FINAL Report

UK progress against Courtauld 2025 targets and UN Sustainable Development Goal 12.3

This report outlines progress in reducing UK food waste and greenhouse gas emissions associated with food consumed in the UK – in the context of the Courtauld Commitment 2025 targets (2015 to 2018) and the UN Sustainable Development Goal 12.3 (2007 to 2018)

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Our mission is to accelerate the move to a sustainable resource-efficient economy through re-inventing how we design, produce and sell products; re-thinking how we use and consume products; and re-defining what is possible through re-use and recycling.

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Front cover photography: Representation of the scope of the Courtauld 2025 food waste and greenhouse gas targets

Executive summary

This report documents progress against Courtauld 2025 and UN's Sustainable Development Goal (SDG) 12.3 food waste prevention targets, and also the Courtauld 2025 greenhouse gas emissions (GHG) target[1]. **The analysis suggests that the UK is on a trajectory to achieve national and international food waste prevention targets, assuming rates of progress between 2007 and 2018 are maintained, and that the strategies WRAP has developed under Courtauld 2025, delivered through wide-ranging partnerships and supported by industry are effective. When consumers and businesses are reached and motivated to act significant reductions are achieved. Much more action is needed to ensure that most people and organisations are engaged and making the required changes**.

WRAP, food businesses and other partners have delivered large-scale interventions to reduce food waste across supply chains, and households for more than ten years (since 2007), supported by UK Governments and enabled by a series of collaborative voluntary agreements. This contributed to a decrease in post-farm gate total food waste between 2007 and 2015 of around a million tonnes. Whilst being recognised as world-leading[2], progress in reducing household food waste stalled between 2012 and 2015, and only modest reductions were made in supply chain food waste. Courtauld 2025 was launched in 2016 with a new collaborative approach to increase the resource efficiency of the food supply chain.

This report shows that food waste in the UK (post-farm gate) amounted to around 9.5 Mt in 2018, almost 480kt lower than in 2015 and almost 1.7 Mt lower than in the SDG12.3 baseline year. Food waste excluding inedible parts amounted to around 6.4 Mt in 2018, or almost 70% of the total.

Table ES1: Summary of UK food waste arisings (kt) for the SDG12.3 and Courtauld 2025 baseline years and 2018, and changes over time

	SDG12.3 baseline (kt)	2015 (kt)	2018 (kt)	Change vs 2015 (kt)	Change vs 2015 (%)	Change vs SDG baseline (kt)	Change vs SDG baseline (%)
Household	8,085	7,050	6,646	-405	-5.7%	-1,440	-17.8%
Supply chain	3,110	2,951	2,880	-71	-2.4%	-230	-7.4%
Retail	*290*	*261*	*277*	*16*	*6.0%*	*-13*	*-4.6%*
Manufacture	*1,900*	*1,668*	*1,505*	*-163*	*-9.8%*	*-395*	*-20.8%*
HaFS[3]	*920*	*1,022*	*1,098*	*76*	*7.5%*	*178*	*19.3%*
Total	11,195	10,001	9,525	-476	-4.8%	-1,670	-14.9%

[1] A report on progress against the water ambition has already been published (COURTAULD 2025 WATER AMBITION: PROGRESS REPORT - WORKING TOGETHER TO PROTECT CRITICAL WATER RESOURCES; WRAP 2019

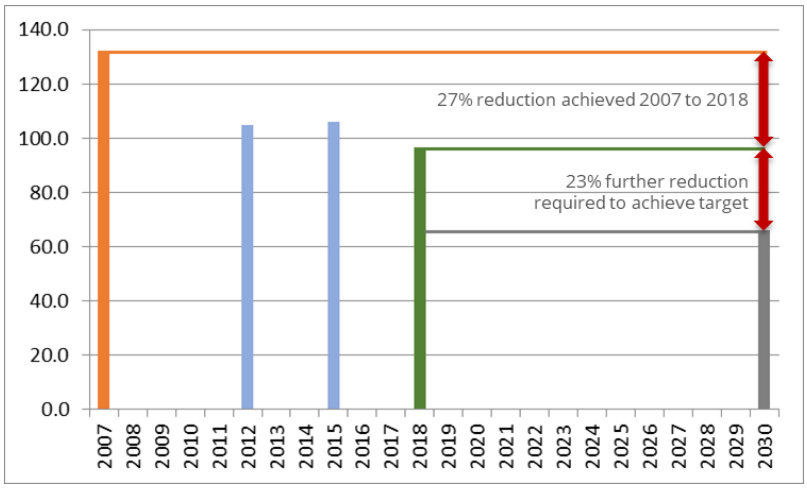
[2] SDG target 12.3 on food loss and waste: 2019 Progress Report; Champions 12.3 Group, 2019

[3] It is important to stress that this is a modelled result, based on changes in the number and types of hospitality and food service sites, and the assumption that food waste per site has remained constant since 2011. Currently there is not a data source to enable a UK-level estimate for food waste from this sector to be robustly estimated

Courtauld 2025 has an ambitious target to reduce total UK food waste (i.e. food and inedible parts; post-farm gate) by a further 20% per person by 2025 against a 2015 baseline. On this basis, the reduction in food waste between 2015 and 2018 was 6.7%, against the Courtauld 2025 target of 20% by 2025. This equates to an average of around 2% a year, which is the rate required to achieve the Courtauld target.

The per capita reduction in wasted food (excluding inedible parts) between 2015 and 2018 was over 9%, and 27% against the SDG12.3 baseline. This represents over halfway to the target of a 50% reduction by 2030 and equates to an average reduction of around 2% a year for the whole period (and 3% for 2015 to 2018), which is the rate required to achieve SDG12.3.

Figure ES4: Progress towards SDG12.3 (UK food waste arisings excluding inedible parts; kg per capita per year)



The value of UK wasted food (i.e. excluding inedible parts) is estimated at around £19 billion. There is almost £1.3 billion less food being wasted a year compared to 2015, and £4.7 billion a year compared to the SDG12.3 baseline.

The amount of food waste generated by households and the hospitality and food service sector, *as a percentage of the amounts of food purchased*, are similar at between 16% and 18% respectively. For manufacturing the percentage food waste of food produced/sold is less than 3%, whilst for retail the figure is under 1%.

Household food waste

Household food waste makes up 70% of the total UK food waste post-farm gate, at 6.6 Mt. Over two-thirds of this (68%; 4.5 Mt) was food intended to be eaten, with a value of almost £14 billion in 2018. The remainder (2.1 Mt) consisted of inedible parts, such as bones and egg shells. After a period of stagnation, household food waste reduced, in absolute terms by almost 6% between 2015 and 2018 and is now almost 18% lower than in 2007. Per capita household food waste is statistically significantly lower in 2018 compared to 2007, 2012 or 2017, but further data will be needed for 2019 onwards to establish whether this is a true downward trend.

There are many factors that can influence household food waste, including a range of behavioural and technical interventions and shifts in demographic profiles and economic conditions. Several actions have been taken since 2015 in order to accelerate progress and increase the likelihood of the UK achieving Courtauld 2025 and SDG12.3 targets. WRAP

developed and has implemented a new strategy for citizen food waste prevention, which includes a refocused Love Food Hate Waste campaign and targeted behaviour change interventions (such as those under the EU-funded TRiFOCAL project). In addition, an enhanced programme aims to drive changes in food packaging design and labelling to make it easier for people to buy what they need and make use of what they buy (new WRAP/Defra/FSA guidance to industry was published in 2017, and progress in this area was reported in November 2019[4]).

The analysis presented in this report is consistent with these interventions, and the impact of an increase in households having separate food waste collections, making a significant contribution to the recent reduction, rather than economic or demographic factors.

Whilst awareness of food waste as an issue, concern about this and intentions to take action have all increased amongst consumers, many do not yet acknowledge that this is an issue relevant to them or are not yet concerned enough to act. To address this WRAP is developing a new 'Food Conversation' campaign, and it is vital that this campaign is supported by food businesses, other organisations and high-profile individuals to ensure it stands out and captures the imagination and hearts of those not yet inclined to engage and make changes.

For those that are engaged, Love Food Hate Waste provides practical tools and advice to make it as easy as possible to reduce food waste at home. Whilst brand recognition is increasing, more active support is needed from a wide range of partners and influencers to ensure this campaign effectively reaches more of the population. Greater levels of support are also required to test and roll out targeted behaviour change interventions that WRAP are developing.

Retailers and brands must also fully implement the WRAP/Defra/FSA best practice on how food is sold, packs designed and labelled, as outlined in the recently published Retail Survey[5].

Supply chain food waste

Supply chain food waste makes up 30% of the total UK food waste post-farm gate, at 2.9 Mt. Over two-thirds of this (65%; 1.9 Mt) was food intended to be eaten, with a value of over £5 billion in 2018. Supply chain food waste reduced, in absolute terms, by 2.4% between 2015 and 2018 and is now 7.4% lower than in 2007. However, there is a lack of reliable data for the hospitality & food service sector; if this sector is excluded, food waste from retail and manufacturing together fell by 7.6% between 2015 and 2018 (and 18.6% compared to the SDG12.3 baseline).

Courtauld 2025 has facilitated a collaborative approach to identifying and addressing barriers to reducing food waste from farm to fork, including a series of category- and theme-specific working groups. One covers redistribution of food surplus, which doubled between 2015 and 2018.

From early 2017, WRAP and IGD worked with a wide range of food businesses and other organisations on a common set of principles for food waste measurement (in order to inform and drive action), which laid the foundations for the ground-breaking Food Waste Reduction Roadmap. The Roadmap encompasses the entire supply chain from farm to fork and asks businesses to commit to implementing a strategy of Target, Measure, Act, taking action to

[4] *Retail Survey 2019: HELPING CONSUMERS REDUCE FOOD WASTE THROUGH BETTER LABELLING AND PRODUCT CHANGES; WRAP 2019]*

[5] *Retail Survey 2019: HELPING CONSUMERS REDUCE FOOD WASTE THROUGH BETTER LABELLING AND PRODUCT CHANGES; WRAP 2019*

reduce food waste in their own businesses and through engagement and innovation helping to reduce food waste from their suppliers and consumers.

The 121 businesses implementing this approach as of September 2019 are likely to generate around a third of the total UK post-farm gate supply chain food waste, with the remaining two-thirds generated by almost 500 major food businesses still needing to implement Target, Measure, Act. It is important that greater numbers of larger food businesses engage with their suppliers, to encourage and support them in acting on food waste. For hospitality and food service, WRAP is working with the sector to build momentum behind the Guardians of Grub campaign as a mechanism to increase the number of businesses measuring and reducing food waste and motivate behaviour change by staff in the sector.

Businesses implementing Target, Measure, Act are already reporting the benefits. For example, 26 businesses publicly reported 2018 and historical data, and collectively reported a 7% reduction in food waste, saving around £100m of food (57,000 tonnes). There is much others can learn from those that have achieved reductions in operational food waste, and WRAP's insights on where the greatest potential lies.

The introduction of mandatory food waste reporting in the UK[6], subject to consultation, will support the ambitions of Courtauld 2025 and the Roadmap. WRAP is working closely with policy makers to help ensure the new regulations will be aligned and informed by the Roadmap and its resources. The mandatory separation of food waste will also make it easier for many businesses to acquire data on how much food waste they are generating. Both will drive further engagement with and adoption of the broader Target, Measure, Act strategy.

The reported reduction in supply chain waste has been driven by the achievements of producers and manufacturers, with food waste from retail increasing and the scarcity of food waste data from the hospitality and food service sector making it impossible to robustly quantify change in this sector. Whilst it is disappointing that retail food waste levels have increased since 2015), it should be borne in mind that retail food waste represents less than 1% of the amounts of food and drink sold, the lowest wastage rate of any supply chain stage. Five retailers have now published time-series data on food waste from their operations, and four have reported a reduction compared to their baselines (which range from 2013 to 2017/18).

Retailers are also engaged in initiatives to help both suppliers and customers reduce food waste, and these can, at least in the short-term, result in an increase in food waste at retail (at depots or in store)[7]. For example, relaxing fresh produce specifications and/or accepting 'gluts' of fresh produce can lead to less food being wasted by producers but more in store (if customers reject some of this produce, or there is insufficient demand). Similarly moves to increase the provision of loose fresh produce can be associated with operational challenges that lead to more waste in store, at least in the shorter term.

Between 2015 and 2018 the amount of food surplus redistributed from retail to charities increased by over 14,000 tonnes, and the total redistributed from retail via charitable and commercial routes in 2018 amounted to almost 25,000 tonnes. The amount of food surplus redistributed from manufacture to charities increased by almost 4,000 tonnes, and the total redistributed from manufacture via charitable and commercial routes in 2018 amounted to almost 26,000 tonnes. This is food that would have otherwise ended up as waste.

The availability and robustness of data needs to improve

In addition to the concerted efforts needed to deliver targets, more is needed to be done on the availability and robustness of food waste data. This is critical to monitor progress, and to inform policy and business decisions on where to focus resources. For the supply chain, developing estimates of national food waste levels from existing data sources, such as those

[6] *See Defra Resources and Waste Strategy* and *the Scottish Government's Food Waste Reduction Action Plan*

[7] *For example see Evaluation of a plastic-free/loose fresh produce trial (Morrisons case study); WRAP 2019*

from the Environment Agency, is not sufficiently robust for all manufacturing sub-sectors, nor even possible for the hospitality and food service sector. More data is needed from businesses, combined with bespoke research such as that carried out by WRAP in the past. Defra, Champions 12.3 and WRAP are calling for more businesses to implement Target, Measure, Act, and publicly report food waste data, ahead of any regulatory requirement to do so.

Food waste in primary production

Courtauld 2025 and the Roadmap have a farm-to-fork ambition and, even though primary production is not within the scope of the quantitative food waste target, there is an expectation that businesses will act in this important area, and this is increasingly a focus for action. The current evidence is not strong enough to serve as a benchmark against which progress can be assessed, and WRAP is working with Governments and businesses to determine how the evidence base can be strengthened and impacts judged.

Courtauld 2025 greenhouse gas (GHG) emission target

The Courtauld 2025 GHG target is for a 20% reduction in the GHG intensity of food and drink consumed in the UK, from 2015 to 2025 calculated as a relative reduction per head of population. WRAP estimates that there has been a 7% reduction (per capita) in GHG emissions associated with food and drink consumed in the UK between 2015 and 2018. The majority of this reduction (more than 80%) is due to decarbonisation of the UK's electricity grid: the average emissions associated with consuming a unit of electricity are 39% lower now than they were in 2015. However, another driver is the avoided GHG emissions associated with food waste reduction, which may have contributed up to around 14% of the overall reduction in GHG emissions.

As earlier noted, WRAP has estimated that 476,000 tonnes less food was wasted in 2018, compared to 2015. The embodied emissions associated with producing this volume of food are around 1.6 Mt CO_2e (14% of the GHG reductions observed between 2015 and 2018). The complexity of the global food system is such that it is challenging to identify and apportion the 'cause and effect' between food waste reduction and food system GHG emissions (for example because reducing food waste can lead to different purchasing patterns, such as 'trading up', or to more food being available for export markets rather than less production in the UK). However, reducing food waste will have contributed to reductions in the GHG emissions associated with UK food and drink through changes in purchases, changes in net trade, changes in processing, distribution, storage and preparation requirements, etc. – as well as reductions in emissions associated with avoided waste management (e.g. reduced landfill emissions).

