Title: Consistent municipal recycling collections in England **IA No:** **RPC Reference No:** **Lead department or agency:** Department for Environment, Food and Rural Affairs (Defra) **Other departments or agencies:**	**Impact Assessment (IA)** **Date:** 14/02/2019 **Stage:** Consultation **Source of intervention:** Domestic **Type of measure:** Secondary legislation **Contact for enquiries:** Ladislav Tvaruzek Javier Igartua
Summary: Intervention and Options	**RPC Opinion:** RPC Opinion Status

Cost of Preferred (or more likely) Option				
Total Net Present Value	**Business Net Present Value**	**Net cost to business per year** (EANDCB in 2014 prices)	**One-In, Three-Out**	**Business Impact Target Status**
£1,341	£1,206m	-£81m	Not in scope	Qualifying provision

What is the problem under consideration? Why is government intervention necessary?

Waste generation produces negative environmental externalities as it emits greenhouse gases when sent to treatment such as incineration or landfill. When waste cannot be prevented, recycling can minimise the environmental costs of products/materials being disposed of, and create value by providing valuable materials for manufacturing. However, current measures and requirements for household collection of recyclable materials, such as landfill tax or dry recycling separation, are proving insufficient to increase recycling beyond the current level of 44-45% and reduce the amount of residual waste produced. Loose requirements on local authority waste collections have led to a variety of different collection systems and materials collected, leading to confusion on what can be recycled. This limits potential recycling and lowers the environmental and economic benefits that otherwise could be achieved. For non-household municipal waste (NHM), businesses usually pay for waste collections on a per lift or bin basis. Consequently, introducing additional recycling bins may not lead to reduced waste costs. Government intervention is therefore needed to require a consistent range of waste materials to be collected from households and businesses in order to overcome these barriers to higher recycling.

What are the policy objectives and the intended effects?

To deliver a consistent range of dry materials for collection from all households, as well as weekly separate food waste collection and free garden waste collection. For the NHM sector the objective is for all businesses to separate dry recyclable material and food waste from residual waste for recycling. This will ensure that businesses present waste separately for recycling. This will increase both (i) the quantity of materials collected, and (ii) the quality of recyclate produced due to improved material segregation. For householders, the proposed changes will help them make the right decisions on what can be recycled, reducing contamination. Decreased contamination will boost reprocessors' confidence in the quality of recyclate being collected, increasing demand for secondary materials. These changes will ensure that minimal waste goes to landfill and more food waste and garden waste is composted or is sent for anaerobic digestion.

What policy options have been considered, including any alternatives to regulation? Please justify preferred option

The impacts of three regulatory requirements for household and non-household waste and recycling collections were considered and then combined for the whole municipal sector:

Option 1M

(i)Household sector: current dry recycling collection systems – requiring collection of six key materials; separate weekly food waste; free garden waste. (ii) NHM sector: requiring collection of dry mixed recyclables (DMR) and separate glass.

Option 2M

(I) Household sector – two-stream collection systems, collection of six materials; separate weekly food waste; free garden waste.
(ii) NHM sector – collection of dry mixed recyclables (no glass recycling) and separate food waste collection.

Option 3M

(i) Household sector – multi-stream collection systems, collection of six materials; separate weekly food waste; free garden waste.
(ii) NHM sector – DMR, separate glass, separate food waste. This is the preferred options based on the overall net societal benefits.

A non-regulatory option was not appraised: LAs are already able to decide on a local basis what materials should be collected from households for recycling and how. This has led to a large set of service collection profiles and current legislative or fiscal drivers are unlikely to change this. The voluntary initiative (Consistency Framework) has not been taken up by the majority of LAs because of other funding pressures and an absence of legal drivers to encourage take up. For businesses, a range of voluntary initiatives have operated but there have been no drivers for the sector to actively recycle waste and costs of the change, without rationalisation of used services, can inhibit the transition. Government is unlikely to meet a target to recycle 50% of household waste by 2020 or future targets. Government has committed to meet a 65% municipal recycling rate by 2035.

Will the policy be reviewed? It will be reviewed. **If applicable, set review date:** 3 years post implementation

Does implementation go beyond minimum EU requirements?		No		
Are any of these organisations in scope?	**Micro** Yes	**Small** Yes	**Medium** Yes	**Large** Yes
What is the CO_2 equivalent change in greenhouse gas emissions? (Million tonnes CO_2 equivalent)		**Traded:** -12.9	**Non-traded:** -13.8	

I have read the Impact Assessment and I am satisfied that, given the available evidence, it represents a reasonable view of the likely costs, benefits and impact of the leading options.

Signed by the responsible SELECT SIGNATORY: ..... Date: .....

Summary: Analysis & Evidence

Policy Option 1M

Description:

FULL ECONOMIC ASSESSMENT

Price Base Year 2018	PV Base Year 2023	Time Period Years 13	Net Benefit (Present Value (PV)) (£m)		
			Low: -£2,225m	**High:** £4,319m	**Best Estimate:** £798m

COSTS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Cost (Present Value)
Low	£399m	7	£370m	£4,828m
High	£399m		£384m	£5,022m
Best Estimate	£399m		£373m	**£4,872m**

Description and scale of key monetised costs by 'main affected groups'

LAs see £373m transition costs as a result of investment needs in new vehicles, containers and wider transition costs. LAs lose an income from garden waste charging scheme of £1,166m. This is a transfer to households as they generate savings from removed garden waste charges. Government loses £3,055m in reduced landfill tax receipts. This is a transfer in savings to LAs and businesses as they forgo the costs associated with disposing of waste to landfill sites. NHM policy support costs to businesses are £278m. All values are discounted.

Other key non-monetised costs by 'main affected groups'

Familiarisation costs to householders and businesses as a result of the introduction of the new practice of effectively separating their waste are not accounted for. Nor are the ongoing costs to households and businesses of sorting waste for collection. Wider impacts on the recycling and waste industry have not been monetised either.

BENEFITS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Benefit (Present Value)
Low	£0m	0	£222m	**£2,604m**
High	£0m		£803m	**£9,340m**
Best Estimate	£0m		£485m	**£5,670m**

Description and scale of key monetised benefits by 'main affected groups'

LAs see net savings (£872m) on ongoing costs of recycling and waste management. These represent additional net service savings, i.e. accounting for savings from increased recycling and reduced residual waste treatment costs, of collecting six key dry materials with current mix of collection services in England, introduction of weekly separate food waste collections and rolling out free garden waste collections. Households' savings from removed garden waste charging estimated at £1,166m over the period. This is a transfer from LAs to householders. NHM sector's waste management savings from increased recycling are estimated at £2,040m. This reflects the reduced residual waste treatment costs as well as avoided landfill tax payments. Greenhouse gas (GHG) emissions savings (traded and non-traded emissions) are estimated at £1,591m. These GHGs savings are net of emissions associated with recycling activities. All values are discounted.

Other key non-monetised benefits by 'main affected groups'

The recycling industry benefits from increased supply of higher quality and quantity of materials. However, this has not been monetised at this stage. International GHGs emissions saving have not been included in the presented estimates but are likely to be significant. Avoiding wider environmental costs, such as landfill aftercare costs, have not been included. Reduced pressure on residual waste infrastructure on net job impacts have not been quantified either.

Key assumptions/sensitivities/risks **Discount rate (%)** 3.5%

For household sector, scenarios reflect the uptake in recycling based on WRAP benchmark tables on achievable recycling yields. These tables differentiate in collection schemes, rurality, deprivation levels and other ONS categories. The low/high sensitivities do not assume any change in the recycling yields from best estimates but account for different material price assumptions. For the NHM sector, we assume 80% out of the total tonnage that could be further recycled is presented by businesses in the central scenario. 60% and 100% rates are assumed in the low and high sensitivities. The NHM baseline recycling rate is assumed to be 35% in best estimate, 40% in low estimate (implying low benefits) and 30% in high estimate (implying high benefits).

BUSINESS ASSESSMENT (Option 1)

Direct impact on business (Equivalent Annual) £m:			Score for Business Impact Target (qualifying provisions only) £m:
Costs: £0m	**Benefits:** £137m	**Net:** £137m	-£687m

Summary: Analysis & Evidence

Policy Option 2M

Description:

FULL ECONOMIC ASSESSMENT

Price Base Year 2018	PV Base Year 2023	Time Period Years 13	Net Benefit (Present Value (PV)) (£m)		
			Low: -£3,093m	**High:** £3,382m	**Best Estimate:** -£419m

COSTS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Cost (Present Value)
Low	£900m	7	£429m	**£5,347m**
High	£900m		£446m	**£5,535m**
Best Estimate	£900m		£445m	**£5,531m**

Description and scale of key monetised costs by 'main affected groups'

LAs see £858m transition costs as a result of investment needs in new vehicles, containers and wider transition costs. LAs lose an income from garden waste charging scheme of £1,166m. Government loses £3,229m in reduced landfill tax receipts. NHM policy support costs to businesses are £278m. All values are discounted.

Other key non-monetised costs by 'main affected groups':

Familiarisation costs to householders and businesses as a result of the introduction of the new practice of effectively separating their waste are not accounted for. **Nor are the ongoing costs to households and businesses of sorting waste for collection.** Wider impacts on the recycling and waste industry have not been monetised either. These costs are likely to be higher here given that it requires the transition of LAs to twin-stream collections and businesses are required to collect dry mixed materials and separate food waste.

BENEFITS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Benefit (Present Value)
Low	£0m	0	£218m	**£2,254m**
High	£0m		£881m	**£8,918m**
Best Estimate	£0m		£502m	**£5,112m**

LAs see net savings (£1,016m) on ongoing costs of recycling and waste management. These represent additional net service savings, i.e. accounting for savings from increased recycling and reduced residual waste treatment costs, of collecting six key dry materials with twin-stream collection services in England, introduction of weekly separate food waste collections and rolling out free garden waste collections. Households' savings from removed garden waste charging estimated at £1,166m over the period. NHM sector's waste management savings from increased recycling estimated at £1,211m because of paying less on refuse treatment costs, including landfill tax. GHGs emissions savings (traded and non-traded emissions) of £1,720m. These GHGs savings are net of emissions associated with recycling activities.

Other key non-monetised benefits by 'main affected groups'

The recycling industry benefits from increased supply of higher quality and quantity of materials. However, this has not been monetised at this stage. International GHGs emissions saving have not been included in the presented estimates but are likely to be significant. Avoiding wider environmental costs, such as landfill aftercare costs, have not been included. Reduced pressure on residual waste infrastructure on net job impacts have not been quantified either.

Key assumptions/sensitivities/risks **Discount rate (%)** 3.5%

For household sector, scenarios reflect the uptake in recycling based on WRAP benchmark tables on achievable recycling yields. These tables differentiate in collection schemes, rurality, deprivation levels and other ONS categories. The low/high sensitivities do not assume any change in the recycling yields from best estimates but account for different material price assumptions.

For the NHM sector, we assume 80% out of the total tonnage that could be further recycled is presented by businesses in the central scenario. 60% and 100% rates are assumed in the low and high sensitivities. The NHM baseline recycling rate is assumed to be 35% in best estimate, 40% in low estimate (implying low benefits) and 30% in high estimate (implying high benefits).

BUSINESS ASSESSMENT (Option 2)

Direct impact on business (Equivalent Annual) £m:			Score for Business Impact Target (qualifying provisions only) £m:
Costs: £0m	**Benefits:** £82m	**Net:** £82m	-£408m

Summary: Analysis & Evidence

Policy Option 3M

Description:

FULL ECONOMIC ASSESSMENT

Price Base Year 2018	PV Base Year 2023	Time Period Years 13	Net Benefit (Present Value (PV)) (£m)		
			Low: -£999m	**High:** £5,110m	**Best Estimate:** £1,341m

COSTS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Cost (Present Value)
Low	£622m	7	£427m	**£5,046m**
High	£622m		£457m	**£5,404m**
Best Estimate	£622m		£443m	**£5,239m**

Description and scale of key monetised costs by 'main affected groups'

LAs face transition costs of £590m of introducing the collection changes associated with multi-stream dry recycling collection, weekly separate food waste and full roll-out of free garden waste collections. LAs lose an income from garden waste charging scheme of £1,166m. Government loses £3,205m in reduced landfill tax receipts. NHM policy support costs to businesses are £278m. All values are discounted.

Other key non-monetised costs by 'main affected groups':

Familiarisation costs to householders and businesses as a result of the introduction of the new practice of effectively separating their waste are not accounted for. Nor are the ongoing costs to households and businesses of sorting waste for collection, though they are likely to be highest under this option. Wider impacts on the recycling and waste industry have not been monetised either. These transition and familiarisation costs might be highest in this scenario given that it requires the most transformational change across the household and NHM sectors.

BENEFITS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Benefit (Present Value)
Low	£0m	0	£391m	**£4,047m**
High	£0m		£1,036m	**£10,514m**
Best Estimate	£0m		£644m	**£6,580m**

Description and scale of key monetised benefits by 'main affected groups'

Despite the initial LAs transitional costs, LAs see a net cost reduction in ongoing waste management costs by £2,435m from diverting waste away from more expensive treatment options (landfill for example), increased material revenues and reduced operating costs. Households' savings from removed garden waste charging estimated at £1,166m over the period. NHM sector's waste management savings from increased recycling estimated at £1,206m. GHGs emissions savings (traded and non-traded emissions) of £1,773m. These GHGs savings are net of emissions associated with recycling activities.

Other key non-monetised benefits by 'main affected groups'

The recycling industry benefits from increased supply of higher quality and quantity of materials. However, this has not been monetised at this stage. International GHGs emissions saving have not been included in the presented estimates but are likely to be significant. Avoiding wider environmental costs, such as landfill aftercare costs, have not been included. Reduced pressure on residual waste infrastructure on net job impacts have not been quantified either.

Key assumptions/sensitivities/risks **Discount rate (%)** 3.5%

For the household sector, scenarios reflect the uptake in recycling based on WRAP benchmark tables on achievable recycling yields. These tables differentiate in collection schemes, rurality, deprivation levels and other ONS categories. The low/high sensitivities do not assume any change in the recycling yields from best estimates but account for different material price assumptions.

For the NHM sector, we assume 80% out of the total tonnage that could be further recycled is presented by businesses in the central scenario. 60% and 100% rates are assumed in the low and high sensitivities. The NHM baseline recycling rate is assumed to be 35% in best estimate, 40% in low estimate (implying low benefits) and 30% in high estimate (implying high benefits).

BUSINESS ASSESSMENT (Option 3)

Direct impact on business (Equivalent Annual) £m:			Score for Business Impact Target (qualifying provisions only) £m:
Costs: £0m	**Benefits:** £81m	**Net:** £81m	-£406m

Executive summary

The scope of this impact assessment (IA) is municipal waste, which is comprised of household waste and businesses and public sector organisations that generate household-like waste. This is in line with the municipal solid waste definition as agreed under the Circular Economy Package. These businesses are referred to as municipal businesses or the non-household municipal sector (NHM). Despite being grouped together as the municipal sector, waste collections for households and municipal businesses are very different and will be addressed separately throughout the IA.

The legal requirements being consulted on are to require local authorities and businesses and public sector organisations that generate household-like waste to collect and present a consistent set of materials for waste collection. The analysis in this IA covers different options and collection systems for local authorities and businesses that would meet this requirement and compares their costs and benefits. The preferred option has been chosen based on the highest net present value delivered by those modelled, but that does not mean that we will legislate to require the waste collection systems under that option. This is because some collection systems may not be best suited to particular areas, and a one-size fits all requirement would present delivery challenges. The legal requirements are solely on what materials that must be collected, not on how they should be collected, recognising that there needs to be flexibility in the systems used to collect waste across England. Further work will be undertaken post-consultation to review the modelling at a local authority and business level, looking at the most cost-effective collection systems.

Current requirements and policy on recycling are proving insufficient to increase recycling beyond the current level of 44-45% for households and 35% for municipal businesses and reduce the amount of refuse waste produced.

Overall, changing collection systems can unlock significant environmental and financial benefits and increase the quantity and quality of materials collected for recycling. There are significant barriers limiting further uptake such as insufficient pricing of environmental externalities, behavioural barriers at the point of materials' collection or fragile secondary materials markets preventing these benefits being realised. Through mandating increased standardisation of recycling collections, we expect that business and residential understanding of what can be recycled would increase, leading to high recycling rates by both sectors as well as lower contamination and better compliance with our requirements.

Following an options analysis, the collection systems that yielded the highest Net Present Value (NPV, net benefit to society), and are therefore our recommended option (Option '3M'), are:

- For households: Multi-stream dry recycling collections of six key materials, separate food waste and free garden waste collections from low-rise properties. Collection of six key materials from high-rise properties.
- For municipal businesses: Dry materials recycling, separate food waste collections and separate glass collections.
- The NPV (2023-2035) of these two options combined is £1,341m.
- There are wider environmental and economic benefits associated with greater waste and recycling separation that have not been monetised at this stage (see Annex E). These are likely to be most prevalent under Option 3M where material quality is highest due to increased waste separation at the point of collection.

The positive net present value for Option 3M of introducing new regulatory requirements on the municipal sector to increase separate recycling collections is the result of following factors (see the Table below):

- Local Authorities (LAs): Only this option shows net savings (-£679m) to LAs. LAs are expected to make long-term savings (-£2,435m) on significantly lower operating costs of multi-stream collections (e.g. reduced staff and vehicle infrastructure costs compared to other options), higher material revenues from selling higher quality dry recyclates and reduced payments to cover landfill and incineration treatment costs. However, LAs would be faced with initial transition costs in the first seven years (£590m) and would also lose the income of £1,166m from charging for garden waste collections. Overall, estimated long-term savings could be achieved only with initial investment from LAs into new waste collection systems.
- Funding for these changes would be a consideration for the next Spending Review period and would take into account the role of future investment available from producer responsibility reforms and other measures to boost recycling as announced in the HMT Budget 2018.
- As a consequence of LAs' changes, householders would see savings of -£1,166m from removed garden waste charges.
- For the wider municipal sector (NHM), net costs will decrease by -£928m. This comprises of -£1,206m savings to the sector from increased recycling and £278m policy support costs. Savings from increased recycling are due to a number of interrelated factors.
- First, evidence shows that dry and food recycling collections are typically cheaper than refuse bin collections. Thus, in theory, businesses should have been already presenting separate recyclates for collection to unlock these savings. However, these savings are achievable only if businesses reconfigure their current services towards increased use of recycling collections through the reduction of size or frequency of refuse waste collections. Otherwise the introduction of recycling collections result in net costs to businesses.
- Large and medium sized businesses have often more flexibility to reconfigure their waste and recycling collections due to the overall size of waste generated per large/medium business. But this is less likely to be an option for small and micro businesses which may not be able to reduce the costs for refuse collections. Certain cost savings can be achieved through shared service provision of recycling and waste collections across several micro/small businesses. Overall, this scenario sees net savings for large, medium and small but net costs for micro businesses. Measures to mitigate costs for small and micro firms will be further investigated through consultation on consistent recycling, engagement with the sector, and developed prior to implementation.
- Second, whilst the sectoral savings are significant, these would be spread across around 2 million business, with substantial differences across sub-sectors and business sizes, and 15 years. These savings translate to around 3-4% waste management cost reduction when compared to baseline costs. Recycling and waste management costs represent relatively small portion of business overall turnover (possibly around 4-5%) and evidence shows that recycling has not been a priority for many businesses, particularly small and micro sized ones.
- Last, our NHM scenarios present a cost-effective path of the uptake in recycling collections. Large and medium businesses are more likely to see net savings than small and micro businesses. Thus, we assumed a phased introduction of recycling requirements, starting with the most cost-effective sectors and not requiring small and micro businesses to start making changes until 2029 and 2032, respectively.
- In order to achieve such a transformational change in the NHM recycling performance, we costed sectoral support (£278m) that would include national communications, share of best practice and development of further cost reduction options to small and micro businesses. These are assumed to be the same across all scenarios modelled.

- We estimate that the shift to increased recycling would result in landfill tax revenue loss of £3,205m but also significant GHGs emissions savings worth -£1,773m.
- At this stage, none of the LAs or NHM savings account for the impact of possible economies of scale through the increased standardisation of recycling collections. We expect that this would further increase the savings of proposed policy options.
- Conversely, we do not quantify potential familiarisation and inconvenience costs to households and businesses because of increased waste separation. WRAP evidence shows three key service features as being important are having a regular and reliable service, being clear on what can/cannot be recycled and sufficient capacity in the recycling container for all their materials. The aspect of not having to separate waste into multiple containers scored lower in importance (see Annex E)[1].

Despite the overall benefits, there are distributional impacts, with some local authorities achieving cost savings while others face net cost increase. Similarly, the transition to higher recycling yields higher benefits for large businesses than for micro businesses.

