while reducing demand for new ones.

We want products to be designed in a manner that promotes greater circularity of production and minimises their end of life impacts.

### 2.4.1 Product design regulations

To date, the main focus of product design regulations has been energy rather than material efficiency. Some product groups deliver greater carbon benefits in production rather than their energy efficiency when used. For laptops and mobile phones, more than 50% of their total GHG emissions are generated during raw material extraction and manufacture. This compares to only 20% during their lifetime use[92]. Applying design for repair regulations could save more carbon emissions than replacing them with a more energy-efficient model[93].

Regulatory standards can help shift businesses to a more resource efficient approach to product design. The existing EU Ecodesign Directive (2009/125/ EC) already offers a suitable regulatory framework. This could be used to establish more product-specific

[92] Ibid
[93] UN Environment (2017), The long-view-exploring-product-lifetime-extension

requirements, for example the mandatory inclusion of an “average expected product lifetime”[94].

Existing energy efficiency product regulations can be built on to include new minimum product design requirements. We are currently conducting research with technical product experts on how product standards can contribute to increased material efficiency and circularity of 12 products under EU Ecodesign Directive and will be looking into the feasibility of extending these principles to other products.

Product design standards are just one tool in a range of wider lifespan extending measures that could be implemented to encourage greater uptake of reuse, repair and remanufacturing. However, for certain products the opportunities to improve resource are likely to focus on one of these avenues.

### 2.4.2 Product design and its role in repair

The products with the greatest potential for repair are small household electricals and mobile devices. WRAP estimate that £220 million in resale value could be realised through the repair, refurbishment and resale of discarded electrical and electronic equipment. This currently ends up as waste, incurring treatment and disposal costs in addition to loss of residual economic value. Small electricals (such as toasters, hairdryers and mobile devices) account for three quarters of this potential economic value that is lost[95].

This could be primarily because small electrical appliances are more likely to be thrown away than repaired since it may not be considered efficient or cost effective to repair small appliances. This behaviour also leads to large quantities of discarded small electrical appliances ending up in landfill, and having huge environmental impacts in addition to loss of economic value.

Barriers to repair are most often cited as the repair costs relative to new product prices, inconvenience and availability of repair options, such as return to manufacturer or repair stations, and the lack of a product guarantee. While new technologies have made repair easier (online tutorials and 3D printing for example), repair is still a labour intensive activity.

Incentives that could overcome these barriers include:

- Reduced VAT on the labour for repair, as introduced in Sweden. This would reduce the cost of repair through authorised routes once products are out of warranty. TechUK (2018) recommends a 0% VAT rate should be applied on the labour cost of repair, maintenance and upgrade services on a range of products[96].

[94] German Environment Agency (2017) Scientific Opinion Paper
[95] WRAP (2011) Realising the Reuse Value of Household WEEE
[96] TechUK report, (2018) Reuse | Repair | Remanufacture in the ICT Sector .

- TechUK (2018) also recommend safeguarding the "repaired as produced principle" for spare parts in the EU Restriction of (the use of certain) Hazardous Substances Directive (RoHS, Directive 2011/65/EU). The availability of spare parts for electronics is key to ensuring that repair, reuse and upgrades of equipment are carried out economically. Any loss of economic efficiency would be counterbalanced by the environmental benefits of reducing waste.[97]
- Repair can also be regulated by extending product warranties. This could be applied to, for example, white goods, electricals and IT equipment such as laptops, washing machines, fridges and freezers etc. through EPR requirements.[98]
- The German Environment Agency also suggests possibly rebalancing consumer rights policy to support more repair activity rather than giving consumers the right to refunds or brand new replacements[99].

### 2.4.3 Product design and remanufacturing

Remanufacturing is one way to retain the value of a functional product rather than focusing on its material value through recycling or recovery[100]. It is defined as "returning a product to at least its original performance with a warranty that is equivalent or better than that of the newly manufactured product."

The process involves dismantling, restoring and replacing components, and testing the individual parts, and the whole product, to ensure that it is within its original design specifications. Performance after remanufacture is expected to be at least to the original performance specifications[101].

Remanufacturing brings products or components back into use. In that sense it sits alongside reuse as a way to extend product lifetime. It is most appropriate where an item is high value, not subject to high levels of technological evolution (such as aeroplanes, automobiles, trains, or large medical machines like MRI scanners), and where there are suitable channels or mechanisms for return to the manufacturer or their agent[102]. Remanufacturing can only take place if a product is designed in a way that allows the removal, repair and replacement of its parts.

- Remanufactured medical devices and aerospace components sell for around 30%-70% cheaper than new ones and uses 85% less energy than primary manufacturing[103]. Better product design would further allow businesses to unlock this potential through ease of dis- and reassembly of products.

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[97] Ibid
[98] Ibid
[99] German Environment Agency (2017) Scientific Opinion Paper
[100] Oakdene Hollins (2018) *Value Retention is the New Recycling*
[101] http://www.remanufacturing.org.uk/what-is-remanufacturing.php
[102] http://www.remanufacturing.org.uk/pdf/story/1p78.pdf
[103] Steinhilper (2006), Remanufacturing: The Ultimate Form of Recycling.

- According to a European Remanufacturing Network report (2015), the sector showing the highest intensity of remanufacturing was found to be the ink and toner cartridges sector. In this sector the resource efficiency savings are fuelled by the sector's aim to cut costs and improve profitability.
- However due to differences in how these products are constructed (glued, riveted, or welded), this potential cannot always be exploited in full. Designing products for ease of disassembly using screws instead of glue also means that the absence of adhesive reduces contamination and makes remanufacturing easier[104].

Remanufacturing is an established process and has previously been driven by the intrinsic value of components, products and materials. There are strong links between remanufacturing, extended producer responsibility and resource efficient business models. Thus, the cross-cutting measures and incentives discussed across the production section would likely help with further growth of the remanufacturing sector. The Consumption Chapter discusses further the demand for and supply of remanufactured products and associated barriers.

[104] The European Remanufacturing Network (2015) Remanufacturing Market Study

# 3 Consumption

## 3.1 Introduction

The Strategy sets out our desired outcome: a world where individuals and organisations adopt behaviours in relation to more sustainable purchasing, more re-use, repair and remanufacture and appropriate disposal at end of use.

The consumption stage begins when an individual or organisation purchases a product. It continues while the product is used and ends at the point when it is disposed of. It is true that consumers are restricted in their choices by decisions made elsewhere in the supply chain. However, consumer feedback ripples up and down the supply chain, influencing how products are designed, manufactured and what is placed on the market. It also influences what reuse, repair, recycling and disposal facilities are provided. Understanding consumer attitudes, knowledge, behaviours and preferences is therefore important.

Policy success depends largely on the extent to which people are persuaded to do things differently. Piscicelli *et al.* (2016) note that strategies to increase sustainable consumption need to understand behavioural motivations[105]. Similarly the OECD (2017) identifies that a change in the behaviour of individuals, households, firms and governmental organisations is required to tackle environmental problems[106]. 'Changing behaviour' means changing 'the way things are done'. It includes how businesses and local authorities provide services as well as individual behavioural choices.

This chapter is divided into two parts. The first part sets out the evidence around possible interventions to tackle gaps in knowledge in order to enable action. It uses mainly social science evidence on knowledge, attitudes, values and behaviours and includes:

- Providing information to influence purchase choice, including labelling
- Using labelling to influence decisions post-purchase
- Education of young people
- Government taking the lead
- Demand for second hand and remanufactured products

The second part sets out the evidence underpinning possible interventions that motivate people by giving them drivers or incentives to consume more sustainably. It covers:

- Consumer behaviour change campaigns
- Public procurement

[105] Piscicelli, L., Moreno, M., Cooper, T., Fisher, T. (2016) 'The Individual-Practice Framework as a design tool to understand consumer behaviour' in Genus, E. (ed.) *Sustainable Consumption: Design, Innovation and Practice* Springer

[106] OECD (2017) Tackling Environmental Problems with the Help of Behavioural Insights OECD Publishing, Paris

- Reducing litter, including through a deposit return scheme

## 3.2 Building knowledge to enable action

Knowledge can be conveyed to individuals and organisations in a range of ways. This includes simple 'push' styles of basic information (e.g. traditional print media, modern digital media methods, and on-pack information), more complex mechanisms (e.g. the use of symbols containing meaning such as the recycling 'swoosh'), the use of exemplification through case studies as well as simply leading by example, the setting of expectations (e.g. through standards), and more structured training and education. This section sets out those relevant to the resources and waste strategy.

### 3.2.1 Providing information to influence purchase choice

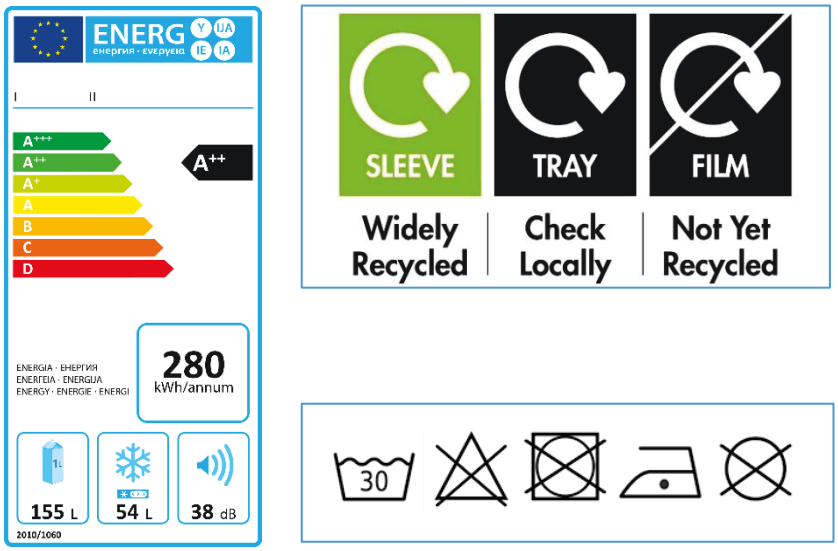
#### *3.2.1.1 Current position*

Factual information provided at point of sale is used all the time to influence purchase decisions, for example on price and product functionality. In an open market, purchasers can make sustainable choices only if they are presented with relevant information. Because price is normally the most salient piece of information provided, there is a risk that choices are made on that alone. This could neglect, for example, relative longevity of different brands and their environmental impacts.

Point of sale information can be exploited to nudge consumers to buy more sustainable products, for example by showing price per unit of expected product life or by rating environmental performance. This can be done in words, or meaning can be conveyed through a visual mechanism such as an icon (e.g. the EU ecolabel or an infographic (see Figures 5 and 6).

**Figure 5: Examples of icons that convey meaning**

**Figure 6: Examples of infographic style labels that convey meaning**




### *3.2.1.2 The case for using this type of intervention*

Evidence suggests that providing point of sale information alone is unlikely to influence purchasing; it is a necessary but not sufficient condition for achieving change. Energy labelling, combined with regulation and changes in the way products are designed, has been particularly successful; an evaluation by Ecofys for the European Commission concludes that there is no doubt it has transformed the market. Consumers almost universally understand the label, and it is widely used as the basis of decision-making on purchasing due to a) the use of clever and meaningful graphics (shape, size, colour, use of letters) b) the use of closed-scale thresholds and c) trust in the integrity of the label[107]. Energy-using products manufacturers have been significantly affected as well; the most common classification of fridges and freezers in the EU in 1992 was D, in 1996 it was C, in 1999 it was B and in 2003 it was A[108].

The extent to which experience in energy labelling is transferable to resource efficiency is debatable though. UK household energy charges are based directly on energy consumption so the less energy a product uses, the lower the consumer's energy bill. The saliency of operational cost, the directness of this one-to-one relationship between energy use and charges, and the immediacy of the label, nudge purchase choice in the right direction (Newell and Siikamaki, 2013)[109]. Some consumers prefer energy efficient

[107][107] Ecofys (2014) Evaluation of the Energy Labelling Directive and specific aspects of the Ecodesign Directive
[108] European Commission (2015) Evaluation of the Energy Labelling and Ecodesign Directives (Fig. 2 on p.9)
[109] Newell, R.G., Siikamaki, J. V. (2013) Nudging Energy Efficiency Behaviour: The Role of Information Labels

products because of an intrinsic desire for green products, and being able to clearly see this information enables them to make a quicker and more reliable choice (Defra 2011)[110].

Research has shown that labels are more likely to be used by those who are already interested in an issue and for whom the subject of the labelling is already a factor in purchasing choice (for example, Brook Lyndhurst (2010)[111] and University of Cardiff (forthcoming)[112]). This suggests that people need to be motivated to look at product information in order to base decisions on it; they need to care about the subject of the labelling.

Efficacy of the label depends on its clarity and the salience of the information it contains. For example, labels that include average *savings* in energy use are likely to reach a wider audience than labels that include the average *energy use* of the product. Appetite for consumer labelling about environmental issues depends on how much is already known; if the information is new then it is welcomed by the consumer (Dresner et al 2007). Efficacy of labelling can be improved by including a 'stamp of approval' such as the EU logo on the energy label.

There are questions about whether the UK should develop an 'ecolabel' style device post EU exit. Development of a label denoting overall environmental performance of a product, such as an 'ecolabel', is challenging because environmental performance covers a wide range of possible criteria. The European Environmental Bureau (2017) in a report specifically on furniture but with broader applicability, state it would be desirable to develop an agreed common set of core criteria. This includes durability, the use of recycled material and reused components, hazardous substance content, and design to facilitate repair, remanufacture and recycling[113]. There is a good deal of literature on the success of the EU Ecolabel which should be fully taken account of should there be a decision to develop a UK or English version.

[110] DEFRA (2011) Consumer Understanding of Green Terms DEFRA (2011) Consumer Understanding of Green Terms

[111] Brook Lyndhurst (2010) Are Labels the Answer? Barriers to Buying Higher Welfare Products

[112] WRAP has commissioned a project with the University of Cardiff, on behalf of Defra, to explore existing evidence about the effectiveness of providing factual information on the environmental sustainability of a product in influencing consumer (individual and organisational) buying decisions. The evidence review is currently underway and the findings will be published. Early indications are that consumers only look for information about things they are interested in.

[113] European Environmental Bureau (2017) Circular Economy Opportunities in The Furniture Sector

### 3.2.2 Using labelling to influence actions post product purchase

Evidence indicates that labelling used to inform consumers about how they should use and dispose of products can work. This is exemplified by the On-Pack Recycling Label (OPRL) scheme which is used to inform consumers about the recyclability of packaging. It is used by more than 600 brands and retailers and is ground-breaking because it is based on data about what can be recycled *in practice* not just in theory. Packaging is labelled 'widely recycled', 'check local recycling' or 'not currently recycled', driven by inconsistencies in what is collected for recycling across different local authorities or other service providers.


Surveys show that it is an important source of information for consumers about whether an item is recyclable; 46% of households just follow the guidance on packs, and using on-pack information is the second most common way to find out what is recyclable. It is especially used by younger adults (WRAP 2018)[114].

### 3.2.3 Education of young people

#### *3.2.3.1 The current situation*

Resources and waste does not feature explicitly in the primary level national curriculum (key stages 1 and 2; ages 5-11); there is a reference to litter by way of example in a Year 4 programme of study of living things and their habitats[115].

There is a range of voluntary initiatives, locally, nationally and internationally. Eco-Schools is perhaps the best known and claims to be the largest programme of environmental education, operated in the UK by Keep Britain Tidy[116]. Local authorities also run initiatives, including school visits and on-line resources[117]. A variety of other organisations also offer online resources[118].

[114] WRAP (2018) Recycling Tracking Survey 2018
[115] "Pupils should explore examples of human impact (both positive and negative) on environments, for example, the positive effects of nature reserves, ecologically planned parks, or garden ponds, and the negative effects of population and development, litter or deforestation."
[116] https://www.eco-schools.org.uk/
[117] For example Nottinghamshire, Bexley and Norfolk
[118] For example WRAP, Valpak, EcoActive and ChangeWorks

#### *3.2.3.2 The case for this kind of intervention*

Evidence suggests that schools-based education programmes that promote sustainable attitudes and behaviours can work[119,120]. They can help fill gaps in information[121]. They can also lead to behavioural change. For example, the Foundation for Environmental Education's *Eco-Schools* programme has evaluated the impact of its 'Litter Less' work[122]. They conclude that it is having an impact on the young participants with them dropping less litter, recycling and reusing more. It also has impacted positively on the attitudes of young people and prompted them to discuss relevant issues, encouraged them not to drop litter, and caused them to be more bothered by litter.[123]

Educating children and young adults about resource efficiency can transmit messages to adults within their household. Exeter University (2013) found that children can act as catalysts to promote recycling within their households and can identify opportunities to break habits at home that motivate adults to change their own behaviour[124]. Similarly, Icaro's (2017)[125] evaluation of WRAP's Home Recycling Challenge found it can lead to positive impacts among children and their parents.

However, although knowledge may persist, a behavioural effect may not. By the time young people are teenagers, they are less likely to behave pro-environmentally with respect to litter and recycling. None of the teenagers participating in the Exeter University research expressed an interest in recycling[124] and Keep Britain Tidy (2015) found that a larger proportion of litter came from older teenagers and young adults, even though they know that the behaviour is wrong and would not do it in front of their parents or younger siblings; littering by this age group is often done deliberately, overtly and to gain approval from peers[126]. It cannot therefore be assumed that educating and motivating children in resource efficiency will prevent undesirable behaviours throughout teenage years.

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[119] Chatzsifotiou, A. (2006) 'Environmental Education, National Curriculum and Primary School Teachers. Findings of a Research Study in England and Possible Implications upon Education for Sustainable Development' *The Curriculum Journal* 17:4 pp.367-381
[120] Keep Britain Tidy (2013) Eco-Schools England: Exploring success to inform a new horizon
[121] Nisbet, M.C., Newman, T. P. (2015) Framing, the Media, and Environmental Communication *The Routledge Handbook of Environment and Communication* pp. 325-338.
[122] Although this is a self-evaluation, and self-evaluations cannot be assumed to be reliable, this particular evaluation is thought to be credible due to its large sample sizes and the input of an independent steering group.
[123] Foundation for Environmental Education (undated) Learning, Leading, Action and Community: The Litter Less Campaign Impact Measurement & Evaluation Project (2014-2017)
[124] University of Exeter (2013) Unpacking the Household: Exploring the dynamics of household recycling
[125] Icaro (2017) *Schools Resources Evaluation* (unpublished)
[126] Keep Britain Tidy (2015) Soft drinks littering: Understanding and influencing young adult litterers

### 3.2.4 Government taking the lead

#### *3.2.4.1 The current position*

The main mechanism by which Government leads by example is the Greening Government Commitments, which applies to every department and their agencies. The commitments focus on:

1. Reduce our emissions
2. Improve our waste management
3. Reduce our water use
4. Buying 'greener' products and services
5. Being open and transparent[127]

The resources and waste-related commitments are:

- Reduce the amount of waste going to landfill to less than 10%
- Reduce the overall amount of waste generated
- Increase the proportion of waste recycled
- Reduce government's paper use by at least 50% from a 2009 to 2010 baseline
- Continue to buy more sustainable and efficient products and services with the aim of achieving the best long-term, overall value for money for society
- Embed compliance with the Government Buying Standards in departmental and centralised procurement contracts, within the context of government's overarching priorities of value for money and streamlining procurement processes

Defra (2018) has published its 2018 report on the first year of the Greening Government Commitments across Government. It shows significant reductions in greenhouse gas emissions, waste generation and landfilling compared with 2009/10 levels, such that targets for 2019/20 have already been met[128].

There is an evidence gap around the extent to which the Greening Government Commitments are *driving* improvements or whether the observed improvements would have happened anyway.

#### *3.2.4.2 The case for continuing to use this type of intervention*

In one sense the case is quite simple – Government must demonstrate commitment, through action, to its own policies. Further, Government's actions can lead a shift in society towards more sustainable lifestyles. The American Society for Public Administration (Malmberg, 2013) explains that when public servants show leadership, the

[127] Greening Government Commitments 2016 to 2020
[128] Defra (2018) Greening Government Commitments Annual Report April 2016 – March 2017

rest of society is more inclined to take actions that contribute to sustainability rather than maintain the status quo[129]. Using behavioural science terms, Government leadership promotes a sense of reciprocity that encourages others to engage. As the Sustainable Development Commission (2006) noted, 'I will if you will' is important in driving sustainable consumption[130]. If Government itself is not acting, then why should anyone else? Allen (2016) argues that most people are happy to be followers and are looking for someone perceived as trustworthy and expert to demonstrate what to do and the benefits that can accrue from it[131].

### 3.2.5 Demand for second-hand and remanufactured products

#### *3.2.5.1 The current situation*

The majority of UK consumers express a willingness to buy second-hand; in a 2014 Eurobarometer survey on resource efficiency, UK citizens reported a general willingness to buy many items second-hand.[132,133]

However, despite what consumers say, second-hand purchasing[134] is unusual; the vast majority of purchases are of new products. In 2015 80% or more of all purchases of common household purchases were reported to be of new items. Furniture was the most likely to be acquired second-hand and small electricals and gadgets were the least likely to be acquired second-hand. In each case, between 5% and 15% of the population *considered* buying second-hand but went on to buy new.[135] When it comes to remanufactured products, 45% of UK consumers said they had bought a remanufactured product (European Commission 2014) although 41% had never heard of remanufactured products[136].

[129] Malmberg, K. B. (2013) 'The Role of Government Regulation and Leadership in Increasing Sustainability' *PA Times*
[130] Sustainable Development Commission (2006) I Will If You Will: Towards sustainable consumption
[131] Allen, W. (2016) Sustainability: six ways to influence behavior change
[132] The items asked about included books/CDs/DVDs/video games (81% said they would buy them second-hand), furniture (67%), electronic equipment (51%), household electrical appliances (41%), and textiles (43%)
[133] European Commission (2014) Attitudes of Europeans towards Waste Management and Resource Efficiency Flash Eurobarometer 388
[134] By second-hand purchasing, we mean consumers buying something they *knew* to be second-hand. Some remanufactured products are not branded as such, so consumers may have bought remanufactured goods without being aware of it.
[135] WRAP (2016) 3Rs tracking Study 2015: reuse and repair summary
[136] European Commission (2014) Attitudes of Europeans towards Waste Management and Resource Efficiency Flash Eurobarometer 388 here is defined as defined as a used product, the faulty or old components of which have been substituted and which is sold with the same guarantee as a new product.

The main consumer barriers to the acceptability of reused and knowingly remanufactured goods include:[137,138]

- a lack of trust in the supplier
- lack of a warranty
- concern about effective operation of supply and return channels
- acceptance of a different type of product ownership (for example where a lease, repair and return model is offered)
- lack of clarity about the price advantages
- concerns about quality
- concerns about safety
- concerns about life expectancy
- risk that the item will not be fit for purpose
- less choice
- preference for a new product
- social stigma and the association with poverty

#### *3.2.5.2 The case for intervening*

There is evidence that giving products a second (or third or fourth) life reduces consumption and therefore the use of primary resources as well as avoiding waste. Resource Futures (2012) estimates that 27% of second-hand purchases displace what would otherwise have been a purchase of a new item[139] while WRAP estimates that the environmental benefits of re-using one tonne of sofas are the same as recycling one tonne of plastics[140]. WRAP estimates that an increase of 10% in second-hand sales could save 3% carbon, 4% water and 1% waste per tonne of clothing[141].

WRAP states that buying re-used items like sofas and TVs rather than buying new items is already saving UK households around £1 billion a year and helping to create jobs. However, there is scope to do much more:

- 89,000 tonnes of waste electrical and electronic equipment (WEEE) is disposed of in residual waste at HWRCs, with a suggested potential resale value of £28 million
- 160,000 tonnes of WEEE is disposed of via residual household waste collections with a resale value up to £56 million

[137] Resource Futures (2012) The Market Potential and Demand for Product Re-use. Product Module: Furniture.
[138] WRAP (2016) 3Rs tracking Study 2015: reuse and repair summary
[139] Resource Futures (2012) The Market Potential and Demand for Product Re-use: Introduction
[140] http://www.wrap.org.uk/content/re-use-overview
[141] WRAP (2017) Valuing Our Clothes: The Cost of UK Fashion

- 350,000 tonnes of used clothing worth £140 million goes to landfill in the UK every year

One of the issues that could be tackled is the low value of the products once used, which links to the perception of second-hand goods as 'not worth much'; the value of the WEEE mentioned above is just over 30p per kilogram for example.

#### *3.2.5.3 Possible intervention: Standards*

Perceptions in quality, safety and performance could be partially tackled through establishing standards and specifications for reused and remanufactured goods. Conformity with an accredited standard should help to build consumers' trust in products. ISO, the international organisation for standardisation, has published more than 22,000 of them[142]. A Publicly Available Specification (PAS) is a fast-track way of setting out a standard and they have been widely used for waste[143].

Setting standards requires defining and establishing uniform specifications and characteristics for products and/or services[144]. In the case of manufactured products, standards typically relates to physical measurements and dimensions, materials and performance attributes, with a distinction made between technical and performance standards.

