The Financial Impact of Small WEEE and Battery Collection Options and Impacts on Waste Fires

Final Report

Prepared February 2025

Foreword

The findings of this independent report underpin a long-held view, within the waste and resources sector, that the current collection system for WEEE and batteries is inadequate for safely dealing with the proliferation of devices containing batteries, such as disposable vapes, that are discarded today.

Reflecting the sheer volume and variety of battery-powered electronic devices that have come onto the market in recent years, there has been a staggering growth in the costs of battery-related fires to the waste sector – from £150 million per annum in 2021 to over £1 billion today. This in itself presents a clear call to action and signals that more must be done to protect the safety of both waste operatives and the vital infrastructure we all rely on every day.

The waste and resources industry has already invested hundreds of millions of pounds in safety measures to mitigate the risks posed by improperly discarded batteries, but these risks are most effectively mitigated at the point of disposal – which requires a shift in the way we fund and deliver collection services for waste electricals and batteries, driven by new policy and regulation.

Universal kerbside collections must be at the centre of both waste streams to maximise convenience for the householder, and this should be coupled with a well-designed, properly-funded, communications campaign to minimise the incorrect disposal of WEEE and batteries alongside other household waste.

To achieve this, the first steps for Government are to expedite revision of the WEEE Regulations in full and begin the long-awaited review of the Batteries Regulations without further delay.

Jacob Hayler,

Executive Director of the ESA

esa environmental services association

Glossary

Abbreviation	Term
DMR	Dry mixed recycling
EA	Environment Agency
EEE	Electrical and electronic equipment
EfW	Energy from waste
EPR	Extended producer responsibility
HWRC	Household waste and recycling centre
IA	Impact assessment
LA	Local authority
MRF	Materials recovery facility
PR	Producer responsibility
RCV	Refuse collection vehicle
RDF	Refuse-derived fuel
SMW	Small mixed waste of electrical and electronic equipment
WEEE	Waste electrical and electronic equipment
WTS	Waste transfer station

Executive Summary

Context

Eunomia Research & Consulting ('Eunomia') has been commissioned by the Environmental Services Association ('ESA') to investigate the costs and benefits associated with collecting small mixed waste electric and electronic equipment (SMW) at the kerbside. SMW includes mobile phones, toothbrushes, e-cigarettes and vapes, power tools, toys and similar items.

Currently, SMW is rarely collected for recycling at the kerbside. Typically, householders can recycle SMW via their local household waste and recycling centres (HWRCs), dedicated bring banks, or retailer takeback schemes. Portable batteries can also be returned via HWRCs and bring banks, as well as in battery bins at supermarkets and other retailers. 100 of a total 391 local authorities do offer kerbside collection of SMW, however, these cover just 23% of households, since kerbside collections often exclude certain property types like communal or rural properties.[1] Consequently, SMW is often placed in the residual waste bin, or with other recyclable materials in a commingled collection. In either case, there is a risk of compaction and subsequent risk to human health and the environment.

The existing collection methods for SMW are inadequate, leading to improper disposal and heightened fire risks. Many households lack convenient access to recycling options, resulting in valuable materials being lost to landfill and incineration. Approximately 155 kilo tonnes of SMW are improperly disposed of each year, primarily due to the challenges associated with accessing recycling facilities.

Perhaps the most acute issues are waste related fires. Waste fires pose a significant and growing problem for the waste industry and the public at large. Over 1,200 waste battery fires in lorries and at waste sites were reported in 2023. This is a substantial increase from the 700 waste fires reported in 2022.

Options Considered

A solution to this is the introduction of kerbside collection of SMW, potentially also to include batteries and other materials. This report seeks to build on the work already done by DEFRA and Material Focus in appraising the impacts of introducing kerbside collections of SMW (and potentially batteries).

This study seeks to present a series of options that appraise the costs and benefits of introducing kerbside SMW collections for all UK households by local authorities. In addition, we ensure that the benefits gained from material recovery and fire prevention are fully explored. Herein, we refer to the three following options:

1. **Option 1: Kerbside Collection of SMW Only**

   – This option involves adapting existing dry mixed recycling (DMR) collection systems to include SMW. It requires retrofitting refuse collection vehicles (RCVs) with cages to safely store SMW. The operational costs are expected to be comparatively low, as they are integrated into existing collection routes.

2. **Option 2: Kerbside Collection of SMW and Portable Batteries**

   – This option builds on Option 1 by including the collection of portable batteries alongside SMW. It involves additional modifications, such as fitting dedicated containers for batteries in RCVs. This

[1] City of London, Derbyshire Dales, Nottingham and Surrey Heath were excluded from analysis due to the lack of scheme data provided by WRAP

option is projected to yield the highest benefits, significantly reducing fire risks and enhancing material recovery.

3. **Option 3: On-Demand Collection of SMW and Portable Batteries**

   – This option proposes a dedicated collection service using separate vehicles that can be scheduled by residents. While it covers a broader range of households, it incurs higher operational costs due to the need for dedicated vehicles and staffing.

Key Findings

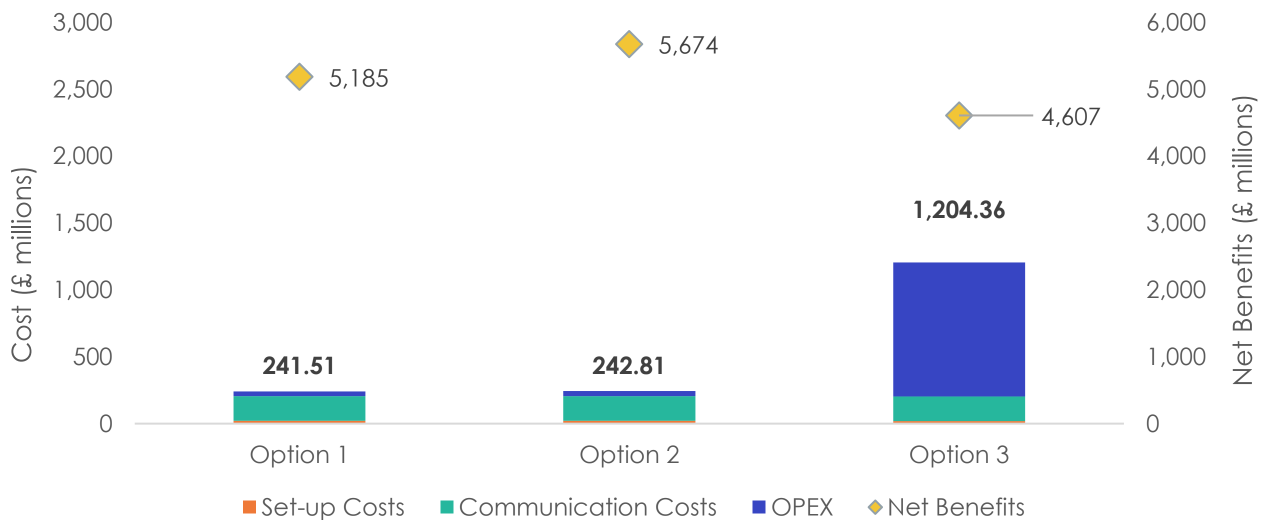
The cumulative costs and net benefits for each option, from 2026 to 2036, was calculated at a Net Present Value (NPV) of 3.5%, consistent with the Green Book discount rate.[2] Comparing the baseline option with Options 1, 2 and 3, based on the baseline cost of fires in 2026, reveals substantial cost savings and environmental benefits from implementing kerbside collection schemes for SMW and portable batteries.

- **Option 1** generates net benefits of **£5,185 million** at a NPV over the 10-year period,
- **Option 2** delivers slightly higher net benefits of **£5,674 million**, and
- **Option 3** yields net benefits of **£4,607 million**.

Option 2 – kerbside collection of SMW and portable batteries – has the greatest net benefit. It is only marginally more expensive than Option 1. Thus, a clear result is **the benefit of including loose batteries** within the kerbside collection scheme; their addition increases the realised benefits but they do not incur much additional cost.

Another clear result is that Option 3, while providing similar environmental and financial benefits to Option 2, incurs the highest operational costs due to the need for dedicated separate pass vehicles, making it the least cost-effective option over time.

Figure ES- 1: Cumulative Costs and Net Benefits for each Option (2026 to 2036)



[2] House of Lords Library, "COP26: changes to the 'green book'", 2021.

The **primary driver of the benefits** is the substantial cost **savings from reducing fire-related expenses** compared to the 2026 baseline of £611.51million. Annually, these fire cost savings range from £503.42 to £573.30 million, highlighting the significant financial impact of reducing fire incidents through the collection and management of SMW and batteries.

Recommendations

Our recommendation is that Option 2, kerbside collection of both SMW and loose batteries, is pursued further. The responsibility for the delivery of this option would lie with local authorities, who already oversee the kerbside service. Extended Producer Responsibility (EPR) can help fund the change and ongoing operations, including communications. It will make recycling SMW and batteries easier for the public, which should increase recycling overall. Whilst there are still some concerns to address – such as where to place a cage in an eRCV – it is imperative the momentum is not lost and progress towards a more circular and safer waste management system is achieved.

The introduction of a structured, UK-wide kerbside collection system for SMW and batteries presents a viable solution to mitigate the risks and costs associated with waste fires. By enhancing public access to recycling options and ensuring producers are accountable for their products, significant financial and environmental benefits can be achieved. A UK-wide rollout would also help minimise the risk of confusion that exists in the SMW and battery service provision, which currently differs from council to council. The report calls for immediate action to reform current practices and improve waste management systems across the UK, ultimately contributing to a more sustainable and circular economy.

All options assume the single-use vape ban would be effective in removing all vapes from the waste stream and reduce any associated fire risk. This reduction is unlikely to be realised from day one of the ban, and the reduction in incidents of fires could be an overestimate if such a ban is not properly enforced, or if multi-use disposable vapes and other contraband on the UK market evade enforcement.

Contents

1.0 Introduction

Eunomia Research & Consulting ('Eunomia') has been commissioned by the Environmental Services Association ('ESA') to investigate the costs and benefits associated with collecting small mixed waste electric and electronic equipment (SMW) at the kerbside. SMW includes mobile phones, toothbrushes, e-cigarettes and vapes, power tools, toys and similar items.

Portable battery-related Waste Fires are a Growing Problem

Currently, SMW is rarely collected for recycling. These materials are often placed in the residual waste bin, or with other recyclable materials in a commingled collection. In either case, there is a risk of compaction and subsequent risk to human health and the environment.

Perhaps the most acute issues are waste related fires. Waste fires pose a significant and growing problem for the waste industry and the public at large. Over 1,200 waste battery fires in lorries and at waste sites were reported in 2023. This is a substantial increase from the 700 waste fires reported in 2022.[3]

The risks of battery fires are numerous. Firstly, there is a significant risk to human health. These fires risk the safety of waste management staff and the public who may encounter them. Recent (2024) reports of large-scale waste facility fires forcing residents to not only keep their windows and doors closed due to the smoke, but also causing nearby schools and nurseries to shut as air quality worsened.[4,5]

Other impacts include severe equipment damage, downtime at waste facilities, and diversion of waste as operations are interrupted, as well as loss of valuable materials – both recyclable items collected alongside batteries, such as plastics, but also the extremely valuable rare earth metals found in electrical items. All of these come at a significant cost to industry, local authorities, fire services, and ultimately, the public.

The Source of the Battery Fire Problem

Batteries can spontaneously ignite, and when collected in waste vehicles with other materials or processed through sorting or recycling facilities, they can quickly set alight flammable material and cause significant damage. The risk increases when batteries are damaged, which occurs frequently over the course of normal waste collection and sorting operations, since many waste vehicles and facilities compact or shred the collected mixed waste. So, batteries being mixed in with other wastes exacerbates the problem. Keeping all batteries separate from other recycling and residual streams is therefore important to mitigate the risk of fires.

Material Focus reported that 1.6bn batteries were thrown away in 2023-24, equating to over 3,000 a minute. Over 1.1bn of these batteries were hidden within SMW. Waste management company, Veolia, claimed to see one fire a day from SMW and portable batteries in the residual stream.[6]

Portable batteries and SMW items' collection system is currently complex. Some items can be returned to retailers (e.g., portable batteries at supermarkets, phones and laptops at certain electrical retailers). There are 100 local authorities (of 391 local authorities across the UK[7]) that currently offer a SMW

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[3] Material Focus. "Over 1,200 battery fires in bin lorries and waste sites across the UK in last year", 2024. Last accessed 30th October 2024.
[4] London Fire Brigade, "Fire at waste collection site – Wimbledon", 2024. Last accessed 6th November 2024.
[5] The Standard, "South-west London schools and nurseries shut as recycling plant fire burns on", 2024. Last accessed 6th November 2024.
[6] Letsrecycle, "Veolia sees one fire a day from WEEE in residual waste bins", 27 August 2024. Last accessed 6th November 2024.
[7] 387 local authorities supplied collection and household data to WRAP, and so have been assessed here. [WRAP LA Portal, 2024. Last accessed 18th November 2024 (requires login).]

collection service.[8] In many instances, however, the public is required to take their SMW to a local household waste and recycling centre (HWRC). Many HWRCs require appointments for visits, and some are drive-through only. Unsurprisingly, the overall SMW collection rates are low; Material Focus estimate that approximately 155 kt of SMW items are wrongly placed into household residual waste each year, in part due to the effort required to access recycling points.[9]

The Solution?

Clearly, the public does not have easy access to a convenient option to recycle their SMW safely. A solution to this is the introduction of a separate kerbside collection of SMW, potentially also to include portable batteries. Indeed, these options have recently been subject to a DEFRA consultation on reforming the producer responsibility system for waste electrical and electronic equipment (WEEE).[10]

This report seeks to build on the work already done by DEFRA and Material Focus in appraising the impacts of introducing kerbside collections of SMW (and potentially portable batteries). Whilst some key costs and benefits have previously been considered, our assessment seeks to understand the additional benefits to be gained from preventing waste fires, which have not yet been fully understood.

[8] Of the UK LAs with waste collection responsibilities that have submitted collection scheme data to WRAP, 72 reported having active kerbside collection of SMW. There were additional LAs highlighted in the Material Focus assessment as having SMW collections. Desk-based research also showed yet additional LAs with separate pass collection services. The summation of these sources totals 99 LAs. [WRAP LA Portal, 2024. Last accessed 18th November 2024 (requires login). Material Focus, "Update to A Review (Economic and Environmental) of Kerbside Collections for Waste Electricals", 2022.]

[9] Material Focus, "UK Electrical Waste: Challenges & Opportunities 2023", 2024. Last accessed 4th November 2024.

[10] DEFRA, "Consultation on reforming the producer responsibility system for waste electrical and electronic equipment 2023", 2024. Last accessed 30th October 2024.

2.0 Overview of Approach and Scope

In the following sections we have outlined our approach and scope of our assessment.

2.1 Approach

We conducted desk-based research and interviews with industry stakeholders to gather data and evidence to inform our analysis of costs and benefits of collecting SMW at the kerbside. The analyses already conducted by DEFRA and Material Focus were incorporated into our work, to ensure alignment across with Government findings. Further details of the approach can be found in the appendix (see Section A.1.0). The analysis assumes kerbside collection of SMW and portable batteries will commence in 2026. The analysis spans a 10-year period (2026-2036), with costs and benefits expressed in real terms (2023 prices) and net costs and benefits are presented as Net Present Value (NPV), with a discount rate of 3.5%.

2.2 Scope

The scope of this study is broad. It covers the whole of the UK and includes all SMW, which is defined as small household-type electrical items collected from homes,[11] including:

- small household appliances;
- IT and communications equipment;
- power tools, toys and sports equipment;
- medical devices;
- control instruments;
- smoke detectors and dispensers; and
- vapes and e-cigarettes.

Bulky WEEE, such as large household appliances (e.g. fridges), is out of scope of this analysis. For bulky waste, convenient and safe collection avenues already exist.

At the time of writing (autumn 2024), it was announced that there will be ban on the sale and supply of single-use vapes in England, which is set to come into force on 1 June 2025.[12] Single-use vapes in this report are included in our analysis in the short-term; they are assumed removed from the waste stream by 2026. As such, single-use vapes are not considered to be a source of battery waste fires from 2026 onwards. For modelling purposes, this study assumes 100% compliance with the single-use vape ban, resulting in all associated single-use vapes being removed from the waste stream and reducing fire risks. However, there is a risk that such a ban could fail to significantly reduce usage levels if not properly enforced or if multi-use disposable vapes and other contraband on the UK market evade enforcement. As a result, our assessment of fewer fires may be overestimated.[13]

Some options assessed also include loose portable batteries, including lithium-ion (Li-Ion) batteries. While Li-Ion batteries pose the greatest fire risk, targeting all portable batteries in collections is considered essential to avoid consumer confusion and ensure effective diversion.

The scope excludes the following items: televisions, computer monitors and other display devices; fridges, freezers, chillers and air-conditioning units; large domestic appliances, white goods; and lightbulbs and lamps. (More details on scope can be found in A.1.1.)

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[11] Gov.uk, "Classify different types of waste", no date. Last accessed 30th October 2024.
[12] Gov.uk, "Government crackdown on single-use vapes", 2024. Last accessed 6th November 2024.
[13] ASH, "Policy options to tackle the issue of disposable single use vapes", 2024. Last accessed 3rd December 2024.

2.3 Costs and Benefits Appraised

In general, the costs and benefits with kerbside SMW collection align with the categories provided in Defra's WEEE consultation Impact Assessment. [14] The categories used in our assessment are summarised in Table 2-1.

Table 2-1: Costs and benefits of Assessment Options

Capital expenditure	Operational expenditure (annual)	Added benefits
• Purchasing containers • Vehicle retrofitting	• Container replacement • Staff/Crew • Overheads • Communication • Costs of additional fuel from additional weight of items • Vehicle hire and running costs	• Net carbon reduction resulting from tonnage diverted from residual to recycling/reuse • Secondary market profits to reprocessors from additional recycled materials (excluding costs of treating SMW for recycling) • Avoided landfill tax costs • Avoided landfill and EfW gate fee costs • ETS cost savings • Avoided fire costs, including equipment replacement and repair, fire services, compensation payouts, loss of earnings

More detail on our approach to these issues is provided in Appendix A.1.0.

2.4 Data Uncertainty

The analysis of the financial costs and benefits of kerbside SMW collections and waste fires is highly dependent on the quality of data used. For waste fires, there is notable uncertainty in the available data. This is in part due to the destruction caused by fires, often obscuring the ignition source. The severity of fires also varies greatly, by factors such as the amount and types of nearby materials burnt, the duration of the fire and the scale of asset damage caused. Similarly, the impact on industry is highly variable. For example, it may be practical for some operators to divert waste collection vehicles to other waste facilities if a facility catches fire; for other operators, this kind of diversion may not be feasible. In these instances, generalising and grouping of the impacts are necessary, albeit a limitation.

For kerbside SMW collections, anticipated participation rates amongst residents and other such forecasting cannot be known with certainty. In this study, existing work and stakeholder feedback is used to determine our assumptions. For instance, local authorities are grouped to allow for some tailoring based on rurality and deprivation levels.

[14] DEFRA, "Reforming the UK producer responsibility system for waste electricals: Impact Assessment", 2023. Last accessed 4th November 2024.

3.0 Current SMW Management

The mismanagement of SMW and portable batteries can lead to their improper disposal and cause waste fires. Therefore, it is important to understand the current disposal practices and management of SMW in the UK. This section summarises these practices, as well as summarising costs associated with waste fires and of the current waste management system.

3.1 Management of SMW

It is estimated that 155 kt of SMW is disposed of annually by households within their residual waste stream.[15] This is equivalent to 5.3 kg per household per year.[16] Once SMW is lost to the residual waste stream, the opportunity to recover valuable materials found in electrical and electronic equipment (EEE), such as precious metals and critical raw materials is lost. Aluminium, for example, has a price of over £1,000 per tonne,[17] and precious metals such as gold, though only found in small percentages in EEE, is often required to be of the highest quality for use in electronics and so can be priced as high as £64 per gram.[18,19]

There are also high volumes of SMW that are not collected each year. When householders do not know how to correctly dispose of an item, they are likely to hoard electronics which means valuable materials are not recovered as quickly as they could be.[20]

3.1.1 Current SMW Collection

Typically, householders can recycle SMW via their local household waste and recycling centres (HWRCs), dedicated bring banks, or retailer takeback schemes. Portable batteries can also be returned via HWRCs and bring banks, as well as in battery bins at supermarkets and other retailers.

