An evaluation of suitable metrics to measure the success of the UK's waste electricals and batteries system

Final report

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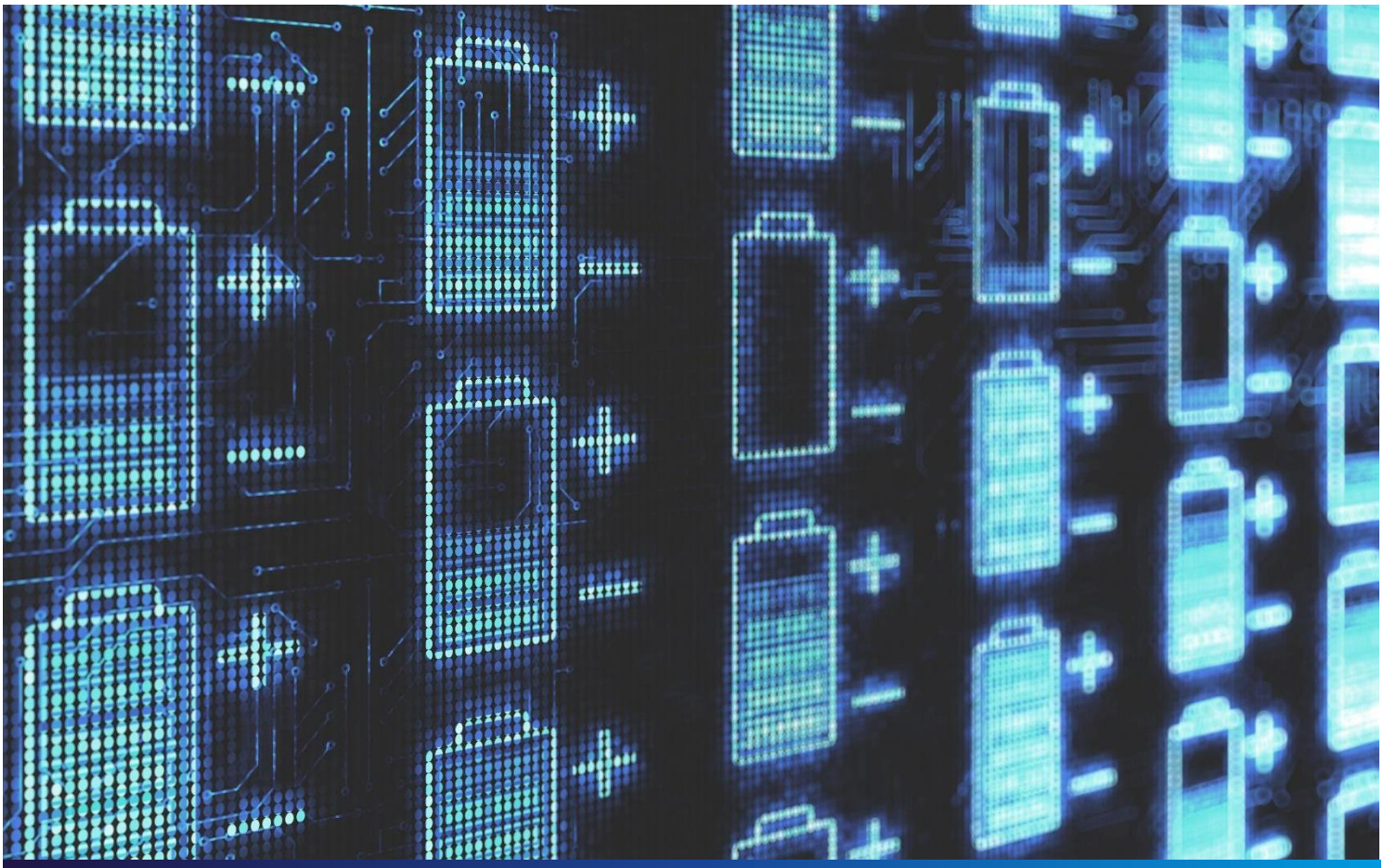
MATERIAL FOCUS



AN EVALUATION OF SUITABLE METRICS TO MEASURE THE SUCCESS OF THE UK'S WASTE ELECTRICALS AND BATTERIES SYSTEM

Consultation Analysis

Report for: Material Focus

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EXECUTIVE SUMMARY

INTRODUCTION

The current UK producer responsibility regulations for Waste Electrical and Electronic Equipment (WEEE) and for Waste Batteries, require the producers of electricals and batteries to report what they placed on the market by weight and by type of product as the basis for defining their legal obligations for financing take-back and recycling at the product's end-of-life. The UK government sets collection and recycling targets - an annual set weight of Household WEEE target and an ongoing percentage target of the weight of portable batteries placed on the market. These regulations require producers (in most cases via compliance schemes) to be responsible for financing the cost of collection, treatment, recycling and recovery of waste electricals and batteries. The current regulations are focused on how much is recycled, with limited consideration of waste reduction, reuse, repair, and refurbishment. Weight-based targets overlook the importance of circular design (designing out waste and pollution whilst keeping products in use for longer), changes in design due to technological advances, the development of service rather than product business models, and the efficiency and quality of the recycling processes and their material outputs.

Material Focus commissioned Ricardo Energy & Environment (Ricardo) to deliver a research project, titled: "A research and evaluation of suitable metrics to measure the success of the UK's waste electricals and waste portable battery systems" (metrics). The metrics project has identified new and additional measures that could be monitored and used to improve the understanding of the level of circularity in the UK's waste electricals and waste portable batteries systems, supporting the sector to expand its focus. Implementing these metrics would give a ***more accurate and holistic view of the performance of the system in moving towards a circular economy***. This improved view includes understanding how effectively waste electricals and portable batteries are being collected for recycling (and reuse), and the value that is being lost from the circular economy (e.g., to landfill, incineration, and other channels). These metrics could be used by stakeholders to help make informed interventions to drive further circularity in the sector. Metrics that can be measured now have been prioritised and recommended. Possible future metrics have also been flagged for consideration.

METHODOLOGY

To ensure that a comprehensive approach was taken, the project was divided into two stages.

Stage 1 – Developing a Longlist of Potential Metrics

1. The first stage of this project was to develop a longlist of potential metrics to measure circularity more accurately in the UK waste electricals and batteries system. Ideas for these metrics were initially informed through a ***literature review*** of key publications and knowledge from previous studies.
2. This was further supported by a ***stakeholder questionnaire*** sent out to a range of stakeholders via Material Focus' advisory panel – to directly engage and gather ideas from stakeholders across the system for new/alternative metrics.

Stage 2 – Shortlisting Metrics for Implementation

1. Following this, the metrics were initially assessed both ***quantitatively and qualitatively*** to produce an initial shortlist of metrics most pertinent to driving circularity.
2. ***Stakeholder interviews*** were conducted to gather views on the shortlisted metrics and to understand how they could be implemented in practice.
3. Ricardo then collaborated with Material Focus to agree on a ***Final Shortlist*** for recommendation, which best matched the original objectives of the project.
4. The insight gained from the stakeholder interviews was then used to develop ***data collection plans*** for each of the key shortlisted metrics.

The final list of metrics and an overview of the requirements for implementation is presented in Table 1 below:

Table 1: Overview of suggested shortlisted metrics and benefits to drive circularity in the UK waste electricals and batteries system

Metric group	Final Metric Title	Metric Description	Benefits
Product flows	**Ongoing reporting of new EEE and batteries placed on the market by quantity in addition to weight.** *(Original Title: New EEE and batteries placed on the market and by channel sold.)*	At present, weight is already being used as a metric in the UK waste electricals and batteries system. This metric adds reporting by quantity/item type.	• Supports understanding of the relationship between initial sales and future returns of items (for reuse and recycling). • Greater understanding of changes in type/weight of products placed on the market, relative to the stream e.g., down or up-weighting of existing products or the impact of new products introductions. • Will support understanding of future Circular Economy requirements by product stream, which will allow for the design and introduction of effective relevant legislation.
	New national material recovery rates reporting system. *(Original Title: Recycled electricals and batteries and Quantity/efficiency of material recovery from WEEE/WPBs.)*	Will ensure comprehensive reporting of all recovered materials (by weight) obtained from approved and authorised UK waste electrical and battery recycling centres (AATFs and ABTOs respectively). This would be enabled through a new national material recovery rate reporting system.	• Full reporting of recovered materials will drive greater understanding of the efficiency of the UK system and allow focus on specific materials, prioritising those of most benefit to a Circular Economy. • Will enable understanding of ongoing progress within the sector. To be effective this would require legislation.
	Establishing a national tracker to better understand consumer hoarding of electricals and batteries. *(Original Title: Hoarded electricals and batteries.)*	Will build up a better picture of the scale and type of hoarding behaviours of electrical and battery consumers in the UK system. Establishing a national tracker and survey to better understand consumer hoarding of electricals and batteries would support the implementation of this.	• Will ensure a more detailed understanding of where waste electricals and batteries are being 'lost' in the UK system. • Ongoing monitoring by this metric will assist in determining interventions, such as consumer communications as well as the effectiveness of these interventions.
	Establishing a national tracker to better understand consumer binning of electricals and batteries. *(Original Title: Binned electricals and batteries.)*	Establishing a national tracker to better understand consumer binning of electricals and batteries. This will be achieved through waste composition analysis.	• More detailed understanding of where waste electricals and batteries are being 'lost' in the system. • Continuous monitoring will support effective interventions, such as geographically targeted consumer communications.
Disposal options	**Establishing a national system to record the number and type of drop-off points for used EEE/Batteries and WEEE/WPB.** *(Original Title: Number of drop-off points.)*	Establishing a national system to record the number and type of drop-off points for used and waste electrical and batteries across the UK.	• Further understanding of consumer access to reuse, repair and recycling options and ongoing changes • In combination with other metrics, this will target interventions and resources on effective consumer solutions. This is hoped to be achieved by voluntary action rather than a mandatory approach.
	Establishing a national system to record the availability of household collection services for WEEE and WPB. *(Original Title: Availability of household collection services.)*		
Consumer perceptions	**Establish a national tracker to measure consumer awareness across a number of data points.** *(Original Title: Various questions on awareness and ease of supporting a circular system (nine initial questions suggested).)*	Establish a national tracker and regular survey to continuously monitor consumer awareness around key topics to move towards a circular economy in the UK waste electricals and batteries system. This would be addressed across several data points, for regular review.	• Aid understanding of overall consumer comprehension of various topics important to furthering Circular Economy activity within the consumer electricals and battery sectors. • Changes in consumer understanding will support the planning and monitoring of targeted interventions.

CONCLUSIONS

The benefits of the shortlisted metrics to a transition to a circular economy are:

1. Greater accuracy and granularity of key data across the UK waste electricals and batteries systems.
2. An increased understanding and ongoing tracking of consumer attitudes and behaviours to waste electricals and batteries in the UK.

The metrics identified will provide information that can assist in targeting useful activities and interventions to improve the systems. Greater understanding of consumer behaviours can assist effective intervention activities. The metrics recommended will deliver the most comprehensive understanding of electrical and battery flows outside of the circular economy performance of the system to date.

Additional metrics were identified which would enhance the objective to achieve a circular economy in the UK electricals and batteries sectors. Whilst these were not proposed for implementation in the scope of this report, they should be considered in the future. These include the following:

- CO_2 emissions of the sector – a significant and complex piece of work but useful for identifying environmental hotspots.
- Promotion and measurement of donation, repair, and reuse – key for highlighting importance of reuse and repair; requires major system changes to facilitate access to data.
- Success of digital inclusion programmes – considers both environmental and social impacts, demonstrating the holistic benefit of the circular economy.

It is estimated that the minimum total cost to implement all the proposed metrics across all regions of the UK is in the order of **£170,000/year**

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GLOSSARY

Acronym	Meaning
AATF	Approved Authorised Treatment Facility
ABE	Approved Battery Exporter
ABTO	Approved Battery Treatment Operator
AE	Approved Exporter
BATRRT	Best available treatment recovery and recycling techniques
BFRs	Brominated flame retardants
CRT	Cathode-ray tube
DCF	Designated Collection Facility
EA	Environment Agency
EEE	Electrical and Electronic Equipment
EPR	Extended Producer Responsibility
GHG	Greenhouse Gases
HWRC	Household Waste and Recycling Centre
LCA	Life Cycle Assessment
LCD	Liquid-crystal display
LDA	Large Domestic Appliances
LED	Light Emitting Diode
LA	Local Authority
MFA	Material Flow Analysis
PB	Portable Battery
POPs	Persistent organic pollutants
SWM	Small Mixed WEEE
WEEE	Waste Electrical and Electronic Equipment
WPB	Waste Portable Batteries

LIST OF TABLES AND FIGURES

1 INTRODUCTION

1.1 CONTEXT

The "The Waste Electrical and Electronic Equipment Regulations 2013 (SI 2013.3113)" ('the Waste Electrical and Electronic Equipment (WEEE) Regulations') ensure that producers of Electrical and Electronic Equipment (EEE) in the United Kingdom finance the cost of collection, treatment, recycling, and recovery of that equipment when it becomes waste [1]. These regulations outline collection, recycling and reuse targets that must be met, with national UK data being published annually to report and monitor the effectiveness of this system. Currently, this data focuses on the weight of electrical products that have been placed on the UK market and the weight of waste electricals collected in the UK. Additional data is collected on the receipt of waste electricals at Approved Authorised Treatment Facilities (AATFs) or approved exporters (EAs) as well as where reuse of waste electricals has been undertaken. This data acts as the baseline for the UK Government to determine whether the UK's waste electrical recovery targets have been effectively achieved. Producer compliance schemes (PCSs), funded by their Producer members, are responsible for registering their Producer members annually and for meeting the collection and recycling obligations of these members under the WEEE regulations. These regulations cover both household and non-household electricals.

Whilst the UK is no longer part of the European Union (EU), the UK's WEEE Regulations were driven by and aligned with the requirements of the EU WEEE Directive (2012/19/EU), which sets legal requirements on individual Member States for the collection and treatment of waste electricals [2]. Due to this historical alignment, the UK system is underpinned by the need to achieve weight-based targets for collection (which are set annually by DEFRA).

The UK's system for waste portable batteries holds similar design characteristics and features as for WEEE, through the "Waste Batteries and Accumulators Regulations 2009" [3]. Its requirements are also heavily influenced by the EU's "Batteries and Accumulators and Waste Batteries and Accumulators Directive (2006/66/EC)" and the ambition of meeting weight-based targets [4]. National data is currently being recorded based on the weight of portable batteries placed on the market each year and the weight being collected by compliance schemes. Additionally, there is a requirement for retailers selling >32kg portable batteries per year to offer free collection points on site for various battery types.

Monitoring and reporting of waste management performance in terms of weight has historically been the primary tool for developing a high-level picture of how waste electricals/waste batteries are collected, transported, treated and/or exported. However, the existing approach of setting weight-based targets for waste electricals and waste batteries may not be the most effective means of measuring success as the system moves towards a circular economy. In recent years, weight-based indicators have been challenged for various reasons. Criticisms include the following [5]:

- Not taking full account of the overarching environmental benefits or impacts of the associated activity (e.g., carbon/GHG emissions from transporting or recycling material).
- Not aligning with the circular economy waste hierarchy - with the reduce, reuse, repair and refurbish messages often neglected with a focus on recycling opportunities.
- Focusing on quantity (to achieve weight targets), meaning that quality is often compromised with low quality and/or contaminated materials being sent for recycling.
- Focusing on end-of-life, which does not incentivise circular design of electrical/portable battery products (such as design for disassembly and reusability).
- Not considering technological advances and the product weight changes associated with these. (An historic example being the reduction in typical TV weights with transition from CRT to LCD and LED over the past 20 years.)
- Changes in material types and composition in electricals/portable battery design. For example, small domestic appliances often have significant use of plastics and metal casings, but sometimes minimal electronics. This can impact findings and even recyclability of the items.

Moving towards a circular economy requires the sector to expand its focus beyond recycling and towards more value-adding opportunities, such as reuse/repair/refurbishment. It also requires all stakeholders across the UK waste electricals and waste batteries system to think differently about how to improve environmental performance across the value chain and how to effectively measure success [5]. Since the release of the "Resources and Waste Strategy for England" in 2018, several new methodologies and metrics have been

proposed by DEFRA [6], for instance, suggestions concerning the implementation of material specific WEEE targets for recyclers. However, these have still been mostly weight-based [7].

1.2 AIMS AND OBJECTIVES

Ricardo Energy & Environment (Ricardo) has been commissioned by Material Focus to deliver this research project, titled: “A research and evaluation of suitable metrics to measure the success of the UK’s waste electricals and waste portable battery systems” as part of the “Material Focus Insights Program”.

Material Focus is an independent not-for-profit company behind the UK-wide ‘Recycle Your Electricals’ campaign, with the aim of ensuring that valuable electricals (and their constituent materials) are never wasted.

Ricardo Energy & Environment (Ricardo) are a UK-based global environmental and technical engineering consultancy business with in-house engineering capability. Governments, public agencies, and businesses around the world trust Ricardo’s deep expertise in solving some of the most complex environmental challenges.

This project’s deliverables are to identify enhanced existing and additional metrics that may be used to support the UK waste electricals and batteries system and which, in combination, may be used to give a much ***more accurate and holistic view of the performance and success of the system in moving towards a circular economy***. This should include how effectively waste electricals and waste portable batteries are being collected for recycling and reuse versus being lost from the circular economy (e.g., to landfill, incineration, and other channels).

The following key objectives were agreed for this project. These were to be achieved whilst engaging with existing and new stakeholders from the UK waste electricals and batteries system value chains throughout the project.

- To identify new and alternative metrics for measuring the success of circularity in the UK waste electricals and batteries system. There was a particular focus on identifying metrics which:
    - May inform changes that could beneficially be introduced to the UK waste electricals and batteries system.
    - Have potential to be used as alternative or additional targets to the current weight-based targets.
    - Allow the measurement of impacts, both positive and negative, social, economic, and environmental.
    - Are practical in terms of the ease of implementation and cost of acquiring the data.
    - Have opportunities to work across sectors outside the waste electricals and batteries systems, where this could achieve greater synergy.
- To shortlist the most appropriate and feasible metrics for improving circularity in the UK waste electricals and batteries system from this longlist. Develop data collection plans for how these metrics could be implemented in practice (without fully implementing them). This to include:
    - Developing a data collection plan, whilst engaging with stakeholders.
    - Identifying key stakeholders for sources of the various data streams.
    - Estimating a cost to the system for the metric’s implementation.

2 METHODOLOGY

To ensure that a comprehensive and robust approach was taken to identifying and developing new and alternative metrics to measure circularity in the UK waste electricals and batteries system , the project was broken down into two distinct stages. These were as follows:

- Stage 1 – Developing a Longlist of Potential Metrics
- Stage 2 – Shortlisting Metrics for Implementation

2.1 STAGE 1 - DEVELOPING A LONGLIST OF POTENTIAL METRICS

Stage 1 of the project involved the development of a longlist of metrics (incorporating existing, alternative and new metrics) which could be used to measure the success of circularity in the UK waste electricals and batteries system . This was developed through an initial research phase, broken down into two streams – a desktop/literature research exercise and an initial stakeholder engagement exercise (via an online survey). These are outlined in further detail in the sections below.

2.1.1 Desktop research

Table 2: List of literature reviewed

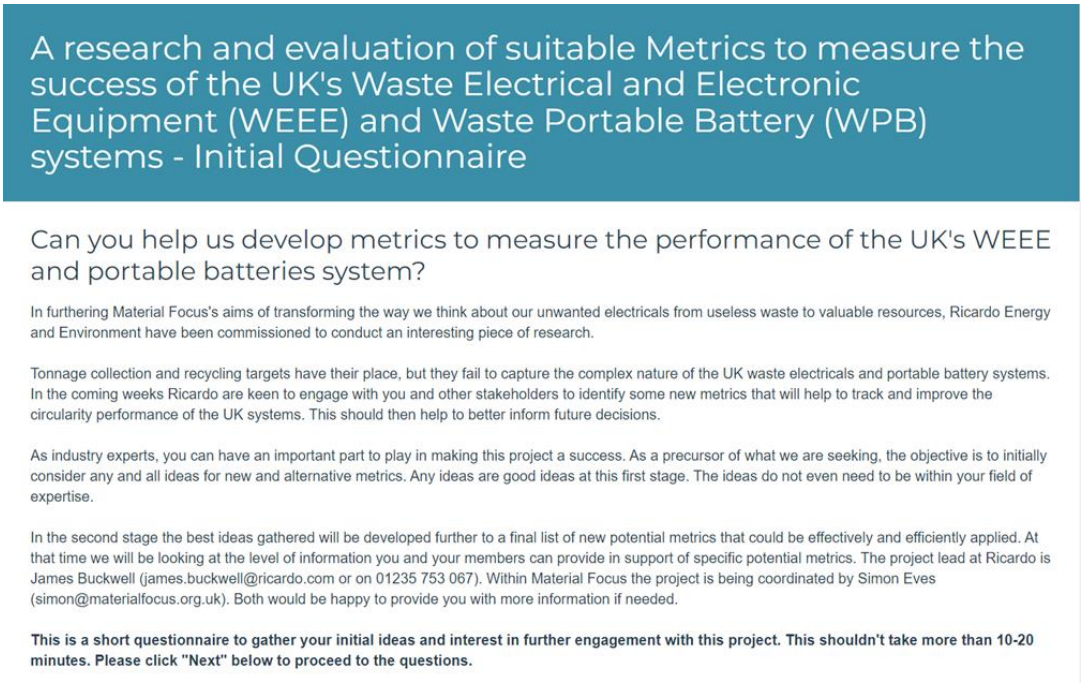
Title	Author	Link
Resources and Waste Strategy for England	DEFRA [6]	https://www.gov.uk/government/publications/resources-and-waste-strategy-for-england
Resources and Waste Strategy: Monitoring & Evaluation	DEFRA [8]	https://www.gov.uk/government/publications/resources-and-waste-strategy-for-england-monitoring-and-evaluation
Review of UK battery legislation	DEFRA [9]	https://randd.defra.gov.uk/ProjectDetails?ProjectId=20542
Making Things Last: A circular economy strategy for Scotland	Scottish Government [10]	https://www.gov.scot/publications/making-things-last-circular-economy-strategy-scotland/documents/
Beyond Recycling	Welsh Government [11]	https://gov.wales/beyond-recycling
Environment Strategy Consultation	DAERA NI [12]	https://www.daera-ni.gov.uk/consultations/environment-strategy-consultation
A Green Future: Our 25 Year Plan to Improve the Environment	HM Government [13]	https://www.gov.uk/government/publications/25-year-environment-plan
Electrical waste – challenges and opportunities	Material Focus, [14]	https://www.materialfocus.org.uk/report-and-research/electrical-waste-challenges-opportunities-2/
Business Electricals - challenges and opportunities	Material Focus	https://www.materialfocus.org.uk/report-and-research/over-200000-tonnes-of-business-electricals-are-currently-thrown-away-in-the-uk/

Ideas for new and alternative metrics were first identified then developed, and later categorised and reviewed. The potential metrics were categorised into two types (existing and new), a description of each metric, the unit of measurement, and the source where it was found or the idea for the metric originated from.

