# Report

# Household food and drink waste in Scotland 2014

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# Contents




**Acknowledgements**

This report builds on a large and ever-growing body of work from not just the UK, but around the world. Zero Waste Scotland would particularly like to thank Andrew Parry and Tom Quested at WRAP for their support not just in analysing data and preparing content for this report, but also for sharing their views on how experience elsewhere may be relevant for Scotland. We'd also like to thank the local authorities who participated in Scotland's compositional analysis programme in 2013/14 and 2014/15 using a common approach – without this data the current report would not be possible.

# 1 Key facts

In 2014 Scottish households generated an estimated 600,000 tonnes of food and drink waste. Around 360,000 tonnes (60%) is "avoidable" – meaning that had food been purchased, planned, stored, or managed differently, then this food and drink could have been consumed.

Avoidable food and drink waste costs Scottish households £1.1 billion in unnecessary purchases each year – an average of £460 per household per year. It accounts for 1.6 million tonnes of carbon dioxide equivalent ($CO_2$eq) emissions, which is 2.1% of Scotland's global consumption footprint in carbon terms.

Scottish households purchase an estimated 3 million tonnes of food and drink annually, of which all food and drink waste represents 20% of the total (1 in 5 bags of shopping), and avoidable food and drink waste 12% of the total (1 in 8 bags of shopping).

Local authorities have to collect and dispose of the majority of our household food and drink waste (390,000 tonnes or 65% of the total). The remainder is disposed of to the sewer (when we pour items down the sink) or at home in other ways (for example composting).

Scotland has made a significant investment in food waste collections in recent years with over 1.5 million households (as of September 2015) having access to a collection. Food waste collections have significant environmental benefits compared to landfill disposal – alternative treatments avoid greenhouse gas emissions, as food no longer decomposes in landfill, and can also generate useful products like compost and fertilizer, as well as energy. However, food waste *prevention* has very significant *additional* benefits in environmental terms as it *also* saves the greenhouse gas emissions associated with growing, harvesting, transporting, processing, and cooking the wasted food in the first place (all of which are wasted when food or drink is thrown away) as well as the landfill emissions.

Measuring food and drink waste is challenging and this can make robust comparison over time difficult. Our best estimate for change in Scotland between 2009 and 2014 is of an absolute reduction of 19,000 tonnes, though we acknowledge significant uncertainty around this in the main report. The reduction in food waste disposed to landfill is far greater (around 50,000 tonnes less between 2009 and 2013, the most recent data we could draw on) reflecting increased provision of separate food waste collections as well as absolute reductions in food waste.

As Scotland's population grew between 2009 and 2014 the reduction in food waste against a "business as usual" scenario, where the population grew, but there was no change in food waste behaviour per household, is greater, and estimated at 37,000 tonnes in our analysis. This level of change will have saved Scottish householders around £92 million in unnecessary purchases, and Scottish local authorities £2.3 million in avoided disposal costs, in 2014. The per year carbon saving in 2014 is estimated to be around 140,000 tonnes of $CO_2$eq.

We think three key factors are likely to have driven changes seen in this period. These include economic factors (particularly food price inflation and tightly constrained household incomes); the impact of government, local authority, and third and private sector interventions, campaigns, and media coverage targeting food waste, and encouraging food waste prevention (including Scottish Government's Greener Campaign, and Zero Waste Scotland and WRAP's Love Food Hate Waste activity); and the introduction of food waste collections to the majority of households in Scotland which may encourage people to reconsider their disposal choices around food waste more generally. It is not possible to determine the relative impacts of these different factors given available data – and they are likely to be synergistic in any case.

# 2 How much household food and drink waste was produced in Scotland in 2014?

## 2.1 The amount of food and drink waste by households

Our best estimate for food and drink waste generated by Scottish households in 2014 is 600,000 tonnes.

We estimate around 360,000 tonnes (60%) is “avoidable” – meaning that had food been purchased, planned, stored, or managed differently, then this food and drink could have been consumed. A further 100,000 tonnes (17%) are classed as “possibly avoidable”, meaning the way the food is prepared, and individual preferences on what is eaten, determines whether it is wasted (e.g. potato peelings, bread crusts).


**Figure 2.1 The breakdown of household food and drink waste by avoidability**

Avoidable food waste costs Scottish households £1.1 billion in unnecessary purchases each year – that’s an average of £460 per household per year. And avoidable food waste also accounts for 1.6 million tonnes of carbon dioxide equivalent ($CO_2$eq) emissions – which is 2.1% of Scotland’s global consumption footprint in carbon terms.

We estimate that around 390,000 tonnes of food waste is collected by local authorities, either in residual waste collections or in dedicated household food waste collections. The number of dedicated food waste collections has risen rapidly in recent years, with over 1.5 million households having access to a collection[1].

While food waste collections generate significant environmental benefits (sending food to landfill produces methane, a powerful greenhouse gas, while sending it to be reprocessed avoids these emissions and can also produce energy, compost, and fertilizer), food waste prevention is even better, as we save the greenhouse gas emissions associated with growing, harvesting, transporting, processing, and cooking the food (all of which are wasted when food is thrown away) as well as the landfill emissions. So food waste prevention is beneficial, whether the food waste prevented would have gone in the landfill bin, or in a food waste collection.

[1] As of September 2015, which is somewhat higher than will have been the case in 2014

This amount of food and drink waste can be compared to the total amount of food and drink purchased in Scotland – around 3 million tonnes every year. On a weight basis food and drink waste represents 20% of purchases – with avoidable food and drink waste representing 12%[2].

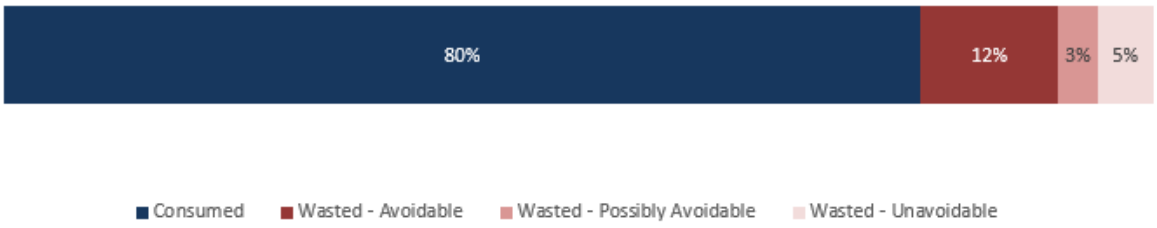


**Figure 2.2 Food and drink waste contrasted with all food and drink purchases.**

## 2.2 How do we know?

There are two elements to food and drink waste disposal. The largest part (65% of the total) goes into the municipal waste management system and is dealt with by local authorities. The remainder is disposed of by other routes – most significantly home composting and down the sink.

The local authority collected waste is the element for which we have significant new evidence. In 2013-15 Zero Waste Scotland supported a number of waste compositional studies in Scotland. These studies have been combined to give a "2014" estimate, although some parts of some studies fall slightly outwith this twelve month period. These local studies involved local authorities measuring the different materials they were collecting, including food waste. This local authority data did not cover all of Scotland, but does cover a representative sample of local authorities, and results were then scaled using national waste data. Greater detail on this process is available as an appendix.

Other disposal routes are more difficult to measure, and are typically quantified using food waste diaries from a representative sample of the population. However there is no recent data for this in Scotland. For the current estimates we assume the percentage reduction in disposal to sewer is the same as that seen for food waste dealt with by local authorities, but more conservatively assume that other disposal routes (e.g. composting and the amount fed to animals) have stayed the same at a per household level. This is in line with the approach taken for UK estimates in 2012[3]. UK estimates also include a very small fraction of food waste from household waste recycling centres and from contamination in dry recycling collections. Again, we have made a small adjustment to our figures for Scotland to account for this. Greater detail on this process is available elsewhere in this report.

A final important factor in the estimate is the proportion of food waste that is "avoidable". The compositional studies in Scotland in 2014 did not measure this, and so the split of avoidable and unavoidable food waste used here was derived from the UK study in 2012 mentioned above[4].

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[2] Greater detail on this calculation is included as an appendix. We would highlight that purchase weights and disposal weights may not match exactly, so this figure should be considered as indicative.

[3] Quested, T, Ingle, R, and Parry, A, 2014, *Household Food and Drink Waste in the UK 2012*, WRAP, at http://www.wrap.org.uk/content/household-food-and-drink-waste-uk-2012. The main report details the results, while the methodology is set out in annexes. We have also discussed these points with experts at WRAP in preparing the current report.

[4] An earlier Scottish study in 2009, described in section 3.1, used a different methodology to more recent work both to scale food waste, and to classify some of it (there was no "possibly avoidable" fraction). This suggested 69% of food waste was avoidable. Given differing methodologies, and the likely change since 2009, we would not expect this figure to match UK 2012 estimates, and the range of difference in these estimates seems acceptable.

Zero Waste Scotland has worked closely with food waste experts at WRAP in preparing this report, and we have used a blend of Scottish and UK data and research in reaching our conclusions.

# 3 How has this changed over time?

This section first sets out the baselines against which change could be measured, before showing our preferred estimates for change over time.

## 3.1 What are we comparing to?

The first estimate of Scottish food and drink waste from households was published in 2010, and relates to 2009[5]. Different studies since have used slightly different methodologies to obtain a national estimate from the same 2009 compositional data – these estimates are shown below. For the current report two different approaches were considered, both shown. In seeking to assess change it is essential that comparable approaches are used for both 2009 and 2014, otherwise any apparent differences seen may be purely methodological.

| | Changing estimates for 2009 over time | | | |
|---|---|---|---|---|
| Element of household food and drink waste | The Food We Waste in Scotland *(published 2010)* | Updated Estimates for Household Food and Drink Waste in Scotland 2012[6] *(published in 2014)* | Current study – Method A *(published in 2015)* | Current Study – Method B[7] *(published in 2015)* |
| Total collected by local authorities | 341,000t | 470,000t | 430,000t | 410,000t |
| *…of which residual waste collections* | *n/a* | *456,000t* | *420,000t* | *390,000t* |
| *…of which food waste collections* | *n/a* | *4,000t* | *4,200t* | *4,200t* |
| *…of which other disposal routes[8]* | *n/a* | *n/a* | *13,000t* | *13,000t* |
| Total disposed of by other routes | 225,000t | 212,000t | 220,000t | 220,000t |

[5] Zero Waste Scotland, 2010, *The Food We Waste in Scotland* at http://www.zerowastescotland.org.uk/content/food-we-waste-scotland-report. Although the figures quoted have been revised as methodologies have evolved over time, this remains the only study to seek to understand food and drink waste by item, and the reasons for this, in Scotland (as opposed to for the UK as a whole).
[6] Zero Waste Scotland, 2014, *Updated Household Food and Drink Estimates for Scotland 2012* at http://www.zerowastescotland.org.uk/content/updated-household-food-and-drink-waste-estimates-scotland-0.
[7] For those familiar with the detail of WRAP's work on household food waste estimates, our method A is equivalent to their "standard method" and our method B is equivalent to their "alternative method".
[8] A small amount of food waste is found in Household Waste Recycling Centres, and a small amount is found as contamination in dry recyclate collections (e.g. food left in jars).

| | | | | |
|---|---|---|---|---|
| *…of which disposal to the sewer* | *n/a* | *n/a* | *150,000t* | *150,000t* |
| *…of which home composting / fed to animals* | *n/a* | *n/a* | *69,000t* | *69,000t* |
| **Total for all disposal routes** | **566,000t** | **682,000t** | **650,000t** | **620,000t** |
| ***…of which avoidable*** | ***389,000t*** | ***n/a*** | ***400,000t*** | ***380,000t*** |

**Table 3.1 Different estimates for 2009 food and drink waste levels in Scotland over time. All used the same source data, but different scaling methodologies. The current study uses Method B to generate the headline impact figures. Figures for methods A and B are rounded to two significant figures and so may not sum. All other numbers are presented as in the published report cited, so there may be inconsistencies in rounding and categorisation between columns.**

The current study considered two methods (both shown), which both allowed for direct comparison of 2009 and 2014. The differences between these two approaches are quite technical and are discussed in the appendix. Ultimately method B was preferred. On balance it was felt to be more likely to be appropriate for Scotland, given the nature of Scottish collection services in 2009 (the choice makes little difference to the 2014 estimate). But it is worth noting that method A, used in the past for UK estimates, is also considered robust, and would in fact give a higher apparent reduction between 2009 and 2014 than those headlined in this report. WRAP have used method A to generate their most recent estimates for England and Wales.