There is no room for complacency as there are significant challenges remaining. In order to achieve the SDG12.3 target another 1.8 Mt of food waste will need to be prevented by 2030 compared to 2018, around 1.3 Mt from reducing household food waste, over 90,000 tonnes from retail, around 250,000 tonnes from manufacturing and almost 200,000 tonnes from hospitality and food service[8]. Achieving the Courtauld 2025 food waste target would also result in a further 4 Mt of CO_2e avoided GHG emissions, in total contributing to around 25% of the GHG target.

In the first phase of Courtauld 2025 the primary focus has been on food waste reduction as an important way of improving the efficiency of the UK's food and drink system: helping to feed more people with lower emissions overall. This will continue to be a core focus, but

[8] Based on WRAP analysis of the potential to reduce food waste at different stages of the supply chain. Achieving the Courtauld 2025 food waste target would require a 1.1Mt reduction by 2025 compared to 2018 (0.8 Mt from households, 50kt from retail, 135kt from manufacturing and 115kt from hospitality and food service)

more effort is also required on 'non waste-related' actions to reduce GHG emissions, particularly within the supply chain. Many Courtauld 2025 signatories have developed 'science-based' targets to reduce their supply chain GHG emissions and WRAP is reviewing the collaborations / tools / support that these businesses need to help deliver change at scale. In addition, major sector initiatives like NFU's Net Zero will play a particularly important role in delivering far-reaching change, and can be made even more effective if supported through collaboration across the whole food and drink industry.

Contents

1.0 Introduction

WRAP, food businesses and other partners have delivered large-scale interventions to reduce food waste across supply chains, and households for more than ten years, supported by UK Governments and enabled by a series of collaborative voluntary agreements (Courtauld 1, 2 and 3, the Hospitality and Food Service Agreement and the Courtauld Commitment 2025). This contributed to a decrease in post-farm gate total food waste between 2007 and 2015 of around a million tonnes. Whilst being recognised as world-leading[9], progress in reducing household food waste stalled between 2012 and 2015, and only modest reductions were made in supply chain food waste.

Courtauld 2025 has an ambitious target to reduce UK food waste (post-farm gate) by a further 20% per person by 2025 against a 2015 baseline. The 2015 UK food waste total of 10 Mt translates into the equivalent of 154 kg per person per year. Achieving the Courtauld 2025 target would therefore reduce this to 123 kg per person per year by 2025. This would result in 1.5 Mt a year less food waste arising in 2025 compared to 2015[10].

The UN's Sustainable Development Goal (SDG) 12.3 is that "By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses". The Champions 12.3 Group propose that the '50%' target should apply across the whole supply chain, from farm to fork[11].

A 50% reduction in UK wasted food (excluding inedible parts) per capita by 2030 compared to 2007 would equate to a reduction from 132 kg per person to 66 kg per person. Taking into consideration population growth, this would mean a reduction in food going to waste of around 3.5 Mt a year (2007 levels were 8.2 Mt [11.2 including inedible parts], and in 2030 they would be 4.6 Mt [8.1 Mt including inedible parts]).

Several actions have been taken since 2015 in order to accelerate progress and increase the likelihood of the UK achieving Courtauld 2025 and SDG12.3 targets. WRAP developed and has implemented a new strategy for citizen food waste prevention, which includes a refocused Love Food Hate Waste campaign and targeted behaviour change interventions. In addition, an enhanced programme aims to drive changes in food packaging design and labelling to make it easier for people to buy what they need and make use of what they buy (new guidance to industry was published in 2017, and progress in this area was reported in November 2019[12]).

In terms of supply chain food waste, WRAP and IGD worked with a wide range of food businesses and other organisations on a common set of principles for food waste measurement (in order to inform and drive action), which laid the foundations for the ground-breaking Food Waste Reduction Roadmap. The Roadmap encompasses the entire supply chain from farm to fork and asks businesses to commit to implementing a strategy of Target, Measure, Act. This means setting a food waste reduction target for their UK operations, measuring and reporting food waste according to the Roadmap guidelines and taking action to reduce food waste in their own businesses and through engagement and innovation helping to reduce food waste from their suppliers and consumers.

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[9] SDG target 12.3 on food loss and waste: 2019 Progress Report; Champions 12.3 Group, 2019

[10] The UK population is forecast to grow by around 4 million by 2025 (vs 2015), a 6% increase, which means the reduction in total UK food waste is less than 20% (ca 15%, or 1.5 Mt a year less in 2025 than in 2015)

[11] Guidance on Interpreting Sustainable Development Goal Target 12.3; Champions 12.3 2017

[12] Retail Survey 2019: HELPING CONSUMERS REDUCE FOOD WASTE THROUGH BETTER LABELLING AND PRODUCT CHANGES; WRAP 2019

In September 2019 WRAP reported that since launch the number of organisations committed to the Roadmap (which include businesses, trade bodies and others) had more than doubled, from 90 to 185, and the number of food businesses committed had risen from just over 70 to 156[13]. 121 large businesses had provided evidence to WRAP of implementing Target, Measure Act (all large grocery retailers and 106 other large food businesses; around 80% of those committed to the Roadmap). Others had begun implementation, for example by undertaking measurement and acquiring data before setting a target.

Several Courtauld 2025 working groups were established to facilitate the development of category or theme-specific solutions to common barriers, including on redistribution of food surplus[14]. A doubling of UK redistribution was reported in May 2019[15].

In addition to the Courtauld 2025 food waste target, there are two others – a 20% per capita reduction in the greenhouse gas (GHG) intensity of food and drink consumed in the UK and a reduction in impact associated with water use in the supply chain. This report will cover progress against both the food waste and GHG targets, as a report on progress against the water ambition has already been published[16].

[13] *Food Waste Reduction Roadmap Progress Report 2019; WRAP, 2019*
[14] *Courtauld Commitment 2025 Milestone Progress Report; WRAP 2020*
[15] *Surplus food redistribution in the UK; 2015 to 2018; WRAP 2019*
[16] *COURTAULD 2025 WATER AMBITION: PROGRESS REPORT - WORKING TOGETHER TO PROTECT CRITICAL WATER RESOURCES; WRAP 2019*

2.0 Methodology – Food waste

This report sets out the estimated change in food waste arisings between the Courtauld 2025 baseline (2015) and the first reporting year of the Commitment (2018). In addition, it also sets out estimated progress against the UK baseline for SDG12.3. This is a composite baseline, comprising data from different years for different elements of the food system, determined by the availability of robust data. In Historical changes and how amounts might be influenced in the future WRAP made the case for a baseline year of 2007 against which to assess changes in UK food waste over time. This was on the basis that a) there is robust data on the largest fraction of UK food waste from that year (i.e. household food waste; approximately 70% of the total post-farm gate) and b) this is when the UK began large-scale interventions to reduce food waste (which were aimed exclusively at household food waste until 2010 – with a focus on supply chain food waste commencing under Courtauld 2 in 2010, and in 2012 on food waste from the hospitality and food service sector. The elements of UK food waste that are covered in this report, and the year robust data is first available, are as follows:

1. Household waste (2007)
2. Retailers (2009)
3. Manufacturers (2011)
4. Hospitality and Food Service (2011)

The method for quantifying each element is set out separately below.

2.1 Household food waste

2.1.1 Food waste arising

The following are classified as disposal routes for household food waste:

1. Residual waste collected at the kerbside (i.e. the general bin);
2. Collections by local authorities that target food waste (either separate food waste collections or mixed garden and food waste collections);
3. Contamination of 'dry' kerbside recycling collections (e.g. glass, paper);
4. Residual waste collected at household waste recycling centres;
5. Sewer (mostly down the kitchen sink); and
6. Home composting

Household waste collected by local authorities was estimated by combining data on the composition of the household residual waste and organics recycling streams, collected through conducting a synthesis of all the UK waste composition analysis studies available for that year[17], with arisings data for these streams from WasteDataFlow. The method is discussed further in the Courtauld 2025 baseline report[18], while the detailed 2018 methodology and results are published alongside this report[19].

There is less information for other disposal routes, namely sewer disposal and home composting. For sewer waste, data for 2018 have been calculated using the method outlined in detail in a previous report[20]. The data have been updated for 2018 based on the assumption that disposal to sewer remains constant as a proportion of local authority collected food waste. This is identical to the approach used when calculating the Courtauld 2025 baseline.

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[17] *The 2015 baseline was based on kerbside composition studies covering 116 local authorities; the 2018 update collated data from 129 authorities. Impact of household food waste collections on household food waste arisings, WRAP 2020*

[18] *Courtauld Commitment 2025 food waste baseline for 2015; WRAP 2018*

[19] *Synthesis of household food waste compositional data 2018; WRAP 2020*

[20] *Methods used for Household Food and Drink Waste in the UK 2012; WRAP 2013*

Home composting is a relatively minor route for discarding food waste. For the 2015 baseline it was assumed that the same amount per person of food waste went to home composting as in 2012 (8.0 kg / person / year). There is no more recent evidence of a change in the amount of food going to home composting, and therefore this assumption (based on analysis of 948 kitchen diaries from 2012) has been maintained for the 2018 update[21].

2.1.2 Food ('edible parts') vs inedible parts of food

The estimate of the relative proportions of food ('edible parts') and inedible parts are based on a large-scale household food waste composition analysis conducted in 2012[22]. The use of this data to establish the split of food and inedible parts of food for the 2015 baseline is discussed in detail elsewhere[23].

Estimation of inedible parts for 2018 is based on the same method, which assumes that the amounts of inedible parts per capita remains constant and that change in food waste occurs only to the food ('edible' parts) fraction. It is true that changes to the overall quantity or type of food purchased may influence the amounts of inedible parts, but in the absence of data on the composition of food purchased or wasted, this assumption is likely to produce a reasonable estimate over the short term. WRAP will seek to conduct future empirical research in the future to test and revise this assumption.

2.1.3 Costs of food waste

The cost of household food waste is based on the detailed composition of food waste established by the 2012 waste composition analysis. As for the Courtauld 2025 baseline, this has been inflation adjusted using the Consumer Price Index. All costs in this report have been inflated to reflect 2018 prices.

2.2 Retail food waste

Retail signatories to Courtauld 2025 are estimated to cover more than 95% of the food retail sector by sales[24]. Signatories submit data on their food waste arisings annually to WRAP. Given the rate of coverage, the potential inaccuracies introduced by simply scaling the retail signatory data are very low. The approach taken was therefore to scale the data up by dividing the total food waste arising from signatories reporting data by the market coverage (85% in 2015; 95% in 2018; differences resulting from not all signatories reporting in 2015).

There is no available data on the proportion of food and inedible parts in the retail waste stream. As with for the Courtauld 2025 baseline, the assumption made is that all the food waste from retailers is food, rather than inedible parts, as the vast majority will be from food originally intended to be sold (a small amount may be from food prepared for deli counters etc.). Clearly, this is a limitation of the method, as a proportion of the wasted food will contain inedible parts, such as bones and inedible peel; the method is, however, consistent and comparable with that used previously.

Estimates for the total cost per tonne of food waste in 2015 (from the Courtauld 2025 baseline) have been inflated using the Consumer Price Index and weighted by arisings to derive a cost of retail food waste for 2018.

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[21] *Household Food Waste in the UK, 2015; WRAP 2017 and an evidence review by WRAP in September 2019*
[22] *Household Food and Drink Waste in the United Kingdom 2012; WRAP 2013*
[23] *Household food waste: restated data for 2007-2015; WRAP 2018*
[24] *Using data from Kantar and Statistica*

2.3 Manufacturing food waste

The approach to calculating the arising of food waste from the food manufacturing sector is based on combining:

1) Site visit data to establish the percentage of food waste in various waste classifications (European Waste Catalogue [EWC] codes) for a range of food manufacturing sectors.
2) Data on waste (by EWC code) by sector submitted to the Environment Agency under the Integrated Pollution Prevention and Control Regulations. This data covers a limited number of sites operating above a risk-based production threshold that varies by sector.
3) Scaling this up to the UK by using data on the total number and size band of sites from the Interdepartmental Business Register.

Each business submitting an IPPC return is assigned a sector (by SIC [Standard Industrial Classification] code) and total waste arising in the IPPC dataset is calculated by EWC code and SIC code. These values are then multiplied by the food waste percentage for each SIC/EWC code (established in step 1 above) to establish the quantity of food waste in the IPPC dataset by SIC code. This is then grossed up from the IPPC data to the UK using the IDBR.

The method is set out in detail in previously published WRAP reports, including how the proportion of inedible parts is estimated[25].

2.3.1 Changes to the manufacturing method for 2018

This year for the first time IPPC data were supplemented by data collected under the Food Waste Reduction Roadmap[26] for several major branded and own brand Tesco suppliers. This was particularly important as a way of improving estimates for sectors that are under-represented in the IPPC data (e.g. fresh produce, bakery) and for which very high extrapolation factors would otherwise have been required.

Further modifications to the method involved the use of new information from the Dairy and 'Meat/ Poultry/ Fish' sectors on the assumed relationship between tonnage of sludges (on-site treatment + washing and cleaning) and food waste. These sources included: site visits linked with a Zero Waste Scotland project on food waste to drain, information obtained by WRAP through review of IPPC data with one large meat processing business and ongoing discussions with Dairy UK and application of WRAP sector guidance on food waste reporting and waste-water/ sludges for the dairy sector. Over time, WRAP plans to work closely with bodies like Dairy UK to improve the sector-level estimates.

These changes resulted in estimates that were not directly comparable to the 2015 baseline. The 2015 baseline was therefore recalculated using the revised approach and assumptions in order to produce a more comparable figure. More detail can be found in Appendix 1.

2.4 Hospitality and food service food waste

For estimation of UK food waste arisings from the hospitality and food service sector, WRAP followed the method used for the Courtauld 2025 baseline. This used remodelled food waste arisings based on WRAP's 2013 analysis of food waste in the hospitality and food service sector[27]. This employed a combination of waste composition analysis and analysis of data from DEFRA's 2009 Commercial and Industrial Waste Survey.

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[25] *Quantification of food surplus, waste and related materials in the supply chain; WRAP 2016 and Courtauld Commitment 2025 food waste baseline for 2015; WRAP 2018*

[26] *See http://www.wrap.org.uk/food-waste-reduction-roadmap*

[27] *Overview of Waste in the UK Hospitality and Food Service Sector; WRAP 2013*

In establishing the 2015 baseline, data from the 2013 study were reweighted to account for the change in number and size of premises (as set out in the 2015 Inter-Departmental Business Register (IDBR)), number of pupils served by school catering etc.

This approach was repeated for 2018, scaling the data by revised factors to produce the 2018 hospitality and food service food waste estimate. In both cases, the data were reduced by the estimated impact (12,000 tonnes) of WRAP's Hospitality and Food Service Agreement. More detail can be found in Appendix 2.

It is important to stress that this is a modelled result, based on changes in the number and types of hospitality and food service sites, and the assumption that food waste per site has remained constant since 2011 (and the proportion of inedible parts). Currently there is not a data source to enable a UK-level estimate for food waste from this sector to be robustly estimated.

2.5 Limitations of the methods

The household and retail baselines are believed to be robust.

- The household estimate is based on data from 129 separate waste composition analyses (conducted between late 2017 and throughout 2018) and represents direct empirical data from tens of thousands of households. This was in turn scaled to WasteDataFlow, which contains waste collection and disposal data for every local authority in the UK.
- The retailer data is based on a sample of around 95% of all retail grocery turnover in the UK. With such high coverage, extrapolation to the remainder of UK grocery retail presents very few possibilities for significant error.