2.1.2 Stakeholder Engagement – Initial Metric Questionnaire

To complement the desktop research, and to ensure strong stakeholder engagement from the start of the project, a questionnaire was developed and distributed amongst key stakeholders in the UK waste electricals and batteries system. Primarily, this was achieved by approaching Material Focus' connections in the sector which included parties both within and outside of the UK system – to understand what learnings could potentially be taken from waste electricals/battery systems in other countries, which could be applied to the UK system. Representatives from the initial stakeholder list were then requested to promote the questionnaire to their downstream members to ensure maximum exposure and input from all stakeholder groups across the UK system. Figure 1 below displays a screenshot of the landing page for the questionnaire published and

Appendix 6.3, outlines the detail of the questions and context given in the subsequent pages of the questionnaire.



A research and evaluation of suitable Metrics to measure the success of the UK's Waste Electrical and Electronic Equipment (WEEE) and Waste Portable Battery (WPB) systems - Initial Questionnaire

Can you help us develop metrics to measure the performance of the UK's WEEE and portable batteries system?

In furthering Material Focus's aims of transforming the way we think about our unwanted electricals from useless waste to valuable resources, Ricardo Energy and Environment have been commissioned to conduct an interesting piece of research.

Tonnage collection and recycling targets have their place, but they fail to capture the complex nature of the UK waste electricals and portable battery systems. In the coming weeks Ricardo are keen to engage with you and other stakeholders to identify some new metrics that will help to track and improve the circularity performance of the UK systems. This should then help to better inform future decisions.

As industry experts, you can have an important part to play in making this project a success. As a precursor of what we are seeking, the objective is to initially consider any and all ideas for new and alternative metrics. Any ideas are good ideas at this first stage. The ideas do not even need to be within your field of expertise.

In the second stage the best ideas gathered will be developed further to a final list of new potential metrics that could be effectively and efficiently applied. At that time we will be looking at the level of information you and your members can provide in support of specific potential metrics. The project lead at Ricardo is James Buckwell (james.buckwell@ricardo.com or on 01235 753 067). Within Material Focus the project is being coordinated by Simon Eves (simon@materialfocus.org.uk). Both would be happy to provide you with more information if needed.

This is a short questionnaire to gather your initial ideas and interest in further engagement with this project. This shouldn't take more than 10-20 minutes. Please click "Next" below to proceed to the questions.

Figure 1: Screenshot of the landing page of the private link sent for the Stakeholder Questionnaire

The questionnaire was open to responses for circa one month to allow for individual follow-up and engagement with Material Focus/Ricardo over e-mail in the interim. In total 52 complete responses and 134 partial responses were received from stakeholders across a range of key groups within and outside the UK, including: Producer Compliance Schemes, Trade Associations, regulators, local authorities, recyclers, and producers.

2.2 STAGE 2 - SHORTLISTING METRICS FOR IMPLEMENTATION

2.2.1 Development of "Initial Shortlist"

Following this, the metrics were initially assessed quantitatively, using a scoring system which sought to rank their various circular benefits. However, upon review of the outputs of this process, it was decided that this was not the most effective approach to match the project objectives. Consequently, a qualitative assessment was used in collaboration between Material Focus and Ricardo to produce an initial shortlist of metrics most pertinent to driving circularity in the UK waste electricals and batteries system.

This involved the team firstly grouping the longlist of metrics into key subject areas, namely:

- Product flows.
- Disposal options.
- Environment and social impacts.
- Consumer perceptions.

To avoid biases and ensure integrity, additional conversations were carried out between Ricardo and Material Focus to agree upon the initial shortlist of metrics. A summary of the reasoning for some of the key metrics not carried forward to the Initial Shortlist is summarised in Table 3.

Table 3: Example metrics not included in initial shortlist and reasons for exclusion (not comprehensive)

Metric from Initial Longlist	Reasoning for not Progressing to Initial Shortlist
Use of critical materials	Further upstream in the value chain and ultimately less relevant to the key project objectives. Metrics should be more focused on what critical raw materials are coming out of the system rather than being put in.
Contribution of recycled materials to raw materials demand	
New material avoided	
Level of recycled content/recycled output for a particular EEE product.	
Penalties for improper disposal of WEEE/fly tipping	Highly dependent on level of enforcement and therefore not as effective as alternatives for understanding disposal.
Proportion of EEE manufactured containing Persistent Organic Pollutants (POPs).	Legislation has been in place to stop POPs in new electricals since 2007, so technically no “new POPs” should be coming into the system. Therefore, not as relevant to be included in the shortlist.
Estimated product lifespan of different EEE product types and batteries.	Very difficult to get accurate data for (particularly at the point of end-of-life) and not a priority in terms of measuring the circularity of the WEEE/WPB system.
Costof expenditure on research and development	Not as relevant as other metrics for measuring circularity in the system and in meeting the wider project objectives.

2.2.2 Stakeholder interviews

After the initial shortlist of metrics was created, a series of 11 interviews were undertaken with key stakeholders across the value chain of waste electricals and batteries. The stakeholders interviewed were selected from a group of questionnaire respondents who expressed their interest in further engagement with the project. The 11 interviewees were selected from this group to give an even spread across the various stakeholder groups. The key aim of these interviews was to gain a better understanding of the feasibility of each metric, in terms of ease of implementation and cost of acquiring the data. The 1-hour, semi-structured interviews were conducted online via Microsoft Teams. Interviews were carried out with representatives across the organisations outlined in Table 4.

Table 4: List of key stakeholders interviewed

Stakeholder group	Organisation name
Producer compliance schemes	WEEE Forum
	REPIC
Commercial waste collector/waste management company/AATFs	SWEEEP Kuusakoski
	WasteCare Ltd.
	Veolia
Retailers	Next
Charities/not-for-profits	Re-Use Network
	Material Focus
Local Authorities	Belfast City Council
	Devon County Council
Regulators/policymakers	DEFRA

For each interview, three of the initially shortlisted metrics were selected based on their relevance to the individual stakeholders’ activities. Appendix 6.1 highlights the list of the initially shortlisted metrics. These three selected metrics formed the basis of the conversation with each stakeholder; however, interviewees were also given the opportunity to discuss any other metrics of key importance or personal interest. For an overview of the key questions asked, please refer to Appendix 6.4.

2.2.3 Final Shortlist and Data Collection Plans

Following the interviews, feedback on the specific questions was assessed and key metrics were prioritised for the Final Shortlist recommended for implementation, together with associated data collection plans. Further detail on the reasoning for carrying metrics forward to this stage is outlined in the subsequent report sections.

3 DETAILS ON INITIAL SHORTLIST

This section presents the key findings from engaging with stakeholders via the survey and semi-structured interviews. For each metric that was initially short-listed, a high-level overview is given alongside a detailed SWOT analysis and reasoning for its inclusion or exclusion in the final shortlist.

3.1 PRODUCT FLOWS

3.1.1 New EEE and batteries placed on the market and by channel sold (measured in items and tonnes, by channel sold, including physical retailers, online marketplaces, households, and business, etc.)

This metric involves measuring the weight of new electrical products and batteries that are placed on the market (POM) each year, in terms of the associated tonnage, item type and channel sold.

For both electrical products and batteries, POM data is already being measured across the UK in tonnes, with a coarse level of granularity. Table 5 presents the existing categories for reporting electrical products POM and likewise Table 6 for batteries.

Table 5: Overview of existing reporting categories for electrical products POM[1] (UK Government, 2022)

Category	Electronics Categories
1	Large Household Appliances
2	Small Household Appliances
3	IT and Telecoms Equipment
4	Consumer Equipment
5	Lighting Equipment
6	Electrical and Electronic Tools
7	Toys Leisure and Sports
8	Medical Devices
9	Monitoring and Control Instruments
10	Automatic Dispensers
11	Display Equipment
12	Cooling Appliances Containing Refrigerants
13	Gas Discharge Lamps and LED Light Sources
14	Photovoltaic Panels

Table 6: Overview of existing reporting categories for portable batteries POM (UK Government, 2021)

Category	Portable batteries
1	Lead-acid
2	Nickel-Cadmium
3	Other

In relation to batteries specifically, the National Packaging Waste Database publicly reports upon the weight of portable batteries POM by large producers quarterly (while final data is published annually), however this offers only high-level data. As a result, DEFRA is considering ways to improve this metric through adopting a

[1] Although categories 1 and 2 include 'household' in the title, all the categories cover both household (B2C) and non-household (B2C).

more granular breakdown on a voluntary basis in the UK. This would include splitting the POM data by batteries that are supplied loose and batteries that are included in products.

The POM data that is reported for portable batteries is available on the National Packaging Waste Database (NPWD) [15]. This data splits the tonnage of batteries produced between each compliance scheme as well as small producers. 2021's data is presented in Table 7 below:

Table 7: Overview of POM data for portable batteries (2021)

UK compliance scheme	Pb/acid	Ni-Cd	Other	Total
BatteryBack	248	75	13683	**14005**
Ecosurety	440	35	5247	**5723**
ERP UK Ltd	145	27	13013	**13184**
REPIC eBatt	104	17	1756	**1877**
Valpak Ltd	422	35	8227	**8684**
Sub Total	**1359**	**189**	**41926**	**43474**
Small Producers	11	8	126	**145**
Total	**1369**	**197**	**42052**	**43619**

Though the publicly available data is high-level, it is understood that producers maintain more detailed internal reporting. In a 2021 review of the UK's battery legislation, Ricardo obtained 33 sets of data from compliance scheme members that were used to estimate a more detailed breakdown of battery types [9]. The estimated quantities from 2020 are found in Table 8 below:

Table 8: Estimated quantities of batteries POM in 2020 (by battery type)

Battery type	Chemistry type	Actual quantity (in %)	Estimated quantity (in tonnes)
Non-rechargeable	Alkaline	88%	13,803
	Lithium	6%	976
	Zinc Carbon	4%	669
	Zinc Air	0%	1
	Mercury Oxide	0%	-
	Silver Oxide	0%	15
	Other	2%	345
	% of total portable	**39%**	**15,810**
Rechargeable	Nickel Cadmium	0%	79
	Lead	0%	92
	Nickel Metal Hydride	15%	3,699
	Lithium Ion	49%	12,348
	Lithium Polymer	29%	7,238
	Other	7%	1,722
	% of total portable	**61%**	**25,177**
TOTAL		**100%**	**40,987**

Some producers also record or estimate percentages of the channel through which the batteries were sold (i.e., online or in person), and whether the batteries are sold in packs or already integrated into electrical products.

For electricals and electronic equipment, data is collected by compliance schemes and the sum of this data is reported at a national level.[2] Through engaging with stakeholders and carrying out desk-based research, several further studies have been identified that have previously calculated electrical products POM flows in the UK. These are:

- UK EEE Flows [16]
- UK EEE Flow [17]
- Study on collection rates of waste electrical and electronic equipment (WEEE) [18]

Producers who place more than five tonnes of electricals on the UK market must register with a relevant compliance scheme while those who place less than five tonnes on the market should register with an environmental regulator. The categories that producers must report against are high-level, and one suggestion from stakeholders was to align with the Irish system of reporting, as is explored in greater detail in Section 4.1.1.

The main challenge with this metric regards the availability of data. As mentioned above, the categories that producers are required to report against are broad and outdated, and while internal reporting is often more granular, producers and compliance schemes are not required to publicly report this. Clear communication of the rationale and benefits of this approach, and maintenance of collaborative and supportive relationships between compliance schemes and their members, will enable high quality data to be obtained and analysed under the current system infrastructure.

While it is expected that producers will be capable of reporting data in quantities, administrative pressures and unwillingness to share this information means it is unlikely to be made available universally on a voluntary basis. As a plan B option, the use of conversion factors could be considered. However, these estimates will lower the accuracy of the output. This will not be an issue if a regulatory approach were to mandate the reporting of more detailed information.

Figure 2 presents a SWOT analysis which includes all the key opinions expressed through the stakeholder interviews for this metric.

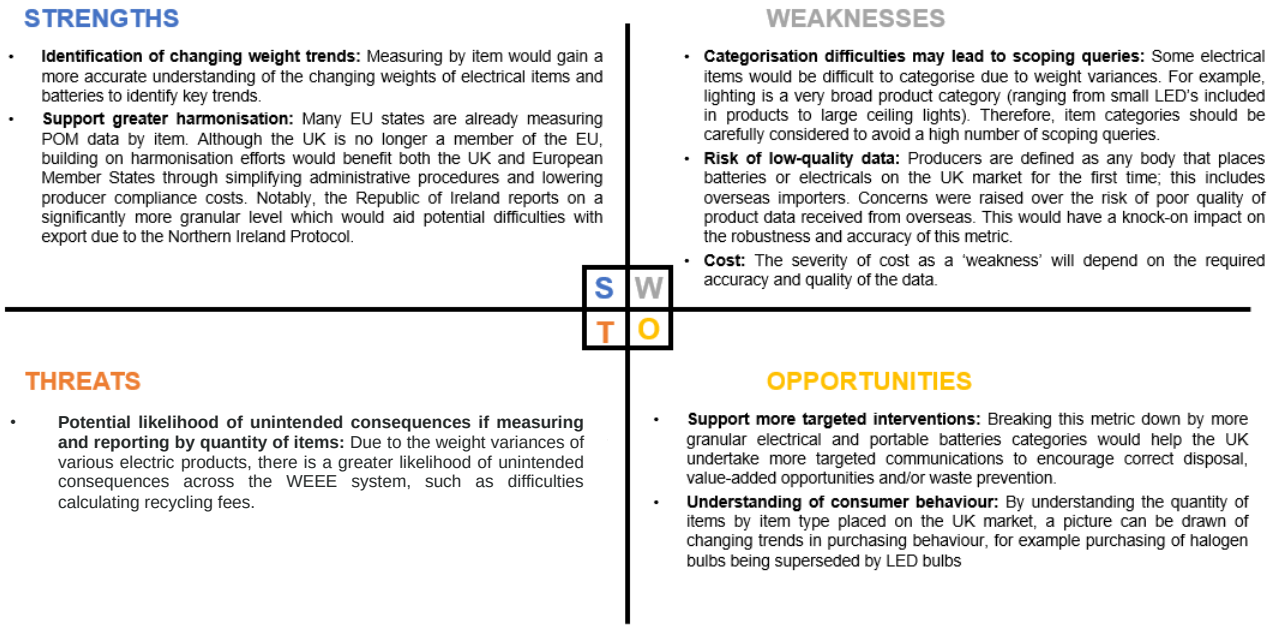


Figure 2: SWOT analysis for 'New EEE and batteries placed on the market (measured in items and tonnes, by channel sold)

Inclusion in final shortlist:

Based on the feedback received by the stakeholders interviewed and the results of the SWOT analysis, this metric was recommended for inclusion in the final shortlist, as it was seen as **essential to building up an accurate picture of the input to the UK waste electricals and batteries system – particularly with**

[2] Waste electrical and electronic equipment (WEEE) in the UK - GOV.UK (www.gov.uk)

monitoring changing weight trends for specific electrical products as the market develops. In addition to weight-based reporting, measuring by number of items would also support this. As with any change, concerns were raised, in this case over potential accuracy and misinterpretation of data as well as other possible unintended consequences. Expanding the granularity and type of reporting should not be undertaken before giving due attention to identifying such issues and suitably mitigating against them in parallel to maximising the long-term benefits the changes would provide to driving circularity in the systems.

Ricardo did not recommend at this stage to measure electricals and batteries placed on the market by channel sold. It was considered more important to focus on obtaining accurate data for items and tonnes, before adding additional mandated reporting requirements on stakeholders. However, understanding the channels through which electricals and batteries are primarily sold will be important in driving more targeted intervention activities, and several producers and retailers are already recording this data internally - even though it is not currently reported.

3.1.2 Used EEE and batteries sold by channel (measured in items and tonnes, including charity shops, online platforms, etc.)

This metric involves measuring the amount (weight and/or number) of used electricals and batteries that are re-sold on the UK market each year, through their various channels. This considers those items that have reached their ‘end-of-use’ but not their subsequent ‘end-of-life’. This metric is similar to the metric discussed in Section 5.1.3 on “Donated/reused electricals and batteries (measured in items and tonnes) and Repaired electricals and batteries (measured in items and tonnes)”. However, it differs in that, in this case, the items are exchanged for a monetary value. It is also expected that used electricals and batteries that are resold are often sold through online platforms including CeX, Facebook Marketplace, eBay, Amazon Refurb, Gumtree and Back Market.

It is proposed that the metric is implemented in terms of the tonnage sold, number of items by item type and items by channel sold. This metric was discussed with both retailers and reuse charities and the consensus was that most channels highlighted above currently have access to this data, at this level of detail. However, current reporting is not mandated and therefore is not consistent. There may therefore be inconsistencies between item categories used and methods of recording data which may make the overall data difficult to analyse. It was also highlighted that those stakeholders that are already required to report data on their contributions to the UK waste electricals and batteries system may be more well-equipped to collate and report the data required for this new metric, than those that have not previously needed to report (i.e., those stakeholders that are not producers). It was also raised that the identifying and gathering of data may be challenging for some players in the resale market, particularly when considering the large growth of this market and rate at which new players are beginning operation.

It was noted that online platforms like eBay, which are collaborating with reuse charities to improve the consistency of reused items sold on the platforms, already have access to much of the data required for this metric, however, since they are not formally accountable to the UK waste electricals and batteries system and there is no existing incentive for them to share this data, it was indicated that it is highly unlikely transaction data would be voluntarily provided. It was also mentioned that the readiness to voluntarily share this data would depend a lot on the size of the individual company and its ethos.

Figure 3 presents a SWOT analysis which includes all the key opinions expressed through the stakeholder interviews for this particular metric.

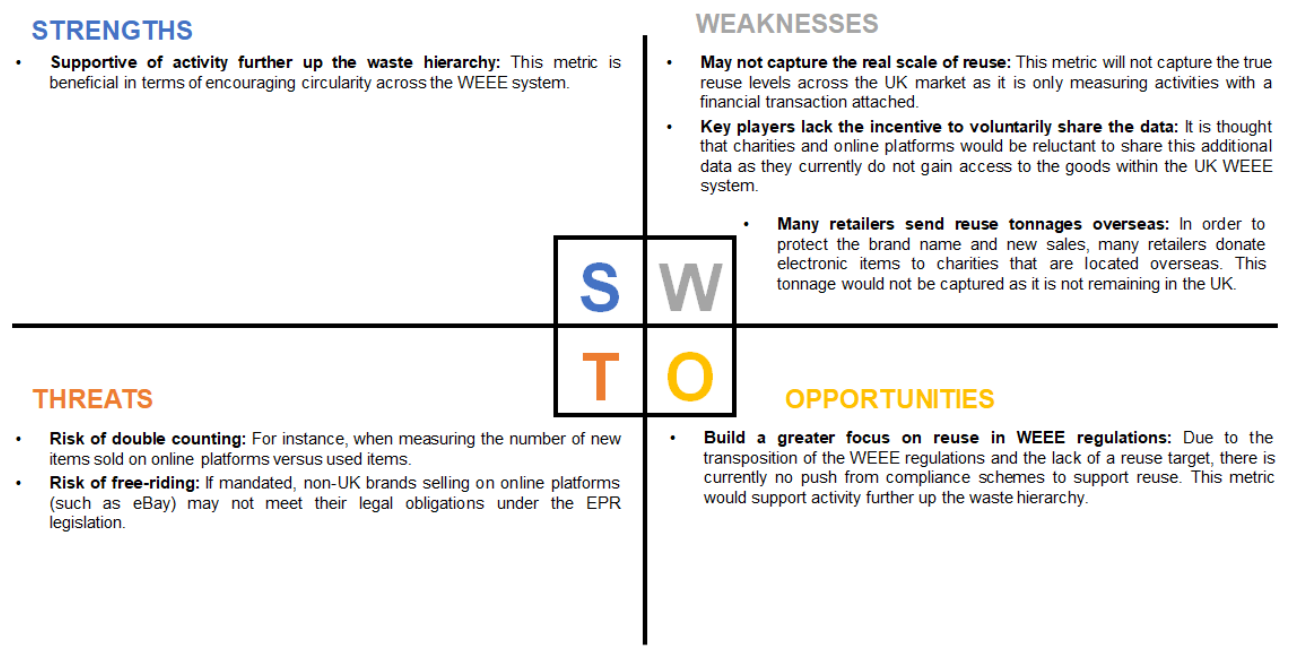


Figure 3: SWOT analysis for 'Used EEE and batteries sold by channel (measured in items and tonnes)

Inclusion in final shortlist: Not selected for inclusion

Based on the feedback received by the stakeholders interviewed and the results of the SWOT analysis, Ricardo proposed to not prioritise this metric for inclusion in the final shortlist. This is primarily due to the challenges in gathering the accurate and relevant data from the larger number of resale platforms, as well as the wider systemic changes needed to ensure consistency in reporting – which would almost certainly need to be mandated. This is in addition to the changes required to ensure that any items sold as "used" have been safely and competently tested and repaired where appropriate. Due to the additional socio-economic benefits and easier access to data, it would be recommended to prioritise the metric in Section 3.1.3 on "Donated/reused electricals and batteries (measured in items and tonnes) and Repaired electricals and batteries (measured in items and tonnes)", over this metric.

3.1.3 Donated/reused electricals and batteries (measured in items and tonnes) and Repaired electricals and batteries (measured in items and tonnes)

Metrics around the two circular economy "R-strategies" of "Reuse" and "Repair" were considered as priority for inclusion in the "Initial Shortlist" of alternative metrics to measure circularity in the UK waste electricals and batteries system. The primary reason for their inclusion was that both the "Reuse" and "Repair" themes are further up the hierarchy of the nine circular economy strategies than the alternative "Recycle" options - which the UK waste electricals and batteries system have been historically more focused upon. Reasons for their preferable use include the reduced energy consumption of these strategies versus recycling, as well as the wider social value and digital inclusion benefits presented to those individuals who receive donated and repaired items. This metric would include items repaired and reused by the original owner, and items donated, repaired and then re-used by a new individual.