Using either method A or method B gives a smaller apparent reduction than would be the case if we simply compared against the 2009 baseline reported in 2014.

The figures shown in the original 2009 estimate, published in 2010, use a widely divergent method to all subsequent studies. This is explained in more detail as an appendix. This approach is no longer typically used in UK studies. Greater detail on these changes is available as an appendix.

A final factor to consider in assessing change is that the number of people in Scotland has changed since 2009, with the 2011 census also resulting in some revisions of historical data (this is accounted for in the revised figures above for 2009). We've used the growth in *household* numbers (2.9% between 2009 and 2014) to create our counterfactual[9]. The growth in Scotland's population means that, all other things being equal, food waste would have risen between 2009 and 2014. It is therefore possible to measure food waste reductions in absolute terms (e.g. headline figure against headline figure) or relative to population (e.g. compared to a hypothetical scenario where population grew but per household levels of food waste remained the same).

[9] Household figures in the current study for both 2009 and 2014 were taken from National Records of Scotland, 2015, *Estimates of Households and Dwellings in Scotland, 2014*, NRS at http://www.nrscotland.gov.uk/files/statistics/household-estimates/2014/household-est-2014.pdf. We've used household numbers as these have to date been the standard unit of analysis in constructing the actual estimates – however a case could be made for using absolute *population* numbers, which would give a marginally lower rate of increase, and we may adopt a per capita approach in future, given the nature of Scotland's food waste prevention target.

| Element of household food and drink waste | Counterfactual estimate for 2014, given a growing population but no changes in food and drink waste behaviour[10] |
|---|---|
| Total collected by local authorities[11] | 420,000t |
| Total disposed of by other routes | 220,000t |
| *…of which disposal to the sewer* | *150,000t* |
| *…of which home composting / fed to animals* | *71,000t* |
| **Total for all disposal routes** | **640,000t** |
| ***…of which avoidable*** | **390,000t** |

**Table 3.2 Estimated food and drink waste in Scotland in 2014 in the absence of any changes in behaviour since 2009. Scotland's population grew between 2009 and 2014, and this table assumes food waste would have grown proportionally in the absence of other changes. All numbers are presented to 2 significant figures.**

In this paper we only consider change between 2009 and 2014. In practice an interim estimate for Scottish food and drink waste arisings was published, based on 2012 data (published in 2014). This drew heavily on data and experience elsewhere in the UK in the absence of Scottish compositional studies. This was the best available evidence at the time, but the much more extensive Scottish data now available allows for a far better estimate. We have chosen in this study to compare just 2009 to current (i.e. 2014) data as the methods of calculation for the former are most comparable, and the evidence base is more specific to Scotland and less dependent on data from elsewhere[12].

## 3.2 How confident can we be in the results?

Food waste estimates are just that – estimates. They are based on sampling waste in a selection of households and local authorities and scaling this to a national picture. In the case of non-local authority collected food and drink waste we are also dependent on people being able to accurately and consistently record food waste via diaries. The better the design of this process, and the more households and local authorities included, the better the data. But this can be expensive to obtain. We think the 2014 estimate for Scotland is the best yet – a systematic approach to data collection proved both cost-effective, and obtained a large amount of high-quality data (which will help inform far more than food waste research, as it will also guide local authority management of waste collection services across all materials).

However, in looking at a single estimate, and especially in quantifying change, "confidence intervals" are typically assigned to the numbers, presenting the statistical uncertainty in how the data was gathered and analysed. In practice, uncertainty may actually be *greater* than this purely statistical measure, as different assumptions around how to best measure and scale food waste data can also

[10] This is based on the Method B analysis previously presented.
[11] No split for different streams was calculated in the counterfactual estimate as these might be expected to vary independently of food waste prevention behaviour change
[12] A direct comparison to the 2012 estimate would suggest a larger reduction, but we do not consider the comparison valid.

noticeably affect results (a good example of this is the way the same 2009 source data has been interpreted differently over time, highlighted above). This second source of uncertainty cannot be accounted for statistically, but provides another reason to be cautious in interpreting food waste estimates – and in particular change between two measurement points.

Change that falls within the confidence intervals of a previous measurement cannot be considered statistically significant – there is too big a chance that the difference may be a result of how waste was sampled, rather than a real reduction. And, as stated, other sources of uncertainty also exist. However, adhering strictly to this approach in the case of food and drink waste would make it exceptionally hard to conclude anything about change in the Scottish context in a timely fashion, as confidence intervals have typically been wide. This challenge is not unique to Scotland, though the smaller a country, the fewer data points are likely to be available unless (as in 2013-2015) a systematic effort is made to gather comparable data[13]. Thus in the next section we present the apparent reduction in household food waste between 2009 and 2014 based on the "central estimate" (the mid-point) for the respective comparison years, and we will use this as a working assumption in our delivery of future change. We also present additional supporting evidence for our belief that this does represent a real reduction in Scotland. But we cannot definitively say our current estimates of change are correct, and will continue to review our position in light of new evidence – this is discussed further in section 5.

Readers interested in the detail on the confidence intervals and ranges obtained in analysis can find this in the appendix.

## 3.3 What is the best available estimate for change?

This section considers change in two ways. It first considers the absolute reduction seen since 2009. However, in the absence of any changes in household behaviour, food waste levels would have been expected to rise in line with the growth in the Scottish population over this period as discussed in section 3.1. We therefore think the best measure of improvement in household food and drink waste is one that is compared to this "no changes to household behaviour" scenario. The second part of this section does just that.

This section talks only about change between the two comparison years. In practice changes will both have accumulated over time and should persist into the future (i.e. all other things being equal we would expect per annum benefits seen in 2014 to be seen again in 2015, and potentially for several years to come[14]). These means the lifetime benefits of change, both to date, and going forwards, will be much greater than the per annum benefits shown here.

### *3.3.1 The size of the absolute reduction seen in food and drink waste*

The table below shows food waste estimates for 2009 and 2014, and the changes seen between the two measurement points. Both have been calculated this year using a comparable method, and thus the 2009 estimate differs somewhat to previously published estimates, even though the source data is the same – the change in 2009 estimates over time was highlighted in section 3.1. All numbers are shown to two significant figures and thus do not always sum exactly.

[13] For a discussion of the challenges, the methods Annex of Quested, T, Ingle, R, and Parry, A, 2014, WRAP, as above, is relevant. http://www.wrap.org.uk/sites/files/wrap/Methods%20Annex%20Report%20v2.pdf

[14] For the period 2009 to 2014 our cumulative benefit is thus the sum of incremental change in each year covered. Beyond 2014, a key question (which is not well understood) is the likely persistence of change in the absence of further interventions – per household food waste levels may stay the same, if change has become habituated, or they may slowly start to revert to pre-intervention levels, if changes to behaviour have become less well embedded. In either case we would expect a large part of the benefits achieved to date to continue for at least some time into the future – and this is a very significant multiplier of benefits. In addition of course future interventions would be expected to lead to further additional reductions independently of persistence from change to date.

| Element of household food and drink waste | 2009 Estimate | 2014 Estimate | Change |
|---|---|---|---|
| Total collected by local authorities | 410,000t | 390,000t | -15,000t |
| *…of which residual waste collections* | *390,000t* | *340,000t* | *-50,000t* |
| *…of which food waste collections* | *4,200t* | *40,000t* | *+35,000t* |
| *…of which other disposal routes* | *13,000t* | *12,000t* | *-840t* |
| Total disposed of by other routes | 220,000t | 210,000t | -3,500t |
| *…of which disposal to the sewer* | *150,000t* | *140,000t* | *-5,500t* |
| *…of which home composting / fed to animals* | *69,000t* | *71,000t* | *+2,000t* |
| **Total for all disposal routes** | **620,000t** | **600,000t** | **-19,000t** |
| ***…of which avoidable*** | ***380,000t*** | ***360,000t*** | ***-19,000t***[15] |

**Table 3.3 Estimated absolute reduction in food and drink waste between 2009 and 2014, based on the central estimate within the confidence intervals for both 2009 and 2014. All numbers are presented to 2 significant figures.**

This highlights that the vast majority of the change seen in absolute terms comes from avoidable food and drink waste (which is what we would expect). Of the remaining food and drink waste, a reduction in "possibly avoidable" waste is essentially offset by an increase in "unavoidable" waste, assumed to result from increased population, and means there is little overall change.

Notably this table shows how a combination of food waste collections and food waste prevention measures have reduced the amount of food waste disposed of in the residual bin (and thus sent to landfill). This reduction, of around 50,000 tonnes (a 13% reduction in absolute terms, or 15% on a per household basis), is by far the largest reduction for a single element.

Readers interested in per household levels of food and drink waste can find this information in an appendix, as well as greater detail on changes in "avoidable", "possibly avoidable", and "unavoidable" food and drink waste proportions.

### 3.3.2 *The size of the reduction in food and drink waste compared to a situation where household behaviour had not changed*

The table below shows an estimate for food waste levels for 2014 if there had been no changes in household behaviour around food and drink waste. This provides a "business as usual" comparison of change. As set out in section 3.1 this is a simple projection applying the growth rate in the number of Scottish households between 2009 and 2014 to the levels of food waste seen. This is then compared to the actual 2014 estimate, which is the same as that used in the previous section.

[15] Rounding to two significant figures obscures the small difference between total food waste and the avoidable fraction in this case. Detailed figures are available in the appendix.

| Element of household food and drink waste | Counterfactual estimate for 2014, given a growing population but no changes in food and drink waste behaviour | Actual 2014 Estimate | Change |
|---|---|---|---|
| Total collected by local authorities | 420,000t | 390,000t | -27,000t |
| Total disposed of by other routes | 220,000t | 210,000t | -9,800t |
| *…of which disposal to the sewer* | *150,000t* | *140,000t* | *-9,800t* |
| *…of which home composting / fed to animals* | *71,000t* | *71,000t* | *0* |
| **Total for all disposal routes** | **640,000t** | **600,000t** | **-37,000t** |
| ***…of which avoidable*** | ***390,000t*** | ***360,000t*** | ***-30,000t*** |

**Table 3.4 Estimated reduction in food and drink waste compared to a counterfactual scenario accounting for population growth, but assuming no change in householder behaviour. This is based on the central estimate within the confidence intervals for both 2009 (the basis for scaling the 2014 counterfactual) and 2014. All numbers are presented to 2 significant figures.**

The overall reduction in food and drink waste is 37,000 tonnes (5.7%), while that for avoidable food waste only (30,000 tonnes) is greater in percentage terms at 7.7%. This is what we'd expect – the vast majority of food and drink waste prevention appears to come from changed behaviour reducing the controllable element of the waste stream.

It may seem surprising, given a growing population, that "unavoidable" food waste reduces at all. In fact, "unavoidable" food waste consists of two elements, including "possibly avoidable" waste, where classification is dependent on how the item is prepared. The reductions seen in fact occur in this latter category[16].

Readers interested in per household levels of food waste can find this information in an appendix.

These figures are then the basis for calculating cost and carbon impacts from food waste. The factors used are given in the appendix. In talking about the negative economic and environmental costs of food waste we typically only refer to that arising from the avoidable fraction. This is what *prevention* interventions target, and is the best indication of the size of the waste reduction opportunity.

However, as discussed, we do see reductions in the "unavoidable" fraction too in this period. We assign no cost saving benefit to this, and a much smaller carbon factor is applied (covering only disposal savings), reflecting the fact that purchase of unavoidable food waste is not discretionary, and that only carbon savings from avoided disposal are relevant (as we do not displace any food production in the supply chain). This approach could be considered conservative if, in fact, some element of the "possibly avoidable" food and drink waste that we are counting as unavoidable is in fact treated by households as "avoidable" waste – in this case higher cost and carbon factors for this element of the waste stream would be appropriate.