100 of a total 391 local authorities also offer kerbside collection of SMW[21], however, these cover just 23% of households, as kerbside collections often exclude certain property types like communal or rural properties.[22] Some LAs that offer kerbside SMW collections exclude certain categories of SMW, such as vapes, microwaves, lightbulbs, or electrical items made predominantly of ceramic or glass, whilst also requiring residents to remove portable batteries from these items.[23,24]

Since those local authorities that have introduced a kerbside SMW collection have designed them themselves, the collection method varies. Commonly, SMW items are presented alongside residual or recycling bins and are collected on an existing round, often by adapting vehicles with cages or lockers to separate SMW from other waste streams. Other local authorities use dedicated vehicles to collect SMW, either in a regular, separate round or as an on-demand collection service.

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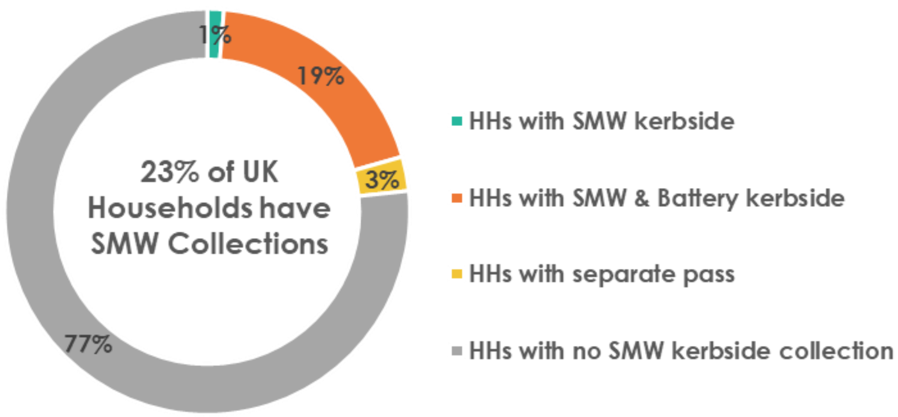
[15] Material Focus, "Update to A Review (Economic and Environmental) of Kerbside Collections for Waste Electricals", 2022. Last accessed 4th November 2024.
[16] Material Focus, "Update to A Review (Economic and Environmental) of Kerbside Collections for Waste Electricals", 2022. Last accessed 4th November 2024.
[17] Lets Recycle, "Aluminium can prices 2024", 2024. Last accessed 6th November 2024.
[18] Gold Traders UK, "Scrap Gold Prices UK", 2024. Last accessed 6th November 2024.
[19] Epec, "Guide to Using Different Types of Gold in PCB", 2018. Last accessed 6th November 2024.
[20] Material Focus, "Encouraging battery recycling to reduce waste stream fires", 2021. Last accessed 12th November 2024.
[21] 387 local authorities supplied collection and household data to WRAP, and so have been assessed here. [WRAP LA Portal, 2024. Last accessed 18th November 2024 (requires login).]
[22] DEFRA, "Reforming the UK producer responsibility system for waste electricals: Impact Assessment", 2023. Last accessed 4th November 2024.
[23] Horsham District Council, "Textiles and small electricals recycling collection", no date. Last accessed 6th November 2024.
[24] Central Bedfordshire, "Small electrical items, reusable textiles and batteries", no date. Last accessed 6th November 2024.

The guidance to households can also vary, both between collection authorities and within the same authority (depending on household type). In some areas, households can also put their SMW and batteries into separate carrier bags on top of their recycling bin lid for collection (though guidance can vary as to whether the bags should be tied).[25] Other authorities prefer SMW (and batteries) to be bagged and placed within the dry mixed recycling container (potentially bagged separately, tied or untied).[26] There may be limitations on the size of the bags that can be used and the number of bags that can be collected per household per collection round. Sometimes, items are not required to be bagged at all, and simply placed into a recycling box.[27] Evidently, there is no consistency between current collection schemes.

Of all the collection options available to householders, HWRCs remain the primary option for disposing of SMW for most.

Figure 3-1: Households (HHs) with SMW Collections (UK)



Local authorities face a number of challenges when seeking to increase their capture of SMW waste. As is described in Section 3.2, public awareness of how and where to dispose of portable batteries and SMW items is often poor, leading to high volumes of these wastes ending up in household waste bins. Aside from lack of knowledge, the next most cited barriers to householders recycling SMW were related to the inconvenience of the current system, such as poor ease of access to a HWRC or that the time required to take it to a bring site was too high.[28] Communications and engagement campaigns that can tackle the challenge of public awareness can be resource-intensive. One local authority stakeholder fed back that aside from the ongoing cost of collection, communications were the biggest cost associated with running a kerbside collection service.[29]

Effective collection of SMW requires significant infrastructure, particularly kerbside collections that may require the adaption of collection vehicles to be able to collect SMW separately from other waste streams. HWRCs and bring banks also require ongoing maintenance to ensure SMW can be collected effectively. All such elements require significant investment from local authorities and with limited budgets, implementing robust collection systems can be costly.

[25] Tied bags on top of recycling bins is allowed in Buckinghamshire; Untied bags on top of blue, green or brown bin lids (or placed next to sacks) can be used in Oxfordshire. Reading allows for one untied bag per household per collection, with a defined maximum size, which can be left on red bins. Blaenau Gwent offers joint collection of batteries, SMW, and textiles – and offers a reusable small white bag for loose batteries, limiting the types of batteries that can be collected via this route.
[26] East Devon requires SMW to be placed in a tied bag within the recycling box.
[27] SMW should be put in the kerbside recycling boxes, unbagged, in North Lincolnshire.
[28] Material Focus, "Waste Electrical and Electronic Equipment (WEEE): Public Attitudes and Behaviours in the UK", 2021. Last accessed 5th November 2024.
[29] Stakeholder interview conducted by Eunomia, October 2024.

3.1.1.1 Costs of Current SMW Collection

The current costs of SMW collections in the UK are difficult to estimate. One reason for this is that it is difficult to assign a portion of the cost of running a HWRC to SMW, since these sites would operate to capture other waste streams if SMW was captured or not. On the kerbside collection of SMW, research by Material Focus quotes one waste collector explaining SMW to be a "parasitic" waste stream, since SMW doesn't materially increase weight collected or time to carry out collections.[30]

We have been able to estimate the current annual operating costs, in real terms, based on the number of households in local authorities that report to have some form of SMW kersbide collection. The estimation varies by deprivation of the local authorities, as well as the frequency of the collection offered. (More details on the methodology can be found in the appendix, A.1.2).

Figure 3-2: Current Estimated Cost of SMW Collection (Operating Kerbside Costs only)

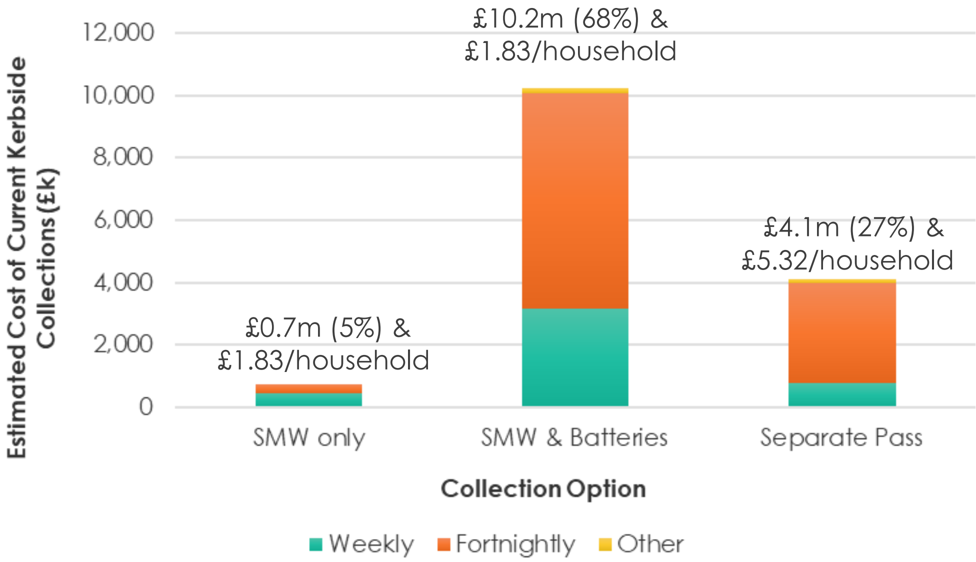


Figure 3-2 shows the estimated cost of operating kerbside collcetions of SMW in the UK sits at about £15.1m across the UK, across 100 local authorities and almost 6.8 million households. Most operating collection schemes cover both SMW and portable batteries (83% of housheholds are covered by a scheme, 68% of the costs of schemes). Similarly, most operating schemes are fortnightly (representing 69% of costs and 59% of households covered). However, over a quarter of current schemes are weekly collections (29% of costs; 28% of households). Separate pass is the most expensive to operate per household (and in some local authorities, the service does come at an extra charge). **Overall, this shows that fortnightly and weekly schemes for both SMW and batteries, as part of the wider collection service, are currently preferred by local authorities.**

Additionally, the case study below illustrates indicative costs of an SMW collection service. It covers both operating and capital costs, as well as some findings from its set up and implementation.

[30] Material Focus, "Update to A Review (Economic and Environmental) of Kerbside Collections for Waste Electricals", 2022. Last accessed 4th November 2024.

Case study: LA on-demand SMW collection

One stakeholder described their LA's on-demand collection service that covers approximately **75% of households**. Residents can arrange a collection of **SMW** alongside **batteries**, **coffee pods** and **textiles**, which is presented in sacks alongside household waste bins on collection days. When booking, residents are presented with one collection day every two weeks which corresponds to their regular recycling or residual collection day. A dedicated collection vehicle visits the booked properties and any collected SMW is returned to a waste transfer station for bulking.

Costs

Capital expenditure included **£10,000** initial van fit out and communications campaign and **£15,000** waste sack purchase and distribution to households.

Operational expenditure is **£35,000 annually** for van rental, staff costs, administrative costs and communications.

Findings

The LA summarised that the impact of providing sacks for the collection of SMW and other items did not significantly contribute to the success of the scheme, and thus, residents can now use **any standard carrier bag** to present these items for recycling. As such, £15,000 in capital expenditure could be saved.

Communications campaigns included doorstepping, social media engagement, physical leaflets and council magazine adverts (which primarily focused on the textile and coffee pod collection). To increase resident participation and capture of WEEE, the LA understands it will need to **increase the spend on communications** for this service. Therefore, the operational expenditure associated with communications is expected to increase.

3.1.1.2 Benefits of SMW Recycling

It is estimated that 227,800 tonnes of SMW is already recycled in the UK each year[31]. Since 2006, producers that place more than five tonnes of EEE onto the market each year are required to finance the costs of collection, treatment, and disposal of those materials via a producer responsibility (PR) mechanism. Since its introduction, WEEE PR has led to improvements in the recycling rate of WEEE and research by Anthesis indicates that the latest UK collection rate of WEEE is 57%.[32] This is above the UK recycling rate for waste from households, which was reported as 44% for 2022.[33]

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[31] DEFRA, "Reforming the UK producer responsibility system for waste electricals: Impact Assessment", 2023. Last accessed 4th November 2024. Source quotes 227,800 tonnes of SMW for 2019.
[32] DEFRA, "Reforming the UK producer responsibility system for waste electricals: Impact Assessment", 2023. Last accessed 4th November 2024.
[33] DEFRA, "UK statistics on waste", 2024. Last accessed 6th November 2024.

One of the main benefits of recycling SMW is that it diverts waste from landfill and incineration to recycling. The more SMW diverted to recycling, the more local authorities can reduce their disposal costs, including reducing landfill tax costs, and landfill and incineration fate fee savings. The secondary market, i.e. reprocessors and recyclers, make profit from sale of sorted and recycled materials. Hazardous materials in SMW can contaminate soils and leach into groundwater when sent to landfill, and both landfill and incineration treatments generate greenhouse gas emissions that are reduced when more SMW is diverted to recycling.

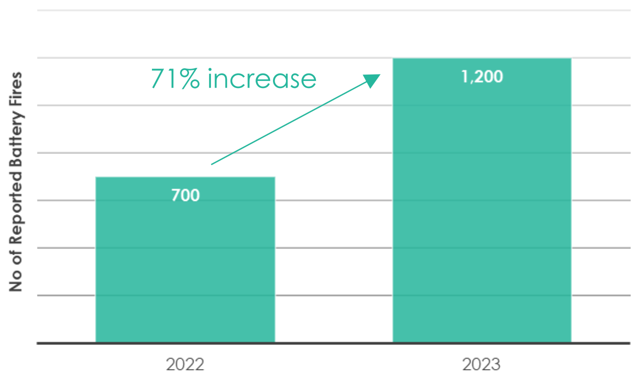
Recycling reduces reliance on virgin materials, since more recycled material is available for use in EEE products. This helps to avoid the negative externalities associated with the extraction of materials such as greenhouse gas emissions, deforestation, and air and water pollution. Critical raw materials such as lithium, cobalt and copper that are frequently used to make EEE products are particularly rare and high in value due to their high demand. Keeping these materials in the economy by recycling them minimises the negative environmental, social and economic impacts that mining these materials has. According to Material Focus, over £148 million of critical and precious materials reach recyclers each year.[34]

3.2 Improper Disposal of Batteries Causes Fires

Waste fires cost millions every year for waste collectors, recyclers, local authorities and fire services across the UK. Fires can occur anywhere within the waste management chain, from litter bins and refuse collection vehicles (RCVs) to waste transfer stations (WTSs) and sorting and recycling facilities. Ultimately, the frequency and severity of these fires puts workers and the public in direct danger.[35]

Battery waste fires increased by 71% in 2023 according to Material Focus, (see Figure 3-3).[36] The same research found that 94% of local authorities view battery-related fires as an increasing challenge,[37] whilst a survey carried out by Eunomia found that waste fires caused by lithium-Ion (Li-Ion) batteries, one of the most common battery types found in SMW, were a problem for 97% of local authority respondents.[38]

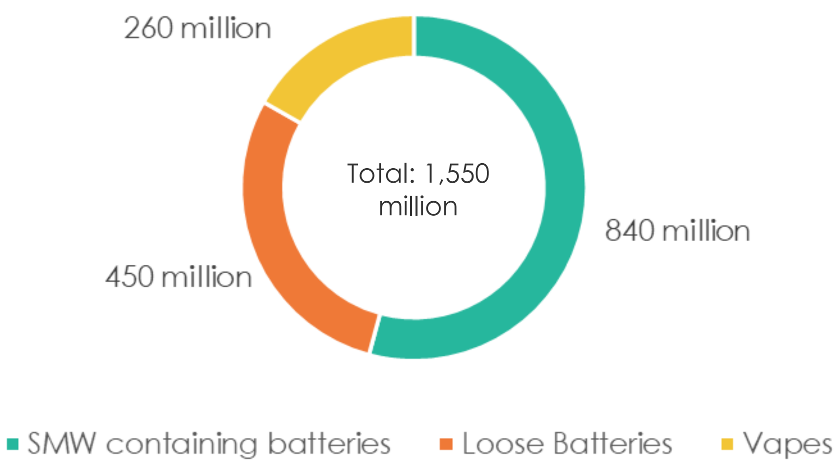
Figure 3-3: Number of Battery Fires in the UK



[34] Material Focus, "UK could recover critical raw materials worth £13m/year from waste electricals", 2021. Last accessed 20th November 2024.
[35] Veolia, "Unsafe disposal of electrical items causes daily fires: Veolia urges caution to keep people safe", 2024. Last accessed 4th November 2024.
[36] Material Focus. "Over 1,200 battery fires in bin lorries and waste sites across the UK in last year", 2024. Last accessed 30th October 2024.
[37] Material Focus. "Over 1,200 battery fires in bin lorries and waste sites across the UK in last year", 2024. Last accessed 30th October 2024.
[38] National Fire Chiefs Council, "Li-Ion battery waste fires costing UK over £100m a year", 2021. Last accessed 13th November 2024.

The issue stems from improper disposal, with UK adults admitting to binning 24 batteries per year via their household collection service, 9 portable/loose and 15 embedded in electricals such as vapes or other SMW items.[39] Overall, 1.6 billion batteries were discarded in 2023, of which 1.1 billion hidden in electronics, including 260 million vapes (see Figure 3-4).[40] Li-ion batteries are the most common type of rechargeable battery used in portable electronics, largely due to their high energy density compared to other options. However, their structure and chemistry make them particularly prone to causing fires when damaged or improperly discarded, posing a significant risk in residual and mixed recycling streams. This study focuses on all portable batteries, including li-ion batteries. While li-ion batteries pose the greatest fire risk, targeting all portable batteries in collections is essential to avoid consumer confusion and ensure effective diversion. Differentiating battery types embedded in electronics in the waste stream is challenging, so a comprehensive approach helps capture all batteries safely, reducing the overall risk to waste infrastructure.

Figure 3-4: Scale of Battery Sources Wrongly Disposed into UK Household Waste Streams



When damaged, batteries can heat up rapidly and ignite fires, the ignition often presenting as a short, intense spark or explosion, unlike some other ignition sources, which can be unpredictable.[41] Compaction in waste collection vehicles can cause such damage and ignite flammable materials collected in the vehicle. However, the risk escalates at later stages of sorting and recycling, since large stockpiles of flammable material and reduced ability to closely monitor thermal events means fires can start and spread quickly. One stakeholder reported that more than 90% of waste fires occur in HWRCs, WTSs, materials recovery facilities (MRFs) or other facilities across the recycling chain, compared with waste fires on vehicles.[42] One RDF producer reported multiple fires weekly in shredders, nearly all traced back to damaged batteries igniting highly flammable waste. Those flammable materials (e.g. paper, plastics) are frequently found in household waste streams, and so items containing batteries that are disposed of incorrectly via these streams continue to be a source of risk for the waste industry.

Public awareness of these risks remains low. One survey found that nearly half of UK adults were unaware that electrical items with built-in batteries can catch fire if damaged or crushed;[43] another corroborated this lack of awareness, with the majorities of respondents expressing a lack of confidence in how to safely dispose of items such as single-use vapes. Given that most household SMW items and portable batteries can easily fit in household waste bins, many householders are incorrectly disposing of items without

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[39] National Fire Chiefs Council, "Over 1,200 battery fires in bin lorries and waste sites across the UK in last year", 2024. Last accessed 6th November 2024.
[40] Material Focus. "Over 1,200 battery fires in bin lorries and waste sites across the UK in last year", 2024. Last accessed 30th October 2024.
[41] Eunomia and ESA, "Cutting Li-Ion Battery Fires in the Waste Industry", 2021. Last accessed 4th November 2024.
[42] Stakeholder interview conducted by Eunomia, October 2024.
[43] Material Focus. "Over 1,200 battery fires in bin lorries and waste sites across the UK in last year", 2024. Last accessed 30th October 2024.

understanding the damage they can cause, contributing to fires and placing waste services under significant strain.

Identifying the exact source of a fire can be difficult, however, one stakeholder suggested that where portable batteries could not be directly identified as the source of a fire, the source was likely to be a battery concealed in SMW. The same stakeholder suggested that as many as 82% of all waste fires are related to batteries, loose, or as part of SMW.[44]

3.2.1 Costs of waste fires

The resulting financial costs for local authorities and waste operators associated with waste fires is high. Whilst small fires or thermal events can be brought under control quickly thanks to the vigilance of staff members, stakeholders shared a number of examples of extreme damage cause by battery-related fires. One stakeholder spoke of a fire that required complete replacement of a recycling facility, causing £3.9 million worth of equipment and building damage.[45] Due to the severe damage, the facility was out of use for eight months, which was accompanied by a number of other costs. One such cost was that of diverting waste to other facilities, which requires additional transport fuel, and may come with less favourable gate fees increasing the cost of disposal per tonne. Combined with additional labour costs, this cost the stakeholder an additional £10k in loss of profits each day the facility was out of operation. A separate stakeholder estimated the replacement of one of their facilities destroyed by a battery-related fire, a MRF and RDF plant, cost £10 million worth of damage.[46] They also stated that in instances where waste must be diverted from an out-of-service facility, the increased costs often means recyclable waste is sent to be treated as residual waste which comes with its own increase in treatment fees.