It should be noted that the Initial Shortlist had these two metrics separated individually around the "Donation/Reuse" and "Repair" themes. Following discussions with leading re-use charities in the UK system it was highlighted that the "Donated/reused" metric should always be coupled with the "Repair" metric for electrical items – regardless of whether the item is retained by the original user or passed onto a new user. The key reasoning for this was that almost all electrical appliances will fail at some point, often with a single failure mechanism that, on repair, can significantly extend the life of the product. Obsolescence could also be in the form of gradual reduction in the item's function, sudden failure after a period of time, or aesthetic obsolescence (i.e., the item will become out of fashion, or the type of technology is no longer considered relevant to the user). Stakeholders indicated that in most cases a used electrical product/portable battery which

is passed on will require some level of repair (and/or testing) before it reaches its next point of use – even if the repair is minimal. This is primarily to assure that the item is in a safe, usable condition for the individual. It is extremely rare that people are found to pass on fully functioning, used electrical products/portable batteries without some sort of remuneration.

Examples of repairs that may need to be done to reused electrical/portable battery items, can include the following activities:

- Changing a motor brush
- Replacement or repair of cracked/damaged smart phone/tablet screen.
- Changing a bearing
- Changing a PCB/component part on a PCB
- Replacements of other mechanical or electrical parts
- Replacement of motors
- Replacements of cooker heating elements
- Re-gassing of fridges (i.e., putting gas back in due to gas venting from leak)

Reuse of any electrical item in all cases should come alongside a full test and repair, where the tests would guarantee both electrical safety and functional safety. Of course, reuse of electrical items should be encouraged – but only where the item is guaranteed as suitable and safe to reuse.

To address these safety concerns, the Reuse Network - a UK charity network connecting and supporting reuse charities across the UK to help them alleviate poverty, reduce waste, and tackle climate change – launched the “Fit for Reuse” initiative in September 2022 [19]. This website comprises up-to-date guidance for the safe repair and reuse of electrical and electronic equipment – see Figure 4 for the documentation currently available and soon to be launched. In doing so, they are diverting safe and usable goods from landfill and into the homes of local people in need, helping to tackle poverty and inequality. See below a quote from Craig Anderson, CEO of Reuse Network on Fit for Reuse:

> *“Thanks to Ecosurety and the judging panel, this grant funding will allow us to review, update and republish this guidance to ensure ongoing compliance with recent regulatory updates and standards, and to future-proof and be ready for the impact of eco-design and circular economy policy measures when they are put into practice.”*
>
> ***Craig Anderson***
> *CEO of Reuse Network*

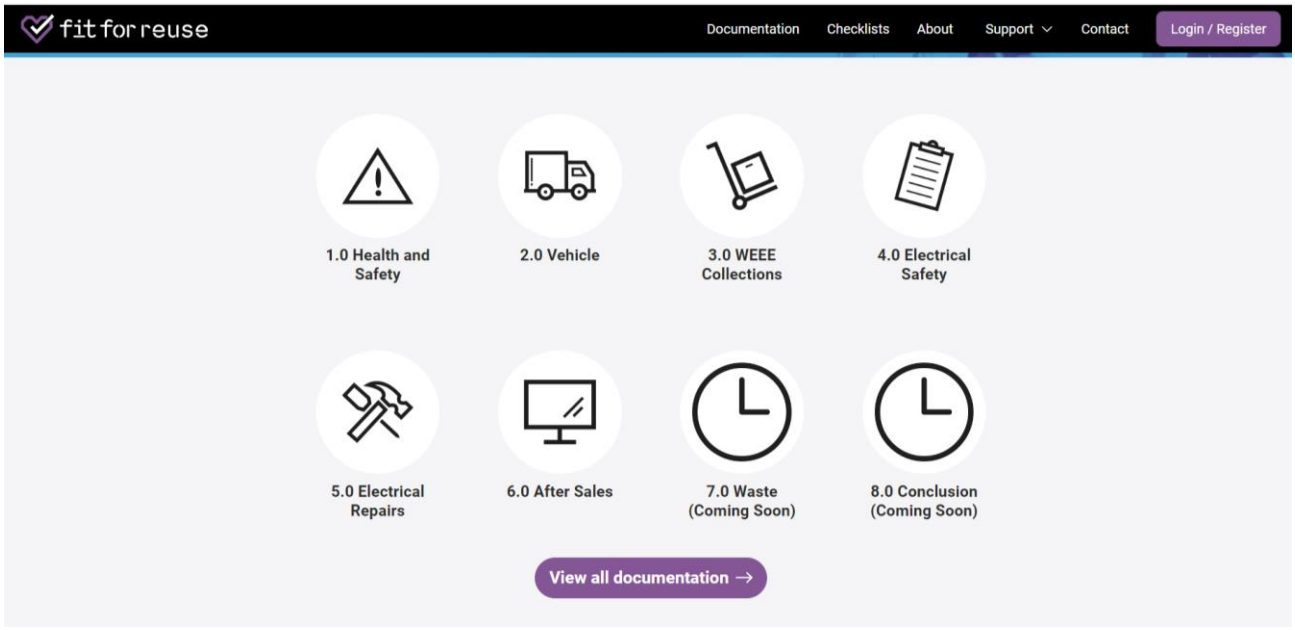


Figure 4: Screenshot from the front page of the Reuse Network's "Fit for Reuse" initiative

To systematically review the potential of this metric around donated/repaired/reused items for measuring circularity in the UK waste electricals and batteries system, Figure 4 below outlines a SWOT analysis for implementing a metric around these themes.

Figure 4: SWOT analysis for 'Donated/reused electricals and batteries (measured in items and tonnes) and 'Repaired electricals and batteries (measured in items and tonnes)

STRENGTHS

- **Moves away from recycling aspects, to more desirable CE strategies, further up the waste hierarchy – reuse and repair:** Historically, the UK WEEE/WPB sector has been focused on the recycling aspects of the circular economy. However, the most desirable strategies to support a circular economy are targeted at reducing consumption and this is what the focus should be on.
- **One of the strongest metrics in driving positive social and economic impact in communities** – Encouraging donation, repair and reuse up-skills communities to support a circular future. Re-use charities providing repaired WEEE, can allow low-income families to have access to electronics. Tools such as the Reuse Network's "Impact Calculator", have already developed models to correlate this to: households helped, household savings and CO_2 savings.

WEAKNESSES

- **Definition of waste is different between devolved nations:** The definition of waste will vary dependent on the devolved nation you are recording in. In Scotland, everything that is donated is waste. However, the definition of waste in England is different because of the "Thorn Trial" (see: Legal definition of waste guidance - GOV.UK). Therefore, *donated WEEE/WPB from householders* in England, Wales and NI is not considered waste and is considered as outside of the UK WEEE system. This means there would be no obligation for this data to be reported to the Environment Agency in these nations.
- **Lack of incentive to voluntarily share the donated "non-waste" data:** Re-use charities may be reluctant to share additional data as they do not currently gain access to, or benefit from, the goods within the WEEE system – which have the potential to be reused.

S W T O

THREATS

- **Risk of double counting:** The same product may be reused and repaired multiple times and there is no way to track this flow throughout the system.
- **Opposition from recyclers/AATFs:** An increase in reuse and repair could drive material away from where it would previously be sent for recycling. This would have a negative impact on the AATF business model and could result in opposition from the AATF community to this metric because of this.
- **Encouraging reuse of WEEE/WPB without testing/repair where needed could compromise circularity/social benefits** – Despite the enormous social and economic benefits of donating and re-using WEEE/WPB it is important that driving reuse does not encourage sharing of "unsafe" used electrical items.

OPPORTUNITIES

- **Build a greater focus on donation, repair and reuse in WEEE regulations:** Due to the transposition of the WEEE regulations and the lack of a reuse target, there is currently no push from compliance schemes to support reuse. Monitoring current and future reuse/repair activity would place a greater emphasis on these strategies.
- **Identification of focus areas for donation/reuse/repair:** The metric would help identify areas in the system where reuse/repair is working and where additional support or intervention is needed to encourage further donation/reuse/repair. This could be through public awareness campaigns, regulation or targeted funding to support the reuse sector.
- **Capturing data from informal donation/repair streams –** Implementing a metric focused on "donation, repair and reuse" would increase understanding on the extent of "informal" activity, in parts of the system where data currently may not be recorded and/or reported.

Inclusion in final shortlist: Not selected for inclusion

Despite both the reuse and repair metrics from the "Initial Shortlist" being considered as strong metrics to measure and drive circularity in the UK waste electricals and batteries system, they have not been suggested for inclusion in the final shortlist for this project. This is primarily because it is felt there are wider systemic changes that need to be addressed first – outside of the scope of this project – to ensure that the development of a robust data collection plan can be facilitated. However, we would like to highlight the feedback from this metric as part of the wider recommendations from the project.

Following discussions with leading reuse charities in the UK, the overarching challenge identified for the "reuse" metric was around the definition of waste when applied to donated items in England. If you donate an item to a reuse charity in England, it is considered that your intention is not to ultimately discard this item as waste. Therefore, it doesn't fall under the waste definition – it remains a product in the UK waste electricals and batteries system where there is no obligation to record this transaction. Although several reuse charities in the UK record this data internally, there is currently no incentive for reuse charities to share this data with the UK waste electricals and batteries system

Ricardo has recommended to group the "repair" metric of this alongside the "donated/reused" metric, and believe more work is needed to encourage, and potentially mandate the testing and repair of any donated waste electricals items intended for reuse. Specifically, the "repair" stage (with safety testing as a minimum), is recommended as a pre-requisite to consideration for the reuse of waste electricals or portable batteries. This would be particularly important for "Repair Shops/Cafes". Whilst the intention for driving circularity and social improvement is welcome, there is currently no regulation to ensure that the repair activities are carried out in a safe and consistent manner. Considering testing and repair (if needed) as a pre-requisite to reuse of waste electricals/waste portable batteries is essential in ensuring the wider socio-economic benefits of reuse are not compromised through the acquisition of faulty and potentially dangerous electrical items.

3.1.4 Hoarded electricals and batteries (measured in items and tonnes)

This metric explores the amount (weight and/or number) and type of electricals and batteries that are hoarded by UK households and non-households each year, i.e., those that are not being used but are not disposed of or donated. This would help to quantify the 'lost opportunity' in terms of the value of raw materials (such as gold, copper, aluminium and steel) that are effectively stored in unused products and which could alternatively be shifted to value retention processes (such as reuse, repair and/or material recycling). It is proposed that this metric is measured in items and tonnes.

Although following Ricardo's research and stakeholder engagement it has been deemed to be unfeasible to retrieve fully accurate data for this metric, it would be useful to quantify the 'lost opportunity' to the UK waste electricals and batteries system, as this represents a relatively little understood area of the sectors. Material Focus has previously worked with Anthesis to understand the waste electricals flows in the UK which included some discussion on hoarding, including the definition of hoarding that has been used for this report: "the time in storage when an electrical device (or battery) stops being used and before it is discarded, referred to as 'in storage' or 'hoarded'" [14]. This report estimated the weight of electricals being hoarded via a combination of previously conducted surveys and desk-based research, and Ricardo has deemed that the best method of data collection for this metric would be an annual survey that could be disseminated in the same way as Material Focus' Bellwether survey (discussed further in Section 3.2).

There are some challenges with this metric that largely centre around the need for consumer self-reporting and estimating scaled up quantities:

- There is a high risk of double counting. All hoarded items are items that will eventually be disposed of somehow; the main uncertainty is when and via what route. The survey should be designed to capture what quantity of hoarded electricals/portable batteries are disposed of each year.
- However, when asking respondents which of their previously hoarded items they have now disposed of, they may not remember, leading to undercounting. This is particularly true for portable batteries which may be hoarded in greater number than electricals like old phones or laptops until they are taken to a battery collection bin. There may be a need to add a time element definition to hoarding, due to the likelihood for consumers to stockpile batteries before taking them to a drop-off point.
- It will be difficult to gain an unbiased result from respondents when reliance is placed on self-reporting. If a respondent is reminded via this survey of the hoarded electricals they currently possess, they may be more likely to take these electricals to be disposed of and could under-report their hoarding to account for this.
- Scaling up the weight of hoarded electricals/portable batteries from a representative sample, while necessary for cost reasons, adds uncertainty to the results due to the necessity to estimate weights based on conversion factors. It will be necessary to update the weight conversion factors used to account for changing trends in electricals and battery weights.

Figure 5 presents a SWOT analysis which highlights the key opinions expressed throughout the stakeholder interviews for this metric.

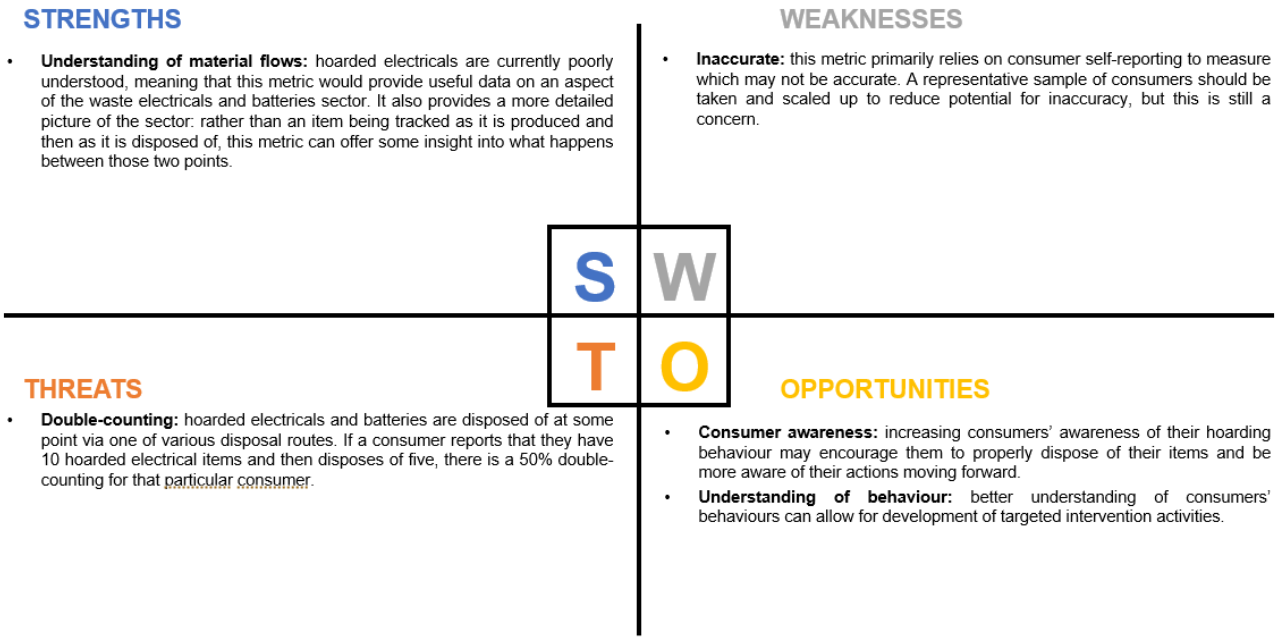


Figure 5: SWOT analysis for 'Hoarded electricals and batteries (measuring in items and tonnes)

Inclusion in final shortlist:

Based on the feedback received by the stakeholders interviewed and the results of the SWOT analysis, Ricardo proposed to include this metric in the final shortlist, since **it is essential to understanding a currently "hidden" waste stream in the sector**. The metric also offers an insight into consumer behaviour, particularly where consumers are asked to explain their reasons for hoarding - which may include lack of knowledge on safe disposal of waste electricals and batteries. Delivery of this metric presents the opportunity to better understand consumer behaviours and support identification of suitable interventions. By tracking hoarding trends year-on-year, the impact of interventions made to reduce hoarding may be assessed. Despite the challenges identified in accurately reporting on this metric, it is strongly interlinked with many other product flow metrics and can supplement understanding of the material flows in the sector.

3.1.5 Recycled electricals and batteries (measured in items and tonnes) and Quantity/efficiency of material recovery from WEEE/WPBs

This metric explores the amount (weight and/or number) of waste electricals and batteries that are recycled in the UK each year (in tonnes and items). It also aims to quantify the input and output fractions of the recycling processes to determine the recycling efficiency rate. It is important to mention that this metric is material specific. This means that it is not covering efficiencies relating to energy efficiency, emissions control, general waste management or water use.

It should be noted that the Initial Shortlist formerly had these two metrics included individually as *'Recycled electricals and batteries (measured in items and tonnes)'* and *'Quantity/efficiency/quality of material recovery from WEEE/WPBs'.* However, during the process of creating the data collection plan for each, it was decided to group the 'quantity' and 'efficiency' element of the latter metric with this metric. By grouping these metrics, we can better understand the real recycling activity across both UK systems, including what material is input and output. For information on the 'quality' aspect of material recovery of waste electricals/waste portable batteries, please see Section 4.1.2.

In relation to measuring recycling tonnages, AATFs already collect this information through the national protocols guidance developed by the EA for facilities that treat or transfer waste electricals [20]. This requires evidence of reuse or treatment by AATF's, alongside any export of whole appliances by an approved exporter. An AATF is obligated to issue evidence if the EEE has become waste in the UK, it is the first AATF to receive the waste electricals and it has received the WEEE from a product compliance scheme. Evidence is issued on

household waste electricals (B2C) and non-household waste electricals (B2B). Designated collection facilities (DCFs) collect waste electricals in the following six separate streams, outlined in Table 9.

Table 9: Overview of the six separate WEEE streams that DCFs collect

Stream	Description
A	Large domestic appliances (LDA)
B	Cooling appliances
C	Display equipment
D	Lamps
E	All other WEEE (normally called small mixed WEEE (SMW))
F	Photovoltaic panels

For streams A and E, there are specific protocols that AATFs must follow. The protocols provide an average percentage breakdown by category that can be applied to the total waste electricals received by the AATF for treatment from LA DCFs. For additional information on the SWM and LDA protocol, please refer to Appendix 6.5.

Similarly, to the 'New EEE and batteries placed on the market' metric, the fundamental basis of measuring the tonnage of waste electricals and waste batteries that are recycled each year is 'business-as-usual'. For waste electricals, current legislation requires AATFs to prove that they can achieve the recovery and recycling targets, which are presented in Table 10. Recycling is defined as the reprocessing of waste materials in a product process for reuse. Alternatively, recovery includes activities such as incineration with energy recovery, recovery of metal and metal components and recovery of inorganic materials (e.g., glass and plastic).

Table 10: Recovery and recycling targets for categories of WEEE (from 1st January 2019 onwards)

Category	Description	Recovery (%)	Recycling (%)
1	Large Household Appliances	85	80
2	Small Household Appliances	75	55
3	IT and Telecoms Equipment	80	70
4	Consumer Equipment	80	70
5	Lighting Equipment	75	55
6	Electrical and Electronic Tools	75	55
7	Toys Leisure and Sports	75	55
8	Medical Devices (with the exception of all implanted and infected products)	75	55
9	Monitoring and Control Instruments	75	55
10	Automatic Dispensers	85	80
11	Display Equipment	80	70
12	Cooling Appliances Containing Refrigerants	85	80
13	Gas Discharge Lamps and LED Light Sources	No target	80
14	Photovoltaic Panels	80	70

To report upon the above data requirements, AATFs maintain site input and output records of WEEE or WEEE-derived materials that are received and/or sent to a third-party site for recovery and recycling. According to the national protocols, the evidence needed to demonstrate that the targets have been met may vary depending on the WEEE category and treatment activity. For instance, with some mixed WEEE streams, it may be sufficient to assume all the metal content is recycled. A flow chart to follow is provided by the UK Government to prove how you have met these targets [21]. AATFs are required to complete a 'Actual recovery and recycling

rate template' each year [22]. One of following methodologies can be adopted to calculate recovery and recycling rates:

- Mass balance data.
- Batch testing specific collection streams (AATFs must choose their own batch size).
- Another methodology (AATFs must check this approach with their environmental regulator).

There are appropriate measures for permitted facilities treating or transferring waste electricals, which are the standards operators need to meet to comply with their environmental permit requirements [23]. Table 11 presents a non-exhaustive list of the requirements outlined in the appropriate measures that are most relevant to this metric.

Table 11: Overview of key requirements of the appropriate measures

Key area	Sub-area	Specific requirements/KPIs
Waste treatment (5)	General waste management (5.2)	● Use material flow analysis for relevant contaminants in the waste to identify flow and fate. This should consider waste input, different waste treatment outputs and waste treatment emissions. ● Monitor and record the outputs of the treatment activity, including their weight.
	Process monitoring (5.4)	● Carry out a mass balance exercise to determine and record the mass of each individual output fraction derived from a given mass of input material (at least once a year for every WEEE stream).
	Record keeping for all treatment residues (5.13)	● Regulated facilities obliged to record the following in a waste tracking system: ○ WEEE that has been treated or consigned to another WEEE treatment facility. ○ WEEE that has been prepared for reuse or consigned to a preparing for reuse operator. ○ The treatment residues, treated components and fractions.

For batteries, current legislation requires for Approved Battery Treatment Operators (ABTOs) and Approved Battery Exporters (ABE). Similarly, to the 'New EEE and batteries placed on the market' metric, recycling tonnages are currently being split into the 3 battery categories (industrial, automotive and portable) and 3 battery chemistries (lead acid, NiCad and other). As previously mentioned, there is an ongoing consultation led by Defra which looks to explore the potential of breaking down the 'Other' category into sub-categories. Additionally, there are rules for any ABTO and ABE that manage waste batteries (including collection, treatment, recycling and export) [24].

The WEEE Forum has developed a reporting tool called the 'Rep Tool', which aims to harmonise reporting. This tool includes harmonised lists of definitions for key processes (such as material recycling, energy recovery, thermal disposal, etc.), technologies and input and output fractions [25].

Challenges in data collection:

As outlined by Zero Waste Scotland, the following points must be considered when carrying out a WCA study [26]:

- WCA are a snapshot in time based on waste sampled from a particular locality during a certain week/weeks and season.
- The nature and quality of waste is subject to many constantly changing variables (including householders' behaviours, demographics and materials used at home).
- Although a large enough sample of houses could theoretically be chosen to account for this variability, it is usually difficult to determine how large the sample would likely be, without first conducting a detailed (and costly) pilot study of the waste in a particular area.