The manufacturing estimate has three potentially significant issues:

1. The proportion of food in some EWC codes (particularly sludges) has been estimated, and there is a considerable level of uncertainty in the estimates. Sludges account for almost half of all waste from the food manufacturing sector, therefore this is a very significant source of uncertainty.
2. The IPPC data are collected based on a risk-based production threshold. While coverage of sectors such a meat and dairy is high, that for sectors such as bakery or fresh produce is much weaker. This results in higher extrapolation factors being used. In addition, the data in these later cases are all drawn from large operators and may not capture differences in waste production among SMEs.
3. The IPPC data themselves appear to contain errors, with data being miscoded or subject to unit errors. In addition, changes in ownership and subcontracting arrangements can make it difficult to identify which business has generated the waste, leading to the possibility of misattribution. The data have been reviewed historically and obvious errors (e.g. unit errors leading to a change in waste with a factor of 1,000) corrected, but there may be residual inaccuracies.

The main limitation of the hospitality and food service estimate is that it is based on fieldwork conducted between 2009 and 2011, with no waste data collected since then. It does not reflect any changes that may have taken place in the sector regarding the management of food waste, but merely scales the historical estimate to the current size of the sector. As such, the hospitality and food service figures should be taken as strictly indicative and may be subject to a large margin of error. WRAP plans to conduct an update to the hospitality and food service fieldwork before publication of the second tranche of Courtauld 2025 results in order to produce a more robust estimate.

3.0 Methodology –GHG emissions

The estimated change in greenhouse gas emissions attributable to the UK food system between the Courtauld 2025 baseline (2015) and the first reporting year of the Commitment (2018) was calculated using the following approach.

- The UK food system was broken down into a series of stages, encompassing all of the activities to produce, transport, sell and prepare food, and manage any food wasted.
- These stages included: UK agricultural production (for UK and export markets), food production and import from overseas, UK food & drink manufacture, packaging manufacture, UK supply chain transport, UK retail, UK catering, consumer transport for food shopping, storage and cooking at home, and waste management (across all stages).
- National-level datasets were used to quantify the major flows (e.g. food imports/exports, inputs (e.g. electricity, fuel, fertiliser) and direct GHG emissions (e.g. enteric emissions from livestock, fertiliser emissions) as relevant for each life cycle stage.
- Published emission factors (in carbon-dioxide equivalent (CO_2e)) were used to translate flows and inputs into estimates for 'embodied emissions', and these were added to any direct emissions, to obtain a total estimate of GHG emissions (CO_2e) for each life cycle stage.
- The GHG for each life cycle stage were summed to generate an overarching estimate for GHG emissions attributable to the UK food system.
- These calculations were undertaken for 2015 and 2018, using the same national-level datasets and embodied emission factor datasets, to enable a like-for-like comparison.
    - In most cases the national-level statistics contained time-series data to enable this comparison. However, in some cases a 2018 datapoint was missing, and so the latest year (2017) was used.
    - In some cases, the embodied emission factor datasets contained time-series data to reflect the reduction in embodied emissions over time (for example the unit emissions associated with producing electricity and with road transport have changed over time). In other cases, the change over time in embodied emissions are not known, and so the same emission factor was applied for 2015 and 2018 (for example embodied emissions of food items produced overseas).

As a final step, the combined GHG associated with the total food system were divided by the total tonnes of food purchased (in and out of home) to generate an average GHG emissions per tonne of food and drink in the UK. This was multiplied by total food waste to estimate the total GHG emissions associated with wasted food and drink in the UK.

Appendix 3 contains a full description of the national datasets, embodied emission factor datasets used, as well as any assumptions made when manipulating these datasets.

4.0 Results – food waste

An overview of the results will be presented first, summarising the latest data on UK food waste (2018), and progress against the Courtauld 2025 food waste target, and SDG12.3. Later sections will cover more detail on specific sectors.

4.1 Summary of UK food waste estimates for 2018 and progress against targets

Food waste in the UK (post-farm gate) amounted to around 9.5 Mt in 2018, almost 480kt lower than in 2015 and almost 1.7 Mt lower than in the SDG12.3 baseline year (see Table 1). This represents a 4.8% reduction versus 2015, and almost 15% compared to the SDG12.3 baseline. The largest contribution to the reduction is from household food waste, both in absolute amounts but also percentage reduction, with household food waste falling at a rate 2.4 times faster than that of the supply chain overall. However, there isn't a consistent picture for different parts of the supply chain, and this is discussed in relevant sections below.

Table 1: Summary of UK food waste arisings (kt) for the SDG12.3 and Courtauld 2025 baseline years and 2018[28], and changes over time

	SDG12.3 baseline (kt)	2015 (kt)	2018 (kt)	Change vs 2015 (kt)	Change vs 2015 (%)	Change vs SDG baseline (kt)	Change vs SDG baseline (%)
Household	8,085	7,050	6,646	-405	-5.7%	-1,440	-17.8%
Supply chain	3,110	2,951	2,880	-71	-2.4%	-230	-7.4%
Retail	*290*	*261*	*277*	*16*	*6.0%*	*-13*	*-4.6%*
Manufacture	*1,900*	*1,668*	*1,505*	*-163*	*-9.8%*	*-395*	*-20.8%*
HaFS[29]	*920*	*1,022*	*1,098*	*76*	*7.5%*	*178*	*19.3%*
Total	11,195	10,001	9,525	-476	-4.8%	-1,670	-14.9%

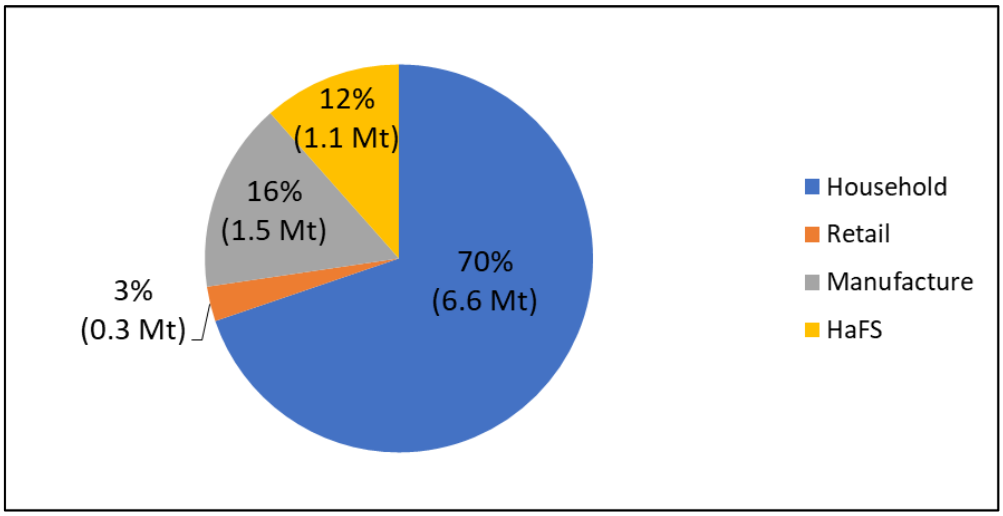
However, there is a lack of reliable data for the hospitality & food service sector (see Section 2.4); if this sector is excluded, food waste from retail and manufacturing together fell by 7.6% between 2015 and 2018 (and 18.6% compared to the SDG12.3 baseline).

Consistent with previous data, household food waste makes up the largest fraction of UK food waste (post-farm gate), at 70% by weight (see Figure 1).

[28] In Historical changes and how amounts might be influenced in the future WRAP 2014, WRAP made the case for a baseline year of 2007 against which to assess changes in UK food waste over time. This was on the basis that a) there is robust data on the largest fraction of UK food waste from that year (i.e. household food waste; ca 70% of the total post-farm gate) and b) this is when the UK began large-scale interventions to reduce food waste (which were aimed exclusively at household food waste until 2010 – with a focus on supply chain food waste commencing under Courtauld 2 in 2010, and in 2012 on food waste from the hospitality and food service sector. The baseline year for Courtauld 2025 is 2015.

[29] It is important to stress that this is a modelled result, based on changes in the number and types of hospitality and food service sites, and the assumption that food waste per site has remained constant since 2011. Currently there is not a data source to enable a UK-level estimate for food waste from this sector to be robustly estimated

Figure 1: Amounts of total food waste arising in the UK by sector (total post-farm gate = ca. 9.5 Mt)[30]



The Courtauld 2025 target is to achieve a 20% reduction in total (i.e. food and inedible parts) UK food waste (post-farm gate) by 2025 compared to 2015, on a per capita basis. Table 2 presents a summary of UK food waste arisings on a per capita basis for the SDG12.3 and Courtauld 2025 baseline years and 2018, and changes over time.

Table 2: Summary of UK food waste arisings (per capita) for the SDG12.3 and Courtauld 2025 baseline years and 2018, and changes over time

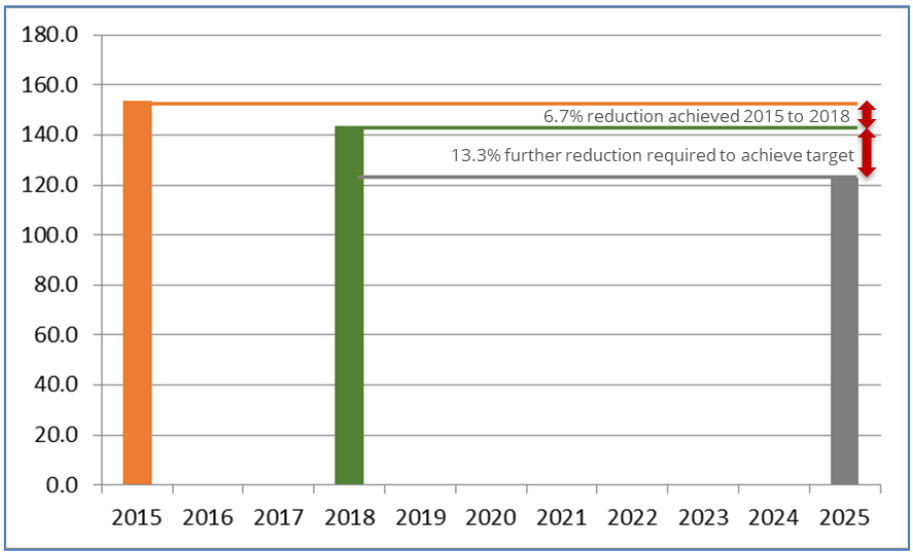
	SDG12.3 baseline (kg/yr)	2015 (kg/yr)	2018 (kg/yr)	Change vs 2015 (kg)	Change vs 2015 (%)	Change vs SDG baseline (kg)	Change vs SDG baseline (%)
Household	132.0	108.3	100.0	-8.3	-7.6%	-32.0	-24.2%
Supply chain	49.2	45.3	43.3	-2.0	-4.4%	-5.9	-11.9%
Retail	*4.7*	*4.0*	*4.2*	*0.2*	*3.9%*	*-0.5*	*-10.6%*
Manufacture	*30.0*	*25.6*	*22.7*	*-3.0*	*-11.6%*	*-7.4*	*-24.6%*
HaFS[31]	*14.5*	*15.7*	*16.5*	*1.0*	*5.3%*	*2.0*	*13.7%*
Total	181.2	153.6	143.4	-10.2	-6.7%	-37.8	-20.9%

As expected, overall reductions are greater on a per capita basis, as UK population increased by 2% between 2015 and 2018, and 5% between 2007 and 2018. The reduction in food waste overall between 2015 and 2018 was 6.7%, against the Courtauld 2025 target of 20% by 2025. This equates to an average of around 2% a year, which is the rate required to achieve the Courtauld target (see Figure 2).

[30] This excludes data for wholesale (an estimate for 2015 can be found here, and food waste in litter (an estimate for 2012) is here) which collectively amount to around 150kt, or less than 2% of the total reported here. Data for household includes waste to sewer, which is not currently available for other sectors.

[31] It is important to stress that this is a modelled result, based on changes in the number and types of hospitality and food service sites, and the assumption that food waste per site has remained constant since 2011. Currently there is not a data source to enable a UK-level estimate for food waste from this sector to be robustly estimated

Figure 2: Progress towards the Courtauld 2025 food waste target (UK food waste arisings (kg per capita per year)



Food waste is made up of food and inedible parts, and whilst there are opportunities to reduce the amounts of inedible parts disposed of, the greatest potential to reduce food waste is through tackling the food element. Table 3 provides a summary of UK food waste arisings excluding the inedible parts for the SDG12.3 and Courtauld 2025 baseline years and 2018, and changes over time.

Table 3: Summary of UK food waste arisings, excluding inedible parts (kt) for the SDG12.3 and Courtauld 2025 baseline years and 2018, and changes over time

	SDG12.3 baseline (kt)	2015 (kt)	2018 (kt)	Change vs 2015 (kt)	Change vs 2015 (%)	Change vs SDG baseline (kt)	Change vs SDG baseline (%)
Household	6,125	4,995	4,549	-447	-8.9%	-1,576	-25.7%
Supply chain	2,040	1,914	1,859	-55	-2.9%	-181	-8.9%
Retail	*290*	*261*	*277*	*16*	*6.0%*	*-13*	*-4.6%*
Manufacture	*1,070*	*898*	*770*	*-128*	*-14.2%*	*-300*	*-28.0%*
HaFS[32]	*680*	*755*	*812*	*56*	*7.5%*	*132*	*19.3%*
Total	8,165	6,910	6,408	-502	-7.3%	-1,757	-21.5%

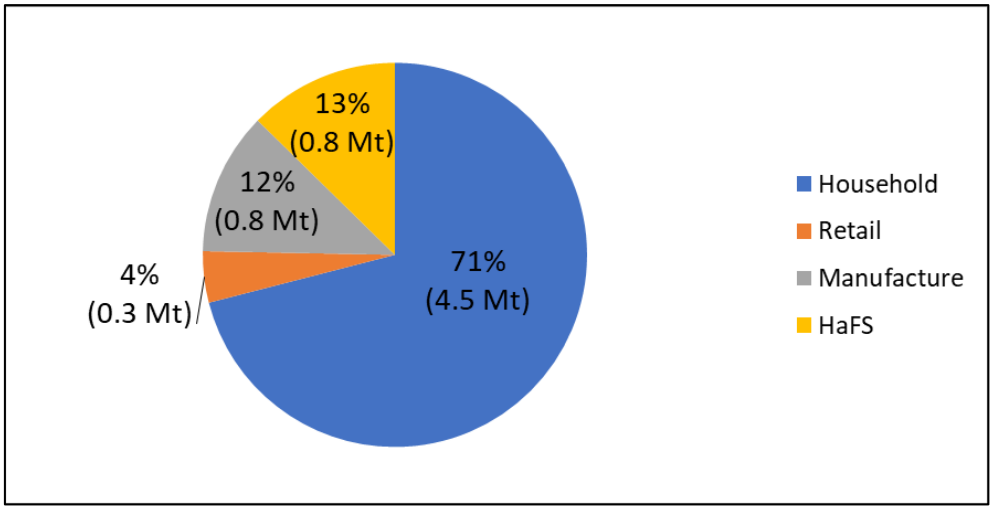
Food waste in the UK (excluding inedible parts and post-farm gate) amounted to around 6.4 Mt in 2018, around 500 kt lower than in 2015 and over 1.7 Mt lower than in the SDG12.3 baseline year. This represents a 7.3% reduction versus 2015, and over 21% compared to the SDG12.3 baseline. As for total food waste, the largest contribution to the reduction is from household food waste, both in absolute amounts but also percentage reduction, with

[32] *It is important to stress that this is a modelled result, based on changes in the number and types of hospitality and food service sites, and the assumption that food waste per site has remained constant since 2011. Currently there is not a data source to enable a UK-level estimate for food waste from this sector to be robustly estimated*

household food waste falling at a rate more than twice as fast than that of the supply chain overall (2.3x). Discussion on changes for different parts of the supply chain can be found in relevant sections below.