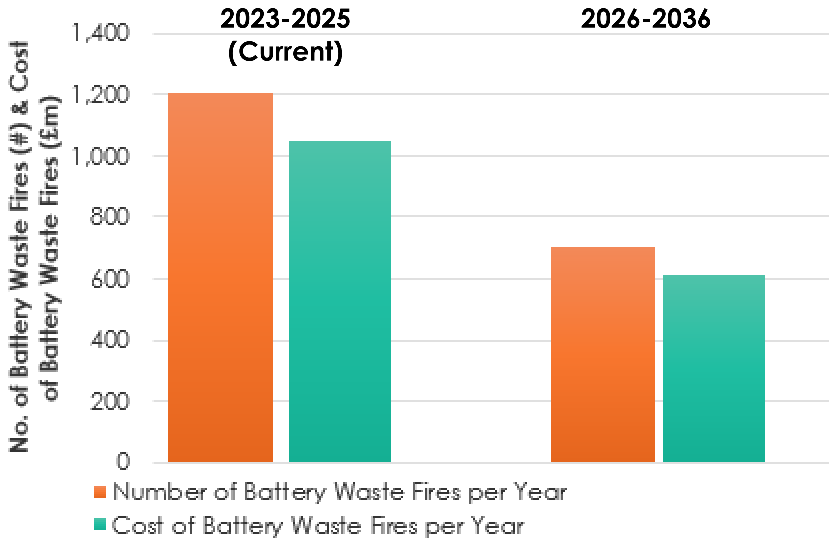
These high capital costs are associated with the replacement of expensive plant sorting and recycling equipment, as well as building damages. There are, also, numerous other financial costs associated with tackling waste fires. One stakeholder suggested that insurance premiums and excess were rising with the rising incidence of waste fires. For this stakeholder, insurance excess had risen fivefold over ten years to around £1 million.[47] Another stakeholder suggested that insurance excesses were often so high that it was more economical to pay outright for fire-related damages than to raise an insurance claim.[48] Other costs given by stakeholders included fines and damages paid to neighbouring businesses that could cost thousands of pounds, the cost of fire water storage and use, and clean-up costs. If a fire interferes with public transport routes including diversion of bus routes, train delays, or road closures associated with waste having to be ejected from collection vehicles due to fires, transport companies can recharge waste operators for their associated loss of earnings. In the worst cases, waste operators can be charged unlimited fines by the Environment Agency (EA) for environmental pollution.[49]

The current (2023) cost of waste fires is estimated at £1,048 million. It is forecast that in 2024 and 2025 the same cost will be incurred each year. The 2023 baseline cost is significantly higher than the £158 million annual cost reported by Eunomia and ESA in 2021.50 This increase is due to several factors. Firstly, there has been a substantial rise in the number of waste fires, with the National Fire Chiefs Council (NFCC) reporting a 71% increase in battery related fires in 2023 compared to 2022 (see Figure 3-3).51 This surge reflects the sharp growth in battery-containing waste, especially from single-use vapes, which now make up a larger share of the waste stream. Notably, single-use vapes represented 6% of global e-cigarette sales in 2021, a figure that more than doubled by 2022.[52] Additionally, the scope of costs in this analysis is

[44] Stakeholder interview conducted by Eunomia, October 2024.
[45] Stakeholder interview conducted by Eunomia, October 2024.
[46] Stakeholder interview conducted by Eunomia, October 2024.
[47] Stakeholder interview conducted by Eunomia, October 2024.
[48] Stakeholder interview conducted by Eunomia, October 2024.
[49] Gov.uk, "Unlimited penalties introduced for those who pollute environment", 2023. Last accessed 4th November 2024.
[50] Eunomia and ESA, "Cutting Li-Ion Battery Fires in the Waste Industry", 2021. Last accessed 4th November 2024.
[51] National Fire Chiefs Council, "Over 1,200 battery fires in bin lorries and waste sites across the UK in last year", 2024. Last accessed 4th November 2024.
[52] University of Bath, "E-cigarettes: Tobacco Company Interests in Single Use Products", 2024. Last accessed 4th November 2024.

broader than in the 2021 estimate, encompassing not only major facility fires but also smaller incidents, such as fires on recycling and residual waste vehicles. This expanded scope provides a more comprehensive view of fire-related expenses across the entire waste management system, contributing to the higher baseline cost reported for 2023.

Figure 3-5: Estimated Baseline Number & Cost of Battery Waste Fires (#, £ million)



By 2026, however, the cost of waste fires is forecast to decrease. This reduction is attributed to the anticipated decline in fire incidents following the 2026 ban on single-use vapes, which is expected to lower the number of battery-related fires from 1,200 per year to 700. As such, the forecast cost from 2026 onwards is £612 million per year, as shown in Figure 3-5.

Non-Financial Costs

Non-financial costs associated with waste fires, such as environmental damage, are also high. Certain instances of waste fires in densely populated urban areas contributed to the local pollution burden, far exceeding the WHO health-based guidelines for acceptable levels of particulate matter in the air. In one instance, thousands of residents were advised to close windows and not leave their homes.[53] In another instance, the direct health and safety threat was so severe local residents were evacuated from their homes. Other indirect costs include the loss of a waste contract. If waste operators must close a site due to a waste fire and are unable to collect or treat their clients' waste due to reduced capacity, they may be in breach of their contract and their clients may take their business elsewhere. Stakeholders suggested the reputational damage on a local and national scale could also impact their business.

Given the scale of the problem, fire services are strained as a result. One stakeholder recounted that a fire at one of their facilities took 12 hours to get under control, with fire services present on site for two days before it was safe to hand back to staff.[54] Another fire in Herne Hill, South London, took five hours to get under control, burned for four days and required 15 fire engines and roughly 100 firefighters to attend the scene, as well as round-the-clock firefighting from London Fire Brigade.[55] Hertfordshire Fire Service reported a recent waste fire where Li-Ion batteries were suspected to have played a significant contributory role, requiring over 24 hours of fire service resources. The Station Commander suggested that

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[53] BBC New, "Residents complain of side-effects after waste fire", 2023. Last accessed 18th November 2024.
[54] Stakeholder interview conducted by Eunomia, October 2024.
[55] National Fire Chiefs Council, "Over 1,200 battery fires in bin lorries and waste sites across the UK in last year", 2024. Last accessed 6th November 2024.

battery-related fires are notoriously difficult to extinguish, as they can burn hotter and spread faster than other fires.[56]

Many waste operators have come to accept the likelihood of waste fires and thus had to invest in fire prevention that can reduce the consequence or severity of fires. Commonly, stakeholders had introduced thermographic cameras and monitoring systems to scan and draw attention to thermal events at processing sites. This technology has helped to identify potential fires before they become too severe, and thus can be dealt with by staff onsite dousing the fires. In certain instances, stakeholders also used water cannon or sprinkler technology that could automatically douse fires that became too threatening. Another method used by a stakeholder to limit the risk of fire was changing management of sites and waste piles. In this example, the site changed its work pattern for staff so that waste piles were reduced each day to limit the risk of fires occurring in large stockpiles. Estimating the total costs of implementing new technologies and working methods is difficult, as many have been applied incrementally. Nevertheless, they account for a significant portion of the overall cost of waste fires. One industry expert suggested that 15-20% of the total capital cost to build recycling facilities is associated with fire suppression systems alone.[57] As such, fire prevention has been considered in the scope of this analysis.

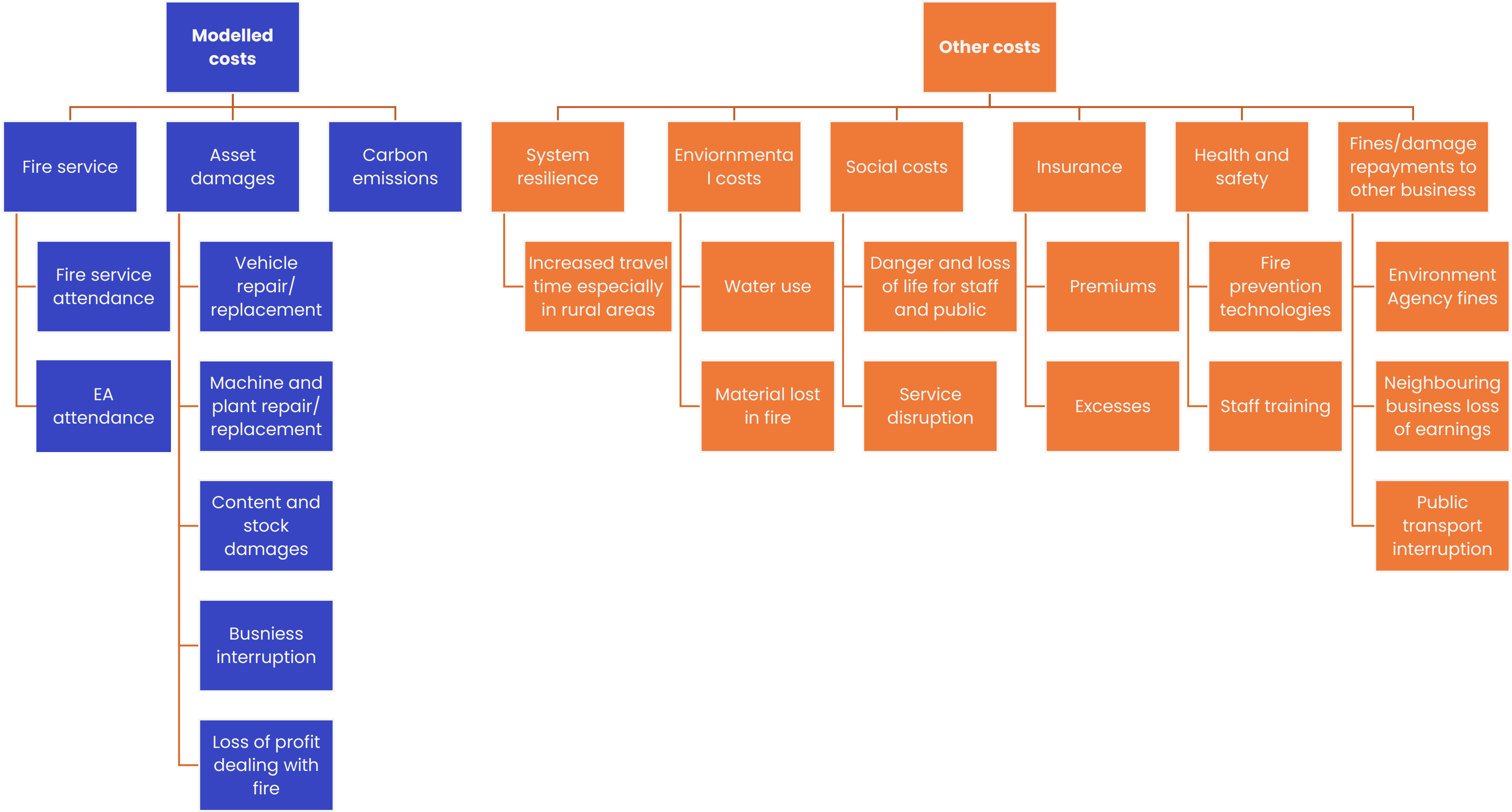
Another critical consideration, which was not modelled due to the challenges in quantifying its impact, is the effect of waste fires on overall system resilience. Fires at waste facilities can significantly disrupt waste management systems, particularly in rural areas where alternative infrastructure is sparse. In these areas, a single facility fire can necessitate longer travel distances to divert waste to other sites, increasing transportation costs, emissions and operational challenges. This creates a disproportionate strain on the waste systems resilience in rural areas compared to urban or densely populated regions, where multiple nearby facilities offer greater flexibility and shorter diversion distances.

A summary of the costs associated with waste fires can be found in Figure 3-6. The measurable costs that have been modelled for this research are given in blue, and other costs are given in orange.

[56] The Hertfordshire Fire Service Station Commander is quoted as saying that "the flame heat release rate from a Li-Ion battery fire can be seven times more intense than a traditional flame". 'Heat release rate' is a key metric used in fire science, and a high heat release rate indicates a higher risk fire that can be more dangerous and produce more smoke and toxic gases. A fire with a high heat release rate will transfer more energy to its surroundings, often resulting in higher temperatures and quicker spread. See Material Focus. "Over 1,200 battery fires in bin lorries and waste sites across the UK in last year", 2024. Last accessed 30th October 2024; Springer Nature, "Heat Release Rate", 2020. Last accessed 12th November 2024.

57 Industry stakeholder feedback obtained by Eunomia, October 2024.

Figure 3-6: Summary of Costs Associated with Waste Fires



3.3 Summary of Current SMW Management

The current SMW management system results in significant loss of recyclable material, representing a missed opportunity to retain value of precious resources they are made of. A key reason for this is that householders across the UK struggle to understand or use the collection system as it is currently configurated, relying heavily on householders using HWRCs to safely dispose of their SMW. As a result of this mismanagement, high numbers of portable batteries and SMW items are wrongly disposed of in household bins. This increases the risk and incidences of waste fires. These fires cost local authorities and waste operators millions of pounds – both in additional tools to mitigate fires and in damages. What is more, waste industry workers, fire service workers and members of the public are put in danger when exposed to these fires.

4.0 Reform to SMW Collection

The current SMW management system allows for valuable material to be lost, particularly when found in household waste streams, which can cause negative environmental and health impacts that will persist if regulations and practices are not changed.

Under the current UK-wide collective producer responsibility scheme, which is defined by the WEEE Regulations 2013, [58] EEE producers help finance the collection and treatment of SMW based on their market share. However, since WEEE is lost due to improper disposal, producers do not bear the full costs for the impacts their products have and are thus not incentivised to reduce their impact.

The previous Conservative Government launched a consultation, 'Electrical waste: reforming the producer responsibility system', which ran between December 2023 and March 2024, sought views on how to reform the current system with the aim of improving performance.[59] The Government consultation recognises that while large WEEE is collected effectively, 155 kt of SMW is improperly disposed of in residual household waste streams annually.

The impact assessment (IA) accompanying the consultation modelled several possible options that reform the financing and logistics of WEEE collection, sorting and treatment operations.[60] These options were formulated to encourage the reuse and recycling of WEEE in general, by making it more convenient for the public to deal with WEEE properly, whilst placing the full net cost of managing WEEE on its producers. The principle of placing the full cost of managing products at end-of-life on producers is referred to as extended producer responsibility (EPR). The IA proposes new policies and collection methods for a UK-wide EPR for WEEE will replace the current WEEE producer responsibility scheme. The cost of tackling waste fires and the benefits associated with reducing the risk and incidence of waste fires was not considered.

The summarised list of options proposed in the IA are as follows:

- **Option 1** – Do nothing. Keep the current regulations in place with no amendments.
- **Option 2** – To introduce a UK wide household collection system for SMW, to be financed by producers and free of charge to households
- **Option 3** – To introduce a UK wide household collection system for bulky WEEE in addition to SMW, to be financed by producers and free of charge to households
- **Options 4 and 5** – subsequent additions or amendments to the scheme including strengthening distributor takeback schemes and designating online marketplaces (OMPs) as a new class of producer
- **Option 6** – In addition to the above, to create a new regulatory category for vapes (single-use and reusable) as separate from other items in its category: toys, leisure and sports equipment (see Section 2.2). At the time of drafting, this was designated by the Government as the preferred option for the consultation, since the cost of recycling vapes was much higher than the other products in its category, placing unequal responsibility on producers of those items to finance the cost of disposal and treatment of vapes, and reducing the incentive for vape producers to make their products more easily recyclable.[61] However, with a recent announcement banning the sale

[58] Legislation.gov.uk, "The Waste Electrical and Electronic Equipment Regulations 2013", 2014. Last accessed 5th November 2024.
[59] Gov.uk, "Electrical waste: reforming the producer responsibility system", 2023. Last accessed 13th November 2024.
[60] DEFRA, "Reforming the UK producer responsibility system for waste electricals: Impact Assessment", 2023. Last accessed 4th November 2024.
[61] DEFRA, "Reforming the UK producer responsibility system for waste electricals: Impact Assessment", 2023. Last accessed 4th November 2024.

of single-use vapes from June 2025,[62] it is expected that vapes will no longer make up a significant portion of WEEE in this category and so this option is made redundant.

The incoming Labour Government has not yet announced a clear position on WEEE collections from households and reforms to the current WEEE producer responsibility scheme and it is unclear, which, if any, of these options are likely to be adopted.

4.1 Options Considered in This Study

Following on from the consultation, Defra's impact assessment,[63] and the Material Focus report on kerbside collection for waste electricals,[64] this study seeks to present a series of options that appraise the costs and benefits of the IA's Option 2: introducing kerbside SMW collections for all UK households by local authorities. In addition, we ensure that the benefits gained from material recovery and fire prevention are fully explored. Herein, we refer to the three following options:

Option 1: kerbside collection of SMW. Existing DMR collections for local authorities are adapted to include the collection of SMW items. This requires fitting a cage onto all DMR RCVs in each local authority with single-stream or two-stream collections and allocating a compartment in all kerbside sort vehicles to SMW. Also considered, is the provision of one 55L SMW container to all flat households.[65] This option assumes no additional vehicles will be required, as existing collection services will be adapted to accommodate the changes required. However, it is important to note that costs will vary depending on collection frequency, with higher expenses expected in areas maintaining weekly collections, and lower costs in local authorities with less frequent schedules. For modelling purposes, fortnightly collections have been modelled, representing the current service frequency of 75% of local authorities. Key changes that impact the costs and benefits of this option are:

- High set up cost of retrofitting collection vehicles;
- Comparatively low operational costs, since these are attributed to the SMW collection as a proportion of the DMR collection by weight;
- Communication costs associated with advertising the new service and encouraging ongoing resident participation;
- Benefits of the value of material diverted to recycling; and
- Reduction in the incidence of fires.

Option 2: kerbside collection of SMW and portable batteries.[66] Building on Option 1, this option includes collection of portable batteries alongside SMW. To facilitate this, an additional 55L container would be fitted in RCV cages for the capture of portable batteries separately to SMW, or an equivalent volume would be allocated in kerbside sort vehicles. Households would place portable batteries in a small bag alongside their other household recyclables for collection. It is assumed that the inclusion of portable

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[62] DEFRA, "Ban on the sale and supply of disposable vapes in England", 2024. Last accessed 5th November 2024.
[63] DEFRA, "Reforming the UK producer responsibility system for waste electricals: Impact Assessment", 2023. Last accessed 4th November 2024.
[64] Material Focus. "Kerbside Collections for waste electricals", 2022. Last Accessed 12th November 2024.
[65] The assumption of providing all flat with a 55L container represents a high-cost scenario. Costs may be lower if not all flat properties require containers, as SMW volumes typically accumulate more slowly than other waste streams. In many cases, households could use small plastic bags for collection day when necessary – in line with many of the current SMW collection schemes. This may represent the preferred and more convenient option for small flats.
[66] DEFRA, "Classifying portable and industrial batteries", 2022. *A portable battery is defined as any battery which is sealed, weighs 4kg or less, not an automotive or industrial battery and not designed exclusively for industrial or professional use.*

batteries will not significantly increase collection times and, therefore, will not affect round sizes. In addition to the costs and benefits outlined in Option 1, Option 2 introduces the following key changes:

- Added costs associated with the additional weight of portable batteries collected;
- Higher values achieved for material diverted to recycling;
- Greater reduction in taxes and fees associated with disposal via landfill and EfW; and
- Greater reduction in the incidence of fires.

Option 3: on-demand collection of SMW and portable batteries. This option involves the provision of a dedicated kerbside collection service using separate pass vehicles for SMW and portable batteries that can be organised in advance by householders (so called 'on-demand'). This option would require the procurement of vehicles dedicated to the collection of SMW and portable batteries. Although this option is designed as an on-demand system, for modelling purposes, collections were assumed to occur on an average of every fortnightly to cover all households. In reality, costs of this option will vary depending on how frequently the service is requested by households. In contrast with Options 1 and 2, key costs and benefits associated with this option are:

- Set up costs that cover more households than Options 1 and 2, as they can cover households without a dedicated DMR collection;
- Comparatively high operational costs due to vehicle, fuel and staffing costs associated solely with SMW rather than an add on to DMR collections; and
- Potential additional benefits associated with the scope to collect additional materials such as textiles.

Each of these options seek to build upon the options considered by the previous government by providing households a universal collection of SMW.