Standards have proved successful in Scotland to address lack of consumer confidence. Zero Waste Scotland worked with the reuse sector to develop the Revolve Reuse Quality Standard, an externally validated tool designed to increase the purchasing of used goods in shops[145]. A 'Committed to Excellence' accreditation scheme consists of checks for legal compliance across 22 standards and successful completion of a retail audit[146]. The shop is then entitled to display the Revolve sign. More than 100 shops are now accredited and in a sample of 23 stores, revenue doubled between 2013 and 2017. In 2016/2017, accredited shops together reported a revenue of £33.4M and a total of 23,000 tonnes of goods reused[147,148].To give an idea of scale, the 2016 shop-based turnover of one of the major

[142] https://www.iso.org/standards.html
[143] For example recycled paper (PAS105), plastics packaging (PAS103), wood (PAS111), compost (PAS100) and anaerobic digestate (PAS110)
[144] https://stats.oecd.org/glossary/detail.asp?ID=3313
[145] https://www.ellenmacarthurfoundation.org/case-studies/scotland-increasing-customer-confidence-in-reused-products
[146] www.wrapni.org.uk/sites/files/wrap/WRAP%20NI%20Zero%20Waste%20Scotland%20presentation.pdf
[147] https://www.zerowastescotland.org.uk/content/revolve-goes-strength-strength-first-private-sector-businesses-certified
[148] The time period over which this increase occurred is unknown since the case study is undated. https://www.ellenmacarthurfoundation.org/case-studies/scotland-increasing-customer-confidence-in-reused-products

players – the British Heart Foundation – was £22.6 million and 65,000 tonnes of goods were reused[149].

Consumers, however, are more sceptical about the role standards have to play in promoting resource efficiency with just 28% of UK citizens saying in 2014 that setting more efficient, environmentally friendly product standards would make the biggest difference in how efficiently we use resources[150]. This suggests that using standards alone may not be effective.

#### *3.2.5.4 Possible intervention: Campaigns*

Campaigns are unlikely to be successful in this context. Resource Futures (2012) note that large scale behavioural change is difficult to achieve and a change in overall image of the re-use sector would likely require access to expensive retail space[151].

#### *3.2.5.5 Possible area of focus: Internet-connected devices and data security*

Internet-connected (or 'smart') devices are on the increase. Worldwide, Consumers International (2017) estimates between 20 billion and 30 billion devices will be internet-connected by 2020, with consumer applications making up 63% of the market (e.g. smart TVs, fridges, security camera and vehicles)[152]. Business Insider predicts that there will be more than 55 billion internet-connected devices by 2025, up from about 9 billion in 2017[153]. In the UK, Ofgem cites a forecast that internet-connected devices will increase from 13 million in 2016 to 156 million in 2024. Current growth is found in consumer wearables and white goods, but expected growth will be in automotive, consumer electronics and the utilities. Although estimates vary across sources, it is clear this is market is expected to grow exponentially.

Evidence on whether data security is a concern for consumers when disposing of smart devices is equivocal. WRAP (2017) in its review of the evidence concludes consumers are unaware that personal data is left on devices, do not understand the risks, and know neither the options for eradication nor which devices present a risk[154]. By contrast, TechUK (undated) say that data security *is* an issue for consumers and that industry has

[149] British Heart Foundation (2017) Putting theory into practice: Annual report and accounts 2017
The weight of reused goods would be expected to be higher than average because the BHF has a major stream of its business focusing on furniture.
[150] European Commission (2014) Attitudes of Europeans towards Waste Management and Resource Efficiency Flash Eurobarometer 388
[151] Resource Futures (2012) The Market Potential and Demand for Product Re-use. Product Module: Furniture.
[152] Consumers International (2017) Testing our trust: consumers and the Internet of Things, 2017 review
[153] http://uk.businessinsider.com/the-internet-of-things-2017-report-2018-2-26-1
[154] WRAP (2017) Smart Devices and Secure Data Eradication: The Evidence

recognised it as a barrier to sales[155]. The explanation may be that the consumer focus to date has been on security of personal data *while the product is being used* rather than at point of disposal[156,157]. However, there is some evidence that data security affects disposal decisions. WRAP (2016) found this to be one of the reasons why unused electronic devices are being stockpiled by households rather than being allowed to flow through the economy. WRAP found that 61% of households have at least one smart device stored and unused at home and estimated that up to 125 million mobile phones may already be hoarded in the UK. Data security concerns are the second most commonly stated reason for this behaviour in relation to computers/ laptops/ tablets and fourth most common in relation to smartphones. The top reason for both is keeping devices because they might be useful as spares[158].

Evidence suggests that smart devices containing data entering the waste stream will double from about 40 million in 2017 to 81 million in 2020[158]. An estimated 2.5 million of these were offered for re-use in 2017 and this is expected to rise to 4.2 million in 2020. Smart devices are on average 6.5% of all products presented for reuse. Over 90% of these presented a 'high' data security risk because they contain sensitive data on operating systems, hard drives and memory. Even assuming that some of these are old and of no value, there is still potential for increased recycling, especially as the market grows.

A stakeholder workshop run by WRAP identified that there is a need for detailed and coherent guidance for stakeholders on their liabilities and protocols for data eradication; and simple advice to consumers on how to eradicate data on their device(s) as well as awareness when selecting a professional data eradication service provider at end of life

## 3.3 Improving drivers and incentives

### 3.3.1 Behaviour change campaigns

Providing consumers with information is essential. For example, Tidy Britain Group's *#CrimeNotToCare* campaign is specifically tackling the lack of knowledge people have about their own responsibilities towards rubbish that may end up fly-tipped, recognising that 47% of people do not know that they are responsible in law if their waste is fly-

[155] For example TechUK (undated) Trust in an Internet of Things World, Consumers International (2017) Securing consumer trust in the internet of things: Principles and Recommendations and Ellen MacArthur Foundation (2018) Circular Consumer Electronics: An initial exploration
[156] OECD Working Party on Communication Infrastructures and Services Policy (2016) The Internet of Things: Seizing the Benefits and Addressing the Challenges Background report for Ministerial Panel 2.2
[157] Information Commissioner's Office (2017) Big data, artificial intelligence, machine learning and data protection
[158] WRAP (2016) *Sustainable EEE Consumer Tracker spring 2016*. Unpublished but cited in WRAP (2017) Smart Devices & Secure Data Eradication: the Evidence

tipped[159]. But while improving knowledge through providing factual information is necessary, it is rarely sufficient to change behaviour. For instance, just under 20% of recyclers in the UK say "I do enough so don't tend to worry about the odd thing here and there" – they know what they should be doing, but still do not do it[160]. Similarly, knowledge about the desirability of eating five portions of fruit and vegetables a day, not smoking, and taking regular exercise is almost universal, yet most people do not take the necessary actions.

Knowing *why* you are expected to do something as well as what you are expected to do may be important: consumers need to be motivated to carry out actions that may be inconvenient to themselves, and understanding why it is important may help. They may be persuaded to do the right thing for the greater good, for example. Norms come into play as well; consumers may also be persuaded on the basis that 'everyone else is doing it', that it is a very normal and easy thing to do, or that people who are like them and hold their values are doing it.

However, designing an effective and affordable campaign is challenging, in particular because evidence suggests there is no such thing as 'typical' behaviour.[161] An effective campaign should consider many factors: who is being targeted, their barriers and triggers for taking action, and who should be the change agent.[162,163] Generic campaigns are unlikely to be successful for this reason, and the Government's communication plan[164] recognises this in its commitment to transform the mass of data it has about audiences into actionable insights. But targeted campaigns can be more expensive.

EAST is a simple memory-jogger that helps in designing effective consumer campaigns. It stands for Easy, Attractive, Social, Timely – if messaging is designed with these principles in mind, it is more likely to be effective[165].

[159] Keep Britain Tidy (2018) #crimenottocare
[160] WRAP (2018) Consumer Recycling Tracker
[161] WRAP (2016) Understanding consumer decision-making for re-use and repair
[162] Keep Britain Tidy (2013) Breaking Barriers: How to get people involved in their community
[163] Rogers, E. M. (1962) *Diffusion of Innovations* (fifth edition) The Free Press
[164] HM Government (2018) Government Communication Plan
[165] The Behavioural Insights Team (undated) EAST: Four simple ways to apply behavioural insights

Good campaigns should also[166]:

- Accommodate variability in behaviours by providing information that can be tailored for various contexts
- Focus on locations, moments in life and population segments where people are most open to change
- Use messaging in locations where people are doing a related activity
- Tackle negative social myths
- Provide action-orientated ('how') messages not just information on why people should act
- Think about word-of-mouth as one of the most effective change mechanisms, so ensure messages are easy to remember and pass on

The Behavioural Insights Team (2017) notes that it can be difficult to change consumers to more sustainable behaviour because it can be require a shift in ingrained habits or be perceived as making a sacrifice. In these situations behaviour can be 'sticky' and providing information alone is often not enough[167]. Using behavioural insights as guiding principles can help with this. Behavioural insights provide a more realistic model of human decision-making, which take account of individuals' inherent biases and preferences. This helps us to design, trial and implement campaigns that are more effective at changing behaviour because they 'go with the grain' of the decisions and choices people naturally make. The likelihood of a consumer engaging in a behaviour depends on how easy it is to carry it out, whether the issue is relevant to the individual, or if there are appropriate incentives[168].

Communications campaigns are often not enough on their own to provoke significant behaviour change and need to be accompanied by other mechanisms[169]. For example, in 2006, WRAP funded 280 local authorities to run schemes to increase participation in recycling. All schemes involved communication to residents, but schemes that also improved existing infrastructure increased participation by 22 percentage points, compared with schemes that relied solely on communications, which increased participation rates by only 5 percentage points. [170]

[166] In relation to reuse and repair in particular. WRAP (2016) Understanding consumer decision making for reuse and repair
[167] Behavioural Insights Team (2017) The Behavioural Insights Team Update Report 2016-17
[168] Nisbet, M.C., Markowitz, E.M., Kotcher, J.E. (2012) Winning the Conversation: Framing and Moral Messaging in Environmental Campaigns in Ahern, L., Bortree, D. (eds.) *Talking Green: Exploring Current Issues in Environmental Communication* pp. 9-36
[169] The Scottish Government's ISM model recognises the importance of looking at behaviour change in the round, and the role of social and material factors as well individual factors.
[170] WRAP (2006) Helping you to recycle more and landfill less: Achievements Report 2005/06 Banbury: WRAP

**Box 4 Examples of existing consumer-facing behaviour change campaigns**

**Recycle Now** is the national recycling campaign for England. It is run by WRAP and used locally by more than 90% of local authorities. It aims to help people recycle more things more often, without contaminating recycling streams with non-recyclables[1].

**Bin the Butt** is Tidy Britain's campaign to discourage smoking-related litter. It operates through local authorities. The most recent iteration encourages behaviour change by raising awareness of the damage discarded cigarette butts cause to marine animals[1].

**Love Food Hate Waste** aims to raise awareness of the need to reduce food waste and help consumers take action. It showcases practical everyday things that consumers can do to waste less food, benefiting household finances and the environment. The campaign is run by WRAP and taken up by retailers, local authorities and voluntary groups.

**Love Your Clothes** aims to change the way that UK consumers buy, use and dispose of clothing. The ultimate aim is to reduce the environmental impact of clothing across the UK and influence a more circular approach to clothing globally. It is part of the Sustainable Clothing Action Plan (SCAP), which is coordinated by WRAP[1].

**Box 5 Examples of existing business-facing behaviour change campaigns**

**Your Business is Food** is a campaign run by WRAP that persuades food manufacturers and hospitality businesses to waste less food by adopting a three-step plan of measurement, action and maintenance[1].


**Right Waste Right Place** is a campaign run by the Environmental Services Association (ESA) to inform companies about their legal duties around managing waste, in particular their Duty of Care obligations, and encourage them to make changes to comply[1].


## 3.3.2 Public procurement

### *3.3.2.1 Current position*

Public procurement amounts to a significant spend, accounting for 14% of UK GDP in 2015, amounting to €350 billion[171]. Even small improvements in the sustainability of products bought with public money will likely have very significant effects.

*Sustainable* procurement is the process by which more sustainable goods and services are specified and purchased; Defra (2006) defines it as "a process whereby organisations meet their needs for goods, services, works and utilities in a way that achieves value for

[171] DG GROW (2016) Public Procurement Indicators 2015 (data from Table 1 and Table 2)

money on a whole life basis in terms of generating benefits not only to the organisation, but also to society and the economy, whilst minimising damage to the environment."[172]

#### *3.3.2.2 The case for intervention*

The OECD states that well designed public procurement can contribute to pressing policy goals such as environmental protection[173]. The European Commission comments that public authorities are major consumers and can make an important contribution to sustainable consumption and production by using their purchasing power to choose environmentally friendly goods, services and works. The Commission further identifies it can help stimulate a critical mass of demand for more sustainable goods and services which otherwise would be difficult to get onto the market.[174]

The Chartered Institute of Procurement and Supply (CIPS) states that sustainable procurement is good practice which can drive improved economic, environmental and social outcomes[175]. It is widely acknowledged that sustainable procurement has many business benefits, including long-term efficiency savings, more effective use of natural resources, encourages innovation and sends strong signals to the sustainable products market. Socially, it can reduce the harmful impact of pollution and waste and reduce the impact of hazardous substances on human health and the environment[176].

However, evidence of the benefits is limited to individual cases showing what is possible rather than systematic impact evaluations. A good deal of evidence work was carried out on sustainable public procurement in the mid-2000s. But these early studies struggled to find strong evidence of the anticipated downstream effects[177]. In response Defra initiated work to develop robust measurement methods, including the development of indicators, but little progress seems to have been made since[178].

In 2016 the UN acknowledged the challenge in documenting and articulating the environmental, economic and social benefits of sustainable public procurement (SPP)[179]. It confirmed that outcomes of SPP are rarely presented with supporting quantitative data[180].

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[172] Defra (2006) Procuring the Future: Sustainable Procurement National Action Plan: Recommendations from the Sustainable Procurement Task Force
[173] OECD (2015) Recommendation of the Council on Public Procurement
[174] http://ec.europa.eu/environment/gpp/index_en.htm
[175] Chartered Institute of Procurement and Supply (2009) Sustainable procurement
[176] For example UNGM (2006, updated 2012) UN Procurement Practitioner's Handbook
[177] A search for 'procurement' on the Defra science page reveals several 2006 studies for example.
[178] Defra (2011) How can Government assess the success of Sustainable Procurement in the public sector?
[179] UN Environment (2016) Measuring and Communicating The benefits of Sustainable public Procurement (SPP) Baseline Review and Development of a Guidance Framework
[180] UN Environment (2017) Global Review of Sustainable Public Procurement 2017

Generalising the findings of numerous published case studies is challenging[181]. Oakdene Hollins (2011) review of the effects of procurement on waste prevention observed that the evidence was largely drawn from case studies, so was "anecdotal in flavour"[182]. Despite the UN's evaluation toolkit for public procurement being published in 2016 there has been little progress in making systematic measurements of impacts and collating the results across cases.[183] This remains an evidence gap.

#### *3.3.2.3 Resource Efficient Business Models*

Section 3.2 in Chapter 2 covers resource efficient business models. For public procurement, the key is to devise specifications in a way that enables suppliers to offer products using innovative, resource efficient models.

**Box 6: Examples of resource efficient business models**

- Phillips offer a 'pay per lux' service which sells the commodity of 'light' rather than the light bulbs. By moving from a one-time sale to a 'pay per lux' model in which Philips maintain ownership of the materials, contractors benefit from maintenance and service. There are options to adapt or upgrade the setup and the manufacturer is able to recover the materials when necessary[1].
- WRAP's evaluation of opportunities in the clothing sector concluded that three models (baby clothes leasing, formal clothing hire, buy-back and resale) had potential to be commercially viable, especially if sufficient demand could be created to roll them out at scale[1,1].
- MUD supplies 'subscription jeans' where the consumer pays a monthly subscription to lease up to three pairs of jeans[1].
- Better World Fashion focuses on leasing leather apparel[1].

Samsung trialled an 'Upgrade Product' for mobile phones and TVs that enabled customers to have a new product every two years, fulfilling customer requirements for keeping up to date. It also allowed Samsung to 'call in' and professionally refurbish the previous phones to maximise resale value and gave assurance of full data removal for the former customer and potential new owner[1].

[181] For example, UNEP (2012) The Impacts of Public Procurement: Eight Illustrative Case Studies highlights the positive environmental impacts of the individual cases only
[182] Oakdene Hollins; Brook Lyndhurst; Resource Recovery Forum (2011) WR1403: Business Waste Prevention Evidence Review: L2m4-3 Procurement and Supply Chain: A Report for Defra
[183] UN Environment (2017) Global Review of Sustainable Public Procurement 2017

#### *3.3.2.4 Possible focus: Purchasing reused, repaired or remanufactured products*

One way to reduce the impact of purchased goods is to preferentially purchase second-hand, for example goods that have been passed on, repaired or remanufactured.

A key challenge is the perception of the appropriate price for reused, repurposed, refurbished and remanufactured items. Eunomia's (2017) analysis of opportunities in the furniture market concluded that the price differential from new products is not great enough to drive behavioural change[184]. Remanufacturing would be one way to take away any stigma associated with second-hand or repaired products[185].

#### *3.3.2.5 Possible focus: Specifications for goods*

Giving suppliers some flexibility around *how* they provide goods is needed to promote greater uptake. This can be achieved through innovative design of specifications. This is not always straightforward. UNEP's training model states that formulating performance-based specifications including maintenance, instead of ownership, is easier said than done. Nevertheless, there are resources available to assist with this.[186]

### 3.3.3 Reducing litter – beverage containers, single-use carrier bags and disposable cups

#### *3.3.3.1 The current position*

Litter is of concern to people: 81% of British people are angry and frustrated by the amount of litter in their local area and the National Crime Survey has found that 28-30% of people perceive "litter and rubbish lying around" to be a problem in their area. In the 2016 Great British Beach Clean, 802 litter items were collected per 100 metres of beach in England. More information about litter is available in the Government's Litter Strategy[187].

Beverage containers are a significant component of litter. The Local Environmental Quality Survey of England (2017/18) found alcoholic drinks-related litter at 25% of the sites surveyed, up from 19% in 2014/15. Non-alcoholic drinks-related litter was found at 52% of the sites surveyed[188,189].

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[184] Eunomia Research & Consulting Ltd (2017) Circular Economy Opportunities in the Furniture Sector.
[185] Steinhilper R., Hieber, M. (2001) 'Remanufacturing-the key solution for transforming "downcycling" into "upcycling" of electronics,' *Proceedings of the 2001 IEEE International Symposium on Electronics and the Environment.* pp. 161-166.
[186] For example http://www.oneplanetnetwork.org/sites/default/files/level_2_1_day_cp_training.pdf
[187] HM Government (2017) Litter Strategy for England
[188] Drinks related litter includes packaging components such as ring pulls and bottle tops
[189] Keep Britain Tidy (2018) Litter In England: The Local Environmental Quality Survey of England 17/18

Since 5 October 2015, large retailers in England have been required by law to charge 5p for all plastic single-use carrier bags (SUCBs). Evidence suggests that this charge has been successful. The Government reports that the current 5p charge has seen an 86% reduction in supply of SUCBs by the seven main retailers in 2017 to 2018 compared to the calendar year 2014[190].

Plastic single-use carrier bags are known to be a significant source of marine litter. That too has been in decline following the introduction of the charge. Maes et al (2018, for Cefas) found that there has been a sharp decline in the percentage of plastic bags on the seafloor in the seas around the UK compared to pre-2010[191]. Data from seafloor trawling in the Greater North Sea and the Celtic Sea were combined into three zones and the mean percentage of trawls that contained plastic bags calculated for grouped years (pre-2010 and 2010 onwards). The analysis showed statistically significant differences (p=0.05 for zones 1 and 2, p=0.01 for zone 3) between the two time periods (1) 43% vs 16%, (2) 53% vs 21% and (3) 65% vs 24% (section 3.3 of the paper).

Many of those who responded to the government's call for evidence on single-use plastic waste specifically highlighted disposable cups as a problematic item, highlighting the fact that they are difficult to recycle due to their plastic lining and are often littered. The majority of disposable cups are made of a paper body with an attached internal lining made out of polyethylene. Separating the plastic from the paper can only be done in specialist facilities in the UK, meaning that although technically they can be recycled, they rarely are.

The House of Commons' Environmental Audit Committee (2018) found that an estimated 2.5 billion disposable cups are used every year in the UK. Of these less than one in 400 are recycled, creating a negative consumption externality as the cost of the disposal is primarily borne by local authorities, rather than retailers or consumers. As well as the costs of dealing with disposable cup litter, which is estimated to be half a million cups per day, local authorities incur the costs of dealing with disposable cup contamination in on-street recycling bins[192].

#### *3.3.3.2 The case for intervention*

A negative externality occurs in the case of litter because neither the producer nor consumer pay for the costs of litter picking, transport and disposal. Instead the cost is borne by local authorities and it is significant. Street cleaning cost local government £778m

[190] Defra (2018) Single-use plastic carrier bags charge: data in England for 2016 to 2017 and Defra (2018) *Single-use plastic carrier bags charge: data in England for 2017 to 2018*
[191] Maes, T. et al (2018) 'Below the Surface: Twenty-Five years of Seafloor Litter Monitoring in Coastal Seas of North West Europe (1992-2017)' *Science of The Total Environment* 630 pp. 790-798.
[192] House of Commons Environmental Audit Committee (2018), Disposable Packaging: Coffee Cups; HC 657; House of Commons: London, UK, 2018.

in 2015/16.[193] Tidy Britain Group estimate that the total cost of litter to the taxpayer is £1bn a year.[194]

Dropping litter is a widespread behaviour. An estimated 62% of the population drop litter although only 28% admit to it. It is something that people either do or do not do – there is little middle ground. [195] A survey carried out in 2014 found that the age and gender groups who drop most litter are women aged 18-34 followed by men aged 18-34, then the under 18s and finally men aged 34-50. The over 50s are the least likely to drop litter, with over 70s the least likely of all[196].

The success of single-use carrier bag charging has shown how a relatively small charge can significantly change behaviour. One way to internalise externalities of littered items is artificially to create value that can only be realised if they are returned for recycling. This provides a financial incentive for would-be litterers to dispose of the container properly.

Whether the items are returned in practice to reclaim the deposit depends on whether the level of deposit is a sufficient incentive, which in turn depends on the reasons why people litter in the first place.

There are a number of financial mechanisms that could be considered, including taxes, charges or the application of a deposit return mechanism.

#### *3.3.3.3 A Deposit Return Scheme (DRS) for beverage containers*

A DRS has been widely advocated by stakeholders. The principle of DRS is that consumers pay an upfront fee for a beverage container in the form of a deposit. Once consumed, the container can be returned and the deposit redeemed. This encourages return of the packaging, enabling it to be recycled. If a customer chooses not to return the container they forego the deposit. Typically containers are returned to supermarkets and shops either at a counter or automated reverse vending machines (RVM).

DRSs are thought to be economically efficient[197]. However, this may apply only in countries without comprehensive kerbside collection of recycling.

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[193] HM Government (2017) Litter Strategy for England
[194] Tidy Britain Group (2013) The Big Litter Inquiry: The public's voice on litter
[195] Tidy Britain Group (2013) The Big Litter Inquiry: The public's voice on litter
[196] Recycling and Waste World (2014) 'Young women most likely to drop litter'
[197] Dinan, T. M. (1993) Economic Efficiency Effects of Alternative Policies for Reducing Waste Disposal *Journal of Environmental Economics and Management*
Fullerton, J. and T.C. Kinnaman (1995) Garbage, Recycling, and Illicit Burning or Dumping *Journal of Environmental Economics and Management*
Palmer, K. and Walls, M. (2002) The Product Stewardship Movement – Understanding Cost, Effectiveness, and the Role for Policy

International evidence suggests that DRSs can be effective at reducing litter[198]. For instance the Keep Australia Beautiful National Litter Index showed that in 2015/16 the jurisdictions with a DRS had a lower rate of beverage container litter compared to four other jurisdictions without a DRS[199]. The Voluntary and Economic Incentives Working Group (2018) reviewed the international evidence and concluded that a well-designed, well-run DRS can deliver a sizeable increase in the amount of beverage containers collected for recycling. It can also deliver a better quality of recyclate (i.e. the containers are less likely to suffer contamination)[200].

Various theoretical studies have been carried out on the likely effectiveness of a DRS for drinks containers in the UK and its nations. Eunomia (2010) concluded that although the upfront infrastructure costs would be high, the economic benefits from the reduction in litter and increase in recycling warrants the introduction of a DRS in the UK. Eunomia (2015) for Zero Waste Scotland, and Suez (2018), reached similar conclusions, although Suez found the case for metal cans to be less strong than that for PET[201].