Change over 2023-2035 (discounted, against baseline) Costs (+) savings (-)	**Option 1M** HH: current systems NHM: DMR + separate glass	**Option 2M** HH: two-stream NHM: DMR + separate food waste	**Option 3M** HH: multi-stream NHM: DMR + separate food waste + separate glass
Municipal recycling rate achieved (baseline 40%, 44% HH and 35% NHM)	57% (56% HH, 58% NHM)	62% (56% HH, 70% NHM)	64% (55.5% HH, 74% NHM)
Additional LAs net waste management costs(+)/savings(-) from changes in dry recycling, food waste and free garden waste collections for all HHs	£667m: £373m transition costs, -£872m savings on ongoing costs, and £1,166m lost income from garden waste charging	£1,008m: £858m transition costs, -£1,016m savings on ongoing costs, and £1,166m lost income from garden waste charging	-£679m: £590m transition costs, -£2,435m savings on ongoing costs, and £1,166m lost income from garden waste charging
Savings to households from removed garden waste charging	-£1,166m	-£1,166m	-£1,166m
Net waste management costs (+)/savings(-) to NHM businesses under increased recycling collections	-£2,040m	-£1,211m	-£1,206m
Policy costs to apply best practices in recycling collections	£278m	£278m	£278m
Reduction in government landfill tax receipts (benefits to municipal sector included in LA and NHM rows)[2]	£3,055m	£3,230m	£3,205m
GHGs emissions savings (UK only, traded and non-traded)	-£1,591m	-£1,720m	-£1,773m

[1] WRAP (2015) Recycling Tracker Survey. Sample size: 1,771.

[2] As explained in the key municipal-wide sector assumptions section, the landfill tax value is assumed to be flat and at the 2015/16 level of £82.60 per tonne of waste sent to landfill. Whilst the landfill tax is expected to rise in line with the growth in the Retail Price Index in reality, a constant rate has been assumed for the modelling purposes as all other prices have been kept constant.

Net present value (- for societal costs; + for societal savings)[3]	**£798m**	**-£419m**	**£1,341m**

See 'Description of options considered' section for more detail and definitions

The IA starts by setting the problem under consideration, rationale for government intervention to overcome market failures and other barriers, and the policy objective we want to achieve. Following on from that, the IA sets out the recycling baseline for the two parts of the municipal sector and describes the recycling collection system options that have been considered. This will be followed by economic analysis that will look at the economic and environmental costs associated with each of the available options. A section that looks at the assumptions made in each of the scenarios then follows, with which we conclude.

The IA presents only summary results in the main sections, with a more detailed explanation of the sector and analysis included in supporting annexes at the end of the document. Annexes included are:

A. Additional detail on household and non-household municipal options considered,
B. Additional detail on the baselines used for the household and non-household municipal sectors,
C. Additional detail on the economic assessment of collection systems options for the household, and non-household municipal sectors
D. Environmental impacts,
E. Non-monetised costs and benefits, and;
F. Key Assumptions

[3] The net present value calculation removes the garden waste charges and landfill tax changes from the overall societal costs or savings as these are transfers between relevant parties (garden waste charging – costs to LAs, savings to householders; landfill tax changes – loss to Government, saving to municipal sector).

Problem under consideration

Household waste collections

English household recycling rates have been static at around 44-45% for five years with few local authorities (LAs) expanding services to add new materials to be collected. Some authorities have also stopped services such as separate food waste collection or collection of plastic pots, tubs and trays. Some have introduced charges for previously-free services such as garden waste collection[4]. Local authorities' budget provisions have reduced and, together with the slowing impact of current incentives, this has led to a lack of investment in new recycling services.

Landfill tax has been the main driver for local authorities to divert household waste from landfill and towards energy recovery or recycling. This has incentivised local authorities to provide recycling services for most dry materials but at current levels the marginal cost of introducing new services such as separate food waste collection outweigh the environmental benefits that would be realised as a result of diverting that waste from landfill or incineration. Similarly the benefits of expanding recycling services to include certain types of plastics are limited because the value of those materials on secondary markets does not outweigh the costs of collection.

Current targets for recycling are weight based but Government has said it may review its approach to weight based targets and alternatives such as carbon based. These options are not considered as part of this impact assessment but the accompanying consultation seeks views on possible alternatives.

Dry recycling collections

The Government has made a manifesto commitment for comprehensive rubbish and recycling collections. Currently there is limited consistency over the materials local authorities collect for recycling, with only 70% collecting the six main material streams of glass, paper, card, metal, plastic bottles and pots, tubs and trays. This reduces the quantity of material collected overall and undermines public confidence and participation in recycling because householders are confused about what can and can't be recycled.

WRAP surveys show that over three quarters of UK households (76%) add one or more items to their recycling collection that is not accepted locally. In addition, more than half (54%) put at least one item in the general rubbish that could be recycled[5]. As a result householders either recycle fewer items than they are able to or contaminate recycling bins with items that are not collected locally for recycling or items that cannot be recycled (e.g. soiled packaging). Such contamination can reduce the quality and value of materials recycled and can even lead to whole loads being rejected at reprocessing or sorting centres. This in turn reduces the amount of material made available to producers to be recycled into new products and also makes it harder for the UK to match the 65% of municipal waste recycling ambition by 2035 (set in Resources and Waste Strategy). Or for packaging producers to achieve targets and obligations to recycle a set proportion of the packaging they place on the UK market.

China's recent ban on the import of certain types of recycling has reinforced the need for us to improve the quality of what is recycled and to increase the separation of dry materials for recycling so that there is less cross contamination between glass and paper for example and also of recyclable and non-recyclable materials. China will be introducing further changes in the near future.

[4] WRAP LAs recycling performance portal.

[5] WRAP, 2017, Recycling Tracker Report.

High profile media coverage such as The Blue Planet means that there is high public demand to tackle the problem of waste in more effective ways and to recycle more materials especially plastics.

The quality of dry recycling has also failed to improve in recent years, with Materials Recovery Facilities (MRFs) reporting a target material[6] percentage of 87.5% at the start of 2018, a fall from 90.6% since quarter 4 2014, with a notable rise in non-recyclable material received[7]. This is influenced by both collection services run by LAs as well as products being placed on market by producers. More composite or difficult to recycle products placed on the market cannot be controlled by local authorities or waste management companies running the MRFs.

Food waste collections

Approximately 4.1 million tonnes of food waste are sent to landfill each year, with 1.9 million coming from households[8]. This contributes to greenhouse gases (GHGs) emissions from landfill. The government has made a commitment in its Clean Growth Strategy to work towards no food waste entering landfill by 2030.

Currently 51% of local authorities collect food waste separately from residual waste but only 33% collect this separately from other biodegradable waste and on a weekly basis with remaining authorities collecting food waste mixed with garden waste (Table 1). Collecting food waste mixed with garden waste is less efficient than weekly separate collection. It leads to lower amounts of food waste being collected and less efficient treatment through in-vessel composting compared to anaerobic digestion, which produces energy and organic soil improver or fertiliser[9]. If all local authorities provided at least kerbside properties with a household food waste collection this would increase the amount of food waste collected by an estimated 1.4 million tonnes by 2035.

Table 1: Percentage of English LAs collecting selected materials for recycling

% of English LAs collecting	Beverage cartons	Card-board	Foil	Glass	Metal packaging	Mixed plastic film	Paper	Plastic Bottles	Plastic Pots, Tubs and Trays	Separate food waste
2016/17	63%	99%	72%	89%	100%	21%	100%	99%	73%	33%

Source: WRAP Local Authorities portal

Garden waste collections

Providing all kerbside garden properties with a free garden waste collection would help to increase recycling rates further and also ensure this material was sent to composting rather than sometimes discarded as residual waste. Charging for garden waste is likely to reduce the number of households using the service, therefore increasing garden waste in residual waste. Where this is sent to landfill this generates greenhouse gas emissions as well as leachate, an acidic liquid which needs to be extracted and treated. There is also evidence that home composting of garden waste is often less efficient than a dedicated collection and composting service.

Around 58% of local authorities charged for garden waste collections in 2017/18[10] but this results in significantly lower participation than a free service (Annex F).

[6] Target material is materials is capable of being recycled and is targeted by MRFs. Non-target material can be either non-recyclable material or non-target, which means it is recyclable but it is not a material that a MRF is looking to sort.

[7] http://www.wrap.org.uk/sites/files/wrap/WRAP_MF2018_Q1Commentary_FINAL_0.pdf

[8] http://www.wrap.org.uk/sites/files/wrap/Estimates_%20in_the_UK_Jan17.pdf

[9] http://www.wrap.org.uk/sites/files/wrap/Food_Garden_Waste_Report_Final.pdf

[10] http://laportal.wrap.org.uk/

Overall, national household recycling rates have stagnated over the past five years with few drivers to help local authorities increase recycling or address the waste hierarchy[11].

Business waste collections

The revisions introduced to the Waste Framework Directive by the Circular Economy Package bring business waste similar to household waste into the definition of municipal waste which also covers the household. This definition is used to measure progress against recycling performance and targets. We expect the revised definition for municipal waste to become law by 2020.

Given the size of the business sector (around 2 million business and public administration units), it potentially makes a significant contribution to the overall municipal recycling targets. The various sub-sectors in business have not historically had direct policy measures to drive their recycling performance apart from the price they pay for the collection of waste. Business waste and recycling services tend to be a very small proportion of overall business turnover and so efficiency gains in diverting more waste to recycling may yield comparatively few savings at site level and provide limited financial incentive to separate waste[12].

The Waste (England and Wales) Regulations 2011 require waste collectors to collect paper, metal plastic or glass separately where it is technically, environmentally and economically practicable and appropriate to meet the necessary quality standards for the relevant recycling sectors. Generally waste collection services are offered on a per bin or per lift basis and businesses would pay a higher cost for having additional bins unless reducing the use of refuse waste bins. Therefore there may be a little saving per business to arrange for separate collection of recyclables and especially separate collection of food waste.

Currently, there is a substantial variation in the sector's performance, both across sub-sectors and business sizes, and data quality is significantly poorer compared to household sector. We estimate levels of recycling from municipal businesses at around 35%. However, there is potential to increase these rates through introducing requirements for greater separation especially of dry materials and food waste.

Our analysis indicates that this could increase recycling to as much as 84% under full capture of remaining recyclates. This a theoretical potential that could be only achieved under substantial changes to the way the NHM waste sector operates. These changes could, for example, include measures to ensure more municipal businesses have access to recycling collection services at reasonable cost. This could be achieved through businesses working together to procure services or local authorities or other bodies such as facilities managers controlling waste procurement over a group of premises in a single building or shopping centre etc. to realise economies of scale and to increase recycling provision. The consultation IA does not examine specific measures.

Rationale for Intervention

Waste generation is a source of negative environmental externalities as it can emit greenhouse gases when sent to treatment such as incineration or landfill. When waste cannot be prevented, recycling can minimise the environmental costs of products/materials being disposed of, and create value by providing valuable materials for manufacturing.

[11] WRAP, 2016, Systematic Survey of Local Authority Plans for Waste and Recycling Services in England.

[12] The Chartered Institute of Procurement and Supply (CIPS) estimate the amount spent on waste to be around 4% to 5% of business turnover, possibly up to 10% for certain businesses.

Current measures and requirements for household collection of recyclable materials, such as landfill tax or dry recycling separation, are proving insufficient to increase recycling beyond the current level of 44-45% and reduce the amount of residual waste produced. Loose requirements on local authority waste collections have led to a variety of different collection systems and materials collected, leading to confusion on what can be recycled. This limits potential for recycling and lowering the environmental and economic benefits that otherwise could be achieved.

For NHM sector, businesses usually pay for waste collections on a per lift or bin basis. Consequently, introducing additional recycling bins may not lead to reduced waste costs. Government intervention is therefore needed to require a consistent range of waste materials to be collected from households and from businesses to overcome these. This will enable current measures such as landfill tax to be most effective at driving waste up the waste hierarchy.

Behavioural barriers

Overall, the case for change in the municipal sector is undermined if the overall business case from higher recycling is marginal, upfront costs are high and future savings are uncertain because they depend on assumptions of higher recycling rates and secondary material prices. In addition waste and recycling services have not been a priority area for businesses or Local Authorities in recent years. Business waste services represent a small cost for most operators which means few incentives to improve even though changes could lead to savings over time. In addition current waste service arrangements in the commercial sector do not drive economies of scale or incentivise recycling over residual waste.

Household sector

Local Authorities provide collections of recyclates based on their own decisions. Whilst this helps to account for local circumstances, evidence shows that this can create confusion to householders over the type of materials collected and the way they should be presented for the collection[13]. Requiring a certain set of materials to be collected consistently across England, and possibly through standardised collection systems, would improve householders' understanding and participation in the use of the collection systems.

Although our analysis suggests that certain collection schemes might result in cost savings for LAs, some authorities may see the change as a risk increasing their cost burden in the short-term. This is because the savings depend on an uncertain income from selling separately collected materials, reduction in gate fees' payments, compared with what the LA are used to pay at the moment. Significant risk aversion due to clear upfront costs but uncertain long-term savings may thus be a cause of them not making the change themselves. Another possible factor is political preference to collection schemes requiring less bins which reduces the LAs cost savings potential in the long-term.

Non-household municipal sector

With respect to businesses and public sector organisations generating household-like waste (i.e. non-household municipal sector (NHM)), the main behavioural and cost barriers are particularly relevant to small and micro businesses. These are understood as the following: waste and recycling is low on business agenda, there is lack of clarity of responsibilities

[13] WRAP, 2017, Recycling Tracker Report.

between businesses and waste management companies and possible split incentives[14]; there is little knowledge of how through re-configuring their collection provisions the overall waste management costs can be reduced; possible space issues especially for micro businesses; high turnover of staff etc.[15]

Businesses typically pay for the collection and subsequent processing of material in their waste and recycling collection containers on a regular schedule under contract. Recycling collection charges per 'bin-empty' are lower than for residual bins due to the value of the material or their lower processing costs compared to refuse. However, diverting some recyclable waste from the refuse bin may still mean that a refuse container is required despite it becoming less full. The need for a range of recyclable containers to collect the extra material streams will increase cost to businesses unless all of the waste from the refuse bin can be removed and that service suspended or reduced in frequency.

For larger businesses, reducing a number of refuse containers and using savings to pay for more recycling is possible and likely to generate overall savings. A key issue for very small businesses is that re-configuring the container mix is more difficult when there may be limited containers to start with and adding in extra recycling bins at current market prices may increase overall costs.

The majority of the charges for commercial collections relate to the operational delivery cost and not the treatment of the material. Increase in tax will have limited impact on the overall cost choice for the business between recycling and residual streams.

The waste composition profiles for the diverse NHM sectors all show much larger proportions of recyclable waste than for household waste. This is primarily due to businesses purchasing packaged goods from their supply chain, food waste generated in preparation and post-consumer waste. As such the recycling potential from NHM sectors is significantly greater than from household sector which contain greater proportions of non-recyclable waste.

New regulation would save businesses money overall by driving high participation in recycling services through the requirement to separate key materials which in turn improves the economies of scale in collection. Businesses would be required to segregate their core waste into up to four streams depending on the types of waste the businesses generate. Without the intervention of legislation there appear limited options to incentivise businesses in the separation of key recyclables which are important to meet future national targets.

It is important to note that whilst the savings in waste management costs for the NHM sector appear large the savings are relatively small at individual site level given the two million businesses included in the NHM sector. Waste management and recycling costs remain a very small proportion of overall turnover. The importance of legislation is to force the business case which otherwise would be unlikely to happen without large scale participation across the numerous and diverse NHM sectors.

Savings also rely to some extent on higher revenues for separated material being passed on in savings for the waste-generating businesses. This wouldn't necessarily be the case if a business were to adopt a preferred collection regime in isolation. This is because of the cost overhead involved for a collection vehicle to get to a business' site. It is thus possible that a co-ordination problem has prevented the realisation of benefits.

[14] For example, charging on a per lift basis regardless of whether the bins are full or not can possibly make the use of recycling services more expensive, if simply added next to the refuse waste collections.

[15] WRAP review of studies of SMEs barriers to higher recycling

The charges for container collections in this analysis use current market prices which are a reflection of current low levels of participation and separation. A key benefit of intervention through legislation would be that the higher presentation rates of recyclable materials reduce the charges to businesses. Charges would reduce from improvements in the efficiency of collection, making better use of collection assets and increased revenue from the capture of more recyclable materials. However, given the complexity in charging and range of NHM business a future reduction in container charges has not been assumed in this assessment.

WRAP's analysis of barriers to SMEs recycling and 2017 consultation with industry outlined that there are a range of current and future potential options that could reduce current charges for businesses. These options include proliferation of Business Improvement Districts to realise economies of scale and greater collaborative procurement at site level or area level; use of local household bring sites for commercial waste drop off; expansion of dedicated commercial waste bring centres and a number of international examples of joint procurement driven by Local Authorities. A number of these scenarios are currently under review by Defra and WRAP, and will be included in the final impact assessment. These measures should help to reduce costs of waste collection per business by having collections of waste and recycling managed across several businesses so that each user pays a smaller proportion of cost for the service received.

Environmental externalities

The municipal sector is not fully accounting for the environmental impacts of the resources it uses and waste it generates when making decisions on recycling and waste disposal. Despite incentives being aligned to the waste hierarchy, with landfill being subject to landfill tax as it is the worst option environmentally for most materials, there is still a significant amount of waste that ends up in landfill and incineration. In fact, the total amount of residual waste (sent to landfill or incineration) generated by local authorities has remained stable over recent years[16].

These environmental impacts range from the impact on natural resource depletion, greenhouse gas emissions, and wider ecosystem impacts associated with the production of raw materials when compared to the use of secondary, recycled, materials. This should also reflect the environmental impacts of waste management activities when comparing recycling to refuse waste treatment options (energy from waste incineration or landfilling). Generally, recycling activities are less carbon intensive compared to the refuse waste treatment options and help avoid suboptimal extraction of virgin materials. Further, there are known long-term environmental issues and high management costs associated with landfill aftercare treatments.

System-wide failures

Suboptimal levels of recycling have wider, system-wide implications. First, recycling activities are generally less capital and infrastructure intensive when compared to residual waste treatment. As recognised by National Infrastructure Commission, the higher recycling performance generally leads to lower pressures on residual waste infrastructure[17].

A fragmented approach to recycling currently undermines the development of viable and resilient secondary markets for materials and goods in the UK. The contamination of materials for recycling was identified as one of the key barriers in relation to plastics, paper and cardboard, metals and glass in a recent WRAP research[18]. There is particular concern about the impact of co-mingled kerbside collections of dry recyclates on paper quality, the ability to colour separate glass and more generally challenges for all materials around the recycling

[16] https://www.gov.uk/government/statistical-data-sets/env18-local-authority-collected-waste-annual-results-tables

[17] National Infrastructure Commission, 2018, National Infrastructure Assessment.

[18] Anthesis, forthcoming, Characterising Supply and Demand within secondary material and goods markets.

infrastructure in the UK and how this can create wider issues further down the supply chain. The different preferences at LAs collection side (a complex variation of collection systems with materials often collected co-mingled) and the NHM side (low recycling levels and material separation) against supply chain preference (calls for separating glass and paper and other fibres) shows that there are split incentives between those presenting and collecting materials at one side and preferences down the supply chain.

Finally, UK secondary material markets have recently experienced a turbulent situation with regards to export markets. Whilst the reasons for this are wide-ranging, a failure in improved quantity and mainly quality of presented recyclates may have contributed to UK's high dependence on export markets rather than strengthening domestic reprocessing capabilities and use of secondary materials in domestic production.

Policy objective

We want all local authorities in England to collect a core set of dry materials. These would be glass, paper, cardboard, metal packaging, plastic bottles and plastic pots, tubs and trays. These are currently collected by 70% of local authorities[19]. Expansion to all local authorities would increase the amount of dry materials collected. This measure together with clearer labelling of recyclable packaging, would also reduce confusion among households over what can and can't be recycled. This would help to reduce contamination of non-recyclable items in recycled materials, providing a higher quality recyclates for reprocessors and secondary materials markets. Evidence from nationally collected data from MRFs shows much higher levels of contamination for whole mixed material streams than when compared to part mixed or separate streams[20].

We also want all local waste authorities to separately collect food waste, which can then be sent to anaerobic digestion sites where it generates biofuel and a nutrient-rich fertiliser, rather than landfill, where it releases methane and contributes to the generation of leachates. The UK committed to working towards sending no food waste to landfill by 2030 through its 2017 Clean Growth Strategy.

We want all businesses and public sector organisations generating household-similar waste to segregate this into a core set of dry materials and food waste. Greater consistency in the range of materials presented will enable increased economies of scale in service provision (e.g. reducing the costs of food waste collections) and reduced charges to businesses. The increased quantity and quality of materials will ensure more viable and resilient secondary markets. These measures would impose some additional costs on businesses but there would be scope to reduce these costs by measures to share collection services across businesses or districts. This could reduce collection overheads for individual businesses.

We will issue key guidelines to ensure minimum standards are achieved in the design and delivery of these new collections in order to achieve high levels of performance. The standards will also ensure consumers have access to frequent quality services which enable high levels of satisfaction and participation.