Figure 6 presents a SWOT analysis which includes all the key opinions expressed throughout the stakeholder interviews for this metric.

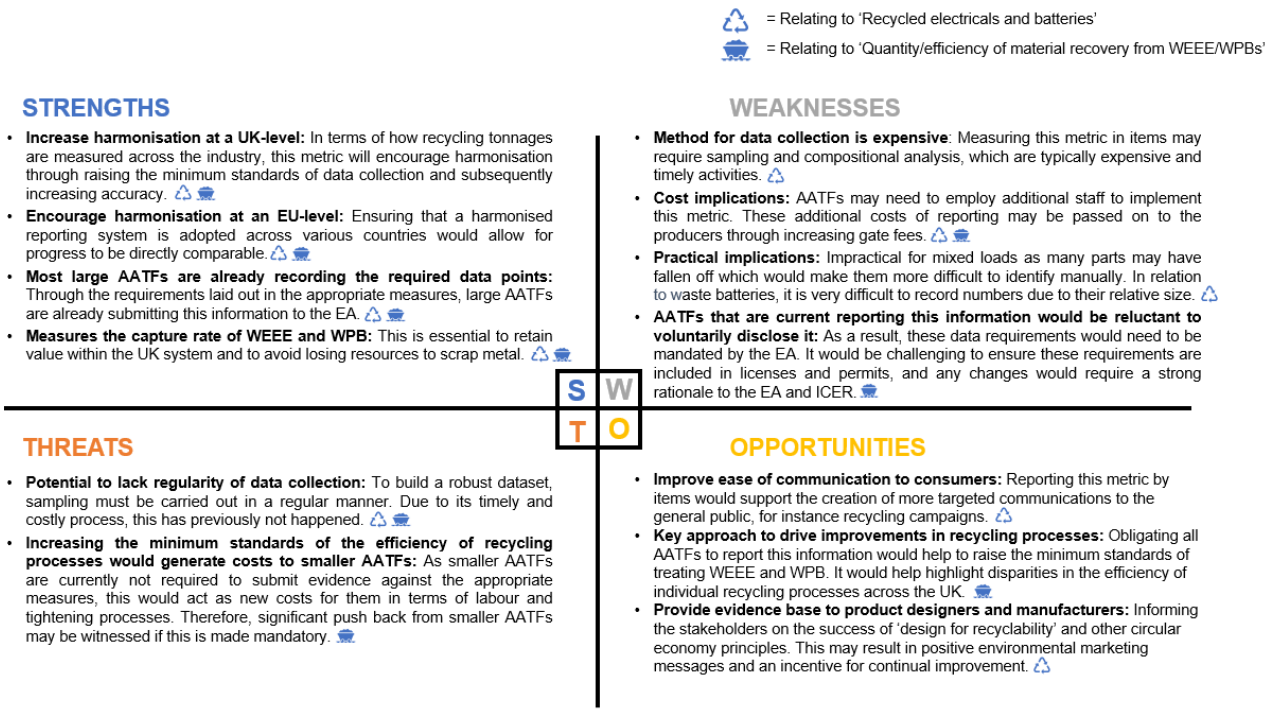


Figure 6: SWOT analysis for 'Recycled electricals and batteries (measured in item and tonnes)' and 'Quantity/efficiency of material recovery from WEEE/WPBs

Inclusion in final shortlist:

Based on the feedback received by the stakeholders interviewed and the results of the SWOT analysis, Ricardo proposed to include this metric in the final shortlist. Reasoning includes the fact that AATFs and ABTOs are already recording their recycling tonnages, input and output fractions and recycling efficiencies, allowing ease of implementation. **This metric also encourages harmonisation in reporting of recycling activities across both a UK and EU-level, making it crucial to ensure consistency of data collection**. Furthermore, measuring the capture rate of waste electricals and batteries **will allow for more value to be retained within the system and drive improvements in the collection and recycling processes**. Challenges around measuring this metric in items - including reporting difficulties, accuracy levels and additional costs to treatment facilities - are considered in the data collection plan.

3.1.6 Binned electricals and batteries (measured in items and tonnes)

This metric involves measuring the amount (weight and/or number) of electricals and batteries that are thrown away by households into residual waste each year. This proportion of waste electricals in residual waste would represent the 'lost opportunity' through calculating what is sent to landfill or incineration and subsequently not recirculated into the system through higher value applications. It is proposed that this metric is measured in items and tonnes.

In terms of identifying new metrics that are not currently being reported on through existing regulations, this binned electricals and batteries metric was viewed as a priority for implementation by the interviewed stakeholders. Research carried out by Material Focus estimated that at least 500,000 tonnes of waste electricals were annually lost through being thrown away, hoarded, stolen or illegally exported [14]. 31% of this (155,000 tonnes) was thrown away in domestic bins and incinerated or landfilled. Waste electricals that are disposed of through residual waste are guaranteed to not be given a second life through reuse or recycling. It is therefore in the industry's interests to quantify the waste electricals that are currently being disposed of via this route to increase capture rates and encourage value-add applications.

Figure 7 presents a SWOT analysis which includes all the key opinions expressed throughout the stakeholder interviews for this metric.

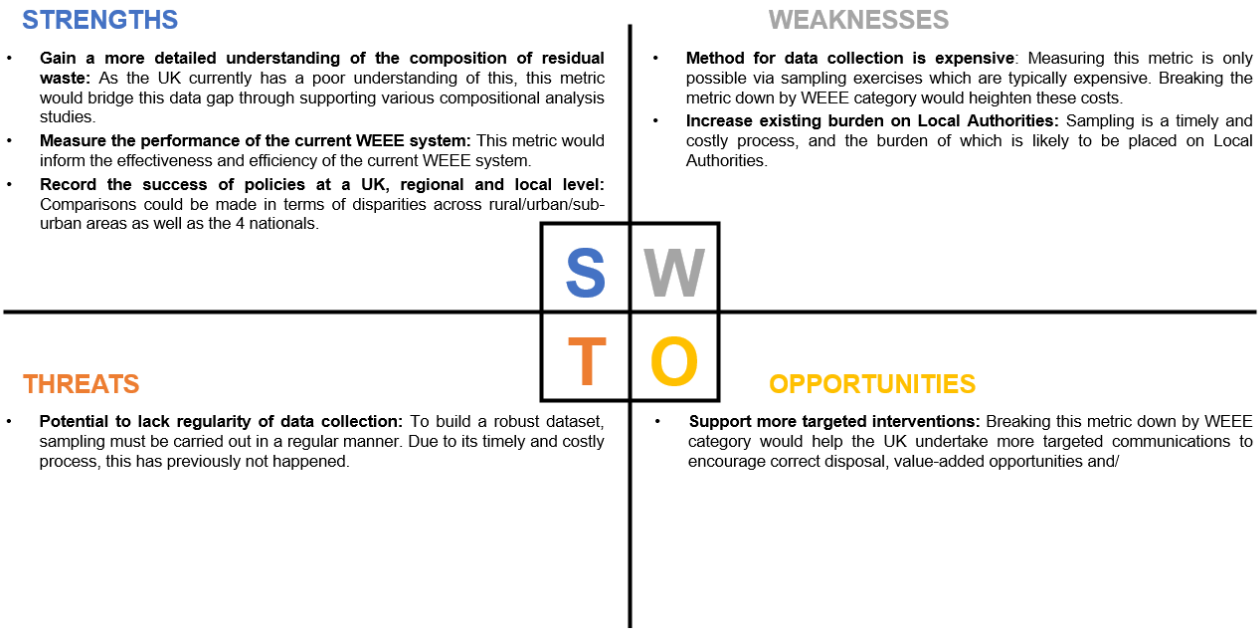


Figure 7: SWOT analysis for 'Binned electricals and batteries (measuring in items and tonnes)'

Inclusion in final shortlist:

Based on the feedback received by the stakeholders interviewed and the results of the SWOT analysis, Ricardo proposed to include this metric in the final shortlist. This metric will also support circularity through **capturing the 'lost opportunity' and informing the effectiveness of the current system**. Ricardo believes that measuring by item type would be of particular benefit since it would **support targeted interventions, at a regional level.**

3.1.7 WEEE and WPB in fly-tipping/illegally tipped waste in waste sites

This metric involves measuring the number, weight and type of waste electricals and waste portable batteries that are fly-tipped/illegally dumped in waste sites each year. Currently, while local authorities do record waste that is fly-tipped, the level of detail that is recorded is very low. Accurately measuring the quantities of waste electricals and batteries that are fly tipped each year would provide a better overall picture of the system and its material flows.

Conversations with stakeholders including local authorities found that councils record and track the waste that is fly tipped within their geographical boundaries. However, waste from each instance of fly tipping is recorded as one category, for example residual waste, furniture, or electricals, regardless of the quantity of waste. This is as councils do not sort through the fly tipped waste due to time resource constraints and worker safety hazard concerns. In practice, this means that if an instance of fly tipped waste contained waste electricals or batteries, but was primarily comprised of another waste stream, those waste electricals and batteries would not be recorded.

Requiring local authorities to record instances of fly tipped waste in more detail would provide a more accurate picture of waste electrical and battery material flows, which would also allow for the planning specific interventions. Items may be fly tipped if consumers are unsure of how to dispose of them properly, so if a specific type of item is commonly fly tipped, the design and delivery of targeted awareness campaigns and activities may help to tackle this.

However, from discussions with stakeholders, it was felt that electricals are not generally among the most commonly fly tipped items, and that fly tipped electricals and batteries are a relatively minor waste stream in the sectors overall. Therefore, it is recommended that other metrics are prioritised over this one, particularly for the purpose of developing a more accurate understanding of the main material flows.

Figure 8 presents a SWOT analysis which highlights the key opinions expressed throughout the stakeholder interviews for this metric.

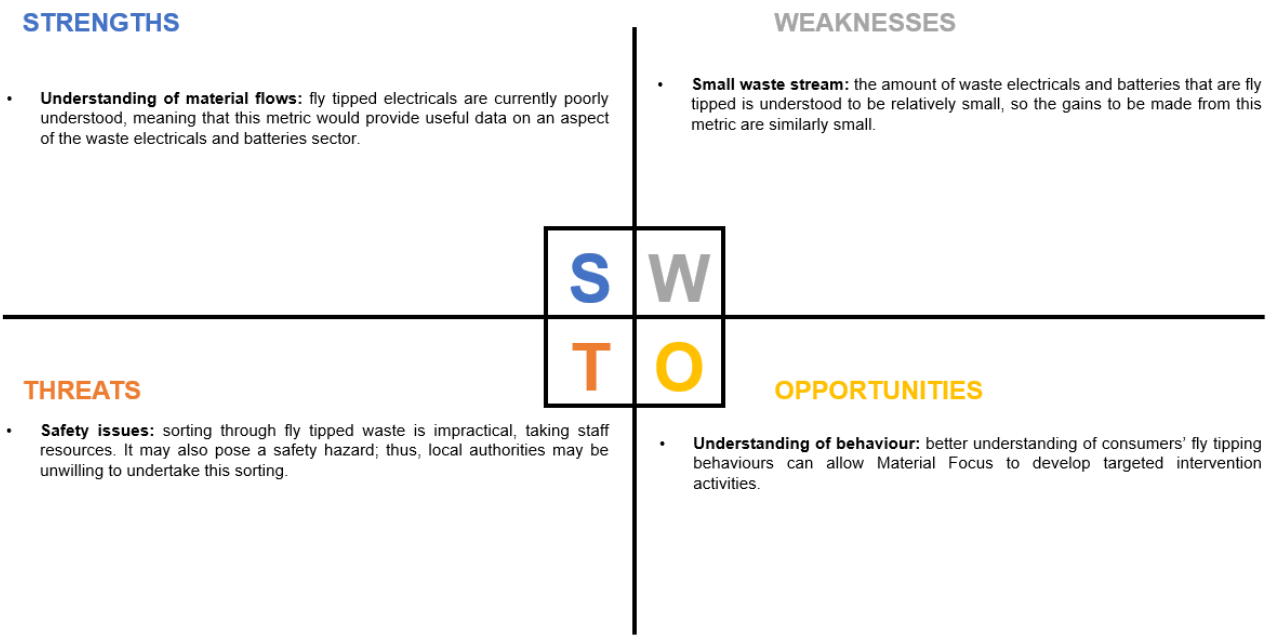


Figure 8: SWOT analysis for 'WEEE and WPB in fly-tipping/illegally tipped waste in waste sites'

Inclusion in final shortlist: Not selected for inclusion

Based on the feedback received by the stakeholders interviewed and the results of the SWOT analysis, Ricardo proposed to not include this metric in the final shortlist. This is primarily since Ricardo recommend prioritising metrics which support building a better picture of key material flows in the system as opposed to those more minor streams – which can form part of a longer-term ambition for metrics.

3.1.8 Electricals recycled by non-AATFs (substantiated estimates in tonnes and items)

This metric involves calculating an estimate of the number, weight, and type of electricals recycled as scrap metal or by unauthorised recyclers. It is proposed that this metric is measured in both tonnes and items.

It has been previously estimated by Material Focus that between 66kt to 109kt of business electricals were recycled with light iron at scrap metal processors in 2019 [27]. This commonly results in valuable materials not being recycled, as they are arriving at facilities as 'scrap/light iron', as opposed to being processed by AATFs as waste electricals. Scrap metal recycling is currently not regulated to the same standards as waste electricals at AATFs, and this is particularly problematic for refrigeration equipment that may not be appropriately de-gassed due to copper/compressor removal prior to non-AATF light iron recyclers obtaining the material.

In addition to this, Valpak have previously carried out research on behalf of WRAP to produce a substantiated estimate figure that DEFRA could use to contribute to the national 65% collection target.

It is important to mention that this metric is not advocating the increased or decreased use of substantiated estimates across the waste electricals system. The main aim of the metric is to build greater transparency and robustness into the system.

Figure 9 presents a SWOT analysis which highlights the key opinions expressed throughout the stakeholder interviews for this metric.

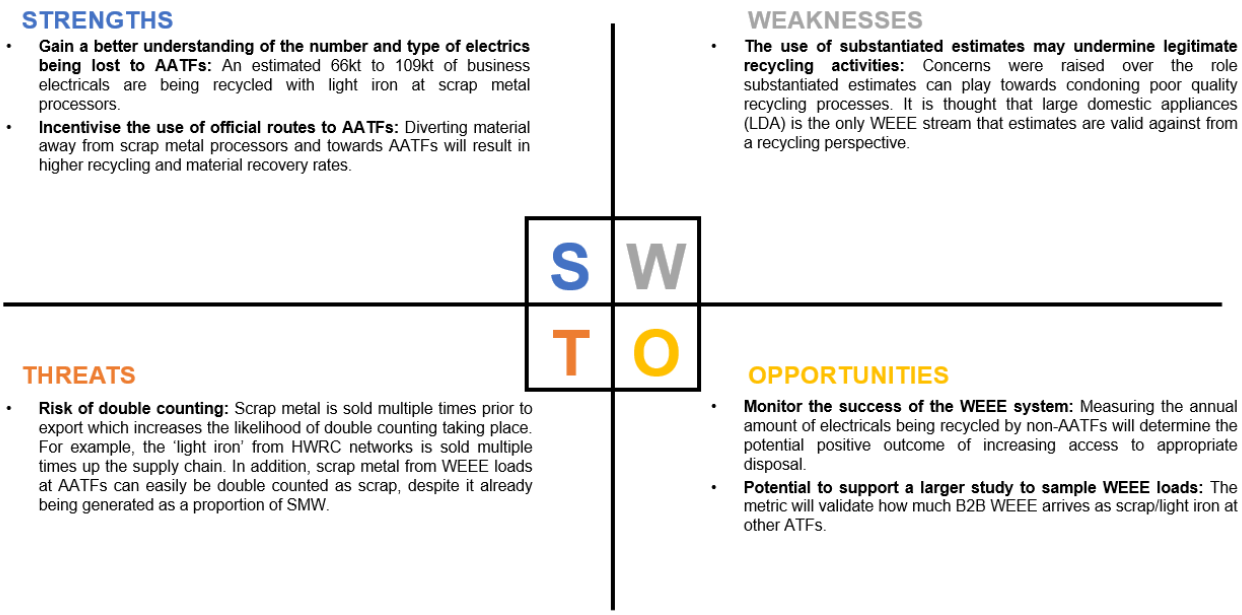


Figure 9: SWOT analysis for 'Electricals recycled by non-AATFs (substantiated estimates in tonnes and items)'

Inclusion in final shortlist:

Based on the feedback received by the stakeholders interviewed and the results of the SWOT analysis, Ricardo proposed to not include this metric in the final shortlist. This is since Ricardo felt the priority for circularity at present should be placed on metrics which deliver a greater chance of successful interventions further up the value chain – including electricals in residual waste or recycling practices at AATFs/ABTOs. Minimising the waste electricals and batteries lost to non-approved facilities is important but should form part of the longer ambitions, building upon the research recently done by Material Focus in this area. [27]

3.1.9 Illegal export of EEE/WEEE and batteries

This metric explores the flow of electricals/waste electricals and batteries that are illegally exported out of the UK each year, including the proportion of waste electricals that are posing as new electricals. This material flow is relatively unknown, and therefore the main aim of beginning to measure this metric would be to create an evidence base and to improve estimates over time.

In the UK, the WEEE regulations state that exporters must provide evidence that testing has been carried out on goods to ensure their suitability for export. However, waste electrical items that cannot be reused are not allowed to be exported to countries beyond the list of members in the Organisation for Economic Co-operation and Development (OECD). Previous studies have identified a trend in the illegal export of waste electricals from the UK, with the UK exporting the most e-waste across the EU to developing countries [28]. It has been estimated that 40% of e-waste collected in the UK (up to 209,000 tonnes) is illegally exported overseas.

Figure 10 presents a SWOT analysis which highlights the key opinions expressed throughout the stakeholder interviews for this metric.

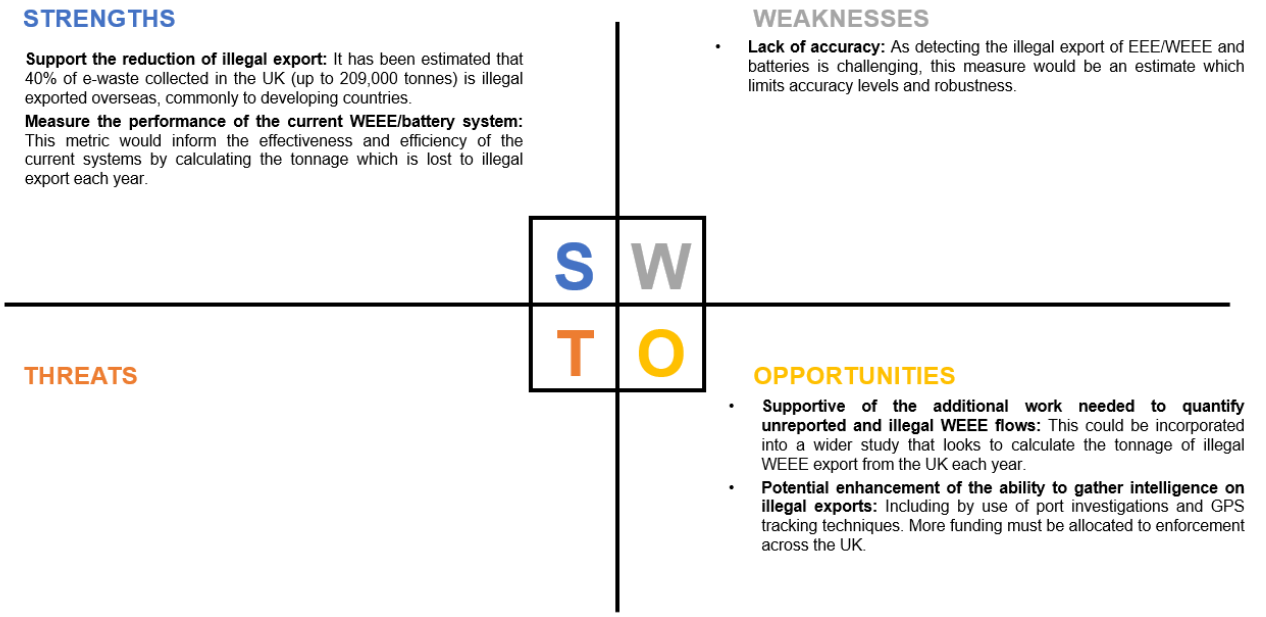


Figure 10: SWOT analysis for 'Illegal export of EEE/WEEE and batteries'

Inclusion in final shortlist: Not selected for inclusion

Based on the feedback received by the stakeholders interviewed and the results of the SWOT analysis, Ricardo proposed to not include this metric in the final shortlist. Despite its ability to measure the flow of material that is lost to the UK systems through illegal activity (which would positively support the increase of recycling), it has been determined a lower priority due to the challenges in gathering robust and accurate data.

3.2 DISPOSAL OPTIONS

3.2.1 Number of drop-off points by type and items accepted

This metric would be the analysed output of a simple database of drop-off points across the UK, including both publicly and privately operated points, categorised according to the type of drop-off point and the type of items it accepts.

Feedback on this measure was obtained through discussions with Material Focus, which currently maintains such a database, publicly available online, of different drop-off points nationwide. It was noted that there are four main channels through which an individual may drop off waste electricals or waste portable batteries:

- LA sites such as HWRCs or waste electrical drop-off banks.
- Other LA facilities including libraries and community centres.
- Retailers which operate take-back schemes (thought to be around 25,000 stores in the UK).
- Charities that accept donations of electronics.

The database is relatively easy and inexpensive to maintain, though of the four metrics regarding disposal options that are discussed here, it provides the most basic level of data. The main challenge with this metric is keeping the list of sites up to date. Potential issues include:

- A site closing that is still listed on the website, leading to a negative experience for users.
- A misunderstanding of what a given drop-off point accepts, especially if store policy is not known by staff.
- A site changing opening times or requiring booking appointments post-Covid.
- A site that is only usable by households living within its LA, even if users outside of the boundary live close by.
- A site that is not wheelchair accessible, or accessible to those with other disabilities.

The database is also not exhaustive: additional types of drop-off points such as repair cafes and reuse networks could be added, increasing the level of work to maintain the list but also increasing the coverage of the metric.

Figure 11 presents a SWOT analysis which highlights the key opinions expressed throughout the stakeholder interviews for this metric.