5.0 Options Analysis

The purpose of the options analysis was to evaluate the costs and benefits of implementing nationwide kerbside collections for SMW and portable batteries from 2026, when the scheme is modelled to be implemented through to 2036.

Our analysis focuses on three core areas, with the detailed methodology for each component provided in A.1.0. This section aims to present the results of the analysis and highlight key findings, offering insights into the projected costs and benefits of each option.

1. **Cost of introducing and operating the SMW collection service**: assessing the financial implications of implementing nationwide collection of SMW (and portable batteries) for each option. Our assessment seeks to draw upon the methodology developed by Material Focus.[67]

2. **Benefits from collected** SMW **(and portable batteries)**: quantifying the waste flows of SMW (and portable batteries) for each option to quantify the total waste diverted from the residual stream to recycling and the financial implications of the changes. Our assessment seeks to draw upon the Government's Impact Assessment.[68]

3. **Benefits associated with changes in the number of waste fires**: evaluating how each collection option might influence the incidence and cost of waste fires across the UK. Our assessment is based upon work previously completed by Eunomia examining Li-Ion fires.[69]

5.1 Option 1: Costs and Benefits

In Option 1, kerbside collections for SMW are assumed to be implemented from 2026, with our cost projections extending to 2036.

This option assumes modifications to existing dry mixed recycling (DMR) collection systems to accommodate SMW. The key changes are associated with the need for safe compartments to store the SMW. It is assumed that RCVs are retrofitted with an external undercarriage cage for SMW and kerbside sort vehicles are equipped with a separate compartment dedicated to SMW. This option assumes that there is no change collection frequency, method or time taken by operatives to collect the additional bin, in line with the assumptions included within the Material Focus study.

Additionally, all flats are provided with a dedicated 55L container for SMW, positioned alongside their general DMR recycling (see Figure 5-1). For modelling purposes, it is assumed that all flats can accommodate a 55L container alongside existing bins. However, in practice, some flat households may lack the necessary space requiring alternative service provisions, for example, separate bags for SMW and portable batteries.

[67] Material Focus. "Kerbside Collections for waste electricals", 2022. Last Accessed 12th November 2024.
[68] DEFRA, "Reforming the UK producer responsibility system for waste electricals: Impact Assessment", 2023. Last accessed 4th November 2024.
[69] Eunomia and ESA, "Cutting Li-Ion Battery Fires in the Waste Industry", 2021. Last accessed 4th November 2024.

Figure 5-1: Example of placing 55L container next to general DMR bins at flat households[70]

For the analysis, an 80% fill rate of the SMW cage or compartment is assumed and the total volume of the vehicle remains unchanged, reflecting actual operations.

The costs associated with SMW include **three main components**:

1. **direct costs** from introducing SMW collections (e.g., retrofitting RCVs with undercarriage cages);
2. **incremental costs** due to the added SMW weight (e.g., increased fuel expenses); and
3. a proportional allocation of **DMR operating costs** to SMW collection, reflecting shared resources such as vehicle capital, operational costs, and staffing.

For further details on the assumptions behind the cost results, see A.1.2, adapted from Material Focus' methodology.[71]

The benefits of implementing kerbside SMW collections include significant **cost savings** by reducing disposal expenses, primarily through **avoided landfill tax and gate fees** for both EfW and landfill. By diverting SMW from the residual waste stream, local authorities can lessen their reliance on costly disposal methods, directly lowering expenditures tied to landfilling and incineration. Additionally, this diversion boosts revenue from the recycling of valuable materials previously lost in residual waste.

By reducing the volume of material sent to disposal, local authorities can also help reduce their liability associated with the upcoming inclusion incineration within the UK ETS, which will increase disposal expenses for incineration emissions from non-biogenic sources (such as SMW). Together, these benefits reflect both financial savings and enhanced resource recovery from increased recycling.

The resulting costs and benefits are presented in Figure 5-2.[72]

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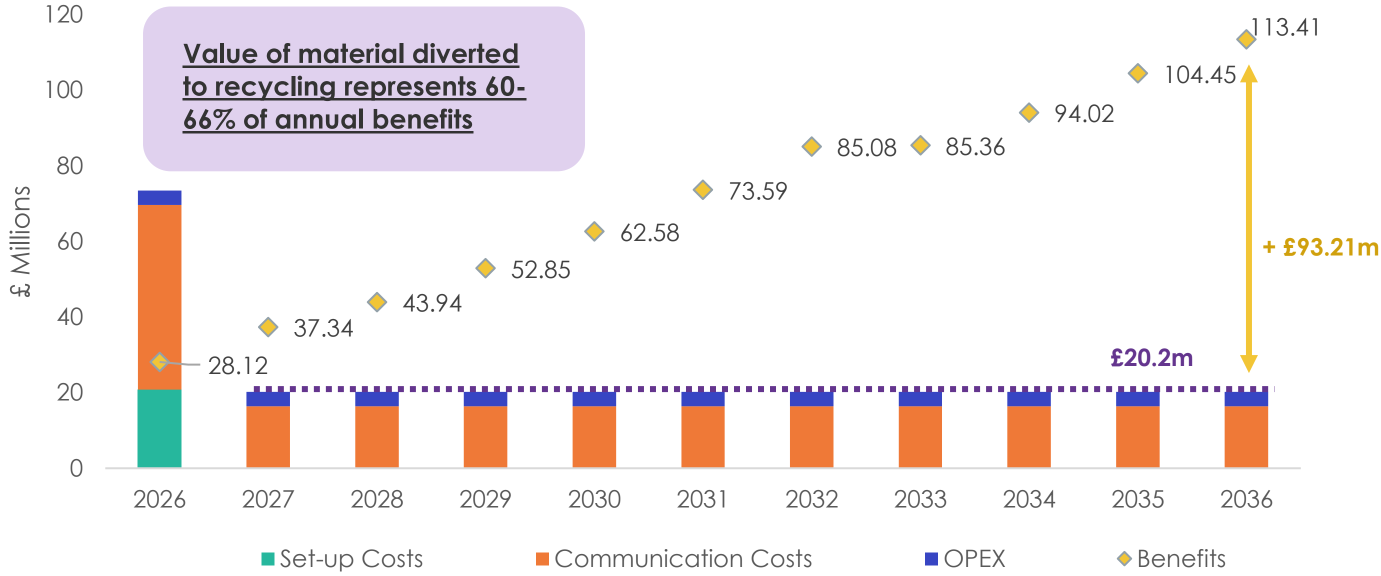
[70] Image sources: Malloy, K. "Recycling Intervention Rolled Out Across Lambeth Flats", 2021. And Even Greener, "Straight 55 Litre Blue Kerbside Box", n.d.
[71] Material Focus. "Kerbside Collections for waste electricals", 2022. Last Accessed 12th November 2024.
[72] For a detailed explanation of the methodology used to calculate these benefits, based on DEFRA's impact assessment approach, please refer to A.1.1. For detail on each cost element, see A.1.1.1.

Figure 5-2: Total Costs and Benefits of Option 1 in the UK (2023 prices £GBP)



Overall Option 1 results in total costs of £73.5 million in the first year, down to £20.2 million by 2036, and total benefits of £28.1 million in 2026 rising to £113.4 million by 2036 as participation in the scheme grows and more SMW is diverted from the residual stream.

Notable costs include the high initial set-up costs of £20.8 million (£0.71 per household) in 2026, representing a one-time expense to provide containers to all flat households. Set-up costs are highest for RCVs compared to KS sort vehicles, because across the UK, only 13% of households receive multi-stream (via kerbside sort vehicle) collections compared 87% to co-mingled and two-stream collections (via RCV vehicles).

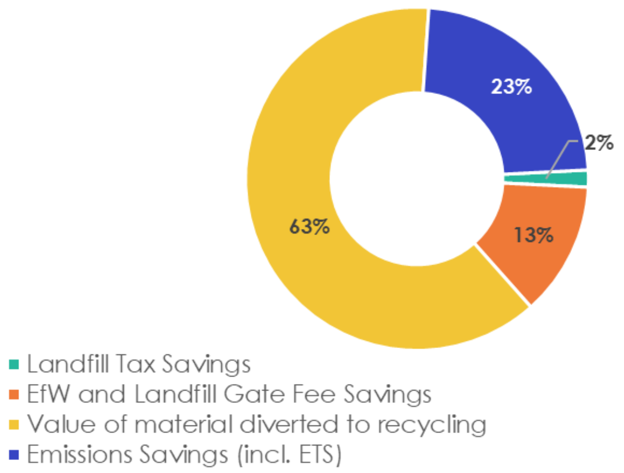
Communication costs take up the highest share of total costs year on year, aimed at educating and encouraging participation in the scheme. In line with DEFRA's Impact Assessment and adjusted for inflation, communication costs are assumed to cost £1.68 per household on average in the first year of the scheme, decreasing to £0.56 per household per year for each year thereafter.[73] Communication costs are consistent across all options, as each requires similar outreach to inform households about changes to their kerbside collections. The core messaging, aimed at encouraging participation and disposal, remains the same, so the costs do not vary between options. It is recognised that LAs would face different communication costs based on their size, and possibly their levels of deprivation. However, for the sake of analysis, DEFRA's average estimates have been used and adjusted for inflation.

Operating costs are forecast to remain stable between 2026-2036 and are dominated by container replacement costs and staff costs, which collectively make up 72% of total operating costs each year. Kerbside sort vehicle costs are higher than RCV costs due to the inclusion of a portion of the vehicle capital costs, standing costs and running costs associated with a dedicated compartment for SMW collection, which could have otherwise been taken up by different materials. While for RCVs, these costs are excluded as they are already incurred despite the inclusion of SMW. Rural areas tend to incur higher expenses per household. This disparity is largely due to the logistical challenges in rural areas, where smaller collection rounds are necessary because of greater distances between households. Consequently, a larger number of vehicles operate in rural areas, increasing the portion of vehicle costs associated with SMW.

[73] DEFRA, "Reforming the UK producer responsibility system for waste electricals: Impact Assessment", 2023. Last accessed 4th November 2024.

The most significant benefit of the scheme is the value generated from materials diverted from the residual waste stream, estimated at £17.4 million in the first year and increasing to £68.2 million by 2036 as household participation grows and the scheme becomes more established. Notably, this value could potentially be even higher, as precious metals beyond silver and gold—often of substantial value—have been excluded from the analysis due to limited data availability. Including these additional metals could further enhance the overall financial benefit of the scheme. Figure 5-3 provides a breakdown of the key contributing benefits in Option 1.

Figure 5-3: Breakdown of Total Benefits (2026-2036 %)



Note: Breakdown applies to all options

5.1.1 Impacts on Fires

Under Option 1, the number of fires caused by batteries embedded in SMW is projected to drop from 700 incidents in 2026 to approximately 121 fires in 2026 and 96 fires by 2036. For methodological details on this reduction, see A.1.5. This decrease reflects the impact of separating SMW from the residual stream, reducing flammable materials in general waste.

Cost estimates for these fires are based on a severity distribution from prior Eunomia research,[74] with fires categorised as follows: 0.8% Severity 1 (most severe), 4.5% Severity 2, 73.6% Severity 3, and 21.1% Severity 4 (least severe). This severity breakdown was applied to calculate annual fire costs. For details on the cost calculation methodology see A.1.5. Fires at recycling facilities are expected to remain stable in number, but with lower severity due to improved containment of SMW, limiting fires to Severity Levels 3 and 4 and reducing facility-wide impact. Figure 5-4 illustrates the changes in number of fires across different locations to 2036.

In its first year of kerbside collections of SMW, Option 1 brings fire-related costs down to £108.1 million in 2026, an 83% reduction compared to the 2026 baseline following the introduction of the vape ban. By 2036, costs are expected to fall further to £86.1 million, reflecting improved scheme performance as public participation and adherence increase over time. These reductions highlight the substantial financial and safety benefits of diverting flammable materials from the residual waste stream, leading to fewer emergency responses, reduced facility repair costs, and minimised operational disruptions.

[74] Eunomia and ESA, "Cutting Li-Ion Battery Fires in the Waste Industry", 2021. Last accessed 4th November 2024.

Figure 5-4: Comparison of Total Waste Fires in the UK Under Option 1 to the 2026 Baseline

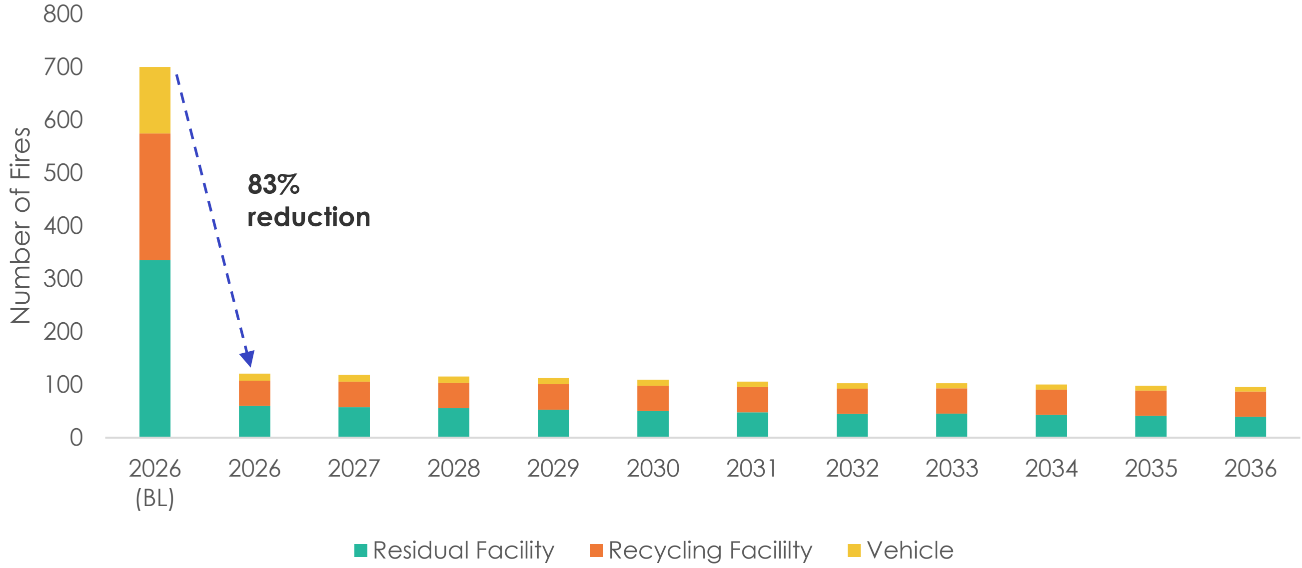


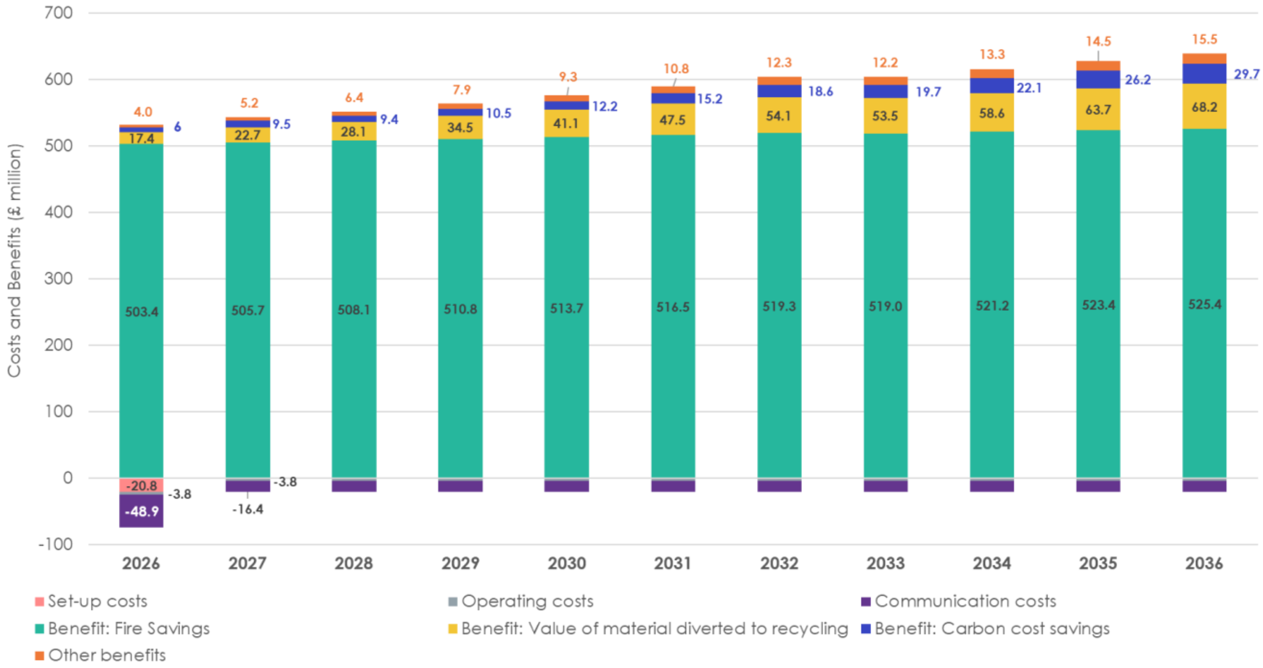
Table 5-1: Option 1 Total Cost and Benefit (avoided cost) of Waste Fires in the UK (£m)

£m	2026 BL	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Cost	611.51	108.08	105.79	103.43	100.67	97.85	95.05	92.20	92.47	90.29	88.07	86.14
Benefit	-	503.42	505.72	508.08	510.84	513.67	516.46	519.31	519.04	521.22	523.44	525.38

5.1.2 Net Costs and Benefits of Option 1

Over the 10-year assessment period, Option 1 delivers net benefits of £5,185 million (NPV). The most significant benefit arises from fire reduction savings, followed by the value of materials diverted to recycling, as displayed in Figure 5-5. On the cost side, set-up costs represent the largest expense in Year 1, but ongoing communication costs become the most significant contributor over the decade. In contrast, annual operating costs remain minimal, totalling £4 million per year, with £2 million allocated to staff costs. A full breakdown of year-on-year costs and benefits can be found in the appendix A.1.2.1.

Figure 5-5: Option 1 summary of costs and benefits



5.2 Option 2: Costs and Benefits

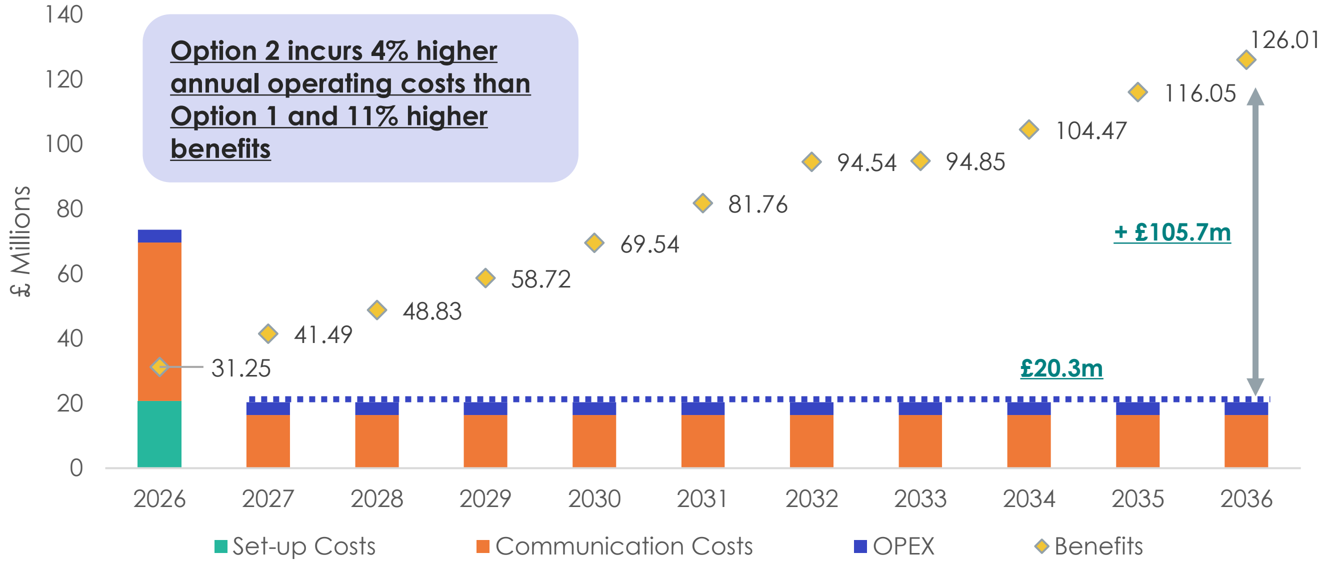
In Option 2, kerbside collections for both SMW and portable batteries are introduced starting in 2026, with cost projections extending through to 2036. This option builds on the approach outlined in Option 1, involving adjustments to the existing DMR collection systems to accommodate the separate collection of SMW and portable batteries. Under Option 2, additional modifications include the installation of a dedicated 55L container within the undercarriage cages on RCVs specifically for portable batteries, separating them from SMW. Similarly, this 55L container is added to the compartment on all kerbside sort vehicles to ensure batteries are kept separate during collection. Consistent with Option 1, all flat households will be provided with a 55L container for disposing of SMW. Portable batteries should be placed in a small bag inside the container. During collection, the bag of portable batteries will be transferred to the designated 55L container within the RCV cage or kerbside sort compartment, while SMW will be placed directly into the cage or compartment. This option may necessitate additional sorting of SMW and batteries during the consolidation and bulking stage to ensure they are properly separated for treatment. Depending on the facility, this could involve sorting within MRFs or at Waste Transfer Stations, ensuring that SMW is processed at AATFs and batteries at ABTOs, as distinct from the approach outlined in Option 1. However, this impact has not been modelled, as it is assumed to be minimal and unlikely to significantly affect overall costs. To facilitate kerbside collections of batteries would also require updates to UK battery regulations. At present, such regulations oblige UK distributors and retailers that sell or supply more than 32 kg of batteries a year to provide a take back service.[75] Updated regulations would have to include an obligation on distributors and retailers of portable batteries to contribute to the kerbside collection scheme.