The Scottish government's impact assessment of introducing a DRS in Scotland suggests substantial benefits in all the proposed designs for a DRS[202]. Defra is currently working with Keep Britain Tidy to estimate the disamenity effects of litter. Defra is also currently scoping a project that will help us understand consumers' likely engagement with a DRS in England and Wales. It will explore a range of deposits and the corresponding potential return rate, where consumers buy and consume drinks and how they dispose of used drinks bottles, so that the most effective deposits and return mechanisms can be established.

#### *3.3.3.4 Extending the single-use carrier bag charge to SMEs and/or increase the charge*

The single-use carrier bag charge in England has been a success, with an overall decrease in bags of 86% for the seven main retailers since before the charge was introduced; this equates to more than 6.6 billion fewer single-use carrier bags in 2017/18

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[198] Views differ about how much international experience can be applied to the UK due to differences in a) design of the systems, b) the time and context in which they were introduced, c) what the reported data on collection/recycling rates actually represents, d) the exact way in which wider waste management systems work and e) cultural differences between countries. A project has been commissioned by Defra to understand the potential impact of a DRS on reducing litter in England, including any associated amenity benefits to society.

[199] Keep Australia Beautiful (2016) National Litter Index 2015-2016

[200] Voluntary and Economics Incentives Working Group (2018) Voluntary and economic incentives to reduce littering of drinks containers and promote recycling

[201] Eunomia (2010) Have We Got the Bottle? Implementing a Deposit Refund Scheme in the UK, Eunomia (2015) A Scottish Deposit Refund System Suez (2018) How a deposit return scheme for 'on the go, could be designed for the UK

[202] https://consult.gov.scot/environment-forestry/deposit-return-scheme/supporting_documents/DRS%20%20BRIA.pdf

compared to 2014[203]. Similar schemes in Scotland, Wales and Northern Ireland have also been successful[204]. Consumers adapted easily and quickly to the charge in England and generally support it; levels of support were at 52% before its introduction and this increased to 62% six months after the charge came into effect[205].

Wales introduced its charge before England, and findings of the post-implementation review show that retailers are largely neutral or positive about the charge, with just 13% saying that it had had a negative impact on their business[206].

Small and medium-sized retailers have so far been exempt from the charge. It is estimated that over 3.4 billion single-use plastic bags are supplied annually by them[207]. In March 2018 the Government worked with two large trade bodies to launch an industry-led voluntary initiative to encourage their members to charge for bags. Initial feedback suggests that acceptance by retailers has been widespread[208]. Results are not yet available on the effect on SUCB usage.

Another option is to increase the charge. There are precedents from other countries in doing this. The Republic of Ireland originally introduced a €0.15 levy in 2002 but this was increased to €0.22 in 2007. The reason for the increase was that the number of plastic bags used per capita per annum had increased from 21 in 2002, after the charge was introduced, to 31 in 2006[209]. In Italy, the charge was initially set in 2004 at €0.13 per bag, but raised to €0.20 in 2007. Eunomia (2011) recommends that, when implementing taxes on single-use disposable products, the tax should continually be reviewed to ensure that its effectiveness is not being eroded over time[210].

#### *3.3.3.5 Disposable cups*

Increasing the use of *reusable* cups is a potential way to reduce littering of disposable cups. A field experiment run in 2016 at twelve university and business sites showed modest increases in use of reusable cups where a) environmental messaging was

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[203] https://www.gov.uk/government/publications/carrier-bag-charge-summary-of-data-in-england/single-use-plastic-carrier-bags-charge-data-in-england-for-2017-to-2018
[204] Zero Waste Scotland (2015) Carrier Bag Charge 'One Year On'; https://www.heraldscotland.com/news/16598986.plastic-bag-charge-why-was-it-introduced-and-what-impact-has-it-had/; Welsh Government (2016) Post Implementation review of the single use carrier bag charge in Wales and https://www.daera-ni.gov.uk/sites/default/files/publications/daera/stats-carrier-bag-levy-2017-18-report.pdf
[205] Poortinga, W., Sautkina, E., Thomas, G.O., Wolstenholme, E. (2016) The English plastic bag charge: Changes in attitudes and behaviour
[206] Welsh Government (2016) Post Implementation review of the single use carrier bag charge in Wales
[207] Defra (2018) The Single Use Carrier Bags Charges (England) Order 2015 impact assessment
[208] The two trade bodies are the Association of Convenience Stores and the Federation of Independent Retailers
[209] Institute for European Environmental Policy (2016) Plastic Bag Levy in Ireland
[210] Eunomia (2011) A Comparative Study on Economic Instruments Promoting Waste Prevention Final Report to Bruxelles Environnement

provided, b) when a charge was applied to disposable cups and c) where reusable cups were provided. Discounting drinks for those using reusable cups did not have an effect. The greatest behaviour change was achieved when a combination of measures were used. The interventions did not negatively impact the total number of hot drink sales. One university, which charged for disposable cups at the same time as providing a large number of free reusable cups, increased the use of reusable cups to 34% one year on[211].

Many coffee retailers offer discounts to customers who use reusable cups when purchasing a hot drink. However, Starbucks, in collaboration with Hubbub, extended the incentive by placing an additional 5p charge on disposable cups in 35 trial stores in London. The proportion of purchases by consumers using reusable cups rose in this time from 2.2% to 5.8%. Although use of reusable cups also increased in the control stores where no charge was in operation (from 2.2% to 3.3%), the net increase suggests that the incentive had some impact[212]. The initiative has since been rolled out to all Starbucks stores.

However, there is limited evidence that a widespread levy on all disposable cups would at this point deliver a decisive shift from disposable to reusable cups across all beverage types.

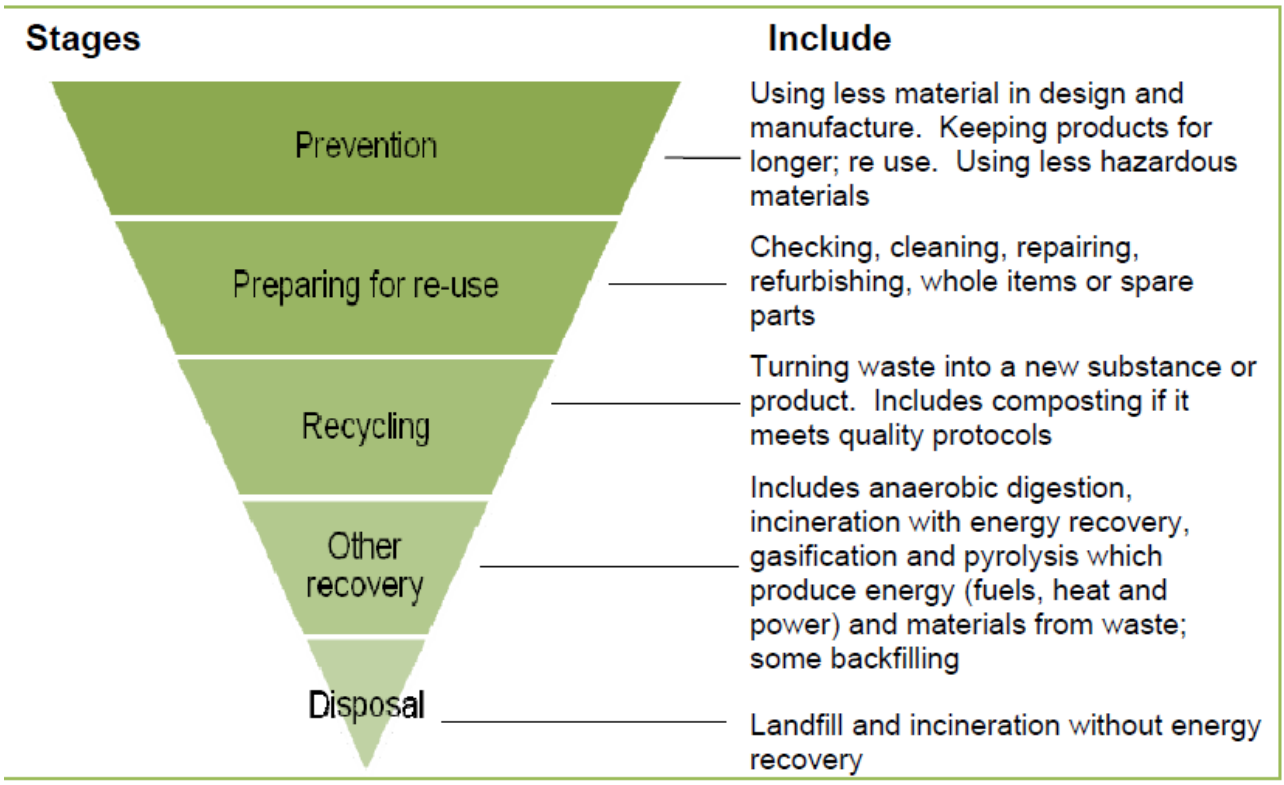
[211] Poortinga, W. and Whitaker, L. (2018) Promoting the Use of Reusable Coffee Cups through Environmental Messaging, the Provision of Alternatives and Financial Incentives. The percentage relates to the number of hot drinks sold.
[212] Hubbub (2018) Disposable Cup Charge: Impact Report

# 4 End of life

## 4.1 Introduction

The end of life stage begins when a household or businesses chooses to dispose of a product. At this point, the material or product has failed to be prevented from becoming waste[213] or being-reused and enters the waste system. (See Figure 7 for stages in the waste hierarchy below prevention and re-use that are considered waste.) The waste system includes both the collection of waste and its treatment/management.

**Figure 7: The Waste Hierarchy**




*Source: Defra, Guidance on applying the Waste Hierarchy*[214]

Total waste generated in the UK was 222Mt in 2014, with 82% (182Mt) generated in England. Table 5 shows how waste generated is split across four main waste streams: Construction, Demolition and Excavation Waste, Household Waste, Commercial and Industrial Waste, and Other Waste such as mining, agriculture and forestry.

[213] For further detail on the legal definition of waste please visit: Legal definition of waste guidance
[214] Defra (2011), Guidance on applying the Waste Hierarchy

**Table 5: Waste generation tonnages by responsible economic activity, UK, million tonnes, 2014**

| Waste type | Commercial & industrial | Construction, demolition & excavation (includes dredging) | Household Waste | Other waste inc mining, agriculture, forestry | Total |
|---|---|---|---|---|---|
| **Waste arisings (Million tonnes)** | **39** | **131** | **27** | **26** | **222** |

*Source: UK Statistics on Waste*

There are many types of waste management facilities, with some examples being landfill sites, incineration plants, recycling sorting facilities that then send recycling material to reprocessing plants, etc. (see Table 6).

**Table 6: Waste management sites and tonnages managed, England, 2016**

| Management Method | Number of sites permitted at end 2016 | Number of sites that accepted waste in 2016 | Million tonnes managed in 2016 |
|---|---|---|---|
| Landfill | 507 | 340 | 44.7 |
| Transfer | 2,987 | 2,340 | 46.7 |
| Treatment | 2,782 | 2,075 | 72.4 |
| Metal Recovery | 2,420 | 1,244 | 13.8 |
| Incineration | 146 | 81 | 11.6 |
| Use of Waste | 175 | 90 | 1.6 |
| Land Disposal | 317 | 212 | 12.2 |
| **Total** | **9,334** | **6,382** | **203** |

*Source: Waste Management for England, 2016*

By tonnage, recycling and other recovery[215] is the most common final waste treatment type in the UK in 2014, accounting for 96.3 million tonnes (46.9%). Waste split by treatment is given in Table 7 below.

**Table 7: All waste at final treatment, split by method, UK, million tonnes, 2014**

| Waste type | Incineration | Energy Recovery | Recycling and other recovery | Backfilling | Deposit onto or into land (landfill) | Land treatment and release into water bodies | Total |
|---|---|---|---|---|---|---|---|
| **Million tonnes** | 8 | 2 | 96 | 22 | 48 | 30 | 205 |

*Source: UK Statistics on Waste*

[215] 'Recycling and other recovery' refers to the Eurostat category 'Recovery other than energy recovery'.

One of the key drivers determining the way in which waste is managed is financial cost[216], which is why current policy such as landfill tax aims to make the least environmentally-preferable waste management options the most expensive too (see Table 8). This ensures the waste hierarchy is followed, although it is possible that waste management options for some materials do not keep with the hierarchy order[217].

**Table 8: Gate fees across waste management sites[218]**

| Treatment | Materials / Type of facility / Grade | Median | Mode2 | Range3 | No of gate fees reported |
|---|---|---|---|---|---|
| **MRF** | All contracts (4 materials or more) | £22 | £0 to £5 | –£37 to £95 | 94 |
| **Organics** | In-Vessel Composting (IVC)4 | £49 | £45 to £50 | £9 to £47 | 34 |
| | Anaerobic Digestion (AD) | £26 | £35 to £40 | –£5 to £68 | 62 |
| **EfW5** | All | £86 | £85 to £90 | £33 to £117 | 62 |
| | Pre-2000 facilities | £57 | £55 to £60 | £44 to £94 | 20 |
| | Post-2000 facilities | £89 | £85 to £90 | £33 to £117 | 42 |
| **Landfill** | Non-hazardous waste including landfill tax | £107 | £106 to £111 | £88 to £168 | 80 |
| | Non-hazardous waste excluding landfill tax | £20 | £20 to £25 | £2 to £82 | 80 |

*Source: WRAP Gate Fees 2017/18 Final Report*

In terms of its contribution to the economy, the waste sector contributes nearly £7bn, representing nearly 0.5% of total UK Gross Value Added (GVA), and employs over 120,000 people.[219] Waste crime, however, remains an issue, costing the English economy an estimated £600m[220] each year.

[216] Usually known as the gate fee, which is the fee per tonne charged by a facility to treat waste
[217] Defra (2011), Guidance on applying the Waste Hierarchy
[218] Negative gate fees imply that waste facilities purchase materials to treat, as opposed to charging for its treatment. Gate fees charged will depend on market and site conditions
[219] Defra (2018), Digest of Waste and Resource Statistics – 2018 Edition
[220] ESA (2017), Rethinking waste crime

We have identified the following challenges at the end of life stage to deliver a more efficient approach to waste management and improve environmental outcomes. These are:

1. Household and business recycling
2. Environmental costs of residual waste
3. Waste crime

The reason for focusing on those three challenges is because they are where there are the largest economic and environmental gains to be made. Other important areas such as construction and demolition waste already perform well in terms of waste management despite producing large quantities of waste. In 2014 about 90% of waste from construction and demolition was recycled[221]. Evidence to improve resource efficiency in this sector is explored in the production chapter.

## 4.2 Household and business recycling

Local authorities (LAs) are responsible for all household recycling collections and some business collection. LAs have significantly improved their waste management practices, showing an 85% drop in waste sent to landfill between 2000/01 and 2017/18[222]. In addition, the recycling rate for waste from households for England was 45.2% in 2017[223]. Recycling increases have however stagnated in England over the last five years[224].

However, LAs lack the incentives to invest in collecting more and additional types of recycling, particularly if the price of recycled materials is uncertain or volatile. In addition, household behaviour is key to deliver value for money for local authority recycling services[225]. Yet households do not have direct incentives to use services properly. Furthermore, current rules on how and what must be collected for recycling do not require consistency across different LAs. This has led to a myriad of different recycling collection schemes across the country and differences in materials collected (see Table 9). This can create confusion for householders and makes it more difficult to recycle correctly.

[221] UK Statistics on Waste
[222] Local authority collected waste: annual results tables
[223] Local authority collected waste management - annual results
[224] Local authority collected waste management - annual results
[225] Because the correct use of bins by households increases the quantity and quality of recycling, increasing the value that can be extracted from waste.

**Table 9: Percentage of English LAs collecting selected materials for recycling, 2017/18**

| Beverage cartons | Card | Glass | Metals (Cans/Tins) | Paper | Plastic Bottles | Plastic Pots, Tubs and Trays | Separate Food waste |
|---|---|---|---|---|---|---|---|
| 63% | 99% | 89% | 100% | 100% | 99% | 77% | 35% |

*Source: WRAP LA portal*

WRAP (2016) found households are unsure of whether certain materials are collected for recycling and what they need to do to prepare them for recycling[226]; this can cause contamination[227]. Just 25% of households were found to be effective recyclers. Urban environments tend to perform worse in terms of recycling rates due to limited space, less garden waste, more difficult participation for flatted properties and greater transience of population. For example, an urban council such as Westminster only recycles 17% of its waste, compared to a more rural area such as Rutland council, who recycle 60%[228]. WRAP (2015) found that as much as 29% of the variation across local authority recycling rates could be explained by contextual variables, such as their rural nature or deprivation levels, whereas up to 65% of the variation could be explained by LA-controlled variables, such as waste collection system types and frequency[229].

Recycling that is collected may get contaminated by food or other materials, reducing quality and therefore its economic value. Products that are difficult to recycle fail to deliver secondary materials that producers want. Evidence shows the quality of recycling collected has failed to improve in recent years, with Materials Recovery Facilities (MRFs) reporting a target material percentage of 87.5% at the start of 2014 compared to 90.6% in 2018, with a notable rise in non-recyclable material received.[230,231] This is influenced by what producers placed on the market. The volume of composite or difficult to recycle products cannot be controlled by local authorities or the waste management companies running the MRFs. This ultimately reduces opportunities to recycle and reprocess waste into new raw materials

Businesses are often charged for waste by the frequency of collections and by the size and number of bins they choose. Given that most if not all businesses will likely require a refuse bin, requesting additional bins for recycling and collecting food waste can impose

[226] WRAP (2016) 3Rs Recycling Knowledge Attitudes and Reported Behaviour Survey
[227] WRAP (2015) Dry recyclables: improving quality, cutting contamination
[228] Local authority collected waste: annual results tables
[229] WRAP (2015) Analysis of recycling performance and waste arisings in the UK 2012/13
[230] Target material is materials is capable of being recycled and is targeted by MRFs. Non-target material can be either non-recyclable material or non-target, which means it is recyclable but it is not a material that a MRF is looking to sort.
[231] WRAP (2018) Materials Facility Reporting Portal Q1 2018 – Commentary

an additional cost[232]. This pricing model dis-incentivises recycling, particularly for small businesses, where waste volumes may not be large and one refuse bin is sufficient to manage their waste. However, medium-sized and large businesses can generate enough waste to make recycling improvements that are financially beneficial[233].

Huge variations in how waste is presented by businesses and households impede scale-up of waste management operations, decreasing their efficiency[234].

Evidence on possible solutions to the problem described above is discussed in the sections below.

### 4.2.1 Consistency of recycling collection systems

WRAP have undertaken research that examines the most cost-effective collection regimes. This research suggests that in order to maximise the benefits of recycling, a phased approach should be taken. This includes introducing multi-stream dry recycling with separate food waste collections for all kerbside properties. Areas with high density housing should be given additional time to comply and/or flexibility. Despite the potential benefits to be gained from a consistent kerbside collection regime, LAs are unlikely to transition independently. This is due to behavioural barriers such as transition costs, existing contracts and difficulties of making changes to current arrangements[235]. The research and analysis is presented in more detail below.

#### *4.2.1.1* ***Kerbside Collection***

WRAP (2016) carried out extensive research into the most effective kerbside collection regimes for capturing the following set of materials: [236]

- Paper;
- Card;
- Plastic bottles;
- Plastic packaging, pots, tubs and trays;
- Metal packaging cans, aerosols and foil;
- Glass bottles and jars;
- Food & beverage cartons; and

[232] Prices charged by waste management companies to pick up recycling bins are often cheaper than prices charged to collect a refuse bin (from WRAP internal research and consultation). However, picking them up is an additional cost to just having a refuse bin.
[233] These businesses may have more than one refuse bin, and can replace refuse bins for recycling ones to save money (WRAP internal research)
[234] Purnell (2017) On a voyage of recovery: A review of the UK's resource recovery from waste infrastructure
[235] Defra (2018, forthcoming) 'Post Implementation Review of the Waste (England and Wales) Regulations 2011' on legislation.gov.uk.
[236] WRAP (2016) The Case for Greater Consistency in household Recycling,: Supporting Evidence and Analysis

- Food waste.

The research examined three main systems, all with separate food waste:

**System 1: Multi-stream and Separate Food:** Materials are presented for collection in four streams and separated into five compartments on the vehicle:

- Plastic packaging (bottles, pots, tub and trays), metal packaging (cans, aerosols and foil) and cartons;
- Glass containers and card (presented together in one container but separated at the kerbside by crews into different compartments on the vehicle);
- Paper; and
- Food waste.

**System 2: Two-Stream With Packaging Co-Mingled with Separate Fibres and Separate Food:** Materials are presented for collection in three streams. The packaging stream would require sorting at a MRF.

- Plastic packaging, metal packaging, glass and cartons as one stream;
- Paper and card (fibres) as one stream (both streams collected fortnightly in a split compartment vehicle); and
- Food waste collected weekly in a separate vehicle in all but the most rural areas.

**System 3: Co-Mingled Mixed Dry Recyclable with Separate Food:** Materials are presented for collection in two streams. The dry recyclable stream would need to be sorted at a MRF.

- All mixed dry recyclables as one stream (collected fortnightly in a single compartment vehicle and sorted at a MRF); and
- Food waste, collected weekly in a separate vehicle in all but the most rural areas where it is collected with the recyclable stream one week and the residual waste on the alternating week.

This analysis demonstrated the most cost-effective collection regime was System 1, which the WRAP model estimated could deliver financial benefits of up to £400 million over 8 years from reduced (net) waste management costs. Other estimated benefits of system 1 would include:

- Up to £478 million of materials returned to the economy from the sale of dry recyclables.
- Up to 11.6mt of materials and food waste collected for recycling, adding about 7 percentage points to the household waste recycling rate for England.

- 13.2 million more households (including those in flats) provided with a food waste collection service. 11 million more households provided with a recycling service for dry recyclables.
- Up to £33 million in reduced costs to reprocessors from not having to remove contamination from materials before processing.
- Up to 8mt of organic fertiliser available to the agri-sector, with a nutrient value of £30 million
- Supplying around 682,000 homes with renewable energy generating sales of up to £280 million a year, improving the UKs energy security.
- Improved environmental outcomes with up to 5.1mt CO2e avoided, benefiting the environment directly and supporting the UK's overall carbon budget targets.
- WRAP's evidence suggests that alongside well operated and communicated services, greater consistency in the materials collected for recycling is likely to result in better capture of target materials and less contamination of the recycling stream.

This conclusion is further supported by the Eunomia (2016) review of the success of the Welsh Assembly Government's Collections Blueprint[237]. The Blueprint recommended implementation of System 1.[238] The Eunomia valuation concluded that:

> "…the Collections Blueprint does still appear to offer clear benefits in terms of cost and material quality, while offering no relative overall disadvantages in terms of recycling performance and health and safety (and clear advantages regarding residual waste volume restriction and food waste collection)."

WRAP (2016) identifies that achieving the full financial benefits would be challenging. This is due to constraints from existing contracts and varying proportions of areas of higher density housing and deprivation. However, the calculations also assumed local authorities worked independently and did not include any potential savings from increased joint and cross-boundary workings (see section 5.2.2).

In order to maximise engagement, service design must be simple and convenient. Table 10 shows the results of WRAP research[239] which asked people to rank a number of service features of a recycling system.

[237] Eunomia (2016) Review of the Welsh Government Collections Blueprint
[238] Welsh Assembly Government (2011), Collections Blueprint For affordable and sustainable local authority collection services for recyclable, compostable and residual waste

[239] WRAP (2015) Recycling Tracker Survey

**Table 10: Percentage respondents ranking** these factors as more important and percentage ranking these factors as less important (Sample size: 1,771)

| | Capacity/ Space | Not Having to Separate Into Multiple Containers | Regular Service | Reliable Service | Containers returned to the same place | Area is Clean and Tidy | Clarity Over What Can/Can't be Recycled |
|---|---|---|---|---|---|---|---|
| More Important (1-3) | 41% | 26% | 74% | 65% | 23% | 27% | 44% |
| Less Important (5-7) | 41% | 65% | 15% | 19% | 63% | 57% | 40% |

*Source: Wrap (2015) Recycling Tracker Survey*

This suggests that public acceptance of a new, more consistent recycling system would be high. The three key service features identified by respondents as being important are having a regular and reliable service, being clear on what can/cannot be recycled and sufficient capacity in the recycling container for all their materials.

#### *4.2.1.2 Collection in Areas of High Housing Density*

About 20% of the UK population live in flats, and it is generally accepted that yields from flats are about half that of households with a kerbside collection[240]. WRAP (2018) identified challenges including higher levels of transience and deprivation, limited access to recycling services and space for storage of recycling, both inside and outside the properties[241].

WRAP (2018) examines how to increase recycling in urban areas. They identified a lack of substantiated data as to how improvements in urban recycling could be achieved[242]. A few common factors between successful urban recycling systems were identified:

- having strong legislative drivers providing a legal requirement for residents to recycle;
- differential charging for the provision of residual waste collection services compared with recycling services, which encourages the use of recycling schemes;
- frequent collection of a wide range of dry recyclable materials through the delivery of a high-quality service; and

[240] WRAP (2018) Increasing recycling in urban areas
[241] Ibid
[242] Ibid

- pro-active multi-channel communication with residents which informs residents about the service and encourages its use.