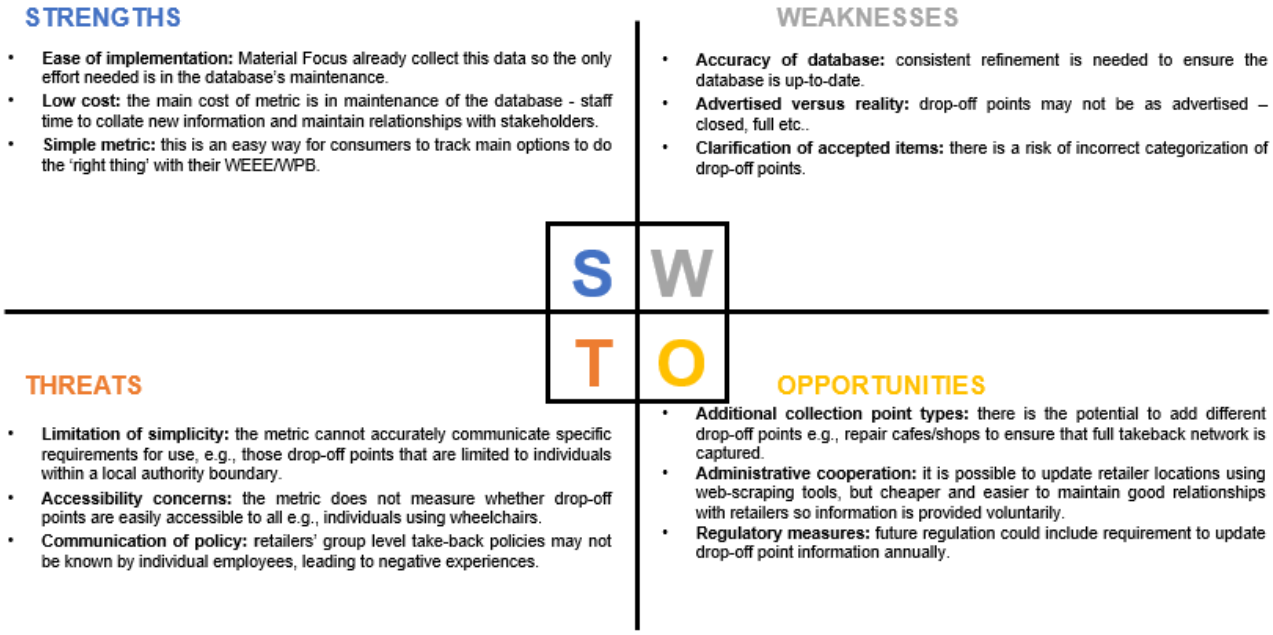


Figure 11: SWOT analysis for 'Number of drop-off points by type and items accepted'

Inclusion in final shortlist:

Since Material Focus has already proven the feasibility of the underlying data collection and collation for this metric, it was recommended for inclusion in the final shortlist. Maintaining and analysing the output of a similar database is an important way for consumers to find out where to safely dispose of their waste electricals and batteries, **which is key for increasing circularity in the sector**. Where there are fewer barriers to consumers taking positive action, the more likely they are to take positive action to support a circular economy. The metric derived from analysis of the number and type of drop off points will allow for tracking of progress over time and potential targeted development of new services to fill identified gaps.

3.2.2 Average distance of consumers to their nearest drop-off point

This metric uses the information collected in the above database and combines it with household data to determine the average distance of a household from a drop-off point in a particular area.

Through discussions with Material Focus, it was highlighted that this metric would require significantly more data than the database, at an additional cost - household data from Ordnance Survey is available for around £17,000, while postcode data would cost roughly £1,000. In addition, significant computational power would be required to calculate the average distance for each of these postcodes. There could be additional complexity if work was undertaken to account for drop-off points within a particular LA's boundaries, or to implement route mapping instead of distances "as the crow flies".

Figure 12 presents a SWOT analysis which highlights the key opinions expressed throughout the stakeholder interviews for this metric.

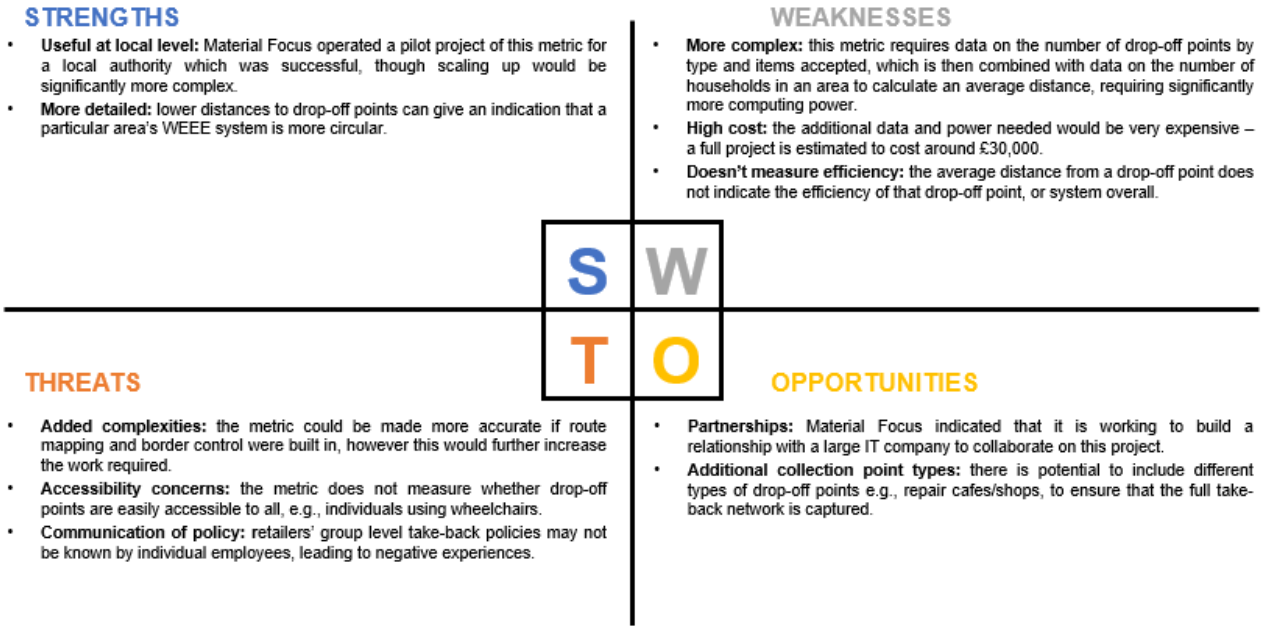


Figure 12: SWOT analysis for 'Average distance of consumers to their nearest drop-off point'

Inclusion in final shortlist: Not selected for inclusion

Due to the high complexity of this metric, it was not brought forward to the final shortlist. However, it is understood that Material Focus is currently exploring a partnership with an IT provider. This should provide learnings which will render the metric more feasible for future progression within the system.

3.2.3 Drop-off point density per town/local authority/region

This metric sits between the above two in terms of complexity. It would take the database of drop-off points and determine how many of them serve a particular area per the number of households in that area.

The main challenge associated with this metric is the potential for boundary issues: certain drop-off points may be off-limits to households outside the local authority: some HWRCs only permit households in the relevant area to use its services, which could skew the results. It would give an indication, however, as to the waste electricals and batteries system performance in an area if we assume that the more drop-off points, the more efficient the system.

Figure 13 presents a SWOT analysis which highlights the key opinions expressed throughout the stakeholder interviews for this metric.

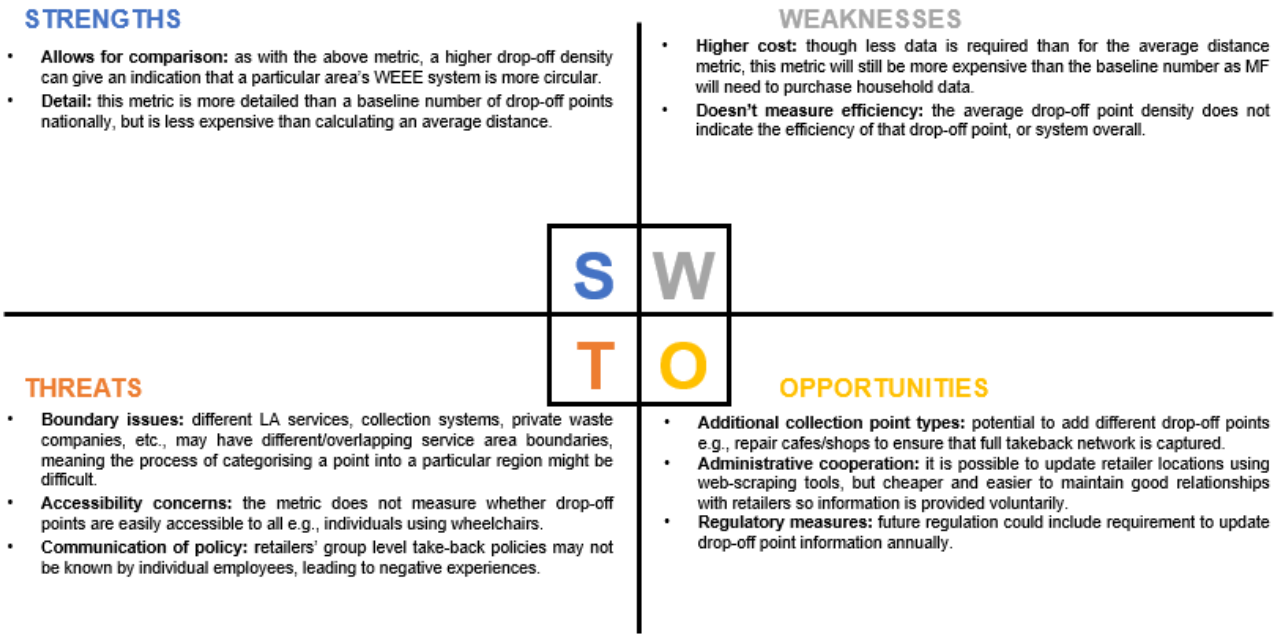


Figure 13: SWOT analysis for 'Drop-off point density per town/local authority/region

Inclusion in final shortlist: Not selected for inclusion

This metric was not progressed to the final shortlist since it was felt that the 'Number of drop-off points' metric adequately captures this side of the waste electricals system without needing additional household data.

3.2.4 Availability of household collection services

This metric is largely similar to the 'Number of drop-off points' metric, but for household collection services specifically. It is understood that Material Focus is currently building a list of these services; once complete, the only cost to maintain it should be staff time.

Stakeholder interviews highlighted that for LA-operated services, it would be relatively simple to collect and maintain service information: a web script could be set up and maintained by Material Focus to monitor LA websites and flag if the site changes. For non-LA operated services, data collection would likely be more difficult due to the range of organisations offering collection services. As with the 'Number of drop-off points' metric, efforts should be made to develop relationships with these organisations to make the process easier. Ease of access to waste electricals/waste portable batteries recycling facilities is the best way to improve the viability of the system and this metric, along with the 'Number of drop-off points' metric is a relatively simple way to measure this.

Challenges with this metric are similar to the drop-off point metric:

- A service closing that is still listed on the website, leading to a negative experience for users
- A misunderstanding of what a given service accepts
- A service changing operating times
- A service that is only usable by households living within its LA, even if users outside the boundary live close by
- A service that only serves certain types of households, e.g., not serving those living in flats

Figure 14 presents a SWOT analysis which highlights the key opinions expressed throughout the stakeholder interviews for this metric.

Figure 14: SWOT analysis of 'Availability of household collection services'

Inclusion in final shortlist:

It was decided to progress this metric to the final shortlist. Its relative simplicity, along with the fact that Material Focus is already working on a database (that could act as proof-of-concept), means that this metric can be rapidly deployed to provide insight into the UK's collection services. As with the number of drop-off points, this database allows consumers to easily dispose of their waste thus maximising recycling rates. **The two databases combined, and the relevant analyses to establish and develop the relevant metrics, will provide a sector-leading understanding of options for domestic disposal of waste electricals and batteries**, placing it in an excellent position to maintain its positive impact.

3.3 ENVIRONMENTAL AND SOCIAL IMPACTS

3.3.1 Quality of material outputs from WEEE/WPBs

This metric assesses the quality of material outputs from recycling waste electricals and waste portable batteries, which refers to the contamination levels of the waste input and output of the recycling system.

As previously mentioned, there are appropriate measures for permitted facilities treating or transferring waste electricals [29]. AATFs already measure a series of small data points which contribute towards this metric. Table 12 presents a non-exhaustive list of the requirements laid out in the appropriate measures that are most relevant to this metric.

Table 12: Overview of key requirements of the appropriate measures

Key area	Sub-area	Specific requirements/KPIs
Waste treatment (5)	General waste treatment (5.2)	● Use material flow analysis for relevant contaminants in the waste to identify flow and fate. This should consider waste input, different waste treatment outputs and waste treatment emissions.
	Treatment of WEEE containing BFRs and POPs (5.3)	● Identify, separate and remove any plastic containing BFRs for further treatment. ● Any WEEE items, components or material fractions derived from the treatment of WEEE that is POPs waste are treated as required by the appropriate legislation [30].
	Treatment of SMW (5.8)	● Where you use a mechanical process to shred SMW you must sample the physically finest non-metallic fraction at least once every 6 months and

Key area	Sub-area	Specific requirements/KPIs
		test for: mercury with a limit value of 1mg/kg and cadmium with a limit value of 100mg/kg.

AATFs must also treat waste electricals using the best available treatment recovery and recycling techniques (BATRRT) [31]. This provides guidance as to how the standards for treatment, recycling and recovery set out in the WEEE Directive are to be interpreted by DEFRA, the Welsh Assembly Government and the Scottish Government in order to comply.

Despite many AATFs already collecting and reporting upon the above information, the stakeholders interviewed feared that AATFs would be reluctant to share this information voluntarily. It was suggested that this would need to be mandated into reporting requirement by the EA for all AATFs to record and share. If it were to be decided that mandating this would be the best route to take, key stakeholders to include in this process would be the EA, ESA, AATF Forum and ICER. It is expected that the costs for collecting data would fall on the AATFs.

Figure 15 presents a SWOT analysis which highlights the key opinions expressed throughout the stakeholder interviews for this metric.

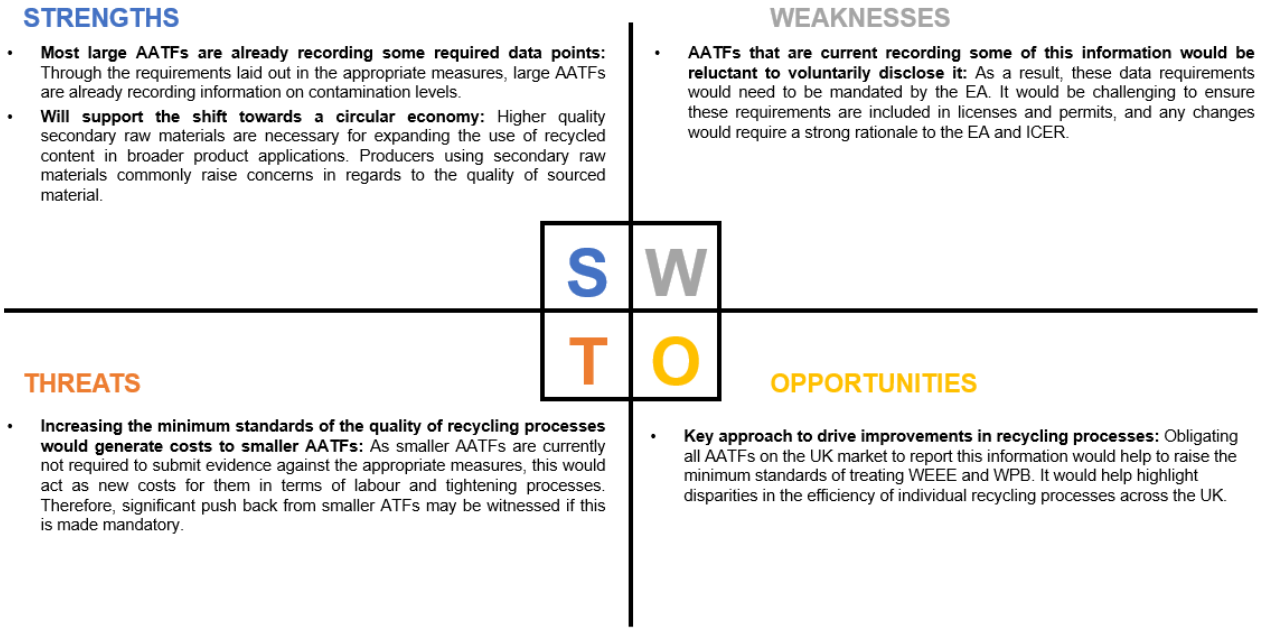


Figure 15: SWOT analysis of 'Quality of material outputs from WEEE/WPBs'

Inclusion in final shortlist: Not selected for inclusion

Based on the feedback received by the stakeholders interviewed and the results of the SWOT analysis, it was determined that this metric is important to ensure that high quality recyclate is produced. However, this metric was deemed lower priority - due to its more advanced nature - and therefore was not progressed to the shortlist.

3.3.2 CO_2 and other greenhouse gas (GHG) emissions impact/performance of the WEEE/WPB sector

This metric aims to measure the impact or performance of the waste electricals/waste portable batteries sectors in terms of CO_2e. emissions. Whilst, as discussed further below, this metric has not been selected for inclusion in the final shortlist, Ricardo feels that it is a crucial metric that warrants a separate piece of work solely dedicated to developing it for use.

Overall, the CO_2e emitted per functional unit (for example, per tonne of waste electricals or waste portable batteries), when compared year-on-year, may rise or fall due to several variables, such as a higher quantity of materials in items that can be recycled, an increase in recycling rates over landfilling, or a reduction in transport to AATFs. Depending on the boundary of the system, avoided emissions from reuse of electricals may also be

included. By understanding where emissions are primarily arising, it could be better understood in which parts of the supply chain interventions are needed.

Some emissions data are already recorded through permits, and some key actors are working on models as part of their Net Zero ambitions. For example, REPIC is using a model from a Masters research project [32] "The Carbon Footprint of WEEE (Waste Electronic and Electrical Equipment) in the UK - a case study based on the UK's largest WEEE producer compliance scheme". Similarly, Recolight is currently working on the draft of the "Net Zero specification for the WEEE sector" with the Net Zero working group within ICER. It should be noted that these projects both only measure the emissions of the waste electricals sector and not waste portable batteries; no projects focusing on waste portable batteries emissions have been identified.

While work on measuring the emissions of the waste electricals sector is ongoing, there are several issues that must be overcome. A key issue identified from Repic's study was limited data availability. While Repic is a compliance scheme and thus has access to data regarding the quantities of electricals arising as waste, it was difficult to obtain data from hauliers and AATFs and so estimates and assumptions had to be used. There was also a lack of consensus from previous studies regarding the system boundary and inclusion or exclusion of certain materials, including environmentally damaging refrigerants.

Stakeholders interviewed also agreed that there is no common or agreed methodology in the waste electricals/portable batteries sector yet to measure this metric. They believe, as does Ricardo, that such a methodology should be developed to understand the sector's environmental impacts, but that it will be a large project to establish and expect that there will be high costs to gather data from the stakeholders in the system, in particular from hauliers and treatment facilities. It is recommended that work be done to ensure that material flows in the sector are as accurate as possible, in part by mandating for better reporting requirements, before calculating its emissions.

Figure 16 presents a SWOT analysis which highlights the key opinions expressed throughout the stakeholder interviews for this metric.

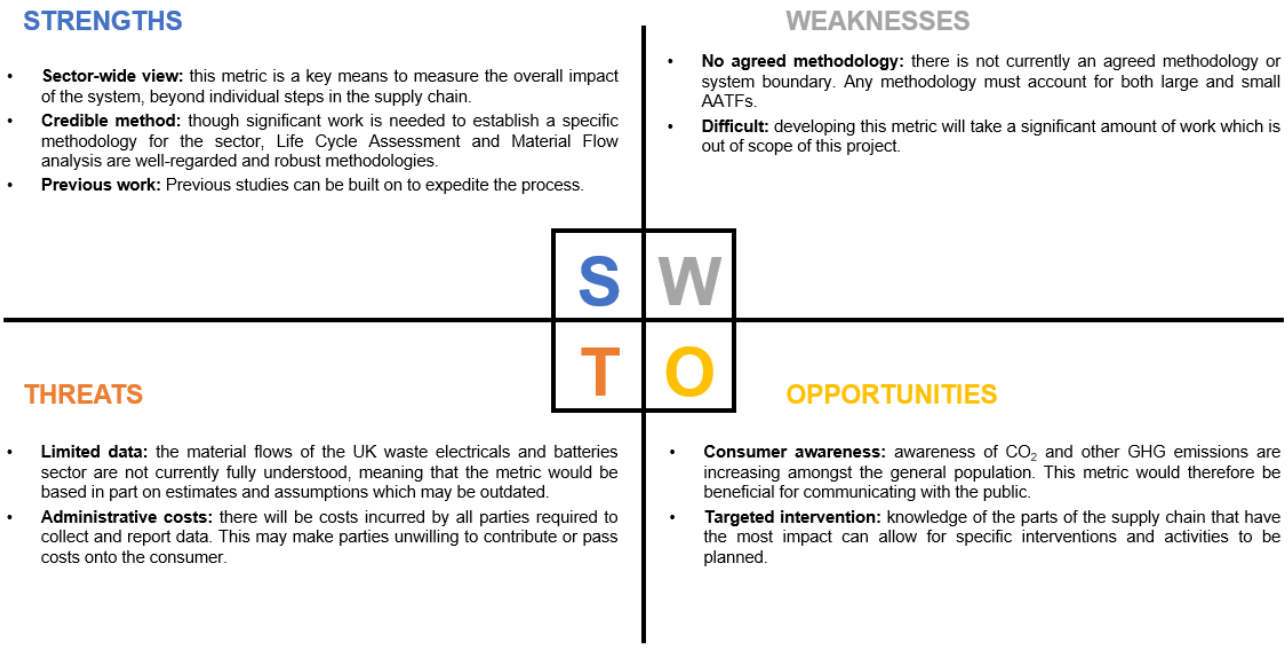


Figure 16: SWOT analysis for 'CO_2 and other GHG emissions impact/performance of the WEEE/WPB sector'

Inclusion in final shortlist: Not selected for inclusion

This metric was considered important in capturing and quantifying the circularity of the whole system. However, there are significant challenges in its development, including a lack of agreed methodology, high costs in development and limited data availability. Thus, while Ricardo agrees that this is an important metric in assessing overall environmental performance, it warrants a dedicated piece of work (outside of the scope of this project) for effective development. This metric was therefore not included in the final shortlist for this project.