The benefits in Option 2 reflect the total combined tonnage of SMW and portable batteries collected from households, resulting in a 10% increase in benefits compared to Option 1. This increase corresponds to the estimated 10:90 weight ratio of portable batteries to SMW within the residual waste stream. Collecting portable batteries alongside SMW enhances the environmental and financial impact of the

[75] UK Government, "Guidance. Regulations: waste batteries" 2021. Last accessed 5th February 2025.

scheme by capturing additional valuable materials that would otherwise be lost in residual waste disposal. The resulting costs and benefits are outlined in Figure 5-6.

Figure 5-6: Total Costs and Benefits of Option 2 in the UK (2023 prices £GBP)



Including portable batteries alongside SMW in kerbside DMR collections results in total costs of £73.6million in 2026, decreasing to £20.3 million annually from 2027 to 2036, with total benefits estimated at £31.2 million in 2026 rising to £126.0 million in 2036 once the scheme matures. Setup costs in Option 2 are slightly higher than in Option 1, due to the need to equip all vehicles with a 55L container for separately storing batteries within the SMW cage or compartment. This additional cost amounts to £ 0.0001 per household. Consequently, replacement costs for these containers also increase at the same rate as in Option 1, as the added containers require periodic replacement. The variation between rural and urban local authorities follows the same trend as Option 1. Regardless of the collection method, the inclusion of portable battery collection with SMW kerbside services results in minimal (0.20%-0.70%) increase to total overall costs each year

Communication costs remain consistent with Option 1, as outreach efforts for both batteries and SMW can be integrated without additional expense. Similarly, staff and vehicle retrofitting costs are unchanged, as retrofitting is limited to adding a container within each vehicle, requiring no further structural modifications and it is assumed that the additional time taken to collect portable batteries alongside SMW could be absorbed by the round with no additional costs[76].

The primary variable cost in Option 2 is additional fuel required to collect batteries alongside SMW, increasing by 35% compared to Option 1. The added weight of portable batteries and their containers impacts fuel efficiency, reducing overall miles per gallon and increasing annual fuel consumption to cover the same collection routes. For this analysis, an 80% fill rate for the cage or compartment was assumed, consistent with the Material Focus study, to model a realistic load capacity and associated fuel costs.

As outlined above, the benefits generated in Option 2 are 8-9% higher than those in Option 1, due to the additional weight of portable batteries collected alongside SMW, which increases the total material diverted from the residual waste stream. This added diversion not only amplifies disposal savings, such as avoided landfill tax and EfW gate fees, but also enhances the value of recyclable materials recovered. The inclusion of batteries, which contain valuable components, contributes to a more significant revenue

[76] Material Focus. "Kerbside Collections for waste electricals", 2022. Last Accessed 12th November 2024.

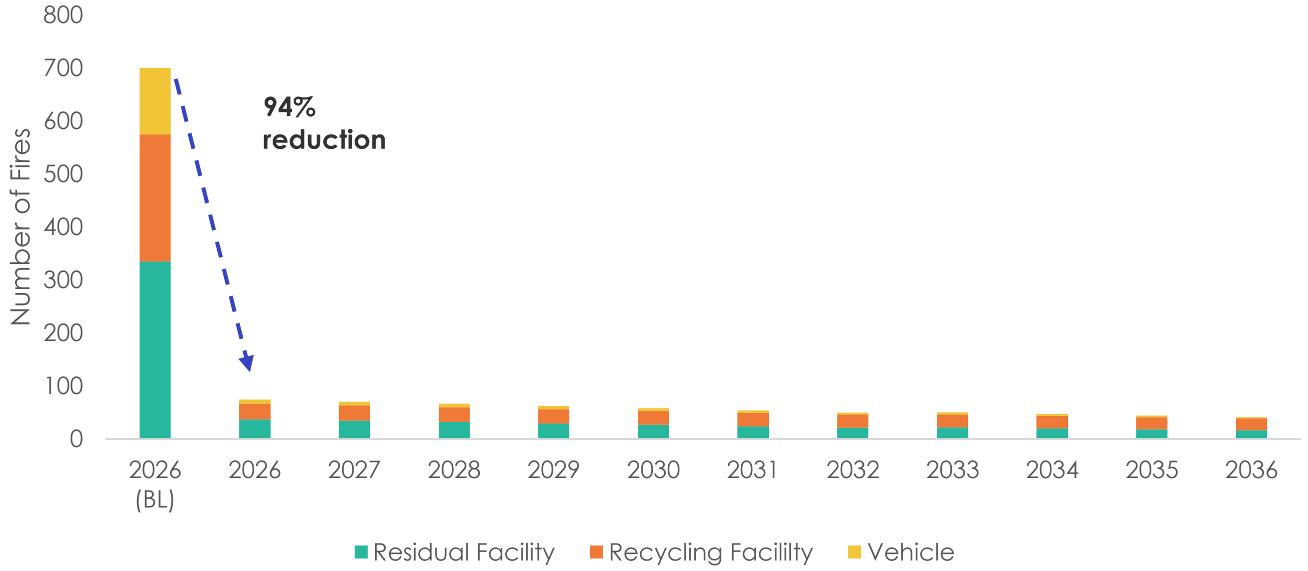
stream from recycling, boosting the overall financial return of the scheme. The percentage split of benefits contributing to total savings remains the same as Option 1.

5.2.1 Impacts on Fires

Option 2 is projected to achieve greater reductions in fire-related costs compared to option 1, largely due to the additional collection of portable batteries alongside SMW, which further decreases the total number of fires. According to NFCC data, each household disposed of an average of 24 batteries in 2023, with 38% being loose batteries and the remainder embedded within SMW.[77] This distribution was used to estimate fire risk in Option 2. In addition to the 80% overall reduction in fires achieved by diverting SMW from the residual waste stream, the separate collection of loose batteries is assumed to reduce fire incidents by an additional 38% compared to Option 1.

In addition, the inclusion of loose batteries alongside SMW leads to a greater diversion of flammable materials from the residual stream compared to Option 1. As a result, the total number of fires is projected to reduce from 121 in 2026 in Option 1 to 74 in Option 2, reflecting the enhanced fire prevention benefits of including loose batteries in the collection scheme.

Figure 5-7: Comparison of Total Waste Fires in the UK Under Option 2 to the 2026 Baseline



In the first year of kerbside collections of SMW and portable batteries, Option 2 brings fire-related costs down to £66.9 million. By 2036, costs are expected to fall further to £38.2 million, reflecting improved scheme performance as public participation and adherence increase over time.

Table 5-2: Option 2 Total Cost and Benefit (avoided cost) of Waste Fires in the UK (£m)

£m	2026 BL	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Cost	611.51	66.93	63.56	60.20	56.38	52.58	48.95	45.39	45.72	43.07	40.44	38.21
Benefit	-	544.59	547.95	551.32	555.14	558.93	562.56	566.13	565.79	568.45	571.08	573.30

[77] National Fire Chiefs Council, "Over 1,200 battery fires in bin lorries and waste sites across the UK in last year", 2024. Last accessed 6th November 2024.

5.2.2 Net Costs and Benefits of Option 2

Over the 10-year assessment period, Option 2 delivers net benefits of £5,674 million (NPV). The most significant benefit stems from fire reduction savings, followed by the value of materials diverted to recycling as shown in Figure 5-8. Among costs, set-up costs dominate in Year 1, but ongoing communication costs become the most significant over the 10-year period. In contrast, annual operating costs are the smallest share of total costs, amounting to £4.0 million per year. These are primarily driven by staff costs (£1.72 million) and flat container replacement costs (£1.07 million).

Figure 5-8: Option 2 Summary of Costs and Benefits

5.3 Option 3: Costs and Benefits

In this option, it is assumed that SMW and portable batteries from households are collected exclusively by separate pass vehicles on an on-demand basis. The modelling primarily focused on the collection of SMW and portable batteries; however, due to the available capacity in the separate pass vehicles, additional waste streams, such as textiles, could also be collected. This integration would increase the benefits from the value of recovered materials without increasing the required expenditure to implement this option.

Although Option 3 is designed as an on-demand system, for modelling purposes, collections were assumed to occur on a fortnightly basis, covering all households with at least residual collections. This assumption addresses the challenges of accurately estimating the frequency of on-demand collections. However, in reality – costs presented in Option 3 could be lower or higher depending on how frequently the service is requested by households. Each vehicle is modelled to operate at 70% capacity, in line with the methodology outlined by Material Focus.[78]

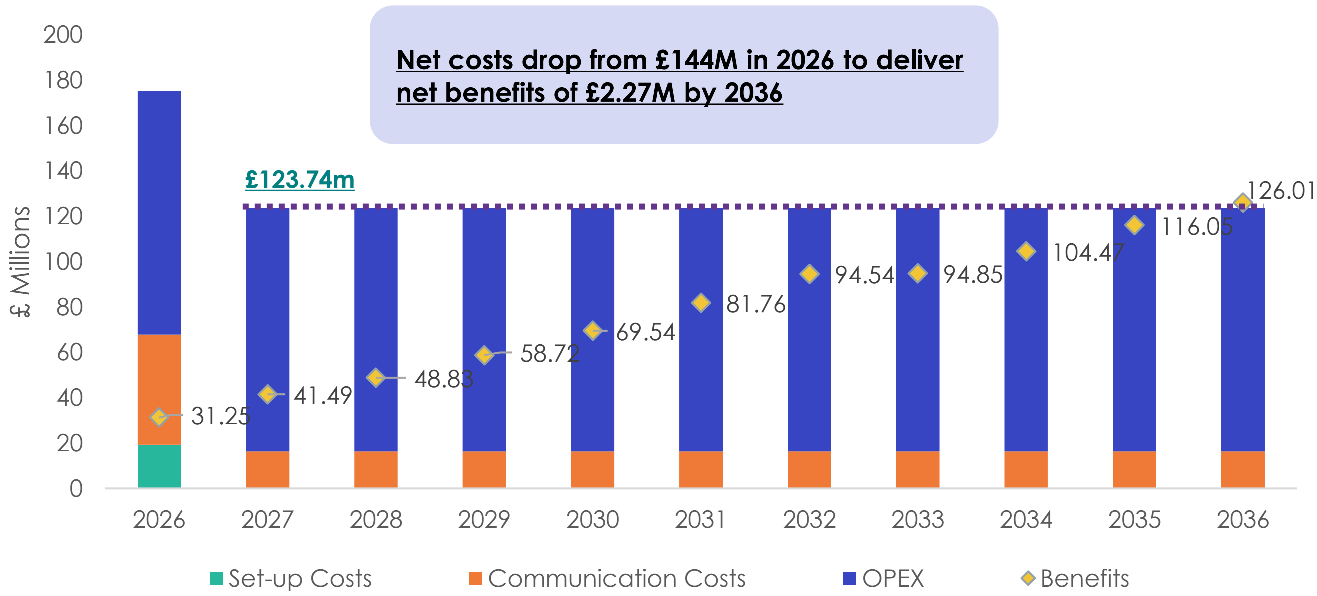
[78] Material Focus. "Kerbside Collections for waste electricals", 2022. Last Accessed 12th November 2024.

In all options, the initial setup cost is primarily driven by the expense of providing containers to all flat households in the UK and communication costs are consistent on a per household basis. However, Option 3 includes a broader coverage by accounting for households that have at least residual waste collections, resulting in a larger number of households being included in the scheme compared to Options 1 and 2, which only service households that have existing dry mixed recycling collection services.

Annual operating costs for Option 3 differ significantly from previous options because the entire vehicle fleet and associated operating costs are dedicated solely to the collection of SMW and portable batteries. In contrast, Options 1 and 2 integrate SMW and portable batteries into existing collection routes, with costs proportionally adjusted to account for this addition.

The benefits in this option are similar to those in Option 2, where SMW and batteries are collected together. The addition of alternative material stream, for example, textiles, could further increase the overall value of materials diverted to recycling.

Figure 5-9: Total Costs and Benefits of Option 3 in the UK (2023 prices £GBP)



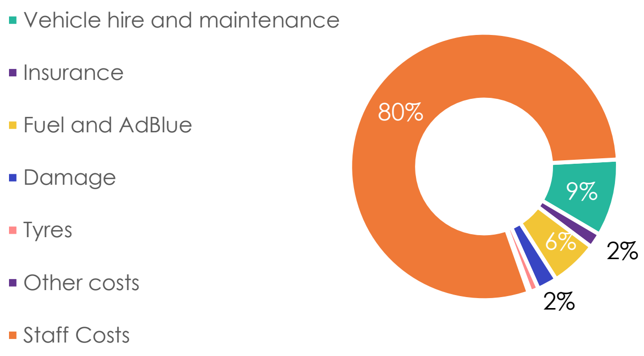
Option 3 presents a total cost of £175.2 million in 2026, which decreases to £123.7 each year to 2036. Total benefits presented in the option reflect the same results as Option 2, as both SMW and portable batteries are diverted from the residual waste stream.

The initial setup costs for Option 3 are comparable to those in Options 1 and 2, with a UK-wide setup cost of £19.2 million. Despite Option 3 covering a larger number of households—those with residual waste collection—its setup costs are lower than those for RCV and kerbside sort vehicles. This cost efficiency is due to a reduced number of flat households factored into the model. In Options 1 and 2, flat households are modelled specifically for each collection type, resulting in a higher percentage of flats overall. In contrast, Option 3 uses the average number of flats across each LA group, leading to a slightly lower proportion of flat households. For example, the average percentage of flats is 23% for co-mingled collections, 21% for two-stream collections, and 20% for separate pass vehicles. Communication costs in Option 3 are assumed to be consistent with those in Options 1 and 2 on a per-household basis. However, due to the slightly larger number of households receiving residual kerbside collections, the total communication costs are marginally higher overall.

Figure 5-10 provides a breakdown of annual operating costs, with staff costs making up 80% of total operating costs. Annualised operating costs per vehicle are £75,507 drawing on costs presented in the

Material Focus report, adjusted for inflation[79]. These costs cover vehicle leasing, insurance, staff costs, fuel – in whole dedicated to the collection of SMW and batteries. Therefore, overall annual costs per vehicle are higher than Option 1 or 2 where only part of the total operating expenses are attributed to the collection of SMW. Scaled-up UK-wide, total operating expenses per year are £107.5 million. However, this approach should be caveated, as due to a lack of data on participation under the scheme, the model conservatively assumes that separate pass vehicles would service all households with residual waste collections in each LA. In practice, however, separate pass vehicles often serve as supplemental "mop-up" crews rather than the primary collection method, meaning fewer households would need to be covered. As a result, fewer vehicles would likely be needed, reducing operating costs further.

Figure 5-10: Breakdown of Total Operating Costs (2026-2036 %)



5.3.1 Impacts on Fires

In this option, the number of fire incidents follows a similar approach to Option 2. However, unlike Option 2, where fire risk is diverted to fire-safe cages in recycling vehicles, Option 3 assumes this risk is transferred directly to the recycling vehicles themselves. Unlike the specialised cages on RCVs or compartments in kerbside sort vehicles, separate pass vehicles lack dedicated containment for batteries and SMW, increasing the potential fire risk.

As a result, the fire risk containment achieved through specialised cages in Option 2 is lost in Option 3, leading to a higher overall number of fires. Consequently, the total number of fires in 2026 for Option 3 reflects the fire incidents in Option 2 before accounting for the reduction from fire-safe cages. Therefore, Option 3 is projected to experience 88 fires each year. The resulting fire-related costs under Option 3 are modelled to be around 3% higher than Option 2, and 22% lower than Option 1. Option 3 still delivers significant reductions compared to 2026 baseline fire costs, with an 86% reduction reflecting the overall effectiveness of diverting SMW and batteries from the residual stream.

[79] Material Focus. "Kerbside Collections for waste electricals", 2022. Last Accessed 12th November 2024.