Similar to total food waste, household food waste makes up the largest fraction of UK food waste excluding inedible parts (post-farm gate), at just over 70% by weight (see Figure 3).

Figure 3: Amounts of food waste excluding inedible parts arising in the UK by sector (total post-farm-gate = ca. 6.4 Mt)



SDG12.3 seeks to achieve a 50% reduction in food waste by 2030, on a per capita basis. As explained above (Section 1.0), whilst the stated scope for this quantitative reduction is 'retail and consumer'. WRAP supports the ambition of the Champion 12.3 best practice of applying this across the supply chain and therefore estimates for manufacture are also included. As the UK has suitably granular data, the 50% reduction is focused on food only (i.e. excluding inedible parts). Table 4 presents a summary of UK food waste arisings (excluding inedible parts), on a per capita basis for the SDG12.3 and Courtauld 2025 baseline years and 2018, and changes over time.

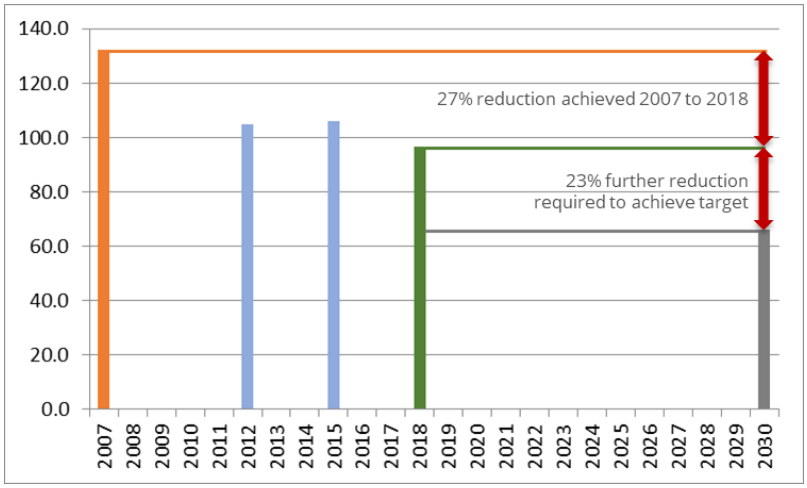
Table 4: Summary of UK food waste arisings (excluding inedible parts; per capita) for the SDG12.3 and Courtauld 2025 baseline years and 2018, and changes over time

	SDG12.3 baseline (kg/yr)	2015 (kg/yr)	2018 (kg/yr)	Change vs 2015 (kg)	Change vs 2015 (%)	Change vs SDG baseline (kg)	Change vs SDG baseline (%)
Household	100.0	76.7	68.5	-8.3	-10.8%	-31.5	-31.5%
Supply chain	32.3	29.4	28.0	-1.4	-4.9%	-4.3	-13.4%
Retail	*4.7*	*4.0*	*4.2*	*0.2*	*3.9%*	*-0.5*	*-10.6%*
Manufacture	*16.9*	*13.8*	*11.6*	*-2.2*	*-15.9%*	*-5.3*	*-31.4%*
HaFS[33]	*10.7*	*11.6*	*12.2*	*0.6*	*5.3%*	*1.5*	*13.7 %*
Total	132.3	106.1	96.4	-9.7	-9.1%	-35.9	-27.1%

[33] It is important to stress that this is a modelled result, based on changes in the number and types of hospitality and food service sites, and the assumption that food waste per site has remained constant since 2011. Currently there is not a data source to enable a UK-level estimate for food waste from this sector to be robustly estimated

Again, as expected, reductions are greater on a per capita basis, due to the increases in UK population referred to above. The per capita reduction between 2015 and 2018 was over 9%, and 27% against the SDG12.3 baseline. This represents over halfway to the target of a 50% reduction by 2030 and equates to an average reduction of around 2% a year for the whole period (and 3% for 2015 to 2018), which is the rate required to achieve SDG12.3 (see Figure 4).

Figure 4: Progress towards SDG12.3 (UK food waste arisings excluding inedible parts; kg per capita per year)



If the narrower (FAO) scope of SDG12.3 is used (retail, hospitality and food service and household), the reductions are slightly smaller (8.1% versus 2015 and 26.5% versus the SDG12.3 baseline).

4.2 Value of UK food waste and reductions to 2018

The value of UK wasted food (i.e. excluding inedible parts) is estimated at around £19 billion, and the breakdown of this is shown in Table 5.

Table 5: Value of UK wasted food (post-farm gate) (£bn; all expressed in 2018 prices)

	SDG12.3 baseline (£bn)	2015 (£bn)	2018 (£bn)	Change vs 2015 (£bn)	Change vs SDG baseline (£bn)
Household	18.58	15.16	13.80	-1.35	-4.78
Supply chain	5.15	5.10	5.19	0.08	0.03
Retail	*0.92*	*0.82*	*0.87*	*0.05*	*-0.04*
Manufacture	*1.58*	*1.32*	*1.14*	*-0.19*	*-0.44*
HaFS	*2.66*	*2.96*	*3.18*	*0.22*	*0.51*
Total	23.74	20.26	18.99	-1.27	-4.75

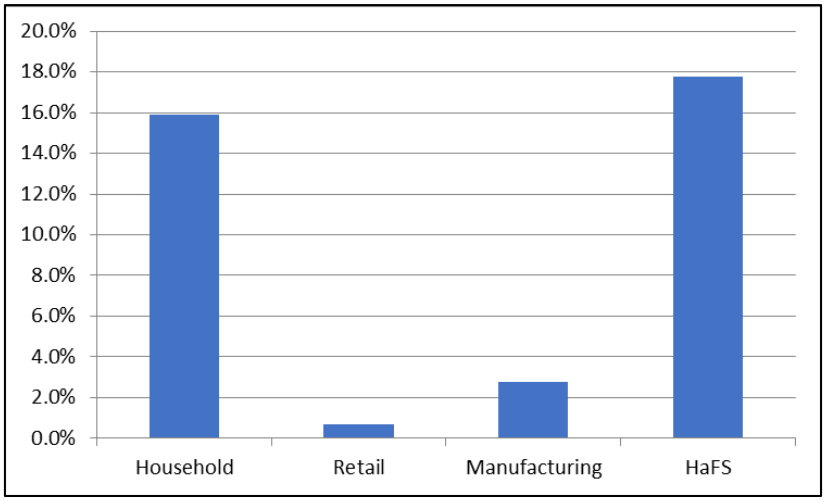
There is almost £1.3 billion less food being wasted a year compared to 2015, and £4.7 billion a year compared to the SDG12.3 baseline.

Food thrown away from households makes up almost three quarters (73%) of the £19 billion total, with hospitality and food service contributing 17%. Retail and manufacture represent 5% and 6% respectively.

4.3 Food waste as a percentage of purchases / sales

The amount of food waste generated by households and the hospitality and food service sector, *as a percentage of the amounts of food purchased*, are similar at between 16% and 18% respectively (Figure 5). For manufacturing the percentage food waste of food produced/sold is just less than 3%, whilst for retail the figure is under 1%. More detail can be found in the sections below.

Figure 5: Food waste expressed as a percentage of food purchases (household/HaFS) or sales (manufacture, retail), on a weight basis



4.4 Household food waste

Household food waste makes up 70% of the total UK food waste post-farm gate, at 6.6 Mt. Over two-thirds of this (68%; 4.5 Mt) was food intended to be eaten, with a value of almost £14 billion in 2018. The remainder (2.1 Mt) consisted of inedible parts, such as bones and egg shells. These numbers are large, and those engaging with householders find messages that focus more on individuals, households or families more effective in communications and key ones are listed below[34]:

1. Food wasted excluding inedible parts per person per month 5.7 Kg
2. Food wasted excluding inedible parts per household per month 13.7 Kg
3. Food wasted excluding inedible parts per family per month 20.1 Kg
4. Value of food wasted per average person (per year) £210
5. Value of food wasted per average person (per month) £17
6. Value of food wasted per average household (per year) £500
7. Value of food wasted per average household (per month) £40
8. Value of food wasted per average family (per year) £730
9. Value of food wasted per average family (per month) £60

Table 6 provides data on the destinations for household food waste. The amount of household food waste collected by local authorities reduced by 1.1 Mt between 2007 and 2018, and the amount in separate organic collections (food only or food plus garden waste) increased by over 10-fold. In 2007 separately collected food waste made up around 1% of

[34] *These are average values based on ONS mid-2018 estimates for UK population (66,435,600) and number of households (27,576,000). Previous WRAP research (Household food waste: restated data for 2007-2015; WRAP 2018) identified that food waste from the average family was 3.53 times that of the average person, and this has been used in this analysis. Some financial values have been rounded.*

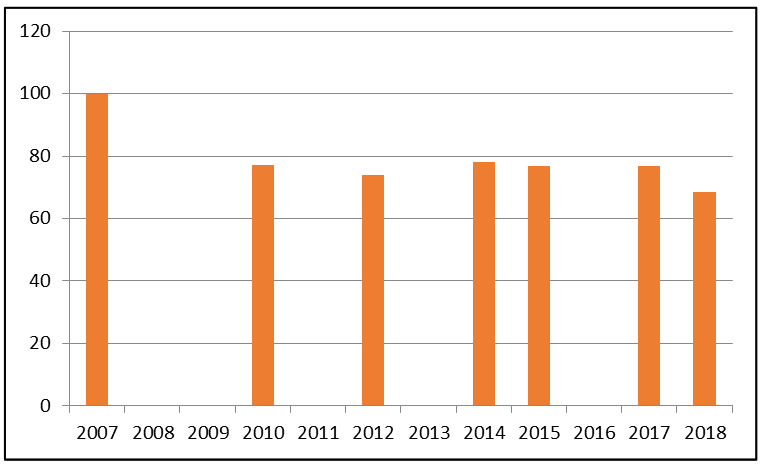
the total food waste collected, but this had risen to almost 17% by 2018. Collected household food waste makes up 69% of the total, with 31% being disposed of via the sewer (mainly the kitchen sink) or used in home composting[35].

Table 6: Destinations for household food waste

	SDG12.3 baseline (2007; kt)	2015 arising (kt)	2018 arising (kt)	% by destination (2018)
Household food waste, of which:	8,085	7,050	6,646	
LA collected residual waste	5,488	4,117	3,642	55%
LA collected organics	65	639	777	12%
LA collected other	146	140	166	2%
Disposed to sewer	1,904	1,636	1,532	23%
Home composted	482	518	528	8%

More data exists for household food waste than any other UK sector, and comparable data between 2007 and 2018 are shown in Figure 6. As reported in an accompanying report[36], per capita estimates of household food waste are statistically significantly lower in 2018 than those for 2007, 2012 or 2017, but it will be important to have data for 2019 onwards to determine the extent to which this is a true downward trend.

Figure 6: Changes in household food waste over time (UK food waste excluding inedible parts; kg per capita per year)



[35] *To note, as described in Section 2.1.1 the 2015 and 2018 estimates for household food waste do not contain new (i.e. 2015 or 2018) data on food waste to sewer or food used for home composting – these are modelled based on 2012 data*

[36] *Synthesis of household food waste compositional data 2018; WRAP 2020*

WRAP has previously reported on how changes in household food waste compare to changes in food purchases[37]. The total amount of food and drink purchases in the UK increased between 2007 and 2018, from 38.6 Mt to 39 Mt. However, when expressed on a per person basis, purchases reduced by 790 grammes per week, and excluding drink by 415 grammes per week. In comparison to food (and drink) waste reducing by 450 grammes per week (data is not available on the composition of the food waste prevented, but 80% of what is wasted is food rather than drink, and most of the focus of interventions is on food). There are of course many influences on the amounts and weight of food (and drink) that people buy (including measures to eat more healthily and economic factors) but the reduction in purchases is consistent with people having to buy less food as they reduce the amount that is thrown away.

The amount of household food and drink wasted is equivalent to around 16% of purchases on a weight basis, and for food only (excluding drink) this rises to 21% (i.e. around a fifth)[38].

The GHG emissions associated with food wasted from households equates to 21 Mt of CO_2e, or 14 Mt of CO_2e excluding inedible parts. Emissions associated with this wasted food (excluding inedible parts) are equivalent to around 20% of those from private vehicle journeys in the UK[39]. This can be expressed as equivalent to the emissions of around 1 in 5 cars on UK roads.

4.4.1 Factors influencing the reduction in household food waste

There are many factors that can influence household food waste, including a range of behavioural and technical interventions and shifts in demographic profiles and economic conditions[40]. Due to the complexity of the potential influences, and interrelationships between many of these, it is not possible to robustly determine cause and effect. However, there is evidence that helps to understand some of the possible drivers of the changes seen in UK household food waste. WRAP has previously published analysis of the significant reductions between 2007 and 2012[41], and commented on the lack of significant change between 2012 and 2015[42]. This section will therefore focus on the reduction from 2015 to 2018.

Interventions focused on raising awareness, increasing motivation and enabling behaviour change

In response to the stalling of progress in reducing household food waste, WRAP developed a new strategy for citizen food waste prevention and the Love Food Hate Waste (LFHW) campaign. This was launched in 2017 and involved a more targeted approach (in terms of audience, influencers, channels, etc.) to reaching those that waste the most food, the most wasted food items and key behaviours. Examples of campaign 'moments' include 'Save Our Spuds', 'Give a Cluck', 'Make Toast Not Waste' and 'Chill the Fridge Out'. Such campaign

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[37] Household Food & Drink Waste – A Product Focus, WRAP 2014 (Section 2.1.2)

[38] Based on data for food and drink purchases derived from Defra's Family Food Survey for 2017/18, using the methodology described in Household food waste: restated data for 2007-2015; WRAP 2018. Food and drink purchases were calculated at 39.0 Mt or 11.3 kg pp pw, and food only at 22.7 Mt or 6.6 kg pp pw.

[39] In 2016, there were 31.2 million cars licensed in the UK. Annual Greenhouse Gas emissions from private cars and taxis in 2016 were 70.3 Mt CO_2e, resulting in an estimate of 2.2 Mt CO_2e per car (Transport energy and environment statistics, 2018)

[40] For example see Spaghetti soup: The complex world of food waste behaviours, Quested et. al. 2013 and Historical changes and how amounts might be influenced in the future, WRAP 2014

[41] Reduction in household food & drink waste – Estimating the influence of WRAP and its partners, WRAP 2011; Econometric modelling and household food waste, WRAP 2014. Both can be found here.

[42] Household food waste in the UK, 2015, WRAP 2016

activities have reached millions of people through digital channels, and tens of millions through mainstream media. A large spectrum of partners are supporting this work, reaching customers, members, employees etc.

WRAP research carried out in May 2019[43] showed that three quarters (75%) of UK households had seen or heard information about food waste in the preceding year – either more generally about the amount of food that is thrown away/wasted (69%) or more specifically about how to plan, buy, store or prepare food to help reduce the amount that gets thrown away (49%). Recall of both types of information is significantly higher in 2019 than in previous years. For example, recall of information about the amount of food thrown away/wasted has increased from 36% in 2015 to 69% in 2019 (the highest level recorded by WRAP's regular survey).