This policy will dovetail with reforms to packaging Extended Producer Responsibility (EPR) and the potential introduction of a Deposit Return Scheme (DRS). These provisions will see producers bearing much greater costs for collection and disposal of packaging placed on the market than at present. This additional financial obligation will be used to support both local authorities and businesses to reduce costs of collecting packaging. In turn, the increased

[19] WRAP Local Authorities portal

[20] http://www.wrap.org.uk/sites/files/wrap/WRAP_MF2018_Q1Commentary_FINAL_0.pdf

quantity and quality of recycling collected will help producers to meet packaging obligations to demonstrate that packaging placed on the market is properly recycled. For modelling purposes we have assumed that implementation of changes to adopt consistent dry collections, separate food waste collection and free garden waste collection would begin from April 2023 and would continue for several years as local authorities renegotiated contracts and adopted additional collection arrangements. As announced in the Budget 2018 Government is consulting on reforms to EPR and will be consulting on a plastics tax to boost recycled content in plastics, Future revenues raised from these measures will enable investment to address single-use plastics, waste and litter to meet the government's ambitions for resources and waste.

Description of options considered

The options considered in this analysis are informed by previous WRAP and Defra studies on maximising national recycling performance (e.g. consistency framework, 50% recycling target, Circular Economy Package). The scenarios include well established scheme design principles and peer reviewed industry assumptions. Good practice scenarios have been looked for both household and NHM sectors and this study focuses on the combined impacts.

Based on the analysis of costs and benefits, the following three municipal options are presented in the overall NPV calculations (Table 2). These have been selected from a list of potentially nine scenarios when combining three household and three NHM options.

Table 2: Description of options considered for household and non-household municipal waste

Sector	Option 1Municipal (M)	Option 2Municipal (M)	Option 3Municipal (M) **Preferred option**
Household Sector (HH)	*Option 1hh*: Consistent collection of dry recyclables under current systems for low-rise properties Weekly separate food waste collection, free garden waste collections for low-rise properties Collection of key dry recyclables at flatted properties.	*Option 2hh:* Consistent two-weekly collection of dry recyclables under "two-stream" systems for low-rise properties Weekly separate food waste collection and free garden waste collections for low-rise properties Collection of key dry recyclables at flatted properties.	*Option 3hh:* Consistent weekly collection of dry recyclables under "multi-stream" systems for low-rise properties Weekly separate food waste collection and free garden waste collections for low-rise properties Collection of key dry recyclables at flatted properties.
Non-Household Municipal (NHM) sector	*Option 1nhm:* Businesses separate waste to mixed dry recyclables and separate glass waste collections.	*Option 2nhm:* Businesses separate waste to mixed dry recyclables and separate food waste collections.	*Option 3nhm:* Businesses separate waste to mixed dry recyclables, separate glass waste collections and separate food waste collections.

See Annex A for more detail

Waste collection system definitions

- **Dry recycling/recyclables:** Paper, cardboard packaging, plastic packaging, glass packaging, metal packaging etc.
- **Multi-stream collection:** Dry recycling materials are presented for collection by the household in three separate containers.
- **Two-stream collection:** Dry recycling materials are presented for collection in two separate containers, for example fibres (paper and cardboard) in one and other dry materials in another.
- **Mixed dry recyclables collection:** Dry recycling materials are presented together in one bin. This also called co-mingling.
- **Separate food waste collections:** Food waste is collected in a separate container, on its own, as opposed to mixed garden and food waste collections.
- **Separate free garden waste collections:** For households, garden waste is collected separately from other waste materials and is not directly charged for.

Low-rise and flatted properties: For households, properties that are usually three stories or less whose waste is collected at kerbside. Flatted properties are those usually higher than three stories. Their waste may be collected at kerbside but also there may be recycling facilities with shared bins within the building complex. The reason for the distinction is that it is usually easier to collect waste from low-rise properties and residents tend to use recycling bins more than in flatted properties. This is because the recycling facilities in the flatted properties are more complex, there may be inadequate space at the point of collection to separate recyclables, etc.

Summary results on municipal waste collection systems options

Municipal sector summary

Combining the household and non-household recycling scenarios as described in the 'Description of options considered' section results in the following impacts (Table 2). The scenarios are based on the assumption that these collection systems would be introduced through a variety of different regulatory requirements.

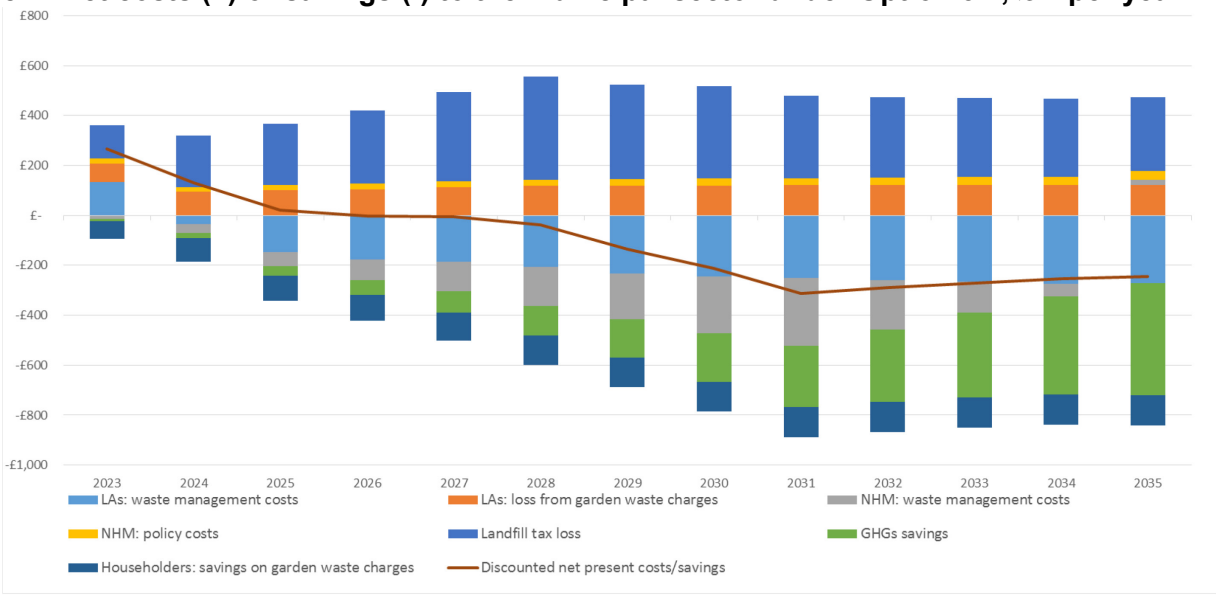
- **Recycling rate**: the combination of ambitious household and NHM scenarios achieves an increase in the recycling rate in the range of 55% to 64% by 2035. This excludes the contribution of metals recovered and recycled from incinerated bottom ash.
- **LA waste management costs**: see a net increase in costs for 1M and 2M scenarios but a reduction in net costs by 2035 for 3M scenario. The latter assumes the full roll-out of multi-stream dry recycling collections. These results also account for all LAs rolling out free garden waste collections. For all scenarios there is an increase in costs during the initial implementation.
- **Garden waste charging:** All household scenarios assume LAs provide free garden waste collections. LAs face the costs of this service while households see a reduction in costs of the free service of up to £121m per year from not being directly charged for the service.
- **NHM waste management costs:** are estimated to fall across all scenarios over the period of 2023-2035. The largest savings are observed for large, medium and small businesses. Micro businesses typically experience a net cost increase in waste management costs (see the 'Small and Micro Business sized Assessment' section). These substantial savings may be attributed to optimised use of recycling and waste services, i.e. the reduced use of

residual waste collections which are generally more expensive than recycling collections. And, for small and micro businesses, use of services such as shared service provision of recycling and waste collections. In our analysis we assume that some micro and small businesses would make use of the provision, although only a few may be doing so at present.

- **NHM sector support costs:** are assumed to rise from £19m in 2023 to £36m in 2035 across all municipal scenarios. These include national communication campaigns, random site visits, mailing and design costs and other policy support activities essential for effective transition to higher recycling.
- **Landfill tax impact:** All municipal scenarios are estimated to see a substantial reduction in landfill tax by 2035. The modelling results show that all scenarios see only 5% of municipal solid waste (MSW) sent to landfill by 2035, compared to 10% in baseline.
- **GHG emissions savings:** All municipal scenarios achieve a substantial reduction in GHGs emissions with associated societal savings. These grow to £388m and £421m per year for Options 1M and 2M in 2035 and £449m for Option 3M in 2035.
- **Net present value:**
    - Option 1M sees societal savings in 2023-2035. This is mainly due to the additional ongoing savings to LAs and significant cost savings in the NHM sector. GHG emissions savings are lowest for this option.
    - Option 2M sees marginal societal costs over the appraised period. LAs face transition costs of moving to twin-stream that translate to ongoing net savings but not enough to counter the initial transition costs and income losses from removed garden waste charging (when compared to 3M). In addition, food waste requirements in the NHM sector reduce the overall sectoral savings as food waste collections will add cost mainly because they target a dense material that does not free up sufficient space from the residual waste bin to enable sufficient savings in optimisation. GHG emissions saving are larger than in 1M scenario.
    - Option 3M achieves societal savings over the period of 2023-2035. This is due LAs net cost savings from introducing the multi-stream collections, waste management savings across the NHM sector and, consequently, significant GHGs emissions savings.
- **Non-monetised costs and benefits:** See Annex E on the implication of these scenarios with respect to recycling and waste infrastructure needs; familiarisation costs, wider economic benefits; landfill aftercare costs, international GHGs emissions savings and household and business inconvenience and disamenity costs. Non-monetised costs on households and businesses are likely to be higher under Option 3 than under other options (though evidence on inconvenience costs suggests they might not be significant), but the non-monetised wider benefits of option 3 are also likely to be higher.

Results presented below relate only to the assumption made in the central case.

Figure 1: Net costs (+) or savings (-) to the municipal sector under Option 3M, £m per year



Source: Defra analysis

Table 3 below summarises the net costs and savings of each municipal scenario. Figure 1 shows the profile of costs and savings to the municipal sector over the period of 2023-2035 for Option 3M. All results are shown with constant prices and, where relevant, applying an annual discount rate of 3.5% per year[21]. The analysis follows the Aqua book principles throughout[22].

Table 3: Summary of impacts of considered policy options

Change over 2023-2035 (discounted, against baseline) Costs (+) savings (-)	**Option 1M** HH: current systems NHM: DMR + separate glass	**Option 2M** HH: two-stream NHM: DMR + separate food waste	**Option 3M** HH: multi-stream NHM: DMR + separate food waste + separate glass
Municipal recycling rate achieved (baseline 40%, 44% HH and 35% NHM)	57% (56% HH, 58% NHM)	62% (56% HH, 70% NHM)	64% (55.5% HH, 74% NHM)
Additional LAs net waste management costs(+)/savings(-) from changes in dry recycling, food waste and free garden waste collections for all HHs	£667m: £373m transition costs, -£872m savings on ongoing costs, and £1,166m lost income from garden waste charging	£1,008m: £858m transition costs, -£1,016m savings on ongoing costs, and £1,166m lost income from garden waste charging	-£679m: £590m transition costs, -£2,435m savings on ongoing costs, and £1,166m lost income from garden waste charging
Savings to households from removed garden waste charging	-£1,166m	-£1,166m	-£1,166m
Net waste management costs (+)/savings(-) to NHM businesses under increased recycling collections	-£2,040m	-£1,211m	-£1,206m
Policy costs to apply best practices in recycling collections	£278m	£278m	£278m
Reduction in government landfill tax receipts (benefits to municipal	£3,055m	£3,230m	£3,205m

[21] HM Treasury, 2018, The Green Book – central government guidance on appraisal and evaluation.

[22] HM Treasury, 2015, The Aqua Book: guidance on producing quality analysis for government.

sector included in LA and NHM rows)[23]			
GHGs emissions savings (UK only, traded and non-traded)	-£1,591m	-£1,720m	-£1,773m
Net present value (- for societal costs; + for societal savings)[24]	**£798m**	**-£419m**	**£1,341m**

Source: Defra analysis
Note(s): See Annex C for more detail

See Annex C for more detail on the household and NHM options assessment, Annex D for more detail on the calculation of GHGs emissions impacts, Annex E for more detail on costs and benefits that have not been possible to monetise and Annex F for the key assumptions underpinning the calculations and results.

Small and micro sized business assessment

Small and micro businesses account for the largest proportion of the NHM sector. 84.7% of the sector is attributed to micro businesses and 12.8% to small businesses in terms of the business population. 2016 ONS IDBR data suggests that there are 1.7 million micro businesses and 258 thousand small businesses in the NHM sector.

Micro and small businesses produce approximately 5.0 million and 6.5 million tonnes of waste each year, respectively. This accounts for 25% (micro) and 32% (small) of total NHM waste arisings. Overall, small and micro businesses represent 97.5% of NHM sector's business population and around 59% of the total NHM sector's waste arisings.

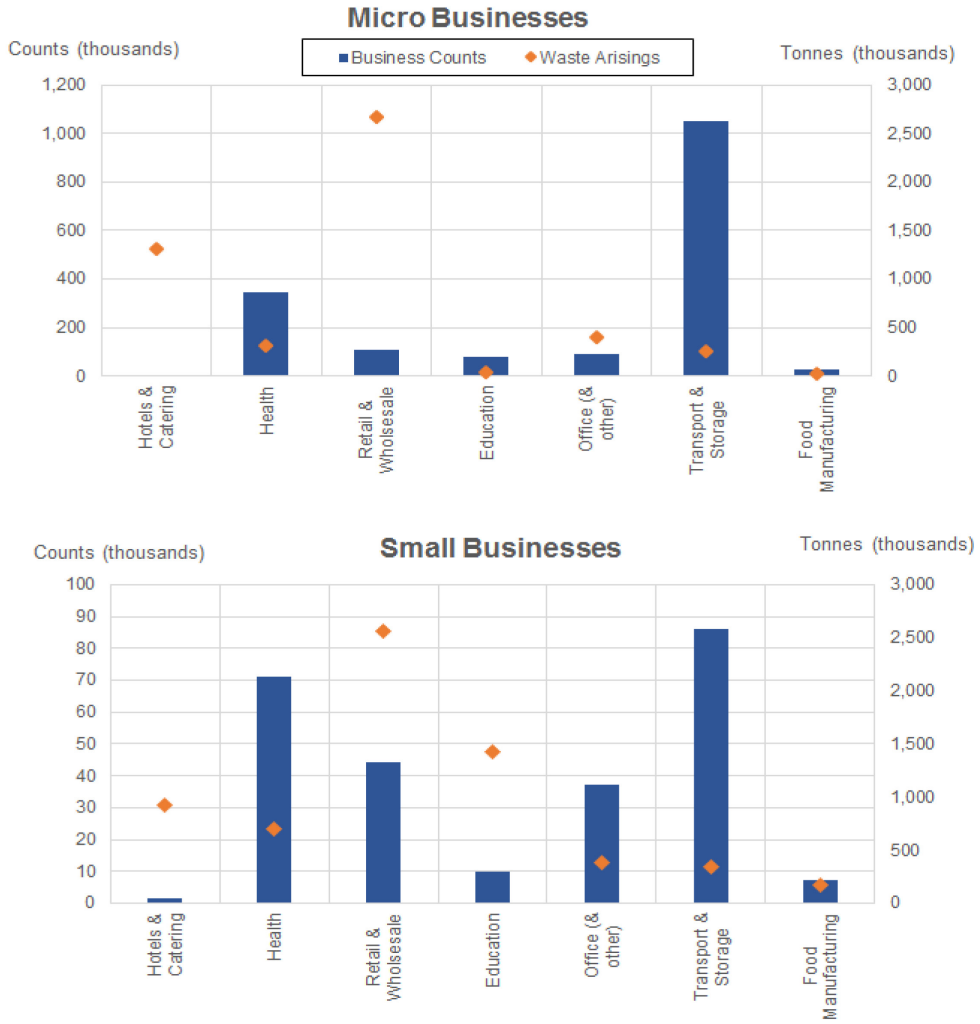
The highest waste arisings from micro and small businesses are attributed to the retail & wholesale sector estimated at 2.7 million and 2.6 million tonnes of waste per year respectively. For small businesses the second highest waste arisings are seen in education at 1.4 million tonnes per year. For micro businesses, a significant amount of waste also comes from hotels & catering estimated at 1.3 million tonnes per year.

Figure 2 presents the business population against estimated waste arisings for each of the main NHM sub-sectors.

[23] As explained in the key municipal-wide sector assumptions section, the landfill tax value is assumed to be flat and at the 2015/16 level of £82.60 per tonne of waste sent to landfill. Whilst the landfill tax is expected to rise in line with the growth in the Retail Price Index in reality, a constant rate has been assumed for the modelling purposes as all other prices have been kept constant.

[24] The net present value calculation removes the garden waste charges and landfill tax changes from the overall societal costs or savings as these are transfers between relevant parties (garden waste charging – costs to LAs, savings to householders; landfill tax changes – loss to Government, saving to municipal sector).

Figure 2: Micro and small business counts, and waste arisings, England 2016



Source: Based on WRAP analysis of the NHM sector[25]

Starting with micro businesses, in option 1nhm and 2nhm, three sectors per option see cost savings. In option 1nhm these are estimated to stand at £24 million for hotels & catering, £64 million for retail & wholesale and £15 million for transport & storage. Conversely in option 2nhm, cost savings are estimated at £70 million (retail & wholesale), £0.2 million (education) and £1.9 million (transport & storage). The rest of the sectors modelled see rising costs, due to an increase in the recycling rate. The largest increase is seen in offices due to its large business population – these translate to £341 million net costs per year on average (Table 4). In option 3nhm, costs savings are only seen in the retail & wholesale sector. These are estimated to stand at £90 million. Table 5 indicates the net annual costs or savings per micro business.

Note that micro businesses are assumed to start fully separating their waste to recyclates only from 2032 and achieve the central uptake by 2035. Thus these costs or savings are not realised in the years before, i.e. micro businesses stay at their baseline recycling performance of 35% until 2031. Also, these cost estimates do account for some waste provision sharing with the small and micro businesses, but only up to a shared provision between two businesses. See Annex F –'NHM scenario assumptions' for more details.

[25] Waste arisings are based on WRAP estimates. Business counts are based on 2016 data from the interdepartmental business register published by the ONS. Due to scaling issues, business counts for micro hotels and catering are close to zero. Micro hotels and catering are estimated at around 5000.

Table 4: Scenarios' annual net costs (+) or savings (-) relative to baseline, micro businesses, in £m

Sector	Option 1nhm: DMR + glass	Option 2nhm: DMR + separate food waste	Option 3nhm: DMR + separate food waste + separate glass
Hotels & Catering	- £ 23.6m	£ 0.7m	£ 20.6m
Health	£ 28.3m	£ 31.0m	£ 61.8m
Retail & Wholesale	- £ 64.4m	- £ 70.0m	- £ 90.0m
Education	£ 8.6m	- £ 0.2m	£ 20.7m
Office (& other)	£ 340.5m	£ 372.3m	£ 271.4m
Transport & Storage	- £ 15.4m	- £ 1.9m	£ 5.7m
Food Manufacturing	£ 1.5m	£ 1.7m	£ 2.0m
Total	**£ 276m**	**£ 334m**	**£ 292m**

Source: Defra estimates based on Wrap and ONS IDBR data

Table 5: Indicative net annual cost (+) or saving (-) per micro business relative to baseline

Sector	Option 1nhm: DMR + glass	Option 2nhm: DMR + separate food waste	Option 3nhm: DMR + separate food waste + separate glass
Hotels & Catering	- £ 220	£ 10	£ 190
Health	£ 320	£ 350	£ 700
Retail & Wholesale	- £ 190	- £ 200	- £ 260
Education	£ 290	- £ 10	£ 710
Office (& other)	£ 320	£ 350	£ 260
Transport & Storage	- £ 190	- £ 20	£ 70
Food Manufacturing	£ 320	£ 350	£ 430
Average	**£ 93**	**£ 119**	**£ 300**

Source: Defra estimates based on Wrap and ONS IDBR data

Unlike micro businesses, small businesses observe considerable savings across the seven sectors with a few exceptions. In option 1nhm all small business sectors see cost savings ranging from £1.1 million in health to £119 million in retail & wholesale. As waste collection becomes more separated, an increasing number of sectors see reduced savings or net costs. For option 2nhm, three sectors see net costs: health, office and food manufacturing and are estimated to stand at £0.1 million per sector. For scenario 3nhm, cost savings are only observed in retail & wholesale (£126m), office (£13m) and food manufacturing (£0.3m). Tables 6 and 7 provide details for small businesses.

Note that small businesses are assumed to start fully separating their waste to recyclates only from 2029 and achieve the central uptake by 2031. Thus these costs or savings are not realised in the years before, i.e. small businesses stay at their baseline recycling performance of 35% until 2028. See Annex F –'NHM scenario assumptions' for more details.