[16] Wholly "unavoidable" food waste, while remaining constant on a per household basis, in fact increases in absolute terms, in line with the growth in household numbers

| Element of household food and drink waste / impact measure | Counterfactual estimate for 2014, given a growing population but no changes in food and drink waste behaviour | Actual 2014 Estimate | Change |
|---|---|---|---|
| Avoidable food waste reduction only | 390,000t | 360,000t | -30,000t |
| *…which is responsible for $CO_2$eq emissions of* | *1,800,000t $CO_2$eq* | *1,600,000t $CO_2$eq* | *-140,000t $CO_2$eq* |
| *…which costs in household food and drink purchases* | *£1,200,000,000* | *£1,100,000,000* | *-£92,000,000* |
| Additional savings from "possibly avoidable" and wholly "unavoidable" food waste (treating both as "unavoidable") | 250,000t | 240,000t | -6,500t |
| *…which would be responsible for further $CO_2$eq emissions of* | *110,000t $CO_2$eq* | *110,000t $CO_2$eq* | *-2,800t $CO_2$eq* |

**Table 3.5 Calculations for the wider environmental and economic impact of food and drink waste in terms of carbon emissions and householder purchasing costs. Counterfactual scenario as above. All numbers are presented to 2 significant figures.**

Based on this, the environmental and economic impact of the food waste reduction seen against a business as usual comparison for 2014 is around 140,000 tonnes of $CO_2$eq. Saved purchase costs for households are around £92 million.

In addition, we estimate that local authorities will see a saving in *disposal* costs (the amount they pay in gate fees and landfill tax) of around £2.3 million per year compared to a business as usual scenario where no behaviour change had occurred. We do not estimate any reduction in *collection* costs, as many other factors will influence these, and they will certainly not be directly proportional to reductions in food waste. Food waste collected for reprocessing should also save local authorities money as against food waste disposed of in residual waste, but this is not calculated here as this is not a benefit of food waste *prevention*.

The changes seen should not distract from the scale of the remaining challenge. This report considers only household waste, but nonetheless "avoidable" household food and drink waste still accounted for 1.6 million tonnes of $CO_2$eq emissions in 2014. "Unavoidable" and "possibly avoidable" household food and drink waste contributed a further 110,000 tonnes of $CO_2$eq emissions. Avoidable household food and drink waste is estimated to be responsible for approximately 2.1% of Scotland's total consumption footprint in carbon terms, while household food and drink waste as a whole accounts for around 2.2%[17].

[17] These percentages will change in line with wider changes in Scotland's economy, and treatment routes for food and drink waste that does arise, as well as actual changes to household food and drink waste itself.

## 3.4 Other evidence for change

As already highlighted, the apparent change between 2009 and 2014 *could* also be explained by statistical (or methodological) uncertainty given the challenges of measurement and the size of the change seen to date. However, the figures presented here are the best estimate available. In addition, there are a number of factors that support the expectation that food waste will have reduced somewhat during this period.

Several supporting strands of evidence support the conclusion that there has been a reduction in household food waste between 2009 and 2014, rather than the difference shown above resulting purely from methodological artefacts, while other strands of evidence are more ambiguous.

***Absolute reductions versus per household or per person reductions***

Firstly, in considering change against a counterfactual baseline, we are not just looking for a reduction against a static 2009 baseline. Absolute, per person, and per house household measures of change all use the same source data, and so do not strictly provide an independent comparison. However, in the absence of food waste prevention action by households, food waste volumes in Scotland would be expected to have risen. This makes it more likely that the fall we see is from genuine improvement, rather than simply a measurement effect. Nonetheless, even comparing changes in per household levels of food and drink waste (which removes the impact of population growth) the reduction seen between 2009 and 2014 falls within statistical confidence intervals and cannot be treated as conclusive.

***Evidence of change in the amounts of food purchased***

Secondly, we examined estimates around food purchases in Scotland in this period (Figure 3.1). This data is based on analysis of the UK Family Food Survey[18], which records purchases, with weight data then modelled from responses given[19]. In a period of food waste reduction we would expect food purchases per person to reduce, assuming that the weight of food actually eaten (per person) is constant and that avoidable food waste reductions will therefore be reflected in a reduction in unnecessary purchases[20]. UK analysis of the period 2007 to 2012 showed just such a correlation between purchase reductions and food waste reductions[21].

There appears to be a relatively high degree of scatter in the purchasing data for Scotland and this may be down to the relatively small sample size for Scotland (an average of 465 households each year over the last three years) in what is a UK-wide survey (with an average sample size overall of 5,500 each year)[22]. Therefore, the variation due to sampling will be greater in Scotland than for the UK[23]. Also contributing to the scatter may be real variation in the amount of food people buy from year to year – as the scale of the graph is in grammes, these fluctuations are in fact relatively small.

Overall this data appears to support the contention that food purchases per person in Scotland in 2013 (the most recent year for which data is available) were probably lower than in 2009. This would be consistent with a reduction in avoidable food waste both logically, and given UK correlations seen in an earlier period (though other explanations for the Scottish data are also possible). There are clear caveats around this strand of evidence, but tentatively, it appears to support the case for a real, rather than simply an apparent, reduction in food waste.

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[18] Defra, 2014, *Family Food 2013*, at https://www.gov.uk/government/statistics/family-food-2013

[19] We'd like to thank WRAP for sharing this modelled weight data with us

[20] Though there could be additional confounding factors – changed dietary preferences, or more (or less) food being grown at home that could complicate this assumption significantly.

[21] Quested, T, and Murphy, L, 2014, *Household Food and Drink Waste: A Product Focus*, WRAP at http://www.wrap.org.uk/sites/files/wrap/Product-focused%20report%20v5_3.pdf

[22] Data for the UK as a whole is much smoother, while that for the other smaller nations (Wales and Northern Ireland) show similar levels of fluctuation to Scotland.

[23] In fact see greater variation in Scotland, Wales, and Northern Ireland than is seen for England or the UK as a whole.

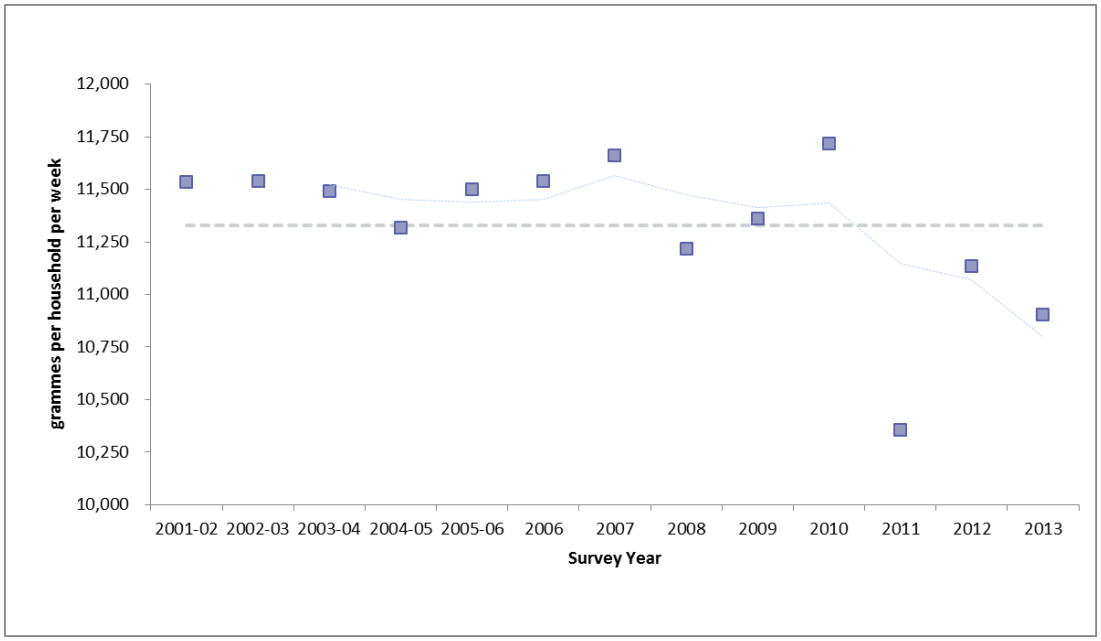


**Figure 3.1 Graph of per person food purchases in Scotland over time, modelled from data in the UK Family Food Survey. The data points show the estimated figure for each year of the survey, the dotted grey line shows the average for the whole period, and the dotted blue line shows a three-year smoothed average[24]. Note the y axis does not start at zero.**

### *Evidence of changing household behaviour*

Thirdly, we examined behavioural data. We have consistently tracked self-reported behaviours around food planning, preparation, storage, and disposal six-monthly since 2010. The behaviours tracked (e.g. planning meals, or making a shopping list) are a selection of factors that should have an impact on eventual food waste generation. However, the chosen behaviours are unlikely to cover the full range of causal factors, and the interplay between them may be complex[25]. In addition, there are potential limitations on the accuracy of self-reported measures.

Six of these measures have shown a correlation with actual levels of household food waste in studies where information on both has been available[26]. Combining responses on these six to give a single indicator shows an improvement over the period in question. As a composite indicator, the weighting given to different elements is a significant variable, but this is consistent over the period.

[24] It is unclear whether the smoothed average is a valid way to consider this data or not, and we do so tentatively. We will continue to monitor this data source for Scotland in future years, and reconsider this analysis in due course.

[25] In some cases, undertaking one behaviour may negate the need to do another – for example, a household that plans meals very well, may make little or no provision for dealing with leftovers, and still generate little food waste. In other cases, some behaviours initially tracked have since been shown to have little correlation with food waste behaviours. This may be due to wider changes – for example, at the outset it was assumed that using airtight containers for these items, rather than simply the original packaging, was typically preferable – however smarter packaging, which is re-sealable, may well mean this is no longer so relevant. The most recent study considering these points is Quested, T, and Luzecka, P, 2014, *Household Food and Drink Waste: A People Focus*, WRAP, at http://www.wrap.org.uk/sites/files/wrap/People-focused%20report%20v6_5%20full.pdf

[26] A graph showing data for all 9 tracked behaviours is available as an appendix.

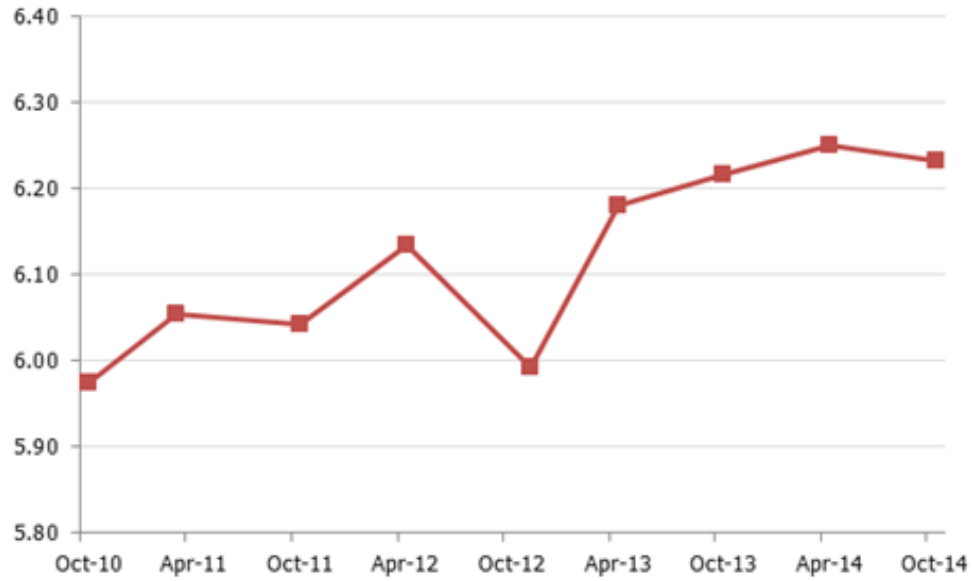


**Figure 3.2 Combined indicator for six tracked behaviours in Scotland. The theoretical range for this indicator is from zero to ten, and so the scale shown here is selective. Source: Zero Waste Scotland's Household Food Waste Tracker**

We would expect improvements in reported behaviours to correlate with reductions in food and drink waste arisings, so the behavioural data may provide further evidence that change has occurred.