WRAP ran pilot projects to increase recycling in urban areas across the country. This included providing single-sacks, internal caddies for recycling and targeted communications[243]. The projects did not yield statistically significant changes in recycling levels. Even though significant increases in recycling were not seen, there have been some reported changes in residents' behaviour which, over time, could lead to measurable increases in recycling collected. Nonetheless, this highlights the complexity of the issue and how a one size fits all approach does not work across areas.

#### *4.2.1.3* ***Business waste***

Data and evidence for business waste are more limited than for LAs[244]. WRAP's internal research has found that large and medium sized businesses can make savings by increasing their recycling collections, reducing refuse. However, for small businesses there could be a cost increase. This analysis will be presented as part of the consultation on delivering national consistency for recycling collections. The consultation will also be used to gather evidence on how to increase recycling from businesses.

### 4.2.2 Local authority collaboration

A Local Government Association report identified potential savings for local authorities in areas such as joint procurement and partnership working, shared operation of HWRCs, staffing and communications rationalisation, and sharing and harmonising best practice[245]. The Environmental Services Association estimates that more consolidated LA resource management systems could save between £200 million and £450 million[246]. The Ministry for Housing Communities and Local Government looked into better procurement through partnership working, estimating benefits of over £70m a year from clearer specifications and procuring in larger volumes in partnership with other councils[247].

There is also growing anecdotal evidence that the recycling credits system in two-tier authorities[248] is not being used and alternative arrangements are being put in place. This questions the need for the recycling credits system in its current form. This is a cost-sharing system between waste collection and waste disposal authorities to ensure savings from cheaper disposal of waste are shared across both parties, incentivising the collection

[243] WRAP (2018) Increasing Recycling in Urban Areas
[244] Please see data chapter in the strategy document for commitments on better data
[245] LGA (2012) Services Shared, Costs Spared?
[246] ESA (2016) Resourceful: Delivering a strong and competitive UK resource economy
[247] MHCLG (2015) Household Waste Collection: Procurement Savings Opportunities
[248] Authorities where the responsibility of waste collection is at district level (Waste Collection Authority) and responsibility for the management/disposal of waste is at county level (Waste Disposal Authority)

authorities to collect waste in a manner that ensures cheaper disposal, i.e. reducing residual waste disposal.

### 4.2.3 Communications and incentives

Communication is integral to delivering our ambitions on waste prevention and a higher quantity and quality of recycling. For example, WRAP (2017) find the level of confidence expressed by householders in what can and cannot be recycled is correlated with whether they had received information about the collection in the past year[249]: 56% of those who say they are 'very confident' say they received information compared to just 23% who are '50:50' and 17% of those who are 'not very' or 'not at all confident'. Levels of missed recycling are highest among those with less confidence about what can and cannot be recycled (64% vs. 43% of those who are very confident). However, contamination of recycling is not affected by confidence. There is also a strong correlation between reported receipt of information on the kerbside collection and levels of effective recycling[250].

Despite this, reported levels of confidence in recycling have remained stable since 2014 with reducing information received[251]. In 2015, 57% of UK households reported receiving information on recycling and reuse in the past year, significantly fewer than in 2014, when 69% said they had received information. Comparisons between 2015 and 2014 reveal a pattern of reduced information, with all but two types of information having seen a statistically significant decline.

Brook Lyndhurst (2013) explored reward and recognition schemes to prompt household behaviour change in recycling. Improvements in recycling and reuse were linked to better services and promotion rather than being attributable directly to the rewards. The report concludes that rewards and recognition have the potential to validate, reinforce and, possibly, improve a pre-existing behaviour rather than act as a catalyst for new behaviours[252].

## 4.3 Environmental costs from residual waste

Residual waste is waste that has not been prevented, re-used or recycled. It is usually collected from households or businesses in a black bag or a wheelie bin, and is then sent for treatment to ultimately end up at an energy recovery plant or landfill. The waste composition of residual waste will determine how environmentally damaging it will be when it is sent for treatment. Policies are needed at the end of life stage, but also at the production and consumption stages, to ensure residual waste is minimised.

[249] WRAP (2017) Recycling tracking survey 2017. Behaviours, attitudes and awareness around recycling
[250] However, causality is not established in the report
[251] WRAP (2016) 3Rs Recycling Knowledge Attitudes and Reported Behaviour Survey
[252] Defra (2013) Evaluation of the Waste Reward and Recognition Scheme: Emerging Findings

Despite a significant 70% decline in greenhouse gas (GHG) emissions since 1990, the waste management sector still accounts for 4.3% of UK GHG emissions, with landfill comprising over two-thirds of that[253]. The main source of GHG emissions in landfill is the anaerobic decomposition of biodegradable waste into methane. Landfill accounts for 27% of all UK methane emissions and is the second biggest source after agriculture[254]. Other than GHGs, biodegradable waste in landfill also produces leachate, a toxic liquid which can be difficult to extract and expensive to treat.

GHG emissions are also generated from the incineration of municipal waste[255]. This is usually referred to as energy from waste (EfW) and accounts for 0.8% of UK GHG emissions[256]. There are also associated emissions of air pollutants such as particulate matter or nitrous oxide, but these are tightly regulated and small. GHG emissions from EfW are generated when fossil-based waste is combusted, such as plastic. Latest Environment Agency data show 40 operating municipal and or industrial & commercial waste incineration facilities in England[257]. Existing plants are all enabled to use heat, but less than a quarter do so[258]. Distributing the heat generated from combustion of waste, as well as the electricity produced, can increase the efficiency of incineration plants and reduce their environmental impact[259]. However, it can be costly to build networks to distribute heat[260]. England has 11.4Mt of EfW permitted capacity dedicated to treating municipal and/or industrial and commercial waste[261,262]. Defra internal analysis estimates over 2Mt of municipal waste incineration treatment capacity to come on stream from EfW plants which are in construction to 2020.

Without new policy, municipal residual waste arisings could be 30.1 million tonnes in 2035, up from 27.8 million tonnes in 2016. Depending on how they are implemented, policies such as consistency of collections can significantly reduce the expected amount of residual waste generated through higher recycling (Figure 8).

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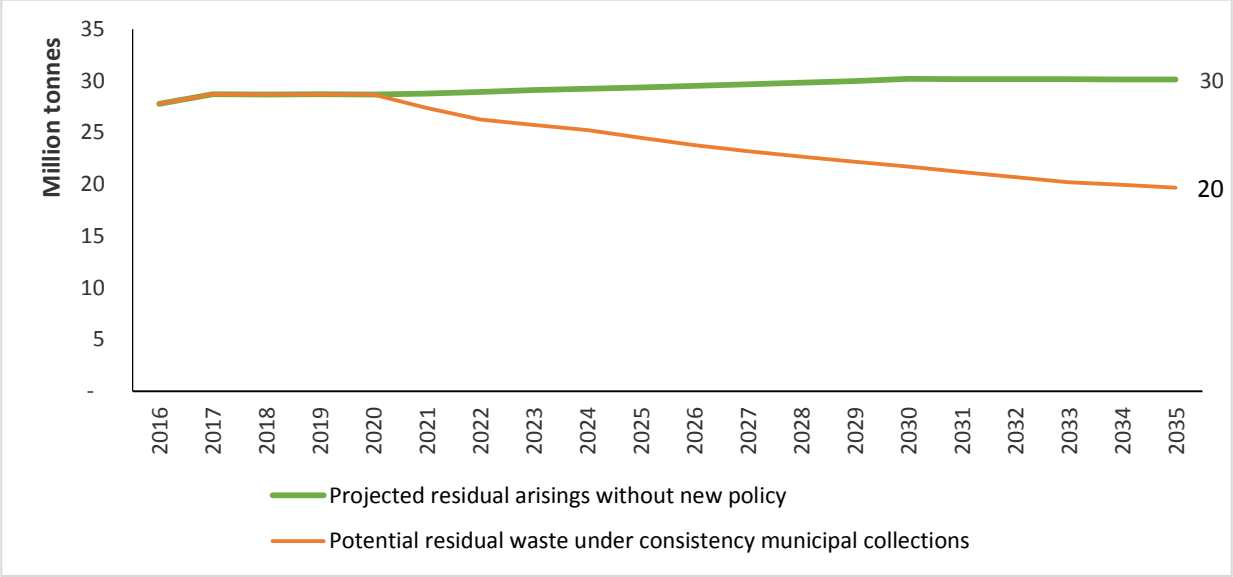
[253] As defined in the National Atmospheric Emissions Inventory: landfill, waste-water handling, waste incineration, composting, anaerobic digestion and mechanical and biological treatment
[254] Final UK greenhouse gas emissions national statistics 1990-2016
[255] Counted in the power section of the National Atmospheric Emissions Inventory as opposed to being in the waste section
[256] National Atmospheric Emissions Inventory data.
[257] Waste Management for England 2016
[258] Source: Defra infrastructure data
[259] Defra (2013) Incineration of municipal solid waste
[260] Defra (2013) Incineration of municipal solid waste
[261] Permitted capacity needn't equal the maximum throughput tonnage plants can take, as the amount of waste that can be burnt will be affected by its composition and calorific value or operational downtime.
[262] Waste Management for England 2016

**Figure 8: Projected municipal residual waste arisings with and without new policy**



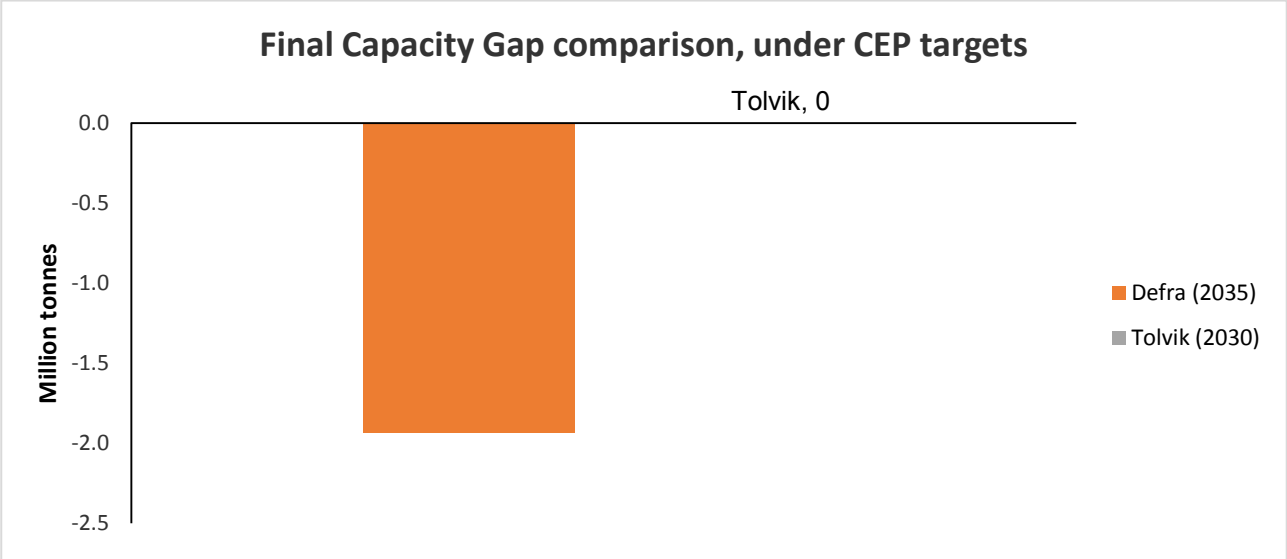

*Source: Defra modelling*

According to our internal analysis, shown below (Figure 9), significant additional residual waste energy recovery capacity such as incineration or advanced conversion technologies – above that already operating or planned to 2020 – would not necessarily be needed to meet an ambition of no more than 10%[263] Municipal Solid Waste (MSW) to landfill by 2035, if a 65% MSW recycling rate is achieved by that same year[264]. The analysis assumes refuse derived fuel (RDF) exports remain at current levels. However, if energy recovery continues to provide a better environmental alternative to landfill, more investment to reduce tonnages of MSW to landfill further would deliver environmental benefits[265].

Tolvik Consulting Ltd. carried out a similar assessment, bringing together existing reports around Energy from Waste, and concluded that there would not be a gap in incineration capacity in 2030, provided the 65% MSW recycling rate ambition was met (Figure 9 below). The risk of a gap in capacity is, however, still relevant, as projections on future capacity, exports and arisings are subject to uncertainty[266].

[263] 10% of MSW is estimated to be between 5Mt-6Mt per annum by 2035
[264] With MSW residual arisings predicted to fall to 20-21Mt per annum by 2035 under a 65% recycling rate
[265] The environmental balance between landfill and energy recovery will depend on several factors such as the composition of waste landfilled, the efficiency of energy recovery, etc.
[266] Tolvik Consulting Ltd. (2017) UK residual waste: 2030 market review

**Figure 9: Capacity Gap comparison, under 65% MSW recycling, with Defra high and low waste arisings scenarios[267]**




*Source: Defra and Tolvik analysis*

Regarding health impacts of incinerators, Public Health England's position is that it has issued a statement that modern, well managed incinerators make only a small contribution to local concentrations of air pollutants. It is possible that such small additions could have an impact on health but such effects, if they exist, are likely to be very small and not detectable.[268] Another paper examining this issue, Ghosh et al. (2018), found no evidence of a link between exposure to particulate matter from modern municipal waste incinerators, or living close to them, and infant mortality, low birth weight, still birth or the other birth outcomes investigated[269].

The landfill sector presents a different set of challenges. Waste deposited in landfill slowly releases methane over a very long period of time. This requires long-term management. There are currently 21,453 known landfill sites in England[270]. Of these, there are 1,841 sites which have a permit, and 360 are currently accepting waste. While landfill sites currently accepting waste are subjected to the Landfill Directive, older sites are subject to a patchwork of ownership and legislative regimes. Many legacy sites were built prior to strict environmental regulation, often with unknown ownership and possibly abandoned. Although landfill operators closing now will have been required to set aside capital to manage the site after closure, analysis of aftercare costs and timescales suggests the amount is likely to be inadequate[271]. As policies aim to shift biodegradable waste out of landfill, reducing income for operators, a re-examination of the economics of landfill management is required.

[267] Defra scenarios allow for 10% of MSW to go to landfill
[268] Incinerators and public health
[269] Ghosh et al. (2018) Fetal growth, stillbirth, infant mortality and other birth outcomes near UK municipal waste incinerators; retrospective population based cohort and case-control study
[270] Defra research, soon to be published
[271] Defra WR1919: Landfill Aftercare Scoping Study, 2018 (to be published soon)

Evidence on possible solutions to the problem described above is discussed in the sections below.

### 4.3.1 Preventing additional landfill emissions by landfilling less biodegradable waste

Landfilling should be the disposal method of last resort, but despite increasing resource efficiency and increasing diversion of valuable materials, there will always come a point when further treatment/recycling is no longer practical or economically viable. However, the environmental impacts of this waste can be significantly reduced through removal of the biodegradable fraction whose breakdown is responsible for the generation of methane and leachate. Although we are on track to meet the landfill diversion target set by the Landfill Directive[272], our latest available estimates show that 54% of waste collected at kerbside that ends up in landfill is biodegradable.[273]

Analysis by Ricardo AEA[274] calculated the contribution of various waste streams entering landfill to overall methane emissions and found that paper and card contribute the most to the total, due to their high carbon and lignin content by weight, followed by food waste. Degradation of biodegradable waste also leads to leachate generation and its associated treatment costs. Diversion of these waste streams would allow the environmental impact of future landfill to be significantly reduced. The Committee for Climate Change (2018) have estimated it will deliver 1.3MtCO2e savings by 2025 and 2.6Mt CO2e yearly savings by 2030 if no more biodegradable waste were sent to landfill by 2025[275]. Total UK emissions from landfill were 13.8Mt of CO2e in 2016[276].

### 4.3.2 Managing the Environmental impact of legacy landfill sites

Biodegradable waste from landfill breaks down slowly. It means legacy landfill sites continue to release methane and leachate for a considerable time period. Depending on their period of operation, landfill sites vary widely in contents of deposited waste, pre-designed engineering containment and the ownership and legislative requirements that apply.

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[272] Reduce biodegradable municipal solid waste sent to landfill to no more than 35% of the tonnage produced in 1995, by 2020. Data for 2016 show the UK has reduced tonnages to 22% of the 1995 value.
[273] Defra (2014) Analysis of biodegradability of residual waste based on subtraction of diverted materials
[274] Internal requested by Defra
[275] The Committee on Climate Change (2018) An independent assessment of the UK's Clean Growth Strategy
[276] Final UK greenhouse gas emissions national statistics: 1990-2016 This figure accounts for emissions from waste deposited before 2016 too.

There is currently a lack of clarity regarding the point at which the landfill permit can be surrendered, and the Environment Agency (EA) ceases regulating and monitoring the site. Current guidance states that this can take place when: [277]

(i) the site ceases accepting waste
(ii) relevant closure procedures have been complied with
(iii) an appropriate period of aftercare has passed to allow the waste to stabilise and to gather evidence to demonstrate that pollution control measures are no longer necessary
(iv) waste deposits are in a satisfactory state that, if left undisturbed, will not cause pollution of the environment.

The EA is currently reviewing this risk-based approach and its report is due for publication next year. There is growing evidence that degradation of the waste may be slower than originally thought[278]. This will significantly extend the timescale over which the criteria outlined above would be reached. This has major implications for funding and post-closure management of landfill sites.

Defra has commissioned a scoping study to look at the issues surrounding landfill aftercare and its financing, which will be published this year[279]. It will identify whether further research is needed into the issues surrounding the accelerated breakdown of biodegradable waste. Techniques considered include aeration, landfill mining and leachate recirculation. Research is needed into both the technical feasibility and economic viability

The study will also identify how improving passive management techniques could reduce ongoing management costs and environmental damage. Passive treatments include such techniques as improving surface methane oxidation and reed bed leachate treatment, and present low-intervention (and hence low cost) options for ongoing management of closed landfill sites. Improvement of passive treatments will also influence the setting of criteria that must be met before landfill sites can revert back to the EA and will allow industry to set targets and plan accordingly. Defra will carry out further research in this area and will use the outputs to inform future policy.

[277] Environment Agency (2005) Landfill (EPR5.02) Guidance Note
[278] Defra (2018) Landfill Aftercare Scoping Study, 2018 (WR1919)
[279] Defra (2018) Landfill Aftercare Scoping Study, 2018 (WR1919) Defra WR1919(2018) Landfill Aftercare Scoping Study, 2018

### 4.3.3 Fiscal measures at end of life to incentivise better environmental outcomes

The intention of this section is not to present an exhaustive list of fiscal measures available but to highlight the potential these measures have to deliver change and considerations around their implementation.

Fiscal incentives like taxes, fees and charges can be powerful policy instruments to deliver behaviour change and desired outcomes. In waste policy one of the most prominent has been landfill tax. Since its introduction in 1996, it has been a clear driver to divert waste out of landfill and increase recycling. Indeed, between 2000/01 and 2017/18, there has been an 85% decrease in the waste collected by LAs sent to landfill[280]. The 5p charge on single-use plastic carrier bags has also delivered behaviour change, with data showing an 86% drop in the number of single-use plastic carrier bags between 2014 and 2017/18[281]. Despite this, the level of LA waste not recycled has remained stable over the last 5 years.

One example of an additional fiscal incentive would be to introduce a tax on facilities that incinerate municipal waste. Such a tax would make incineration more expensive, encouraging diversion of waste from this form of waste management.

According to the waste hierarchy, incineration of waste with energy recovery is preferred to landfill, and landfill tax[282] ensures economic incentives reflect this. WRAP estimate that median gate fees in England are £86 per tonne for incineration compared to £125 per tonne for landfill[283]. WRAP data show that in some cases EfW and landfill gate fees can be similar. The introduction of a tax on incineration could make it a more expensive form of waste management than landfill. This could unintentionally divert more biodegradable waste to landfill and from current biogenic carbon emissions[284] to more harmful methane emissions.[285] **Introduction of an incineration tax, if considered, must take into account the landfill tax** and address other waste management routes such as RDF exports.

In theory, this should provide a financial incentive for LAs and businesses to take more action to recycle because refuse collection will become more expensive. It could stimulate investment in better recycling collection systems, particularly of heavier materials. However, those that have to deal with waste are unable to address fundamental issues

[280] Local authority collected waste: annual results tables
[281] Single-use plastic carrier bags charge: data in England for 2017 to 2018
[282] Standard rate for 2018/19 is £88.95 per tonne landfilled
[283] WRAP (2018) Comparing the costs of alternative waste treatment options
[284] Biogenic carbon dioxide emissions are defined as carbon emissions related to the natural carbon cycle, as well as those resulting from the combustion, harvest, combustion, digestion, fermentation, decomposition, or processing of biologically based materials. Therefore, additional biogenic emissions are not counted as an increase in carbon emissions.
[285] Ricardo AEA analysis and NAEI activity and GHG data

like product design, weak secondary material markets or household and business behaviour. Any consideration of an **incineration tax would need to take account of other policies to increase recycling.** This conclusion is supported by European Commission (2012)[286]. Overall, an incineration tax might provide incentives to divert waste higher up the hierarchy, but it must complement and be introduced alongside other policies. It is worth noting that higher prices for waste disposal may encourage waste crime, although it is not necessarily the only factor[287].

As set out at Budget 2018, the government will consider such a tax in the longer term if other policies do not lead to the change desired to meet the government's waste ambitions.

**Box 7: Area of Research Interest 3: minimising environmental impacts of waste**

Throughout this document, a number of evidence gaps have been identified and following on from the 2015 Nurse Review of the UK Research Councils and our previous strategic approach, we want to provide a clear steer regarding our future research needs in the form of Areas of Research Interest (ARIs). For this area we want to focus on:

- Waste Infrastructure data and capacity
- Maximising quality and efficiency of waste treatment
- Moving waste up the hierarchy
- Environmental impacts of different waste streams/technologies
- Reducing landfill aftercare costs
- Data on commercial waste and composition

Issues around waste definitions

## 4.4 Waste regulation and crime

Crime has wide-ranging impacts on how the waste sector functions. Among the main costs are those to society from pollution risks and disamenity. However, valuing the benefits of avoiding these damaging effects can be difficult. The latest available suitable data are from Ricardo AEA's 2016 Technical Report on Waste Crime. These provide empirical estimates of both the costs of illegal and abandoned waste sites.

[286] European Commission (2012) http://ec.europa.eu/environment/waste/pdf/final_report_10042012.pdf
[287] ESA (2017) Rethinking waste crime

Ricardo AEA (2016) estimates the benefits of avoided ecological and environment damage by illegal waste sites at £1.86–£1.88 per tonne of waste and avoided disamenity at £6.02–£6.18 per tonne[288]. ESA (2017) estimates waste crime costs the English economy £600m each year[289]. This is sizeable when compared to the estimated £6.6 billion in Gross Value Added of the waste sector as a whole in 2015[290].

The waste sector has become more fragmented in England, with more treatment options available, as reliance on landfill has diminished. Organisations and individuals are encouraged to become involved in the sector by low barriers to entry in some parts of the industry, for example to be a waste carrier or to operate a waste site under exemptions[291]. This fragmentation has created competition in the market that has benefited those that produce.

However the multitude of business transactions has made enforcing rules and regulations more challenging for the EA. This increases the risk of illegal activity on waste management sites which can be difficult to detect. Sites usually operate in locations less visible to the general public, which appeals to those wishing to conduct illegal activities. On first sight it can be hard to discern the difference between legitimate and illegitimate sites. As of June 2016, the EA estimated that over one and a half million tonnes of waste were held in known active illegal waste sites in England[292]. This is likely to be an underestimate because it relates only to known sites. Increased efforts by the EA has tended to reveal more. It is thought possible that a sizeable number of illegal sites remain undiscovered.

Criminal activity is not just limited to those operating outside of the regulatory framework. It can also be caused by a breach of an environmental permit or failure to comply with the terms of a registered exemption[293]. Such breaches can pose a significant risk to human health and the environment. For example, waste can create a fire hazard or collapse. Operator competence is tested but only applies to sites that require environmental permits. Those exempted from the permitting regime are not being assessed and this can leave significant shortfalls in performance.

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[288] Ricardo (2016) Waste Crime Intervention and Evaluation Project (Technical Report for the Environment Agency).

[289] ESA (2017) Rethinking waste crime. It should be noted that this value does not include all of the environmental and social impacts that are known to occur.

[290] DEFRA (2017), Digest of Waste and Resource Statistics, March 2017,

[291] A waste exemption is a waste operation that is exempt from needing an environmental permit. Each exemption has specific limits and conditions you need to operate within.

[292] Environment Agency communication.

[293] For example a site might deliberately accept too much waste, store waste in an inappropriate manner or accepting waste that needs a permit.

Fly-tipping is a wide-ranging offence. It is defined as 'the illegal disposal of household, industrial, commercial or other 'controlled' waste without a waste management licence'[294]. In many instances it is an opportunistic, one-off occurrence, with perpetrators seeking to avoid waste treatment or disposal costs. But collectively such activities cause significant economic, social and environmental damage.