There has also been a significant increase in LFHW brand recognition - over one in five (22%) recalled seeing the logo in the past year, significantly higher than previous years when recall was consistently in the range of 13%-16%. Furthermore, those who recall LFHW are more likely than average to say that they have talked to others about food waste.

Increasing awareness and campaign recognition does not automatically result in changes in behaviour, but it is encouraging that WRAP research showed that citizens who had seen the 'Chill the Fridge Out' campaign over-indexed on changing their fridge temperature recently (33% vs 17%). This is early evidence that suggests that these targeted campaigns have a measurable impact on behaviour.

Running until January 2020, WRAP, working with Groundwork and Resource London, established a project in London known as TRiFOCAL (Transforming City FOod hAbits for LIFE). Funded by the LIFE Programme of the European Union, the project trials new combined food waste prevention, recycling and sustainable healthy eating communications. Although the project ran across the whole of London, concentrated interventions happened in selected boroughs. As part of the TRiFOCAL trial, pre-intervention (March/April 2017) and post-intervention (February/April 2019) household waste composition analyses, covering the residual and organic waste streams were performed in 6 boroughs. The average total amount of food waste disposed of at the kerbside via both residual and recycling containers fell by an average of 0.37 kg per household per week or 19.4 kg per household per year. A decrease of 14%[44].

In its most recent Biannual public attitudes tracker[45], FSA reported that food waste (in the context of broader food issues) was for the first time the greatest concern for consumers (at 51%), higher than the sugar content of food (49%), animal welfare (43%) and food prices (43%).

Whilst it is not possible to determine the overall impact of the above, based on the analysis of the contribution to the change between 2007 and 2012 (ca. 40% of the overall reduction, at a time when economic factors were also acting as a driver to reduce food waste), and the potential impacts of other factors discussed below, it seems plausible that campaign activity (in its broadest sense and delivered by WRAP and the wide range of other organisations involved) has made a significant contribution to the overall reduction.

[43] *Food Trends Survey 2019: Citizen behaviours, attitudes and awareness around food waste, WRAP 2020*
[44] *TRiFOCAL: Transforming City Food Habits for Life – Summary Report, WRAP 2020 (to be published January 2020)*
[45] *Public Attitudes Tracker, May 2019, FSA*

Working with the food industry on food labelling and packaging

The way food and drink products are packaged, labelled and priced can make a significant difference to waste levels at home – for example by:

1. Helping consumers to buy the right amount (e.g. by providing smaller packs for individual consumers);
2. Providing clarity on when a product is still fit to eat (by using the right date label) and giving consumers as long as possible to use it (i.e. extending product life);
3. Providing clear instructions of what consumers can do to make their purchases last longer, particularly through advising on the best way to store food (e.g. in fridge / not in fridge, at what temperature, in packaging, etc.);
4. Making it clear when products can be frozen – and making it easier to defrost, or cook them from frozen;
5. Giving advice on serving sizes / cooking the right amount; and
6. Providing tips and advice on what to do with leftovers.

There is also an important role for more education and awareness-raising. For example, helping consumers to understand the difference between types of date label, when food is safe to freeze, how to safely defrost, etc., links into the campaign work described above.

WRAP has previously estimated that around 150,000 tonnes of household food waste was avoided in 2015 compared to 2007, as a result of technical changes to products, saving UK families around £400 million a year and that 'around 350,000 tonnes of avoidable household food waste, worth an estimated £1 billion annually, could be prevented through further changes to key food items in the UK's shopping aisles'[46].

Since developing this estimate, WRAP has worked with Sheffield University to develop a Household Simulation Model, which gives better insight on the potential food waste savings from different types of actions for different types of products (e.g. the effect of milk having longer shelf life, or encouraging more people to freeze bread, etc.)[47].

Using these insights, together with new data gathered via WRAP's 2019 Retail Survey[48] and WRAP's food trends survey[49] strong progress has been identified across several of the key areas above, which will have contributed to the overall reduction in household food waste. In particular:

- A shift towards removing date codes on fresh produce when they are not needed (around one quarter of pre-packed fresh produce items sampled in early 2019 were found to carry no date label). On potatoes alone, WRAP estimates that >50,000 tonnes/year waste savings could result from a removing date labels, with consumer instead deferring to typical storage life (which is typically much longer)[50]
- For products that do carry date labels, there have been some positive increases in the average available shelf life for customers. For example, a 1.5 day increase on

[46] *Helping Consumers Reduce Food Waste: Retail Survey 2015; WRAP 2017*
[47] *Household Simulation Model: Methodological Summary, WRAP 2019*
[48] *Retail Survey 2019: HELPING CONSUMERS REDUCE FOOD WASTE THROUGH BETTER LABELLING AND PRODUCT CHANGES, WRAP 2019*
[49] *Food Trends Survey 2019: Citizen behaviours, attitudes and awareness around food waste, WRAP 2020*
[50] *In 2015 6% of potatoes packs were found not have carry a date label, which had risen to 14% in 2018; Helping Consumers Reduce Food Waste – Retail Survey 2015; WRAP 2017 and Retail Survey 2019: HELPING CONSUMERS REDUCE FOOD WASTE THROUGH BETTER LABELLING AND PRODUCT CHANGES, WRAP 2019*

milk since 2011 – estimated to translate into >20,000 tonnes less waste at home through consumers having longer to use it

- Products now routinely carry clear storage guidance and there has also been increased adoption - and householder recognition of - WRAP's 'Little Blue Fridge' icon to indicate ideal storage temperature (below 5°C). For example, this was found on more than one third of all pre-pack carrots in stores. This is particularly important because many fresh produce items can last for up to 2 weeks longer in the fridge. Together with WRAP's 'Chill the Fridge Out' consumer campaign, this clearer guidance on pack has been making headway to address the challenge that fridges in UK homes are too warm, leading to premature spoilage and more waste. Extending shelf life through better storage is estimated to have the potential for >100,000 tonnes/year food waste reduction at home
- There has been a large increase in the number of products that are clearly marked suitable for freezing, using the snowflake icon – and consumer recognition of this snowflake logo is high (65%). Since 2015, the proportion of relevant products clearly marked with the snowflake logo has increased from 15% to 48% - with an even bigger increase for bread (an increase from 38% to 79%). Together with WRAP's 'Make Toast Not Waste' consumer campaign, this clearer guidance on pack is a hugely positive move, and WRAP estimates that >200,000 tonnes/year less food would be wasted if freezing is maximised
- Following WRAP's survey findings that consumers respond well to, and are motivated to act by, statements about the provenance / journey of food – there has been some new adoption of this type of 'motivational message' on pack

Whilst it is not possible to determine the overall impact of the above, based on the analysis of the contribution to the change between 2007 and 2012 (ca. 10% of the overall reduction), and outputs from the simulation model (e.g. impacts of increasing milk shelf-life) it seems reasonable to say that the changes to packs and labelling might have resulted in around 10% - 15% of the change from 2015 to 2018 (i.e. 40,000 to 60,000 tonnes).

Increased number of households with separate organic/food waste collections

The results from the analysis WRAP carried out as part of updating the estimate for household food waste in 2015 showed no significant effect of food waste collections on food waste arisings, however, the results were only marginally non-significant ($p = 0.058$) with an average reduction of 6.5 (±6.7) kg per household per year with the introduction of a targeted food waste collection[51]. This indicates that the presence of collections targeting food waste might be associated with slightly lower levels of food waste generated (the total of that in kerbside residual and in collections targeting food waste). This could be due to greater awareness of the amounts of food waste disposed by households that use collections targeting food waste, leading to a change in actions (e.g. shopping, food preparation)[52].

A more recent (but not comparable) study, making use of data from 2017 and earlier, found that separate food waste collections were significantly associated with lower total food waste arisings[53]. Specifically, local authorities with a separate food waste collection produced an average of 16.1 kg per household per year less food waste than those without. The margin of error around this estimate was large, suggesting that the true difference could be between 2.3 kg per household per year and 29.8 kg per household per year food waste (with 95% confidence).

[51] *Synthesis of Food Waste Compositional Data 2014 & 2015, WRAP 2016*
[52] *Effect of food waste collections on arisings: recent evidence, WRAP 2013*
[53] *Impact of household food waste collections on household food waste arisings, WRAP 2020*

Between 2015 and 2018 the numbers of households with access to a separate food waste collection increased by almost 1.8 million. Some of these previously had separate organics collections (i.e. mixed food and garden waste), and the overall increase in households with access to any form of separate collection for food was 1.1 million. The mean potential reductions from the above two studies (which equate to between a 3.7% and 8.7% reduction in food waste arising), were applied to an estimate of the food waste from households that had been offered any form of separate collection since 2015, or to those offered separate food waste collections (which could accept a wider range of food types). This results in an estimate of between ca. 7,000 tonnes and 28,000 tonnes that may have been avoided due to an effect of separate collections, which would equate to ca. 2% to 7% of the overall reduction seen between 2015 and 2018. Due to the uncertainties associated with the scale of any potential effect, these results should however be treated with caution.

Economic factors

WRAP published an investigation of the influence of economic factors on household food waste in 2014[54]. In terms of macro factors:

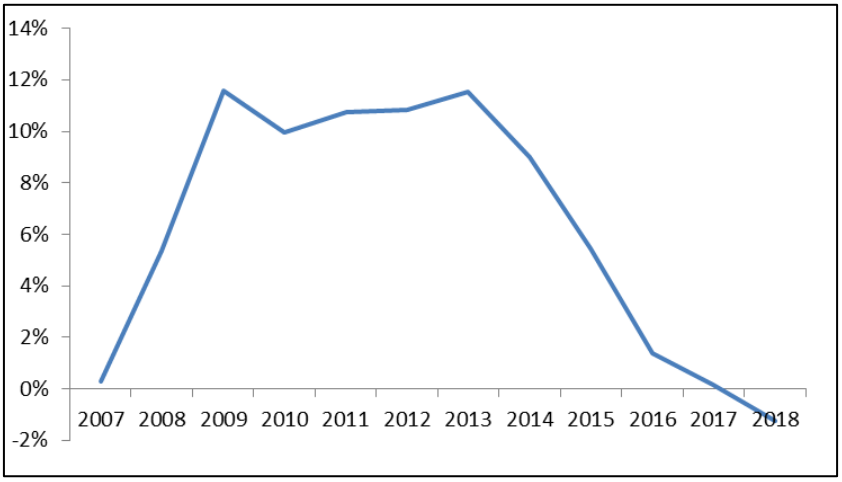
- Changes in income: as income increases, relative to trend, the quantity of food that is purchased will tend to rise. Other things being equal, this raises food waste
- Changes in price: a higher price for a given food type will tend to decrease the proportion of that food type that is wasted. An increase in the price of food, relative to the price of other goods and services, will tend to reduce the quantity of food purchased. Other things being equal, this too will contribute to lower food waste

Between 2007 and 2013 annual retail food prices typically increased relative to the Retail Price Index (RPI); the sharpest rate of increase occurring during 2008 and 2009, and then milder relative price increases between 2010 and 2013. Later in the time period (between 2014 and 2018) the relative prices of food versus RPI narrowed due to outright declines in retail food prices during 2015 and 2016 and then lower than the cost of living rate of increases in 2017-18 (Figure 7).

All things being equal, this should have led to a decrease in food waste early in the period (2007-15), and an increase (or a slowing in the rate of decrease) in food waste later in the period (2015-18).

[54] *Econometric modelling and household food waste, WRAP 2014*

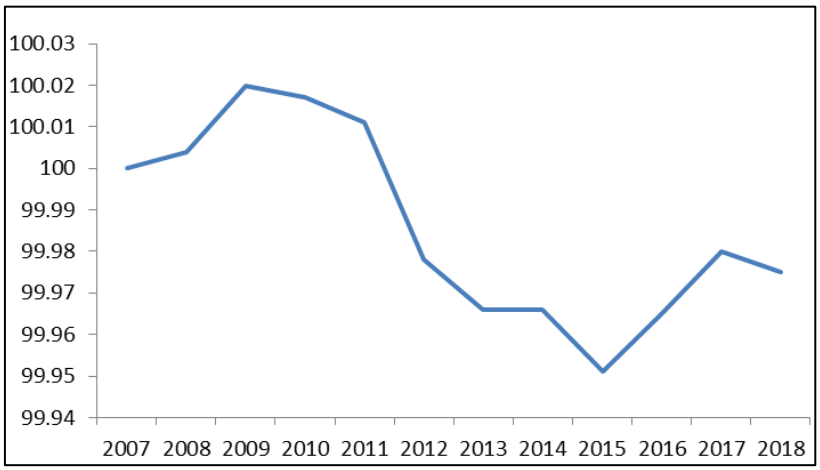
Figure 7: Retail food prices relative to RPI



Source: ONS

Real incomes rose very early in the period however from 2009 to 2015 real incomes gradually fell as wages stagnated following the financial crisis while inflation increased. It was only in 2016 that real income levels started to rebound. In 2018 average real income levels have not recovered to their pre-financial crisis level (Figure 8).

Figure 8: Real income level



Source: ONS

A decline in real income levels should point to less food waste early in the period during which household disposable spending was being squeezed. The rebound in real incomes later in the period (2015-18) would normally be associated with an increase (or a slowdown in the decline) in food waste.

Overall, the prevailing economic conditions during 2015 to 2018 would have more likely to drive an increase in household food waste rather than contribute to the observed reduction.

Demographic factors

Key factors are obviously the overall population, the number living alone (where food waste can be ca. 40% higher per capita) and those over 60 (who traditionally waste less food than average). The UK population increased by over 1.3 million between 2015 and 2018 (2%). The proportion of those over 60 increased marginally from 22.4% to 23.8% of the population, whilst those living in single person households increased slightly from 28.6% of

all households to 29.0%. On balance it seems unlikely that changes in UK demographics would have contributed to a reduction in household food waste, but rather the opposite.

4.5 Retail food waste

Retail food waste makes up only 3% of the total UK food waste post-farm gate, at 277kt. The majority of this was food intended to be eaten[55], worth over £870 million in 2018.

Overall retail food waste shows a modest reduction compared to the SDG12.3 baseline (-4.6%) but a small increase between 2015 and 2018 (6%) (Tables 1 and 7). It may be that retail food waste has plateaued, but more data is required in order to draw any conclusions about medium term trends. Between 2015 and 2018 there has been a shift in retailer food waste reporting being based on weighbridge to product (SKU) level data – which has improved the quality of the information provided and will aid scrutiny of future trends.

Table 7: Changes in retail food waste over time (2009 data contributes to the SDG12.3 baseline)

	2009	2012	2015	2017	2018
Total food waste (kt)	290	240	261	278	277

Whilst it is disappointing that retail food waste levels have increased since 2015 (and in fact 2012), it should be borne in mind that:

- Retail food waste represents less than 1% of the amount of food and drink sold, and UK retailers that have published relevant data report food waste as a percentage of sales of between 0.02% and 1.25%. Hence changes in operations that affect waste in a given year (such as increased use of small format stores, stock withdrawal/ disposal due to a health or safety concern or an uncommon weather occurrence impacting on forecasting) can show up as a significant % increase.
- Five retailers have now published time-series data on food waste from their operations, and four have reported an absolute reduction compared to their baselines (which range from 2013 to 2017/18[56]). These range from 8.1% to 29% on an absolute tonnage basis, and collectively this amounts to almost 17,000 tonnes of food saved, worth over £50 million. It should be pointed out that this does not mean that other retailers have not made reductions, nor that these four have all reported (to WRAP) reductions from *2015 to 2018* – individual retailer food waste is subject to fluctuations over time, in part due to the actions described below.
- Retailers are engaged in initiatives to help both suppliers and customers reduce food waste, and these can, at least in the short-term, result in an increase in food waste at retail (at depots or in store). For example, relaxing fresh produce specifications and/or accepting 'gluts' of fresh produce can lead to less food being wasted by producers but more in store (if customers reject some of this produce, or there is insufficient demand[57]). Similarly moves to increase the provision of loose fresh

[55] Small amounts of inedible parts are likely to come from food preparation at deli counters where these are present, but this has not been quantified

[56] Data can be found here for Tesco, Morrisons (p37), Lidl (p28), Co-op (p17) and M&S

[57] For example see Tesco means to push on despite missing food waste elimination target, The Grocer 2018 and Evaluation of a plastic-free/loose fresh produce trial (Morrisons case study); WRAP 2019

produce can be associated with operational challenges that lead to more waste in store[58].