***Evidence of change in other UK nations***

Fourthly, we considered a comparison against trends in other UK nations. Data is available for the UK for the period 2007 to 2012, which gives some overlap with our analysis period. UK data showed the largest reduction earlier in the analysis period (around a 13% fall in all food and drink waste and an 18% fall in avoidable food and drink waste between 2007 and 2010). For the whole period 2007 to 2012 the overall reduction was around 15% in all food and drink waste and around 21% for avoidable food and drink waste[27]. These reported reductions do not account for population growth as quoted here, so the fall against a "business as usual" scenario is in fact greater (note the graph below does normalise for population growth). Also of interest in the context of the Scottish data, for the UK too, the apparent reduction between 2010 and 2012 fell within the statistical confidence intervals, highlighting that this can be a common measurement challenge.

[27] Quested, T, Ingle, R, and Parry, A, 2014, WRAP, as above

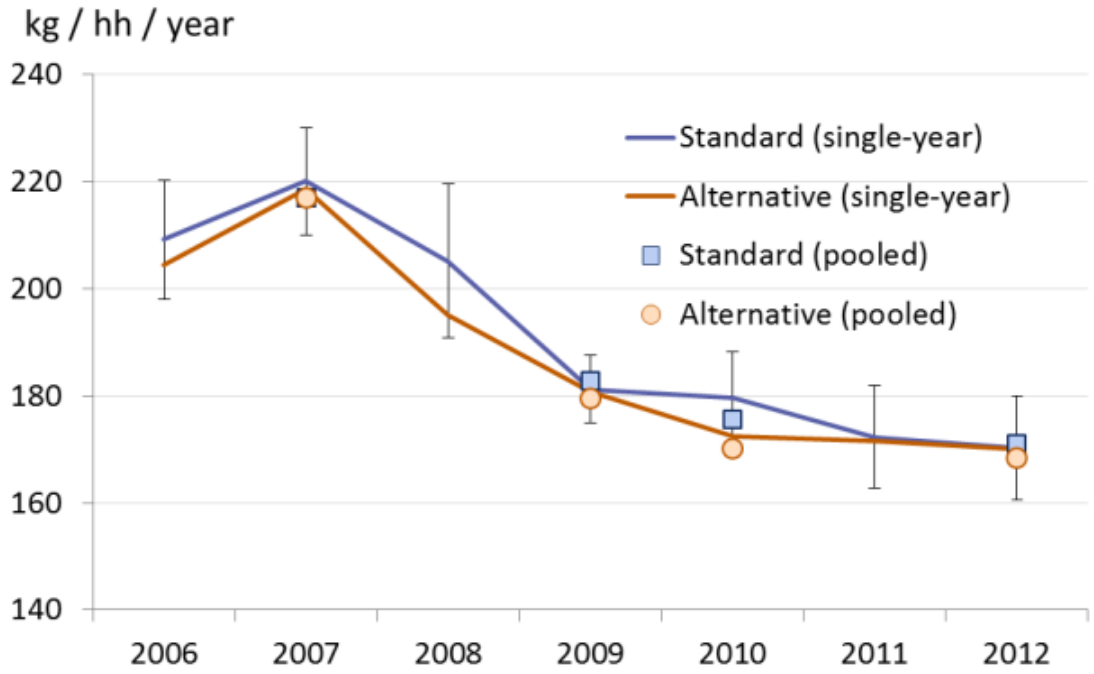


**Figure 3.3 UK food waste trends between 2007 and 2012 shown as kilogrammes per household per year (and thus normalising for population growth). Source:** *Synthesis of Food Waste Compositional Data 2012*, **WRAP**[28]

Little Scottish data fed into analysis of *change* in these studies (though it did contribute significantly to the UK 2010 estimate, using the same data as for the 2009 baseline in this report). Nonetheless the UK picture gives some support for the case for substantive change in Scotland between 2009 and 2014. UK data shows changes were occurring across the UK nations for at least some of our period, and that significant reductions in food waste are therefore very likely to be achievable within a somewhat similar context to Scotland. It would be surprising if Scotland had not contributed to this UK picture. At the same time, it appears that the reductions in UK food and drink waste were "front-loaded" (also coinciding with the economic downturn) and thus all other things being equal the post 2009 period in Scotland *might* be expected to have seen a slower rate of change (though it is also possible the timing and speed of change does differ across nations, especially as policies have diverged). New data for the UK is expected in late 2016[29].

***Examining intervention logic***

A further factor that lends some support to the case for real change is linked to our knowledge of interventions undertaken in the period and the potential economic and other drivers of food waste reduction (see section 4). We know significant large scale activities to encourage food and drink waste prevention have been undertaken, and we know that interventions of this type are associated with changes in food waste behaviour and reductions in food waste in more localised contexts. We also know that economic conditions were likely to have provided a motivation (and even a necessity)

[28] Bridgewater, E, and Quested, T, 2013, Synthesis of Food Waste Compositional Data 2012, WRAP at http://www.wrap.org.uk/sites/files/wrap/hhfdw-synthesis-food-waste-composition-data.pdf

[29] WRAP will publish estimates of UK change between 2012 and 2015 (partially overlapping with the period covered here). One part of this forthcoming study has potential methodological relevance to Scotland as analysis highlighted a potential source of increased methodological uncertainty relevant to all compositional studies. This relates to the fact that different organisations carrying out the fieldwork for the compositional studies on which estimates are based may consistently tend to measure food waste levels higher or lower, meaning who undertakes a study may complicate comparison. Several factors may lie behind this apparent effect, and its relevance for Scotland in the 2009-2014 period is unclear. WRAP analysis shows little systemic effect before 2013, while the fact a range of organisations carried out fieldwork in Scotland for the 2014 estimate, and a standardised methodology was used by all (which is not the case in England) may well minimise the relevance of this insight. But it does increase methodological uncertainty somewhat.

for households to change behaviour. Whilst these are indirect lines of evidence for change in themselves, they do support a logically consistent picture that we would expect to see in a period of food and drink waste reduction.

***The likely impact of economic drivers***

A final factor is the economic context in Scotland between 2009 and 2014. This is discussed in more detail in the next section as a possible cause of food waste reduction. In summary though, we expect straitened economic circumstances to contribute to reduced volumes of food waste (clearly seen in UK data, which has more measurement points than Scotland), and straitened economic circumstances certainly applied for much of our measurement period, especially towards the start. This line of evidence also suggests Scotland may have seen large reductions in food and drink waste just prior to our measurement period (the fastest period of food waste reduction in the UK as a whole since measurement started in 2007 was between 2007 and 2010). Oddly, this expected pattern of change does not fit that suggested in the Scottish purchasing data above (which hints at greater reductions later on in the period).

Overall, it is our assessment that these strands of evidence lend some support to the case that the food waste reduction indicated in the quantitative analysis is real, rather than simply down to uncertainty in measurement, though we are cautious in asserting this. We hope confidence will be strengthened in future as better evidence on these supporting strands comes to light – this is discussed further in section 5.

# 4 Why have food and drink waste volumes declined in Scotland since 2009?

Before answering this question it is important to restate the caveat in section 3.2 that it is possible based on the statistical analysis alone that the apparent reduction in food waste is the result of uncertainty in measurement rather than a real reduction. However, Zero Waste Scotland's view is that this is not the case, based on other contextual evidence.

There are three potential drivers of food waste reductions in Scotland in this period. It is likely that all three have helped drive change, and it seems probable that they are synergistic – i.e. the net effect is greater than the sum of its parts. This section sets out what these three drivers may be, and then briefly discusses the extent to which Zero Waste Scotland can claim to have influenced this, though we do not seek to quantify this influence.

## 4.1 Three possible drivers of change

Three key explanations can be advanced for the estimated reduction in food waste in Scotland.

### *4.1.1 Economic drivers – food waste prices and household incomes*

These two contextual factors may be important drivers of change in food purchasing and management by households. Increasing prices and relative declines in household incomes will squeeze budgets and shape purchasing choices. Reducing food waste reduces food purchasing requirements and makes financial sense – especially for those on lower incomes. UK research covering the period 2007 to 2010 considered both these factors and the extent to which they may have influenced reductions seen at that time[30]. It concluded that they were indeed significant. While they may have been less critical for the period 2009 to 2014 in Scotland, both factors are clearly relevant for this period (especially earlier on).

[30] Britton, E, Brigdon, A, Parry, A, and Le Roux, S, 2014, Econometric Modelling and Household Food Waste, WRAP, at http://www.wrap.org.uk/sites/files/wrap/Econometrics%20Report.pdf

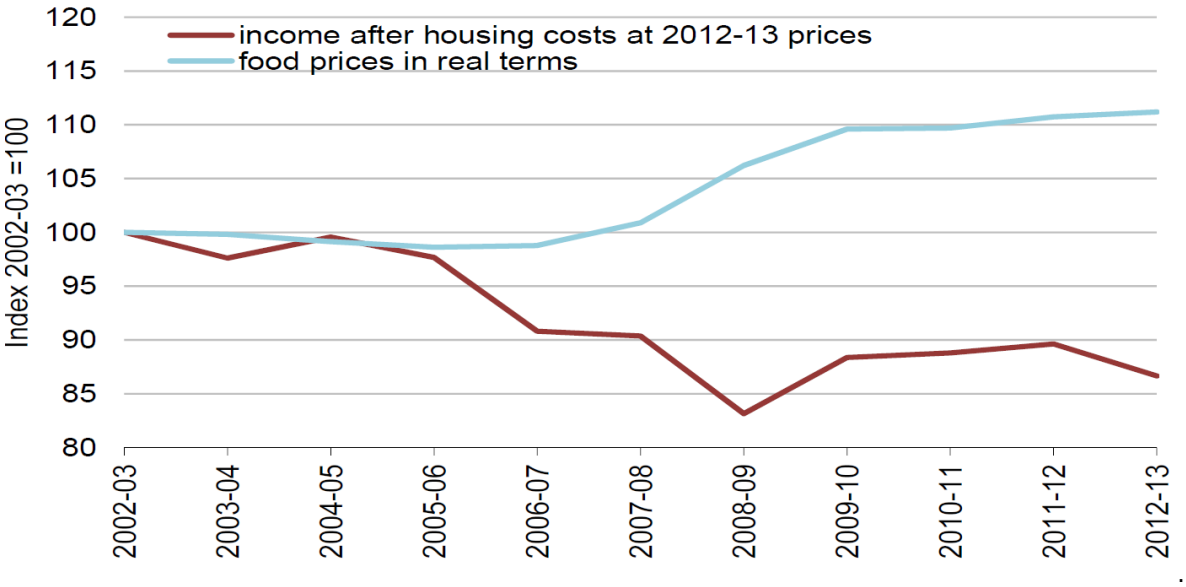


**Figure 4.1 Graph of UK food prices and household income from 2002/03 to 2012/13. Source: Food Statistics Pocketbook 2014, Defra[31]**

Since 2012/13 (the last year shown in figure 4.1) food price inflation has fallen markedly, and thus may be declining in importance as a driver of change, at least temporarily[32].

Interestingly, even if economic factors are a key driver for change, they do not in themselves account for *how* change happens. In this regard the interplay between economic factors (perhaps providing a motivation for change) and the awareness factors below (perhaps highlighting how change can happen, or enabling more efficient behaviours) might be considered an essential part of how change is actually realised.

Two UK studies concluded that around 50% of the total reductions seen in UK food waste during this period may have been in response to economic factors, such as those described above, but that around 50% was likely to have resulted from awareness raising, behaviour change, and technical interventions designed to help householders waste less[33]. We would tentatively suggest economic factors may be less influential in the period 2009 to 2014, based on the data above, where the steepest changes are seen prior to this period. However this relationship may not necessarily be straightforward, and we have not conducted analysis on this question at this time. We do not know which parts of the population have contributed most to reductions in food waste, or if reductions are split across the population. If the economic drivers are significant we might expect the greatest savings to come from those on lower incomes (for whom food purchases take up a larger proportion of household income[34]), or those for whom food makes up a larger part of their household expenditure. This would be interesting, but challenging, to explore further.