Local authorities generally deal with fly-tipped waste on public land. But the EA takes control if it exceeds 20 tonnes, contains significant amounts of hazardous material or is known to be linked to organised crime. The EA reported 226 large-scale illegal dumping incidents in 2017/18[295]. In 2017/18, local authorities dealt with 998,000 fly-tipping incidents. These incidents represent a significant level of illegal activity[296].

These figures are not representative of the true scale of fly-tipping in England because they do not capture waste fly-tipped on privately-owned land. Yet this will cause economic damage and disamenity costs, such as from vermin population increase and adverse visual effects, especially if it occurs close to local communities or in agri-tourist locations.

The limitation of existing regulation and shortfalls in waste site performance generates negative externalities on society, a form of market failure. These externalities consist of environmental and disamenity impacts which are subsequently not reflected in market prices. This also compromises fair competition for sites that operate responsibly through compliance of regulations and safety standards.

### 4.4.1 Waste management regulations

**Waste Tracking Notes**

For most individuals and businesses, their first engagement with the waste management industry is via a waste carrier or broker. This requires carriers and brokers to provide reliable advice and manage their waste legally. There is concern the requirements for becoming a registered waste carrier, broker or dealer are too lax[297].

Waste producers have an obligated duty of care to provide an accurate description of the waste when they transfer it to another party. These are recorded by creating a waste transfer note (WTN). It is estimated that more than 23 million WTNs are produced on paper each year in the UK. WTNs capture key information about who owns waste, its description, quantity, source and destination. But paper-based WTNs complicate enforcement on operators and makes it difficult to identify where crime is taking place. This

[294] House of Commons (2016) Briefing Paper: Fly-tipping The Illegal Dumping of Waste, May 2016
[295] Environment Agency, Waste Crime Data.
[296] DEFRA (2017) Fly-tipping statistics for England, 2017/18, November 2018
[297] Defra (2018, forthcoming) 'Post Implementation Review of the Waste (England and Wales) Regulations 2011' on legislation.gov.uk.

can be overcome by making WTNs electronic, making it easier to track waste and provide the intelligence for more effective and timely intervention against waste crime[298,299].

All businesses that produce or handle waste are already required by law to complete a written description of their waste when they transfer it to someone else. We will consult on options to make these records, including on international waste shipments, digital and mandatory through legislation. We are funding the development of a proof of concept model for the digital recording of waste movements though the GovTech Catalyst competition challenge. The GovTech fund is designed to incentivise Britain's tech firms to come up with innovative solutions to public sector problems and improve services for citizens. In this initial three-month phase starting in December 2018, five companies are awarded up to £80,000 each to develop their ideas. If successful up to two projects will be funded a further £500k to take forward the proposals.

**Competence of waste site operators**

Intervention is necessary to strengthen the regulators' assessment and enforcement of the competence of waste site operators. Defra's call for evidence in 2015 identified four elements of operator competence from the Environmental Permitting (EP) Core Guidance 2013 which need strengthening: [300]

1) Past operator performance;
2) Management systems;
3) Technical competence;
4) Financial competence.

Previous changes to the EP Core Guidance expanded the regulator's ability to refuse and revoke permits on competence grounds. This resulted in a 6% fall (217 to 203) of persistent poor performers from 2014 to 2015. Evidence collected by the EA shows these four elements of competence are linked to poor compliance.[301] This suggests the case for improving operator competency in these areas should help reduce non-compliance and deliver environmental and amenity benefits.

### 4.4.2 The waste exemptions regime

The waste exemptions regime aims to provide an effective method of regulating lower risk activities. However, government and industry recognise there is potential for the system to

[298] ESA (2017) Rethinking waste crime
[299] Defra (2018, forthcoming) 'Post Implementation Review of the Waste (England and Wales) Regulations 2011' on legislation.gov.uk.
[300] https://consult.defra.gov.uk/waste/crime-and-poor-performance-in-the-waste-sector/results/summaryofresponses.pdf
[301] Environment Agency: 'Regulating the waste industry: 2015 evidence summary'

be abused. For example, waste exemptions can be registered alongside environmental permits. Unscrupulous operators might try to avoid some of their activities being included within their permit conditions[302].

There are over 500,000 exemptions registered in England alone. These exemptions are registered for businesses, charities, schools, public sector organisations and government bodies. A large proportion of exemptions are registered at agricultural sites by farmers[303].

- In England there are 528,734 exemptions registered across 94,257 sites.
- In Wales there are 39,912 exemptions registered across 5,535 sites.
- The total number of businesses with exemptions registered is 66,952 in England and 3,703 in Wales.
- 86% (455,000) of all exemptions registered in England are for a mix of agricultural and non-agricultural waste and take place on agricultural premises, with 57% (303,000) for agricultural waste. Only 14% (74,000) are for non-agricultural waste only.
- 30,100 of the exemptions registered are for those exemption types routinely used to mask illegal activity.

In 2015 the EA carried out a campaign of site visits to assess the extent of illegal waste activities at exempt sites. During the course of the campaign, a total of 609 sites visits were carried out across 5 areas in England, focussed on non-agricultural exemptions[304]. The survey collected evidence which suggests that 10 exemption types are routinely used to hide illegal waste activities from regulatory oversight. The findings show that 22% of sites with registered exemptions were either illegal or potentially illegal.

Removing these exemptions should help reduce the opportunities for criminals to deal with waste under an air of legitimacy. Defra has already consulted on proposals to remove exemptions and will be looking to legislate these changes in the near future.

### 4.4.3 Serious and organised crime in the waste sector

Industrial scale waste crime has emerged as an increasing problem in recent years. This matters in two key respects. First, it generates significant environmental costs, adversely

[302] http://www.esauk.org/esa_reports/20170502_Rethinking_Waste_Crime.pdf
[303] https://consult.defra.gov.uk/waste/crime-and-poor-performance-in-the-waste-sector/supporting_documents/Impact_Assessment_PartB.pdf
[304] The distinction between agricultural and non-agricultural waste exemptions is made because of the different types of waste being processed at agricultural and non-agricultural sites, the associated difference in environmental or disamenity risks, and the difference in systematic illegality between these site types. EA data implies that farmers often register multiple exemptions on a “just in case” basis which are then not used.

affecting communities and creating inconvenience and often misery for people where they live or work. Second, it undermines our efforts to dispose of waste responsibly and creates a competitive disadvantage for the legitimate waste sector which is playing by the rules.

This has culminated in the independent review of serious and organise crime in the waste sector. The Review found a complex and ill-understood system which was under-regulated and open to abuse, enabling organised crime groups to flourish. Waste has become commoditised, in large part due to the Landfill Tax creating a value for waste, and the legislation and enforcement has not kept pace with organised criminality. The recommendations in the Review are designed to create a more strictly regulated industry and provide the EA with the powers and funding to tackle the issue. One unifying theme throughout the Review was the clear view to focus on prevention and disruption rather than costly criminal sanctions, many of which have been unsuccessful.

To provide the evidence for the review we have conducted a wide-ranging literature review to understand the current context and background to the subject. Government has also issued a call for evidence from the public, the waste sector, regulators and enforcement agencies[305].

The Review's recommendations are split into 5 areas:

- **Organisation and leadership –** The Environment Agency should work more closely with local police, local authorities, and industry. A Joint Unit for Waste Crime (JUWC) should be created to gather and share information and coordinate responses effectively.
- **Enforcement powers and regulation** - Expanding powers to raise the barriers to entry into criminality, reduce the regulatory gaps and equip the Environment Agency with the tools they need.
- **Technology and data –** Mandating the standards for an electronic system to track waste effectively.
- **Duty of care –** Create a more robust duty of care with stricter liabilities on waste producers, carriers, brokers and dealers, backed by measures to ensure compliance.
- **Business Model** - The EA could be funded by reforming the allocation of tax revenues, licence fees or introducing a voluntary levy with industry.

### 4.4.4 Fly-tipping

In 2017/18, local authorities dealt with 998,000 incidents of fly-tipping in England, a small 1% decrease from 2016/17, following annual increases since 2013/14 [306]. Care should be taken when interpreting the trends, especially for individual local authorities. Any changes and especially increases, may reflect both improvements to the capture of fly-tipping

[305] This was published in November 2018 and can be found online here
[306] Fly-tipping statistics for England 2017/18, November 2018

incidents as well as genuine increases in the number of incidents. Most incidents occurred on public land, with the most common place for fly-tips occurring on highways. Two thirds (66%) of fly-tips in 2017-18 involved household waste.

Ministers are considering giving the power to local authorities and the Environment Agency to issue a Fixed Penalty Notice (FPN) of up to £400 to a householder who has passed their waste to an unauthorised person[307]. Householders can check on the Environment Agency website if a waste carrier is licensed to take their waste[308]. This FPN will give local authorities and the Environment Agency a more proportionate option than prosecuting a householder through the courts. The Environment Agency is responsible for dealing with large-scale, serious and organised illegal dumping incidents which pose an immediate threat to human health or the environment. In 2017/18 the Environment Agency dealt with 226 incidents of large-scale illegal dumping of waste in England.

To clear and dispose of fly-tipping is estimated to cost local authorities £58 million[309] when estimates were last published for 2016-17. For 2017-18 only the costs to deal with certain larger categories of waste that are directly reported by local authorities were published. This is because of a lack of confidence in the standard unit costs for other categories. The precise scale of fly-tipping on private land is unknown as there is no requirement for landowners to report to Defra, though some do so voluntarily. Landowners have estimated that fly-tipping costs them £50m-150m a year. We are working to improve the reporting and data collection of fly-tipping on private land to target enforcement in the worst affected areas. The Defra chaired National Fly-tipping Prevention Group (NFTPG) is a group of organisations working with a common aim to help prevent and tackle fly-tipping through influencing, advising and raising awareness about the anti-social nature and potential health and environmental damage fly-tipping can cause.

[307] For example, not the local authority or a registered waste carrier
[308] https://environment.data.gov.uk/public-register/view/search-waste-carriers-brokers
[309] Defra 2018 Fly tipping incidents and actions taken in England - GOV.UK

# 5 Priority materials: Food waste

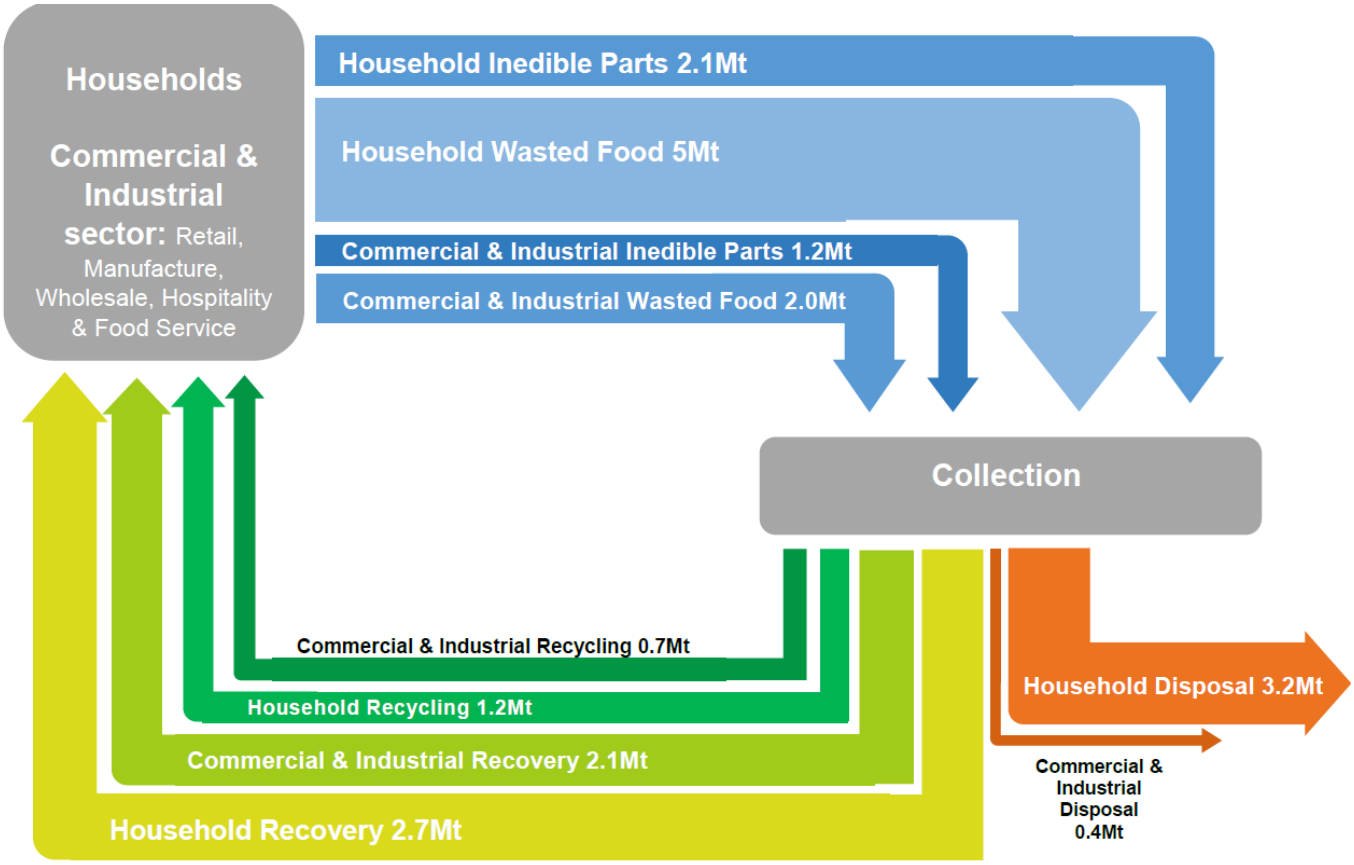
## 5.1 Introduction

### 5.1.1 The current position

Food waste warrants special attention[310, 311]. In the UK, more than 10 million tonnes of food, worth over £20 billion, is wasted each year[312,313]. WRAP (2018) find 70% of this could have been avoided (edible food rather than peels and bones)[314]. Households are responsible for 7.1 million tonnes a year or around 70% of total food waste. Food manufacturing wastes 1.9 million tonnes a year (18% of total food waste), the hospitality and foodservice sector 1 million tonnes a year (10%) and the retail and wholesale sector 0.3 million tonnes a year (2.5%)[315]. Figure 10 illustrates food waste arisings and their destination in the UK.

[310] 'Food waste' is used as shorthand for 'food and drink waste'. The term that encompasses all waste associated with food items is 'food and associated inedible parts'. For the sake of brevity, we refer to food waste throughout this section but mean 'food and associated inedible parts'. Unless explicitly stated we also include food 'loss' when we refer to food waste. Food loss is where items that were intended to be food for human consumption leave the human supply chain, but they may not meet strict legal definitions of 'waste'. The generic term for all types of food waste is 'food loss and waste' or FLW.
[311] FAO (2013) Food Wastage Footprint: Impact on Natural Resources
[312] This figure includes waste from farm gate to consumer. WRAP have made an indicative estimate of 2.5Mt for food waste on farm, but data on on-farm waste is less reliable.
[313] http://www.wrap.org.uk/food-waste-reduction-roadmap
[314] http://www.wrap.org.uk/food-drink/business-food-waste/courtauld-2025
[315] WRAP (2018) The Courtauld 2025 baseline and restated household food waste figures

**Figure 10: Sankey diagram showing flows of food waste throughout the economy in 2015**




*Source: WRAP data*

WRAP (2018) estimates that nearly 18% of household food purchases are discarded (by weight)[316]. The most commonly wasted items by households each year are:

1. Fresh vegetables and salads (1.6m tonnes worth £2.7bn)
2. Drink (1.2m tonnes worth £1.2bn)
3. Fresh fruit (0.92m tonnes worth £1.1bn)
4. Meat and fish (0.51m tonnes worth £2.6bn)
5. Bakery (0.5m tonnes worth £0.87bn)
6. Dairy and eggs (0.47m tonnes worth £0.75bn
7. Home prepared and pre-prepared meals (0.42m tonnes worth £1.8bn)
8. All other food and drink (1.1m tonnes worth £2.9bn)

[316] WRAP (2018) Household food waste: restated data for 2007-2015

### 5.1.2 The case for change

WRAP estimates than an additional 4 million tonnes of food will be required by 2025 to satisfy projected increases in the UK population[317].

Food waste has adverse environmental impacts. It is associated with over 25 million tonnes of greenhouse gas emissions, the most significant contributors being milk, coffee and wheat products[318]. In addition, food waste decomposes and releases methane when landfilled, a potent greenhouse gas. The water footprint of household food waste alone is more than 6 billion cubic metres per year or 243 litres per person per day. A quarter of the water footprint relates to water used to grow and process food here in the UK, the rest being felt overseas including in areas of water stress[319]. Food waste is not just a UK problem. Globally, over one third of food is wasted throughout the entire production and consumption process[320]. This has been recognised by the UN which set Sustainable Development Goal 12.3 on food waste reduction. BCG (2018) estimate global annual food loss and waste could increase from 1.6 billion tonnes a year currently to 2.1 billion by 2030, worth $1.5 trillion[321]. It is estimated to account for 8% of annual global greenhouse gas emissions[322].

Food waste also has a financial cost. WRAP (2018) estimates that in 2015 the value of food waste in the UK was over £20bn, £14.9bn of it from household waste. Businesses also have significant gains to make, with Champions 12.3 (2017) identifying a median cost benefit ratio of 14:1 for food loss and waste reduction efforts[323,324]. However, taking action to reduce food waste requires understanding how much you waste, and data availability and recording is often poor (see next section). Despite the challenges that remain, much progress has been made in the UK. For example, between 2007 and 2015, there was a 13% reduction in total household food waste, 18% reduction in the total amount of food thrown away that could have been eaten, and a 23% reduction in the total amount of food thrown away that could have been eaten, per person[325].

[317] IGD, WRAP (2013) Food Vision
[318] WRAP (2018) Food Surplus and Waste in the UK – Key Facts
[319] WRAP, WWF (2011) The water and carbon footprint of household food and drink waste in the UK
[320] http://www.fao.org/save-food/resources/keyfindings/en/
[321] https://www.bcg.com/en-gb/publications/2018/tackling-1.6-billion-ton-food-loss-and-waste-crisis.aspx
[322] Champions 12.3 (2017), The business case for reducing food loss and waste
[323] Estimate obtained from assessing nearly 1,200 business sites across more than 700 companies
[324] Champions 12.3 (2017), The business case for reducing food loss and waste
[325] WRAP (2018) Courtauld Commitment 2025 Food waste baseline for 2015

### 5.1.3 Data issues

Quantifying food waste is an area where there are evidence gaps but also significant ongoing improvement efforts[326]. The UK is a global leader in food waste measurement through novel approaches such as the Food Waste Reduction Roadmap[327].

For downstream wastes, the main challenge with quantifying food waste is that the majority is currently collected mixed with other types of waste[328]. This means that true measurement methods are methodologically complex and costly, requiring compositional analysis[329]. WRAP (2007) took this approach for a representative sample of household waste which was hand-sorted and weighed. The results were combined with survey and diary data, to derive not only quantities at a very granular level but also insights about who wastes what. This was repeated in 2012 and partially replicated to evaluate a communications campaign in West London[330,331]. The granularity of the data means the method is able to quantify the scale of individual products wasted reliably. However, the data is now out of date and is a significant evidence gap. Despite the cost, it is widely recognised that more measurement efforts are now needed to understand current levels of household and non-household food waste[332].

For upstream losses, the main challenge is the cost of primary data gathering[333]. There is a general lack of evidence in the sector and a bespoke method needs to be developed for each food product due to differences in production systems and value chains[334]. WRAP have published generic and sector-specific guidance on measuring food surplus and waste, including guidance for farming and we will work with the research community to improve food waste data collection and measurement (Box 8) [335].

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[326] For example, work is currently underway, led by UN Environment and involving WRAP and others, to develop robust yet practicable methods for countries to report against Sustainable Development Goal 12.3 on food waste. The global initiative to develop a reporting standard on food waste, involving a multi-stakeholder partnership and convened by the World Resources Institute, proposed a reporting framework and guidance on measurement in 2016 (http://flwprotocol.org/). And two European projects, both of which involved WRAP, have looked at methods for measuring food waste (https://www.eu-fusions.org/ and https://eu-refresh.org/).

[327] http://www.wrap.org.uk/food-waste-reduction-roadmap

[328] Downstream wastes occur from manufacturing, retail, hospitality, foodservice and consumption

[329] A technique by which a sample of waste is sorted into categories and weighed to determine its proximate composition

[330] http://www.wrap.org.uk/content/household-food-and-drink-waste-uk-2012

[331] http://www.wrap.org.uk/content/west-london-food-waste-campaign

[332] For example, Shanes *et al (2019)* state, "From a scholarly perspective, studies employing more objective techniques for data collection, such as trash sorting or kitchen diaries instead of self-reported mechanisms (which can bias individuals towards underestimating their food waste and potentially limit the comparison with other variables) are needed.

[333] Upstream waste occurs from primary production, mainly farming

[334] WRAP (2017) Food waste in primary production a preliminary study on strawberries and lettuces

[335] http://www.wrap.org.uk/food-waste-reduction-roadmap

**Box 8: Area of Research Interest 4: Food waste**

Areas of interest for food waste include:

1. Obtaining data on farm to fork food waste for specific categories.
2. Reducing the environmental impact of food.
3. Food waste measurement more generally – developing cost-effective methods for England.
4. Understanding the relationship between food waste collection and prevention. One theory suggests that by making the amount of food waste more visible, collections increase the salience of the issue and encourage action to reduce it. A contradictory theory suggests that by collecting food waste households believe that something good is happening to it so they do not need to worry about it. A literature review has been carried out[1], and WRAP are currently exploring empirical data on behalf of DEFRA.

Impact and cost-effectiveness of different consumer food waste interventions – what works for whom in what circumstances? There has been some evaluation work carried out by WRAP but further evaluation is needed. WRAP has an evaluation plan that sits alongside its Love Food Hate Waste campaign.

This Chapter is divided into three parts, each of which sets out the evidence for intervention. Section 5.2 covers changes in retail, hospitality and food manufacture. Section 5.3 focuses on changes in individual consumption. Section 5.4 changes in local authorities.

## 5.2 Making changes in retail, hospitality and manufacturing

### 5.2.1 The current position

There is already a large scale voluntary agreement to tackle food waste in the UK. Courtauld 2025 (C2025) aims to achieve a 20% per person reduction in UK food and drink waste associated with production and consumption by 2025, relative to 2015 levels[336]. The agreement covers the post-farm gate supply chain, tackling food waste from manufacturing to retail and households. The agreement has a high level of signatories in

[336] http://www.wrap.org.uk/content/what-courtauld-2025

the retail sector and increasing representation in the manufacturing and hospitality and food service sectors[337].

There are several working groups, coordinated by WRAP, where data and best practice are shared so that signatories can take action to reduce food waste. Robust measurement of food waste is key to implementing actions to reduce it. Through C2025, WRAP disseminate best practice and expertise in measuring food waste and taking action to reduce it.

### 5.2.2 The case for intervention

The case for government support was made prior to the launch of Courtauld 2025. Annual reporting is a core part of the agreement, and there is an overarching evaluation plan which is owned by WRAP. We periodically review whether the case for Government support is still valid based on this monitoring and evaluation. The case for intervening to reduce food waste and manage it better is the negative externality imposed by food waste generated in the form of greenhouse gas emissions and generation of toxic substances when landfilled. These implications are not necessarily factored in by consumer and business decisions when choosing to dispose of food.

In addition, food waste data are not readily available or collected, and, despite WRAP's world leading food waste data research and measurement framework[338], there is a role for Government to take action to improve the data available, improving decision making and action to reduce food waste.

### 5.2.3 Possible areas of intervention

**Food surplus redistribution**

WRAP (2018) estimates that around 43,000 tonnes of food surplus were redistributed in 2017 for human consumption, a 50% increase since 2015. However, there is an additional 200,000 tonnes of food fit for human consumption which is sent for animal feed or waste treatment[339].

Increasing redistribution of unused food can reduce food waste, generating environmental benefits. Allowing food that might otherwise have been thrown away or sent for animal feed to be eaten by humans generates social benefits[340]. To realise these benefits, C2025

[337] WRAP (2018) Courtauld Commitment 2025: Food waste baseline for 2015
[338] http://www.wrap.org.uk/food-waste-reduction-roadmap
[339] Data in the redistribution section comes from WRAP (2018) Surplus food redistribution in the UK; 2015 to 2017
[340] Fareshare, The wasted opportunity

set up a redistribution working group to support cross-sector collaboration. It focuses on non-financial barriers[341]. There is anecdotal evidence on financial barriers to redistributing food surplus however, therefore additional research can inform possible interventions to address those. WRAP are currently undertaking research to improve the evidence base around why more surplus food is not being redistributed[342].