Table 6: Annual scenario net costs (+) or savings (-) relative to baseline, small businesses

Sector	Option 1nhm: DMR + glass	Option 2nhm: DMR + separate food waste	Option 3nhm: DMR + separate food waste + separate glass
Hotels & Catering	- £ 18.4m	- £ 2.0m	£ 9.8m
Health	- £ 1.1m	£ 0.1m	£ 11.4m
Retail & Wholesale	- £ 119.0m	- £ 120.1m	- £ 125.9m
Education	- £ 30.5m	- £ 5.2m	£ 2.8m
Office (& other)	- £ 2.8m	£ 0.1m	- £ 13.2m
Transport & Storage	- £ 4.6m	- £ 0.8m	- £ 0.7m
Food Manufacturing	- £ 2.4m	£ 0.1m	£ 0.3m
Total	**- £ 179m**	**- £ 128m**	**- £ 116m**

Source: Defra estimates based on Wrap and ONS IDBR data

Table 7: Indicative net costs (+) or savings (-) per small business relative to baseline

Sector	Option 1nhm: DMR + glass	Option 2nhm: DMR + separate food waste	Option 3nhm: DMR + separate food waste + separate glass
Hotels & Catering	- £ 420	- £ 50	£ 220
Health	- £ 30	£ 0	£ 310
Retail & Wholesale	- £ 1,630	- £ 1,690	- £ 1,770
Education	- £ 4,270	- £ 730	£ 390
Office (& other)	- £ 30	£ 0	- £ 150
Transport & Storage	- £ 460	- £ 70	- £ 70
Food Manufacturing	- £ 1,380	£ 50	£ 170
Average	**- £ 1,180**	**- £ 356**	**- £ 129**

Source: Defra estimates based on Wrap and ONS IDBR data

Overall, in the two business sizes, micro businesses face the highest cost with retail & wholesale being the only sector to see savings across all three NHM options modelled. In terms of total value, the highest net cost in all three options is faced by offices but that is mainly due to the size of the business population. The indicative costs per business show the highest net cost increase for small businesses in the education sector.

Clearly, small and micro businesses will need to be paid special attention when introducing the waste and recycling separation requirements. From a 2017 industry consultation waste managers have outlined to WRAP a range of options that could reduce the cost burden to small and micro businesses via alternative procurement and service delivery models. With limited data for each option, WRAP was unable to incorporate these reductions into the above presented scenarios at this stage. Defra and WRAP are currently further investigating these options in closer detail to generate sufficient evidence that will be included in the final impact assessment of the NHM scenarios for small and micro businesses. Measures to reduce costs for small and micro firms will be further investigated through consultation on consistent recycling, engagement with the sector, and developed prior to implementation.

Annex A: Additional description of household and non-household municipal options considered

Household sector options

The household sector comprises of the waste collected at kerbside (door to door collections) for low-rise household properties, waste from flatted properties, bring sites for waste, bulky waste and waste presented at Household Waste Recycling Centres (HWRCs). All scenarios model changes in the first two categories only and assume no change in the latter given the lack of quality data on cost and performance.

The analysis on this sector has focussed on kerbside (door to door) collections. Bring sites and Household Waste Recycling Centres are not included for reasons of data quality, particularly around cost, and their performance is assumed to continue at current levels.

Baseline

This scenario assumes that LAs provide waste management services as observed in 2015/16 WasteDataFlow data and make no change in the period of 2015-2035. Please refer to the Baseline Analysis section in Annex B for more details on the counterfactual.

Option 1hh – Closest to current system collections, separate food waste and free garden waste collections

This household collection scenario assumes the following:

- At low-rise household properties[26], all Local Authorities collect on a weekly basis the set of six dry materials (plastic bottles, metal cans, paper, cardboard packaging, glass packaging and plastic pots, tubs and tubes) for recycling through the collection systems that are already in place. Using 2016/17 data, this means that 72 LAs would use multi-stream collection, 171 co-mingled dry recycling and 113 two separate stream collections.
- At low-rise household properties, all Local Authorities provide weekly collections of separate food waste.
- At low-rise household properties, all Local Authorities provide free collections of garden waste on the currently operated frequencies.
- At low-rise household properties, all Local Authorities, except those that had already introduced a less frequent collections, provide fortnightly collections of refuse waste. This means that 99% of households are on refuse collection every two weeks. This has been modelled to minimise costs of transitioning to new collection systems and increase recycling yields.
- At high-rise properties[27], LAs introduce comprehensive collections of the six dry materials. No changes are assumed with respect to food waste or refuse waste collections.

Option 2hh – Two-stream dry recycling collections, separate food waste collections and free garden waste collections

This household collection scenario assumes the following:

[26] Estimated to affect 20 million households in 2015/16, growing to 23 million by 2031.

[27] Estimated to be 3.4 million households in 2015/16, rising to 4.0 million by 2031.

- At low-rise household properties, all Local Authorities collect on a two-weekly basis the set of six dry materials (plastic bottles, metal cans, paper, cardboard packaging, glass packaging and plastic pots, tubs and tubes) for recycling through two separate collection streams. One for paper and cardboard packaging and other for the remaining dry materials. Using 2016/17 data, this means that all 359 collection schemes now operate through using a twin-stream for dry recycling (compared to 113 schemes in 2016/17).
- At low-rise household properties, all Local Authorities provide weekly collections of separate food waste.
- At low-rise household properties, all Local Authorities provide free collections of garden waste on the currently operated frequencies.
- At low-rise household properties, all Local Authorities, except those that had already introduced a less frequent collections, provide fortnightly collections of refuse waste. This means that 99% of households are on refuse collection every two weeks. This has been modelled to minimise costs of transitioning to new collection systems and increase recycling yields.
- At high-rise properties, LAs introduce comprehensive collections of the six dry materials. For those type of properties, again, no changes from baseline are made with respect to food waste or refuse waste collections.

Option 3hh – Multi-stream dry recycling collections, separate food waste and free garden waste collections

This household collection scenario assumes the following:

- At low-rise household properties, all Local Authorities collect on a weekly basis the set of six dry materials (plastic bottles, metal cans, paper, cardboard packaging, glass packaging and plastic pots, tubs and tubes) for recycling through a multi-stream collection. This means a provision of three separate containers for (i) plastic packaging and metal packaging and cartons, (ii) glass and cardboard (separated out by crews into different compartments on the vehicle), (iii) and paper. Using 2016/17 data, this means that all 359 collection schemes now operate through using a multi-stream for dry recycling (compared to 72 schemes in 2016/17).
- At low-rise household properties, all Local Authorities provide weekly collections of separate food waste.
- At low-rise household properties, all Local Authorities provide free collections of garden waste on the currently operated frequencies.
- At low-rise household properties, all Local Authorities, except those that had already introduced a less frequent collections, provide fortnightly collections of refuse waste. This means that 99% of households are on refuse collection every two weeks. This has been modelled to minimise costs of transitioning to new collection systems and increase recycling yields.
- At high-rise properties, LAs introduce comprehensive collections of the six dry materials. No changes are assumed with respect to food waste or refuse waste collections.

In each system dry recycling capacity for low-rise (kerbside) properties is assumed in the modelling to be equivalent to at least 140 litres per week, food recycling capacity is 23 litres per week and residual waste capacity is around 120 litres per week. The analysis assumes the industry standard good practice containers, vehicles and crew profiles.

Please refer to Annex C for the details of scenarios' analysis.

Non-household municipal (NHM) sector options

Baseline

There is no robust reporting on the recycling performance in the NHM sector. As explained in more detail in Annex B, we assume a 35% recycling rate in the baseline which does not change over the appraised period. A proportion of this is assumed to be dry recyclates and separate food waste recycling. See 'Baseline analysis' section for further details.

The following options have been considered against the baseline:

Option 1nhm: Dry mixed recyclates (DMR) + separate glass collections

The waste composition profiles of the NHM sub-sectors all show that businesses have much higher proportions of potentially recyclable waste than is prevalent in the household waste stream. With measures to compel businesses to separate their waste high levels of recycling rate, the potential is significant compared to the baseline. This scenario depicts the whole NHM sector collecting consistently six dry mixed recyclates: paper, cardboard packaging, plastic bottles, plastic pots, tubs and trays (PTTs), metal packaging and, separately, glass packaging. This is likely to be closest to current baseline. Under our best estimate, this implies an overall recycling rate of 58% by 2035 with the remainder sent for residual waste treatment.

Option 2nhm: DMR + separate food waste collections

This option assumes the collection of five dry recyclates as Option 1nhm but does not consider collection of glass packaging, neither in mixed dry recyclates or separately, and it remains in residual waste collections. Instead, it accounts for the requirement of collecting food waste separately. Our central estimate indicates that this could result in a recycling rate of 70% across the sector.

Option 3nhm: DMR + separate food waste collections + separate glass collections

This is a full separation scenario in which waste is separated between dry recyclates, glass packaging and food waste. This scenario achieves a recycling rate of 74%. The sector uses four bins for their waste disposal: dry recyclates, glass, food waste and refuse waste.

Annex B: Additional detail on the baselines used for the household and non-household municipal sectors

Household sector and baseline scenario

The baseline scenario assumes that LAs make no changes with respect to the offered dry recycling collection systems, separate food waste collections, free garden waste collections or any changes in the frequency of refuse waste collections. In particular, the modelling uses the real data on Local Authorities to provide low-rise kerbside services as observed in the 2016/17 year:

- LAs use the following dry kerbside collection schemes for low-rise properties: 72 with multi-stream collections, 171 with co-mingled collection, 113 with two stream collections and 3 with single material collection.
- 89% collect glass, 100% metal cans and tins, 100% paper, 99% plastic bottles, 99% collect cardboard packaging. Overall, 67% of LAs collected all five widely recycled materials and PTTs (plastic pots, tubs and trays).

- 33% (104) of LAs provide separate food waste collections.
- 52% of LAs charge for the collection of garden waste.
- 2% of households have their refuse collected more than weekly, 33% on weekly , 64% on fortnightly and 1% on three-weekly refuse waste collections.

The current coverage of recycling and service profiles from high rise flats varies considerably across Local Authorities. The known coverage varies from flats having only a residual waste collection to full segregation of dry materials and food waste. Baseline assumes no change from the current service provisions.

Consequently, the household sector recycling rate stood at 43.7% in 2016/17 and is expected to remain broadly unchanged at around 43.5% by 2030/31 as collection systems do not change over time. Waste arisings grow in-line with household projections with an assumed fixed recycling yield[28] per household each year.

The baseline scenario then estimates the net service costs[29] of waste management for both low-rise and high-rise properties to be around £2.4 billion in 2015/16, rising to around £2.9bn by 2030 as results of projected growth in the number of householders at low-rise from 23.6 million to 26.7 million of households in 2030. The largest proportion (49%) of the overall costs are annual operating and communications costs (including staff costs), followed by annual bulking costs of dry recycling and treatment costs of food waste and residual waste (44%, covering the cost of sending waste to relevant facilities for waste treatment and paying associated gate fees), annualised capital costs for vehicle and containers replacement (bins). This 'net' estimate also accounts for any revenues received through selling separately collected dry recyclates directly to reprocessors (e.g. paper to paper mills).

Non-household municipal sector and baseline scenario

Following industry peer review and Defra approved methodology, WRAP estimated that the NHM sector is made up of approximately 2 million business and public sector entities based on 2016 data from the International Business register (IDBR) published by the Office for National Statistics. The sector scope of NHM businesses included is defined by a close examination of European Waste chapter codes and their mapping onto the best available reported sector waste flows via the Environment Agency's Waste Data Interrogator. This mapping helps to determine which sub-sectors are generating household similar waste as per the CEP definition. From this analysis, over 85% are micro businesses, 13% are small businesses, 2% are medium businesses and 0.4% are large businesses (Table 8).

Following the Circular Economy Package definition of municipal waste, the NHM sector covers seven industry sectors: Hotels and Catering, Health, Retail & Wholesale, Education, Office, Transport and Storage, and Food Manufacturing[30]. Overall, there are 46 sub-sectors which then break down to different business sizes. Defra commissioned WRAP to map the national commercial and industrial data returns onto the individual business profiles. This research estimates the total sector produced 20.3 million tonnes of waste in 2015. This is an average across four estimated scenarios that WRAP developed and range from 14.9Mt to 26.3Mt. The methodology on these four sensitivities is explained in more detail in the 'Key NHM scenarios assumptions' section.

[28] Yields represent material collected from the kerbside and therefore include contamination. The contamination rates are then applied per each collection system to derive the recycling tonnage net of contamination. See the 'Key household scenario assumptions' section for more details.

[29] Overall cost for all English local authorities of running their waste collection systems, net of revenue they generate such as the sale of separately collected dry recyclable material.

[30] It is important to note that only a small proportion of food manufacturers are included within the NHM definition. The majority are deemed to be generating industrial scale waste outputs.

Table 8: Number of businesses/public units, counts by employment band size, England, 2016

Sector	**Micro**	**Small**	**Medium**	**Large**	**Total**
Food Manufacturers	4,695	1,710	720	320	**7,445**
Retail & Wholesale	343,265	71,040	9,420	1,505	**425,230**
Hotels & catering	106,705	44,345	4,390	205	**155,645**
Transport & Storage	80,000	10,020	3,260	665	**93,945**
Health	88,565	37,015	6,595	315	**132,490**
Office	1,052,825	86,250	17,185	3,500	**1,159,760**
Education	29,095	7,150	2,080	645	**38,970**
Total	**1,705,150**	**257,530**	**43,650**	**7,155**	**2,013,485**

Source: WRAP analysis based on Office for National Statistics, Inter Departmental Business Register (IDBR) data

The highest contribution comes from retail and wholesale which accounted for 36% of total waste. Education makes the second highest contribution of 19%, while the lowest is seen in office with 7% of waste arisings. Given the number of business units, micro businesses generate the largest share of waste, followed by small, medium and large businesses (Table 9).

Table 9: NHM waste arisings in tonnes by sector and business size

Sector	Micro	Small	Medium	Large	Total
Retail & Wholesale	2,676,000	2,562,000	1,337,000	722,000	7,298,000
Hotels & Catering	1,305,000	929,000	384,000	43,000	2,661,000
Education	44,000	1,428,000	1,847,000	527,000	3,846,000
Food Manufacturing	23,000	175,000	247,000	1,657,000	2,101,000
Office	406,000	382,000	331,000	293,000	1,413,000
Transport & Storage	250,000	343,000	471,000	42,000	1,106,000
Health	316,000	695,000	363,000	462,000	1,836,000
Total	5,020,000	6,514,000	4,981,000	3,746,000	20,261,000

Source: WRAP analysis
Note(s): Figures have been rounded to the nearest thousand.

This sector is overall more complex than household sector given its diversity. In 2017 and 2018 WRAP have undertaken large scale surveys of waste container profiles from the NHM sector to help understand the baseline profiles for the businesses in scope and found that:

- Businesses and public sector units are predominantly charged by pick up and pay per volume[31] of an ordered container.
- The costs are officially not reported as commercially sensitive and vary according to, quite often short, contract terms which are influenced by the take up of a range of other services, as well as national or regional contract terms.

[31] A flat rate is charged per pick up of a container, irrespective of its weight or how full it is.

- The type of collection for the NHM sector can vary from sack pick-ups, 120 litres wheeled bins, up to 1280l wheeled bins and can provide collections of general refuse waste, mixed dry recycling with and without glass, separate paper and cardboard packaging, mixed plastics, mixed glass and food waste.[32]
- Waste management companies collecting waste from businesses tend to favour the customer (business) in using 1100l waste bins for general waste. This is largely because the collection vehicles are suited to lifting this type of bin, convenient for the customers' use and it is cost efficient for the waste management company in terms of operations.

Whilst charges for recycling services are lower than for residual waste ordering more containers often results in more costs to the NHM sector businesses. Reducing or avoiding cost increase is possible where businesses and public sector units decide to cost-optimise their collections through measures such as reduced size for refuse containers, decreased frequency of collections or shared waste service provisions. All these measures are considered in increased recycling scenarios and described in more detail in the 'Key NHM sector assumptions' section. From WRAP's survey of NHM businesses, it appears that limited proportions of NHM sectors are currently implementing these measures. Factors such as coordination failure among businesses due to lack of information on services available to them to minimise costs, may be a considerable contributing factor. For example, businesses operating in the same work space such as a shopping mall, may have little to no knowledge of the amount of cost savings they could make if they made use of the shared service provision or collectively reduce the size of their refuse containers etc.

Baseline scenario for the NHM sector

There is currently no robust data reporting, of similar quality to the Waste Data Flow used on the household side, which could be used for the NHM sector analysis. We have asked WRAP to develop the evidence for the NHM sector which this IA builds on. The IA develops the baseline scenario on a number of assumptions described below.

Like in the household sector, the NHM baseline scenario assumes that the sector makes no change to their current use of waste collection systems or collection frequency. We assume that the NHM recycling rate in baseline is between 30% and 40%, with a central estimate of 35%, or 7.1Mt of waste currently recycled. This range is based on the ongoing WRAP bottom-up analysis[33] that indicates an average recycling rate of around 35% for the data gathered so far. However, due to uncertainties of where the NHM baseline recycling rate lies we allow for a five percentage points range above and below our central estimate recycling rate (35%). Hence, the high sensitivity baseline recycling rate is 30% while that of the low sensitivity scenario is assumed to be 40%.

Since NHM and Commercial & Industrial (C&I) waste compositions are fairly comparable (i.e. commercial waste makes up two-thirds of C&I), our central estimate is therefore in line with Defra's latest (2016) working estimates for C&I waste in England which indicate a current C&I recycling rate of around 40%. NHM recycling rate is expected to be lower than that of C&I given that C&I waste streams tend to be purer compared to NHM waste streams. The C&I figure is based on dividing the C&I data into broad treatment categories, according to the source of the data, and defining 'recycling' as dry recyclates plus composting. It should be noted that, while Defra have worked closely with industry experts to review and improve the C&I methodology for

[32] Container and material types are known to vary even further for broader commercial and Industrial waste streams but these are not in scope of this analysis since they would not follow the standard municipal waste definition.

[33] This is an actual sub-sector profiling of waste generation per material and type of business.

England, significant uncertainties and limitations remain in the available underlying data. Full details of the revised C&I methodology.

Next, we assume that, out of this recycled tonnage, overall around 80% are dry mixed recyclates (DMR) and 20% represent separate food waste collections sent for recycling. This split is based on an average of the individual sub-sector waste composition estimates for the overall sector. WRAP estimate the following split for the total 20.3Mt of waste arisings:

- 12.9Mt could be collected as dry material recyclates (including glass)
- 4.0Mt represent total food waste available for recycling
- 3.3Mt are currently non-recyclable materials[34].

The three baseline estimates (40%, 35% and 30% recycling rates) are run against the low, best and high estimate of NHM scenarios as a sensitivity of options to baseline recycling rate. In each of the baseline scenarios, we assume the recycling rate remains unchanged from year to year over the period covered across all business sizes.

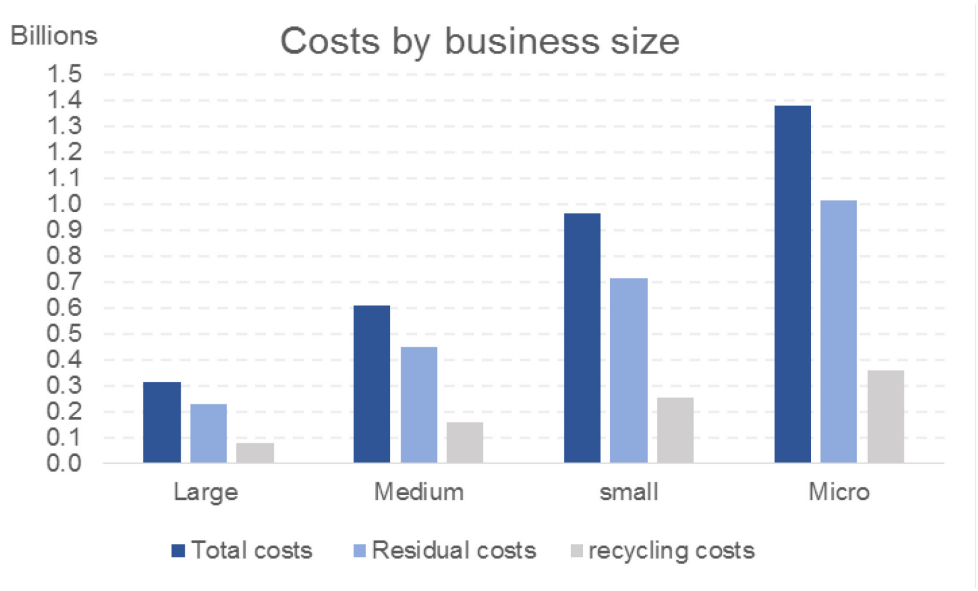
The assumed baseline's 35% recycling rate in 2018 implies the NHM waste management costs of £3.3 billion per year. These costs are then estimated to be £3.2bn in 40% and £3.4bn in 30% baseline recycling scenarios. Due to the lack of official data on the sector, the baseline costs are inherently uncertain and are based on the following approach:

- WRAP developed a scenario of 100% residual waste, or 0% recycling rate, and estimated the overall sectoral cost to be £3.87bn per year.
- Further, WRAP estimated that, if recycling dry mixed materials only (excluding glass and food waste), the sectoral costs could drop down to £2.76bn per year. This would imply a recycling rate of 58% if all dry materials are captured.
- Thus, for the 35% recycling scenario, we estimated the sectoral costs to be simply the point between 0% and 58% recycling rate for each of the sub-sectors, or £3.3bn per year, assuming only DMR recycling and no food recycling. This is an approximation of the current baseline cost.

Of the four business sizes, micro and small businesses face the highest cost burden of approximately £1.4bn (or £800 per business) and £1.0 billion (£3,700 per business) per year respectively. The high cost burden seen in micro businesses is attributed to the number of micro business which account for 85% of the NHM sector's business sector population (Figure 3).