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[31] Defra, 2014, Food Statistics Pocketbook 2014 at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/423616/foodpocketbook-2014report-23apr15.pdf. This graph (on p.20) is in turn sourced from data in Belfield, C, Cribb, J, Hood, A, and Joyce, R, 2014, *Living Standards, Poverty and Inequality in the UK, 2014*, Institute of Fiscal Studies

[32] For recent trends, see for example Trading Economics, United Kingdom Food Inflation 1989-2015 at http://www.tradingeconomics.com/united-kingdom/food-inflation, checked on 08/10/15

[33] See Britton, E, Brigdon, A, Parry, A, and Le Roux, S, 2014 as above and also Parry, A, 2011, *Reduction in household food & drink waste – Estimating the influence of WRAP and its partners*, WRAP at http://www.wrap.org.uk/sites/files/wrap/Agreeing%20an%20attribution%20factor%20for%20WRAPs%20work%20to%20reduce%20household%20food%20waste.pdf. A range of estimates for how influence could be apportioned to different factors were put forward by experts and stakeholders during the development of these studies, with a consensus reached on an estimate of 50%.

[34] Defra 2014, as above

### 4.1.2 *Increased awareness – communications, campaigns, retailer actions, and media coverage*

A significant amount of effort has gone into promoting food waste prevention in Scotland in this period. Notable examples include:

- Love Food Hate Waste, a householder facing behaviour change programme managed by Zero Waste Scotland in Scotland and WRAP in the UK as a whole.
- Greener Scotland, Scottish Government's campaign to encourage a suite of pro-environmental behaviours, and which has focused heavily on both food waste collections and food waste prevention during this period
- Associated media and news coverage, frequently supported by the above interventions
- Promotion by partners ranging from local community groups (supported by Zero Waste Scotland's Volunteer and Community Advocate Programme) to local authorities
- Work with retailers as part of the Courtauld Commitment, on customer facing communications, changes to date labelling and storage instructions, changes to item sizes and promotional practices, and technical changes to packaging to prolong shelf-life and ease consumer storage[35].

This activity does filter through to high levels of awareness of food waste and related issues among the general public, as demonstrated by Zero Waste Scotland's "tracker" survey, conducted on a representative sample of the Scottish population on a six monthly basis.

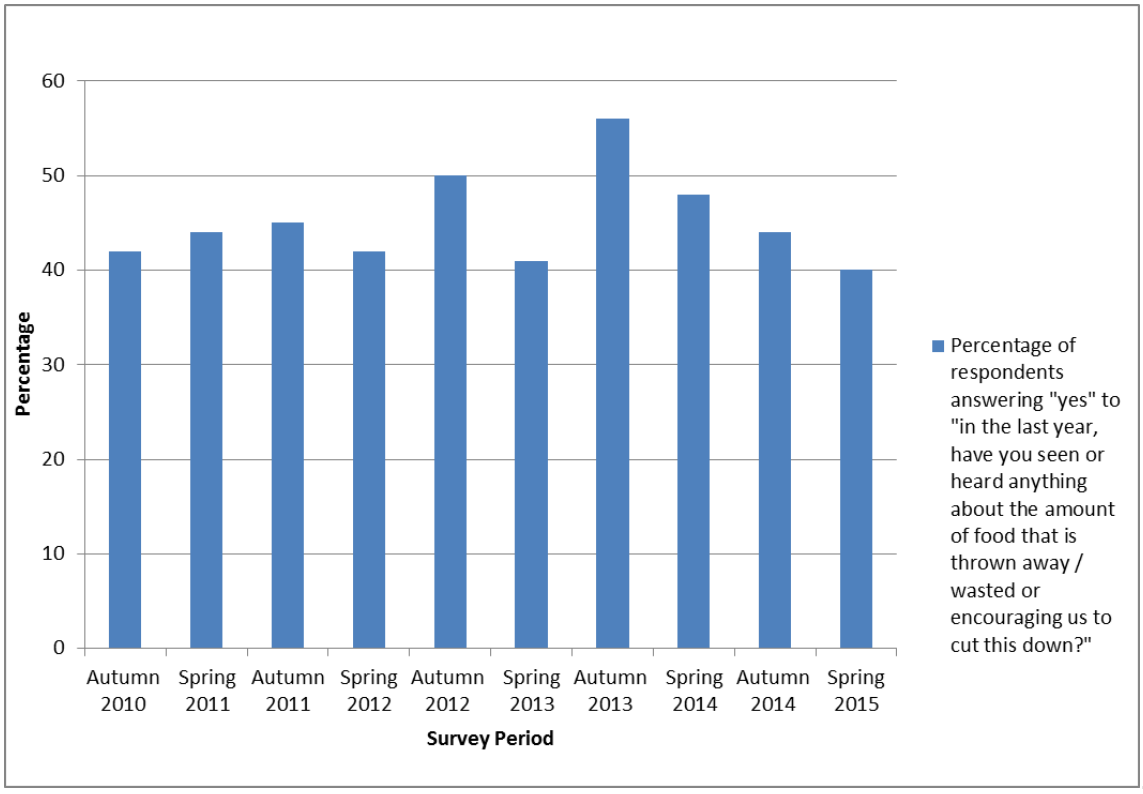



**Figure 4.2 Graph showing stated awareness publicity or other communications around food waste between 2010 and 2015. Source: Zero Waste Scotland's Household Food Waste Tracker**

As well as showing overall awareness being consistently maintained over time, there are also peaks associated with specific periods of enhanced communications activity (e.g. Scottish Government's Live Greener campaign during the summer of 2013 may account for the peak in awareness that autumn).

[35] Examples of the kinds of activities undertaken by retailers are available in Brook Lyndhurst and WRAP, 2012, *Helping consumers reduce food waste - a retail survey 2011*, WRAP at http://www.wrap.org.uk/sites/files/wrap/240412%20Retailer%20review%202011.pdf.

Comparison to other UK nations by WRAP shows that these peaks relate to both Scottish and wider changes in activity. However it is important to note that some behavioural shifts may be achieved subconsciously – through "nudging" behaviour, through technical changes in packaging and food technology, background awareness of the issues, or simply copying friends, family, or neighbours.

A large amount of communications activity in Scotland has also championed food waste collections – with local authorities as a significant partner in this case. While strictly a distinct issue area in policy terms (though see discussion below), it seems very likely that coverage of collections feeds into overall awareness of food waste and the likelihood people reflect on food waste either consciously or unconsciously.

This said, it is harder to definitively prove the extent to which increased awareness and communications lead to behaviour change. The studies referred to in 4.1.1 suggested around 50% of change in the period 2007-2010 was not due to economic drivers, and was likely to be influenced by WRAP and partners' UK activity (including both communications and other support)[36]. To the extent that economic drivers are weaker (if indeed they are) in Scotland in the period 2009 to 2014, then this implies other factors would account for, if anything, a larger percentage of impacts. At local level several studies have shown communications and engagement activity leading to behaviour change[37]. In Scotland, evidence comes from community engagement which is more one-to-one, but again we have seen communications and engagement work credited with generating changed behaviour in a number of contexts[38].

### *4.1.3 Changing patterns of behaviour around food waste disposal – food waste collections*

We know this has changed dramatically in Scotland in the time period in question. We do not have individual estimates for the number of households with a collection in each year, but to give a sense of the scale of change, in 2015 over 1.5 million households had a kerbside food waste collection, up from 310,000 in 2011, a fivefold increase. We also see strong evidence that the presence of collections is also changing the way people choose to dispose of food waste.

[36] Using the proxy of "media mentions" to represent communications activity in the econometric modelling suggested between 29% and 40% of the reductions seen between 2008 and 2011 could be associated with communications activity.

[37] See WRAP, 2011, Reducing Food Waste Through Community Focussed Initiatives, WRAP at http://www.wrap.org.uk/sites/files/wrap/2011.11_Worcestershire_CC_LFHW_2011_case_study.3e14035c.11397.pdf (though note full data was not published in this report) and Quested, T, and Ingle, R, 2013, West London Food Waste Prevention Campaign Evaluation Report, WRAP, at http://www.wrap.org.uk/sites/files/wrap/West%20London%20Food%20Waste%20Campaign%20Evaluation%20Report_1.pdf

[38] See Zero Waste Scotland, not yet published, Assessing the impact of the Volunteer and Community Advocate Programme, Zero Waste Scotland, and, although based on work in England, but reflecting similar delivery in Scotland, Downing, P, and King, G, 2012, Evaluating the Impact of Cascade Training, WRAP at http://www.wrap.org.uk/sites/files/wrap/Evaluation%20of%20Cascade%20Training.pdf

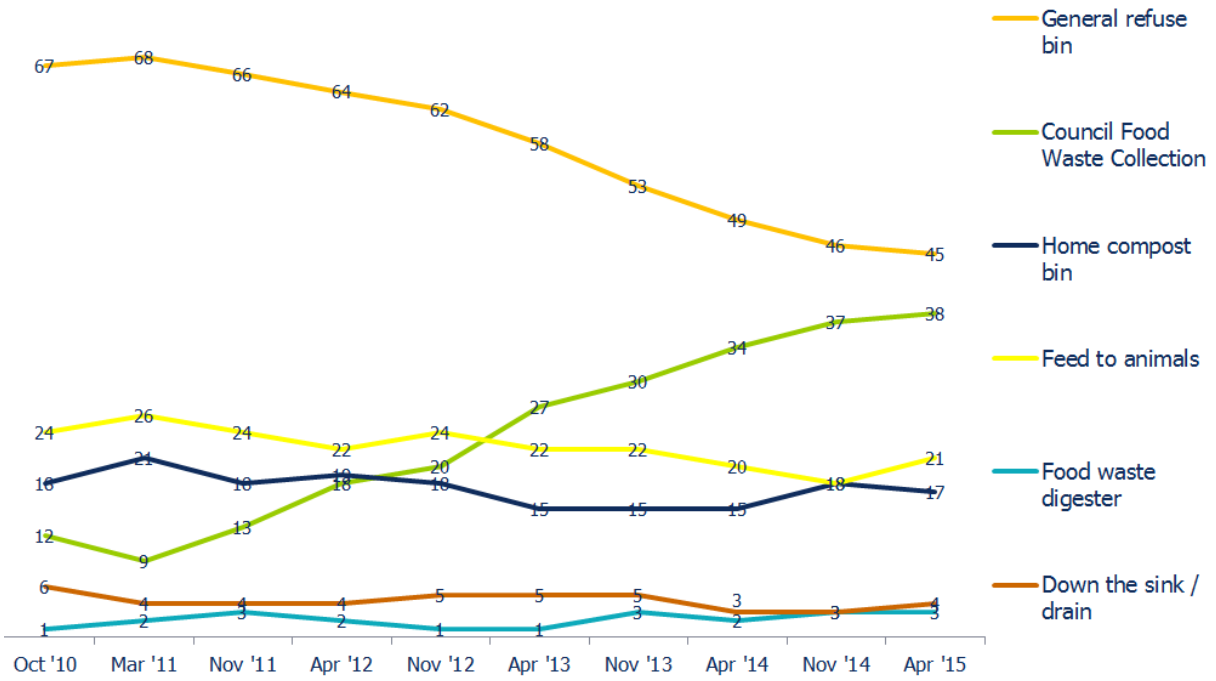



**Figure 4.3 Graph showing stated disposal routes for food waste for Scottish households between 2010 and 2015. Source: Zero Waste Scotland's Household Food Waste Tracker**

This picture also provides some reassurance that the reduction in council-collected waste overall is not due to greater disposal via other routes (such as composting) as people's self-reported behaviour shows little change in use of these other routes.

What is less clear is whether food waste collections also have a prevention effect. An initial evidence review by WRAP (for the UK) in 2011 suggested various strands of evidence to support this proposition, but ultimately the evidence was judged to be inconclusive[39]. Subsequent analysis by WRAP[40], including statistical analysis comparing arisings in local authorities with and without collections has failed to *prove* such an effect exists.

At the same time, this connection has not been *disproven*[41] and it does seem likely that collections will prompt a reappraisal of how a household deals with food waste. Theories have been advanced to suggest that this may: prompt prevention behaviour (as we become more aware of what we waste, through separating it out, we may reassess the scale of the issue and act to reduce waste); make no difference; or, potentially, licence higher waste generation (as people perceive wasted food is going to a "good" use via a collection). Collections may also impact behaviour relating to different disposal routes, such as home composting, with similar results. In practice it seems likely different households will react to collections in different ways, and all factors may be in play in at least some households. If this is indeed the case then the context in which a collection is launched and operated may be a key factor in determining how people respond.