Figure 5-11: Comparison of Total Waste Fires in the UK Under Option 3 to the 2026 Baseline

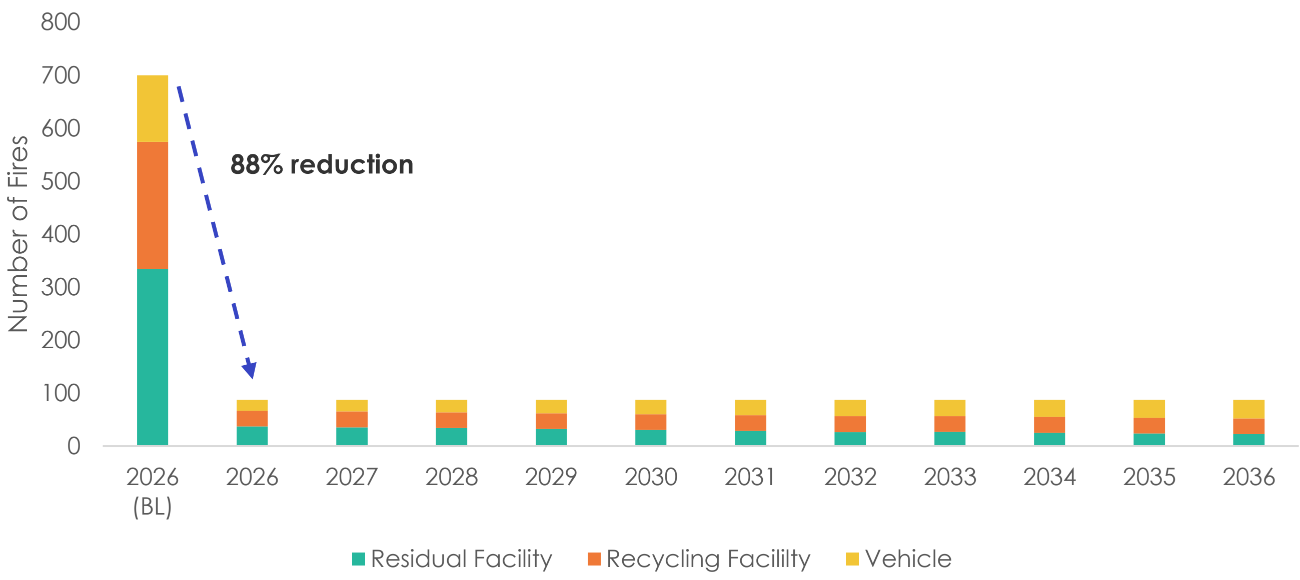


Table 5-3: Option 3 Total Cost and Benefit (avoided cost) of Waste Fires in the UK (£m)

£m	2026 BL	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Cost	611.51	69.37	68.12	66.83	65.32	63.78	62.25	60.69	60.84	59.65	58.43	57.38
Benefits	-	542.14	543.40	544.69	546.19	547.76	549.26	550.82	550.67	551.86	553.08	554.13

5.3.2 Net Costs and Benefits of Option 3

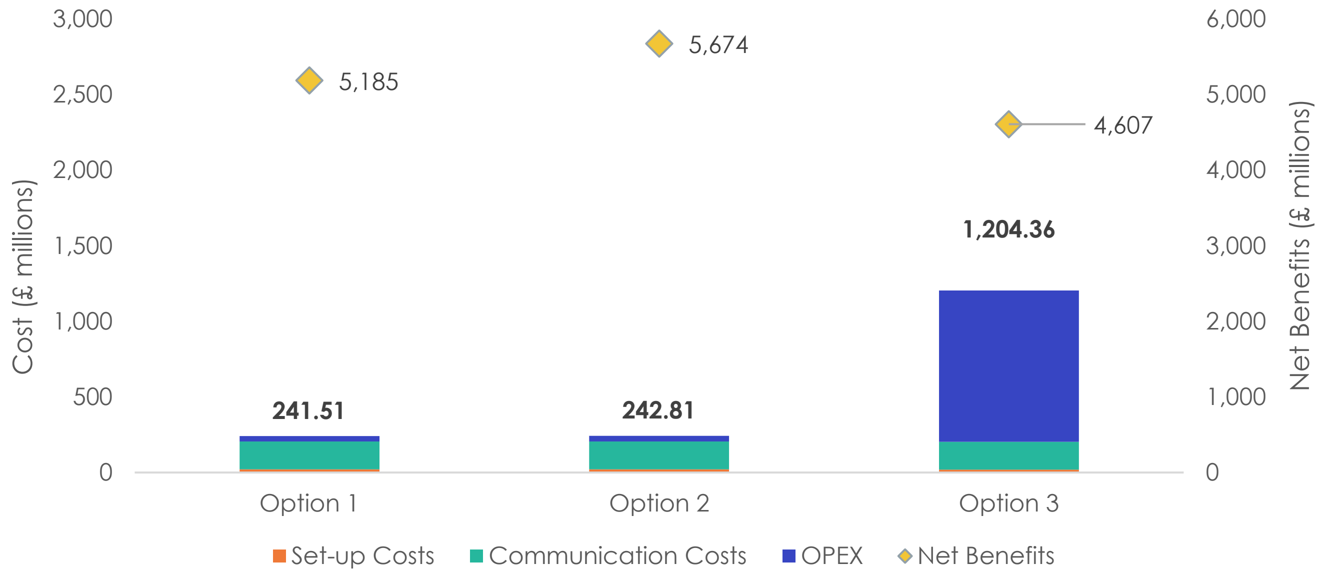
Over the 10-year assessment period, Option 3 delivers net benefits of £4,607 million (NPV). While significant benefits are achieved, primarily from fire reduction savings and the value of materials diverted to recycling, this option incurs notably higher costs compared to Options 1 and 2. Annual operating costs are the largest expense, totalling £107 million per year, driven by staff costs (£84 million per year) and vehicle rental and running costs (£16 million annually). Communication costs represent the second-largest expense as seen in Figure 5-12. Despite the higher costs, Option 3 still achieves substantial net benefits. For a detailed cost breakdown, refer to A.1.2.1.

Figure 5-12: Option 3 Summary of Costs and Benefits

5.4 Summary of Options

Figure 5-13 provides a summary of the cumulative costs and net benefits for each option from 2026 to 2036, calculated at a Net Present Value (NPV) of 3.5%, consistent with the Green Book discount rate applied to future costs and benefits[80]. Comparing the baseline option with Options 1, 2 and 3, based on the baseline cost of fires in 2026, reveals substantial cost savings and environmental benefits from implementing kerbside collection schemes for SMW and portable batteries. Option 1 generates net benefits of £5185 million at a NPV over the 10-year period, while Option 2 delivers slightly higher net benefits of £5,674 million. Option 3 yields net benefits of £4,607 million.

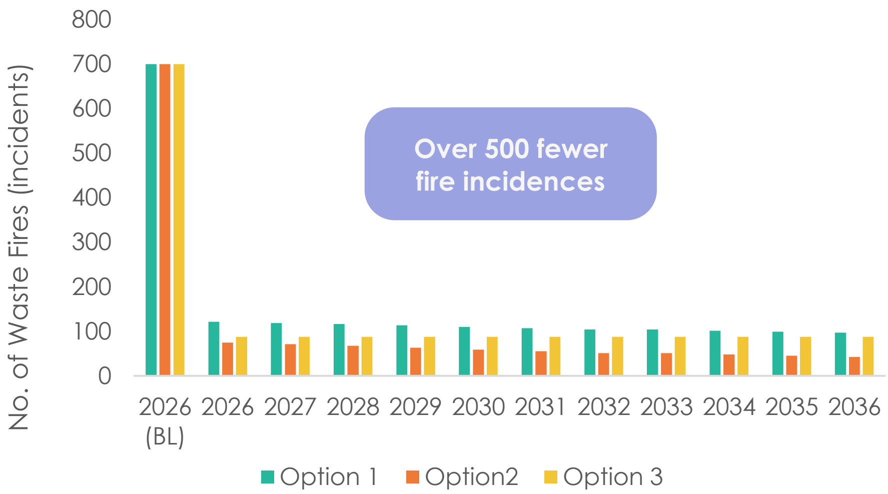
Figure 5-13: Cumulative Costs and Benefits (2026-2036) Across all Options Compared to 2026 baseline (NPV at 3.5%)

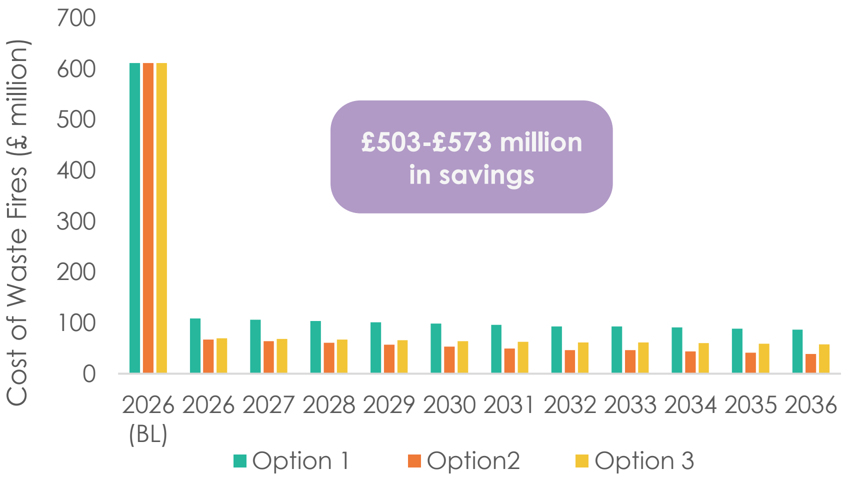


The primary driver of the benefits is the substantial cost savings from reducing fire-related expenses compared to the 2026 baseline of £611.51million. Annually, these fire cost savings range from £503 to £573 million, highlighting the significant financial impact of reducing fire incidents through the collection and management of SMW and batteries.

[80] House of Lords Library, "COP26: changes to the 'green book'", 2021.

Figure 5-14: Total Number, Costs and Savings from Reduction in Waste Fires





Regardless of the collection method used, the inclusion of portable battery collections with SMW kerbside services in Option 2 results in minimal cost increase reflecting the additional costs of equipping vehicles with battery containers, annual replacement of the containers, and the additional fuel costs due to the load of batteries. The minor additional costs associated with collecting batteries is offset by the marginal increase in the benefits of diverting batteries and SMW from the residual stream to recycling, due to the increased tonnage of batteries.

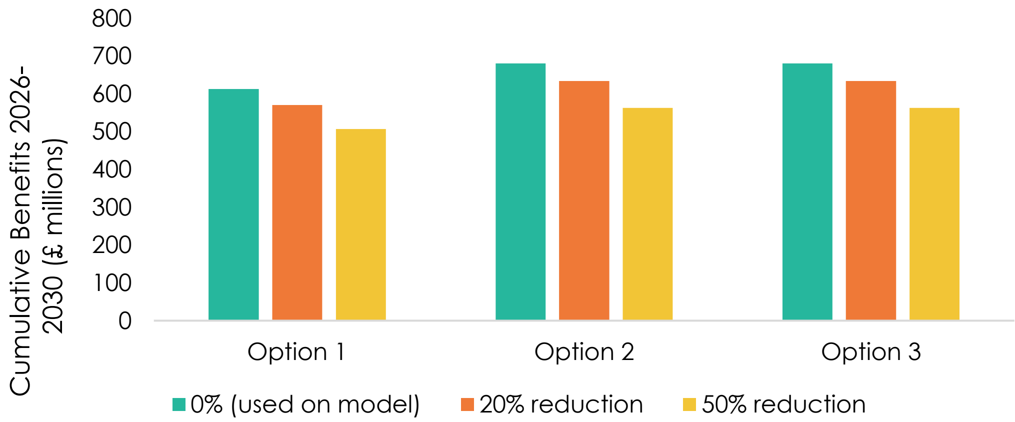
Option 3, while providing similar environmental and financial benefits to Option 2, incurs the highest operational costs due to the need for dedicated separate pass vehicles, making it the least cost-effective option over time. However, all options demonstrate significant improvements over the baseline scenario, particularly in terms of fire risk mitigation, reduced emergency response needs, and increased revenue from recyclable materials, underscoring the benefits of implementing dedicated SMW and portable battery collection schemes across the UK.

Across the three options, total costs are notably higher in rural areas compared to urban areas. This discrepancy is largely due to the logistics of servicing lower-density populations: rural areas require more vehicles to cover the same number of households as urban areas, where round sizes are more efficient due to higher household density. As a result, rural collection routes are longer and involve increased vehicle and fuel costs, driving up overall expenses. It was also found that overall, 21% of rural local authorities currently have multi-stream collections via kerbside sort vehicle, which as discussed above is more costly than RCV collections, while in urban areas only 6% of local authorities have multi-stream collections.

When comparing the baseline to Options 1, 2, and 3, it's important to acknowledge that each option involves a variety of costs and benefits, all influenced by numerous data points and assumptions, leading to several potential sensitivities. To avoid duplicating work already conducted by Material Focus, no additional sensitivity analyses were applied to the collection options in this model, as it follows the Material Focus methodology. For detailed sensitivity analyses, please refer to the Appendix of the Material Focus report.[81]

The key sensitivities outlined with regards to the waste flows, benefits and fires involve, firstly, the assumption that households will quickly adapt to the new collection system, with cost savings growing as participation stabilizes. However, the effectiveness of communication and actual adaptation rates may impact these outcomes. If household uptake is lower than expected the tonnage of SMW and portable batteries diverted from the residual stream will decrease, reducing total benefits. As a result, Figure 5-15 includes a sensitivity analysis, showing changes to total cumulative benefits between 2026-2036 with a 20% and 50% reduction in the total kg of SMW and portable batteries collected from households in present values discounted at 3.5%.

Figure 5-15: Sensitivity Analysis – Impact of Reduced Uptake of SMW and Portable Batteries per Household on Cumulative Benefits 2026-2036 (Excluding Fires) at NPV 3.5%

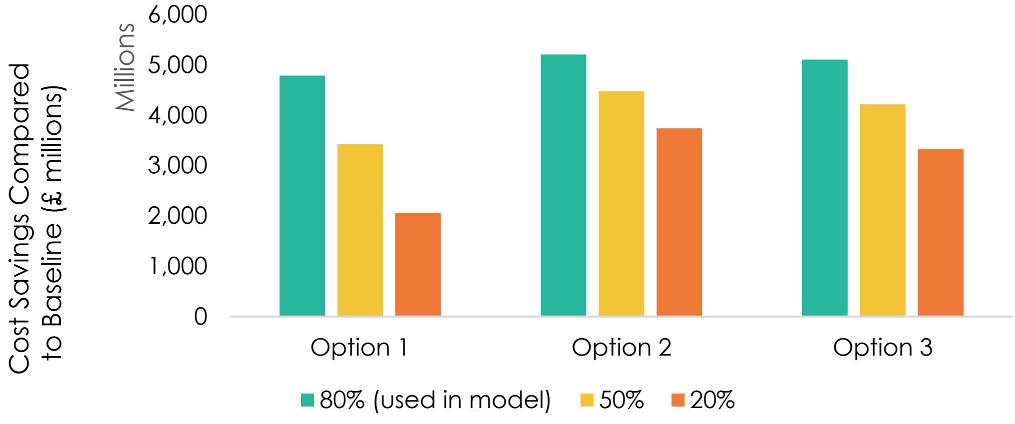


The reported cost savings related to fire incidents are based on the baseline cost of 700 fires recorded in 2026. Accurately attributing fires to vape disposal alone is challenging. The reduction in fire incidents is based on an estimate, reflecting a notable increase in vape disposal between 2022 and 2023. This estimated reduction assumes that the increase in vape usage and disposal has contributed significantly to the rise in waste fires, making the projected decrease plausible with the proposed ban.

An estimated 80% reduction in battery-related fires has been derived from Eunomia's interview with a waste management operator, as comparable data for local authorities implementing similar schemes is not yet available. To account for this uncertainty, a sensitivity analysis was conducted, modelling potential fire reductions at 50% and 20% to explore a range of possible outcomes. The resulting cost savings from these reductions, relative to the 2026 baseline, are presented in Figure 5-16, covering the period from 2026-2036. Even at the lower bound of a 20% reduction in fires, the analysis demonstrates that the cost savings remain significant when compared to the baseline, highlighting the potential financial benefits of even modest reductions in fire incidents. It is important to note that these cost savings are not directly aligned with the 50% and 20% fire reduction estimates, as they are adjusted for the additional 38% reduction in fires in Options 2 and 3 due to the inclusion of portable batteries, as well as the fire reduction associated with diverting waste from the residual stream.

[81] Material Focus. "Kerbside Collections for waste electricals", 2022. p.92-98. Last Accessed 12th November 2024.

Figure 5-16: Sensitivity Analysis – Impact of Reducing Fire Incidents on Cumulative Fire Cost Savings 2026-2036 at NPV 3.5%



6.0 Next Steps

Across all options assessed, UK-wide kerbside collection of SMW and batteries is shown to have a notable net benefit, especially when accounting for the impact of avoided waste fires.

Each of the three collection options demonstrate significant net benefits, **as high as £5.7billion cumulatively** from 2026 to 2036 when comparing it to the total cost estimated to be incurred in 2026. This is a staggering total savings to achieve in 10 years.

Most of this saving is due fire prevention from batteries – loose and those found in SMW (depending on the option assessed). The reduction in waste fires would in turn **reduce the demand on fire services**. The fire services' time and resources would be freed up to conduct additional fire prevention activities, further reducing the negative impacts of fires more widely in the UK. This could help reduce the public expenditure on fire services in the UK, which reached £3.6 billion in 2023/24 – higher than the previous annual costs incurred (about £3 billion per year since 2009/10).[82]

Another clear result is **the benefit of including loose batteries** within the kerbside collection scheme; their addition increases the realised benefits but they do not incur much additional cost at the collection stage. Another clear result is that Option 3, **separate pass collection, is significantly more expensive than kerbside collections**. Although the addition of other streams, such as textiles, could marginally increase benefits, the overall cost of implementation and operation is still about 5 times more than Options 1 and 2.

The recommendation based on this analysis is that Option 2– kerbside collection of both SMW and loose batteries is pursued further. The responsibility for the delivery of this option would lie with local authorities, who already oversee the kerbside service. EPR can help fund the change and ongoing operations, including communications. It will make **recycling SMW and batteries easier and more convenient than existing collection routes** , which should increase recycling overall. For the majority of UK households, it will introduce a new, more convenient method to safely dispose of these items (instead of needing to go to HWRC). Whilst there are still some concerns to address – such as where to place a cage in an eRCV – it is imperative the momentum is not lost and progress towards a more circular and safer waste management system is achieved.

6.1 Next Steps for the Government

Before local authorities and industry can work together to realise this reform, Government must first **finalise the reform in law**. It is imperative that the legal reform happens as soon as possible as local authorities and industry will need time to implement the necessary system changes and related communications. At present, SMW and batteries are governed by separate regulations. The 2022-2024 Conservative Government outlined plans to update the Waste Batteries and Accumulators Regulations as part of its broader Resources and Waste Strategy in 2024, however, consultation on these reforms is yet to be initiated.[83,84] At present, the UK regulation differs significantly from the EU New Batteries Regulation, which applies strict battery distributor take-back obligations.[85] Any update to the UK regulations should enforce mechanisms that improve the capture of batteries in legitimate recycling schemes, including collection at the kerbside.

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[82] Statista, "*Public sector expenditure on fire-protection services in the United Kingdom from 2009/10 to 2023/24(in billion GBP)*", 2024. Last accessed 6th November 2024.
[83] DEFRA, "Policy paper: Maximising Resources, Minimising Waste: policy summary table", 2023. Last accessed 5th February 2025.
[84] Uk Parliament, "Batteries: Waste Disposal. Question for Department for Environment, Food and Rural Affairs", 2024. Last accessed 5th February 2025.
[85] EU Commission, "Batteries", N.D. Last accessed 5th February 2025.

The **Government should also liaise closely with industry and local authorities**, to ensure that concerns are adequately addressed. This will smooth the implementation process, as well as support the existing national ambitions of moving towards a more circular, net zero economy. As with all legal reform, securing buy-in from relevant stakeholders helps to ensure the fairness, participation and best practice is achieved.

The public also should be supported through this change by the Government working with industry to develop **a clear communications plan**. Ensuring **the simplicity and ease of the proposed new system is understood by the public** is recommended to be part of the Government's policy planning.

6.2 Next Steps for Industry Stakeholders and Local Authorities

Currently, **kerbside collections are the responsibility of local authorities** across the UK. It is recommended that this responsibility is maintained – to ensure cost efficiencies are achieved within existing kerbside schemes and to avoid any confusion around household collection services available to the public. As such, local authorities should be tasked with expanding their existing kerbside schemes.

The expansion of kerbside schemes will need to be done in collaboration with the waste management industry – who are often the service providers, on behalf of local authorities. Practically, contracts will need to be amended, followed by updates to the infrastructure of the collection schemes. This will all take time. The timescales of implementation may therefore be longer than anticipated. We recommend that **decision-making is progressed efficiently and robustly to minimise any potential delay** to realising the benefits of this reform.

As part of the implementation recommended here, **cages will need to be added to RCVs.** For fossil-fuelled vehicles, this is not a problem, as cages can be added between axels by the tyres. However, for electric RCVs (eRCVs), this **space is already occupied by the battery**. This is an area of concern that needs still to be addressed. It is expected to be a growing concern, as more authorities and waste management companies move towards eRCVs as part of their net zero goals.

Another concern, as is the case with all recycling, is **participation**. It has been highlighted that participation is key to reducing fires, recovering precious metals, and maximising the benefits from the expanded system. Compared with HWRC drop-offs, the **increased convenience and ease of access of kerbside collection** should encourage higher participation. Although the future level of participation cannot be known, case studies and interviews show that public communication campaigns are crucial in driving high participation. It is recommended that **robust annual communication plans** are conducted by local authorities. Under EPR, producers may also be expected to partially fund communications campaigns. Retailers may also be required to fund their own communications campaigns that align with and support local authority communications. Though exact costs of such a communication plan are unclear, significant financial investment is essential for an effective and lasting campaign. Beyond funding, a communications campaign must be well planned and structured to ensure uptake of the collection service is strong and incorrect disposal is minimised. Any campaign must both inform consumers about the collection service and provide local authorities with resources to educate residents on the safe storage and presentation of WEEE and batteries. Over time, campaigns will need to evolve to reflect system adoption, public behaviours, and adjust to the introduction of new materials on the market.

In future years, this could lead to **overall improvements to the quality of all dry recycling** too. This could be due to indirectly promoting the public to think more about what and how to recycle. Alternatively, it could create an opportunity for local authorities to create one joint recycling comms campaign. This would give the public one succinct place to better understand the rules of recycling. Doing so would also allow for the financial burden to spread across all relevant recycling streams (such as packaging), expanding the funding scope to include more producers and EPR schemes.

Appendix

A.1.0 Modelling Methodology

A.1.1 Scope

Current WEEE regulations place EEE products into 14 categories,[86] nine of which are classified as SMW (see Table A- 1). Bulky and other wastes, covered by the remaining 5 categories, are not within the scope of this study. For bulky waste, more robust collection avenues already exist. What is more, bulky waste cannot be easily hidden in household waste bins, meaning they are unlikely to pose the same fire risk along the waste management chain as SMW since they are kept separate and are unlikely to be accidentally damaged by household collection and sorting equipment.