Figure 3: Total baseline costs in £bn by business size per year, England

[34] Whilst averages are shown for illustration the analysis uses individual sub-sector waste compositions and calculates tonnage for each.



Source: WRAP data. Defra assumptions for baseline NHM recycling rate of 35%.

Municipal sector baseline

For the overall municipal sector, i.e. adding household and NHM waste arisings together, our best estimate is that there is overall 43.6Mt of waste arisings out of which around 40% is currently sent for recycling (44% for household and 35% for NHM waste).

Annex C: Additional detail on the economic assessment of collection systems options for the municipal, household and non-household municipal sectors

Municipal sector

The tables below provide detailed, yearly estimates of modelled associated economic cost for the three municipal options considered. These costs presented are all relative to the current baseline. Figures presented are all undiscounted unless otherwise stated. Also note that, costs of free garden waste collections are associated costs due to eliminating garden waste collection charges to households.

Table 10: Modelled costs and benefits of municipal Option 1M, £ millions, 2023 to 2035

	Household sector			NHM sector		Overall municipal sector		
	LAs: waste management costs(-)/ savings(+)	LAs: costs of free garden waste removal	Householders: savings from free garden waste collections	NHM: waste management costs(-) / savings(+)	NHM: policy costs(-)/ savings (+)	Landfill tax revenue : gains(+)/ loss(-)	GHGs emissions savings	Discounted net present costs(-)/ savings (+)
2023	-74	-72	72	19	-19	-142	10	-206
2024	-43	-94	94	48	-20	-202	23	-186
2025	28	-101	101	78	-21	-228	40	-97
2026	50	-104	104	115	-22	-259	58	-52
2027	53	-111	111	171	-24	-303	81	-19
2028	58	-118	118	227	-25	-347	109	19
2029	70	-119	119	272	-26	-376	138	63
2030	80	-120	120	339	-28	-369	175	155
2031	84	-121	121	406	-29	-327	219	268
2032	89	-121	121	337	-31	-321	257	243
2033	94	-121	121	268	-32	-315	298	221
2034	99	-121	121	199	-34	-314	342	200
2035	97	-121	121	131	-36	-296	388	188

Source: Defra analysis

Table 11: Modelled costs and benefits of municipal Option 2M, £ millions, 2023 to 2035

	Household sector			NHM sector		Overall municipal sector		
	LAs: waste management costs(-)/ savings(+)	LAs: costs of free garden waste removal	Householders: savings from free garden waste collections	NHM: waste management costs(-) /savings(+)	NHM: policy costs(-)/ savings(+)	Landfill tax revenue: gains(+)/ loss(-)	GHGs emissions savings	Discounted net present costs(-) / savings(+)
2023	-371	-72	72	14	-19	-145	11	-510
2024	-126	-94	94	36	-20	-215	24	-291
2025	12	-101	101	58	-21	-252	42	-150
2026	45	-104	104	83	-22	-294	62	-114
2027	36	-111	111	121	-24	-356	87	-118
2028	49	-118	118	160	-25	-412	119	-92
2029	81	-119	119	192	-26	-377	150	16
2030	94	-120	120	239	-28	-370	189	97
2031	99	-121	121	287	-29	-328	236	201
2032	104	-121	121	204	-31	-322	277	171
2033	110	-121	121	121	-32	-316	322	145
2034	116	-121	121	37	-34	-314	371	121
2035	115	-121	121	-46	-36	-296	421	104

Source: Defra analysis

Table 12: Modelled costs and benefits of municipal Option 3M, £ millions, 2023 to 2035

	Household sector			NHM sector		Overall municipal sector		
	LAs: waste management costs (-) / savings(+)	LAs: costs of free garden waste collections	Householders: savings from free garden waste collections	NHM: waste management costs(-)/savings(+)	NHM: policy costs(-)/ savings(+)	Landfill tax revenue: gains(+)/ loss(-)	GHGs emissions savings	Discounted net present costs(-) / savings(+)
2023	-135	-72	72	15	19	-134	7	-266
2024	34	-94	94	36	20	-206	20	-131
2025	146	-101	101	58	21	-245	38	-23
2026	177	-104	104	83	22	-292	59	4
2027	185	-111	111	119	24	-360	85	5
2028	206	-118	118	156	25	-412	119	37
2029	232	-119	119	185	26	-377	153	135
2030	244	-120	120	228	28	-370	194	211
2031	251	-121	121	271	29	-328	246	312
2032	258	-121	121	198	31	-322	290	289
2033	265	-121	121	125	32	-316	339	270
2034	273	-121	121	52	34	-314	393	254
2035	272	-121	121	-21	36	-296	449	244

Source: Defra analysis

Household sector

This presents the detailed costs and savings across the three household scenarios. Note that all the values are undiscounted here and thus do not equal to discounted values presented above.

Through Options 1hh to 3hh, householders are expected to increase the level of material separation to relevant waste streams. Each option implies different participation rates and is based on the evidence from LAs already operating these collection systems. For example, this implies that Option 3hh (multi-stream dry recycling collections) achieve a slightly lower overall tonnage of recycling when compared to the other two options. But this Option delivers higher material quality that is then reflected in material revenues received by LAs for separately collected dry recyclates.

See Annex F for underpinning modelling assumptions.

Option 1hh – Closest to current system collections, separate food waste and free garden waste collections

In 2023/24, the WRAP model assumes that around 66% of LAs would be able to switch to a new service with all the remaining 34% transitioned to the new collection system by 2026/27. The majority of LA collections (58%) are operated by in-house services which are able to move onto new services more quickly than contracted services. A smaller number of the out-sourced services are also available to change given the timing of their contract renewal dates in line with the scenario.

In terms of net collection costs of improved dry recycling and separate food waste, this option burdens LAs with the lowest transition costs as LAs are assumed to use their current collection services but introduce weekly collections of separate food waste.

This implies transition costs of around £399m in the period of 2023/24-2029/30 with £186m capital spent on additional (mainly food waste and garden waste) containers, £68m on wider transition costs[35] and £145m of annualised costs on new vehicles to collect separate food waste and free garden waste.

As for ongoing cost, LAs would see increased annual operating and communications costs rising from £78m in 2023/24 to £189m by 2035, or an average of £164m per year over the period of 2023-2035. Regarding the ongoing savings, the model estimates falling bulking and waste treatment costs (net of revenue for separately collected materials) to be -£118m in 2023/24 and rising to -£314m by 2035, or average savings of -£261m per year.

Overall, improvement in dry recycling, food waste and garden waste collections with fortnightly refuse waste collections result in LAs waste management (undiscounted) savings of -£686m over the period of 2023-2035.

In addition, the Option 1hh assumes, as well as all other household options, that LAs would introduce a free garden waste recycling collections. This has two main implications on the LAs costs:

- LAs would lose the income received from households. WRAP estimate this be around up to £121m per year that would not be received by LAs anymore. This would result in the loss of garden waste charging income of £1,442m. Householders would see savings of the same value, £1,442m, over the same period as a result of removed charging for garden waste collections.

[35] For each scenario, these include the costs of project management, re-routing of vehicles, roll out communication costs, depot hire for containers, engagement staff costs, call centre costs and delivery costs of new containers.

- LA data indicate that free garden waste collection systems are more efficient in raising households' participation. In particular, free collections can achieve up to 80-90% participation rate in households with garden waste when compared to estimated 35% only under charged services[36]. Thus, we estimate an increase in the household recycling rate by 6 percentage points.

Once accounting for the loss of garden waste charging income, this scenario estimates 2% increase in LAs waste management costs (£756m, or £667m when discounted) over the period of 2023-2035. This consists of £399m initial transition costs, -£1,085m ongoing net savings, and £1,442m costs due to the loss of garden waste charging. The recycling rate is estimated to increase by 12% points to around 55.9% by 2035[37]. Table 13 shows the modelled costs for the period of 2023-2035.

Table 13: Modelled costs (+) and savings (-) of household Option 1hh, £ millions, 2023 to 2035

Year	Container capital costs	Wider transition costs	Annualised vehicle	Annual operating and comms	Annual bulking and treatment (net of material revenue)	**Total net service cost(+)/saving(-)**	Out of which: transition costs	**Loss of garden waste charging income**
2023	£ 101	£ 1	£ 11	£ 78	-£ 118	£ 74	£ 114	£ 72
2024	£ 42	£ 45	£ 18	£ 127	-£ 189	£ 43	£ 104	£ 94
2025	£ 13	£ 10	£ 21	£ 147	-£ 219	-£ 28	£ 43	£ 101
2026	£ 6	£ 3	£ 22	£ 153	-£ 234	-£ 50	£ 31	£ 104
2027	£ 11	£ 2	£ 23	£ 163	-£ 252	-£ 53	£ 36	£ 111
2028	£ 10	£ 4	£ 25	£ 173	-£ 269	-£ 58	£ 38	£ 118
2029	£ 3	£ 4	£ 26	£ 181	-£ 284	-£ 70	£ 32	£ 119
2030	£ 2	£ -	£ 26	£ 182	-£ 290	-£ 80		£ 120
2031	£ 2	£ -	£ 26	£ 184	-£ 296	-£ 84		£ 121
2032	£ 2	£ -	£ 26	£ 185	-£ 302	-£ 89		£ 121
2033	£ 2	£ -	£ 26	£ 186	-£ 308	-£ 94		£ 121
2034	£ 2	£ -	£ 27	£ 188	-£ 314	-£ 99		£ 121
2035	£ 2	£ -	£ 27	£ 189	-£ 314	-£ 97		£ 121

Source: WRAP modelling

Table 14 then shows the transition costs for dry recycling, food waste and garden waste collection changes, avoided capital and vehicles costs associated with mixed garden waste collections and residual waste collections, as well as wider transition costs. Transition costs are only modelled until 2029 because these are, by definition, temporary. They consist of additional vehicles, containers and wider costs to enable the transition to a new collection system or a new waste contracts. When all LAs have moved to the new collection system there are no longer any transition costs.

Table 14: Modelled transition costs (+) and savings (-) of household Option 1hh, £ millions

Year	Dry recycling collections	Separate food waste collections	Free garden waste collections	Mixed food and garden waste collections	Residual waste collections	Wider transition costs
2023	£ 3	£ 38	80	- 5	- 3	-
2024	£ 5	£ 34	35	- 8	- 6	45
2025	£ 5	£ 22	23	- 9	- 7	10
2026	£ 6	£ 20	20	- 10	- 8	3
2027	£ 6	£ 22	25	- 11	- 8	2
2028	£ 6	£ 22	26	- 12	- 9	4
2029	£ 7	£ 22	21	- 12	- 9	4

Source: WRAP modelling, Defra assumptions on the length of transition period

[36] See key household scenario assumptions section for more evidence on garden waste collections.

[37] These cost results also reflect the changes at high-rise properties but these are currently reported only as part of the overall LAs waste management costs.

Option 2hh – Two-stream dry recycling collections, separate food waste collections and free garden waste collections

The LAs' ability to switch to new collection systems is as described under Option 1hh.

The modelling of the fortnightly two-stream dry recycling and weekly separate food waste and free garden waste collections implies the highest transition costs when compared to other household options. In particular, it estimates the transition costs to be £900m over the period of 2023/24-2029/30:

- Those LAs that currently do not operate with two-stream dry recycling systems would need to invest in separate containers for fibres (paper and cardboard packaging) and other materials. Further new investments would be needed in separate food waste and garden waste containers when currently not in place. The modelling estimates this capital container cost to be £401m in 2023/24, or £641m over the whole transition period.
- Additional investments in new vehicles are modelled to be around £156m over the period, or £22m per year.
- The wider transition costs[38] are estimated to be around £102m, or £15m per year over the period.

In terms of the ongoing net costs and net savings, the two-stream scenario estimates the following:

- LAs would see increase in annual operating and communications costs of, on average, £214m per year over the period of 2023-2035. This is mainly due to the costs associated with deploying two sets of staff and vehicles in terms of collecting dry recyclables and food waste.
- Conversely, the model estimates an average -£325m saving per year on the annual bulking and treatment costs. This level of ongoing savings is higher than in Option 1hh as the scenario expects LAs receiving higher payment on separately collected fibres but lower than in Option 3hh because that scenario delivers highest material revenues to LAs.

The introduction of free garden waste would have the same implications as described in Option 1hh: LAs would lose the income from garden waste charging of £1,442m, and an increase in the household recycling rate by 6 percentage points. Householders would see savings of the same value, £1,442m, over the same period as a result of removed charging for garden waste collections.

Overall, this scenario estimates 2.3% increase in net service costs to LAs (£1,077m, or £1,008m when discounted) over the period of 2023-2035 with initial transition costs of £900m, ongoing service savings of £1,265m and garden waste income loss of £1,442m. The recycling rate is 56.0% by 2035.

Table 15 shows the modelled costs for the period of 2023-2035. Table 16 then shows the transition costs for dry recycling, food waste and garden waste collection changes, avoided capital and vehicles costs associated with mixed garden waste collections and residual waste collections, as well as wider transition costs. Transition costs are only modelled until 2027 because these are, by definition, temporary. They consist of additional vehicles, containers and

[38] For each scenario, these include the costs of project management, re-routing of vehicles, roll out communication costs, depot hire for containers, engagement staff costs, call centre costs and delivery costs of new containers.

wider costs to enable the transition to a new collection system or a new waste contracts. When all LAs have moved to the new collection system there are no longer any transition costs.

Table 15: Modelled costs (+) and savings (-) of household Option 2hh, £ millions, 2023 to 2035

Year	Container capital costs	Wider transition costs	Annualised vehicle	Annual operating and comms	Annual bulking and treatment (net of material revenue)	**Total net service cost(+)/saving(-)**	Out of which: transition costs	**Loss of garden waste charging income**
2023	£ 401	£ 1	£ 12	£ 104	-£ 148	£ 371	£ 415	£ 72
2024	£ 111	£ 68	£ 20	£ 166	-£ 239	£ 126	£ 199	£ 94
2025	£ 32	£ 15	£ 23	£ 192	-£ 274	-£ 12	£ 70	£ 101
2026	£ 20	£ 4	£ 24	£ 201	-£ 294	-£ 45	£ 47	£ 104
2027	£ 40	£ 3	£ 25	£ 212	-£ 316	-£ 36	£ 68	£ 111
2028	£ 31	£ 6	£ 26	£ 225	-£ 337	-£ 49	£ 63	£ 118
2029	£ 5	£ 5	£ 27	£ 235	-£ 353	-£ 81	£ 37	£ 119
2030	£ 3	£ -	£ 27	£ 236	-£ 361	-£ 94		£ 120
2031	£ 3	£ -	£ 28	£ 238	-£ 368	-£ 99		£ 121
2032	£ 3	£ -	£ 28	£ 240	-£ 375	-£ 104		£ 121
2033	£ 3	£ -	£ 28	£ 242	-£ 383	-£ 110		£ 121
2034	£ 3	£ -	£ 28	£ 243	-£ 391	-£ 116		£ 121
2035	£ 3	£ -	£ 28	£ 245	-£ 391	-£ 115		£ 121

Source: WRAP modelling

Table 16: Modelled transition costs (+) and savings (-) of household Option 2hh, £ millions, 2023 to 2029

Year	Dry recycling collections	Separate food waste collections	Free garden waste collections	Mixed food and garden waste collections	Residual waste collections	Wider transition costs
2023	£ 289	£ 55	£ 80	-£ 5	-£ 5	£ -
2024	£ 67	£ 45	£ 35	-£ 8	-£ 8	£ 68
2025	£ 19	£ 31	£ 23	-£ 9	-£ 9	£ 15
2026	£ 14	£ 29	£ 20	-£ 10	-£ 10	£ 4
2027	£ 29	£ 32	£ 25	-£ 11	-£ 10	£ 3
2028	£ 21	£ 33	£ 26	-£ 12	-£ 11	£ 6
2029	£ 2	£ 33	£ 21	-£ 12	-£ 11	£ 5

Source: WRAP modelling, Defra assumptions on the length of transition period

Option 3hh – Multi-stream dry recycling collections, separate food waste and free garden waste collections

The LAs' ability to switch to new collection systems is as described under Option 1hh.

Option 3hh would require an initial investment in providing householders in low-rise properties with new services operating weekly multi-stream collections of materials for dry recycling and separate food waste collections, as well as free garden waste collections. For those LAs necessitating a service change, this would require capital investment in new containers, vehicles and additional operational spend on new staff as well as spend on communication and transition costs[39]. The multi-stream costs are lower due to operational savings in fewer overall vehicles and associated crews particularly where food is collected on board with dry recyclables. WRAP modelling estimates the following for the switch to weekly multi-stream and separate food waste:

[39] For each scenario, these include the costs of project management, re-routing of vehicles, roll out communication costs, depot hire for containers, engagement staff costs, call centre costs and delivery costs of new containers.

- In the first year, the LAs face transition costs of investments in new containers (£237m) annualised capital costs of new vehicles (£13m) and wider transition costs (£3m). LAs would also see a net cost increase in annual operating and communications cost (£80m) and net savings in annual bulking and treatment due to diversion from residual waste treatments and increased savings from selling separately collected dry materials (-£198m). Overall, this translates to additional net service costs (compared to baseline) of £135m in the first year.
- Over the remaining transition years (2-7) years, the LAs would see transition costs of container capital of £113m, annualised capital costs of new vehicles (£149m) and wider transition costs of project management, vehicles re-routing etc. (£108m). In terms of the annual costs, LAs would see additional operating costs and communications of £160m per year and -£385m savings per year from material revenues and waste treatment cost savings. Overall net service costs reduce by -£164m per year.
- These overall savings are a result of (i) operational savings on using only one vehicle for collecting both dry recyclables and food waste, and (ii) increased savings due to reduced payments for dry recyclates sorting at material recycling facilities and increased revenue from selling separately collected dry materials; (iii) reduced payments on residual waste treatment (residual waste treatment gate fees and landfill tax).
- Overall, multi-stream dry recycling, separate food waste and free garden waste would result in -£2,409m net savings in LAs waste management costs over the period of 2023-2035, or 3% decrease when compared to baseline, and result in 12 percentage points increase in household recycling rate.

The introduction of free garden waste would have the same implications as described in Option 1hh: loss in garden waste charging income of £1,442m. Householders would see savings of the same value, £1,442m, over the same period as a result of removed charging for garden waste collections.

Overall, the LAs waste management costs would be lower by -£967m over the period of 2023-2035, or -£679m when discounted. This is result of the initial transition costs (£622m), which include capital container costs, ongoing annualised capital investment costs in new vehicles and wider transition costs[40]; -£3,031m savings on ongoing costs to LAs; and lost income from garden waste charging (£1,442m).

Overall recycling rate from households would increase to 55.5% by 2035. This is slightly lower than under Option 1hh or 2hh. WRAP evidence suggests that these collection options result in slightly higher participation rate per householder, and thus higher dry recycling tonnage overall when compared to multi-stream dry collections.

Table 17 shows the modelled costs for the period of 2023-2035. Table 18 then shows the transition costs for dry recycling, food waste and garden waste collection changes, avoided capital and vehicles costs associated with mixed garden waste collections and residual waste collections, as well as wider transition costs. Transition costs are only modelled until 2027 because these are, by definition, temporary. They consist of additional vehicles, containers and wider costs to enable the transition to a new collection system or a new waste contracts. When all LAs have moved to the new collection system there are no longer any transition costs.

[40] For each scenario, these include the costs of project management, re-routing of vehicles, roll out communication costs, depot hire for containers, engagement staff costs, call centre costs and delivery costs of new containers.