[39] Foley, K, and Hilton, M, 2011, *Literature Review - Relationship between Household Food Waste Collection and Food Waste Prevention*, WRAP, at http://www.wrap.org.uk/sites/files/wrap/Impact_of_collection_on_prevention_FINAL_v2_17_8_11.33a4f2d0.11159.pdf

[40] Quested, T, 2013, *Effect of food waste collections on arisings: recent evidence*, WRAP at http://www.wrap.org.uk/sites/files/wrap/Effect%20of%20food%20waste%20collection%20on%20arisings%20WRAP%20UK_0.pdf

[41] In discussion with WRAP, the possibility that future work may reopen this debate, and potentially demonstrate a relationship more conclusively, has certainly not been discounted, and we will continue to follow and support work in this area closely.

This makes the Scottish experience very interesting – it may well be that the conjunction of introducing food waste collections to a large number of households, in a nation that is also experiencing high levels of communication and engagement on food waste prevention, is a particularly effective context in which to leverage and maximise the prevention potential of both. To explore this further, systematic cross-nation comparison would be helpful.

If this combination of circumstances is a key factor this raises some interesting points for the future. To date, it shows the combination of recycling, waste prevention, and resource management policies and interventions adopted and funded in Scotland in the period have proved complimentary, and generated real change. But if the large-scale introduction of collections is a key trigger, then this factor is not, in itself, repeatable in Scotland. More optimistically, it could be argued that the continued presence of collections refines waste prevention awareness on an ongoing basis, though it remains our view that the moment of transition is likely to be more significant (assuming any connection at all). The case for ongoing effects would though be strengthened if local authority communications promoting the service were also a trigger for change. This impact could be maximised by explicitly linking the two subjects, an approach pursued by some Scottish local authorities and supported by Zero Waste Scotland's Love Food Hate Waste and Recycle for Scotland programmes. This remains an area that it would be invaluable to understand better to guide future interventions.


**Figure 4.4 An example of local authority communications on food waste collections that also promote food waste prevention. It seems likely that the two behaviours can influence each other, and that interventions can seek to leverage this, but further research is needed to confirm this effect.**

## 4.2 The extent to which Zero Waste Scotland has contributed

Both the latter two causes are the result of action by a wide range of partners, from government, setting policy, to local community groups spreading the word about practical food waste reduction measures. We do not seek here to assign responsibility for change to different groups – as with the drivers of change, the actions of partners are also highly likely to be synergistic. Researchers elsewhere have talked of a "food waste coalition"[42], and this may be a good way to conceptualise the way different actors have contributed.

We do though believe Zero Waste Scotland has been at the heart of activity in both these cases. In Scotland we have worked directly on food waste prevention through our direct communications on Love Food Hate Waste, through our engagement with local authorities, through our work to support Scottish Government's Greener campaign, through our funding and support for community groups to

[42] As in the Sustainable Consumption Institute's *Households, Retailers and Food Waste Transitions* project, detailed at http://www.sci.manchester.ac.uk/households-retailers-and-food-waste-transitions, checked 08/10/15

champion the issue at the local level, and through media work. We have also been central to supporting the Scottish government policy to introduce food waste collections to the vast majority of Scottish households, providing local authorities with technical, financial, and communications support as they have introduced significant changes. At the UK level we have worked closely with WRAP on Love Food Hate Waste, and the associated UK-wide publicity generated, and on the cross-nation Courtauld Commitment whereby retailers engage with the issue both through customer facing communications, and technical changes to food packaging and product offers. These initiatives have all been co-funded by Scottish Government via Zero Waste Scotland.

# 5 When will we know more?

The Scottish results raise a number of interesting questions that it would be valuable to explore, both in Scotland, and with other UK nations. These include:

- Comparing the Scottish experience with other UK nations (which have some policies in common but have seen differing levels of engagement activity) might add confidence in whether the Scottish context is unique, and has led to differential change, or whether wider drivers are more important. This might be particularly useful in considering the influence of economic factors, which would be broadly similar across the UK nations. Unfortunately, different nations undertake extensive compositional studies and data analysis at different times, and all are constrained by the measurement uncertainties highlighted in this report.
- Cross-nation comparison could also examine in more detail the relationships between purchase data and food waste, and between tracking data and food waste, which might also help develop these as proxy indicators. There might also be scope to analyse in greater detail the extent to which different purchasing patterns (if any) between the UK nations might correlate with food waste generation. Data on food purchases has not been analysed in Scotland from a food waste perspective previously, and monitoring changes in this over time, including an investigation of the relationship between prices and weight, might also provide useful insight.
- Scotland does not expect to undertake large scale compositional analysis of household food waste until 2018 at the earliest, and it is unlikely that new data on household food and drink waste in Scotland will be available before then. The current analysis highlights that measurement techniques are not yet sophisticated enough to confidently pick up smaller changes, so accurate measurement at longer intervals appears to us the best way to track household food waste.
- We will continue to work closely with WRAP to explore patterns of food waste behaviour – and to try and understand where we are generating most change, and how this can be maximised.

# Appendix: Detailed methodology

## How are estimates derived in the current study?

### *From compositional data to national estimate*

The methodology is similar to that used in both the 2010 and 2012 synthesis studies for the UK[43]. It involves analysing waste compositional data alongside information on the amount of material in various waste streams from WasteDataFlow (WDF).

These compositional studies classify the waste into different materials, (usually between 40 and 70 categories depending on the detail required and the amount of waste to be sorted). Food waste is generally one of these categories, though sometimes different classifications of food waste (avoidable, unavoidable, etc) are included. The Scottish data for both 2009 and 2014 is more standardised than is typically the case for the UK as a whole as in both cases fieldwork for almost all the included projects was commissioned on the basis of a common methodology and set of classifications. This reduces some elements of methodological uncertainty, and the Scottish model used in 2014 is being considered with interest by other UK nations.

This data was analysed alongside information from WDF relating to the total weight of material collected within different waste streams. WDF information includes quantities for individual waste streams and materials. Once checked by the organisations overseeing WDF, the data is published and can be used in research (such as these 'syntheses'), often negating the need for all waste streams to be sampled in waste compositional analyses. For instance, local authorities which have separate food waste collections will usually record the amount in the correct category in WDF and therefore do not need further measurement to determine the quantity of food in this waste stream.

However, the type of materials present in the residual waste streams are not recorded in WDF. To obtain an estimate of the amount of food in each residual stream, the percentage of food waste in a stream (as measured by the local authority compositional analysis studies) was applied to the total weight of that residual stream from WDF.

The waste compositional datasets collated for the current study were assessed on two selection criteria to determine whether to include them:

- **The date of the fieldwork.** Studies undertaken between April 2013 and March 2015 were included. There is a trade-off between the number of studies included and getting studies as close to the target timespan (calendar year 2014) as possible. By selecting these two financial years, it maximises the number of studies used, without straying too far from the target timespan.

- **Whether samples were reasonably representative of the socio-demographic profile of the relevant local authority.** Waste compositional analyses that included some form of socio-demographic stratification[44] were included. This criterion was met by the great majority of collated datasets.

Multi-phase waste compositional analyses were split into their individual phases. The most important advantage of this approach is that it has increased the number of data points that can be included for

[43] Bridgwater, E. and Quested, T. Synthesis of Food Waste Compositional Data 2010, WRAP, 2011: http://www.wrap.org.uk/sites/files/wrap/Synthesis%20of%20Food%20Waste%20Compositional%20Data%202010%20FINAL.pdf
Bridgwater, E. and Quested, T. Synthesis of Food Waste Compositional Data 2012, WRAP, 2013: http://www.wrap.org.uk/sites/files/wrap/hhfdw-synthesis-food-waste-composition-data.pdf

[44] Examples included MOSAIC run by Experian and the Output Area Classification run by the UK Office for National Statistics (ONS). The latter classifies 41 census variables into a 3 tier classification of 7, 21 and 52 groups.

the purposes of producing updated UK estimates, thus increasing the effective sample size in the analysis.

The current study uses WDF data as close to the calendar year 2014 as possible. For Scotland, this meant using data for the calendar year 2013, as data for 2014 was not available at the time of analysis.

The key to the standard method is that it treats the kerbside residual waste stream in isolation from other waste streams, obtaining the average percentage of food in the residual stream and applying this to the total amount of waste in this stream.

Within previous studies, a number of developments to the method have been made to improve its accuracy:

- The stratification of the sample and population according to whether local authorities have any collections targeting food waste;
- Adjustment to account for different yields of collections targeting food waste between the sample and the population; and
- Disaggregation of multi-phase studies.

The methodology consists of the following stages:

**Kerbside residual:** To scale from the sample of local authorities with waste compositional analyses to the whole of Scotland, the following method has been used. Firstly, the percentage of food waste in each stratum was calculated from local authorities with waste compositional data within that stratum. These strata are:

- Local authorities that target food waste at the kerbside for treatment
- Local authorities that do not target food waste at the kerbside for treatment.

For each stratum, the percentage of food waste is then multiplied by the amount of residual waste for all local authorities in the stratum (irrespective of whether they have waste compositional analyses). This gives a total of food waste in each stratum. These totals are then added to obtain an estimate for the whole of Scotland.

**Kerbside collections targeting food waste:** the total food waste arising across all local authorities in Scotland was estimated from WDF data. The process primarily used WasteDataFlow (WDF) tonnages and collection data held by Zero Waste Scotland and WRAP, and occasionally individual local authorities have been contacted.

Kerbside organics tonnages have been taken from Question 10 of WDF. Tonnages have been presented by local authority for each organic material stream. The following WDF categories are relevant:

- **Waste food only**: this category is straightforward as the vast majority is food waste, and it is also an important indicator of the presence of separate food waste collections. A small amount of the material collected as food waste consists of contamination. An analysis of 8 waste composition datasets of separate food waste collections indicates an average contamination rate of 2.0%. A reduction of 2.0% has therefore been applied for separately collected food waste to account for this contamination.

- **Mixed garden and food waste**: this category is less easily dealt with as the proportion of food waste in this material cannot be determined directly from the WDF tonnages. For the mixed garden and food waste tonnages that have been confirmed to relate to a mixed collection, the food waste component is estimated. This is calculated by applying a yield 44.1 kg/hh/yr for weekly collections, and 24.0 kg/hh/yr for fortnightly collections. These figures were produced by Resource Futures through combining data analysed as part of WRAP's LEN002-003[45] project with additional kerbside organics that have been collated for the current project.

[45] WRAP LEN002-003, Material Splits in Co-mingled Recycling, Resource Futures, 2014

In some instances the tonnage calculated by applying the yield above may be greater than the reported tonnage for mixed garden and food waste. This is clearly implausible, and so an alternative method must be used to determine the food waste component. A percentage split is applied to the mixed garden and food waste tonnage; 27.0% is assumed to be food for weekly collections, and 14.0% for fortnightly collections. These assumptions have been derived from the data that formed the basis of the analysis for WRAP's LEN-003 project (see above).

- **Other compostable waste**: this category is highly uncertain as it could consist of garden waste, food waste, cardboard or mixed food and garden wastes. For authorities reporting tonnages in this category reference has been made to data supplied by WRAP on kerbside organics recycling scheme types for local authorities.

WRAP scheme data was used to cross check the WDF tonnages. The scheme data used was financial year scheme data for separate food collections and garden waste collections (which also includes mixed garden and food waste collections).

On occasion it was necessary to contact some local authorities directly fill data gaps, though this was typically not required in Scotland.

**Kerbside dry recycling:** a similar procedure to kerbside residual was carried out for kerbside dry recycling: where compositional data identifies food waste contamination in kerbside dry recycling, this is used to arrive at an average proportion of the dry recycling waste stream that is food. This average proportion was multiplied by the total amount of dry recycling collected to arrive at an estimate of food waste in kerbside dry recycling in the UK. The 'per household' data from the UK was then applied to Scotland. This waste stream has a very minor contribution to the total amount of food waste from households.