Table A- 1: WEEE regulation categorisation of EEE items

Waste type	Category and description
Bulky	1 - Large Household Appliances (LHA) (E.g., washing machines, dishwashers, cookers)
SMW	2 - Small Household Appliances 3 - IT and Telecoms Equipment 4 - Consumer Equipment 5 - Lighting Equipment Small Mixed WEEE (SMW) 6 - Electrical and Electronic Tools 7 - Toys, Leisure, and Sports equipment (including vapes) 8 - Medical Devices 9 - Monitoring and Control Instruments 10 - Automatic Dispensers
Bulky	11 - Display Equipment (E.g., TVs, Monitors) 12 - Cooling Appliances Containing Refrigerants (E.g., Fridges, Freezers)
N/A	13 - Gas Discharge Lamps and LED light sources 14 - Photovoltaic Panels

A.1.2 Cost of Collection Options

To model UK-wide costs of collection options, first data from WRAP was collected for 2023, detailing the number of households within each LA that currently receive dry recycling services. This dataset provided information on the frequency of collections, the collection system in use (co-mingled, two-stream, or multi-stream), as well as additional characteristics of each LA, including rurality (categorized as urban, rural, mixed, inaccessible), levels of deprivation (low, medium, or high), and the proportion of flats[87].

[86] Legislation.gov.uk, "The Waste Electrical and Electronic Equipment Regulations 2013", 2014. Last accessed 5th November 2024.
[87] ONS, "Census – 2021 Accommodation Type", 2023. Last Accessed 12th November 2024.

Local authorities were organized into 10 distinct groups based on rurality and deprivation levels. Each group was then divided into three sub-groups according to the type of existing collection system: co-mingled, two-stream, or multi-stream. Following the approach in the Material Focus report, it was assumed that LAs using co-mingled or two-stream collection systems utilize Refuse Collection Vehicles (RCVs) for their DMR collections, while LAs with multi-stream collections use kerbside sort vehicles.

Table A-2 summarizes the Local Authority groupings. Costs for introducing kerbside collections of SMW were calculated separately for each group and collection system type (co-mingled, two-stream, or multi-stream). This approach enabled estimating the average cost for a single example Local Authority within each grouping, with variations based on the collection system type to account for the different vehicle requirements. These average costs were then scaled up by the total number of Local Authorities in each group. Finally, the total costs across all groups were aggregated to provide an estimate of the overall cost for implementing kerbside SMW and battery collections in the UK.

Table A- 2: Average and total number of households per Local Authority by DMR collection type

			Average number of households			Total number of households		
LA category	**Total Number of LAs**	**LAs with existing KS SMW collections**	**RCV Co-mingled DMR**	**RCV Two-stream DMR**	**Multi-stream DMR**	**RCV Co-mingled DMR**	**RCV Two-stream DMR**	**Multi-stream DMR**
A (Urban, Low Deprivation)	38	18	81,952	105,955	73,715	1,720,982	1,589,328	147,430
B (Urban, Mid Deprivation)	33	4	92,732	111,935	109,499	2,040,098	671,609	547,497
C (Urban, High Deprivation)	38	2	110,357	127,051	0	2,317,498	2,159,868	0
D (Mixed, Low Deprivation)	47	17	57,957	53,522	78,693	1,217,092	1,177,480	393,467
E (Mixed, Mid Deprivation)	43	12	74,292	82,470	77,800	1,560,125	1,154,586	622,398
F (Mixed, High deprivation)	49	8	77,709	74,246	59,887	1,243,351	1,707,669	598,869
G (Rural, Low Deprivation)	47	16	58,786	59,371	57,085	1,528,443	1,009,302	228,340
H (Rural, Mid Deprivation)	57	18	61,124	53,142	57,178	1,466,985	1,062,830	743,311
I (Rural, High Deprivation)	32	6	60,643	97,764	51,381	970,286	488,818	565,195

J (Rural, Inaccessible)	6	0	53,019	11,813	3,000	159,058	23,625	3,000

Following the Material Focus methodology, cost elements were calculated for each representative local authority within each group, using costs directly from the report, adjusted for inflation to reflect 2023 values (see pages 92-99 for costs used and adjusted for inflation)[88]. This approach maintains consistency with Material Focus's model, with low, average, and high-cost scenarios provided as well as variations for rural, urban and mixed local authorities. For reporting purposes, average values were used, with low and high-cost results included as a sensitivity analysis.

For Options 1 and 2, the costs in scope of the assessment include additional expenses directly related to SMW and portable battery collections, the incremental costs of incorporating these materials, and the share of DMR operating costs allocated to SMW and portable battery collection, reflecting the combined use of resources across these services. For Options 1 and 2 cost elements remain largely consistent, with notable variations in fuel costs—where the added weight of portable batteries impacts total expenses—and setup costs, as separate containers need to be purchased for collecting portable batteries alongside SMW. For details on the calculation methodology, see pages 28-31 and pages 45-47 of the Material Focus Report[89]

In Option 3, an on-demand collection system for SMW and portable batteries is implemented, with all cost elements fully dedicated to collecting these materials, removing the need for cost apportionment. Setup and communication costs are calculated in the same way as in Options 1 and 2; however, they are based on the number of households with residual collection. A detailed breakdown of cost elements and methodology underpinning Option 3 can be found on page 51 of the Material Focus Report, with costs adjusted to 2023 values for accuracy.[90]

Operational costs in Option 3 encompass the full expenses related to vehicle rental, maintenance, insurance, and staffing, reflecting the dedicated focus of this service. The costs presented per vehicle are multiplied by the total number of vehicles required to service each local authority. The Material Focus report presents multiple scenarios for calculating the number of vehicles required under a separate pass option. In this model, the required number of vehicles was determined based on the size and rurality of each local authority, with the assumption that sufficient vehicles are needed to cover all households with DMR and residual waste collection. This is a conservative, worst-case estimate; in practice, if separate pass vehicles are used based on bookings from households, there would be fewer households to cover overall. Due to limited data on practical capture and participation rates, a baseline of 100% capture and participation was assumed in this Option, under which vehicle needs were based solely on household coverage, rather than the tonnage of SMW. This baseline estimate was used to project UK-wide costs and costs per household.

[88] Material Focus. "Kerbside Collections for waste electricals", 2022. Last Accessed 12th November 2024.
[89] Material Focus. "Kerbside Collections for waste electricals", 2022. Last Accessed 12th November 2024.
[90] Material Focus. "Kerbside Collections for waste electricals", 2022. Last Accessed 12th November 2024.

A.1.2.1 Cost and Benefit Results

Table A- 3: Option 1 Costs and benefits of introducing kerbside collections of SMW (£ millions undiscounted)

		2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Costs	Set-up costs (containers)	20.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Vehicle Retrofitting Costs	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
	Flat container replacement costs	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
	Cost of additional fuel attributed to SMW collections	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
	Staff Costs	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69
	Overheads	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
	Communication Costs	48.86	16.40	16.40	16.40	16.40	16.40	16.40	16.40	16.40	16.40	16.40
Benefits	Landfill Tax Savings	0.45	0.59	0.73	0.89	1.06	1.23	1.40	1.38	1.51	1.65	1.76
	EfW and Landfill Gate Fee Savings	3.50	4.58	5.68	6.97	8.29	9.59	10.93	10.80	11.82	12.86	13.76
	Value of material diverted to recycling	17.35	22.68	28.14	34.52	41.07	47.54	54.14	53.50	58.55	63.70	68.17
	Carbon Cost Savings (incl. ETS from 2028)	6.82	9.49	9.39	10.46	12.17	15.22	18.62	19.68	22.13	26.25	29.72
	Fires (savings from 2026 BL)	503.42	505.72	508.08	510.84	513.67	516.46	519.31	519.04	521.22	523.44	525.38
	Total Costs	**73.46**	**20.21**	**20.21**	**20.21**	**20.21**	**20.21**	**20.21**	**20.21**	**20.21**	**20.21**	**20.21**
	Total Benefits	**532**	**543**	**552**	**564**	**576**	**590**	**604**	**604**	**615**	**628**	**639**

Table A- 4: Option 2 Costs and benefits of introducing kerbside collections of SMW and portable batteries (£ millions undiscounted)

		2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Costs	Set-up costs (containers)	20.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Vehicle Retrofitting Costs	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
	Flat container replacement costs	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
	Cost of additional fuel attributed to SMW collections	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
	Staff Costs	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69
	Overheads	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36
	Communication Costs	48.86	16.40	16.40	16.40	16.40	16.40	16.40	16.40	16.40	16.40	16.40
Benefits	Landfill Tax Savings	0.50	0.65	0.81	0.99	1.18	1.37	1.55	1.54	1.68	1.83	1.96
	EfW and Landfill Gate Fee Savings	3.89	5.09	6.31	7.74	9.21	10.66	12.14	12.00	13.13	14.28	15.29
	Value of material diverted to recycling	19.28	25.20	31.27	38.36	45.63	52.83	60.15	59.45	65.06	70.78	75.74
	Carbon Cost Savings (incl. ETS from 2028)	7.57	10.55	10.44	11.63	13.52	16.91	20.69	21.87	24.59	29.17	33.02
	Fires (savings from 2026 BL)	544.59	547.95	551.32	555.14	558.93	562.56	566.13	565.79	568.45	571.08	573.30
	Total Costs	**73.60**	**20.35**	**20.35**	**20.35**	**20.35**	**20.35**	**20.35**	**20.35**	**20.35**	**20.35**	**20.35**
	Total Benefits	**576**	**589**	**600**	**614**	**628**	**644**	**661**	**661**	**673**	**687**	**699**

Table A- 5: Option 3 Costs and benefits of introducing on-demand collections of SMW and portable batteries (£ millions undiscounted)

		2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Costs	Set-up costs (containers)	19.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Vehicle costs	16.37	16.37	16.37	16.37	16.37	16.37	16.37	16.37	16.37	16.37	16.37
	Flat container replacement costs	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
	Cost of additional fuel attributed to SMW collections	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33
	Staff Costs	83.79	83.79	83.79	83.79	83.79	83.79	83.79	83.79	83.79	83.79	83.79
	Overheads	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Communication Costs	48.53	16.29	16.29	16.29	16.29	16.29	16.29	16.29	16.29	16.29	16.29
Benefits	Landfill Tax Savings	0.50	0.65	0.81	0.99	1.18	1.37	1.55	1.54	1.68	1.83	1.96
	EfW and Landfill Gate Fee Savings	3.89	5.09	6.31	7.74	9.21	10.66	12.14	12.00	13.13	14.28	15.29
	Value of material diverted to recycling	19.28	25.20	31.27	38.36	45.63	52.83	60.15	59.45	65.06	70.78	75.74
	Carbon Cost Savings (incl. ETS from 2028)	7.57	10.55	10.44	11.63	13.52	16.91	20.69	21.87	24.59	29.17	33.02
	Fires (savings from 2026 BL)	542.14	543.40	544.69	546.19	547.74	549.26	550.82	550.67	551.86	553.08	554.13
	Total Costs	**175.23**	**123.74**	**123.74**	**123.74**	**123.74**	**123.74**	**123.74**	**123.74**	**123.74**	**123.74**	**123.74**
	Total Benefits	**573**	**585**	**594**	**605**	**617**	**631**	**645**	**646**	**656**	**669**	**680**

A.1.3 Waste Flows

To calculate the potential benefits of introducing kerbside collection for SMW and portable batteries, it was first essential to analyse the waste flows of SMW and portable batteries to estimate how much could be diverted from the residual waste stream. Baseline waste flow data were taken from DEFRA's 2019 Impact Assessment, with an assumed annual growth rate of 3%[91]. In 2019, DEFRA reported that 622,915 tonnes of SMW (including portable batteries) from all streams were generated, with 37% recycled, 9% reused, and 55% disposed. Of the waste disposed, it is assumed that 10% would end up in landfill and 90% in EfW, in line with DEFRA's data on the disposal routes of local authority collected waste in 2023.[92] This split is assumed to remain consistent to 2036, as no additional recycling services for SMW will be implemented in the baseline scenario.

Using this baseline, the tonnages of SMW that would be reused, recycled, and disposed through to 2036 were forecasted, as shown in Table A- 6. These projections provide an indicative view of the diversion potential of SMW and portable batteries through a kerbside collection scheme. However, it is important to note the inherent uncertainties in forecasting SMW arisings. Variations in consumer behaviour, product lifecycles, and disposal habits can all impact actual waste generation rates.

Table A- 6: SMW (including portable batteries) Waste Arisings and Treatment Projections (Kt, rounded)

Year	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Reuse	61	63	65	67	69	71	73	75	77	80	82	84	87	90
Recycling	256	264	272	280	289	297	306	315	325	335	345	355	366	377
EfW	345	356	366	377	389	400	412	425	437	451	464	478	492	507
Landfill	12	12	12	13	13	13	14	14	15	15	16	16	16	17

To estimate the anticipated tonnage of SMW and portable batteries that could be diverted to recycling once household collections are implemented across all local authorities, baseline kerbside collection tonnages of SMW and portable batteries were first extracted from WasteDataFlow[93]. This data indicates that, in 2023, 2,653 tonnes of were collected kerbside across all UK LAs. For the years leading up to the scheme's implementation in 2026, collection volumes in 2024 and 2025 are projected to grow by 3% annually, aligning with the forecasted increase in overall waste arisings.

The average kilograms collected per household across local authorities with existing kerbside collection schemes for SMW was used as a benchmark for expected uptake during the scheme's first year in 2026, derived from interview data with these local authorities conducted by Material Focus[94]. This figure is projected to rise to the upper quartile level of the reported uptake across local authorities with existing schemes within two years and achieve the maximum levels observed in existing schemes by 2036. A conservative estimate assumes it will take 10 years for the entire UK to reach the uptake levels of the best-performing existing kerbside schemes. Since current kerbside collection systems are not universally accessible, a nationwide rollout—bolstered by comprehensive outreach—is expected to boost participation, albeit gradually, with collection potential per household meeting or exceeding existing scheme levels within 10 years. These per household values were multiplied by the total number of

[91] DEFRA, "Reforming the UK producer responsibility system for waste electricals: Impact Assessment", 2023. Last accessed 4th November 2024.
[92] DEFRA, "Local authority collected waste management – annual results 2022/23", 2024. Last accessed 4th November 2024.
[93] Waste Data Flow, "Summary Reports", n.d. Last accessed 4th November 2024.
[94] Material Focus. "Kerbside Collections for waste electricals", 2022. Last Accessed 12th November 2024.

households in the UK, with a growth rate of 1% applied year on year, reflecting trends in the growth of households in the UK between 2021-2023.[95]

Using the 2023 tonnage level for kerbside SMW and portable battery collections as a baseline (excluding any growth in SMW), the anticipated increase in kerbside collections relative to the baseline were calculated, shown in Table A- 7. This projected tonnage was then added to the annual recycling tonnage forecasted, with baseline recycling tonnage subtracted to estimate the additional recycling volumes. For instance, in 2026, 17,887 tonnes collected at kerbside are added to the projected 280,203 tonnes for recycling that year, minus the 2023 baseline of 256,426 tonnes, resulting in an estimated additional 41,665 tonnes sent to recycling in 2026 compared to 2023. As portable batteries are collected alongside SMW, the proportion of SMW to portable batteries in residual waste were modelled at a ratio of 90:10 based on weight, as per the Material Focus methodology.

Table A- 7: Estimated Tonnage of SMW and Portable Batteries Diverted from Residual Waste

	2026 (Yr 1)	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Annual SMW collections from KS (kg/hh/year)	0.68	0.82	0.96	1.16	1.36	1.55	1.75	1.95	2.15	2.34	2.54
SMW uptake compared to 2023 baseline (tonnes)	17,887	22,264	26,727	33,125	39,649	45,735	51,819	40,258	42,047	43,751	43,518
Tonnage Diverted to recycling	41,665	54,448	67,569	82,885	98,594	114,141	129,970	128,447	140,575	152,927	163,662

A.1.4 Benefits of Options

Based on the estimated tonnage of SMW and portable batteries that can be diverted from the residual waste stream with the introduction of the scheme in 2026, and using the established 90:10 ratio of SMW to batteries by weight in this stream, the potential benefits of reducing residual waste have been calculated, drawing on DEFRAs Impact Assessment methodology[96]. This section outlines the approach taken to derive these anticipated benefits, focusing on the cost savings achieved by redirecting this material away from disposal and toward recycling.

Landfill Tax

Redirecting SMW from residual disposal will reduce the volume of WEEE ending up in landfill, generating cost savings for local authorities that currently incur landfill tax for disposing of household residual WEEE.

[95] Statista, "Number of Households in the United Kingdom from 1996 to 2023", 2024. Last Accessed 12th November 2024.
[96] DEFRA, "Reforming the UK producer responsibility system for waste electricals: Impact Assessment", 2023. Last accessed 4th November 2024.

Assuming that 10% of SMW is directed to landfill, potential savings are estimated by calculating the tonnage of WEEE diverted from residual waste, applying the 10% landfill rate, and multiplying by the landfill tax rate of £122.8 per tonne from 2026 when the scheme is introduced. The landfill tax rate is derived from the reported rate from 2025 onwards of 126.2, deflated to represent current values. This approach provides an estimated reduction in landfill tax expenses for local authorities.

Gate Fees and Carbon Tax

In addition to savings on landfill tax, local authorities can anticipate further cost reductions from avoided landfill and EfW gate fees, along with anticipated savings from the inclusion of waste incineration in the UK Emissions Trading Scheme (UK ETS) starting in 2028. To estimate these savings, the projected diverted tonnage is split between landfill and EfW disposal (10% to landfill and 90% to EfW) and multiplied by the respective gate fees, set at £25 per tonne for landfill and £101 per tonne for EfW in 2023. Although gate fees are generally expected to rise with inflation (RPI), to reflect current prices, they are held constant at 2023 levels through 2036 in this analysis.

To calculate the cost savings associated with reduced carbon emissions from diverting material away from the residual stream, WRAP's carbon WARM factors were applied based on the composition of WEEE outlined in Table A- 10 in the section below. However, due to data limitations, silver and glass were excluded from the composition, with the remaining materials scaled to 100%. This adjustment allows for a focus on the most impactful materials while maintaining accuracy in emissions calculations.

The methodology involved calculating total emissions savings by multiplying the annual tonnage diverted from the residual stream by the carbon factor assigned to each material (detailed in Table A-8). This provided the total CO_2e savings, reflecting emissions avoided through increased recycling of SMW and portable batteries. To convert these emissions savings into financial benefits, current traded carbon market values were applied (see Table A- 9), representing the monetary savings from reduced carbon costs by recycling instead of disposing of SMW and portable batteries.

From 2028 onward, when the UK ETS will impose costs on incineration emissions, it is anticipated that these emissions savings will align with UK ETS rates rather than current traded carbon values. However, since future UK ETS costs are not yet defined, traded carbon market values have been used in projections through 2036 to provide a consistent estimate for emissions savings from diverted incineration waste.

Table A- 8: Carbon WARM Factors for WEEE (kgCO2e/tonne)[97]

Emissions Factors	Recycling (closed-loop)	EfW	Landfill
Iron/Steel	-1,061.53	19.43	9.03
Aluminium	-7,469.39	23.87	9.03
Plastic (average of polymers)	-565.20	1,746.81	9.03
Glass (clear)	-326.35	7.85	9.03

Table A- 9: Traded Carbon Market Values (£/tCO2e)[98]

Year	Traded Carbon Market Values in 2023 (£/tCO2e)
2026	91

[97] WRAP, "Carbon Waste and Resources Metric", 2021. Last Accessed 12th November 2024.
[98] DESNZ, "Traded carbon values used for modelling purposes, 2023", 2023. Last Accessed 12th November 2024.

2027	97
2028	98
2029	89
2030	87
2031	94
2032	101
2033	108
2034	111
2035	121
2036	128

Value of Material Diverted to Recycling

Using the methodology from DEFRA's Impact Assessment, this analysis evaluates the potential revenue for recyclers from the increased diversion of SMW and portable batteries to recycling. To estimate the net profit, the cost of processing this material stream was account for, including separation and sorting expenses, which are deducted from the total revenue derived from recycling.