Table 17: Modelled costs (+) and savings (-) of household Option 3hh, £ millions, 2023 to 2035

Year	Container capital costs	Wider transition costs	Annualised vehicle	Annual operating and comms	Annual bulking and treatment (net of material revenue)	**Total net service cost(+)/saving(-)**	Out of which: transition costs	**Loss of garden waste charging income**
2023	£ 237	£ 3	£ 13	£ 80	-£ 198	£ 135	£ 253	£ 72
2024	£ 56	£ 73	£ 21	£ 132	-£ 314	-£ 34	£ 149	£ 94
2025	£ 14	£ 16	£ 23	£ 152	-£ 351	-£ 146	£ 53	£ 101
2026	£ 9	£ 4	£ 24	£ 158	-£ 372	-£ 177	£ 37	£ 104
2027	£ 21	£ 3	£ 25	£ 165	-£ 401	-£ 185	£ 50	£ 111
2028	£ 13	£ 7	£ 27	£ 175	-£ 428	-£ 206	£ 47	£ 118
2029	£ 0	£ 5	£ 28	£ 180	-£ 446	-£ 232	£ 33	£ 119
2030	£ 0	£ -	£ 28	£ 182	-£ 454	-£ 244		£ 120
2031	£ 0	£ -	£ 28	£ 183	-£ 463	-£ 251		£ 121
2032	£ 0	£ -	£ 29	£ 185	-£ 471	-£ 258		£ 121
2033	£ 0	£ -	£ 29	£ 186	-£ 480	-£ 265		£ 121
2034	£ 0	£ -	£ 29	£ 187	-£ 490	-£ 273		£ 121
2035	£ 0	£ -	£ 29	£ 189	-£ 490	-£ 272		£ 121

Source: WRAP modelling

Table 18: Modelled transition costs (+) and savings (-) of household Option 3hh, £ millions, 2023 to 2029

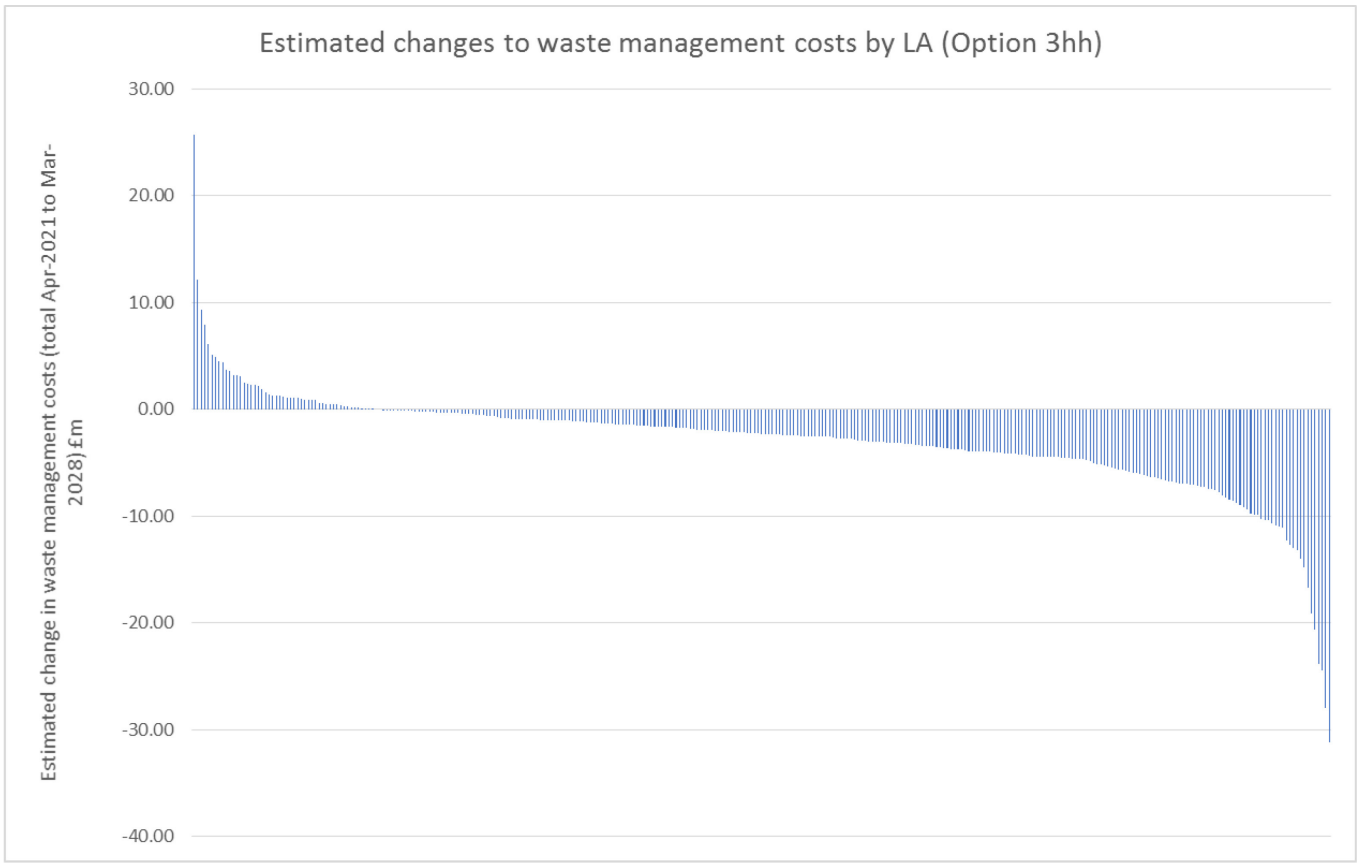
Year	Dry recycling collections	Separate food waste collections	Free garden waste collections	Mixed food and garden waste collections	Residual waste collections	Wider transition costs
2023	£ 184	-£ 5	£ 80	-£ 5	-£ 5	£ -
2024	£ 62	-£ 4	£ 35	-£ 8	-£ 9	£ 72
2025	£ 38	-£ 4	£ 23	-£ 9	-£ 10	£ 16
2026	£ 38	-£ 4	£ 20	-£ 10	-£ 11	£ 4
2027	£ 49	-£ 5	£ 25	-£ 11	-£ 11	£ 3
2028	£ 43	-£ 5	£ 26	-£ 12	-£ 12	£ 7
2029	£ 37	-£ 5	£ 21	-£ 12	-£ 12	£ 5

Source: WRAP modelling, Defra assumptions on the length of transition period

Distribution of impacts on LAs and households

Although the main collections modelling does not simulate specific LAs, an attempt has been made to estimate the projected costs for individual LAs. This involves taking averages for various factors and the LA-specific estimates are therefore uncertain and merely indicative. The estimated cost of each option varies at the LA level, with some LAs predicted to make savings and others predicted to face costs. The cost / saving for an individual LA depends to a great extent on the existing collections system in place there. The chart in Figure 4 shows the estimated changes to LAs' waste collection costs up to the end of 2025/26 (including transition costs) with the majority of LAs seeing net savings from moving to multi-stream collections.

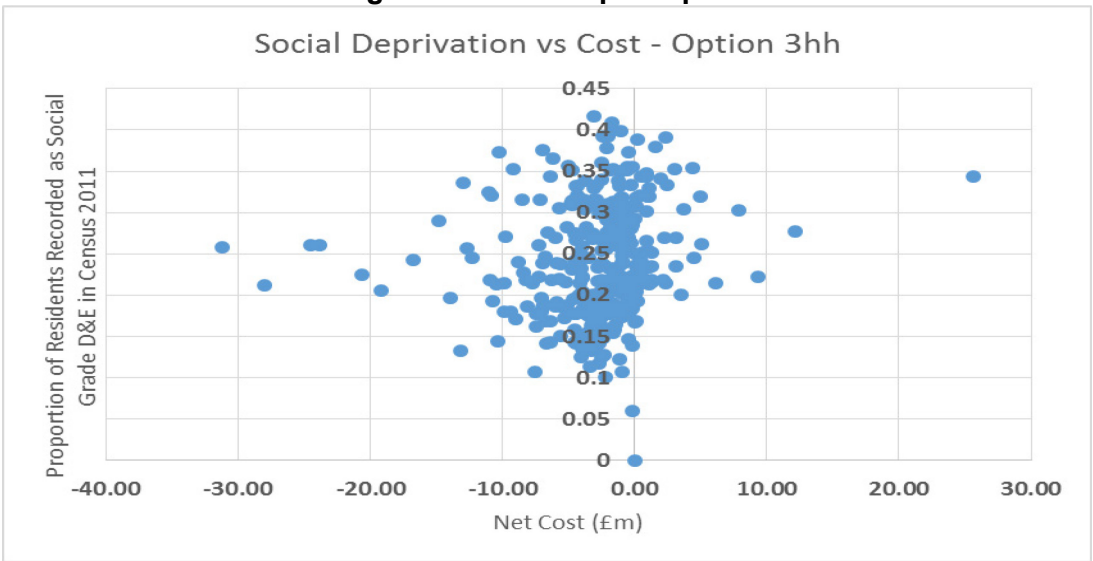
Figure 4: Estimated change in waste management costs (total 2023/24 to 2029/30) under Option 3hh



Source: WRAP modelling

Under all three options there is a weak positive correlation between an LA's estimated cost and its proportion of residents recorded as social grade D&E in the 2011 census (see Table 19 and Figure 5). Although the correlation is weak, these correlations are statistically significant at the 5% level.

Figure 5: Scatter plot of proportion of an authority's population reported as social grade D&E in 2011 census versus estimated change in total cost up to April 2026.



Source: Defra analysis

Table 19: Correlation coefficients for estimated change in total cost up to April 2028 and the proportion of the authority's population reported as social grade D&E in 2011 census.

Option	Pearson correlation coefficient
1hh	0.14
2hh	0.17
3hh	0.13

Source: Defra analysis

Non-household municipal sector

As for the household recycling scenario, the landfill tax and GHGs emissions impacts are reported for the overall municipal sector as the infrastructure for both household and NHM waste is interlinked. Thus, the overall net present savings account for municipal-wide impacts with respect to GHGs emissions and landfill waste reductions.

Waste management costs to businesses are relatively small. According to the Chartered institute of Procurement and Supply (CIPS), they account for around 4% to 5% of total business turnover, potentially up to 10%. Bearing this is mind, the following modelled scenarios describe the net costs or savings per business size and sub-sector.

Option 1nhm – Dry mixed recyclate and separate glass collections

This option estimates the costs and savings to businesses and public sector when presenting comingled dry mixed recyclates and separate glass by using typical collection containers for each of the sub-sectors and business sizes. As explained in Annex F - 'Key non-household municipal sector assumptions' section, we assume that large businesses would first achieve higher recycling performance, followed by medium, small and micro businesses.

Using WRAP cost estimates, this scenario implies the following costs per business sizes:

Large businesses face baseline waste management costs of £313m. These waste management costs are estimated to fall by £78m, to £235m per year in 2025, once 80% of dry mixed materials and separate glass are presented in separate containers and refuse collections are optimised accordingly. This is because sending waste for recycling is cheaper than sending it to landfill or incineration had it been collected as refuse. As such, prices charged to businesses for recycling collections are lower than for refuse collections, so diverting away from refuse bins to recycling bins generates savings. Large businesses are often more flexible in reducing the sizes of their refuse waste collections, thus reducing the costs for the remaining refuse pickups. We assume that these improvements are achieved over the period of 2023-2025. This is around £10,800 savings per large business per year.

Next, medium sized businesses and public sector organisations start making improvements from 2026 and achieve 80% separation of dry mixed materials and glass waste by 2028. In similar fashion to large businesses, the costs are expected to decrease from £612m per year to £463m per year, or £150m savings in 2028. This is around £3,400 savings per medium-sized business per year.

Small sized businesses are estimated to face current costs of waste management of £967m in 2018 and a 80% separation of DMR and glass could result in overall savings of up to £179m per

year as result of cost optimisation and use of shared service provision (see details on this in the 'Key non-household municipal sector assumptions' section). This equates to £700 savings per small business per year. Small business start making improvements from 2029 and achieve 80% separation of dry mixed materials and glass by 2031.

Finally, micro businesses see an increase in costs from £1.38bn per year to £1.65bn as a result of achieving 80% separation of DMR and glass. Across the board, this equates to net costs of £162 per micro business per year. Micro businesses may see cost increases because given the small numbers of bins each business is likely to have, increasing recycling may not reduce the number of refuse bins the business needs. A recycling bin would therefore add an additional cost, rather than replace a refuse bin. Micro businesses will only start making improvements from 2032 and should achieve 80% separation of dry mixed materials and glass by 2035. For more details see the Small and Micro Businesses Assessment section, which includes potential measures to reduce costs for these businesses.

Overall, this scenario results in the waste management costs for the sector to decrease from around £3.3bn in 2023 to £3.1bn by 2035 as the overall recycling rate increases from 35% to 58%. Over the period, NHM waste management costs reduce by -4%. Table 20 provides more detail on the path of waste management costs and recycling rates.

Table 20: Option 1nhm costs and recycling rate over the appraised period, undiscounted

Option 1nhm: DMR + glass	2018	2025 (large businesses transitioned)	2028 (+ medium businesses)	2031 (+ small businesses)	2035 (+ micro businesses)
Waste management costs, £m	£3,271m	£3,194m	£3,044m	£2,865m	£3,140m
Business support policy costs	-	£21m	£25m	£31m	£36m
Recycling rate	35%	38%	45%	52%	58%

Source: Defra analysis of WRAP data.

There is significant variation not only across business sizes but also across sub-sectors. WRAP's scenario estimates the following net costs or savings, and recycling rates, per sub-sector against the baseline. These describe the point at which 80% of additional recyclable materials are captured for recycling. The recycling rate performance varies across the diverse sectors included in the NHM analysis according to their waste composition and business size (Table 21).

Table 21: Option 1nhm net cost (+) or saving (-) per year against baseline and achieved recycling rate[41]

Sector	Micro	Small	Medium	Large	Total	*r.r. (%)*
Hotels & Catering	-£ 23.6m	-£ 18.4m	-£ 11.3 m	£ 7.6m	-£ 45.7 m	*56%*
Health	£ 28.3m	-£ 1.1m	-£ 4.2 m	-£ 9.3 m	£ 13.6m	*68%*
Retail & Wholesale	-£ 64.4m	-£ 119.0m	-£ 75.7 m	-£ 37.4m	-£ 296.4m	*69%*
Education	£ 8.6m	-£ 30.5m	-£ 39.0 m	-£ 14.4m	-£ 75.3m	*38%*
Office (& other)	£ 340.5m	-£ 2.8m	-£ 9.5 m	-£ 16.9m	£ 311.3m	*66%*
Transport & Storage	-£ 15.4m	-£ 4.6m	-£ 8.3 m	-£ 4.1m	-£ 32.3m	*57%*
Food Manufacturing	£ 1.5m	-£ 2.4m	-£ 1.8 m	-£ 3.1m	-£ 5.7m	*36%*

[41] Note that this costs are only applicable once the relevant business sizes transition to recycling scenario. See the 'Key NHM scenario assumptions' for more detail.

Total	**£ 276m**	**-£ 179m**	**-£150 m**	**-£ 78m**	**-£ 131m**	***58%***

Source: Defra calculations based on WRAP analysis

Option 2nhm – DMR and separate food waste collections

Contrary to Option 1nhm, this scenario assumes that businesses and public sector would not use separate glass collections and instead fully adopt DMR services together with separate food waste collections where applicable. This means that glass still ends in refuse collections.

Consequently, this scenario implies the following costs across business sizes, generally higher than in Option 1nhm as collections of separate food waste are typically more expensive then separate collection of glass waste.

For large businesses, the baseline costs of £313m could be reduced by £58m, or to £255m per year by 2025. When averaged across the whole sector, this implies cost savings of around £8,100 per year per large business.

As for medium businesses, the scenario estimates their waste management costs to decrease from £612m to £510m per year by 2028. This implies annual savings of £2,300 per medium-sized business.

With respect to small businesses, the scenario estimates the costs of DMR and food to result in net savings of £130m per year, reducing their overall waste management costs from £0.97bn to £0.84bn. This equates to savings of £500 per small-sized business per year.

Finally, the scenario expects net increase in waste management costs to micro businesses. These are estimated to increase from £1.38bn per year to £1.71bn per year, or £334m net costs, as a results of 80% separation of waste to dry mixed materials and food waste. This would result in net service costs per micro businesses of £200 per year. Micro businesses may see cost increases because increasing recycling is unlikely to reduce the number of refuse bins a business needs, although capacity could be reduced.

Overall, this scenario estimates the NHM waste management costs to marginally increase from £3.27bn in 2018 to £3.32bn in 2035 due to the separation of DMR and food waste. However, given the introduction changes first in large businesses and last in micro businesses, the sector sees net cost of -4% over the period of 2023-2035 from achieving a 70% recycling rate by 2035. This overall cost saving hides a significant variation across sub-sectors and business sizes, with increased costs to micro businesses when compared to baseline. Tables 22 and 23 provide more details on the scenario's costs and achieved recycling rates.

Table 22: Option 2nhm costs and recycling rate over the appraised period, undiscounted

Option 2nhm: DMR + food waste	2018	2025 (large businesses)	2028 (+ medium businesses)	2031 (+ small businesses)	2035 (+ micro businesses)
Waste management costs, £m	£3,271m	£3,213m	£3,112m	£2,984m	£3,317m
Business support policy costs	-	£21m	£25m	£31m	£36m
Recycling rate	35%	40%	49%	61%	70%

Source: Defra analysis of WRAP data

Table 23: Option 2nhm net cost (+) or saving (-) per year against baseline and achieved recycling rate[42]

Sector	Micro	Small	Medium	Large	Total	*r.r. (%)*
Hotels & Catering	£ 0.7m	-£2.0m	-£4.7m	-£0.5m	-£6.4m	*61%*
Health	£31.0m	£0.1m	-£3.5m	-£4.2m	£23.5m	*72%*
Retail & Wholesale	-£70.0m	-£120.1m	-£78.1m	-£35.5m	-£303.6m	*77%*
Education	-£0.2m	-£5.2m	-£3.9m	-£7.1m	-£16.4m	*68%*
Office (& other)	£372.3m	£0.1m	-£8.7m	-£9.4m	£354.3m	*72%*
Transport & Storage	-£1.9m	-£0.8m	-£3.2m	-£1.6m	-£7.4m	*60%*
Food Manufacturing	£1.7m	£0.1m	£0.2m	£0.4m	£2.4m	*57%*
Total	**£333m**	**-£128m**	**-£102m**	**-£58m**	**£46m**	***70%***

Source: Defra analysis of WRAP data

Option 3nhm – DMR, separate glass and separate food waste collections

This scenario estimates the net costs and savings across the NHM sector if all businesses were to separate their waste arisings to mixed dry materials, glass, food waste and residual waste. This is the most ambitious recycling scenario considered in the analysis of the sector with generally the highest net costs to the sector but also with the largest environmental savings (see the 'Environmental Impacts' section for details).

Large businesses are again estimated to see some savings from higher recycling. In particular, we estimate waste management cost savings of £58m per year by 2025, or around £255m waste management costs from 2025 onwards as a result of full waste separation. The indicative savings per large business are £8,100 per year.

Medium businesses could still see some savings from high recycling performance – the scenario's estimate of £98m savings results in reduced waste management costs to £515m per year by 2028 and onwards. This is a saving of £2,200 per year per medium-sized business.

Small businesses are estimated to have up to £116m savings per year from full waste separation under optimisation and shared service provision of waste services. This would reduce their waste management costs to £851m per year by 2031 and would represent a saving of around £500 per business per year.

Micro businesses would again be likely worst affected in terms of additional waste management costs. The high recycling scenario estimates that their waste management costs could increase by up to £292m by 2035, or from £1.38bn to £1.67bn per year. This indicates average cost increase of £171 per micro business per year against baseline. Micro businesses may see cost increases because increasing recycling is unlikely to reduce the number of refuse bins a business needs, although capacity could be reduced.

Overall, the full separation of waste materials under prices currently offered from waste management companies would result in cost savings to the whole NHM sector of -4% over the period of 2023-2035 but with significant variation across sub-sectors and business sizes. Table 24 summarises the waste management costs and recycling rate performance for option 3nhm and Table 25 provides the estimated net costs or savings per business and achieved recycling rates.

[42] Note that this costs are only applicable once the relevant business sizes transition to recycling scenario. See the 'Key NHM scenario assumptions' for more detail.

Table 24: Option 3nhm costs and recycling rate over the appraised period, undiscounted

Option 3nhm: DMR + food waste + glass	2018	2025 (large businesses)	2028 (+ medium businesses)	2031 (+ small businesses)	2035 (+ micro businesses)
Waste management costs, £m	£3,271m	£3,213m	£3,115m	£3,000m	£3,292m
Business support policy costs	-	£21m	£25m	£31m	£36m
Recycling rate	35%	41%	51%	64%	74%

Source: Defra analysis of WRAP data

Table 25: Option 3nhm net cost (+) or saving (-) per year against baseline and achieved recycling rate[43]

Sector	Micro	Small	Medium	Large	Total	*r.r. (%)*
Hotels & Catering	£ 20.6m	£ 9.8m	£ 0.7m	£ 9.5m	£ 40.6m	*78%*
Health	£ 61.8m	£ 11.4m	-£ 0.2m	-£ 7.2m	£ 65.8m	*74%*
Retail & Wholesale	-£ 90.0m	-£ 125.9m	-£ 57.7m	-£ 34.7m	-£ 308.3m	*76%*
Education	£ 20.7m	£ 2.8m	-£ 22.7m	-£ 9.5m	-£ 8.7m	*69%*
Office (& other)	£ 271.4m	-£ 13.2m	-£ 14.2m	-£ 15.3m	£ 228.6m	*74%*
Transport & Storage	£ 5.7m	-£ 0.7m	-£ 3.7m	-£ 1.6m	-£ 0.4m	*78%*
Food Manufacturing	£ 2.0m	£ 0.3m	£ 0.3m	£ 0.5m	£ 3.1m	*59%*
Total	**£ 292m**	**-£ 116m**	**-£ 98m**	**-£ 58m**	**£ 21m**	***74%***

Source: Defra analysis of WRAP data

Annex D: Greenhouse gas emissions impact

This section presents the estimated GHG impacts from the three shortlisted municipal waste collection system options. As part of our consideration of environmental and wider impacts, we have only been able to monetise the GHG impact, but discuss other areas in more detail under the non-monetised impacts section in Annex E.

Greenhouse gas emissions impacts

The GHGs savings arise from diverting waste away from the residual waste stream (black bag waste) where it will be sent to landfill or energy from waste, having in many cases a negative environmental impact. In the case of landfill, biodegradable waste (food, garden, paper, etc.) can decompose anaerobically, generating methane, a potent GHG. For incineration, burning of fossil-based waste (plastic for example) releases CO_2 into the atmosphere. Despite the fact that both of these waste treatment methods usually recover energy, they remain for many materials a net GHG contributor.