**HWRC residual:** a similar procedure as for kerbside residual and kerbside dry recycling was applied to arrive at an estimate of UK arisings of food waste in HWRC residual. The 'per household' data from the UK was then applied to Scotland. Again, this waste stream only has a small contribution to the total amount of food waste from households.

The sum of food waste arisings across these four household waste streams was then calculated to arrive at a tonnage estimate of Scotland arisings of local authority collected household food waste.

### *Approach to sewer disposal*

There is less information for other disposal routes, including disposal of food and drink to the sewer (mainly via the kitchen sink). UK data for 2009 has been applied to Scotland. The UK data was calculated using the method outlined in *Methods used for Household Food and Drink Waste in the UK 2012*[46] (see sections 2.3 and 3.2). The data source was kitchen diaries, in which participants recorded the amount of food and drink disposed of down the drain.

Similar to the UK estimates for 2012, it was assumed that the amount of food and drink waste going down the sewer in Scotland changed between 2009 and 2014 in line with the reduction seen in food waste within waste streams collected by local authorities.

### *Approach to home composting fed to animals*

There is less information for the amount of food and drink going to home composting and fed to animals. It is a relatively minor disposal route for household food waste.

For both 2009 and 2014, it was assumed that a total of 29.3 kg / household / year of food and drink waste went to these two routes. This is based on the 2012 data for the UK, taken from kitchen diaries for 948 households. In the UK, there has been no evidence of change in the amount going to these two routes between 2007 and 2012, hence the assumption of no change in Scotland.

[46] Quested, T., Easteal S., Ingle R., 2013: http://www.wrap.org.uk/sites/files/wrap/Methods%20Annex%20Report%20v2.pdf

## *Approach to estimating the avoidable fraction*

There is no recent Scottish data on the proportion of household food waste that is avoidable. However, levels of avoidable waste (as a proportion of all household waste) were similar in *Household Food and Drink Waste in Scotland (2009 data)* and the equivalent UK data source.

The 2009 level of avoidable food waste in Scotland has been calculated assuming the same percentage as the UK in 2009 (61.1%), which was based on an interpolation between 2007 and 2012 datasets.

The calculation for the 2014 level of avoidable food waste assumes that – on a per household basis – 82% of the reduction related to avoidable food waste, and 18% in possibly avoidable. These were the proportions seen in the UK between 2007 and 2012.

## *Method A and Method B Data, including per household amounts*

The main difference between these methods is the way in which they account for historical estimates of food waste for 2009.

It is unclear which is necessarily "better" – both arguably give a good sense of the likely scale of reductions in Scotland. Method A treats the waste streams in isolation (by obtaining an estimate for each independently of the other), whereas Method B determines the amount of food waste in the two key streams (residual and collections targeting food waste) for each local authority, and then determining the average amount of food waste per household from this.

In general, there is little to choose between the two methods, with the pros and cons of each method balancing each other. Furthermore, the results for each method are usually very similar. However, for 2009 in Scotland, there was a substantial difference in the results from the two methods.

In crude terms the difference relates to dry recyclate – those local authorities with a waste compositional analysis in 2009 had lower levels of residual waste, which appeared to be the result of higher recycling levels. In extrapolating data from local authorities with waste compositional analyses to those without, Method A implicitly assumes that the additional residual waste has the same proportion of food waste as those local authorities with lower levels of residual waste. However, if this additional material is actually material that could have been collected for dry recycling – which seems the most likely explanation – then Method A overestimates food waste in 2009. Method B does not suffer from this issue and for this reason Method B is preferred for this analysis.

Although we prefer method B for headline results in this report, both are valid in understanding the likely scale of change in Scotland. Greater detail on the two methods can be seen in *Synthesis of Food Waste Compositional Data 2012* [47].

| | 2009 | | 2014 | | Change | | | |
|---|---|---|---|---|---|---|---|---|
| | Absolute | kg / hh / yr | Absolute | kg / hh / yr | Absolute | kg / hh / yr | Absolute, % | kg / hh / yr, % |
| LA collected… | | | | | | | | |
| *… in residual* | *417,056* | *177.3* | *345,701* | *142.9* | *-71,356* | *-34.5* | *-17%* | *-19%* |
| *… in collections targeting food waste* | *4,150* | *1.8* | *39,604* | *16.4* | *35,454* | *14.6* | *854%* | *827%* |
| *… other (dry contamination and HRWC residual)* | *12,935* | *5.5* | *12,100* | *5.0* | *-835* | *-0.5* | *-6%* | *-9%* |
| Total | 434,141 | 184.6 | 397,404 | 164.2 | -36,737 | -20.4 | -8.5% | -11% |
| | | | | | | | | |
| Sewer | 148,161 | 63.0 | 135,623 | 56.0 | - 12,537 | -7.0 | -8.5% | -11% |
| Home compost & fed to animals | 68,906 | 29.3 | 70,904 | 29.3 | 1,997 | 0 | 2.9% | 0.0% |
| | | | | | | | | |
| **Grand total** | **651,208** | **276.9** | **603,931** | **249.6** | **-47,277** | **-27.3** | **-7.3%** | **-9.9%** |
| | | | | | | | | |
| **Avoidable estimate** | **398,142** | **169.3** | **355,262** | **146.8** | **-42,880** | **-22.5** | **-10.8%** | **-13.3%** |
| **Possibly avoidable (classed as unavoidable)** | **111,812** | **47.5** | **103,320** | **42.7** | **-8,492** | **-4.8** | **-7.6%** | **-10.2%** |
| **Unavoidable** | **141,254** | **60.1** | **145,349** | **60.1** | **4,094** | **0.0** | **2.9%** | **0.0%** |
| | | | | | | | | |
| *No. households* | *2,351,754* | | *2,419,921* | | *68,167* | | *2.9%* | |

[47] Bridgwater, E. and Quested, T. Synthesis of Food Waste Compositional Data 2012, WRAP, 2013: http://www.wrap.org.uk/sites/files/wrap/hhfdw-synthesis-food-waste-composition-data.pdf

**Table A1 Full results for Method A (WRAP's "Standard" Method). Although a robust approach, and one that gives a higher apparent level of change, these figures were <u>not</u> preferred for the current report.**

| | 2009 | | 2014 | | Change | | | |
|---|---|---|---|---|---|---|---|---|
| | Absolute | kg / hh / yr | Absolute | kg / hh / yr | Absolute | kg / hh / yr | Absolute, % | kg / hh / yr, % |
| LA collected… | | | | | | | | |
| *… in residual* | *388,941* | *165.4* | *339,239* | *140.2* | *-49,702* | *-25.2* | *-13%* | *-15%* |
| *… in collections targeting food waste* | *4,150* | *1.8* | *39,604* | *16.4* | *35,454* | *14.6* | *854%* | *827%* |
| *… other (dry contamination and HRWC residual)* | *12,935* | *5.5* | *12,100* | *5.0* | *-835* | *-0.5* | *-6%* | *-9%* |
| Total | 406,026 | 172.6 | 390,943 | 161.6 | -15,083 | -11.1 | -3.7% | -6.4% |
| | | | | | | | | |
| Sewer | 148,161 | 63.0 | 142,657 | 59.0 | - 5,504 | -4.0 | -3.7% | -6.4% |
| Home compost & fed to animals | 68,906 | 29.3 | 70,904 | 29.3 | 1,997 | 0 | 2.9% | 0.0% |
| | | | | | | | | |
| **Grand total** | **623,093** | **264.9** | **604,503** | **249.8** | **-18,590** | **-15.1** | **-3.0%** | **-5.7%** |
| | | | | | | | | |
| **Avoidable estimate** | **380,952** | **162.0** | **361,845** | **149.5** | **-19,108** | **-12.5** | **-5.0%** | **-7.7%** |
| **Possibly Avoidable (classed as unavoidable)** | **106,985** | **45.5** | **103,585** | **42.8** | **-3,399** | **-2.7** | **-3.2%** | **-5.9%** |
| **Unavoidable** | **135,156** | **57.5** | **139,073** | **57.5** | **3,918** | **0.0** | **2.9%** | **0.0%** |
| | | | | | | | | |
| *No. households* | *2,351,754* | | *2,419,921* | | *68,167* | | *2.9%* | |

**Table A2 Full results for Method B (WRAP's "Alternative" Method). This approach and these figures were preferred for the full report.**

A "counterfactual" can be simply modelled for both scenarios. Method A suggests a higher level of change than method B, although the latter was preferred for this report. No counterfactual is shown for the different local authority collected routes – it could be argued these would have changed independently of household increase and without any impact on food waste prevention (though in practice we suspect there may be a causal link to the latter).

| ***Method A*** | | **Change (actual vs counterfactual)** | |
|---|---|---|---|
| | **Counterfactual 2014 (t)** | **(t)** | **%** |
| LA Collections | 446,725 | -49,321 | -11.04% |
| Sewer | 152,455 | -14,092 | -9.24% |
| Home compost & fed to animals | 70,904 | - | 0.00% |
| | | | |
| **Grand total** | **670,084** | **-63,413** | **-9.46%** |
| | | | |
| **Avoidable estimate** | **409,682** | **-50,297** | **-12.28%** |
| **Possibly Avoidable (classed as unavoidable)** | **115,053** | **-11,197** | **-9.73%** |
| **Unavoidable** | **145,349** | **-1,919** | **-1.32%** |
| | | | |
| *No. households* | *2,419,921* | *-* | *0.00%* |

**Table A3 Counterfactual results based on Method A (WRAP's "Standard" Method). This approach and these figures were <u>not</u> preferred in the full report.**

| ***Method B*** | | **Change (actual vs counterfactual)** | |
|---|---|---|---|
| | **Counterfactual 2014 (t)** | **(t)** | **%** |
| LA Collections | 417,795 | -26,852 | -6.40% |
| Sewer | 152,455 | -9,798 | -6.40% |
| Home compost & fed to animals | 70,904 | - | 0.00% |
| | | | |
| **Grand total** | **641,153** | **-36,650** | **-5.70%** |
| | | | |
| **Avoidable estimate** | **391,995** | **-30,150** | **-7.70%** |
| **Possibly Avoidable (classed as unavoidable)** | **110,086** | **-6,500** | **-5.90%** |
| **Unavoidable** | **139,073** | **-** | **0.00%** |
| | | | |
| *No. households* | *2,419,921* | *-* | *0.00%* |

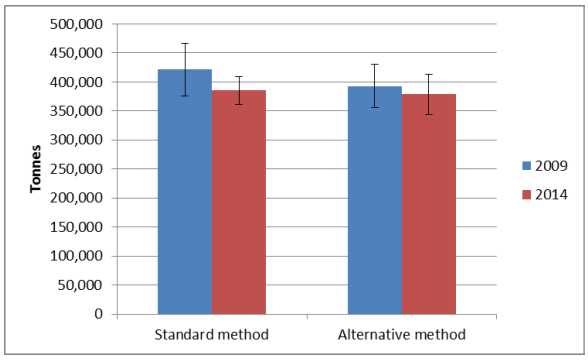
**Table A4 Counterfactual results based on Method B (WRAP's "Alternative" Method). This approach and these figures were preferred in the full report.**

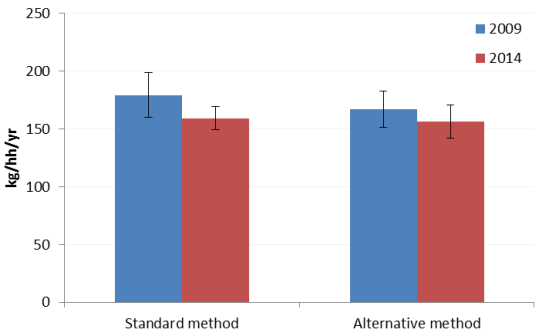
| | Method A | Method B |
|---|---|---|
| ***Carbon (t CO2eq)*** | | |
| Actual 2014 carbon for avoidable food waste | 1,558,181 | 1,625,768 |
| Counterfactual 2014 carbon for avoidable food waste | 1,796,867 | 1,761,231 |
| **Change vs counterfactual** | **- 238,686** | **- 135,463** |
| | | |
| ***Cost (£)*** | | |
| Actual 2014 cost for avoidable food waste | 1,085,326,831 | 1,105,435,608 |
| Counterfactual 2014 cost for avoidable food waste | 1,251,579,601 | 1,197,543,302 |
| **Change vs counterfactual** | **- 166,252,770** | **- 92,107,693** |

**Table A5 Cost and carbon savings against a counterfactual for both Methods A and B. Method B was preferred for the reductions quoted in the full report.**

## What are the formal confidence intervals around the estimates?

The figures below show the confidence intervals around the estimates for local authority collected waste.