**Packaging and on-pack labelling**

Retailers and manufacturers have an important role to play in helping consumers waste less food. This can be through better packaging and the inclusion of on-pack guidance on consumption dates and optimal storage solutions. Relevant evidence on different aspects of manufacturing and retailing that can make a difference to food waste are set out below.

On-pack information helps consumers decide, for example, how long food is safe to eat after being opened, where it should be stored, and whether it can be frozen. As well as providing food safety information, it can help avoid food waste. WRAP found that a date label was a trigger for throwing food away in one third of 'not used in time' instances. This equates to about 660,000 tonnes of food waste that could be avoided[316].

Retailers have made progress in some areas on their own-branded products but have gone backwards in others. WRAP (2017) assessed changes to date labels, storage guidance, freezing and defrosting guidance and the availability of a range of pack sizes. The study saw progress in: [343]

- Confusing 'display until' dates, which have largely disappeared from packs
- Movement towards 'best before' where 'use by' is not necessary, for example hard cheeses and pasteurised juices
- Moving to include 'open life' guidance only on products for which there is a food safety risk

On the back of this and other research, recent guidance was issued for retailers on food labelling[344]. Continued improvement in retailer actions on labels will help to reduce unnecessary food waste. This is being facilitated through C2025 and the survey announced in this Strategy that will assess how far retailers and food businesses have come in implementing key industry guidance and best practice on food waste.

[341] This includes systems and logistics, reputational risk and brand integrity, awareness and understanding, legalities and compliance and resource constraints
[342] https://www.gov.uk/government/news/action-to-reduce-food-waste-announced
[343] WRAP (2017) Helping Consumers Reduce Food Waste Retail Survey 2015
[344] WRAP, FSA, Defra (2017) Labelling Guidance: Best practice on food date labelling and storage advice

**Food Storage**

*Fridge temperatures*

WRAP (2018) estimates 41% of household food waste arises from products 'not used in time'[345]. These are mainly perishable or short shelf-life products, with a value of around £6.0 billion. Each year, this includes 17 billion '5-a-day' portions of fresh produce that are bought but not eaten. These products are mainly designed to be kept refrigerated.

Domestic refrigerators are typically around 6°C yet research has found that the storage lives of the majority of chilled foods would be increased if fridge temperatures could be lowered, to below 5°C for example[346]. Reducing fridge temperatures had the equivalent effect of giving an additional three days of storage life; for example, WRAP found that reducing fridge temperatures to below 5°C could stop more than 50,000 tonnes of milk waste a year[347]. Fridges that clearly display temperature, with readily adjustable controls, could help reduce food waste. Consumers do not know what the optimum temperature is; 50% incorrectly thought that it is between 4 and 7°C[348].

The potential annual UK waste savings resulting both from lowering fridge temperature and refrigerating foods which are predominantly stored at ambient temperatures (but would benefit from being refrigerated), taking into account the additional energy use, leads to a net benefit of around £200 million and a net reduction of around 210,000 tonnes $CO_2e$[349].

The financial value and embodied $CO_2e$ emissions of food waste saved by using the freezer more effectively were over 100 times higher than the cost and $CO_2e$ emissions associated with the extra energy required to freeze the food[350].

*Fridge and freezer storage guidance*

There is widespread lack of knowledge about where and how it is best to store items. For example, 49% of people incorrectly thought apples lasted longer if stored out of the fridge and 39% thought chicken could only be frozen on the day of purchase.

Freezing can reduce food waste by enabling consumers to extend the life of uneaten chilled products. Many packs still contain the guidance 'freeze on day of purchase'. In

[345] WRAP (2018) Household food waste: restated data for 2007-2015
[346] Roccato, A., Uyttendaele, M., Mebré, J-M., (2017) 'Analysis of domestic refrigerator temperatures and home storage time distributions for shelf-life studies and food safety risk assessment' *Food Research International* 96:171-181
[347] WRAP (2018) Opportunities to Reduce Waste along the Journey of Milk, from Dairy to Home
[348] WRAP (2018) *Food Trends Survey Wave 1 – Spring 2018* (unpublished slide deck – shared with Defra in confidence)
[349] WRAP (2013) The impact of using your fridge and freezer more effectively
[350] WRAP (2013) The impact of using your fridge and freezer more effectively

response only 60% of consumers would freeze unopened packs a few days after shopping. This is despite the fact that food can be safely frozen until the end of its pack date. WRAP (2017) concludes that "good progress has been made in moving away from 'freeze on day of purchase', but there is much to do, particularly for meat and bakery products." WRAP also found that the use of the snowflake logo (to indicate suitability for home freezing) had reduced. This was possibly due to pressure on pack space, and so there was a need to reinforce the value of having this on pack with retailers[343].

**Portion sizes**

Inappropriate portion sizing also contributes to food waste. Studies repeatedly find that single person households waste the most food on a per capita basis[351]. This could partly be because they struggle to find food in suitably sized packs[352,360]. WRAP's recent survey of retailers found that the availability of smaller packs of bread had declined, for example[353]. 59% of people often or sometimes buy a bigger pack than they need because a smaller one is not available[354].

**Promotions**

Promotions are a normal part of the retail landscape. They are conducted to increase footfall or to maintain or increase market share. WRAP (2014) estimated that around one-third of all food and drink sales were on promotion[355].

There is no evidence that promotions increase supply chain waste although WRAP's research indicates that 'BOGOF' type promotions may result in more waste compared with other types of promotion mechanic, like 'X for Y' (for example 3 for £2)[356]. Similarly, there is no evidence to show that sales of food on promotion increase the amount of food wasted in the household although there is evidence that certain forms of promotions (multi-buy and y for £x) are associated with the purchase of larger amounts of food, but this is at least in part due to the nature of the promotion[357]. There does not appear to be a case for intervention, especially as WRAP has produced guidance for retailers and manufacturers[358].

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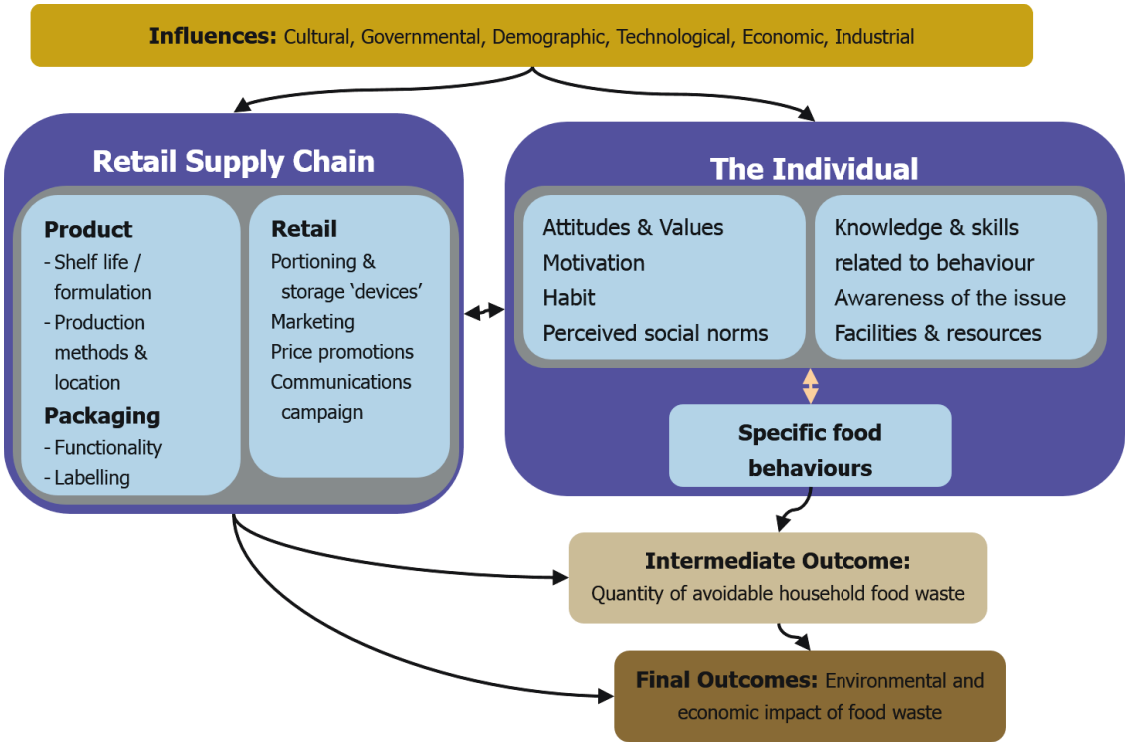
[351] Quested, T. E., Marsh, E., Stunell, D., Parry, A.D. (2013) 'Spaghetti Soup: The complex world of food waste behaviours' *Resources, Conservation and Recycling* 79: 43-51
[352] WRAP (2008) Research into consumer behaviour in relation to food dates and portion sizes
[353] WRAP (2017) Helping Consumers Reduce Food Waste Retail Survey 2015
[354] WRAP (2007) Food Behaviour Consumer Research: Quantitative Phase
[355] WRAP (2014) http://www.wrap.org.uk/food-drink/business-food-waste/guide/investigation-possible-impact-promotions-food-waste-0
[356] WRAP (2014) Preventing waste through good practice in grocery promotions management
[357] WRAP (2011) Investigation into the possible impact of promotions on food waste
[358] WRAP (undated), Food Promotions – Guidance for Retailers and WRAP (undated) Food Promotions – Guidance for Manufacturers

## 5.3 Individual consumers

### 5.3.1 The current position

The generation of food waste is a complex behavioural phenomenon, with many interlinked decisions that together lead to conditions where food is wasted and is usually the result of the interplay between multiple behaviours[359,360,361].

**Figure 11: Behavioural drivers of food waste**




*Source: Spaghetti Soup: The complex world of food waste behaviours*

Understanding and tackling behaviours, and the knowledge, attitudes, social norms and culture that influence them, may therefore be an important way to tackle food waste.

When asked, the reasons households give for wasting food are varied. From a quantitative perspective, most food that could have been eaten is wasted by households because it is not used in time. Of the five million tonnes of food that could have been eaten, 41% of the

[359] Quested, T. E., Marsh, E., Stunell, D., Parry, A.D. (2013) 'Spaghetti Soup: The complex world of food waste behaviours' *Resources, Conservation and Recycling* 79: 43-51
[360] WRAP (2014) Household food and drink waste: A people focus
[361] Schanes, K., Dobernig, K., Gözet, B. (2018) 'Food waste matters A systematic review of household food waste practices and their policy implications' *Journal of Cleaner Production* 182: 978-991

total (2 million tonnes) is due to it passing its pack date or because it looks or smells off. Personal preference is the second most common reason for wasting food [362].

A recent poll suggests that 77% of consumers were concerned or very concerned about food waste[363]. An academic systematic review concluded that "consumers consider throwing away food as improper behaviour"[360].

Most people significantly underestimate the amount of food they waste, with studies finding that 6 in 10 consumers say they throw away hardly any or no uneaten food and just 7% say they throw a reasonable amount or quite a lot[364,365,366,367]. Further, 8 in 10 agree that they are doing as much as they can to minimise the amount of food thrown away. Typically people believe that others are wasting more than they are[360].

Awareness of food waste as an issue has increased significantly over the last 10 years. Research in the late 2000s found that packaging was strongly regarded as a more pressing issue than food waste[345]. In 2011 research found that, when prompted, consumers considered both issues to be 'equally problematic' and did not have a fixed opinion as to which is 'worse'[,368]. WRAP (2013) found that 70% of consumers think food waste is bad for the environment[369].

Typically personal concerns such as the monetary cost of food waste provide a stronger motivator to reduce food waste than environmental or social concerns. Social norms play a relatively weak role in influencing food waste behaviour. This is perhaps because the act of wastage generally occurs in a private setting. Personal norms are far stronger. Believing the ability to reduce food waste is in one's own hands is an important predictor of whether someone will actually reduce food waste[360].

#### *5.3.1.1 Buying the right amount*

One reason for buying inappropriately is a lack of pre-shop planning. WRAP's food waste trends survey found that 12% of people rate themselves 6 out of 10 or lower at judging and

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[362] WRAP (2018) Household food waste: restated data for 2007-2015
[363] https://www.newfoodmagazine.com/news/44114/food-waste-concern-75-per-cent/
[364] WRAP (2007) We Don't Waste Food! A Household Survey which found that "nearly all respondents were initially adamant that there was little food waste within the household" but that "as the interview progressed nearly all groups admitted that food sometimes was thrown away rather than being eaten as it had gone off or was 'leftovers'" (p.4)
[365] WRAP (2007) Food Behaviour Consumer Research: Quantitative Phase which found "few consumers say they waste significant amounts of food" (p.1)
[366] WRAP (2008) The Food We Waste which found that "even householders who are adamant that their household wastes no food at all are throwing away 88kg of avoidable food a year; that's a typical 50l kitchen bin full." (p.5)
[367] WRAP (2018) *Food Trends Survey Wave 1 – Spring 2018* (unpublished slide deck – shared with Defra in confidence)
[368] WRAP (2011) Investigation into the possible impact of promotions on food waste
[369] WRAP (2013) Consumer Attitudes to Food Waste and Food Packaging

buying only the amount they are likely to use; this is the worst for potatoes (30%) and the best for chicken (9%). 36% made a shopping list and checked the fridge, freezer and cupboards before their last shop, with younger people and one-person households least likely to display this behaviour[370].

Indiscipline while shopping is another cause of food waste: 79% of people have bought something they did not plan to because it attracted their attention and 70% have bought an item they did not plan to because a family member wanted them to[371].

Consumers undertake a number of shopping behaviours that are more likely to result in buying too much: 86% sometimes or often buy a bigger or additional pack because it is better value and 82% sometimes or often buy extra because it is on special offer[372].

#### *5.3.1.2 Using what is bought*

Buying food and not eating it in time is a common occurrence: less than half of people (44%) managed to use all of six common perishable food items[373]. in time on the last buying occasion, and 31% wasted potatoes and 27% wasted bread because they did not use it in time.

Some of this results from actions of retailers and manufacturers, for example through more effective date labelling, helping consumers set the right fridge temperature and use of the fridge and freezer for extending life (all discussed above).

Confidence in deciding whether something is safe to eat rather than simply acting on the date on the pack is important for reducing food waste. However, 20% of people who threw away bread, 8% of people who threw away potatoes and 27% who threw away milk relied solely on the pack date[374].

Another aspect is confidence in cooking, specifically being able to make meals from random ingredients. This has been a key aspect of the Love Food Hate Waste campaign over a number of years. Most people are reasonably confident, but 8% are not confident about using leftovers, 8% not confident about judging how much to cook for the number of people eating and 9% not confident about combining ingredients to make a meal.

[370] WRAP (2018) *Food Trends Survey Wave 1 – Spring 2018* (unpublished slide deck – shared with Defra in confidence)
[371] Ibid
[372] Ibid
[373] Ibid. The products are potatoes, bread, carrots, apples, milk and chicken.
[374] Ibid

### 5.3.2 The case for intervention

To summarise the case, the evidence for which is largely set out above, most food waste in England is produced by households, but because households do not pay for their waste according to how much is produced, or how environmentally damaging it is, they do not perceive there to be a problem. In fact, we know that almost all households underestimate how much food waste they produce, and food waste is sometimes felt to be a worthwhile trade-off with flexibility and choice. Food is also relatively cheap, modern lives are busy, food waste as an issue has low resonance apart from as an issue caused by 'somebody else', and people make decisions on a less than rational basis. On top of this, people do not always know the right thing to do in terms of food storage and management. All this together means that households are not acting in their own best interests or the best interests of the environment. There are clear market failures and there is a case for government intervention.

### 5.3.3 Behaviour change campaign

One mechanism open to Government is to use a behaviour change campaign. Behaviour change campaigns, as opposed to information campaigns, are more than exercises in improving knowledge; they set out to persuade people to behave differently.

The evidence about the effectiveness of behaviour change campaigns is mixed. Independent evidence suggests that some behaviour change campaigns have been successful at catalysing change (see Box 9). There are, however, other examples of campaigns that have been relatively ineffective, for example a recent anti-drug campaign in England, the evaluation of which could not produce any evidence of impact or estimate value for money[375].

[375] HM Government (2017) An evaluation of the Government's Drug Strategy 2010

**Box 9: Successful consumer campaigns**

**Make Poverty History**
This was one of the most successful campaigns of the 2000s. It was run by a coalition of international development charities. It aimed to mobilise public opinion to influence politicians in the run-up to a global summit. An independent evaluation found that not only had it achieved significant coverage, it had achieved its aims of public mobilisation and that mass-market popular communications, backed up by solid lobbying and traditional activism, had had significant political impact. Moving people from passive interest to activism was more challenging, and maintaining public momentum required significant work, however[1].

**This Girl Can**
This is a widely acclaimed, evidence-based campaign from Sports England. It has been successful in motivating women and girls to exercise: independent research says 2.9 million women aged 14 to 60 who recognise the campaign say they have done some or more activity as a result and, of those, 1.5 million of those women say they have started or restarted exercising[1]. The Active Lives Survey was launched after the first phase of the campaign, and therefore a pre-campaign baseline is not available. Results from the first two years show that the overall number of women who were active for at least 150 minutes per week was maintained in the year to November 2017, suggesting that population-level behaviour change has been sustained[1].

**Five a Day**
The Five a Day campaign delivered a measurable increase in portions of fruit and vegetables consumed, although by just 0.3 portions on average[1].

#### *5.3.3.1 Love Food Hate Waste*

The *Love Food Hate Waste* campaign is run by WRAP with its partners. It has been called by far the most successful food waste awareness campaign in Europe[376]. The campaign's approach reflects what we know about best practice. Schane *et al*'s (2018) systematic review supports the approach in the following respects:

1. It should address specific information gaps that drive wasteful practices
2. Cooking courses can help make household repertoires more flexible, thereby enabling leftovers and random ingredients to be used up more easily
3. Education is needed on the meaning of date labels

[376] WRAP (2014) Household food and drink waste: A people focus

4. Personalise information for key target groups[377,378].

Behavioural change campaigns require significant levels of funding to be successful. Evidence from WRAP[379] suggests that awareness of the Love Food Hate Waste campaign increased as spend increased, but this is a simple correlation and stronger evidence would be needed to be certain. Quantifying the relationship between spend and impact, and estimating the level of spend required for any one campaign, requires further research.

## 5.4 Making changes in local authorities

WRAP (2018) estimates that 3 of the 10 million tonnes of food waste is inedible[380,381]. Of this, 2 million comes from households, whose waste is collected by local authorities. Inedible food waste will need to be managed through the waste system and is less likely affected by food waste reduction efforts. Resource Futures (2014) estimated that most food waste collected at kerbside ends up in the refuse bin, which will be sent for incineration or landfill[382]. When food waste ends up in landfill it can generate significant negative environmental impacts in the form of greenhouse gas emissions such as methane[383].

### 5.4.1 Separate food waste collections

A separate food waste collection service can ensure food is treated in the most environmentally beneficial way possible, in accordance with the waste hierarchy[384]. However, currently only a third of authorities offer this service. This is mainly because it is costly to introduce[385]. However, DCLG (2017) analysis shows that in some cases LAs have fully offset the costs of introducing new recycling services via related measures such as reducing the frequency of residual waste collection[386]. The East Riding of Yorkshire is one example where the cost of introducing mixed food and garden waste collections has been offset by moving from weekly to fortnightly residual waste collections[387].

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[377] Schanes, K., Dobernig, K., Gözet, B. (2018) 'Food waste matters A systematic review of household food waste practices and their policy implications' *Journal of Cleaner Production* 182: 978-991
[378] WRAP (2014) Household food and drink waste: A people focus
[379] WRAP notes that a combination of increased retailer promotion of food waste messages plus TV coverage of the issues correlated with a rise in public awareness of food waste reduction to 49% of the population in November 2015, the highest level since November 2013 and only the second highest level ever recorded.
[380] Apple cores, fruit stones, meat bones, etc.
[381] WRAP (2018) Courtauld Commitment 2025 food waste baseline for 2015
[382] Resource Futures (2014) Analysis of biodegradability of residual waste based on subtraction of diverted materials
[383] BEIS (2018) Greenhous gas reporting: conversion factors
[384] Note see consistency of waste collections, in Section 5.2.1, which also includes separating food waste
[385] WRAP LA portal
[386] DCLG (2017) Local authority revenue expenditure and financing
[387] Local Partnerships (2015) Delivering Waste Efficiencies in Yorkshire and the Humber

Scenario modelling presented in WRAP (2016) indicates an additional 8.4Mt of food waste (over an 8 year period relative to baseline and including flats) could be made available to the organics industry from the provision of food waste collection services across England as part of a common approach. Greater surety and consistency of feedstock supply can contribute to reduced investor and operational risks to businesses operating anaerobic digestion (AD) facilities. AD facility operators in turn have the potential to generate up to £280 million in renewable energy sales, supplying around 682,000 homes and improving the security of energy supply. It would also provide 8Mt of organic fertiliser to the agri-food sector, with a nutrient value of £30 million[388,389,390].

Introducing separate food waste collections can also help mitigate the following barriers/negative outcomes:

- Food waste into landfill can produce damaging substances such as leachate. Modern landfills can treat it, but it is expensive to do so.
- It builds awareness of food waste in the home: Separate food waste collections can create awareness of how much food is wasted and could help food waste prevention. For example, 4 to 8% of households claim to have changed their attitudes or habits relating to food purchasing and consumption as a result of taking part in a food waste collection service. However, it is not possible to conclude there is causal link between collection and waste prevention from this study[391].
- Food waste collections reduce contamination of dry recycling, reducing reject rates at Material Recovery Facilities[392].

Separate food waste collections for LAs and business will form part of the forthcoming consultation on moving towards national consistency of recycling collections. Data and evidence for business waste are more limited than for LAs[393]. WRAP internal research has found that large and medium sized businesses can make savings by increasing their recycling collections, reducing refuse. However, for small businesses there could be a cost increase. This analysis will be presented as part of the consultation on delivering national consistency for recycling collection. The consultation will also be used to gather evidence on how to increase recycling from businesses.

[388] WRAP (2016) Supporting evidence and analysis: The case for greater consistency in household recycling
[389] Defra internal analysis
[390] Capture rate is the % of food waste captured by separate food waste collections out of food waste generated
[391] WRAP (2009) Evaluation of the WRAP Separate Food Waste Collection Trials
[392] WRAP (undated) Factors affecting MF reject rates
[393] Please see data chapter in the strategy document for commitments on better data

# 6 Priority materials: Plastic

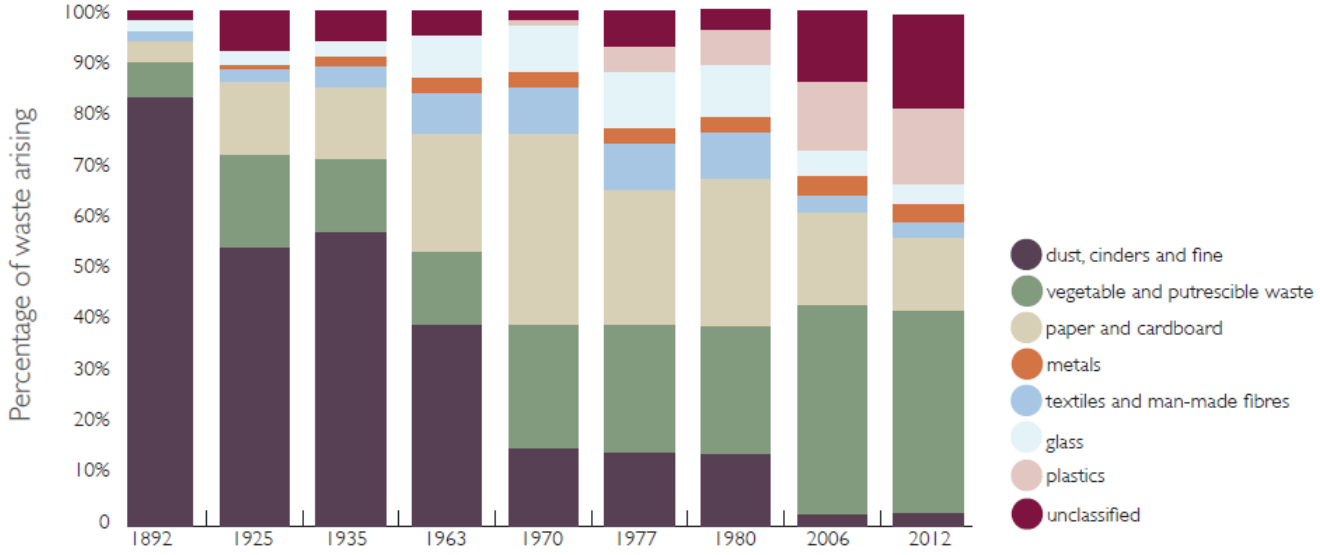
## 6.1 Introduction

### 6.1.1 The current position

Plastics are incredibly durable and ductile; they are strong materials and yet they are still lightweight. Used in the manufacture of a huge range of products, plastics are corrosion resistant, both electrically and thermally insulating and can take on any shape and colour (Andrady and Neal, 2009)[394,395].