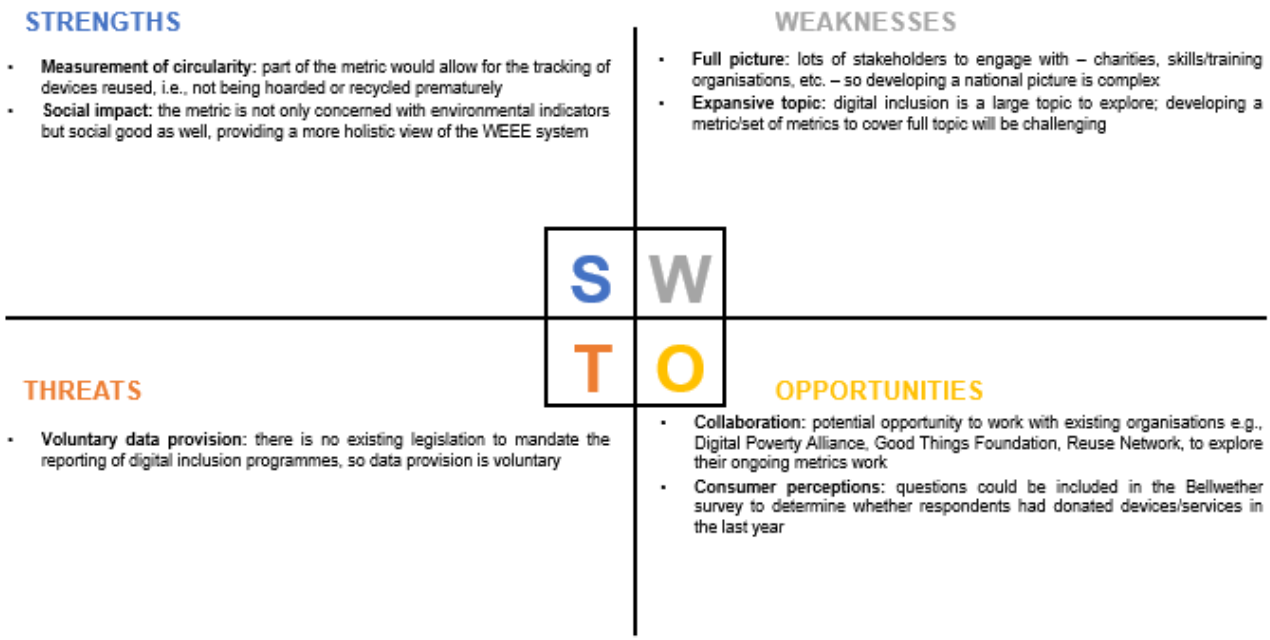
3.3.3 Success of digital inclusion programmes – devices, data and skills

This metric would measure how the digital inclusion system is performing, which may entail the development of specific metrics including the number of devices donated, amount of mobile/broadband data provided, or number of skill hours provided by organisations.

From discussions with Material Focus, it was felt that this was a very important metric though somewhat out of scope of this project. The metric is one of the only ones on the initial shortlist that is intended to measure social as well as environmental effects from the waste electricals system, making it useful for understanding the end impacts of circularity. However, it was agreed that it should be a lower priority until a clearer understanding of the flows of waste electricals and waste portable batteries in the UK is available, and that further research may be commissioned to understand the social impacts of circularity in the sector more generally.

Figure 18 presents a SWOT analysis which highlights the key opinions expressed throughout the stakeholder interviews for this metric.

Figure 18: SWOT analysis for 'Success of digital inclusion programmes – devices, data and skills'



Inclusion in final shortlist: Not selected for inclusion

As discussed above, this metric was identified as being useful for gaining a holistic understanding of circularity in the waste electricals/waste portable batteries sectors, however, it was considered of lower priority in achieving the objectives of this project. Further work should be done in the future to explore the wider social impacts of a circular waste electricals and batteries system in the UK.

3.3.4 Social impacts – numbers of households (and £ value) supported through reuse network partners

This metric aims to measure the social impact of reusing waste electricals/waste portable batteries on households in terms of number of households supported through reuse network partners and total value in Pounds sterling.

Stakeholders interviewed mentioned that some "off of the shelf" tools are already available to evaluate this metric such as WRAP's Environmental and Economic Benefits of Re-use method [33] and Benefits of reuse tool [34]. These tools were developed at a high level aimed at covering various sectors (clothing, furniture, and electricals), meaning that for electricals, data is only available for washing machines and TVs. Still, this could be used as a starting point for organisations, as shown by the Reuse Network, who have developed their own product weight protocol which, used in combination with WRAP's work, evaluates the number of households helped and household monetary savings for large and small household appliances, and ICT [35].

However, stakeholders interviewed also highlighted that social impact is actually wider than supporting households and suggested that the impact of the reuse organisations should be accounted for too. Indeed,

such organisations often provide employment opportunities, help develop skills and knowledge, and support communities, all of which is currently not accounted for in existing methodologies. They stated that this would require the need to undertake a full piece of research. They also mentioned that calculations should be more detailed, as there exists a wide range of products within the electricals category (e.g., clock, TVs, etc), meaning that weights can vary a lot, skewing results. Network Rail launched a Social Value Tool in Spring 2022, which assesses activities by several social impact factors and assigns a monetary value equivalent calculation – this is a good case study of a practical system that could be reviewed if this metric were to be implemented.

Figure 17 presents a SWOT analysis which highlights the key opinions expressed throughout the stakeholder interviews for this metric.

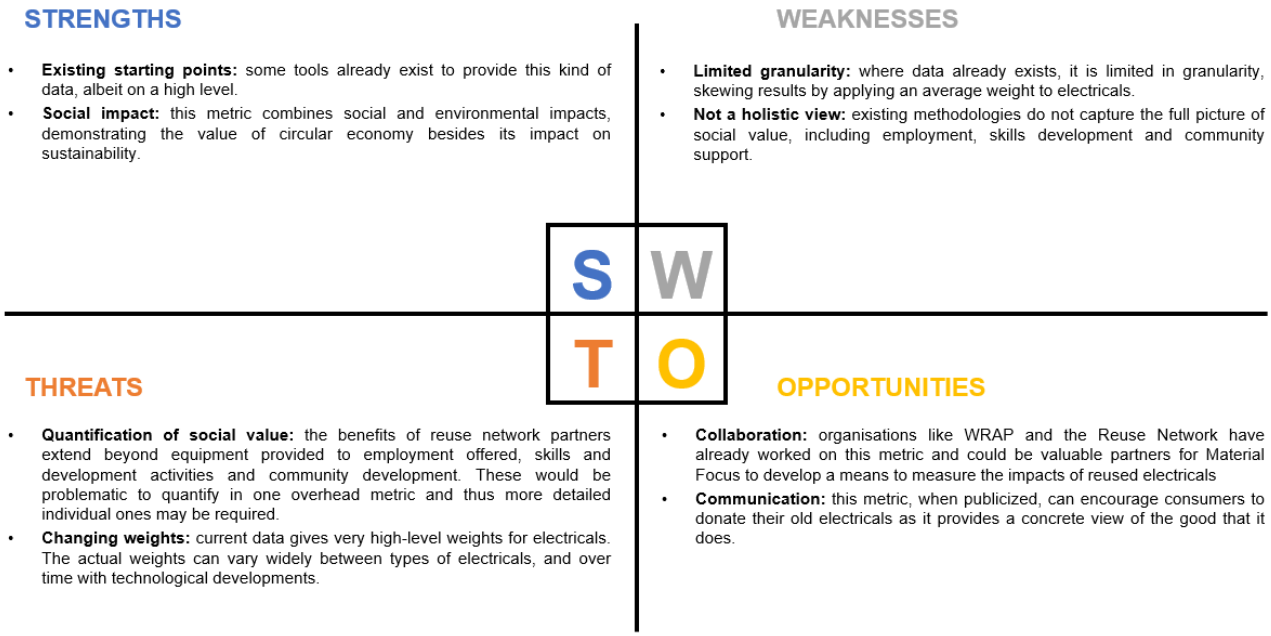


Figure 17: SWOT analysis for 'Social impacts – number of households (and £ value) supported through reuse network partners'

Inclusion in final shortlist: Not selected for inclusion

Ricardo felt that, even though it is important to measure the socio-economic impacts of a circular system, this metric might not be so helpful in targeting interventions as other potential metrics reviewed. Whilst important, we suggested that it should be considered as part of a separate scope of work.

3.4 CONSUMER PERCEPTION METRICS

This section covers the following longlisted metrics:

- Awareness of the need to recycle electricals and batteries
- Perceived ease of recycling electricals and batteries
- Perception that recycling electricals and batteries is worth doing
- Preferred channels for recycling electricals and batteries
- Perception that recycling electricals and batteries is important
- Perception that recycling electricals and batteries is the normal thing to do
- Awareness that binning electricals and batteries is dangerous
- Claimed reuse and recycling behaviours for electricals and batteries
- Attitudes to buying second-hand and refurbished products

Material Focus conducts an annual survey called the Bellwether survey, and currently asks questions regarding all of the above metrics apart from 'Attitudes to buying second-hand and refurbished products'. The survey has been run since 2019 as part of an Omnibus and is sent out to 2000 participants. The process of developing the survey each year is relatively simple: existing questions are not changed so that data from

different years can be reliably compared, and Material Focus employs experts to ensure that the questions are unbiased. The analysis of the survey is also handled by external experts, which is the main cost of conducting the survey. In general, it has been found that the public's awareness of the need to recycle waste electricals and waste portable batteries is high, but actions based on that awareness are much lower. It is hoped that future surveys can identify the reasons for this to plan and understand future interventions and campaigns.

The main challenge to be aware of for these metrics is that it relies on respondents self-reporting, meaning that they might over-exaggerate their own awareness or actions. It is understood that Material Focus' most recent Bellwether survey is intended to dive deeper into the reasons for a relatively high awareness level but lower action level, and questions must be designed carefully to draw out the most accurate possible responses. They must also be designed to limit the amount of bias. Opinium experts have worked with Material Focus to eliminate bias as far as possible from the existing survey, and this should be done for any new questions added to the Bellwether survey or to any similar survey conducted.

Figure 18 presents a SWOT analysis which highlights the key opinions expressed throughout the stakeholder interviews for this metric.

Figure 18: SWOT analysis for consumer perceptions metrics

Inclusion in final shortlist:

Material Focus, through its annual Bellwether survey, has proved the viability and value of the survey process used to collect data to support this type of metric. The use of existing data arising from the survey, and any further inputs that may arise, will support development of the metric through a national measurement system. The intelligence from this metric can help to design, and deliver informed interventions, and track their progress over time. As such, this metric category was suggested for inclusion in the final shortlist. Additional questions can be added to a survey as and when required at low additional cost. This will grant **an invaluable holistic understanding of consumer perceptions of the waste electricals/waste portable batteries sectors**.

4 FINAL SHORTLIST - DATA COLLECTION PLANS

Drawing on the insights gained through desk-based research, stakeholder interviews and the survey (as outlined in Section 3) this section presents the individual data collection plans for the shortlisted metrics – as summarised in Table 13 below. The following information has been provided for each metric: the required data for implementation, sources of the relevant data, methods for data collection, indicative costs of data collection and challenges of data collection.

Table 13: Final shortlist of metrics to measure circularity in the UK waste electricals and batteries system

Metric group	Metric	Units	Data points required	Methodology	Involved actors & responsibility	Indicative cost (£)
Product flows	New EEE and batteries placed on the market	Items & tonnes	Information from producers via compliance schemes and environmental regulators: • The weight of electricals POM by category (measured in tonnes) • The weight of electricals POM by category (measured in number of units) • The weight of batteries POM by chemistry (measured in tonnes) • The weight of batteries POM by chemistry (measured in number of units)	Producer/ compliance scheme-reported data	Producers: provide POM data to compliance schemes or environmental regulators. Compliance schemes: provide POM data to relevant body	Minimal additional cost – one-off administrative costs for producers to map their internal data to a UK reporting template (variable).
	Recycled electricals and batteries and Quantity/efficiency of material recovery from WEEE/WPBs	Items & tonnes	• Collection: Calculating the total tonnage and type of WEEE/WPB that is collected and sent to recycling facilities for recovery. • Input fractions: Calculating the mass of all materials entering the recycling process each year in tonnes. • Output fractions: Calculating the mass of materials that are produced from the input fraction because of the recycling process each year in tonnes. • Recycling efficiency: The ratio obtained by dividing the mass of output fractions by the mass of the input fractions.	Mass balance approach	AATFs: Responsible for data collection. EA, AATF Forum and ICER: Engagement needed to broaden requirements laid out in the existing regulations.	No additional cost for large AATFs. Some costs (not estimated at this time) for small AATFs and the EA
	Hoarded electricals and batteries	Items & tonnes	Information from members of the public regarding the quantity and type of waste electrics and waste portable batteries that are currently hoarded in their homes, including: • How many hoarded items respondents currently possess, per item type. • The length of time the items have been hoarded for.	Household survey	Material Focus, Opinium (a survey platform) and households: Responsible for data collection.	£200 - £250 +VAT per survey question sent to 2000 respondents.

Metric group	Metric	Units	Data points required	Methodology	Involved actors & responsibility	Indicative cost (£)
			• Why the items have been hoarded and not disposed of. • How many previously hoarded items respondents had disposed of this year. • The length of time the items were hoarded for. • How the items were disposed of.			
	Binned electricals and batteries	Items & tonnes	• The weight of electricals thrown away in general household waste (measured in tonnes). • The type of electricals thrown away in general household waste (by WEEE category). • The weight of batteries thrown away in general household waste (measured in tonnes). • The type of batteries thrown away in general household waste (by battery type). • Profile of individual LAs (i.e., region, rurality, socio-economic status).	Waste compositional analysis	LAs: Responsible for data collection. Defra, LARAC: Engagement needed to form wider project.	£3,800 – £10,400 per MCA
Disposal options	Number of drop-off points	Type & items accepted	Material Focus already maintain a database of drop-off points by type and items accepted that is available to the public. The information stored within this database includes: • The name of the drop-off point. • The location of the drop-off point. • If the drop-off point is operated by a LA, which one. • The type of drop-off point (LA, retailer, re-user, etc.). • What items are accepted by the drop-off point.	Material Focus's database of drop-off points.	Material Focus: maintaining and updating list. LAs, retailers: provide up-to-date information.	£10,000 annually
	Availability of household collection services	Type & items accepted	The name of the collection service. The location of the collection service and the area it serves. If the collection service is operated by a LA, which one. The type of collection service (LA, retailer, re-user, etc.). What items are accepted by the collection service. What types of households the collection service serves (for example, a large number of collection services do not serve flats). Whether the service is free or paid for.	Database of collection services	Material Focus: maintaining and updating list. LAs, services: provide up-to-date information.	£10,000 annually

Metric group	Metric	Units	Data points required	Methodology	Involved actors & responsibility	Indicative cost (£)
Consumer perceptions	Awareness of the need to recycle electricals and batteries Perceived ease of recycling electricals and batteries Perception that recycling electricals and batteries is worth doing Preferred channels for recycling electricals and batteries Perception that recycling electricals and batteries is important Perception that recycling electricals and batteries is the normal thing to do Awareness that binning electricals and batteries is dangerous Claimed reuse and recycling behaviours for electricals and batteries Attitudes to buying second-hand and refurbished products	N/A	• The majority of questions in the survey are quantitative, closed questions. For example, respondents are asked: • Whether they know how to dispose of particular items. • How they currently dispose of those items. • If they currently dispose of those items in general waste, why. • Whether they are aware of a number of environmental campaigns. • Whether they agree with statements regarding ease and their understanding of waste electrical recycling.	Material Focus's Bellwether survey	Material Focus, Opinium (a survey platform) and households: Responsible for data collection	£8,500 annually (for a survey of ~40 questions)

4.1 PRODUCT FLOWS

4.1.1 New EEE and batteries placed on the market and by channel sold (measured in items and tonnes, including physical retailers, online marketplaces, household and business, etc.)

Data required to implement metric:

Batteries:

As noted in Section 3.1.1, battery POM data is currently available by weight for a limited number of chemistry types and can be found on the NPWD.

There is no requirement to report by quantity, by sales channel, by sales type (included in an electrical product or sold as a battery) or by further chemistry type other than that already required.

However, from previous exercises it is known that producers would be able to report at a more detailed level. The level of detail easily available would vary producer by producer but as a minimum it is expected that quantity data would be easily available and that more granular reporting by battery chemistry should also be a relatively simple matter.

To achieve this metric there are two potential methods, however it is seen that only the first of these is worthwhile to pursue.

- Obtain more granular data from producers (likely via compliance schemes)
- Use a conversion factor

To obtain full data it would be necessary to mandate producers to provide this information. This would then be reported as an extension of current reporting. Only large producers (as defined by the current regulations) would need to be mandated.

Currently DEFRA are seeking voluntary submission of more granular data from producers, however it is too early to determine how successful this request will be. The risk of using incomplete data is that significant distortions can occur as, due to the major differences in technology and type of battery individual producers market, simply extrapolating data may produce highly misleading results. Whilst there would be an element of increased administrative burden and cost related to a mandatory extension of reporting, it is understood that significant greater granularity may be obtained relatively easily. It has been noted that previous reviews of batteries legislation have found that some stakeholders “were either not willing to share detailed information on weight and quantities placed on the market” [9]. However, it is felt that if producers report this data in the same way as currently done for weight where data is anonymously collated and only published at a national level, this concern should be mitigated.

One other potential method is to use a conversion factor (using the same methodology as the one used for calculating the number of items recycled). However as this would add a potentially high level of uncertainty to the result and as the provision of actual data is seen to be relatively easy to achieve, this method is not further considered.

Electrical and electronic equipment:

The data required for new electricals placed on the market is essentially the same as for portable batteries. This is by weight and not quantity. Section 3.1.1 provides an overview of current reporting categories for the UK electricals system, which are relatively high level.

Public reporting at a national level is made on the DEFRA website of gov.uk.

As with batteries, adding reporting by quantity to the required data submission should add little additional burden to large producers. It is also known that producers have to report at far greater levels of granularity in other jurisdictions. For example, the Republic of Ireland reporting by product type is split into 48 levels as opposed to the UK’s 14. Increasing the level of granularity of UK reporting, especially if matched with other nations reporting requirements (such as Ireland) should also be feasible without major cost impact. The less satisfactory alternative would be to use conversion factors to expand the current UK category reporting.

Methods for data collection:

Batteries:

As noted above, national POM data for batteries by weight is publicly available online split by 3 chemistries, with DEFRA seeking more granular data (quantity and chemistry) on a voluntary basis through the registered Battery Compliance Schemes. It is too early to determine the success of this initiative, however without universal take-up there will always be the risk of data being misleading if even just a few major producers data is not included, as producers often specialise by chemistry and so extrapolation is not a reliable tool in this respect.

It is likely that the mandating of greater data provision would fall on large producers only. That is those producers that place more than one tonne of portable batteries on the market in a single year and who must register with a compliance scheme, of which there are five currently registered in the UK:

- BatteryBack
- Ecosurety Ltd
- ERP UK Ltd
- REPIC
- Valpak Ltd

If a producer places less than one tonne of portable batteries on the market, it must register directly with the relevant environmental regulator and report its POM data on the NPWD, but as small producers account for less than 0.5% of the market, it is unlikely that their reporting requirements would need to change.

Electrical and electronic equipment:

As above, producers of electricals must also register and report the products placed on the market in each calendar year. As with batteries producers, the body with whom a producer must register is dependent on the weight it produces per year: if a producer places less than five tonnes of electricals on the market per year (small producer), it may register directly with the relevant environment agency, while producers of more than five tonnes of electricals are required to register with one of 24 Producer Compliance Schemes:

To meaningfully achieve this metric it is foreseen that mandating enhanced reporting would be necessary, at least to include quantity as well as weight.

If mandatory reporting at a more granular level of product type was not introduced there is the potential to consider using the UNU-KEYS classification system developed by the United Nations University (UNU) which integrates available statistical data and non-statistical data sources into e-waste statistics [36]. Its main aim is to improve the comparability of data between countries, through offering a sound measurement framework which captures the size of the market for electrical products, the weight of waste electricals generated and collection performance. The 54 product groups developed share average weights, material compositions, end-of-life characteristics, and life-time distributions. This can also be linked to the new and old reporting categories of the WEEE Directive. The UNU-KEYS classifications could be used in a number of ways to support the material flow analysis of electricals and waste electricals, including converting the six and 10 electricals categories3 of the EU WEEE Directive (see Table 1 in referenced report).

However full reporting would clearly produce more reliable data. Reference has been made above to the system of reporting used in the Irish Republic. With the oversight of Producer Register Ltd, the Irish waste electricals system has split the EU six categories of electrical products into a series of additional sub-categories by which producers must split their POM data by both weight and quantity [37]. During the interviews, one stakeholder highlighted that they currently adopt these Irish categories across their whole operation as they are the most detailed. As mentioned, the UK equivalent requires producers to submit data at a much less granular level (as presented in Table 4 above).

Indicative costs of data collection:

Batteries:

The cost of data collection for this metric should be minimal. Tonnage data from the NPWD is publicly available, and supplementing this with additional information from producers (via Battery Compliance Schemes) should not incur any costs beyond initial set-up. For producers and compliance schemes, there may be a small

additional cost resulting from set-up and increased administrative activities, but most if not all the required data should be recorded internally already.

Electricals and electronic equipment:

Similarly, data collection costs for electricals should be small. Again, there may be a small set-up and ongoing administrative cost for producers and compliance schemes, but these should be minimal for adding quantity reporting. Should the UK seek highly granular reporting by product type, especially should this go beyond that required in other European countries (e.g. Ireland), then such costs could rise more significantly.

4.1.2 Recycled electricals and batteries (measured in items and tonnes) and Quantity/efficiency of material recovery from WEEE/WPBs

This metric has been grouped with the quantity and efficiency element of the shortlisted '*Quantity/efficiency/quality of material recovery from WEEE/WPBs'* metric. By grouping these metrics, we can understand the real recycling activity across both UK systems, including what material goes in and comes out.