**Figures A1 and A2 Absolute estimates for 2009 and 2014 using Methods A and B for local authority collected waste. These are shown on both a national and per household basis.**

As highlighted in the main text the changes we see fall within the confidence intervals and thus are not statistically significant (i.e. they could arise by chance through the sampling techniques used). Additionally, other sources of uncertainty may arise from the methodology that are not statistically quantified.

We've chosen to treat these reductions as real nonetheless for two reasons – also covered in the main text. Firstly, we think there is other supporting evidence for a tangible change in food and drink waste in Scotland (see section 3.4). This triangulation significantly increases our confidence that the apparent reductions seen are real. The second reason is more pragmatic. This will often be a policy area in which uncertainty exists, given the challenges of measurement, but we must nonetheless make decisions relating to our interventions on a best available evidence approach.

## What are the methodological changes behind the different estimates for 2009 over time?

The approaches to calculating non-local authority collected waste are broadly comparable across all studies. Most changes of significance apply to how the local authority collected proportion has been estimated and these are briefly set out below.

*The Food We Waste in Scotland*, published in 2010, produced national estimates in a completely different way to subsequent studies. This "bottom up" methodology involves working out per household levels of food waste by household size, and then scaling this by the number of households of different size in Scotland. This method typically gives estimates that are lower than the alternatives, and indeed this is seen when it is applied to compositional data collected in 2009. This means that

this method can be a poor fit with national data sources. A number of reasons for this can be advanced, and whilst expert opinion tends to favour a "top down" approach, as now adopted, it is worth noting these drawbacks do not invalidate this method. Rather, they suggest caution in interpreting food waste estimates from different methodologies, and that it is valid to be open to alternatives.

A second drawback is practical however, and relates to the requirement to know household size for households participating in compositional analysis. This makes data collection more complex and expensive, and means such a methodology is less replicable. It's not possible to calculate a 2014 estimate that is comparable to 2009 using this methodology, and it is unlikely to be possible in future (the 2009 study only obtained this more detailed picture of household composition due to wider research aims specific to that study). Thus the bottom up approach was discounted in 2014 as a cost-effective way to measure change in Scotland, and all subsequent estimates use some variation on a "top down" approach.

*Updated Estimates for Household Food and Drink Waste in Scotland 2012*, published in 2014, reflected this decision and sought to estimate a new 2009 baseline (using the same 2009 source data) with a "top down" methodology – comparable in concept to that used in the current study. The main reasons for the divergence in 2009 estimates between the 2014 report and the current report are due to changes in the estimated number of households in Scotland (revisions were made due to the 2011 census) and technical improvements to the scaling methodology for the 2014 estimates. These improvements were applied retrospectively to the 2009 estimate to ensure comparability in the current report.

The 2014 report also made an estimate for food and drink waste in 2012. However, as highlighted in that report at the time, this was dependent on UK data as few compositional studies from Scotland were available. Thus the 2014 report was useful in setting out a transition away from a "bottom up" approach to food waste measurement in Scotland, and in providing an interim updated estimate for food waste levels. But it is now largely superseded by the current report, which is built using far more extensive Scottish data.

This current report uses a top down approach as previously discussed. Two methods of scaling estimates are explored – with the main difference between them being to the 2009 historical data as discussed above.

## What household numbers were used?

Household numbers are shown in the workings for Methods A and B above. These were sourced from National Records of Scotland, 2015, *Estimates of Households and Dwellings in Scotland, 2014,* NRS at http://www.nrscotland.gov.uk/files/statistics/household-estimates/2014/household-est-2014.pdf and account for changes to estimates following the 2011 census.

## What carbon and cost numbers were used?

The following factors were used in preparing this report. The carbon factors used differ slightly from those applied in UK studies, reflecting the slightly different waste management routes employed in Scotland (with a greater proportion of food waste going to anaerobic digestion, and a smaller proportion of residual waste going for incineration, than is the case for the UK as a whole).

| Factor | Figure used (per tonne of food and drink waste) | Comment |
|---|---|---|
| Cost (avoidable food waste only) | £3,055 | This was based on UK estimates for 2012, inflated to reflect food and non-alcohol beverage inflation between 2012 and 2014 and a forecast of food and non-alcohol beverage inflation between 2014 and 2015. The latter is based on a forecast for overall consumer price inflation between 2014 and 2015 adjusted by the historical gap between overall consumer price inflation and food and non-alcohol beverage inflation over the last thirteen years.<br>In the original (2012) calculation for the value of food waste, the bulk of the financial values for the food thrown away came from the UK Family Food Survey, which means they would reflect the average actual price paid by consumers, including for any food on promotion. However, around 20% of the foods could not be costed in this way, and so were costed on the basis of retail prices sourced from a number of retailers. These may not have included the potential impact of promotions.<br>To be conservative the value of food wasted has therefore been adjusted downwards to account for some food potentially being bought at a cheaper price, leading to a revised 2015 estimate of £3,055.<br>Using 2015 estimates in this way may lead to a small inaccuracy in the "2014" estimate, but given the scale of changes seen this is not expected to be significant, and there are other elements of the central "2014" estimate that are dependent on data from adjacent years. |
| $CO_2$eq (avoidable food waste only) | 4.493 | This includes disposal impacts and displaced food production and processing. As explained above this differs slightly from UK estimates, which is due to different assumptions about disposal routes. It is only appropriate to apply this factor to *avoidable* food waste. |
| $CO_2$eq (unavoidable food waste only) | 0.433 | As explained above this differs slightly from UK estimates, which is due to different assumptions about disposal routes. No displacement impacts are counted for unavoidable food waste, so only disposal savings are relevant. |

**Table A6 Conversion factors used in this report.**

## Calculating Cost Savings to Local Authorities

We used a combination of Waste Data Flow information and expert opinion within Zero Waste Scotland to identify the disposal routes used by local authorities for both residual waste and separately collected food waste. Where the exact disposal route was unclear based on this high level assessment (just 9% of residual tonnage) we assigned this tonnage the lowest overall residual disposal cost at the next stage to avoid overstating impact.

We used WRAP's gate fees survey[48] and expert opinion at WRAP to identify the average gate fee for each disposal route, including landfill tax where appropriate. This suggests a landfill gate fee of £19/t plus landfill tax of £82.50/t for landfilled waste (so landfill waste costs local authorities £101.50/t on

[48] WRAP 2014, *WRAP Gate Fees Report 2014*, WRAP, at http://www.wrap.org.uk/content/wrap-gate-fees-report-detailed-2014

average in total). Other residual disposal routes (Energy from Waste, Refuse Derived Fuel, and the unclassified fraction above) were costed at £73/t. For separately collected food waste we estimated the gate fee costs for IVC and AD treatment to be comparable at £40/t.

We then created a weighted average disposal cost per tonne for both residual disposal, and for separately collected food waste.

We applied these factors to the overall reduction in local authority collected food waste identified in our research in proportion to the collection routes actually used in 2014. This is somewhat simplistic as it assumes prevention effects are equally distributed across all disposal routes, which may not be the case. However we do not think this is a particularly sensitive assumption.

This approach gave an absolute cost saving against 2009 of £1.3 million per year, and a reduction against a business as usual scenario of £2.3 million per year.

## More detailed behavioural tracking data

We tracked nine measures of food waste behaviour over the period, of which six have proven to show a correlation to actual food waste amounts in other studies. A composite measure for these six behaviours is shown in the main text. This composite indicator excludes data on storage of cheese and meat, use of the freezer, and checking cupboards.

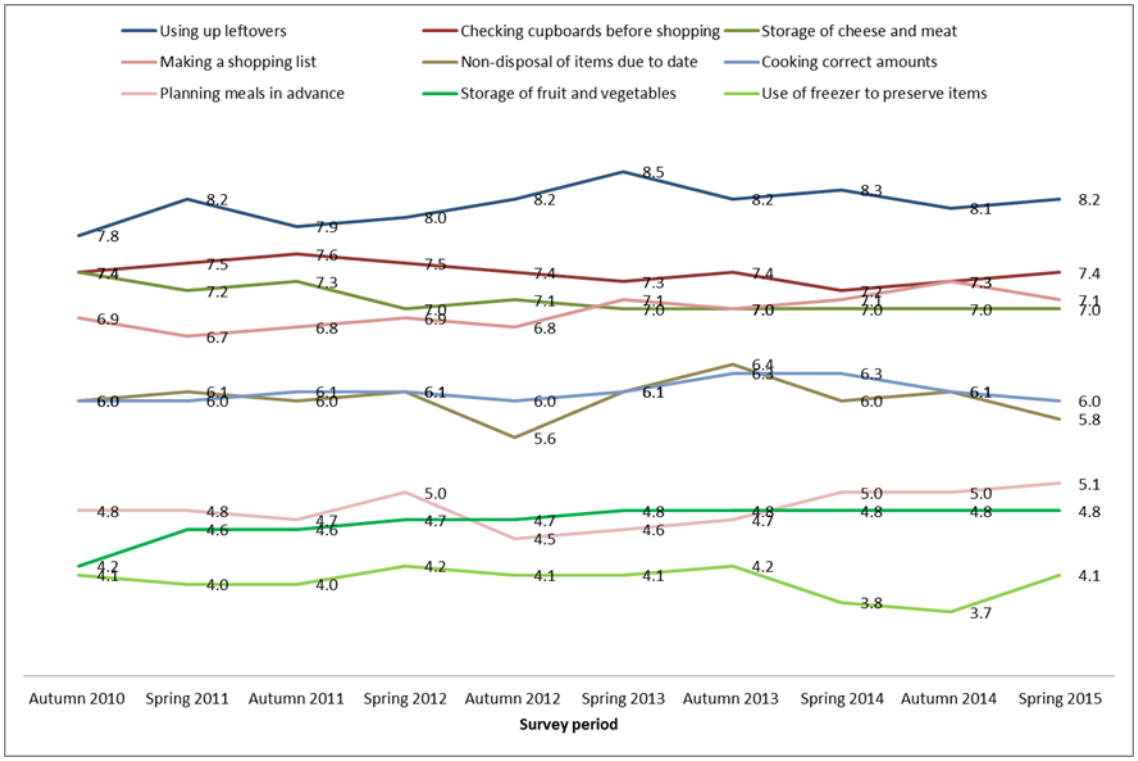



**Figure A3 Graph of composite scores for tracked behaviours relating to food purchasing, storage, and preparation, assumed to relate to food waste prevention outcomes. Planning behaviours are in red, storage behaviours in green, cooking related behaviours in blue, and a question relating to date labels is in brown. Source: Zero Waste Scotland's Household Food Waste Tracker**

## Calculating food and drink purchases in Scotland by Weight

We used the Defra family food survey data, and WRAP analysis of it (as referenced in the main text) and multiplied the per person per week consumption weights by the Scottish population total, and the number of weeks in the year to provide annual figures. We used a three-year average in arriving at

this figure (given the fluctuations shown in figure 3.1 this seemed a more cautious approach, but in practice the figure is around 3 million in all three years).

There are some limitations on this analysis. These include the limitations to deducing weights from the survey data discussed elsewhere in this report. However two other issues arise in contrasting food and drink disposal amounts against purchase amounts. Firstly any methodological differences between calculation of the two elements (and the approaches are quite different) may distort the picture, while the disposal weight may not be the same as the purchase weight for some items (for example uncooked and cooked pasta, with the latter containing a significant amount of water). UK experience suggests this issue of water gain or loss is minimal at the aggregate level (despite being very significant for certain items). It is worth noting that for drinks made with added tap water (e.g. tea) this water content is already excluded in food and drink waste totals quoted. Nonetheless, we would highlight that presenting food and drink waste as a proportion of purchases is done with lower levels of confidence than some other elements of this report.

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