The Strategy identifies plastics waste as a priority material to focus on. This is because of its complexity as a material and environmental impact. In addition, Figure 12 below demonstrates society's increased reliance on plastic over time.

**Figure 12: Composition of waste from households 1892 to 2012** [396]



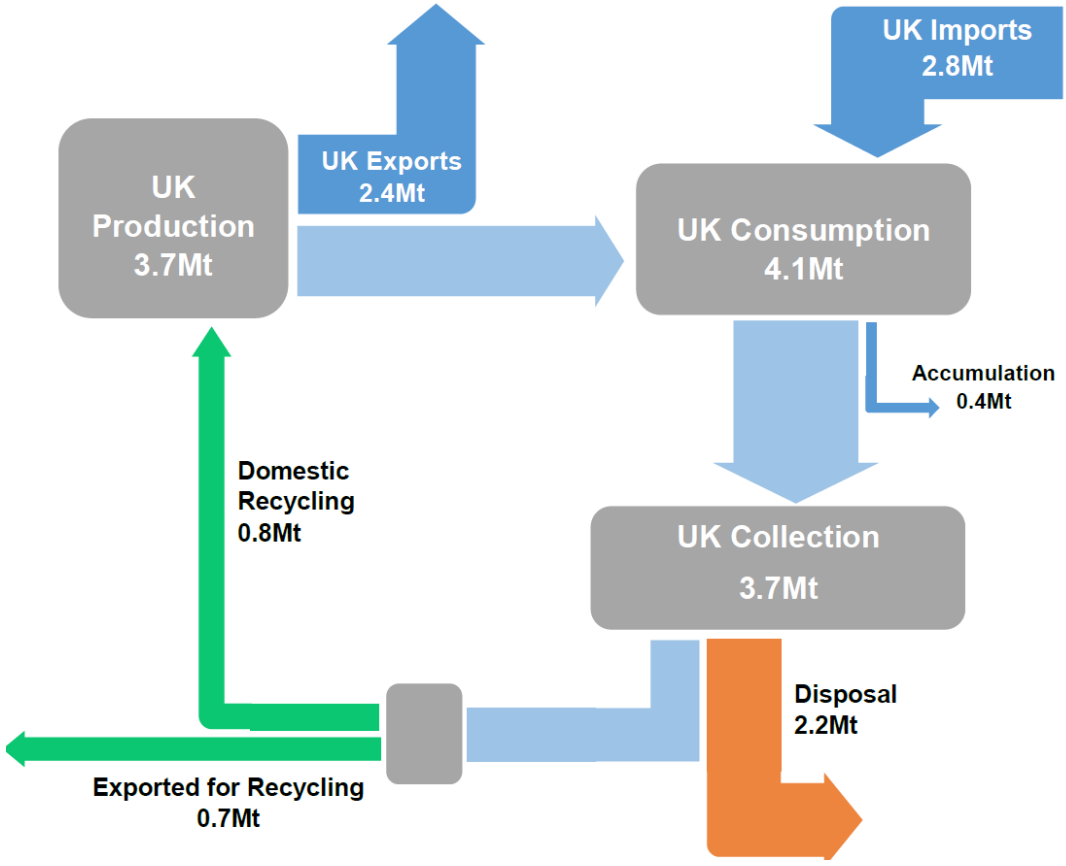

*Source: Government Office for Science (2017), From Waste to Resource Productivity*

The UK produces an estimated 3.7 million tonnes of plastic waste each year. Meanwhile, 2.2 million tonnes of plastic packaging was placed on the market in 2016. Most plastic packaging waste arisings (1.5 million tonnes) come from packaging used in the consumer

[394] Andrady, A.L. and Neal, M.A. (2009) 'Applications and societal benefits of plastics', *Philosophical Transactions of the Royal Society B: Biological Sciences,* 364(1526), pp. 1977-1984.
[395] WRAP (2018) Evidence Review: Plastic Packaging and Fresh Produce
[396] Defra is currently working on updating household waste composition data, aiming for results in 2019

sector (households for example). It includes items such as plastic bottles (over a third of all consumer plastic packaging waste arisings), food packaging, etc[397].

**Figure 13: Plastic packaging flow and end markets in 2017**




*Source: WRAP data*

### 6.1.2 The general case for change

Globally, annual plastic production is estimated to have increased from 15 million tonnes in 1964 to 311 million tonnes in 2014. It is estimated to double over the next 20 years. Out of those, it is estimated 120 million tonnes end up in landfill and 8 million tonnes end up in the ocean. In addition, 95% of plastic packaging material value, or USD 80–120 billion annually, is estimated to be lost to the economy after a short first use[398].

The UN (2018) state that just 9 per cent of the 9 billion tonnes of plastic the world has ever produced has been recycled. Most ends up in landfill or is left to pollute the environment. If current consumption patterns and waste management practices continue, then by 2050 there will be around 12 billion tonnes of plastic in landfill and the environment. By this time,

[397] WRAP (2016) Plastics Market Situation Report
[398] Ellen MacArthur foundation (2017), The new plastics economy: rethinking the future of plastics & catalysing action

if the growth in plastic production continues at its current rate, then the plastics industry may account for 20 per cent of the world's total oil consumption[399].

In England, plastic is widely, but not consistently, collected for recycling across LAs. For example in 2017/18 whilst 99% collected plastic bottles, 77% collected rigid mixed plastics[400]. In addition, plastics recycling levels remain low. Only 15% of plastic waste collected by local authorities gets recycled[401]. Plastic packaging waste has a higher recycling rate of 44.9% but of the 1 million tonnes recycled, nearly 70% gets exported[402,403]. High export volumes for recycling have inhibited the growth of domestic UK reprocessing capacity. In addition, historically low oil prices have reduced the cost of producing virgin plastics, which have forced some reprocessors to shut down[404]. This has reduced the domestic economic potential to extract value from recycling.

Despite the case for change, it should be noted that changes can deliver unintended consequences, and policies should aim to mitigate these. An example is the relationship between plastic packaging and food waste. While much fresh produce are suitable to be sold loose at retail level, in many cases, for example, plastic packaging extends shelf-life and protects food from physical damage during transport and storage. Policies and interventions should take these interactions into account[405].

## 6.2 Reducing diversity of plastic polymers

### 6.2.1 The current position

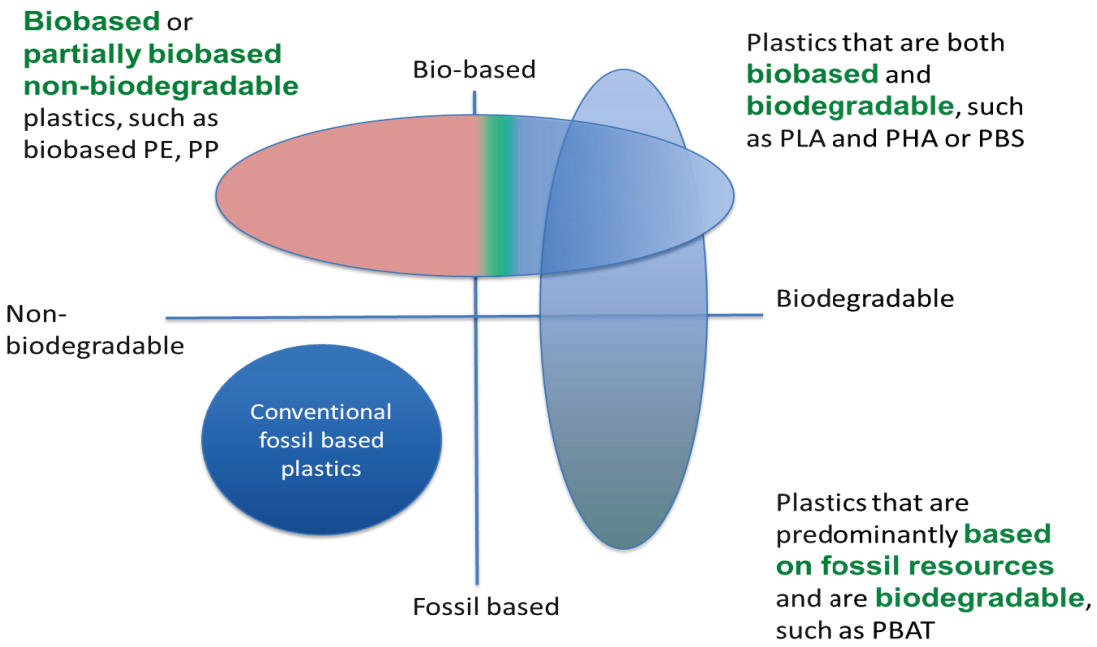
Plastic covers a large range of polymer types. The polymers that plastic products and packaging is made from affects what it is used for and how easily it can be recycled. Plastic can be made from conventional (fossil-based) sources, or from bio-based materials. It can be highly durable, or less so if designed to biodegrade or to compost.

The material base of plastic does not necessarily dictate the way it will behave at the end of its life. Conventional plastics are generally long lived and durable, but can also be designed to be biodegradable. Bio-based plastic can be used to make packaging that is both highly durable and does not biodegrade. It can also be used to make packaging that is biodegradable and compostable. These range of different material bases and how they can be disposed of can create confusion. It is therefore important to understand the

[399] UN (2018) Single-use plastics. A roadmap for sustainability
[400] WRAP LA portal
[401] Defra (2014), Analysis of biodegradability of residual waste based on subtraction of diverted materials
[402] UK Statistics on Waste
[403] National Packaging Waste Database
[404] Government Office for Science (2017), From Waste to Resource Productivity
[405] WRAP (2018) Evidence Review: Plastic Packaging and Fresh Produce

differences. Figure 14 summarises the different material bases of plastic and biodegradability.

**Figure 14: Plastic material base and biodegradability[406].**




*Source: WRAP*

Even within each of the categories above, there is a large range polymers that might be used. For example, conventional fossil based plastics include PET (typically used, for example, in drinks bottles), HDPE (for example milk bottles), polypropylene (for example microwave containers), and several others[407]. Different polymers have different properties, making it a versatile and durable material, which is why it so widely used today.

For bio-based biodegradable plastics, further research is required to understand if they have a role to play to replace conventional plastics that may pollute the environment. Their use needs to be carefully considered and it is essential that they are handled in the right way at the end of their useful life. Currently, there are several issues with their use, such as:

[406] PE= Polyethylene. PP=Polypropylene. PLA=Polylactic Acid. PHA=Polyhydroxyalkanoates. PBS=Polybutylene succinate. PBAT= Polybutylene adipate terephthalate.
[407] Ellen MacArthur foundation (2017), The new plastics economy: rethinking the future of plastics & catalysing action for a more comprehensive list

- Their suitability to be recycled through the conventional recycling routes, anaerobic digestion or composting
- if they deliver better environmental outcomes than recycling conventional fossil based plastic.
- if they degrade in the natural environment[408].

### 6.2.2 The case for intervention

Low plastic recycling levels generate negative economic and environmental consequences, described in Section 6.1.2. The potential economic value in reprocessing plastic waste into new raw material is lost. Sending plastic waste to, for example, incineration, has an environmental cost in the form of additional $CO_2$ emissions. The wide range of plastic polymers has led to composite and diverse plastic products that are more challenging to recycle[409]. In addition, there is a lack of consistency in how they are collected across LAs. Together, this reduces the quantity and quality of material collected for recycling[410]. There is a case for government to intervene to ensure more plastic is recycled, mitigating its environmental impact.

### 6.2.3 Improving design and recyclability of plastic products through regulation, incentives and innovation

Greater plastic recycling will need infrastructure capacity and innovation to process it[411].

The OECD (2018) outline a range of measures that could be used to incentivise and improve plastic recyclability. It recommends a wide range of potential regulatory, economic, technology, data/information or voluntary interventions to address the barriers to properly functioning markets for recycled plastics. While all of these measures are

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[408] Defra (2015), Review of the standards for biodegradable plastic carrier bags
PAS600:2013 Biobased products. Guide to standards and claims
DEFRA (2011) study on plastic bags can be found here and a figure illustrating the global warming potential of each type of bag included in that study is included at the end of this table.(Defra https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/485904/carrier-bag-biodegradable-report-2015.pdf
WRAP (2010) Environmental Benefits of Recycling 2010 update
WRAP (2010) Life cycle assessment of example packaging systems for milk
Umweltbundesamt (German Federal Environment Agency) (2013) Study of the Environmental Impacts of Packagings Made of Biodegradable Plastics
Piemonte, Vincenzo & Gironi, Fausto. (2012). Bioplastics and GHGs saving: The land use change (LUC) emissions issue. *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*. 34. 1995-2003. 10.1080/15567036.2010.497797.
Government Office for Science (2017) From waste to resource productivity
[409] A composite product is made up of two or more constituent materials with significantly different physical or chemical properties.
[410] See discussion in end of life chapter
[411] CIWM (2018) Eliminating avoidable plastic waste by 2042: a use-based approach to decision and policy making

feasible, some have proven to be more effective and successful in their implementation. The well-established intervention include the following three groups:

- Setting statutory targets for recycling to drive supply of material, increase economies of scale, reduce costs and increase resilience.
- Extended Producer Responsibility (EPR) regulation to drive supply of material, increase economies of scale, reduce costs and increase resilience.
- Raising public awareness to create demand for plastics recycling, reduce contamination and littering.

Interventions that are less well-established but are feasible and have the potential of high impact:

- Using public sector procurement policies to create demand for recyclate content.
- Sharing best practice on all aspects of the collection, sorting and reprocessing supply chain.
- Developing and sharing market information to allow actors to expand into new markets.
- Providing information and training to designers and manufacturers to encourage use of recycled content.
- Providing information to consumers to encourage purchase of products using recycled content and drive demand.
- Working with supply chain to encourage use of recycled content. This includes the use of statutory plastics recycling targets to drive the supply for secondary markets and greenhouse gas emissions metrics that reflect the mitigation potential of recycling different materials[412].

Extended Producer Responsibility (EPR) and eco-design can play an important role to improve design and recyclability[413,414]. For example, EPR can incentivise producers of plastic packaging (and other packaging materials) to ensure it can be easily recycled through a system of differential fees. This could effectively raise the cost of using plastic packaging that is difficult to recycle. This 'modulated fees' system reflects the additional economic and environmental costs to society if it is not recycled. The Production Chapter discusses the role of EPR and other measures in increasing the recycled content in plastics. The rest of this section focuses on the role of public procurement, better design and innovation. Incentives such as taxes on virgin plastic are covered in Section 2.3.2.

[412] OECD (2018) Improving Markets for Recycled Plastics: Trends, Prospects and Policy Responses.
[413] Further assessment of these with respect to driving an increased recycled content in plastics can be found in the Production Chapter of this annex.
[414] Resource Recovery from Waste (2018) Delivering Radical Change in Waste and Resource Management: Industry Priorities

Public sector procurement can play an important role to increase the purchase of recycled-content products and create demand for recyclates. Many European countries are working to embed sustainable procurement (SP) within environmental, social, innovation and public procurement policies. This has been implemented in countries such as Italy, France, Norway, the Netherlands, Spain, Belgium, Latvia, Japan, USA and in some instances in the UK. It can encourage producers to implement higher standards more widely. For instance, Ecolabels, which certify products and services that exhibit certain characteristics in terms of environmental and social impact, have been widely used under sustainable procurement[415].

In 2016, the City of Ghent established a four-year framework agreement for the supply of cleaning and polishing products which met the Ecolabel criteria. As a result, the recycled content and recyclability of waste greatly improved. Packaging now uses 85% recycled cardboard, plastic bottles made from polyethylene high-density (PEHD) are 100% recyclable and consist of 10% recycled PEHD, while those made from polyethylene terephthalate (PET) are 100% recyclable and made from 81% recycled materials. In addition, an innovative C2C certified dosage bottle with anti-spilling system was also introduced, reducing overuse and wastage[416].

This can be complemented by setting guidelines to design plastic products that use more recycled content or for recyclability and to provide information and training. This approach has been particularly successful in encouraging recycled content in PET bottles. Some major brands such as Evian and Coca-Cola have already committed to using recycled content in their packaging and Recoup's recyclable packaging guidance has been key in rapidly increasing the proportion of PET bottles[417]. Further, some countries (like Belgium and the USA) have supported the development of tools that help designers and producers compare the environmental impact of a primary and secondary raw materials. Examples include guidance to design recyclable PET bottles by the European PET Bottle Platform (EPBP) and Recoup's recyclable packaging guidance[418].

Innovation is required to improve product design to avoid plastic from leaking into the environment or not being recycled. The Ellen MacArthur foundation has estimated that 30% of global plastic packaging needs fundamental redesign and innovation as otherwise it will not be recycled[419].

[415] The UN Environment Programme (2017) Global Review of Sustainable Public Procurement
[416] European Commission (2017), Public procurement for a circular economy- good practice and guidance
[417]The Guardian (2017); Coca-Cola (2018) Sustainability and recycling
[418] OECD (2018), Improving Markets for Recycled Plastics
[419] Ellen MacArthur foundation (2017), The new plastics economy: rethinking the future of plastics & catalysing action

There is innovation taking place. However, the development and introduction of new packaging materials and formats is happening far faster and is largely disconnected from the development and deployment of corresponding after-use systems and waste infrastructure. At the same time, hundreds, if not thousands, of small-scale local initiatives are being launched each year. This is leading to a fragmented landscape on innovation in materials and initiatives[419]. Government intervention is required to set direction and make sure innovation delivers better environmental outcomes. The recently announced £20m plastics innovation fund and the publication of our Areas or Research Interest (ARIs) in this strategy aim to set this direction[420].

**Box 10: Area of Research interest 5: Plastics**

Throughout this document, a number of evidence gaps have been identified and following on from the 2015 Nurse Review of the UK Research Councils and our previous strategic approach, we want to provide a clear steer regarding our future research needs in the form of Areas of Research Interest (ARIs). For this area we want to focus on:

- Improving recycling, especially in areas of high-density housing
- Communications, schools and consumers
- Plastic avoidance
- Plastic type consolidation
- Increasing recyclability
- Sorting and separation technologies

Improving demand for secondary plastic content

## 6.3 Single-use plastics

### 6.3.1 The current position

There is no accepted definition of single-use plastics, but common considerations include something that is made wholly or partly of plastic, and that is not intended to be reused or refilled for the same purpose as it was made for[421]. Examples of single-use plastics include

[420] https://www.gov.uk/government/news/strong-public-backing-bolsters-fight-against-blight-of-plastic-waste

[421] For example HM Treasury (2018) defines Single-use plastic as 'all products that are made wholly or partly of plastic and are typically intended to be used just once and/or for a short period of time before being disposed of' Tackling the Plastic Problem: Using the Tax System or Charges to Address Single-Use Plastic Waste while the European Parliament (2018) defines single-use plastic as 'a product made wholly or partly

cotton buds, stirrers, straws and sanitary towels. They can be used for as little as a few seconds but when disposed can remain in the environment for hundreds of years. They are not currently recyclable in mainstream schemes.

CIWM (2018) estimates very short use and small plastic items (too small to mechanically separate) comprise between 100,000 and 400,000 tonnes per annum, up to 11% of total plastic waste generated. The paper notes that very short use plastics (less than one day) tend to have the greatest negative impacts at the production and end-of-life stages of the lifecycle[422].

Low gauge carrier bags and disposable plastic lined cups are two further examples of single-use plastics., Single-use carrier bags are discussed in Section 3.3.3.4 in relation to proposals to extend the charge to SMEs. Disposable cups are discussed in Section 3.3.3.5

### 6.3.2 The case for intervention

Single-use plastics are environmentally damaging. At the end of their life, they are often disposed of incorrectly. For example cotton buds might be disposed in domestic toilets while stirrers and straws from take away drinks are found littered[423,422].

Although the UK is not thought to be a major contributor to ocean plastics on a global scale, the economic damage caused is significant as well as the damage caused to wildlife and amenity[424]. Plastic litter in the Asia-Pacific region costs its tourism, fishing and shipping industries $1.3 billion per year, in addition to its environmental damage. In Europe, cleaning plastic waste from coasts and beaches costs about €630 million per year. Studies suggest that the total economic damage to the world's marine ecosystem caused by plastic amounts to at least $13 billion every year[425].

These costs are not incorporated into the price of single-use plastic products, meaning consumers have little incentive to reduce their use of them, nor dispose of them correctly. Intervention to correct this market failure would help to limit their use and protect the natural environment. The economic, health and environmental reasons to act are clear,

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from plastic that is not conceived, designed and placed on the market to accomplish within its lifecycle multiple trips or rotations by being refilled or reused for the same purpose for which it was conceived" Amendments 26-215: Reduction of the Impact of Certain Plastic Products on the Environment

[422] CIWM (2018) Eliminating avoidable plastic waste by 2042: a use-based approach to decision and policy making

[423] CIWM (2018) Eliminating avoidable plastic waste by 2042: a use-based approach to decision and policy making

[424] For example analysis by Resource Futures suggest that just 0.01% of plastic stirrers end up in the marine environment, and analysis by Defra, based on the Resource Futures work, estimates that 0.1% of plastic straws enter seas and oceans. *A preliminary assessment of the economic, environmental and social impacts of a potential ban on plastic straws, plastic stem cotton buds and plastic drink stirrers. Resource Futures, May 2018*

[425] UN Environment (2018) Single-Use Plastics: A Roadmap for Sustainability

and the success of measures such as the 5p plastic bag charge demonstrate the potential for change.

### 6.3.3 Restrict and disincentivise single-use plastics

Evidence compiled by governments, industry and stakeholders suggests that there is no one size fits all solution for issues caused by single-use plastics. The Ellen MacArthur Foundation, CIWM and UNEP all agree that different policy instruments will suit different types of plastic. For very short-use small plastic items such as cotton buds or straws, CIWM recommends eliminating or substituting away from plastic as one option. Government policy has followed suit, by exploring bans on plastic straws (with exemptions for medical reasons), stirrers and cotton buds, launching a call for evidence on taxing single-use plastics (with the resulting plastic packaging tax subject to consultation) and also committing to reforming the packaging producer responsibility system[422,419].

Research undertaken by Resource Futures found a near universal support from the UK's leading retailers for a ban on plastic stem cotton buds, and widespread support for action on plastic drinking straws and stirrers across the hospitality sector. They estimate that a ban on these products would lead to the desired reduction in single-use plastics with a relatively low economic impact[426].