- Between 2015 and 2018 the amount of food surplus redistributed from retail to charities increased by over 14,000 tonnes, and the total redistributed from retail via charitable and commercial routes in 2018 amounted to almost 25,000 tonnes. This is food that would have otherwise ended up as waste. The retail sector has been active in helping to extend the UK food redistribution infrastructure, for example through investments in food redistribution organisations and offering suppliers transport support. This will have played a key role in the increase of food redistribution over the reporting period.

4.6 Manufacturing food waste

Manufacturing food waste makes up 16% of the total UK food waste post-farm gate, at 1.5 Mt, and just over 50% was estimated to be wasted food (the remaining tonnage being inedible parts), with a value of over £1.1 billion in 2018.

Food waste from manufacture shows a reduction of over 30% compared to the SDG12.3 baseline (per capita, excluding inedible parts), with over half of this reduction being achieved between 2015 and 2018 (Table 4).

Between 2015 and 2018 the amount of food surplus redistributed from manufacture to charities increased by almost 4,000 tonnes, and the total redistributed from manufacture via charitable and commercial routes in 2018 amounted to almost 26,000 tonnes. This is food that would have otherwise ended up as waste.

Between 2015 and 2018 the amount of food (and drink) manufactured in the UK increased slightly from 54.2 Mt to 55.5 Mt[59], a 2.5% increase. As a percentage of production, food waste showed a reduction from 3.1% to 2.7%. This is equivalent to a reduction of 12% in waste per tonne of food produced, similar to the 11.6% per capita reduction (Table 2).

21 UK food manufacturers have publicly reported 2018 and historical data, and collectively reported a 6% reduction in food waste, saving over £47 million of food (40,000 tonnes). Of these, 17 reported a reduction in their operational food waste (varying from 2.2% to 48%), and 4 reported increases (from 1.8% to almost 57%). This average 6% reduction over ca 12 months compares with a 9.8% reduction over three years for the sector, consistent with those businesses that are engaged with the Roadmap and implementing Target, Measure, Act making faster and greater progress in reducing food waste.

4.7 Hospitality and food service food waste

Food waste from the hospitality and food service sector makes up 12% of the total UK food waste post-farm gate, at 1.1 Mt, and almost three quarters was estimated to be wasted food (the remaining tonnage being inedible parts), with a value of over £3.2 billion in 2018.

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[58] For example, see ICELAND RELAUNCHES PLASTIC-FREE PACKAGING AFTER INITIAL TRIALS FAIL WITH SHOPPERS, The Independent 2019and For example see Evaluation of a plastic-free/loose fresh produce trial (Morrisons case study); WRAP 2019

[59] Production tonnages derived from PRODOM data as described in Quantification of food surplus, waste and related materials in the supply chain; WRAP 2016. Note that the 2015 estimate for production has been revised from that published in the 2016 report (57 Mt), as a result of new data becoming available

Whilst the data in Table 1 to 4 suggest food waste from this sector has been increasing over time from 2011, it is important to remember (see Section 2.4) that this is a modelled result, based on changes in the number and types of hospitality and food service sites, and the assumption that food waste per site has remained constant since 2011. Currently there is not a data source to enable a UK-level food waste from this sector to be robustly estimated. Unlike retail, where signatories to Courtauld 2025 make up around 95% of their sector, hospitality and food service signatories make up a small percentage of the sector, and therefore data from these businesses cannot be used to develop an overall estimate. Unlike for household (WasteDataFlow) and manufacturing (IPPC) sectors, there is no national dataset to inform any hospitality and food service estimate.

In 2013, WRAP estimated that food waste as a percentage of purchased food (by weight) was around 18% for the hospitality and food service sector, although this varied by sub-sector[60]. This is a similar proportion to households, and much higher than for retail and manufacture. More recent data are not available.

Hospitality and food service businesses also face challenges in measuring food waste, being a complex and fragmented sector (around 50% of businesses are SMEs, and many others operate multi-site or franchised business models). Sites are also likely to have significant amounts of food waste being disposed via effluent streams and in mixed waste from customers' plates. Hospitality and food service organisations have responded by developing, with WRAP, a detailed collaborative Action Plan, published in March 2019, which defines the actions the sector will take to embed a strategy of Target, Measure, Act.

There are an increasing number of case studies[61] detailing how hospitality and food service businesses have delivered significant reductions in operational food waste, of up to 50% in relatively short timeframes, showing what can be achieved when businesses are engaged, and have the motivation and tools to act.

[60] *The True Cost of Waste in Hospitality and Food Service, WRAP 2013*

[61] *For example see the Guardians of Grub and the UK Food Waste Reduction Roadmap websites*

5.0 Results – GHG emissions

The Courtauld GHG target is for a 20% reduction in the GHG intensity of food and drink consumed in the UK, from 2015 to 2025 calculated as a relative reduction per head of population.

WRAP estimates that there has been a 7% reduction (per capita) in GHG emissions associated with food and drink consumed in the UK between 2015 and 2018 (Table 8). Whilst the absolute values reported in Table 8 are subject to a large degree of uncertainty (for example in underlying emission factors), the trend in change over time is demonstrated in national-level datasets that are the best, and most complete, time series data available.

The majority of this reduction is due to decarbonisation of the UK's electricity grid: the average emissions associated with consuming a unit of electricity are 39% lower now than they were in 2015.

As earlier noted, WRAP has estimated that 476,000 tonnes less food was wasted in 2018, compared to 2015. The embodied emissions associated with producing this volume of food are around 1.6 Mt CO_2e (14% of the GHG reductions observed between 2015 and 2018). The complexity of the global food system is such that it is challenging to identify and apportion the 'cause and effect' between food waste reduction and food system GHG emissions (for example because reducing food waste can lead to different purchasing patterns, such as 'trading up'; or to more food being available for export markets rather than less production in the UK). However, reducing food waste will have contributed to reductions in the GHG emissions associated with UK food and drink through changes in purchases, changes in net trade, changes in processing, distribution, storage and preparation requirements, etc. – as well as reductions in emissions associated with avoided waste management (e.g. reduced landfill emissions).

The total GHG emissions associated with wasted food and drink in the UK account for approximately 25 Mt CO_2e (down from 29 Mt CO_2e in 2015)[62].

[62] *This differs from previous values stated for 2015 (of around 25 Mt), which were based on projected data only. An improved/more complete methodology has been used in this assessment, and WRAP has updated the underlying data sources.*

Table 8: Summary of UK GHG emissions data for 2015 and 2018, and main reasons for change

Stage in the value chain	2015 GHG emissions estimate (Mt CO_2e)	2018 GHG emissions estimate (Mt CO_2e)	% increase or decrease between 2015 and 2018	Main reasons for change 2015-2018	% contribution to total value chain emissions
UK primary production				Emissions largely static – though some challenges in monitoring change	
*… UK agricultural emissions**	45.1	45.6 (based on 2017 GHG inventory)	1% increase		31%
…embodied emissions from fertiliser production	2.0	2.0	No change		1%
…embodied emissions from imported feed for use in UK	4.9	4.3	12% decrease	Changes in net trade – in particular changes in net imports of soya beans	3%
Overseas production (net imports)	36.8	39.1	6% increase	Changes in net trade – in particular a major contribution from changes in wheat imports (2Mt of the difference seen). In 2018, the UK drought and low cereal harvest meant much higher imports in comparison with 2015, which was a strong UK wheat harvest.	27%
Food manufacture	9.4	8.5	10% decrease	Decarbonisation of electricity	6%
Packaging	5.0	5.1	2% increase	Changes in packaging volume and composition reported	3%
Supply chain transport in UK	6.5	7.6	17% increase	Unusually low transport mileage reported in 2015 (may be a data artefact). Also an upward underlying increase in mileage for food transport.	5%
Hospitality & Food Service (catering)	7.4	6.8	8% decrease	Decarbonisation of electricity	5%
Retail	7.9	5.3	34% decrease	Reduced demand (e.g. through increased estate efficiency) and decarbonisation of electricity	4%
Consumer transport for food shopping	8.0	8.1	1% increase	Increase in reported car usage for shopping trips	6%
Home (storage and cooking)	18.3	12.2	33% decrease	Reduced demand (e.g. through improved appliance efficiency) and decarbonisation of electricity	8%
Waste disposal	2.1	1.8	15% decrease	Food waste reduction	1%
TOTAL	**154**	**146**	**5% decrease**	Primary driver: decarbonisation of electricity Secondary driver: food waste reduction	
TOTAL PER CAPITA	**2.36 tCO_2e**	**2.20 tCO_2e**	**7% decrease**		

*Of which: 62% emissions from livestock (enteric fermentation and organic wastes); 28% emissions from soils; 10% emissions from stationary and mobile combustion

6.0 Conclusions

The approach is working, but more people and businesses need to act

The 2018 estimates for post-farm gate food waste suggest that the UK is on a trajectory to achieve the Courtauld 2025 and SDG12.3 targets, assuming rates of progress between 2007 and 2018 are maintained. For Courtauld 2025 a reduction of 6.7% in per capita food waste is a third of the 20% target, achieved in the first three years of the ten-year agreement. A 27% per capita reduction over the 11 years between 2007 and 2018 represents just over the halfway point for SDG12.3 – with 12 years remaining before the 2030 target date.

However, there is no room for complacency as there are significant challenges remaining, both in terms of tackling household and supply chain food waste. The analysis presented in this report suggests that the strategies WRAP has developed under Courtauld 2025 are working, when citizens and businesses are reached, motivated to act and their interest is maintained, but much more is needed to ensure most people and organisations are taking action. In order to achieve SDG12.3 more than 1.8 Mt of food waste will need to be prevented. Based on WRAP's previous analysis[63], around 1.3 Mt of this will need to be delivered from reducing household food waste, over 90,000 tonnes from retail, around 250,000 tonnes from manufacturing and almost 200,000 tonnes from hospitality and food service[64].

Achieving the Courtauld 2025 food waste target would also result in a further 4 Mt of CO_2e avoided GHG emissions, in total contributing to around 25% of the Courtauld 2025 GHG target.

Whilst awareness of food waste as an issue, concern about this and intentions to act have all increased amongst consumers, many do not yet acknowledge that this is an issue relevant to them or are not yet concerned enough to act. To address this WRAP is developing a new 'Food Conversation' campaign, whose objective is to reach those who do not care or feel responsible for wasting food, to spark new conversations around wasting food in the UK and bring about a shift in attitudes. Behaviour change takes time, and food waste is a very complex challenge, so it is vital that the 'Food Conversation' is supported by food businesses, other organisations and high-profile individuals to ensure it stands out and captures the imaginations and hearts of those not yet inclined to engage and make changes.

For those that are engaged, Love Food Hate Waste provides practical tools and advice to make it as easy as possible to reduce food waste at home. Whilst brand recognition is increasing, more active support is needed from partners and influencers to ensure this campaign gathers momentum and effectively reaches more of the population. Greater levels of support are also required to pilot and roll out targeted behaviour change interventions that WRAP have and are developing.

Retailers and brands must also fully implement WRAP/Defra/FSA best practice on how food is sold, packs designed and labelled, as outlined in the recently published Retail Survey.

In terms of the supply chain, the turnover of the 121 businesses already implementing Target, Measure, Act as part of the Food Waste Reduction Roadmap represents 50% of the overall turnover for UK food manufacture, retail and hospitality and food service. These

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[63] Historical changes and how amounts might be influenced in the future, WRAP 2014; Quantification of food surplus, waste and related materials in the supply chain; WRAP 2016 and Courtauld 2025 Cost:Benefit Analysis (WRAP, unpublished)

[64] Based on WRAPs analysis, achieving the Courtauld 2025 food waste target would require a 1.1Mt reduction by 2025 compared to 2018 (0.8 Mt from households, 50kt from retail, 135kt from manufacturing and 115kt from hospitality and food service)

businesses are likely to generate around a third of the total UK post-farm gate supply chain food waste, with the remaining two-thirds generated by almost 500 major food businesses still needing to implement Target, Measure, Act. It is also important that greater numbers of larger food businesses engage with their suppliers, to encourage and support them acting on food waste.

For hospitality and food service, WRAP is working with the sector to build momentum behind the Guardians of Grub campaign as a mechanism to increase the number of businesses measuring and reducing food waste and motivate behaviour change by staff.

Businesses implementing Target, Measure, Act are already reporting the benefits. For example, 26 businesses publicly reported 2018 and historical data, and collectively reported a 7% reduction in food waste, saving almost £100m of food (57,000 tonnes). There is much others can learn from those that have achieved reductions in operational food waste, and WRAP's insights on where the greatest potential lies.

Recognising the need for additional support and measures, UK Governments have published new strategies for food waste prevention. The Defra Resources and Waste Strategy reiterated support for the consumer strategy, Courtauld 2025 and the Roadmap. One of the first actions of the Food Waste Champion, Ben Elliot, was to ask organisations to pledge to 'Step up to the Plate' to help halve UK food waste. The Scottish Government's Food Waste Reduction Action Plan also stresses the importance of the Roadmap and Target, Measure, Act in achieving its target to reduce food waste in Scotland by a third by 2025. Welsh Government recently issued a circular economy strategy consultation 'Beyond Recycling' which contains an action to 'Make more efficient use of our food' which proposes that Wales will lead the way in eradicating avoidable food waste by looking at the whole supply chain and working with businesses from farm to fork to minimise waste and maximise resource efficiency.

It is vital that Governments continue to support action in this area and explore all opportunities to increase the likelihood of success. The National Food Strategy could for example help exploit synergies between efforts to improve the nation's diet and reduce food waste[65], and more could be done to integrate efforts to drive waste prevention and participation in separate food waste collections (for households and businesses).

The introduction of mandatory food waste reporting in the UK[66], will support the ambitions of Courtauld 2025 and the Roadmap. WRAP is working closely with policy makers to help ensure the new regulations will be aligned and informed by the Roadmap and its resources. The mandatory separation of food waste will also make it easier for many businesses to acquire data on how much food waste they are generating. Both will drive further engagement with and adoption of the broader Target, Measure, Act strategy.

There are also technical challenges in implementing 'Target, Measure, Act' for certain businesses and sectors, for example around the measurement of food waste. This is an issue for those that dispose of significant amounts of food waste to effluent streams and for hospitality and food service businesses operating across many smaller sites. WRAP, IGD and partners have significantly increased support for the Roadmap, to accelerate the rate of progress and enable businesses to be prepared for the new reporting regulations. Additional funding has also been made available to WRAP by Defra to increase the 'on the ground' support for businesses implementing Target, Measure, Act.