Data required to implement metric:

It is recommended that this metric is broken down into four separate measurements:

1. **Collection:** Calculating the total tonnage and type of waste electricals/waste portable batteries that are collected and sent to recycling facilities for recovery.
2. **Input fractions:** Calculating the mass of all materials entering the recycling process each year in tonnes.
3. **Output fractions:** Calculating the mass of materials that are produced from the input fraction as a result of the recycling process each year in tonnes. In simple terms, this is referring to the proportion of WEEE or WPB that is actually recycled (i.e., the real recycling rate[3] [38]).
4. **Recycling efficiency:** The ratio obtained by dividing the mass of output fractions by the mass of the input fractions.

Figure 19 visually presents the point at which the four above measurements should be calculated in relation to their relative positioning across the recycling value chain.

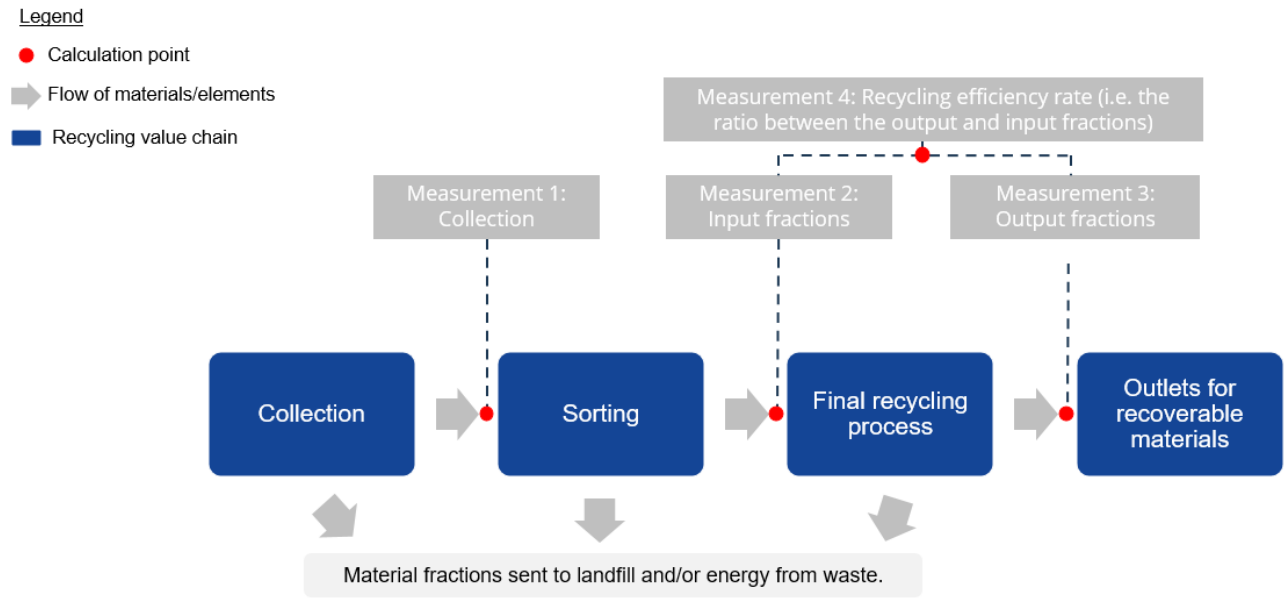


Figure 19: Overview of key metrics relating to the recycling process

Source: Ricardo (Adapted from Eurometaux)

[3] Real recycling takes place after sorting and the final recycling process, where the recyclates are guaranteed to be reprocessed into new applications/products. This is the direction of travel across EU policy.

Sources of relevant data:

The following section is split out into the four individual measuring points that sit under this metric.

1. Collection

The weight of household and non-household waste electricals collected by Producer Compliance schemes and their members is already being collected by the EA and published online. This information is reported against the 14 WEEE categories, alongside 1 category for non-household waste electricals and 3 categories for household waste electricals, namely:

- Household waste electricals from DCFs that has been collected by Producer Compliance Schemes, and household waste electricals that DCFs have cleared themselves.
- Household waste electricals returned by distributors to Producer Compliance Schemes.
- Household waste electricals collected through a collection system a Producer Compliance Scheme operates itself.

Table 14: Household waste electricals collected in the UK between Jan – Dec 2021

	Category Name	Household WEEE collected from a DCF[1] (tonnes)	Household WEEE returned under regulation 43[2] (tonnes)	Household WEEE returned under regulation 50[3] (tonnes)	Total separately collected household WEEE[4] (tonnes)
1	Large Household Appliances	71,730.268	94,329.230	14,986.759	182,645.513
2	Small Household Appliances	26,728.683	674.088	3,902.294	31,386.022
3	IT and Telecoms Equipment	23,835.114	714.732	12,097.219	36,680.887
4	Consumer Equipment	16,403.872	181.420	4,265.901	20,916.591
5	Lighting Equipment	4,407.453	116.878	723.143	5,252.991
6	Electrical and Electronic Tools	20,812.821	244.422	1,658.236	22,740.828
7	Toys Leisure and Sports	4,112.556	36.365	387.549	4,542.176
8	Medical Devices	0.182	0.005	10.347	10.534
9	Monitoring and Control Instruments	837.185	14.450	250.627	1,104.792
10	Automatic Dispensers	0.000	0.000	0.000	0.000
11	Display Equipment	33,081.155	1,514.405	4,995.232	39,706.859
12	Cooling Appliances Containing Refrigerants	79,952.302	48,677.640	12,568.649	141,947.300
13	Gas Discharge Lamps and LED Light Sources	897.837	241.851	2,884.156	4,023.867
14	Photovoltaic Panels	197.434	2.645	54.188	254.192
	Total	**282,996.862**	**146,748.131**	**58,784.300**	**491,212.552**

UK collection rates for batteries are reported on the National Packaging Waste Database [15]. The data is reported in tonnes and split by battery type and compliance scheme. Table 15 is an example of how this data is presented by battery type.

Table 15: WBP collected by Battery Compliance Schemes reported in 2021 (tonnes)

Battery type	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Pb/acid	3,710	3,802	3,628	2,961	14,101
Ni-Cd	91	68	118	47	324
Other	1,081	1,083.996	1,213.846	487.975	3,867.014
Total	**4,883**	**4,953**	**4,959.923**	**3,496.361**	**18,292.238**

2. Input fractions

Measuring the input fractions of the recycling process for both waste electricals and waste portable batteries is already being carried out by ABTOs and AATFs. This is because this data is needed to calculate the proportion of electrics or batteries that are recycled as part of their reporting requirements. However, the input fractions are currently not being reported upon to the EA for either waste electricals or waste batteries. This would need to become mandated in current legislation.

3. Output fractions

Measuring the output fractions of the recycling process for both waste electricals and waste portable batteries is already being carried out by ABTOs and AATFs. For waste batteries, recording their output fractions is part of their reporting requirements for recycling tonnages. For waste electricals, recording output fractions is not part of any reporting requirements. However, AATFs are required to provide evidence of their recycling efficiency rates (see below), of which data on the input and output fractions are both needed to calculate. Therefore, in the national protocols for waste electricals, reporting on output fractions (alongside input fractions and recycling efficiency) would need to be mandated.

4. Recycling efficiency

For batteries, ABTOs are already obliged to report their recycling efficiencies to the EA, under Annex 1 in the Directive for waste batteries and accumulators [39]. For waste electricals, AATFs are also obligated to report their recycling efficiencies to the EA in the form of 'recycling and recovery target' through the national protocols.

Methods for data collection:

The following method is split out into the four individual measuring points that sit under this metric.

1. Collection

It is recommended that existing data released by the EA is utilised to calculate the tonnage of waste electricals and waste portable batteries that are collected each year. To convert the tonnages of collected waste electricals and waste portable batteries into item type (e.g. product category – consistent with other metrics), conversion factors should be adopted. Having consolidated this data, a relevant body would then be able to calculate the collection rate as a percentage through adopting the following calculation:

Collection rate = (Total waste collected / total waste generated) x 100

2. Input & output fractions

To measure both the input and output fractions, it is recommended that AATFs and ABTOs undertake a mass balance exercise. 'Mass balance' is an accounting principle that matches inputs with outputs from a recycling or production process, to determine the recycled content. During the consultation on the new appropriate measures, DEFRA reported that 'there was overwhelming support for the proposal to include an annual mass balance exercise for all waste electrical streams being treated at a site' [40].

A mass balance approach must be strictly regulated and not allow for unreliable accounting. At this time, there does not appear to be guidance set by Defra or the EA on how to carry out a mass balance exercise. Therefore, it is recommended that this guidance and associated regulations are developed to ensure that AATFs and ABTOs are adopting the same approach to maximise the robustness of these figures.

For batteries specifically, there is some additional guidance online on how to calculate the input fractions. For batteries, the measurement of input fractions is on a dry weight basis and includes fluids, acids, and the external jacket of the battery, but exclude the outer casings of the battery pack as they are not included in the recycling process). When assessing the input fraction, the recyclers must carry out three separate activities [41]:

- **Determine the share of different waste battery types or accumulator which are present in the input fraction:** This can be measured by undertaking a sorting analysis of the fraction (either by continuous or representative sampling).
- **Determine the chemical composition of each waste battery or accumulator type present in the input fraction:** This can be measured based on the chemical composition of new batteries and accumulators when placed on the market. Alternatively, recyclers can determine the chemical composition of each battery category based on the available data of recyclers or on information provided by the battery producers.
- **Determine the overall chemical composition of the input fraction:** This can be measured by applying the chemical composition analysis to the types of batteries or accumulators involved in the input fraction.

In relation to output fractions, for batteries this is on a dry weight basis and includes all components that are suitable for recycling after the dismantling of the battery, such as carbon, oxygen, and materials of the battery contained in the slag. Carbon, oxygen, and battery and accumulator materials are identified in the Regulation (493/2012) as three elements (amongst others) that may be accounted for in the output fractions [42].

Measuring the input and output fractions of the recycling process should be carried out annually and broken down by WEEE reporting categories 1-14 (see Table 5) or battery type (see Table 6) – categories which could be expanded further for granularity (as discussed in the previous metric). Both should be measured in material output in weight.

3. Recycling efficiency

Once the AATF has calculated its input and output levels of waste electricals or waste portable batteries, the following calculation can be adopted to measure the efficiency of the recycling process:

Recycling efficiency = (mass of output fractions / mass of input fractions) x 100%

Measuring the recycling efficiency of waste electricals and waste portable batteries should also be carried out annually. For waste electricals, the recycling efficiency should be calculated separately by WEEE reporting categories 1-14 (see Table 5), whilst for waste batteries it should be calculated separately by battery type (see Table 6).

For waste batteries, recycling efficiency is calculated on the basis of the overall chemical composition (at elemental/compound level) of the input and output fractions. Annex 1 in the Directive for waste batteries and accumulators provides a detailed explanation of this calculation for batteries [42].

Due to concerns over industry's willingness to voluntarily disclose this information, it is recommended that this data requirement is mandated into an additional reporting requirement (to the EA) by all AATFs. It is also recommended that this information is reported upon annually, to minimise potential administrative burden and costs for smaller AATFs. If it were decided that mandating this would be the best route to take, the key stakeholders to include in this process should include the EA, ESA, AATF Forum and ICER.

Indicative costs of data collection:

It is expected that the costs for collecting data would continue to fall predominately on the AATFs. No additional costs are expected for large AATFs who are already reporting this data to the EA. However, depending on the required regularity of the data submissions, additional costs may appear in relation to the time needed to collect and submit the data, and the possible need for third party verification.

Finally, there would also be a cost to the DEFRA and/or EA to consult upon and update the national protocols and appropriate measures to make this a mandatory requirement for all AATFs.

Challenges in data collection:

No significant challenges are expected in the data collection for waste electricals or waste portable batteries as the above data points are either already required in legislation or represent calculations that AATFs/ABTOs would already be undertaking to get the mandatory data points (i.e., the input and output fractions).

4.1.3 Hoarded electricals and batteries (measured in items and tonnes)

Data required to implement metric:

This metric requires information from members of the public regarding the quantity and type of WEEE and WPBs that are currently hoarded in their homes.[4] Current definitions of hoarding do not include any consideration of time hoarded, however it would be useful to develop a more distinct definition that defines a hoarded item as one that has been stored for longer than, say, six months. As is discussed below, it is recommended that a survey be conducted to gain a representative sample that can be scaled up to estimate the total amount (type, number and weight) of hoarded waste electricals/waste portable batteries in the UK.

Where problems may occur is in the risk of double counting: some of the waste electricals/waste portable batteries that are hoarded each year will eventually be disposed of, which means that these items could be counted as both hoarded and discarded at the same time. To mitigate against this double counting, the survey may wish to include questions regarding the amount of previously hoarded items that the responder had disposed of in the last year. This relies on the respondent remembering what items they had hoarded and then disposed of, so they may under-report their disposed-of items, but this figure can provide a more holistic overview of current hoarding practices.

Sources of relevant data:

The required data could be sourced via a survey of householders, similar in style to the Omnibus surveys Material Focus uses to track consumer perceptions (see Section 4.3). A sample size of 2000 households will provide a representative sample from which an estimated national quantity of hoarded items can be extrapolated using the number of households in the UK for that particular year. Previous surveys on hoarded electricals have been commissioned by Material Focus and others.

It is recommended that respondents are asked about their hoarded electricals/portable batteries per item rather than by weight as respondents are thought to be less likely to engage with weighing their individual hoarded items. To convert to weight, conversion factors can be used. As discussed above, the United Nations University provides a list of weight conversion factors for a wide range of electricals [36] , while for portable batteries, work should be done to develop conversion factors (see Section 3.1.1).

Methods for data collection:

As noted, the primary proposed method for data collection for this metric is the dissemination of a survey via an Omnibus survey. Alongside capturing demographic information as in the Bellwether survey, the following topics could be covered:

- How many hoarded items respondents currently possess, per item type corresponding to the above electricals and battery categories – this will allow for increased understanding of which items are most commonly hoarded, enabling more targeted interventions to be planned.
- The length of time currently held items have been hoarded for – understanding consumer behaviour will again grant a greater understanding of the psychological aspects of hoarding.
- Why the items have been hoarded and not disposed of – if it is reported, for example, that consumers are hoarding old phones because they do not know where to dispose of them, it is clear that more work needs to be done to signpost drop-off points and other recycling options.
- How many previously hoarded items respondents had disposed of this year – as noted above, some hoarded items will eventually be disposed of. This will allow for understanding of the annual turnover of hoarded items and understand how much hoarded electricals/portable batteries is double counted.
- The length of time the items were hoarded for before disposal – as above, it is useful to understand how long an item was hoarded before it was disposed of to understand why items are hoarded.
- How the items were disposed of – this will help to plan future activities, for example if it is found that hoarded electrical items are disproportionately disposed of to landfill.

In order to calculate the ‘true’ rate of hoarding, the following calculation could be used.

[4] In this case, the definition of ‘hoarded’ is taken as any item of WEEE or WPB which is no longer used but has not been disposed of.

Variables:

A_1 = reported hoarded items (tonnes), information collected in year 1

A_2 = reported hoarded items (tonnes), information collected in year 2

B_1 = previously hoarded items now disposed of (tonnes), information collected in year 1 (data from year 0)

B_2 = previously hoarded items now disposed of (tonnes), information collected in year 2 (data from year 1)

'True' rate of hoarding, $C_1 = A_1 – B_2$

If we assume that $B_1 \sim B_2$, then to ensure that data is not a year out of date the calculation can instead be

'True' rate of hoarding, $C_1 = A_1 – B_1$

Indicative costs of data collection:

Material Focus conducts regular surveys, including its annual Bellwether survey to explore consumer perceptions of waste electricals and waste portable batteries. More detailed cost information is provided in Section 4.3, but currently prices are understood to be in the region of £300 +VAT per survey question..

4.1.4 Binned electricals and batteries (measured in items and tonnes)

Data required to implement metric:

The data required to implement this metric includes:

- The weight and type of electricals thrown away in general household waste (measured in tonnes)
- The weight of batteries thrown away in general household waste (measured in tonnes)
- The type of batteries thrown away in general household waste (by battery type)
- Profile of individual LAs (i.e., region, rurality, socio-economic status)

Sources of relevant data:

Relevant data will all come via undertaking a waste compositional analysis (WCA).

Classification systems, such as ACORN, MOSAIC or the OAC system, can also be utilised to group residents into different bands relating to their socio-economic status. These are based on a combination of census, Electoral Register and survey data on lifestyles and consumer preferences.

Methods for data collection:

It is recommended that this data is collected through undertaking a compositional analysis of general household waste from selected households across the UK. WCA is the process of manually separating, categorising and weighing the various materials in a single waste stream. In order to ensure the success of the WCA, the aims and objectives of the exercise must be well defined at the outset. In the context of this project, the overall aim of the WCA would be the measurement of the weight of waste electricals and waste batteries that are binned each year. The objectives of the activity would alternatively be to maximise the capture rates of waste electricals and waste batteries (through diverting products from landfill) and support the creation of targeted interventions and communications materials.

This would provide insight into the number and weight of different waste electricals and batteries that are thrown away and destined for landfill. Alongside electricals and batteries, packaging, plastics, textiles and food have all been highlighted as key value chains that require urgent and coordinated action in the Circular Economy Action Plan [43].[5] Therefore, carrying out a compositional analysis on general household waste should be equally as beneficial for these other industries in terms of maximising capture rates and supporting targeted interventions. It is hoped that this analysis could be conducted as a wider piece of work, where waste electricals and waste batteries are also included. It has also been identified that Defra is undertaking a national waste compositional analysis in the near future (a Prior Information Notice was published in April 2022 [44]), which has been deemed an opportunity for partnership and alignment of key objectives. It is recommended

[5] The Circular Economy Action Plan was adopted in 2020 and represents Europe's agenda for sustainable growth. The action plan announces initiatives and measures along the entire life cycle of products to promote a circular economy.

that the waste electricals and batteries proportion of the national WCA be investigated as part of this wider scope of work.

It is recommended that the compositional analysis should be carried out in the following steps:

1. Identification of LAs and households

When determining specific LAs and households for sampling, the following key variables must be considered:

Table 16: Factors affecting kerbside collected household waste

Factor	Influence on waste arisings
Socio-economic	The profile of waste arising changes based on a household's disposable income and lifestyle.
Demographic	The age and structure of a household.
Housing type	Differences in housing type will present varying challenges to waste sampling.
Season, weather, climate	The proportion of certain wastes in waste streams may fluctuate based on the season.
Waste service characteristics	Collection frequency, containment capacity, local by-laws and proximity to HWRC and bring sites can all influence kerbside household waste composition.

2. It is suggested that the relevant body considers engaging and/or partnering with LARAC (the leading voice for LAs on recycling, waste and resource management) to build connections with LAs who are willing to undertake this work.

3. Collection & sorting:

Without knowing the actors involved in the WCA and the allocated budget, it is difficult to accurately estimate the sample size needed to carry out this activity in a robust and representative manner. Engagement with the confirmed partner(s) for this work is therefore recommended to determine an appropriate sample size. However, Zero Waste Scotland has created guidance that advises the methodology minimum requirements for a household kerbside WCA. This recommends that a minimum of 4 – 5 samples are taken, across a sample size of 50 households. It should be noted that this sample size is relative to Scotland's overall population size, and this would need to be reviewed for appropriateness against the population of where it is undertaken.

There are two key sampling techniques which can be adopted:

- **Sampling at a kerbside level:** The most common approach, where sampling is undertaken at the level of street blocks with each sample representing a specific number of households. The whole sample bulk is then sorted, representing a bulked sample of waste from a set number of households.
- **Sampling at a household level:** This approach involves the separate sorting of each household's waste. Households are selected from within street blocks which represent particular area types, and as a result, each sample represents a separate households' waste.

In the context of this project and aspirations of creating more targeted interventions (such as waste prevention and recycling campaigns), sampling at the household level would be the most beneficial option, as it would present a house-to-house variation in terms of waste composition. However, this approach does create practical challenges in relation to identifying each household's waste and is more expensive.

4. Categorisation:

The development of a suitable and comprehensive list of waste categories is essential to assure the success of any WCA. As the WCA is predicted to be carried out as part of a wider study, the categorisation process will have to be undertaken in two stages through a hand-sorting operation:

- **Sorting by primary categories:** The main categories for which most WCAs include data. Alongside waste electricals and batteries, these may also include food waste, paper and card, glass, ferrous metals, non-ferrous metals, dense plastic, plastic film, textiles, hazardous, other combustible, other non-combustible, putrescible, fine material and other wastes.

- **Sorting by secondary categories:** Breaking down the main categories into sub-fractions. For the waste electricals fractions, it is recommended that the same categorisation as reported upon through the UK WEEE system be adopted (as presented in Table 5). Previous WCAs led by LAs have not recorded the data to this same level of granularity and have alternatively adopted the following secondary categories: large WEEE and small WEEE [45], [46].

5. Reporting

To ensure that the results of the WCA are directly comparable year on year, it is recommended that a report is developed for each individual activity which includes the following information:

- Key aim, objectives and scope (including a detailed description of the waste streams in-scope)
- Timing and methodology (including key dates, who carried out the sampling, location and description of sample areas/households, route of where the waste has come from, stratification method used and how areas for sampling were selected, sampling processes (i.e., the approach to sampling the waste stream), sorting methodology and the identification of potential biases.
- Results (including key findings/statistics, identification of any caveats).

There is also an opportunity to lead the way in terms of adopting a more modern, innovative approach to WCA, through using artificial intelligence (AI). Although not all have been carried out at scale with waste electricals characterisation as of yet, a number of key technologies have been identified below which could create significant efficiencies:

- **Greyparrot AI Waste Analytics System:** An AI-powered computer vision system which automatically characterises objects with an error rate of less than 1%. A customisable waste analytics dashboard is then provided to display the live compositional data.
- **Recycleye Vision:** Adopting advanced machine learning, computer vision and automation to commodify and revolutionise wate sorting.
- **TrueCircular:** Delivers real time data and insights through a combination of implementing hardware and computer vision AI to calculate the composition of waste by weight as a 95% accuracy rate.

Indicative costs of data collection:

When considering the cost of data collection, internal costs of the LAs and any additional contractor costs must be considered. The main costs will include staff costs for project management, data analysis and reporting, as well as any additional costs for travel and subsistence.

The cost of WCA is highly dependent upon a number of key factors to be decided during the planning stage. For example, this includes the number of households per sample, the way in which the waste is sorted (i.e., at a kerbside or household level), the tonnage of average bin weights and the location of the sorting process, etc.