[426] A preliminary assessment of the economic, environmental and social impacts of a potential ban on plastic straws, plastic stem cotton buds and plastic drink stirrers. Resource Futures, May 2018

# Appendix 1: Glossary

This Appendix explains the meaning of technical terms found in the Resources and Waste Strategy.

| Term | Explanation |
|---|---|
| Alternate Weekly Collection (AWC) | An approach to collecting household waste in which recyclable waste is collected one week, while residual waste is collected the next week, the two alternating with each other on a two-weekly cycle. |
| Anaerobic digestion (AD) | A waste management option for organic wastes which involves the breakdown of biodegradable material in the absence of oxygen by microorganisms called methanogens. AD plants produce renewable electricity and a liquid biofertiliser. [WRAP] |
| Avoidable waste | Waste that is technically, economically and environmentally feasible to reuse or recycle, or, where this does not apply, it is (technically, economically and environmentally) feasible to replace with alternatives that are reusable or recyclable. |
| Biodegradable | Organic materials which are capable, under the right conditions, of being broken down rapidly, through the action of micro-organisms, into simple compounds such as water, carbon dioxide, methane and biomass. |
| Bioeconomy | Those parts of the economy that use renewable biological resources from land and sea – such as crops, forests, fish, animals and micro-organisms – to produce food, materials and energy. [European Commission] |
| Bio-based plastic | Bio-based plastics are made using polymers derived from plant-based sources such as starch, cellulose or lignin. [WRAP] |
| Bio-waste | Biodegradable garden and park waste, food and kitchen waste from households, offices, restaurants, wholesale, canteens, caterers and retail premises and comparable waste from food processing plants. [EU CEP] |
| Carbon emissions | Most manufacturing processes produce greenhouse gases such as carbon dioxide, collectively known as ‘carbon emissions’. |
| Carrier bag charge | The law requires large shops in England to charge 5p for all single-use plastic carrier bags. Charging started on 5 October 2015. Scotland, Wales and Northern Ireland all have their own charge. |
| Circular economy (CE) | A circular economy is an alternative to a traditional linear economy (‘make, use, dispose’) in which we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life. |

| Term | Explanation |
|---|---|
| Circular economy package (CEP) | EU package of policy and legislation focused on resources and waste, finalised in 2018. |
| Co-mingled collection | A method of collecting household waste where all recyclable material is collected in one bin, while residual waste is collected in another. See also *multi-stream collection*. |
| Commercial & Industrial (C&I) waste | Waste arising from commercial premises (e.g. offices) or industrial developments. |
| Compliance scheme | Compliance schemes ensure that the requirements of producer responsibility legislation are achieved in relation to their members. |
| Composite material | A composite material is composed of at least two materials, which combine to give properties superior to those of the individual constituents. [www.compositesuk.co.uk] |
| Compostable | Organic materials that, when placed into a composting facility, will decay spontaneously into a nutrient-rich material. Some such materials are *home compostable* in a domestic compost heap; others will only decompose in the higher temperatures found in a commercial in-vessel composter. |
| Consistency framework | An approach to household waste collection in England which aims to increase the quality and quantity of waste collected for recycling, by encouraging all local authorities to collect the same core set of materials, using one of three standard approaches. |
| Construction & Demolition (C&D) waste | Waste arising from the construction and/or demolition sectors. Typically the largest single contribution to total waste arisings. |
| Consumption | The phase of the product life-cycle from when the product is purchased to when it reaches its end of life. |
| Critical raw materials (CRMs) | Raw materials which are of high importance to the economy, and which have a high risk associated with their supply. [European Commission] |
| Deposit Return Scheme (DRS) | A type of fiscal incentive where consumers are charged an additional deposit when they purchase an affected product, such as a drinks bottle, and receive a rebate when they return the empty packaging for recycling. |
| Disposal | The fifth and final stage of the *waste hierarchy*. Includes any operation which is not *recovery*, even where the operation has as a secondary consequence the reclamation of substances or energy. Includes *landfill*. [EU WFD] |
| Ecodesign | An approach to product design which focuses on minimising the environmental impacts of the product over the whole lifecycle. |

| Term | Explanation |
|---|---|
| Eco-innovation | Any form of innovation aiming at significant and demonstrable progress towards the goal of sustainable development. This can be achieved either by reducing the environmental impact or achieving a more efficient and responsible use of resources. [European Commission] |
| Ecolabel | Any labelling scheme focused on changing consumer behaviour by highlighting the environmental pros and cons of a product. |
| Electronic Duty of Care (edoc) | An online system for recording movements of waste from the producer to final recovery or disposal, to fulfil the requirements of the Duty of Care. Electronic alternative to *waste transfer note*. |
| End of life (EoL) | The phase of the product life-cycle after the product reaches its end of life. It includes collection, treatment and reprocessing. |
| End of Life Vehicle (ELV) | When vehicles are scrapped at the end of their lives, they become ELVs which are subject to the requirements of the ELV Directive. |
| Energy from Waste (EfW) | A form of *recovery* operation in which waste is converted into usable energy (electricity and/or heat), generally through combustion. |
| Energy Technology List (ETL) | A Government-managed list of energy-efficient plant and machinery. Where companies purchase items on the list, they can offset the full cost against income tax or corporation tax. [Source: https://www.gov.uk/guidance/energy-technology-list.] |
| Enhanced Capital Allowance (ECA) | A Government scheme which enables companies to offset part or all of the purchase price of specific items of capital expenditure (e.g. energy-efficient plant and machinery) against tax. See ETL. [Source: https://www.gov.uk/guidance/energy-technology-list.] |
| European Clothing Action Plan (ECAP) | An EU-funded project focused on improving the sustainability of the European clothing supply chain. [www.ecap.eu.com] |
| Extended Producer Responsibility (EPR) | An environmental policy approach in which a producer's responsibility for a product is extended to the post-consumer stage of a product's life cycle. See also Producer Responsibility. [OECD] |
| Fossil-based plastics | Fossil-based (conventional) plastics are made from petrochemicals. [WRAP] |
| Greenhouse gases (GHGs) | Gases which contribute to climate change by trapping infrared radiation within the Earth's atmosphere. The most important greenhouse gases are carbon dioxide, methane, nitrous oxide and various fluorinated gases. |
| Hazardous waste | Waste which displays one or more of the hazardous properties (e.g. explosive, flammable, ecotoxic) listed in Annex III to the EU Waste Framework Directive. [EU WFD] |

| Term | Explanation |
|---|---|
| Household Waste Recycling Centre (HWRC) | Also known as the Civic Amenity site, the tip or the dump, HWRCs are sites operated by or on behalf of local authorities, where householders can take items of waste which are not suitable for the normal domestic collection. |
| Internet of Things | A network of connected smart devices, people and systems, enabling data to be exchanged, combined and analysed to drive efficiency and innovation. [BSi] |
| Landfill | A form of *disposal* operation, in which waste is buried under ground. Sits at the bottom of the *waste hierarchy*. |
| Lifecycle | The lifecycle of a product comprises three stages: production, consumption and end of life. |
| Local Enterprise Partnerships (LEPs) | Business-led partnerships between local authorities and local private sector businesses. There are 38 LEPs across England. [www.lepnetwork.net] |
| Love Food Hate Waste (LFHW) | A behaviour change campaign run by WRAP and focused on helping householders to reduce food waste. |
| Love Your Clothes (LYC) | A behaviour change campaign run by WRAP and focused on helping householders to change the way they buy, use and dispose of their clothing in order to reduce its environmental impact. |
| Material efficiency | Material efficiency strategies include the minimisation of raw materials used in the production process and the reduction and recycling of waste to minimise the amount of material not utilised. |
| Microbeads | Solid plastic particles, not soluble in water, that are smaller than five millimetres in size. [Defra] |
| Microplastics | Items of plastic waste smaller than five millimetres in size. |
| Modulated fees | Under Extended Producer Responsibility schemes, producers pay a lower fee for products which are easy to reuse, repair or recycle than for those that are not. [Defra R&WS] |
| Multi-stream collection | A method of collecting household waste where recyclable material is collected in several separate containers (e.g. A: plastics, metals & cartons; B: glass & card; C: paper), while residual waste is collected in another. See also *co-mingled collection*. |
| Municipal waste | Household waste, and waste (e.g. from businesses) which is similar in nature and composition to household waste. [EU CEP] |
| On-Pack Recycling Label (OPRL) | A label on consumer packaging which indicates whether each element of the packaging is widely collected for recycling or not. |
| Oxo-degradable plastic | Oxo-degradable plastics are fossil-based plastics containing additives which accelerate their fragmentation into small pieces. [EU] |

| Term | Explanation |
|---|---|
| Packaging Export Recovery Note (PERN) | A tradeable permit issued when one tonne of packaging waste has been exported for recycling or recovery outside the UK. PERNs are bought by compliance scheme members to provide evidence that their obligations under the Packaging Waste Regulations have been met. |
| Packaging Recovery Note (PRN) | A tradeable permit issued when one tonne of packaging waste has been recycled or recovered within the UK. PRNs are bought by compliance scheme members to provide evidence that their obligations under the Packaging Waste Regulations have been met. |
| Packaging waste | Any packaging item that has become waste. |
| Pay As You Throw (PAYT) | See **Save As You Recycle**. |
| Persistent Organic Pollutants (POPs) | Organic compounds that are resistant to environmental degradation. Because of their persistence, POPs bioaccumulate with potential adverse impacts on human health and the environment. Controlled by two international Conventions. |
| Polluter Pays Principle | A principle of EU environmental law, that those who produce pollution should bear the costs of managing it. [EU] |
| Preparing for reuse | The second stage of the *waste hierarchy*. Refers to operations such as checking, cleaning or repairing, by which products, or components of products, that have become waste are prepared so that they can be re-used without any other pre-processing. [EU WFD] |
| Prevention | The first stage of the *waste hierarchy*. Waste can be prevented through measures taken before a substance, material or product has become waste, which reduce the quantity of waste, the adverse impacts of the waste, or the content of harmful substances in the material or product. [EU WFD] |
| Producer Responsibility (PR) | A policy approach which requires producers of specified product types to take responsibility for the costs of managing those products at end of life. See also Extended Producer Responsibility. [PJM] |
| Production | The phase of the product life-cycle from the design stage until the product is purchased by the consumer. |
| Raw material consumption (RMC) | Based on ONS UK Environmental Accounts, RMC indicator can be calculated by first accounting for UK domestic extraction of raw materials, then adding UK the weight of raw materials used in imported products and deducing the weight of raw materials used in UK exports. |
| REACH | Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) is a 2006 EU Regulation which addresses the production and use of chemical substances and their potential impacts on human health and the environment. |

| Term | Explanation |
|---|---|
| REBus | An EU-funded project which supported and funded the piloting of a number of Resource Efficient Business Models across the UK and the Netherlands between 2013 and 2017. WRAP was the lead UK partner on the project. |
| Recovery | The fourth stage of the *waste hierarchy*. Refers to any operation, other than *recycling*, the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function, in the plant or in the wider economy. Includes *Energy from Waste*. [EU WFD] |
| Recycle Now | A behaviour change campaign run by WRAP and focused on helping householders to recycle more things more often. |
| Recycled content | The proportion of a product made using recycled, rather than virgin, materials. |
| Recycling | The third stage of the *waste hierarchy*. Recycling waste any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations. [EU WFD] |
| Recycling Locator | An electronic tool which enables consumers to find out where their nearest recycling facilities are, by entering their postcode. Part of the Recycle Now website. |
| Redistribution | The process of avoiding food waste by distributing quality surplus food to those in need. |
| REFRESH | An EU-funded project focused on improving the resource efficiency of Europe's food and drink supply chain, in support of Sustainable Development Goal 12.3's target to halve food waste by 2030. |
| Refuse derived fuel (RDF) | Residual waste that complies with the specifications in a written contract between the producer of the RDF and a permitted end-user for the thermal treatment of the waste in an energy from waste facility or a facility undertaking co-incineration such as cement and lime kilns. The written contract must include the end-user's technical specifications relating as a minimum to the calorific value, the moisture content, the form and quantity of the RDF. [Defra/EA] |
| Remanufacturing | Returning a used product to at least its original performance with a warranty that is equivalent to or better than that of the newly manufactured product. [BS 8887-2] |
| Renewable Transport Fuel Obligation (RTFO) | Legislation to deliver reductions in greenhouse gas emissions from fuel used for transport purposes by encouraging the supply of renewable fuels. |

| Term | Explanation |
|---|---|
| | [Source: https://www.gov.uk/government/collections/renewable-transport-fuels-obligation-rtfo-orders.] |
| Repair | A process which corrects specified faults in a product. |
| Reprocessor | Business which takes sorted waste and converts it back into secondary raw materials which can be sold in competition with virgin raw materials. |
| Reuse | A waste *prevention* operation by which products or components that are not waste are used again for the same purpose for which they were conceived. [EU WFD] |
| Residual waste | Waste that is not suitable for recycling. |
| Resource efficiency (RE) | Using the Earth's resources in a sustainable manner. [EU] |
| Resource efficiency cluster | A group of businesses, generally co-located, that work together to improve their resource efficiency. |
| Resource Efficient Business Model (REBM) | A Resource Efficient Business Model is a way of providing a product or service to consumers with reduced resource impacts. Examples include leasing models and collaborative consumption. |
| Resource productivity | A measure of the value obtained from resources. Typically measured as value added per tonne of resources used. At national level, measured by GDP/Domestic Material Consumption. |
| Resource security | The extent to which the supply of critical resources, on which a national economy depends, are at risk. |
| Resources | Material assets that can be used to create products. Resources can be virgin materials or secondary raw materials. |
| Save As You Recycle (SAYR) | An approach to charging householders for the collection of their waste, the charge varying by how much waste is put out and which bin it is put in. Typically, waste put out for recycling is charged at a lower rate per kilogramme than waste put out for disposal. |
| Secondary materials markets | Markets on which secondary raw materials are bought and sold. |
| Secondary raw materials | Materials reprocessed from waste, suitable for use in product manufacture without further processing, as a direct substitute for virgin materials. |
| Single-use plastics | [***Use HMT definition, once published?***] |
| Solid recovered fuel (SRF) | SRF is a fuel derived from non-hazardous waste and produced in accordance with the requirements of the European standards for SRF, specifically in accordance with EN15359. [www.erfo.info] |

| Term | Explanation |
|---|---|
| Supply chain | The set of organisations involved in producing a product and getting it to the customer. |
| Sustainable Clothing Action Plan (SCAP) | Voluntary agreement of clothing sector signatories, managed by WRAP, which aims to minimise the environmental impact of clothing bought in the UK. |
| Technically, Environmentally & Economically Practicable (TEEP) | A condition found in the EU Waste Framework Directive. Municipal waste must be collected separately unless it is not TEEP to do so. |
| Transfrontier Shipment of Waste (TFS) | The movement of waste from one country to another for recovery or disposal. Such movements are controlled by UK and EU legislation and by the UN Basel Convention. |
| Virgin materials | Materials extracted from the Earth for the first time, in opposition to secondary raw materials. |
| Voluntary agreement (VA) | An agreement entered into by a number of organisations in order to achieve certain objectives. Often seen as an alternative to statutory regulation. |
| Waste | The legal definition of waste is 'any substance or object which the holder discards or intends or is required to discard'. [EU WFD] |
| Waste Electrical and Electronic Equipment (WEEE) | Electrical and electronic equipment, in specific categories, which has become waste. |
| Waste hierarchy | Legally binding priority order of waste management options, starting with prevention, then preparing for re-use, then recycling, then other recovery (e.g. EfW), and finally disposal. Can depart from this ordering if justified by life-cycle thinking. [EU WFD] |
| Waste transfer note | A paper-based method for recording movements of waste from the producer to final recovery or disposal, to fulfil the requirements of the Duty of Care. Manual alternative to *Electronic Duty of Care*. |
| WRAP | The Waste and Resources Action Programme is a UK not-for-profit organisation which works with governments, businesses and communities to deliver practical solutions to improve resource efficiency, both in the UK and across the world. [WRAP] |
| Zero waste | A philosophical approach to waste management which aims to emulate sustainable natural cycles, where nothing is sent to landfill or energy from waste, but all discarded materials become resources for others to use. [based on www.zwia.org] |

# Appendix 2: Conceptual frameworks

## Conceptual frameworks for understanding the issues

Conceptual frameworks are used to structure thinking about the challenges and opportunities posed by society's use of resources. Different frameworks focus attention on different aspects of a situation and may suggest different solutions.

The popularity of individual conceptual frameworks differs over time in line with the kinds of issues that need to be understood. For example, in the infancy of waste policy in the late 1960s, the dominant framework was *pollution* following some high profile domestic and international incidents of waste dumping; this conceptualisation of the problem framed the solutions, which largely took the form of regulation. A popular framework in the 1990s was the concept of the 'environmental rucksack'; this focused attention on the whole-life impacts of products. In recent years resource efficiency and the circular economy have been popular frameworks to adopt, focusing attention on maximising the active life of materials and products.

Currently, natural capital is the dominant conceptual model. In line with the 25 Year Environment Plan, the Resources and Waste Strategy takes natural capital as its organising principle. In a natural capital framework, resources appear in the economy as stocks and flows. This creates both opportunities and challenges. The challenge the strategy addresses is how to minimise the impacts of human activity, in particular the effects of depletion of the world's stock of resources (especially non-renewables) and the adverse impacts of resource flows (especially of waste) on the environment. This way of conceptualising the issues is helpful because it integrates thinking about the problems of consumption with thinking about the problems of waste whereas until relatively recently the policy focus has been solely on protecting the environment from the adverse impacts of waste[427].

[427] The supplementary evidence report to the 25 Year Environment Plan sets this out in more detail.

**Figure 15 A conceptual framework for improving the environment[428]**


## Conceptual frameworks for thinking about the case for intervention

Traditional welfare economics states there is a case for Government intervention on the basis of *inefficiency* (ensuring markets work effectively to make maximum use of scarce resources) or *inequity* (to achieve fairer distribution of resources)[429].

Common market failures include market power,[430] externalities,[431] imperfect information and the existence of public goods[432]. Where a gap has been identified between desired outcomes (i.e. policy goals) and the current situation, and where the reason for that gap has been characterised as inefficiency or inequitable operation of markets, then within this model here is a case for government intervention. A limitation of traditional welfare economics is that it tends to assume people and organisations act rationally. Additionally it

[428] Taken from page 7 of the supplementary evidence report of the 25 Year Environment Plan
[429] For more info, please see HMT (2018) The Green Book.
[430] Typically resulting in a small number of dominant firms. This results from insufficient competition to ensure that a market operates efficiently.
[431] These occur when an activity produces benefits or costs for others.
[432] A public good (e.g. clean air) is a good where it is difficult to actively exclude anyone from enjoying it (non-excludable in supply) and it largely does not matter how many people enjoy it (non-rival in demand). These features mean it is difficult for businesses to provide public goods.

tends to favour incremental change within the current system rather than a thorough overhaul.

We can assess the case for intervention through the lens of markets, innovation and disruptive transition, or behavioural insights[433]. In the Production and End of Life chapters, we focus primarily on challenges as a result of market failure[434]. In the Consumption chapter, we investigate behavioural barriers such as the role of ideology, beliefs and values. We understand there are limitations to any approach to identify the problem, but have taken steps not to let this rule out potential solutions.

Government uses levers such as regulations, fiscal incentives and the provision of information to change the way society behaves. This includes influencing what goods (and services) we buy, how we use them and whether we reuse, recycle or throw them away when they no longer want them. Using a traditional welfare economics framework, which regards people as largely rational and welfare maximising, there are two main barriers that prevent these desired outcomes being achieved:

1. **Lack of knowledge**, including about why act (e.g. the existence or scale of the problem and the consequences of current choices) and how to act (e.g. options for making more sustainable choices).
2. **Lack of incentive** to act**,** covering a lack of rules and associated penalties for non-compliance, inappropriate or absent financial incentives and penalties, and a lack of cultural norms and expectations about appropriate ways of acting

There is growing recognition people do not always assess the costs and benefits of their actions rationally.[435] This does not just apply to individual citizens; the very biggest businesses are staffed by people. As a result, governments are increasingly turning to behavioural insights to complement conventional environmental policy tools[436,437].

Behavioural insights, based on disciplines such as psychology, sociology, behavioural economics and neuroscience, provide a more realistic model of human decision-making. It takes account of humans' inherent biases and preferences. These help to government to

[433] UCL (2018) Resource efficiency and the circular economy, concepts, economic benefits, barriers and policies http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=20074&FromSearch=Y&Publisher=1&SearchText=resource%20efficiency&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description

[434] As is consistent with HMT Green Book guidance: REF

[435] Kahneman, D (2011). *Thinking Fast and Slow.* New York: Macmillan

[436] Since the original Behavioural Insights Team was established in the Cabinet Office in 2010, many Government Departments, including Defra, now have their own behavioural insights teams. The original Behavioural Insights Team is now an independent organisation.

[437] The 2018/19 Government Communication Plan commits the service to "work harder to master the techniques of behavioural science and start considering audiences by personality as well as demographic".

design, trial and implement policies that are more effective at changing behaviour because they complement with the choices people naturally make[438].

There also exists a gap between attitudes and behaviour. This is often referred to as the 'value-action' gap. Defra (2005) highlights that researchers in pro-environmental fields repeatedly show that holding pro-environmental attitudes does not necessarily lead to pro-environmental behaviours[439]. Department for Transport (2010) found an apparent disconnection between attitudes and behaviour. Higher income, highly educated respondents tended to be more pro-environmental in their attitudes but less sustainable in terms of their actual transport behaviour than lower income, less well educated respondents.[440] Addressing attitudes alone is not a promising behaviour change strategy.

It is not helpful to compartmentalise a complex resources and waste system into lifecycle stages, because of close economic relationships between them. An intervention in one place can ripple through it and it is important to understand how these unfold.

However the evidence needs setting in a logical structure. We divide challenges into production and consumption chapters according to whose behaviour we are primarily trying to influence rather than how an action is delivered. For example, although product labelling is the responsibility of producers its role is to provide information to consumers.

The challenges switch from consumption to end of life as soon as materials are discarded. We categorise recycling and the supply of recycled material as End of Life. However, once reprocessed it becomes a secondary raw material, which is a factor of production. And so completes the circle.

[438] Cabinet Office and Institute for Government (2013) *Mindspace: influencing behaviour through public policy* See page 8 for a summary of the MINDSPACE acronym.
[439] Defra (2005) *Promoting Pro-Environmental Behaviour: Existing Evidence to Inform Better Policy Making* and Darnton, A. (2008) Reference Report: An overview of behaviour change models and their uses
[440] Department for Transport (2010) *Climate Change and Transport Choices*

# Appendix 3: Policy instrument choice

## Types of policy instrument

Government has a range of tools in its toolbox. There are many different ways of classifying tools, but one useful approach comes from behavioural insights and can be applied to both individuals and organisations:

1. Tools aimed at increasing **capability** to act in the desired way
    - skill building
    - knowledge building
2. Tools aimed at increasing **opportunity** to act in the desired way
    - infrastructure provision
    - grants and loans
3. Tools aimed at increasing **motivation** to act in the desired way

Instruments to provide motivation to act can themselves be classified into three types – rule-based, market-based and value-based.

### Rule-based instruments

Rule-based instruments are sometimes referred to in the academic literature as 'command and control' or 'regulatory' and include rules imposed by law and those voluntarily submitted to, with government scrutiny. This type of instrument tells organisations or individuals they must do something. The mechanism is typically underpinned by legislation (or the voluntary equivalent of it) and are implemented by those bodies that have designated powers by law or by common consent. They work by stigmatising the old behaviour and appealing to the human desire to conform. They deploy the organising principle of hierarchy including the concept that for the greater good we should obey the people or organisations society empowers to tell us what to do.

### Market-based instruments

Market-based, or economic instruments, typically change markets signals to financially incentivise desired ways or disincentivise undesirable ways of behaving. They are normally underpinned by legislation and implemented by bodies that have designated powers (e.g. HMRC). They do not necessarily stigmatise the old behaviour, just make it less appealing. They appeal to the human desire to 'utility maximise' and deploy the organising principle of markets, in other words the understanding that if I give you something of value you will reciprocate.

### Value-based instruments

Value-based instruments, sometimes referred to as 'persuasive' or 'communicative', tell people that they ought to do something. They are not underpinned by legislation but

appeal to the human desire to do the right thing. They deploy the organising principle of networks and the understanding that common values bind us together as a society.

An effective policy will likely include a judicious mix of instruments to create the right set of conditions for desired actions. For example, for businesses to recycle, they must be capable (staff must have the right knowledge, skills and abilities), have the opportunity (have bins and collection systems) and be motivated to do so (have the right incentives in place – financial, regulatory or value-based).

## Choosing the appropriate instrument

Where a rationale for Government intervention has been established, there are broad criteria against which possible mixes of instruments should be judged. The Green Book provides some guidance on this,[441] focusing on assessing:

- strategic fit to wider policy objectives
- value for money
- affordability
- achievability
- dependencies
- constraints

OECD (1991) suggests a broader range of considerations:[442]

1. Will the instrument or combination of instruments be **effective**? Will they create the change that is required?

2. Are they **economically efficient?** In other words, do they bring society to a place where no one could be made better off without making someone else worse off?

3. Are they **equitable**? Are there distributional impacts that advantage or disadvantage some parts of society disproportionately?

4. Are they **administratively feasible** to introduce and operate? Can they be resourced? Are the means of providing information, monitoring and enforcement available? Are they compatible with existing institutional frameworks?

5. Are they **acceptable** – to those affected, to decision makers and to stakeholders?

6. Are they **flexible** enough to continue offering incentives or motivation even after the initial effect has been felt and behaviour has changed? Can they cope with complexity? Can they facilitate innovation?

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[441] HM Government (2018) The Green Book: Central Government Guidance on Appraisal and Evaluation
[442] OECD (1991) Environmental Policy: How to Apply Economic Instruments Paris: OECD and OECD (2016) Policy Guidance on Resource Efficiency Paris: OECD Publishing

7. Are there minimal **unintended consequences**, particularly on other social policies?

## Choosing mixes of instruments

OECD (2007) found that it was not always the case that a mix of instruments was better than a single instrument; in some cases additional instruments just created additional cost for no environmental outcome[443]. It makes the following recommendations:

- Apply instruments that address the environmental problem as broadly as possible.
- Provide similar incentives at the margin to all polluters.
- Have a comprehensive view on which instruments are required to create an environmentally effective and economically efficient instrument mix.
- Supplement instruments that address total pollution level with instruments that address other aspects of "multi-aspect" problems: Where, when, how, etc.
- Enhance possibilities for instruments to mutually reinforce each other by applying instruments that provide flexibility.
- Use information instruments to enhance the environmental effectiveness of any taxes, fees or charges.
- Pay attention to the incentive impacts of various instrument-design options.
- Avoid overlapping instruments, except when they can mutually reinforce each other, or address different aspects of the environmental problem.
- Avoid a confusing multitude of labelling schemes within a specific environmental area.
- Avoid annual targets for environmental problems that can be adequately addressed even if emissions vary somewhat from year to year.
- Put in place appropriate monitoring and enforcement mechanisms – to safeguard the environmental effectiveness of the instrument mix.
- Consider carefully whether voluntary opt-in possibilities in emission trading systems could jeopardise the environmental effectiveness of the trading system – and/or enhance the economic efficiency.
- Be careful when defining the baselines in any such opt-in options – in order to preserve environmental integrity of the whole scheme.
- Address any social concerns related to environmental policy instruments primarily through non-environmental instruments.
- Make sure to provide a positive incentive to abate at the margin if measures to limit sectoral competitiveness impacts are introduced.
- Address any non-environmental market failures primarily through non-environmental instruments.

[443] http://www.oecd.org/env/tools-evaluation/mixesofpolicyinstruments.htm