First, the cost of recycling SMW and portable batteries was calculated using EC4Ps[99] estimate on the cost to recycle WEEE per tonne at £110 – it should be noted that this may not reflect the true cost of recycling WEEE year on year, but remains stable through to 2036. This value is multiplied by the tonnage of material diverted from the residual stream in line with the above benefits, taking into account the ratio of SMW to portable batteries in the residual stream.

The next step involved calculating the potential revenue from material diverted from the residual stream. DEFRA's assessment simplifies WEEE composition by focusing on the four most prevalent materials—iron/steel, aluminium, plastic, and glass—which make up approximately 80% of the average WEEE item[100]. While this approach captures the majority of materials by volume, it overlooks the high economic value of precious metals, such as gold and silver, which, though present in small quantities, are highly valuable in secondary markets. In our analysis, we refined DEFRA's composition model by incorporating gold and silver, using data sourced from the EU Commission's study on WEEE waste[101].

Due to data limitations and variability in the composition of WEEE, the material composition does not include all the critical raw materials present in WEEE. Therefore, the estimated profit to reprocesspors is likely to be an underestimate of the potential profits available. A study conducted by Material Focus, found that in PCs, laptops, tablets, TVs, monitors, smart phones, and lighting sent to recycling in 2017[102], there was £11.37 million worth of critical raw technology metals. To account for the portion of WEEE not included, the composition has been scaled to 100%, and secondary material values have been

[99] Sphera EC4P, "B2B WEEE Scheme", n.d. Last Accessed 12th November 2024.
[100] DEFRA, "Reforming the UK producer responsibility system for waste electricals: Impact Assessment", 2023. Last accessed 4th November 2024.
[101] European Commission, "Study on Collection Rates of Waste Electrical and Electronic Equipment (WEEE)", 2014. Last Accessed 12th November 2024.
[102] Material Focus, "Contributing towards a circular economy utilising Critical Raw Materials from Waste Electricals", 2021. Last Accessed 4th November 2024.

integrated, using data from Lets Recycle[103] for common materials and Gold Traders[104] for gold and silver values. Table A- 10 provides a detailed breakdown of the adjusted composition and the associated values of each material. For the purpose of this analysis, it is assumed there is no change to material values over the timeframe. The resulting revenue by material is outlined in Table A- 11.

Table A- 10: Composition and value of materials found in average WEEE items

Material	Composition of average WEEE item (%)	£ / tonne (current values)
Iron/steel	55%	200
Aluminium	11%	1,150
Plastic	26%	316
Glass	7%	47
Wood	0.6%	12
Gold	0.001%	26,590,000
Silver	0.005%	780,000

Table A- 11: Total Material Revenue (£ millions)

Material	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Iron/Steel	4.58	5.99	7.43	9.12	10.85	12.56	14.30	14.13	15.46	16.82	18.00
Aluminium	5.27	6.89	8.55	10.48	12.47	14.44	16.44	16.25	17.78	19.35	20.70
Plastic	3.42	4.47	5.55	6.81	8.10	9.38	10.68	10.55	11.55	12.56	13.45
Glass	0.14	0.18	0.22	0.27	0.32	0.38	0.43	0.42	0.46	0.50	0.54
Gold	8.88	11.61	14.41	17.68	21.03	24.34	27.72	27.39	29.98	32.61	34.90
Silver	1.56	2.04	2.54	3.11	3.70	4.28	4.88	4.82	5.28	5.74	6.14
Wood	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

A.1.5 Cost of Waste Fires

The next stage of the analysis focused on estimating the potential cost savings from implementing kerbside collections of SMW and portable batteries by reducing the frequency and cost of waste fires. To begin, a baseline figure for the current number of waste fires was derived, providing a reference point for assessing the impact of kerbside collections. By analysing this baseline and projecting potential reductions in waste fires due to the removal of SMW and portable batteries from the residual waste stream, and into cages or compartments on DMR vehicles, the costs and benefits associated with fire prevention in waste management systems were calculated.

[103] Lets Recycle, "Prices", 2024. Last Accessed 4th November 2024.
[104] Gold Traders, "Scrap Silver Prices", 2024. Last Accessed 4th November 2024.

In 2023, 1,200 waste fires were reported at waste sites and in collection vehicles, up from 700 fires in 2022[105]. For this analysis, it was assumed that, without any intervention targeting the disposal of SMW and portable batteries, the number of fires would remain stable at 1,200 per year until 2026. This baseline scenario reflects current conditions, where batteries continue to enter the waste stream and contribute to fire risks. However, starting in 2026, it is assumed that the number of fires will decrease to 2022 levels, reaching 700 fires annually until 2036. This reduction aligns with the anticipated impact of upcoming legislation, including the recently announced 2025 ban on all single-use vapes, which are a known source of waste fires. This assumption reflects the expectation that removing single-use vapes from the waste stream will significantly mitigate fire risks, thereby reducing the annual number of incidents to pre-2023 levels, whereby in 2023, more than double the amount of single-use vapes compared to 2022 were purchased each week.[106] [107]

To analyse these fires, incidents were grouped into four main categories: fires on recycling trucks, fires on residual trucks, fires at recycling facilities, and fires at residual facilities. This categorization was established by reviewing data from 2020–2022, gathered through Freedom of Information requests sent to 45 fire departments across the UK, representing approximately 77% of all UK fire departments[108]. In the data collected, fire departments used different classifications, which required us to standardize the categories. In some cases, fires were clearly identified as occurring at a recycling facility (e.g., labelled as "recycling facility," "HWRC," or "recycling vehicle"), while in others, recycling and residual fires were grouped together (e.g., labelled as "waste facility recycling and refuse").

To accurately assign fires across the four categories, the known recycling and residual fires were separated, excluding cases where the location was ambiguous. Fires on vehicles were combined into one category, as the type of vehicle was often unspecified. Next, the percentage of fires occurring specifically at recycling and residual facilities was calculated, along with the percentage of total fires that happened on vehicles. For vehicle fires, it was assumed that the distribution between recycling and residual vehicles matched the facility distribution, given the lack of specific vehicle type data. This method allowed for the estimation of the proportion of fires by location and type, forming a baseline for assessing the potential impact of kerbside SMW and battery collections on reducing waste-related fires.

Table A- 12: Location of Waste Fires in the UK

Category of Fire	Proportion of all waste fires (%)
Recycling Facility	34%
Residual Facility	48%
Residual Vehicle	10%
Recycling Vehicle	18%

The methodology for calculating the number of fires in the proposed KS collection scheme is based on an estimated 80% reduction in fire incidents, a figure derived from industry insights provided by Eunomia's interview with a waste management operator in 2024[109]. This reduction reflects the anticipated impact of removing flammable materials, particularly portable batteries and SMW, from the residual waste stream, thereby lowering fire risk. However, it is important to note that these estimates are based on industry

[105] Material Focus. "Over 1,200 battery fires in bin lorries and waste sites across the UK in last year", 2024. Last accessed 30th October 2024.
[106] Lets Recycle, "Single-use vapes to be banned from June 2025", 2024. Last Accessed 4th November 2024.
[107] The Standard, "Are disposable vapes going to be banned? Studies reveal alarming rise in vaping among Brits", 2024. Last Accessed 4th November 2024.
[108] What Do They Know, "FOI: Fires at waste centres / refuse vehicles – a batch request", 2023. Last Accessed 4th November 2024.
[109] Waste management operator Interview, 2024

perception due to the limited data on the effects of existing KS collection schemes on fire frequency and severity.

The methodology for calculating the total number of fires across each scenario is as follows:

1. **Baseline Reduction:** All options assume an 80% reduction in fire incidents compared to the 2023 baseline due to the introduction of KS collection for SMW and portable batteries, as flammable materials are diverted from the residual stream.

2. **Shift in Fire Locations:** The diversion of SMW and portable batteries from the residual waste stream is expected to proportionally reduce the number of fires in the residual stream (see Table A- 13). Any remaining fires on recycling vehicles, based on the fire distribution outlined above, are assumed to shift to these new locations as well.

    a. **Options 1 and 2:** Reduction in fires at residual facilities or trucks, and fires on recycling trucks are redirected to dedicated cages or compartments in DMR vehicles. These fires are removed as fire risk is expected to be minimized due to the reduced exposure to heat and compression in cages or compartments on trucks.

    b. **Option 3:** Reduction in fires at residual facilities or trucks, and fires on recycling trucks are redirected to separate pass vehicles, which have an increased fire risk compared to Option 1 and 2 due to the lack of specialised containment.

3. **Additional Reduction from Loose Battery Collection:** In Option 2 and Option 3, where portable batteries are included alongside SMW, the number of fires is expected to be lower than Option 1, where only SMW is collected. According to the NFCC, in 2023 each household in the UK disposed of 24 batteries on average, of which 38% were loose batteries and the remainder were batteries embedded in SMW. In Options 2 and 3, the overall number of waste fires is anticipated to decrease by an additional 38% in line with the proportion of loose batteries disposed per household compared to batteries embedded in SMW.

Table A- 13: Percentage Reduction in Residual Waste Compared to the Baseline Applied to Residual Fires

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Option 1: SMW Only	10%	14%	17%	21%	25%	29%	33%	32%	35%	39%	41%
Option 2 and 3: SMW and portable batteries	12%	16%	19%	23%	28%	32%	36%	36%	39%	43%	46%

To estimate the cost of waste fires, two categories of costs were calculated: the cost of a fire at a facility (covering both recycling and residual facilities), the cost of a fire on a waste vehicle (including both residual and recycling vehicles). Recycling and residual facilities were combined into one category for facility fire costs, as the type of facility, whether handling recycling or residual waste – does not significantly alter the response or severity factors related to fire incidents. The specific costs associated with each type of fire are outlined below. However, it should be noted that several additional costs associated with waste fires have not been included in the model due to challenges in accurate estimation or limited data. For example, increased insurance premiums for the waste industry, driven by payouts for waste fires, have been excluded. The NFCC reports that claims for some battery-related fires can reach up to £20 million, highlighting a significant but unquantified financial impact[110].

Similarly, the potential danger or loss to human life, both mental and physical, has not been modelled due to the inherent difficulties in assigning a monetary value to such impacts. Additionally, the lack of reliable data to estimate the scale and frequency of these effects further complicates their inclusion.

Another cost to consider is the material value lost in fires at recycling centres. While an estimate has been modelled based on general assumptions, the true costs may be higher when accounting for the loss of secondary materials. Fires at recycling centres are likely more costly than those at residual facilities. However, the implementation of a kerbside scheme for SMW and portable batteries is expected to reduce the frequency and severity of such fires, making this cost less significant in the future.

Facility Fire

The cost of a fire at a facility was determined using fire severity assumptions from Eunomia's previous work for ESA on Li-ion batteries, categorising fires into four levels of severity[111]:

- Severity 1 (most severe): involves prolonged burning (over 72 hours), with more than 500 tonnes of waste burned, and required extensive response (e.g. 10 fire trucks)
- Severity 4 (least severe): involves shorter-duration fires (1-4 hours), with 25 tonnes of waste burned, and minimal response (e.g. 2 fire trucks).

Each severity level 1-4 was assigned a cost multiplier to adjust costs based on the fires impact, with Severity 1 having a factor of 4, Severity 2 a factor of 2, Severity 3 a factor of 1, and severity 4 a factor of 0.1. Costs associated with each fire was scaled accordingly.

The specific costs included in the facility fire model are outlined in Table A- 14 below:

Table A- 14: Breakdown of Facility Fire Costs (£)

Cost Element	Cost	Description	Source
Fire Services	£310	per hour and dependent on the number of fire trucks attending	Eunomia and ESA, "*Cutting Li-Ion Battery Fires in the Waste Industry*", 2021. Adjusted for inflation.
EA Attendance	£141	Per hour	Eunomia and ESA, "*Cutting Li-Ion Battery Fires in the Waste Industry*", 2021. Adjusted for inflation.
Machine and plant damage	£3,900,000	Assumed to represent a category 1 level fire reduced by the severity impact factors.	Eunomia's Interview with a waste management operator, 2024. £3.9 million represents a severe fire requiring £2.5 million for plant

[110] National Fire Chiefs Council, "Over 1,200 battery fires in bin lorries and waste sites across the UK in last year", 2024. Last Accessed November 14th.
[111] Eunomia and ESA, "Cutting Li-Ion Battery Fires in the Waste Industry", 2021. Last accessed 4th November 2024.

			replacement and £1.4 million for building repair.
Content/stock damage	£195,000	Represents 5% of the total property damage costs, scaled down by impact factor.	Home Office, 2024. Economic and Social Cost of Fire[112]
Business Interruption	£195,000	Represents 5% of the total property damage costs, scaled down by impact factor.	Home Office, 2024. Economic and Social Cost of Fire[113]
Loss of profit dealing with fire	£10,000	Per day of fire, scaled up by impact factor	Eunomia's Interview with a waste management operator, 2024.
GhG Emissions	£270.9	Per tonne of waste burnt	Eunomia and ESA, "*Cutting Li-Ion Battery Fires in the Waste Industry*", 2021. Adjusted for inflation.

The costs outlined above, adjusted by fire severity impact factors, yield a total cost per fire, as shown in Table A- 15. From 2026 onwards, all recycling facility fires are expected to be limited to severity level 3 and 4, as SMW and portable batteries will be stored separately at recycling facilities. This containment strategy is anticipated to isolate any fire incidents to specific facility sections, making them easier to control and extinguish. These per-fire costs are then multiplied by the projected number of fires at facilities between 2026 and 2036 across Options 1–3. This calculation provides an estimate of the potential cost reduction in facility fires due to the implementation of SMW collections.

Table A- 15: Total Cost of Waste Facility Fires by Fire Severity (£/fire)

Severity 1	Severity 2	Severity 3	Severity 4
£4,989,426	£2,410,511	£1,156,242	£118,063

Vehicle Fire

To estimate costs associated with vehicle fires, severity impact factors were assigned to reflect varying levels of fire damage. These severity levels are applied proportionally across vehicle fire incidents, with each level adjusting total costs according to the extent of damage. The severity levels are scaled as follows:

- Severity 1 (1.0): representing total vehicle destruction, where the entire truck requires replacing.
- Severity 2 (0.7)

112 Home Office, "Economic and social cost of fire", 2023. Last Accessed 4th November 2024.
113 Home Office, "Economic and social cost of fire", 2023. Last Accessed 4th November 2024.

- Severity 3 (0.4)
- Severity 4 (0.1): Represents minimal damage, affecting only a small portion of the vehicle or limited to burning of material within the vehicle.

The costs calculated for each vehicle fire incident include the following:

Table A- 16: Breakdown of Vehicle Fire Costs

Cost Element	Cost	Description	Source
Fire Services	£310	per hour and dependent on the number of fire trucks attending	Eunomia and ESA, "*Cutting Li-Ion Battery Fires in the Waste Industry*", 2021. Adjusted for inflation.
EA Attendance	£197	Per hour	Eunomia and ESA, "*Cutting Li-Ion Battery Fires in the Waste Industry*", 2021. Adjusted for inflation.
Vehicle Replacement	£500,000	Per fire	Eunomia's Interview with a waste management operator, 2024. Based on the CAPEX for new compacting vehicles.
Content / stock damage	£25,000	10% of the total vehicle damage cost, representing loss of material inside the vehicle	Home Office, 2024. Economic and Social Cost of Fire[114]

For fires affective the vehicle itself, severity impact factors are applied to each of these unit costs to reflect the range of possible damage. The total cost per fire on vehicles is shown in Table A- 17.

These per-fire costs are then multiplied by the projected number of fires on vehicles between 2026 and 2036 across Options 1–3. This calculation provides an estimate of the potential cost reduction in vehicle fires due to the implementation of SMW collections, combined with facility fires.

Table A- 17: Total Cost of Waste Vehicle Fires by Location and Fire Severity (£)

Location of Fire	Severity 1	Severity 2	Severity 3	Severity 4
Fires on Vehicles	525,507	367,855	210,203	52,551

[114] Home Office, "Economic and social cost of fire", 2023. Last Accessed 4th November 2024.

A.2.0 Research Approach

The following section describes the approach that underlies this research. It uses a mixed method approach including desk-based research and interviews with industry stakeholders to provide a picture of the factors affecting the costs and benefits of SMW waste management and SMW- and/or portable battery-related fires in the UK today.

Aims

The aim of the desk-based research was to gather qualitative and quantitative data to address a number of the key research questions, including:

- What are the rates, locations and causes of waste fires?
- What are the costs of waste fires and to whom?
- What are the non-monetary impacts of waste fires?
- What are the drivers and barriers to offering kerbside SMW collections, including adapted DMR rounds or separate pass rounds?
- What are the costs associated with kerbside SMW collections?

A.2.1 Literature review

An initial search to capture available literature on the topic of waste fires and SMW collections was conducted. Sources sought were relevant reports, industry websites, government data. The principal sources identified were:

- Material Focus report on kerbside collection for waste electricals;[115] and
- Defra's WEEE consultation Impact Assessment.[116]

A total of 49 sources were found and catalogued in a database.

Freedom of information (FOI) requests were utilised. All requests related to battery waste fires can be found online.[117] As an example, one was sent to the London Fire Brigade to request relevant data. The FOI response was received and relevant data was incorporated into the options modelling.[118]

A.2.2 Interview Approach

Semi-structured interviews were carried out among a selection of stakeholders that responded to interview requests. The purpose of the interviews was to supplement and corroborate the findings of desk-based research and the options modelling analysis. The stakeholders interviewed included:

- Four waste management operators; and

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[115] Material Focus. "Kerbside Collections for waste electricals", 2022. Last Accessed 12th November 2024.
[116] DEFRA, "Reforming the UK producer responsibility system for waste electricals: Impact Assessment", 2023. Last accessed 4th November 2024.
[117] mySociety. "What Do They Know", last accessed 22nd October 2024.
[118] London Fire Brigade, "Freedom of Information request reference number: 9122.1", 2024. Last accessed 25th November 2024.

- One local authority.

Outreach to more waste management operators and local authorities was conducted but did not result in interviews. Research was conducted to identify other relevant stakeholders for interview including fires services and local authorities. The method for identifying these stakeholders included desk-based research, internal discussion with Eunomia experts and identification of contacts. Ten additional stakeholders were identified and sent invitations for interview, with just one responding and agreeing to interview.

A topic guide was drafted to outline the key research areas and questions to be asked during interview. Eunomia conducted 30-45-minute interviews via MS Teams. Interviews were recorded for note-taking purposes with permission from participants. Participation and confidentiality agreements were made verbally and confirmed via email after interview. Follow up transcripts was sent with a summary of key points and data discussed. Interviewees were given 5 working days to redact or correct any information shared, with no response accepted as confirmation of the information provided and permission to use it for this research.

Interview notes were written and compared, with key data points extracted for use in the options modelling. Key qualitative points were extracted and used throughout the report.

A.2.3 Limitations

There are important limitations to this research. As this is a relatively small-scale study, the results should not be seen as capturing the full spectrum of drivers and barriers of SMW collections, nor the full spectrum of impacts of waste fires.

Sample size: Given the small sample size, the analysis focuses on the overall results and does not try to compare results by geographic region. Future studies should consider expanding the sample and ensuring it is more geographically diverse, which would enable interesting comparisons of drivers and barriers based on organisation or local authority type.

Selection bias: Interviews were conducted with one person from each organisation. While the interviewees' responses were fact checked where possible, many elements discussed and presented in this report inevitably remain subjective by nature. Thus, some statements may reflect a particular perspective of the individual interviewed.

Stakeholders were likely to respond if the research questions were related to challenges their organisation had experienced, for example, if their organisation had suffered damage due to waste fires. The research presented may therefore be skewed towards those that have experienced bigger negative impacts of waste fires. Similarly, only one local authority responded to our request for interview, an authority that offered an on-demand kerbside SMW collection. The research presented may therefore be skewed to local authorities that have fewer barriers to offering an SMW collection.

Prioritisation: Given the above limitations, factors not identified through this research should not be dismissed as less important. The relative importance of certain costs and benefits were discussed during the interviews, however, it is important to keep in mind that these assessments are subjective and cannot provide a comprehensive and objective overview of the factors impacting waste fires and kerbside SMW collections.

Causes of waste fires: Finally, the causes of waste fires are notoriously difficult to pinpoint, and thus it can be difficult to know with certainty whether increasing kerbside SMW collections would have a notable impact on the incidence of waste fires.

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