This section presents the modelled impacts of household, NHM and municipal recycling scenarios on the amount of greenhouse gas emissions (GHGs) when compared to the baseline. Note that the separate household and NHM estimates do not add up to municipal estimates. This is because changes in one sector only have implications to the whole municipal sector's waste treatment.

[43] Note that this costs are only applicable once the relevant business sizes transition to recycling scenario. See the 'Key NHM scenario assumptions' for more detail.

Table 26 presents the GHGs emissions savings for household scenarios only while assuming no change in the NHM sector. As discussed above, these estimates should reflect the fact that:

- Increased household recycling activities (from around 44% in 2018 to around 55-6% by 2027) divert waste from energy from waste plants and landfill, thus reducing overall GHGs emissions in the sector.
- Reduced amount of household's residual waste decreases the proportion of EfW capacity used by LAs and allows the NHM waste to utilise it and reduce the amount of waste sent to landfill.

Options 1hh and 2hh deliver broadly the same level of GHG savings while Option 3hh (multi-stream) shows slightly lower GHG savings as a result of marginally lower overall recycling rate. On average, this results in 2 to 3MtCO_2e over the period of the 5th carbon budget (2028-2032). There are additional GHG savings from having separating waste streams from one another, as that will produce higher quality recyclate that is more likely to find a market and thus be recycled. This has not been possible to monetise however.

Table 26: Household recycling scenarios' GHGs emissions savings in million tonnes of CO_2e

In MtCO_2e	2023-2035	5th carbon budget
Option 1hh	-3.2Mt traded, -4.0Mt non-traded	-1.3Mt traded, -1.8Mt non-traded
Option 2hh	-3.1Mt traded, -4.0Mt non-traded	-1.2Mt traded, -1.8Mt non-traded
Option 3hh	-1.7Mt traded, -3.1Mt non-traded	-0.7Mt traded, -1.4Mt non-traded

Source: Defra analysis

These GHGs savings are then monetised using relevant traded and non-traded carbon prices over the period of 2023-2035. Note that these monetary savings are not discounted in Table 27. The range of savings is purely due to different carbon prices as no sensitivities were run with respect to the recycling capture rates achieved per household option.

Table 27: Household GHG savings, £m undiscounted central carbon prices (low-high)

Household scenarios	2023-2035	5th carbon budget
Option 1hh	-£595m (-£295m; -£895bn)	-£254m (-£127m; -£382m)
Option 2hh	-£584m (-£290m; -£878bn)	-250m (-£124m; -£375m)
Option 3hh	-£408m (-£203m; -£613m)	-£175m (-£87m; -£262m)

Source: Defra analysis

Further, Table 28 presents the GHGs emissions savings of the NHM recycling scenarios. Note that, for the matter of space, we present only the central estimate of savings split to GHGs traded and non-traded emission savings. The low and high estimates are reflected in the overall NPV calculations of each of the option.

The modelling suggests that, under our central estimates, the NHM sector's shows a substantial potential of GHGs emission reduction. This amounts, on average, to 8MtCO_2e over the 5th carbon budget period, or almost three times of the household's emission savings potential. This is a reflection of number of factors, including:

- Relatively low baseline recycling rate for the NHM sector when compared to household (35% against 44%)

- High level of recycling across all NHM options, ranging from 58% to 74% across the options.
- Higher proportion of NHM residual waste currently sent to landfill, thus allowing scope for higher emissions savings from diverting materials such as paper, cardboard and food to recycling.

Table 28: NHM scenarios' GHG emissions savings, in $MtCO_2e$

NHM scenarios	2023-2035	5th carbon budget
Option 1nhm	-8Mt traded, -5Mt non-traded	-3.6Mt traded, -2.1Mt non-traded
Option 2nhm	-11Mt traded, -9Mt non-traded	-5.5Mt traded, -3.6Mt non-traded
Option 3nhm	-13Mt traded, -10Mt non-traded	-6.1Mt traded, -4.3Mt non-traded

Source: Defra analysis

This means that monetary values for the GHGs emissions savings are then also much higher for NHM sector than household scenarios. Table 29 shows the range of savings across low, central and high estimates that differ in the following way:

- Low estimate: best estimate of baseline recycling rate (35%), low capture rate (60%) of additional recyclates in each of the scenarios and low carbon prices for traded and non-traded emissions.
- Central estimate: central values for all of the above.
- High estimate: best estimate of baseline recycling rate (35%), high capture rate (100%) across scenarios and high carbon prices.

Table 29: NHM scenarios' GHGs savings, in £bn, undiscounted central carbon prices (low-high)

NHM scenarios	2023-2035	5th carbon budget
Option 1nhm	-£1.3bn (-£0.6bn; -1.9bn)	-£0.5bn (-£0.2bn; -£0.7bn)
Option 2nhm	-£1.8bn (-£0.9bn; -£2.7bn)	-£0.7bn (-£0.4bn; -£1.1bn)
Option 3nhm	-£2.1bn (-£1.0bn; -£3.1bn)	-£0.9bn (-£0.4bn; -£1.3bn)

Source: Defra analysis

Finally, the last two tables (Table 30 and 31) in this section present GHGs emissions savings with respect to municipal scenarios. Again, only central estimate is presented and split to traded and non-traded emissions savings. Overall, the emission savings are on average $12MtCO_2e$ over the period of the 5th carbon budget. In general, the highest savings are observed under the most ambitious municipal Option 3M but they are only marginally higher compared to Option 2M. There are wider environmental and economic benefits associated with greater waste and recycling separation that have not been monetised at this stage (see Annex E). These are likely to be most prevalent under Option 3M where material quality is highest due to increased waste separation at the point of collection.

Table 30: Municipal sector GHGs savings, in $MtCO_2e$

Municipal scenarios	2023-2035	5th carbon budget
Option 1M	-12.4Mt traded, -11.7Mt non-traded	-5.7Mt traded, -5.2Mt non-traded
Option 2M	-12.8Mt traded, -13.3Mt non-traded	-5.7Mt traded, -6.0Mt non-traded
Option 3M	-12.9Mt traded, -13.8Mt non-traded	-5.8Mt traded, -6.3Mt non-traded

Source: Defra analysis

As above, the monetary savings in Table 31 present a range of estimates in order to reflect the uncertainty with respect to future carbon prices, the NHM sector's current recycling performance and potential capture rates with strong policy in place. Household scenarios' recycling rates are unchanged across the range of estimates.

Table 31: Municipal sector GHGs savings, in £bn, undiscounted central carbon prices (low-high)

Municipal scenarios	2023-2035	5th carbon budget
Option 1M	-£2.14bn (-£0.8bn; -£4.1bn)	-£898m (-£0.3bn; -£1.7bn)
Option 2M	-£2.31bn (-£0.9bn; -£4.3bn)	-£972m (-£0.4bn; -£1.8bn)
Option 3M	-£2.39bn (-£0.9bn; -£4.6bn)	-£1,002m (£-0.4bn; -£1.9bn)

Source: Defra analysis

The municipal recycling scenarios can also be presented in terms of their economic cost-effectiveness in carbon reduction. This exercise sheds light on whether the municipal recycling policies would be a cost-effective way of reducing UK's GHGs emissions. Table 32 shows the results of this assessment:

- Options 1M and 3M are estimated to be a cost-effective way of reducing GHGs emissions when compared to a relevant cost comparator, which represents the maximum amount that is desirable to spend to abate the average tonne of GHGs emissions.
- Option 2M is estimated to be slightly above the relevant cost comparators. Thus, from climate change policy perspective only, it is marginally above the cost-effective way of reducing GHGs emissions from resources and waste management.

Table 32: Carbon cost-effectiveness of municipal scenarios, £/t of CO_2e

£/t of CO_2e	Option 1M	Option 2M	Option 3M
Traded emissions	-£2	£95	-£41
Traded costs comparator	£62	£62	£63
Cost-effective?	*Yes*	*No*	*Yes*
Non-traded emissions	£2	£101	-£27
Non-traded costs comparator	£70	£70	£70
Cost-effective?	*Yes*	*No*	*Yes*
All GHGs	£33	£82	£16
All costs comparator	£66	£66	£66
Cost-effective?	*Yes*	*No*	*Yes*

Source: Defra calculations based on BEIS (2018) Valuation of energy use and greenhouse gas.

Annex E: Non-monetised costs and benefits

For each of the municipal options, there are possibly a number of additional costs and benefits to the municipal sector as a consequence of increasing the recycling performance. However, these are challenging to monetise and are therefore not directly reflected in the modelling approach adopted in this assessment. They costs and benefits are set out as follows.

Recycling and waste infrastructure implications

With improved separation, material quality collected for recycling is higher in each of the three scenarios relative to baseline. This reduces the amount of waste sent to energy from waste plants, landfill and other residual waste treatment facilities. Consequently, there would be less pressure on additional residual waste infrastructure across England[44].

Similarly, household option 3hh of full roll-out of multi-stream would, on its own and in the short-run, likely have a negative economic impacts on some material reprocessing facilities (MRFs). Current collections see around two thirds of dry recyclables collected as comingled material. Under option 3hh, most dry recycling collections would be sorted at kerbside, and would require different sorting processes after collection. Individual facilities may be able to adapt to accept kerbside-sorted material, instead of comingled material. But for some facilities these changes would not be economically feasible so the overall impact of multi-stream collections on sorting infrastructure is currently unclear.

All NHM scenarios assume a significant increase in the collection of dry mixed materials that will need to be sorted by MRFs. Under Option 3M, this would more than offset the loss of supply of comingled dry recyclables to MRFs from household sector.

To the extent that (a) MRFs cannot adapt to accept pre-sorted material and (b) the overall supply of dry recyclables extends (see Tables 33, 34 and 35), there will likely be a requirement for new sorting / bulking facilities handling pre-sorted material.

Table 33: Projected change to dry recycling tonnages under option 1M, in thousand tonnes

	2025	2028	2031	2035
HH dry recycling	+103	+120	+123	+115
NHM dry recycling	+705	+1,948	+3,523	+4,737
MSW dry recycling	+808	+2,068	+3,646	+4,851

Table 34: Projected change to dry recycling tonnages under option 2M, in thousand tonnes

	2025	2028	2031	2035
HH dry recycling	+54	+70	+69	+74
NHM dry recycling	+787	+2,175	+3,932	+5,287
MSW dry recycling	+841	+2,245	+4,001	+5,361

Table 35: Projected change to dry recycling tonnages under option 3M, in thousand tonnes

	2025	2028	2031	2035
HH dry recycling	-155	-176	-187	-186
NHM dry recycling	+908	+2,507	+4,533	+6,096
MSW dry recycling	+753	+2,331	+4,346	+5,910

The policies would also likely have an impact on residual waste treatment facilities. Table 26 shows the estimated tonnage entering residual treatment (mechanical and biological treatment or energy from waste plants) under each scenario. This projection is heavily dependent on the

[44] National Infrastructure Commission, 2018, National Infrastructure Assessment.

extent to which some waste is 'untreatable' by existing methods, as this is a factor which becomes increasingly important with higher recycling rates. Any reduction in waste going to treatment is also sensitive to the level of uncertainty in future recycling rates and future waste arisings. Table 36 shows estimated tonnages undergoing treatment under each option. Note that these projections are subject to significant uncertainty; in particular, the time profile is likely to have been distorted by the modelling approach (see 'Key municipal-wide assumptions' section in Annex F).

Table 36: Projected residual treatment tonnages for the MSW sector under each option, in thousand tonnes

	2025	2028	2031	2035
Baseline	17,063	18,620	19,981	20,781
Option 1M	17,063	18,620	19,981	19,981
Option 2M	17,063	18,620	19,781	19,781
Option 3M	17,063	18,620	19,581	19,581

Calorific value implications for energy from waste facilities

Additional recycling can change the composition of residual waste being sent for incineration. This can change the energy content of mixed residual waste, i.e. its calorific value (CV). Higher CVs imply a higher amount of heat being released during the combustion process. CV changes can have an impact on incineration plant throughputs, with higher CVs reducing the amount of waste a plant can burn and vice-versa. We have not modelled the impact of CV changes on throughput, but indicative modelling suggests that our preferred option in this IA could increase the CV of residual municipal waste by an average of 3% between 2023-2035.

Familiarisation costs

In increasing the recycling performance, associated costs to the public sector, households and businesses as a result of adopting new practices and changing behaviour have not been costed. For example, time costs of businesses familiarising themselves with the new practice of effectively separating their collection waste are not accounted for.

Wider economic benefits

Compared residual waste treatment, recycling is a more labour intensive economic activity. All activities of bulking, sorting, processing and preparing for selling at secondary material markets require labour input. Hence, moving towards higher separation would require additional staff, possibly increasing the net job creation in the sector[45]. However, in a growing sector, the net job creation is expected to be lower than the gross job creation. We have not accounted for any of these wider economic benefits in the analysis.

Landfill aftercare costs

Biodegradable waste in landfill breaks down anaerobically, leading to generation of methane emissions to atmosphere, and the generation of leachate, an acidic liquid which needs to be extracted and treated. There is a significant evidence base which shows that the timescales before these emissions fall below the level when they will no longer need active collection and treatment are many times longer than originally thought. This could have subsequent consequences for the funding of the aftercare period, which occurs once the revenue stream of gate fees and landfill gas combustion have ceased.

[45] Green Alliance and WRAP, 2015, Employment and the circular economy – job creation in a more resource efficient Britain.

All municipal options will, depending on the quantity of biodegradable waste they divert from landfill, have a quantifiable effect on the landfill sector, as it will reduce gas and leachate generation. Thus reducing the landfill aftercare costs.

However, the reduced tonnages going to landfill will reduce gate fees revenue while increasing costs associated with early closure and redesigned closing profiles. These increases, along with the reduction in revenue from landfill gas combustion would have a major effect on the financial provision for landfill aftercare and impact on renewable energy targets, of which landfill gas is a major component.

Savings would be made from the reduced maintenance cost, reduced greenhouse gas emissions, and the shortening of the aftercare period for future landfills, but it should be noted that this will have no benefit for current or historic landfills, and could exacerbate the issues due to diminishing revenues.

International GHGs emissions savings

The estimates calculated in the Greenhouse gases emissions section reflect the contribution of municipal recycling policies with respect to the UK's territorial emissions only. A further reduction in international GHGs emissions would be observed as a result of reduced production from virgin materials.

Household and business inconvenience and disamenity costs

The space taken by additional containers can present a disamenity for households and businesses. In addition, the additional effort to separate waste into more streams can be an inconvenience for households and businesses to take into account. We have not been able to monetise either of these, although they are likely to be highest under Option 3M given the additional household and business sorting required.

On the household side, WRAP undertook research asking respondents to rank a number of service features of a recycling system. The three key service features identified by respondents as being important are having a regular and reliable service, being clear on what can/cannot be recycled and sufficient capacity in the recycling container for all their materials. The aspect of not having to separate waste into multiple containers scored lower in importance[46].

The three key service features identified by respondents as being important are having a regular and reliable service, being clear on what can/cannot be recycled and sufficient capacity in the recycling container for all their materials (Table 37).

Table 37: Percentage of householders ranking these factors as more and less important

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

Source: WRAP (2015) Recycling Tracker Survey. Sample size: 1,771.

[46] WRAP (2015) Recycling Tracker Survey. Sample size: 1,771.

Annex F: Key assumptions and data used

Household scenarios assumptions

The following section describes the key assumptions driving the performance, costs and savings in household recycling scenarios. It is not within the scope of the IA to provide a full model description here. Please refer to WRAP ICP2 – Online Tool Modelling Assumptions Technical Annex[47] for full assessment of the methodology.

Household recycling scenarios modelling approach

The household sector analysis is undertaken from a bottom-up approach which considers the known baseline profiles of each collection authority in England. The data used to build the individual baselines is derived from WRAP's local authority data on the LA Portal[48] which is derived from the national scheme audit undertaken and with performance data benchmarks processed from Waste Data Flow[49].

The overall net service costs of waste and recycling can be split to a number of key elements including the collection costs, material revenue from recyclates (e.g. under separate collection of dry material streams), required sorting costs (e.g. gate fees paid by LAs to process comingled dry recycling through a material recycling facility operations) and treatment and disposal costs (from food waste to garden waste or refuse waste).

However, when scaling and comparing costs across LAs, the comparison is difficult due to different local circumstances[50], different services included in the costs, no formal reporting method and so on. Thus, WRAP developed a Kerbside Analysis Tool (KAT) to establish standardised costs to enable fairer comparison between collection systems. KAT uses actual scheme collection timings collected from over 100 hours of filming a wide range of collection services. The tool assumes the waste flows are linked in a way that collection savings in refuse collection and disposal costs are possible in high recycling scenarios. KAT is typically used for individual LA support projects to produce a bespoke and transparent kerbside analysis to account for aspects such as service profile, operational efficiency, and recycling performance, set out and capture rates, geography and how service profiles interact. Given the number of LAs, it would be too complex to calculate the national cost on the actual local costs.

Therefore, WRAP developed the national indicative cost and performance assessments (ICP) on known average baselines for different areas. In particular, WRAP research showed that the level of economic deprivation and level of rurality are two important contextual factors that have a significant impact on kerbside recycling performance and collection service efficiency. The KAT baselines are set up for six different rurality groups from data covering the majority of England Councils. The baselines account for typical operational conditions with respect to average staff time or average pick rates achieved when servicing properties in a range of areas. The results of the ICP then feed in to WRAP's Routemap model.

The presented household recycling scenarios were prepared using WRAP's Routemap collection model. The model was originally built for the cost and performance analysis of 2020 household recycling target and applies a number of assumptions on waste and recycling collection scenarios on top ICPs results, including:

- Waste arisings: latest tonnages information from WasteDataFlow, waste from household recycling rate calculations or Local Authority Recycling Scheme Updater.

[47] http://laportal.wrap.org.uk/Documents/ICP%20online%20tool%20assumptions.pdf

[48] http://www.wrap.org.uk/content/local-authority-waste-and-recycling-information

[49] http://www.wastedataflow.org/

[50] Such as different property types and travel distances through conurbations and onto treatment end-destinations.

- Effect of changes to waste arisings: the initial recycling 'yield' projections account for anticipated increases in the number of households in each LA, but an uplift is applied based on the ratio of projected arisings to projected households.
- General assumptions: levels of contamination, food waste and garden waste arisings assumptions.
- Assumptions by LAs: with respect to household numbers, material yields (e.g. kg/hh collected under separate food waste services), gate fees, contextual information on the level of rurality and deprivation, transition costs and LAs waste management contract end dates. WRAP's LA analysis is based on data from 2015/16. The baseline collection regimes for each authority are assumed to be those in place in 2015/16, and thus do not reflect changes made since 2015/16.
- Cost assumptions: with respect to dry recycling collection costs, residual waste collection costs, separate food waste collection costs or garden waste collection costs, container delivery cost etc.
- Contract assumptions; when Local Authorities might be able to adopt a new service profile depending on their contract end and renewal dates. Authorities are assumed to change collection system no sooner than 2023. In particular, where an authority's waste management contract is due for renewal sooner than 2023/24, the analysis assumes that contracts can be continued on a rolling basis until the change is made. Any extra costs incurred from this are not reflected in the analysis.
- Transition rate assumptions; the rate at which Local Authorities can implement new services profiles and roll them across their areas, depending on area size and complexity of the new profile. The analysis does not account for any effects resulting from large-scale adoption of certain collection methods, e.g. the spike in demand for certain types of truck.
- In general, the projections from Routemap are based upon observed data in authorities where a particular collection regime has been introduced. It may be that certain factors, not accounted for in the modelling, will affect the yields and prices in ways not reflected in these observed cases. For example, it might be that lack of space for multiple bins affects roll-outs of multi-stream collections in urban centres (to a degree not yet observed).

The spreadsheets producing this analysis have been subjected to external peer review, as well as spot-checking of the syntax by Defra analysts. The outputs from the model runs were subject to analytical review (i.e. sense checking) by Defra staff. The main sources of uncertainty are the complexity of the interlinked models and reliance on indicative costs. The scale of the uncertainty is not negligible, but is also not believed to be such that would affect the choice of preferred option in this IA. Further work will be undertaken in 2019 to work better quantification of the uncertainty into the modelling approach.

Price assumptions

As for price assumptions, all modelling is done based on current prices that do not change over the years. Material incomes are accounted for in sorting costs (i.e. these are net of income received for sold material) as well as direct payment in scenarios where materials are collected separately (i.e. for fibres in twin-stream scenarios and separately collected materials in multi-stream scenarios). The material income is based on the average prices as reported in WRAP's Material Pricing Reports (2016/17 values).

Regarding the treatment and disposal costs, Routemap uses WRAP gate fee costs survey (from 2016/17) across various waste and recycling facilities in England and uses average values for key recycling and waste treatment facilities, including materials recycling facilities (MRFs), energy from waste plants and landfill. In addition, bulking and haulage costs are added relative to the scheme profile where required.[51] Haulage costs are also considered in the materials pricing where appropriate[52].

With respect to low, best and high estimates, the following prices were applied in each household scenario. The low estimates assume low material revenue prices, leading to higher gate fee payments from LAs to treatment operators, and vice versa for high scenario (Table 38). When generating low and high scenarios, we compared baseline with high material prices to scenarios with low materials prices to derive low overall estimate (i.e. worst case scenario) and baseline with low material prices to scenarios with high material prices (i.e. best case scenario).