The availability and robustness of data needs to improve

In addition to the concerted efforts needed to deliver the targets, more is needed to be done on the availability and robustness of food waste data. This is critical to monitor progress, and to inform policy and business decisions on where to focus resources. Data on food waste

[65] *For example see http://www.wrap.org.uk/content/sustainable-eating-wraps-work*

[66] *See Defra Resources and Waste Strategy* and *the Scottish Government's Food Waste Reduction Action Plan*

collected from households is robust, but granular data on the types and amounts of specific food and drink items wasted, and food waste disposed to sewer and used in home composting needs to be updated in order to better target action.

For the supply chain, developing estimates of national food waste levels from existing data sources, such as those from the Environment Agency, is not sufficiently robust for all manufacturing sub-sectors, nor even possible for the hospitality and food service sector. More data is needed from businesses, combined with bespoke research such as that carried out by WRAP in the past. Champions 12.3 and WRAP are calling for more businesses to implement Target, Measure, Act, and publicly report food waste data, ahead of any regulatory requirement to do so.

Food waste in primary production

All data cited in this report relates to post-farm gate, which excludes food waste in primary production. There are no comparable estimates for food waste pre-farm gate in the UK, but the first detailed study[67] undertaken by WRAP revealed that for just two important crops, strawberry and lettuce, £30 million of food ended up as waste (9% of strawberry production and 19% of lettuces grown). As data specific to the UK are unavailable for many sectors, WRAP estimated food surplus and waste levels from primary production based on an extensive literature review[68]. Due to uncertainties associated with the data used, and likely variation in food waste due to weather, market fluctuations etc., ranges were given for both surplus and waste. The central estimate for food surplus is 2.0 million tonnes (range 0.9 – 2.7), and for food waste 1.6 million tonnes (range 0.9 – 3.5).

The estimate for food waste in primary production would suggest that more food waste arises from this sector than from hospitality & food service and retail combined. However, the estimates for food waste from manufacturing, retail, hospitality & food service and households are based purely on UK data, and using methodologies that enable progress to be tracked over time, and therefore no direct comparison can be made.

Courtauld 2025 and the Roadmap have a farm-to-fork ambition and, even though primary production is not within the scope of the quantitative food waste target, there is an expectation that businesses will act in this important area, and this is increasingly a focus for action. The current evidence is not strong enough to serve as a benchmark against which progress can be assessed, and WRAP is working with Governments and businesses to determine how the evidence base can be strengthened and impacts judged.

[67] *Food waste in primary production – a preliminary study on strawberries and lettuces; WRAP 2017*
[68] *Food waste in primary production in the UK; WRAP 2019*

Appendix 1: Manufacturing sector detail

As noted in Section 2.3, changes were made to the methodology relative to the analysis conducted in 2018 for the Courtauld 2025 baseline. Specifically:

1. Data collected under the Food Waste Reduction Roadmap for a number of suppliers was included in the analysis, as a means of boosting the sample for sectors that are under-represented in the IPPC data (e.g. fresh produce, bakery) and for which very high extrapolation factors would otherwise have been required.
2. Information from discussions with meat and dairy producers were used to improve estimates on the food content of sludges. This was augmented with fieldwork data from a Zero Waste Scotland project on food waste disposed to drain and a revision of the approach to dairy sector waste using WRAP guidance on food waste reporting and waste-water/ sludges for the sector.

As a result, the 2018 results were not directly comparable with the published 2015 baseline, which necessitated a revision of the baseline estimate (from 1.85 Mt to 1.67 Mt). The 2015 results published in this report should thus be taken as superseding the previously published ones.

Table 9 - Table 12 overleaf show a simplified summary of the approach to estimating food waste arising from the manufacturing sector, as follows:

1. Table 9 shows the data on wastes likely to contain food in the IPPC data.
2. Table 10 shows the data from the IPPC data scaled to the UK, considering the number of premises in the IDBR and their size bands.
3. Table 11 shows the factors used to convert this estimated waste arising to an estimated food waste arising (i.e. the percentage of each waste stream that is assumed to be food, by subsector).
4. Table 12 shows the final estimates of food waste arising for manufacturing, by subsector.

The figures show a high level of volatility at the sub-sector level. This is likely due to a combination of errors in the data set (e.g. miscoding of materials or misclassification of business SIC codes) and sampling error caused by small numbers of businesses in the IPPC data set for some sub-sectors (for example, ambient products were represented by only four sites in 2015, while a scaling factor of x10 was required for the bakery sub-sector in 2018). As a result of these caveats, the sub-sector breakdown should be treated as indicative.

WRAP will be exploring alternative methods for collecting data on the manufacturing sector (e.g. through data returns from the Food Waste Reduction Roadmap or through mandatory reporting) from 2019 onwards.

Table 9: Food manufacturing sector waste containing food, IPPC data sets (tonnes, unrounded)

	Materials unsuitable for consumption or processing		Sludges from on-site effluent treatment		Sludges from washing and cleaning		Edible oil and fat		Animal-tissue waste	
	2015	**2018**	**2015**	**2018**	**2015**	**2018**	**2015**	**2018**	**2015**	**2018**
Alcoholic drinks	14,125	15,160	74,539	46,663	0	8,271	0	1	0	0
Ambient products	10,605	15,105	10,256	6,482	0	0	0	0	0	0
Bakery	11,736	3,022	12,812	14,022	0	0	0	3	0	0
Confectionery	7,609	10,350	15,329	5,437	0	0	0	9	0	0
Dairy	32,498	55,845	218,372	192,825	0	0	3,496	1,858	0	0
Meat processing (exc. abattoirs)	60,436	51,619	199,958	106,478	150,267	11,889	1,490	2,918	489,639	43,045
Milling	22,272	4,789	5,466	0	0	18	0	0	0	0
Produce	11,201	16,874	28,744	77,869	24,224	29,391	0	1,078	0	0
Ready Meals	18,175	17,236	13,476	14,459	0	1,459	0	0	0	4,290
Soft Drinks	12,087	45,308	1,876	571	208	0	0	0	0	0
Sugar	1,538	869	0	0	1,977	0	0	0	0	0
Total UK	**202,281**	**236,176**	**580,828**	**464,805**	**176,676**	**51,028**	**4,987**	**5,869**	**489,639**	**47,335**

Table 10: Food manufacturing sector waste containing food, scaled to UK (tonnes, unrounded)

	Materials unsuitable for consumption or processing		Sludges from on-site effluent treatment		Sludges from washing and cleaning		Edible oil and fat		Animal-tissue waste	
	2015	**2018**	**2015**	**2018**	**2015**	**2018**	**2015**	**2018**	**2015**	**2018**
Alcoholic drinks	49,562	40,765	261,540	120,222	0	11,399	0	2	0	0
Ambient products	176,743	83,209	170,932	45,172	0	0	0	0	0	0
Bakery	122,246	37,781	133,461	175,279	0	0	0	34	0	0
Confectionery	47,554	16,429	95,805	8,630	0	0	0	15	0	0
Dairy	54,940	138,871	582,533	519,856	0	0	47,775	4,022	0	0
Meat processing (exc. abattoirs)	163,776	190,462	517,004	392,568	375,061	43,709	5,694	10,737	96,582	158,606
Milling	42,313	26,304	7,592	0	0	67	0	0	0	0
Produce	56,007	64,683	143,721	298,497	121,121	112,665	0	4,131	0	0
Ready Meals	85,438	84,911	63,348	62,476	0	6,303	0	2	0	18,535
Soft Drinks	33,575	62,686	5,211	2,115	578	0	0	2	0	0
Sugar	1,922	869	0	0	2,471	0	0	0	0	0
Total UK	**834,077**	**746,968**	**1,981,146**	**1,624,814**	**499,230**	**174,144**	**53,469**	**18,943**	**96,582**	**177,141**

Table 11 Waste to food waste conversion factors by manufacturing subsector

	Materials unsuitable for consumption or processing	Sludges from on-site effluent treatment	Sludges from washing and cleaning	Edible oil and fat	Animal-tissue waste
Alcoholic drinks	100%	40%	40%	100%	#N/A
Ambient products	100%	10%	#N/A	#N/A	#N/A
Bakery	100%	10%	#N/A	100%	#N/A
Confectionery	100%	10%	#N/A	100%	#N/A
Dairy	100%	(55%)†	#N/A	100%	#N/A
Meat processing (exc. abattoirs)	100%	15%	7%	100%	100%
Milling	100%	10%	10%	#N/A	#N/A
Produce	100%	20%	63%	100%	#N/A
Ready Meals	100%	10%	10%	100%	100%
Soft Drinks	100%	40%	40%	100%	#N/A
Sugar	100%	20%	20%	#N/A	#N/A

† Approx. Modelling for dairy sludges uses two factors, for liquid dairy (60%) and other dairy (30%).

Table 12 Food waste from food manufacturing sector (tonnes)

	Materials unsuitable for consumption or processing		Sludges from on-site effluent treatment		Sludges from washing and cleaning		Edible oil and fat		Animal-tissue waste		Total	
	2015	**2018**	**2015**	**2018**	**2015**	**2018**	**2015**	**2018**	**2015**	**2018**	**2015**	**2018**
Alcoholic drinks	50,000	41,000	105,000	48,000	0	5,000	0	0	0	0	154,000	93,000
Ambient products	177,000	83,000	17,000	5,000	0	0	0	0	0	0	194,000	88,000
Bakery	122,000	38,000	13,000	18,000	0	0	0	0	0	0	136,000	55,000
Confectionery	48,000	16,000	10,000	1,000	0	0	0	0	0	0	57,000	17,000
Dairy	55,000	139,000	320,000	286,000	0	0	48,000	4,000	0	0	423,000	429,000
Meat processing (exc. abattoirs)	164,000	190,000	78,000	59,000	26,000	3,000	6,000	11,000	97,000	159,000	370,000	422,000
Milling	42,000	26,000	1,000	0	0	0	0	0	0	0	43,000	26,000
Produce	56,000	65,000	29,000	60,000	76,000	71,000	0	4,000	0	0	161,000	199,000
Ready Meals	85,000	85,000	6,000	6,000	0	1,000	0	0	0	19,000	92,000	110,000
Soft Drinks	34,000	63,000	2,000	1,000	0	0	0	0	0	0	36,000	64,000
Sugar	2,000	1,000	0	0	500	0	0	0	0	0	2,000	1,000
Total UK	**834,000**	**747,000**	**581,000**	**483,000**	**103,000**	**79,000**	**53,000**	**19,000**	**97,000**	**177,000**	**1,668,000**	**1,505,000**

Appendix 2: Hospitality and food service sector detail

Data on the "profit" hospitality and food service sector were modelled based on changes in the number and size of premises, based on the IDBR. Table 13 below shows the total number of premises and estimated food waste arising for each sub-sector. As discussed in the methodology, the factors used to convert premises data into estimated food waste arisings are the same as those employed in determining the Courtauld 2025 baseline.

Table 13 Number of premises and food waste arising, profit sector, 2015 and 2018

	Number of premises 2015	Number of premises 2018	Food waste 2015 (t)	Food waste 2018 (t)
QSR	37,000	39,000	103,000	106,000
Restaurants	56,000	63,000	253,000	289,000
Pubs and clubs	40,000	46,000	202,000	234,000
Hotels	13,000	13,000	83,000	88,000
Leisure, transport and sport	14,000	15,000	60,000	61,000
Total profit sector			**702,000**	**779,000**

The "cost" element of the hospitality and food service sector was modelled using a range of scaling factors where available, while in other cases (where a suitable factor was not available) the estimate has been held constant. The scaling factors are given below (in simplified form – the data have not been disaggregated by size band) along with the food waste arising estimates for each subsector.

Table 14 Food waste arising, cost sector

Sector	Scaling factor 2015	Scaling factor 2018	Food waste arising 2015 (t)	Food waste arising 2018 (t)	Scaling factor
Education, of which:			125,000	127,000	
Primary schools (all sizes)	*5,356,000*	*5,575,000*	*66,000*	*68,000*	Number of pupils. Full model includes size band.
Secondary schools (all sizes)	*3,790,000*	*3,869,000*	*28,000*	*28,000*	Number of pupils. Full model includes size band.
Further education (all sizes)	*1,362,000*	*940,000*	*5,000*	*4,000*	Number of students. Full model includes size band.
Higher education (all sizes)	*2,092,000*	*2,343,000*	*2,000*	*3,000*	Number of students. Full model includes size band.
Other education			*24,000*	*25,000*	
Health, of which:			120,000	120,000	
Nursing and residential	*535,000*	*535,000*	*59,000*	*59,000*	No scaling. Original estimate based on care home population from UK Census 2011
Hospitals	*1,000*	*1,000*	*61,000*	*61,000*	No scaling. Original estimate based on number of catering units by hospital size from Caterlyst 2013.
Services, of which:			65,000	62,000	
Prisons	95,000	85,000	19,000	17,000	Prison population (ONS)
Military bases	1,000	1,000	46,000	46,000	No scaling. Original estimate based on data on numbers of UK military bases (ONS)
Staff catering	8,000	8,000	22,000	21,000	Estimate based on 2013 Caterlyst data with a modelled 2013-2015 reduction to account for historical decline in staff catering.
Total cost sector			**332,000**	**331,000**	

Appendix 3: Full Methodology and Data Sources for Estimating Food System GHG Emissions

The method, assumptions and data sources for calculating GHG emissions for each stage in the food system are outlined below. Key data gaps are also noted.

Emissions factors used are taken from BEIS greenhouse gas reporting conversion factors for every year measured. In all cases, the values used are emission factors including 'well-to-tank' (WTT) emissions, which represent the embodied carbon in the production, processing and delivery of a fuel or energy carrier. In the case of vehicle categories, the emissions factors for the average vehicle in that category is used. When Global Warming Potential (GWP) calculations are made, IPCC AR5 GWP values are used.

6.1 UK agriculture

In summary, emissions for UK agriculture were derived based on:

i. the UK GHG inventory for agriculture;
ii. embodied emissions from fertiliser production (which are not included in the UK GHG inventory);
iii. embodied emissions from imported feed production (which are not included in the UK GHG inventory).

UK GHG inventory for agriculture
UK agricultural GHG estimates were taken from BEIS (2019a) UK greenhouse gas national statistics. As 2018 statistics are not yet available, the 2017 value is used in its place. The value used is the total agriculture emissions which includes emissions from livestock, agricultural soils, stationary combustion sources and off-road machinery. BEIS report a decline in agricultural emissions from 1990 however it has stayed relatively constant since 2009, fluctuating between 44 - 46 million tonnes CO_2e.

In 2017 (the latest dataset available), the relative contribution of GHG emissions from different sources was:

- Emissions from livestock (enteric fermentation and organic wastes) – 62%
- Emissions from soils – 28%
- Emissions from stationary and mobile combustion – 10%

Data gap: the UK GHG inventory dataset does not enable either GHG emissions or positive carbon storage from land use change and land management to be attributed specifically to agriculture, and so this has not been included. Farmland is considered to have significant potential for carbon storage (e.g. in trees, hedgerows, soils, etc.), but calculation methods are currently very uncertain.

Embodied emissions from fertiliser production
Although the UK GHG inventory for agriculture includes emissions related to fertiliser use, it does not record the embodied emissions associated with its manufacture. Therefore, these were estimated separately.

The Carbon Footprint Reference Values provided by Fertilizers Europe (2011) were used for estimating the CO_2e emissions per kilogramme of nutrient production. The Fertilizers Europe value is for the EU-28, which is assumed to be the same as the value for manufacture in the UK.