Table 38: Applied costs per treatment of dry and organic recyclates and savings per material sold

£/t of material		Low	Best	High
Dry recyclates' treatment costs	Gate fee for mixed glass, paper, card, cans, plastic bottles, PTT	£40	£15	-£10
	Gate fee for paper, card, cans, plastic bottles, PTT (no glass)	£30	-£1.3	-£20
	Gate fee for glass, cans, plastic bottles, PTT (no fibres)	£40	£15	-£10
Organic treatment costs	Food waste	£60	£15	£0
Material revenue: used on multi-stream collections and the separate streams of two-stream	Paper	£70	£76	£100
	Cardboard	£60	£71	£120
	Mixed paper and card	£40	£50	£80
	Cans	£60	£72	£140
	Mixed glass	-£20	-£13	£10
	Colour separated glass	£0	£4.5	£20
	Plastic bottles	£50	£79	£150
	Plastic pots, tubs and trays	£0	£42	£5

Source: WRAP modelling assumptions based on Gate Fees 2017/18 Final Report[53]

Dry recycling and separate food waste collections at kerbside (low-rise properties)

WRAP uses data from the WasteDataFlow to calculate the collected tonnages of dry recyclables for each LA and analyse these to calculate dry recycling yields per household for each target material. These yields depend on the different collection system type, collection frequency, rurality and levels of deprivation. When an authority is assumed to move from one collection system to another (to multi-stream for example) the waste yield per household will change based on the above factors.

These yields represent material collected from the kerbsides and thus include a certain amount of non-target materials, or certain level of contamination. A contamination rate is then applied to the tonnage collected and varies by collection approach with the following contamination assumptions applied in the household model:

[51] For example for LAs who might need to haul food waste to an anaerobic digestion facility cross country, or to manage the transfer of segregated dry-recyclables into bulk containers at a local depo

[52] Such as Ex-works costs rather than through the reprocessors' gate.

[53] http://www.wrap.org.uk/sites/files/wrap/WRAP%20Gate%20Fees%202018_exec+extended%20summary%20report_FINAL.pdf

- Co-mingled mixed dry recyclables collections: 12.5%
- Two-stream dry recyclables: 8%.
- Multi-stream dry recycling collections: 2%[54].

All household scenarios assume LAs to adopt separate food waste weekly collections at kerbside. While there are other options for collecting food waste, such as mixed food and garden waste collections, WRAP evidence shows that separate weekly collections of food waste can capture twice as much material per year compared to mixed food and garden waste collections. In addition, more food waste tend to be captured through weekly collections when residual collections are on fortnightly basis (as assumed in all household scenarios). Table 39, adopted from WRAP's publication[55], compares the food waste yields across different profiles. These values are regularly updated based on the latest performance data benchmarks.

Table 39: Food waste yields across different service profiles

	With residual waste collected weekly	With residual waste collected fortnightly
Separate weekly food waste collections	68kg	78kg
Weekly mixed food and garden collections	28kg	41kg
Fortnightly mixed food and garden waste collections	23kg	30kg

Source: WRAP, 2016, A framework for greater consistency in household recycling in England – supporting evidence and analysis.

All household scenarios all assume free caddy liners would be offered and are accounted for as part of the transition and ongoing costs to LAs. The liners are only supplied to participating households to minimise wastage and are costed on the basis of compostable polymers so there might be savings made if a cheaper PE version are suitable at food waste treatment facilities. The start-up costs are around £1.2m in Year 1, dropping to £40k by year 6 of implementation. The ongoing costs are around £1.5 per household but could be £0.5 per household if PE bags are used instead.

WRAP food waste trials[56] show that free caddy liners can result in significantly higher household participation. Without their provision to householders, WRAP estimate around 20% lower yield per household in Year 1, dropping to 50% of expected yield achieved under free caddy liners by Year 3. The recycling performance used in our IA scenarios assume free liner supply so deviating from this would significantly affect national capture and efficiency of separate food waste collections.

Dry recycling and separate food waste collections at high-rise properties (flats)

The performance at flats is calculated in the same way as for kerbside properties. Based on WRAP reviews of urban schemes, flats are assumed to achieve collected dry yields equivalent to 50% of that achievable at kerbside properties. The frequency of the collection for both recycling and residual waste is unchanged.

Given the complexity of the sub-sector, none of the scenarios assumed introduction of separate food waste collections for flats at the moment.

[54] WRAP, 2016, A framework for greater consistency in household recycling in England – supporting evidence and analysis.

[55] Ibid

[56] WRAP (2016), Household food waste collections guide; WRAP (2009), Evaluation of the WRAP separate food waste collection trials.

Free garden waste collections

In terms of the cost benefit between free and charged garden collections the key factors seem to be the quantity of garden waste that is remaining within residual stream, the level of take up in the charged collection and the level of collection efficiency that is able to be achieved in the charged system.

WRAP's analysis comes directly from Local Authority data from combination of national studies undertaken on WasteDataFlow and more recently targeting Councils who have changed their garden collections.

WRAP has undertaken several unpublished studies on garden waste collections performance. The most recent analysis showed that the introduction of charges to existing (previously free) garden waste collection was likely to result in the reduction in recycling yields by on average 25% and arisings per household of 106kg per household per year +/- 26 kg within a 95% confidence interval[57]. In other words, the average subscription rate was 34%. Further studies indicated the level of subscription to be 25%+/-5% of possible users of garden waste collections. WRAP is conducting further research in 2018/19 to corroborate the trends and impact of pricing on the performance of garden waste collections.

In each case of the transition to charged garden collection the kerbside residual waste arisings appear to have increased. This strongly suggests that residents are, in most cases, avoiding the charge and depositing some garden waste into residual streams. Increasing the amount of garden waste in residual waste increases disposal and collection costs to Local Authorities and increases environmental impacts compared to alternative treatment opportunities (garden waste composting).

The transfer of garden waste to household waste recycling centres, where residents are driving garden waste to bring facilities, appears minimal (around 5% switch of total tonnage from household kerbside to bring facilities). In terms of home composting, where garden waste could be diverted to if users do not want to pay a charge, there is limited evidence on how much takes place, therefore we have not been able to take it into account in our analysis, so additional garden waste collected is assumed to be diverted away from the residual waste stream.

WRAP modelling scenarios estimate that LAs charge around £121m per year through the garden waste charging subscription service. This is based on the assumption of an average charge of £40.19 per householder per year.

Key non-household municipal sector assumptions

For the NHM scenarios, the following are the key WRAP assumptions that affect scenario costs and benefits. These are based on industry peer review and Defra approved methodology.

NHM sector total waste arisings

The business classification used in the analysis follows the Standard Industrial Classification of economic activities at the 2 digit level and as such a wide range of businesses are included. For example, the office category in which a significant proportion are micro and small businesses includes estate agents, libraries, financial services, telecommunications centres as well as standard office complexes.

Given the uncertainty in data, WRAP have developed four key sensitivities on the total amount of waste in the NHM sector. This methodology used, among others, the data provided in the

[57] Resource Futures for WRAP, 2017. Impact of garden waste charges, unpublished.

Environment Agency Waste Data Interrogator (WDI) and resulted in four main estimates because the EA data is not conclusive in the sense of:

- In 2015 only 68% of permitted sites included site data in their returns. This could be for multiple reasons: they might have not process any waste, they have closed down, they have just opened, or simply did not include any site data.
- There is no flow of data within the EA WDI, and so it is difficult to know the true path of waste from one facility to another to an end destination. For instance, some waste is shown to go to a Facility, other waste is shown to go to a process (Recovery), and so it is difficult to depict if the Recovery tonnes are counted in a Recovery Site or not.

This means that four sensitivities were required when making assumptions on the EA WDI, so every eventuality is covered. These sensitivities include tonnes shown as gone to a Recovery process (and not), and a proxy extrapolating site data submissions up to 84% (50% increase on 68%).

The four sensitivities are listed as:

- Without Recovery tonnes and 68% Returns (14.9 Mt of waste)
- With Recovery tonnes and 68% Returns (24.3Mt of waste)
- Without Recovery tonnes and 84% Returns (15.5Mt of waste)
- With Recovery tonnes and 84% Returns (26.3Mt of waste)

These sensitivities were then each modelled by sector/sub-sector into waste collection scenarios and extrapolated to a national level to provide the NHM scenario results. For the purpose of this impact assessment, an average across the four sensitivities (20.2Mt of waste) has been taken as our estimate across all scenarios and sensitivities.

NHM waste management costs methodology

Applying costs to services

Similar to the standardised costing approach for HH collections WRAP's NHM model uses Industry charge per container lift data for each service offered to a business. This is then applied to the baseline and the container provision needed for future scenarios. The charges are derived from large scale surveys of commercial collectors and as such remain commercially sensitive. Industry reviews of SMEs and national retailers highlights contract prices that reflect discounting according to a range of factors such as duration, material ranges included, numbers of lifts per site, national or regional contracts.

However, given the range of contract differences and scale of businesses affected in the NHM analysis it is not possible to build in discount factors into the individual site analysis. As such the overall costs generated in the analysis are likely to be overstated, particularly in the new scenarios when fully rolled out.

Shared waste provision

WRAP's NHM model calculates for each of the four sensitivities the tonnes of waste generated per year per business sub-sector and size. It then applies estimated waste compositions to convert tonnes of waste into volume[58] and calculates the lowest collection costs from a range of different bin sizes per business. This means that:

- If it is cheaper for the business to have a larger bin but collected every other week, as each week the bin is less than half full, then this is selected.

[58] Given sector's use of the charge per pick-up rate for a service provided, tonnages of waste need to be converted to volume to account for the amount of space left per applied container or sack.

- If two businesses were to share a larger bin (next size up as such), but have a weekly collection (because of double the amount of waste), then the price per business would remain the same as a fortnightly collection.

Alternatively, if the business was to have a smaller less expensive bin, but collected weekly, the price would only be marginally more than the fortnightly collection alternative with two businesses sharing the service.

The WRAP fieldwork carried out so far shows micro and, to a lesser extent, smaller businesses using a shared provision more often than medium and larger sized businesses. The surveys observed considerable numbers of businesses already operating shared services and employing other options to maintain low charges such as backhauling of their waste. Therefore, the baseline and future scenarios for micro businesses are likely overstated and offer opportunities to reduce on-going charges.

Thus, WRAP's modelled scenarios do account for some waste provision sharing with the smaller businesses, but only up to a shared provision between two businesses. This means that there could be more cost savings if more than two smaller businesses shared a waste provision. Due to lack of available data, it is difficult to quantify take up and cost of a shared waste provision provided by owners or managers of a retail or business complex.

Optimisation

When expanding a waste provision from a residual only collection to a provision that includes additional bins for a recycling collection, two options are available to businesses:

- Non-optimisation of collection services: businesses keep the residual bin currently used and add extra bins to place the recyclates in. This means that the cost of a waste collection with additional recycling bins would increase significantly, because one, or some bins, are not efficiently sized to the volume of waste generated.
- Optimisation of collection services: businesses reduce the residual bin size in line with the amount of recyclable material diverted to the additional recycling bins.

When including recycling bins on top residual waste collections, optimisation is key to keeping the costs down for the business. The additional recycling bins are not necessarily a separate bin for each recycling material. They can, and are often bins that hold multiple recyclable materials (i.e. dry mixed recyclables which contain paper, card, plastics and metal).

Optimisation can be applied on two levels. The first is to reduce the residual bin size sufficient to the volume of residual waste that is left after the recyclable waste has been extracted and placed into recycling bins. The second is, on top of reducing the residual bin size sufficiently, to also have the most suitable recycling bin size appropriate to the volume of recyclate generated by the business.

This means that the cost of a waste provision with additional recycling bins would be less and in some cases cheaper than a residual only collection. This also may mean the waste management companies would need to adapt their collection vehicles to lift the various bin sizes. However, it is suggested some collection vehicles already have this capability.

The presented NHM waste collection scenarios are modelled under optimisation assumptions. For illustrative purposes, Table 40 presents indicative costs of Option 3nhm per business per year in each of the main sectors. Note these business costs are shown under 100% capture rate of relevant recyclates and would therefore be only reflected in the high estimate of Option 3nhm.

Table 40: Indicative waste management costs per business per year under Option 3nhm

£s per year	Micro	Small	Medium	Large
Hotel and catering	2,000	3,100	11,500	82,700
Health	1,300	1,800	4,500	98,100
Retail and wholesale	1,400	4,200	16,200	45,200
Education	3,700	27,100	81,800	89,200
Office	700	1000	2,400	8,300
Transport and storage	1,600	3,000	10,200	23,100
Food manufacturing	900	9,300	18,300	69,100

Source: Based on WRAP NHM analysis, annual costs divided by the number of business units in each sector.

Scenario assumptions

We assume capture rates of 60%, 80% and 100% across each of the scenario to estimate low, best and high estimate respectively. At the moment, these capture rates should be seen as provisional proxy for the sector's potential:

- Currently available NHM data does not allow to extract information on the capture per business site. Defra is commissioning further waste composition research that should allow us to understand the levels of capture per material in key sub-sectors.
- Similar capture rates are often used in household sector modelling. Thus, given that the sector generates household like waste materials, we argue that using similar-to-household capture rates as a proxy for the NHM sector should be a relatively sensible assumption.
- Finally, as explained below, we realise that these capture rates could likely be only achieved under targeted policy measures that support the transition of the sector to higher recycling performance and we account for these business support costs in our analysis.

Given WRAP's findings that the net costs of higher recycling across business sizes are generally lowest for larger businesses and highest for micro businesses, we assumed that large businesses would first shift to higher recycling, followed by medium, small and micro businesses. This scenario approach is also in line with the observation that larger businesses typically have their own recycling policies systems already set up. The following captures are then assumed per each business size in central scenario:

- Large businesses – starting from a baseline recycling in 2023 and achieving 80% capture of additional available recyclates[59] by 2025.
- Medium businesses – start seeing improvements since 2026 and achieving 80% capture by 2028.
- Small businesses – improve recycling performance from 2029 and hit 80% capture by 2031.
- Micro businesses – start with improvements in recycling from 2032 and achieves 80% capture by 2035.

Further, assumptions on baseline recycling rate (30/35/40%) affect the net impact of scenarios with respect to waste management costs (low baseline recycling rate generally leads to higher potential savings in a given scenario). For environmental savings, best estimate of 35% recycling rate is assumed and then compared against scenarios with different capture rates under low, beset and high estimates.

[59] For instance, if 10 kg of food waste are currently sent by a large business for residual waste treatment, we assume that 8kg would be sent for recycling by 2025. The same methodology applies to other businesses sizes.

Next, we assume shared service provision, primarily between micro and small businesses. This assumption lowers costs to these business. WRAP analysis considered two types of shared service provision:

- Two or three smaller businesses jointly purchasing and sharing a provision
- The owners/managers of a retail or business complex making a waste provision service available.

Based on WRAP's field work, the shared service provision is mainly prominent among micro and small businesses than medium and large businesses. Hence, WRAP cost estimates assume only up to two micro and/or small businesses make use of the shared service provision.

The scenarios assume that all businesses optimise their bin sizes according to their waste arisings. For example, the more separated business' waste becomes, meaning more space needed for other bins/bags, the smaller the residual bin required hence reducing residual costs. This option then results in lower overall costs than in baseline for some type of businesses.

NHM policy support costs

We assume that business support costs would be needed in order to achieve such a significant change across the whole NHM sector. These are split to a number of activities of which some are assumed to be applicable for the first year while other are assumed to be ongoing business support costs:

- Year 1 costs: National communications, regional outreach and roadshows, initial mailing and design to target businesses, national web-based resources, monitoring and analysis of tonnages and sub-sector responses, staff costs who pay regular visits to businesses for site checks, transitional support and follow-up checks. WRAP estimates this to be around £39 million.
- Ongoing costs: national communications, mailing, online support tools, monitoring of tonnages per sub-sector and staff costs. Overall costs of £36m per year.

Given that these estimates are for the whole NHM sector but we assumed a staggered approach across business sizes, the analysis assumes the initial costs to be a half of the overall costs (£19.5m in 2023) rising up to £36m per year by 2035, once the whole NHM sector is targeted. We assume these costs stay the same across different NHM scenarios.

Key municipal-wide assumptions

During the main analysis there was uncertainty surrounding the start date for these policies. As a result, the original modelling was performed with year 1 for the introduction of the policy calculated using 2019 projections. This profile beginning from year 1 has here been applied to a start date of 2023. This approach entails the following simplifying assumptions.

- Local Authorities with soon-to-expire waste management contracts are able to continue their current arrangements on a rolling period until 2023.
- The projection of available residual waste treatment infrastructure can be shifted for all options by 4 years into the future with negligible impacts on their relative costs and benefits.
- Growth in both waste arisings and the number of households can be shifted for all options by 4 years into the future with negligible impacts on their relative costs and benefits.

We will further update the modelling scenarios once the exact start date of policy is confirmed.

Next, the findings depend on the amount and composition of MSW arisings in the future. For household waste, these are based on a time series forecast that includes projected consumer expenditure as an explanatory variable. The forecasts are flat after 2030. This is on the basis of an assumption that the UK will successfully 'decouple' its economic growth from its resource use and waste generation. NHM arisings projections are projected as a flat line for the period in question. Future analysis plans to more comprehensively study the uncertainty in waste arisings and the range of impacts on the model's outputs.

Defra's model estimates the mass flow balance across the municipal sector in order to estimate the amount of tonnages treated by different methods and associated GHGs emissions. This is a complex model with a number of key inputs influencing the modelling results. It is out of scope to present detailed assessment of the model here but we present here two key assumptions on which our municipal-wide results depend:

- The model assumes that up to 90% of current energy from waste plants capacity is currently taken by Local Authorities collected waste who are estimated to collect around 7% of the waste in the NHM sector. The remaining NHM waste is collected under commercial contracts with waste management companies. This implies that up to 70% of the overall NHM refuse waste tonnage is initially sent to landfill. This percentage reduces once the scenarios start diverting refuse to recycling in each of the presented scenarios.
- All scenarios assume that at least 5% of municipal solid waste is untreatable at the moment and in the future. This means that it needs to be sent to landfill and cannot be processed through EfW plants or recycling facilities in any of the scenarios.
- Waste composition is assumed to be constant over time. The exact changes are hard to predict, but there will almost certainly be shifts in the composition of waste arisings over time. These changes will, in particular, affect the greenhouse gas emissions and savings under different scenarios.
- There is no explicit modelling of the emergence of new infrastructure handling recycling (such as MRF and AD plants). Where there is an increase in demand for sorting of recyclates or anaerobic digestion, MRF and AD facilities are assumed to be built in order to meet that demand. The modelling does not explicitly account for any delays in building this infrastructure.

The landfill tax value is assumed to be flat and at the 2015/16 level of £82.60 per tonne of waste sent to landfill. Whilst the landfill tax is expected to rise in line with the growth in the Retail Price Index from its current level a constant rate has been assumed for the modelling purposes as all other prices have been kept constant.

All municipal scenarios see a significant reduction the amount of municipal waste sent to landfill. While we assume a constant gate fee costs per tonne of residual waste sent to landfill, this could lead to significant impacts on the economics of landfill management, through the reduction of gate fee receipts, and reduction of revenue from landfill gas combustion through reduced landfill gas generation. We do not reflect this dynamics, and its impact on prices, in the current modelling framework.

Key environmental assumptions

GHG emission savings

The greenhouse gas emissions analysis of recycling scenarios have been done using Defra's in-house model which estimates the net increase or decrease in carbon emissions across the following activities:

- Recycling and composting
- Energy recovery
- Landfill

We report GHGs emissions changes and split them in terms of whether they occur in sectors covered under the EU Emissions Trading Scheme[60] (ETS) ('traded emissions') or outside the EU ETS ('non-traded emissions'). In the case of waste, emissions from waste sent to landfill and incineration[61] are non-traded, and emissions from recycling and composting and traded.

The calculations are based on BEIS greenhouse gas conversion factors from 2017[62]. For each of the options' GHG emissions savings, we applied the carbon prices as presented in Table 41 over the appraised period.

Table 41: Applied carbon prices, in £/t of CO_2e, rounded

Year	Traded carbon prices			Non-traded carbon prices		
Scenario	Low	Central	High	Low	Central	High
2023	12	27	43	36	71	107
2024	16	34	54	36	73	109
2025	20	42	64	37	74	111
2026	23	49	75	37	75	112
2027	27	57	86	38	76	114
2028	31	64	97	39	77	116
2029	35	72	108	39	78	117
2030	40	79	119	40	79	119
2031	43	86	130	43	87	130
2032	47	93	141	47	94	141
2033	51	102	152	51	102	152
2034	54	109	163	54	109	163
2035	58	116	174	58	116	174

Source: BEIS UK traded carbon values for policy appraisal 2017; Table 3 from supporting the toolkit and the guidance 2017 for non-traded carbon values.

[60] https://ec.europa.eu/clima/policies/ets_en

[61] Although incineration emissions are non-traded, the energy recovery component from incinerating municipal waste generates energy which offsets the need to produce that energy through existing UK power plants. That offset is counted as traded emissions savings.

[62] https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2017