For fertiliser manufactured outside of the EU, the Fertilizers Europe values for emissions from fertiliser use were kept constant but 'At plant gate' emissions, which represent emissions from fertiliser manufacture, were replaced with data from Brentrup et al (2016). The mean of Russian, US and Chinese production were assumed to represent all non-EU production. As Brentrup et al. use the same Fertilizers Europe Carbon Footprint Reference Values for EU production, these papers are directly comparable. This allows us to estimate the additional emissions from more carbon-intensive production outside of Europe.

The UK fertiliser consumption figures provided by the Agricultural Industries Confederation (AIC) (2018, 2005-2013) were then adjusted for imported products share from Fertilizers Europe (2018). This EU-28 value is assumed directly comparable with UK fertiliser imported product share, where 'imported' is understood to mean produced outside of the EU. The 2018 import share was assumed to be constant across all years. These values are provided by fertiliser product. As Fertilizers Europe (2018) does not provide import data for sulphur, it is assumed that all sulphur used in the UK is produced inside the EU. These import-adjusted product consumption values were then calculated with EU and non-EU emission factors per product, which is summed for a total GHG estimate.

As AIC consumption data only currently extends to the 2016/2017 growing season, these values were used for 2018.

Embodied emissions from imported feed production

The approach used for imported feed production followed the methodology and data used for trade in agricultural products more generally, which is outlined in full in [Section 6.2]. Data for traded products in SITC category 8, 'Animal Feed', was taken from Eurostat for the years 2015 and 2018. Each product was assigned a carbon emission factor from Clune et al. (2017) for products either directly matching or the closest approximate (for example: linseed was attributed the median emissions factor for seeds as there was no direct estimate available). Feedstuffs that are wastes or by-products were assigned an emission factor of zero, to avoid double counting.

The total emissions attributed to imported and exported feed were then summed to estimate the net carbon footprint of animal feed. The product-specific emissions factors were held constant for both years of analysis.

Data gap: The emissions factors from Clune et al. (2017) do not generally include land use change (LUC). Due to its importance when analysing the carbon impact of specific goods, in particular soybean imported from Latin America, an estimate was attempted of the additional associated emissions. As Castanheira and Freire (2013) demonstrate, however, based on assumptions of the type of land converted and the method of cultivation the carbon footprint of soybean can change drastically between 0.1 – 17.8 kg CO_2e per kilogramme of soybean. Due to the complexity of estimating what share of UK imports contribute to what scenarios of land use change, it is not included in our principal estimate.

MacLeod et al (2013) estimated that, globally, around 20% of the GHG emissions from feed production for pigs and chicken meat arise from land use change driven by increased demand for feed crops. They note the methodological and data uncertainty – and that pigs

and chicken that have a higher proportion of their ration consisting of soybean produced in countries where LUC is occurring will tend to have significantly higher feed emissions. If applying the global average, the additional emissions from LUC (if applied to net soyabean imports only) would add an additional c.0.2 million tonnes CO_2e to the inventory in both 2015 and 2018.

6.2 Overseas production (net imports)

Eurostat trade statistics of EU trade by SITC for 2015 and 2018 were used, with only relevant categories (01 09, 11) included in the calculation. SITC category 08, 'Animal Feed', was removed from the trade calculation and treated separately (see above). Each Eurostat SITC numeric category has been further broken down, whereby the first two digits represents the 'Primary' category, the third digit represents the 'Secondary' category of that primary category and all subsequent digits represent 'Subcategories' of a secondary category. SITC secondary categories are then connected to their most comparable food category, as used by DEFRA (2019). This conversion allows some extra nuance by breaking down SITC primary categories where they have grouped products otherwise separated in UK statistics, namely 'Vegetables and Fruit' into separate vegetable and fruit categories, and 'Beverages' into alcoholic and soft drinks. The SITC category 09, 'Miscellaneous Edible Products and Preparations' was not easily converted and therefore left as an additional 'Uncategorised' group.

As an example to make this way of organising clearer, the product 'Fish, live' with code 03411 is a Subcategory of the Secondary category 'Fish, fresh (live or dead), chilled or frozen' with code 034. This Secondary category sums all products with 034 as the first three digits, all of which correspond to the UK category 'Fish'. Because of Eurostat's groupings there is a danger of double counting the different levels of categorisation. In order to avoid this, all calculations made were sums only of Subcategory values (i.e. specific products), grouped by which UK product group they fall into. To use the same example, the sum of 'Fish' would include values related to product 03411 but *not* 034 as including both would lead to double counting.

UK imports and exports were separated into EU and non-EU and measured by weight. These weights were then multiplied by a carbon emissions factor for each food by weight of product. These values were sourced primarily from Poore and Nemecek (2018) and Clune et al. (2017) for fresh products and from prior internal WRAP carbon emissions of food databases as used in WRAP (2016). Where no direct estimate of the carbon intensity of food exists, the closest approximate product was used. Where no suitable direct proxy was available (e.g. tapioca), the average for the product category (e.g. vegetables) was used.

The sum of emissions by each subcategory was used to estimate the carbon intensity of every tonne of food exported and imported, which are combined to calculate the net impact of food trade.

Data gap: the majority of embodied emission factors used (e.g. from Clune et al. (2017)) include transport to a regional distribution centre, but not onwards transport to the UK. There are no national datasets from which these transport emissions can be determined, but the majority of transport is by sea – with relatively low associated emissions. The exception is where fresh produce may be imported by air, but this comprises a very low proportion of imports and so is unlikely to be significant across the whole food system estimate.

The embodied emission factors also do not include either GHG emissions or positive carbon storage from land use change (LUC) and land management. The net influence of this is not

fully known. There will be some attributable emissions from deforestation (e.g. associated with palm oil and other forest commodities), but also carbon storage in farmland vegetation and soils. Currently calculation methods and attribution are very uncertain and so they have not been included.

6.3 UK food manufacture

UK Food Manufacturing energy-related emissions were derived from two 2019 BEIS datasets: Digest of UK Energy Statistics (DUKES) (BEIS, 2019b) and Energy Consumption in the UK (ECUK) (BEIS, 2019c). DUKES provides a yearly breakdown of final consumption and autogeneration by the food, beverages and tobacco industry across a variety of fuel types. From ECUK (2017, 2019) the energy use specifically by the tobacco industry can be isolated. In line with the Food and Drink Federation's methodology, the total final energy consumption of the food and drink sector was derived as the sum of final consumption and autogeneration with tobacco industry use subtracted. As there are no tobacco industry specific autogeneration statistics, it was assumed that there is no tobacco autogeneration.

The energy use by fuel type was converted from tonnes of oil equivalent to tonnes of CO_2e using the BEIS greenhouse gas reporting conversion (BEIS, 2012-2019d) factors for each specific year.

Data gap: emissions for UK food manufacture (and transport and retail) only include energy/fuel related emissions. A proportion of this energy/fuel will be for refrigeration and so the energy-demand for refrigeration is included. However, direct emissions from refrigerant leakages are not included, as no national-level estimate was available.

Emissions associated with storage in regional distribution centres (RDCs), or other off-site facilities, are also not included – but these are likely to be considerably smaller than, for example, retail emissions (which contribute c. 3% of total emissions).

6.4 Packaging

As part of Courtauld 2025, WRAP tracks the carbon impact of packaging placed on the market. The tonnes of primary and transit packaging of different types reported by all retail signatories (c.90% of the UK retail market) were assumed to be representative of the UK food and drink sector packaging.

Packaging tonnage volumes were converted to CO_2e using the method outlined in WRAP (2010), using updated Life Cycle Inventory data from the earlier references.

Data gap: This is an underestimate, as it does not include packaging for hospitality and food service and does not include any packaging used in the supply chain (e.g. packaging discarded by manufacturers). However, as packaging emissions are a relatively small proportion of the total, this was not considered to be a major data gap.

6.5 Supply chain transport in the UK

Freight of food in the UK was calculated using Eurostat freight transport statistics for rail and road for all years where there is data. Where there are missing data points in the road freight statistics, the values were assumed to be a linear progression between the last two

available data points and, for missing data in 2018, the 2017 value was assumed to have stayed constant.

These tonne-kilometre values are then adjusted to CO_2e values using BEIS greenhouse gas reporting conversion factors for each specific year. All road freight was assumed to have been transported in an average laden, average HGV.

6.6 Hospitality & food service

The data for hospitality and food service energy use comes from BEIS published ECUK statistics (2012, 2014, 2017, 2019c) where it is classed as 'catering' related energy use. In order to avoid double counting, catering energy use within the retail subsector was isolated from retail and attributed to catering.

ECUK statistics are broken down by fuel type, which was converted to CO_2e using BEIS emissions factors for each year.

6.7 Retail

The data for Retail energy use comes from BEIS published ECUK statistics (2012, 2014, 2017, 2019c). In order to avoid double counting, catering energy use within the retail subsector was isolated from retail and attributed to catering.

As the ECUK statistics present energy use in the *total* retail sector, this was adjusted to estimate food and drink retail only using the share of household shopping expenditure on food and drink from ONS consumer trends statistics for each year (2019a). It was assumed that the share of household expenditure on food shopping as a subset of shopping is representative of the share of total retail energy use by food retail.

UK household expenditure on food and drink as a proportion of shopping			
2015	2016	2017	2018
51%	51%	51%	50%

Chained volume measures, seasonally adjusted.
'Shopping' is calculated as the sum of ONS categories 'Food and drink'; 'Alcohol, tobacco and narcotics'; 'Clothing and footwear' and 'Furnishings, household equipment and routine maintenance of the home'. Food and drink shopping includes 'Food and drink' and alcoholic drink subcategories of the 'Alcohol, tobacco and narcotics' group.

6.8 Consumer travel

Consumer transport emissions estimates were calculated using the Department for Transport's National Travel Survey (NTS) (2018). This measures the average distance travelled per person by mode for the purpose of shopping in England. The English per-person distances were assumed to be representative of the whole UK population. This was scaled up to a UK-wide estimate using ONS population statistics (2019b).

The transport emissions per mode of transport were calculated by multiplying the distance travelled, adjusted to kilometres, by the BEIS greenhouse gas emissions factors for each specific mode of transport and year. As car and van transport are grouped in the data, both were converted using the conversion factor for an average car, as was taxi/minicab transport. Motorcycle transport was converted by average motorcycle and all non-London bus transport by average local bus. The travel survey also has data for 'Other private transport' and 'Other public transport' which, based on explanatory footnotes in the National

Travel Survey, are attributed to average local bus and light rail and tram respectively. Any modes of transport in the NTS not mentioned above either do not have emissions associated to them (e.g. walking, cycling) or are directly comparable to a single BEIS emissions factor (e.g. London Underground) so do not require further clarification.

As the NTS statistics are transport for all shopping purposes, this was adjusted to estimate food and drink shopping only using the share of household shopping expenditure on food and drink from ONS consumer trends statistics for each year (2019a). It was assumed that the share of household expenditure on food shopping as a subset of shopping was representative of the share of consumer transport to food shopping as a subset of all shopping-related transport.

6.9 Home

Energy consumption for home food related appliances were taken from BEIS (2019c) ECUK data, which includes consumption by domestic appliances until 2018. The appliances can be grouped into chilling (freezers and fridges), cooking (oven, hob, microwave) and dishwashers and kettles. ECUK only covers electric ovens and electric hobs. In order to estimate use of gas ovens and hobs, the Department of Energy & Climate Change (2014) 'Energy follow up survey' was used. This breaks down the share of ovens and hobs which are electric and gas. In the absence of data tracking changes in ownership of appliances, this share was assumed to stay constant over time. Assuming that demand for energy services from gas and electric appliances are the same, the energy use of electric appliances and their share of total owned cooking appliances can be used to derive an estimate of the energy use of gas appliances. These energy values were then converted using WTT greenhouse gas reporting conversion factors for electricity and natural gas respectively and were be summed to estimate the greenhouse gas emissions for household food-related activities.

Home related emissions, broken down by type (Mt CO_2e)				
Year	2015	2016	2017	2018
Cooking emissions	8.09	7.60	7.11	6.37
Chilling and freezing emissions	6.37	5.41	4.58	3.42
Dishwasher	1.59	1.44	1.25	1.01
Kettle	2.26	2.05	1.77	1.42

6.10 Waste Disposal

The GHG emissions for different methods of waste disposal follow the same methodology and data as the WRAP 'English Carbon Metric' (ECM) with small alterations.

- Firstly: whereas for comparability with old metrics the ECM uses AR4 global warming potential values, this GHG estimate uses AR5 values.
- Secondly: for calculating the impact of nitrogen fertiliser manufacturing offset through composting, the import-adjusted value for nitrogen fertiliser manufacture as described in the 'UK Primary Production' section (Section 6.1) was used.
- Thirdly: offset emissions from avoided grid generation for anaerobic digestion and energy from waste now uses WTT values for electricity production for each specific year, as taken from BEIS conversion factors.

These values were then applied using a variety of data sources.

For **household food waste**, Eurostat's waste treatment data for the UK was used to identify the different disposal routes for 'Mixed Ordinary Waste' and 'Animal and mixed food waste; vegetal wastes'. From these tonnages we can infer what share of mixed and vegetal wastes go through different treatment routes and, assuming that food waste within these waste streams gets split between the treatment routes at the same rate, therefore infer the different destinations of food waste. Where the Eurostat dataset was missing data points, an estimate of disposal routes was calculated as the average of the two adjacent data points. The final year for which data is available is 2016, so 2016 values have been held constant for 2017 and 2018. These disposal route shares were then applied to household food waste arisings for each year as measured for this report (see Section 2 for more detail).

The share of **supply chain waste** going to different disposal routes was derived from WRAP research (WRAP, 2016). These food waste tonnages and disposal route shares were combined to estimate the tonnes of food waste per disposal route, which then was combined with the GHG emission conversion factors described above.

For both household and supply chain food waste, the only waste stream not covered in the ECM calculations which required separate calculation was food disposed to the sewer. This used the same conversion factors as the aforementioned WRAP research (2016), which derived values from WRc (2010).

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Appendix 4: Peer Reviewer Statement

Technical peer review: Peer review of the methodology for assessing progress against the Courtauld 2025 food waste target and SDG12.3 Goal, and the interpretation of the evidence.

An independent peer review was undertaken of the methodology for assessing progress against the Courtauld 2025 food waste target and SDG12.3 Goal, and the interpretation of the evidence.

The peer review was an iterative process which comprised the following steps:

- Meeting with WRAP for a briefing on the aims of the work;
- Review and proposed improvements to the approaches planned;
- Review and proposed improvements to the draft progress reports;
- Review of final report; and
- Provision of peer review statement.

Throughout the peer review process, there has been an ongoing process of dialogue and discussion with the WRAP research team which has provided a good insight into the process of methodology development and evidence gathering and interpretation.

The review process began in July with a face-to-face meeting to agree the aims of the work, followed by a Stage 1 review of the Courtauld Baseline report and sector templates. A key aspect of the peer review process was discussion on the revisions to the methodology since the baseline report.

The final stage of the peer review was the review of the Technical Report 'UK progress against Courtauld 2025 targets and Sustainable Development Goal 12.3', which included methodology and results for food waste and the full methodology and data sources for estimating food system GHG emissions. The final Technical Report provides a full and transparent account of the methodologies and results. A particular strength of the research and reporting has been the clear description of the limitations in the methods and the identification of the need for improvements in the availability and robustness of data.

In summary, I am satisfied that the research presented in this report provides a transparent and robust basis for assessing and reporting progress against the Courtauld 2025 food waste target.

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15th November 2019

www.wrap.org.uk/courtauld-2025

https://champions123.org/target-12-3/