Contractor costs for WCA can significantly vary (as presented in Table 17). The costs included in the table have been taken from tenders submitted during Zero Waste Scotland's 2013 – 15 funding programme. The costs are presented by sample area, which covers waste from 50 households and includes 2 phases of fieldwork sorting both residual and co-mingled dry recycling (and in certain circumstances food and garden waste). Although this activity is clearly larger in terms of scope and coverage, and prices are likely to have increased in the intervening years, this an estimated ballpark figure for the contractor costs involved. It is assumed that at least one WCA would be needed per region to have a representative national sample.

Table 17: Contractor WCA costs per sample for 2 phases of fieldwork (excluding VAT)

Per sample cost	All 2 season	Including collection	Excluding collection
Min	£2,700	£3,819	£2,700
Max	£10,383	£10,383	£7,200
Median	£5,430	£5,8134	£5,158

4.2 DISPOSAL OPTIONS

4.2.1 Number of drop-off points by type and items accepted

Data required to implement metric:

Material Focus already maintain a database of drop-off points by type and items accepted that is available to the public [47]. The information stored within this database includes:

- The name of the drop-off point
- The location of the drop-off point
    - This is used to show the user the distance of the drop-off point from their location
- If the drop-off point is operated by a LA, which one
- The type of drop-off point (LA, retailer, re-user, etc.)
- What items are accepted by the drop-off point

Each drop-off point entry on the database also links to the relevant website as well as to Google Maps so that the database user can easily plan their journey.

No further information is required for this metric, though discussions with Material Focus highlighted a potential issue: some LA sites may be usable only by households within that particular LA. It may be possible to update the database to indicate when this is the case. Additionally, when developing a similar database, information such as the operating times of the drop-off point as well as its accessibility to people with disabilities should be included.

Sources of relevant data:

The data for this metric is all publicly available via the websites of Local Authorities, retailers and waste management companies. The database also utilises Valpak's list of UK recycling centres. Some staff time will be required to maintain the database and update any new or recently closed drop-off points, though it was noted that if good relationships are maintained with all the relevant stakeholders, they may provide this information voluntarily. The database website also prompts users to get in touch if any of the information is out of date.

Methods for data collection:

Building on the original list of recycling centres from Valpak, there are a number of methods that can be used to collect the required data:

- Retailers can be contacted directly and asked to provide a list of their stores that act as drop-off points (Curry's and Next are examples of companies that work with Material Focus in this way)
- Web-scraping tools can be used to gain a list of retailer location; however, this is a more expensive option, particularly as the list is updated regularly – cooperation from stakeholders in the system is thus a more efficient option
- Individual websites can be checked for drop-off locations; staff regularly monitor the database and check for any updates
- As noted above, members of the public can contact the relevant body to provide updates on the database

In future, it would be useful for regulation to include the requirement for organisations to update information on the dropping-off of electricals regularly.

Indicative costs of data collection:

As the database is already operational, the costs involved in establishing it have not been considered in this section. These costs included the development of the postcode locator and a widget to sit on external websites. In terms of maintenance of the database, Material Focus estimates an annual cost of around £10,000, including maintenance of the servers and staff time to update the list. It is expected that costs will be similar for development of a similar database.

4.2.2 Availability of household collection services

Data required to implement metric:

This metric is relatively similar to the above 'Number of drop-off points by type and items accepted'. Material Focus is currently working on a similar database for household collection services, though it is in a less advanced state than the database of drop-off points.

The data that is required for this metric is also fairly similar to the above metric, comprising:

- The name of the collection service.
- The location of the collection service and the area it serves.
- If the collection service is operated by a LA, which one.
- The type of collection service (LA, retailer, re-user, etc.).
- What items are accepted by the collection service.
- What types of households the collection service serves (for example, a large number of collection services do not serve flats).
- Whether the service is free or paid for.

As above, it is also recommended that the service's operating times are also recorded.

Sources of relevant data:

This data, as above, should all be publicly available as it amounts to services offered to members of the public. Material Focus suggested that a webscript could be written and used to monitor changes to LA services, but non-LA operated services are likely to be more difficult to identify. In particular, their areas of operation may be vague and dependent on the circumstance, making their inclusion in the list problematic. In these cases, it would be more effective to communicate with the organisation and maintain a good relationship so that the service's information can be recorded as accurately as possible.

Methods for data collection:

The methods for collecting the required data are relatively similar to the above metric.

- For services provided by LAs, a list of relevant website pages can be maintained, and a simple script used to alert staff to any changes to the website. When a change is reported, a member of staff should update the database with the new information.
- A script or web scraping tool can also be used to identify UK-based private collection services which can then be manually added to the website. This will be a larger task due to the potential variation and vagueness of service areas and business models.
    - Then, it is more efficient to develop relationships with these organisations, particularly larger ones that serve a broad area. The businesses' inclusion in a database of collection services could provide extra business to them, leading to a mutually beneficial relationship.
- As above, members of the public can contact the relevant body to provide updates on the database.

Indicative costs of data collection:

It is anticipated that the same website can be used for the database of collection services as drop-off points, minimising the cost of developing the new database. Therefore, as above, it is expected that annual maintenance costs will be in the region of £10,000.

4.3 CONSUMER PERCEPTION METRICS

This section covers the following metrics:

- Awareness of the need to recycle electricals and batteries
- Perceived ease of recycling electricals and batteries
- Perception that recycling electricals and batteries is worth doing
- Preferred channels for recycling electricals and batteries
- Perception that recycling electricals and batteries is important
- Perception that recycling electricals and batteries is the normal thing to do
- Awareness that binning electricals and batteries is dangerous
- Claimed reuse and recycling behaviours for electricals and batteries
- Attitudes to buying second-hand and refurbished products

Data required to implement metric:

Material Focus currently collects all the information required for these metrics, except for "Attitudes to buying second-hand and refurbished products". Material Focus operates an annual survey known as the Bellwether survey to understand consumer perceptions around waste electricals and waste batteries recycling. This is an Omnibus survey that is sent to a sample of 2000 adults across the UK and which has been operated since 2019. Material Focus is currently working to establish a robust baseline against which future surveys can be compared and the success of targeted interventions assessed.

Most questions in the survey are quantitative, closed questions. For example, respondents are asked:

- Whether they know how to dispose of particular items?
- How they currently dispose of those items?
- If they currently dispose of those items in general waste, why?
- Whether they are aware of a number of environmental campaigns?
- Whether they agree with statements regarding ease and their understanding of waste electrical recycling?

A small number of open questions are also asked to respondents. When asked why they dispose of electrical items in the general rubbish bin, a possible answer is 'Other reason not listed here', which prompts respondents to provide their reasoning.

Sources of relevant data:

The public is the sole data source for these metrics via an Omnibus survey company. Respondents are all volunteers that have been selected so that the sample size is nationally representative. The third-party survey company (currently Opinium) provides Material Focus with full data tables of the responses along with a written topline report.

Methods for data collection:

As noted above, Opinium is responsible for collecting the data from respondents. The survey is operated at roughly the same time each year (generally August to October) to ensure that the results are as standardised as possible. The sample size of 2000 is widely regarded as being robust and representative, with weighting applied when necessary; this is considered to be suitable for analysis at a national or regional level, though a larger sample would be required for more specific comparison between LAs. Currently, responses are split according to gender, age, country, and region , while Material Focus previously conducted a survey that was analysed at a city level with a sample size of 4000. It noted that while it does not operate larger surveys as a matter of course, the process for developing one-off larger surveys is uncomplicated, and that additional surveys are often operated before and after campaigns to track the response to the initiative.

It is important when developing and operating future surveys that the existing questions remain the same. This is to ensure that the results from previous years can be effectively compared. It does not mean, however, that the survey is unchanged year on year: additional questions can be asked to respondents for the fees listed above, depending on changes to the sector or consumer behaviour.

The Bellwether survey focuses on seven overarching topics:

- Whether or not, and how, the respondent can dispose of different types of items in their local area
- Whether the respondent agrees or disagrees with a set of statements regarding the recycling of small electrical items
- What the respondent tends to do with small electronics they no longer need
- How the respondent usually disposes of different types of items that are no longer working
- If the respondent disposes of items in general waste, why they do so
- Whether the respondent is aware of a number of recycling campaigns
- Whether the respondent is able to dispose of small electrical items via kerbside collection

The responses to these topics aid whoever is distributing the survey (in this example Material Focus). to decide where to place its focus for future campaigns. For example, the 2021 survey highlighted that while the majority of respondents felt that it is right to recycle small electricals, at least a quarter don't understand how to so either keep them or throw them in the general waste. This indicates that a knowledge campaign would be useful to increase recycling rates. The survey in its current format is suitable for use towards developing a national metric/metrics. However, development with new, additional questions should be ongoing - to better understand specific topics as trends within the system change.

Indicative costs of data collection:

The main cost of data collection for these metrics is the cost for Opinium to conduct the survey and analysis. Currently, Opinium quotes a fee of £250 (+VAT) per question up to 10 questions and £200 for each question thereafter (there are also discounts for charities and non-profit organisations). For a survey of ~40 questions, this equates to £8,500 without any discounts. Material Focus will likely also utilise staff time to liaise with Opinium to design any additional questions, and to develop initiatives based on the results of the survey.

5 CONCLUSION AND RECOMMENDATIONS

At a high-level, this research has identified both new and existing key stakeholders in the waste electricals and waste batteries systems and encouraged the sharing of knowledge across the value chain. Understanding the opinions, ambitions and challenges of the stakeholders engaged has enabled the development of a final shortlist of practical, impactful metrics and feasible plans for their application. Progressing towards implementation of the metrics in the final shortlist will support the transition from the traditional focus on recycling, towards higher value retention opportunities such as repair and reuse. Alongside the progressing of those plans presented in Chapter 5, the further conclusions and recommendations presented here discuss key actions and strategic direction to facilitate and drive this transition, as well as looking further ahead at future steps towards building a sector fit for purpose within a true circular economy.

5.1 NEW ELECTRICALS AND BATTERIES PLACED ON THE MARKET

This metric is pivotal to understanding the material flows in the electricals and batteries sectors, but current data is limited in granularity. In both cases, producers report (depending on their size) the electricals or batteries placed on the market in weight to compliance schemes or directly to environmental regulators. Importantly, though the legally required data is very high-level (for example, batteries must be split into just three chemistry types), discussions with stakeholders found that internal reporting is usually much more detailed, and it is this detail that should be collected. By collecting POM data in weight and items, and split by more detailed categories, the most comprehensive understanding of the sector to date will be gained. In the future, it is recommended that data also be collected on the channel items are sold through (retail store , online, business-to-business, etc.).

5.2 RECYCLED ELECTRICALS AND BATTERIES AND QUANTITY/ EFFICIENCY OF MATERIAL RECOVERY

Although the requirements laid out in the ‘Recycled electrics and batteries (measured in tonnes and items)’ and ‘Quantity/efficiency of material recovery from WEEE/WPBs’ metrics are not entirely new, it is anticipated that the approach suggested in this report will ensure that a common methodology is adopted to measure recycling tonnages, input and output fractions and recycling efficiency rates across the UK. The implementation of the metric would increase the minimum standard of recycling across the two sector systems.

By requiring AATFs to record and report upon the additional data points (as outlined in Section 4.1.3), a greater understanding of the real recycling activity can be developed across both systems, including what material goes in and what comes out. Real recycling takes place after sorting and the final recycling processes, where the recyclates are guaranteed to be reprocessed into new applications/products. Benefits to supporting real recycling include:

- Ensuring that valuable materials are recycled from end-of-life products, through guaranteeing that collected waste is not allocated as ‘recycled’ before it enters the final recycling process.
- Promoting high-quality material recycling.
- Incentivising better separation, collection and sorting.
- Decreasing contamination.

This is the direction of travel being taken by the EU and aligning with this will future-proof the UK industry for upcoming market and legislation changes.

5.3 HOARDED ELECTRICALS AND BATTERIES

The level to which electricals and batteries are hoarded is currently not well understood, in part due to hoarding taking place in households and businesses away from the main stakeholders in the sector. It is a useful part of the system to understand, however, because it can indicate trends in consumer behaviour, both in terms of purchasing electricals and batteries and in how consumers dispose of these items. A survey, operated in a similar manner to Material Focus’ annual Bellwether survey, will enable consumers to self-report their hoarding behaviours. Though this will not be completely accurate, it is the most effective method to measure hoarding, and previous studies have used the same method with good results.

5.4 BINNED ELECTRICALS AND BATTERIES

Quantifying the number and type of electricals and batteries that are thrown away by UK households annually will support better targeted interventions and communications material to encourage correct disposal and opportunities higher up the waste hierarchy. Aside from measuring the overall performance of the current systems, this metric would also record the success of policies at a UK, regional and local level through highlighting potential disparities across different areas and nations. It has also been identified that Defra is undertaking a national waste compositional analysis in the near future, which has been deemed an opportunity for partnership and alignment of key objectives. It is recommended that the waste electrical and waste batteries proportion of the national WCA be investigated as part of this wider scope of work.

5.5 DISPOSAL OPTIONS

Of the four disposal options metrics identified in the initial shortlist, Material Focus have already implemented a database of drop-off points that is available to the public and is also building a similar list of household collection services. At a higher ambition level, it is working with an IT company to pilot a service that determines the average distance in a local area from a drop-off point and is considering a metric to determine the drop-off point density per a particular region. These more ambitious metrics would be more expensive to implement and require more computing power than is currently being utilised but would also provide a more holistic view of existing services.

Measuring these metrics would have benefits for several stakeholders in the UK system, notably local authorities and waste management companies. Knowledge of what items are underrepresented in terms of drop-off or collection availability will lead to more effective infrastructure development. Developing strong relationships across the country will allow the database administrator to steer the drop-off and collection sector to produce the best outcomes for circularity as well as consumers.

The databases also have significant benefits for consumers. It is well understood that the more barriers there are to completing a particular action, the less likely an individual is to complete said action. In terms of drop-off and collection of waste electricals and portable batteries, collating all the information consumers need in one location enables consumers to make a quick decision to dispose of their waste appropriately instead of disposing of it via landfill.

The databases as they currently exist are not perfect; it is recommended that ways be explored to include accessibility including whether there is step-free access and provisions for people with sight loss, hearing loss, motor disabilities and cognitive impairments. This information would ensure that all consumers are able to trust the information that is provided.

In summary, existing work (such as that done by Material Focus) could be further developed for implementation of this metric. Implementing the work already done is important in ensuring that waste electricals and portable batteries are meeting their appropriate end destinations, whilst more ambitious metrics would give a more developed view of the system.

5.6 CONSUMER PERCEPTIONS

Through Material Focus' annual Bellwether survey, a baseline of consumer perceptions regarding waste electricals and portable batteries has already been established. The survey is relatively inexpensive to operate and provides valuable insight, particularly regarding whether consumers know how to properly dispose of a variety of items, and reasons why consumers do not dispose of items appropriately. It allows for development of interventions and outreach activities that directly target the main issues that consumers report. While the change year-on-year in consumer perceptions cannot be entirely attributed to Material Focus due to the range of organisations that focus at least in part on waste electricals and portable battery recycling, it is understood that Material Focus routinely conducts surveys pre- and post-campaigns, which show the direct impact that Material Focus has.

Material Focus' approach of maintaining consistency in the questions asked and the wording used for each subsequent years' survey is a good one as it will help to determine how consumers' attitudes change over time. However, there is still potential to enhance the survey's delivery, including increasing the number of respondents to break down responses to a more granular local level, adding additional questions (this report recommends that questions regarding consumer attitudes to buying second hand and refurbished products are included in future surveys) and sending supplementary surveys where required.

5.7 PROMOTION OF DONATION, REPAIR AND REUSE OF WEEE/WPB

Despite not being included as a metric in the final shortlist - due to the scale of wider systemic changes required to facilitate access to robust data – this project highlights that the future development of a "donation, repair and reuse" (in this order) metric is of paramount importance to accurately measure circularity in the UK waste electricals and batteries system. It was evident throughout the project's stakeholder engagement activities that the existing systems currently favour the "recycling" aspect of the circular economy. However, it is known that the strongest path to a fully circular system is reduction of consumption, coupled with driving social value. In the "Initial Shortlist", metrics on "reuse" and "repair" were highlighted as those furthest up the hierarchy of circular economy strategies. The "reuse" theme is also captured through the "Used EEE and batteries sold by channel (measured in items and tonnes)". Due to the wider social and economic benefits of donating items, a metric around donated items is considered of greater relative value to the system.

It is recommended that the importance of waste electricals reuse and repair, and the benefits of this to measuring and driving circularity, need to be further embraced and prioritised by the wider UK waste electricals system itself. Recommendations on systemic changes that could support future development of a "donation, reuse and repair" metric include the following:

- Compliance schemes being at the forefront of promoting and driving reuse options, and to mandate their inclusion within future contracts.
- Government progress towards the setting of national reuse mandated/non-mandated targets at a UK-wide level.

It is expected these changes would provide more than 120 reuse charities with greater access to products, increasing UK reuse of waste electricals and subsequently generating evidence notes for compliance schemes. This could then facilitate further discussion at Government and compliance scheme level, on whether we accept all products in the UK as waste; or if the waste electricals system want access to data from UK reuse charities on what they can reuse (by way of donated "non-waste" items). It should also be noted that recyclers are currently charging for compliance notes, whereas reuse organisation are not. Considering the modulation fee and the benefits to circularity and social value, a case could be made for a tonne of reused electrics being worth more to the system than a tonne of recycled. In which case, there could be a higher fee paid for reuse.

On the "repair" front, it is suggested that any item donated and considered for "reuse", should only considered in this category after the appropriate testing and/or repair process has been completed to check the safety of the product. WRAP has previously encouraged the PAS 141 Guide for WEEE treatment – which looked at safe reuse and repair. However, this was more focused on how to comply with the WEEE Directive, rather than focusing on product safety and standards. Checks for safe reuse and repair would need to be tailored to the individual electrical/portable battery items to maximise the potential of getting items into the hands of those that need them. For example, a used smartphone with less safety-critical components may have less stringent requirements over a used fridge-freezer. BEIS and the Office for Product Safety & Standards could be engaged to see how national standards or guarantees around this could be developed.

Implementing the above suggestions would allow access to robust data from all potential "donation, repair and reuse" stream and the development of a data collection system. The metric could then be implemented whilst ensuring safe testing and repair of waste electricals. This would ensure the wider socio-economic benefits of this reuse are not compromised by reuse of unsafe donated products.

5.8 CO_2 EMISSIONS IMPACT/PERFORMANCE OF THE WASTE ELECTRICALS AND BATTERIES SECTOR

As discussed in Section 3.3.2, this metric was not chosen for inclusion in the final shortlist due to two main reasons: it is less related to circularity than the other metrics that were chosen, and the huge amount of work involved in developing a robust and efficient means to measure the emissions impact of the waste electricals and portable batteries sector. It is an undeniably useful metric for measuring the overall impact of the sector and identifying targets for decarbonisation, and it is recommended that a project solely dedicated to this metric be commissioned to explore this further. REPIC commissioned a study into the emissions of the waste electricals sector via a combined MFA and LCA methodology. This research identified the key steps in the waste electricals supply chain and some potential issues to consider, which are explored in Section 3.3.2.

5.9 SUCCESS OF DIGITAL INCLUSION PROGRAMMES - DEVICES, DATA AND SKILLS

Though this metric was not included on the final shortlist due to its weaker connection to circularity than the included metrics, it is recognised as being potentially useful in understanding the connection between environmental and social impacts. Understanding the percentage of used devices that are provided to vulnerable communities will allow for the used electricals sector to develop in such a way that it delivers greater social good. It is therefore recommended that work be done to further this metric through a separate piece of work specifically dedicated to it and other metrics that focus both on social and environmental impacts.

6 APPENDICES

6.1 INITIAL LONGLISTED METRICS

Metric	Measure
Product flows	Data on sold reused goods
	Data from online platforms on volumes of sold second-hand goods
	Data from online platforms on volumes of sold second-hand goods
	Standardised data on repairs of small electrical and electronic goods
	Prevented household waste
	WEEE and batteries that are recycled as the same material
	WEEE and batteries that are recycled as the same material
	Use of critical materials
	Contribution of recycled materials to raw materials demand
	Domestic material consumption (DMC) per capita
	Number of industrial symbiosis initiatives
	Household waste production of WEEE and batteries
	Resource productivity (RP)
	Circular material use rate
	Landfilling of recyclable or recoverable waste
	Total waste generated (relating to EEE and batteries)
	Residual waste generated (relating to EEE and batteries)
	Industrial and commercial waste generated (relating to EEE and batteries)
	Household waste recycling rate
	Capture rate of WEEE in residual waste
	Raw material consumption
	Raw material consumption
	Real recycling rate of EEE and batteries
	Export levels
	New material avoided
	Level of recycled content/recycled output for a particular WEEE product.
	Hoarded WEEE by consumers
	Illegal export of WEEE
	Embedded/installed EEE
	Percentage of online sales of EEE/batteries
	Geographical destination of recovered material
	Proportion of WEEE in incineration feedstock.
	Quantity of WEEE items recycled/reused per household in a scheme network.
	Quantity of WEEE items recycled/reused per household in a scheme network.
	Number of business consumers of EEE/PB by sector or activity e.g., health sector, education sector.
	E-commerce returns for different WEEE types (useable or unusable)
	New EEE and batteries placed on the market and by channel sold (measured in items and tonnes, including physical retailers, online marketplaces etc)

Metric	Measure
	New EEE and batteries placed on the market and by channel sold (measured in items and tonnes, including physical retailers, online marketplaces etc)
	Used EEE and batteries sold by channel (measured in items and tonnes, including charity shops, online platforms etc)
	Used EEE and batteries sold by channel (measured in items and tonnes, including charity shops, online platforms etc)
	Donated/reused electricals and batteries (measured in items and tonnes)
	Donated/reused electricals and batteries (measured in items and tonnes)
	Hoarded electricals and batteries (measured in items and tonnes)
	Hoarded electricals and batteries (measured in items and tonnes)
	Repaired electricals and batteries (measured in items and tonnes)
	Repaired electricals and batteries (measured in items and tonnes)
	Recycled electricals and batteries (measured in items and tonnes)
	Recycled electricals and batteries (measured in items and tonnes)
	Recycled electricals and batteries (measured in items and tonnes)
	Binned electricals and batteries (measured in items and tonnes)
	Binned electricals and batteries (measured in items and tonnes)
	Replacement rate of EEE products
Disposal options	Level of domestic processing infrastructure for recycling
	Level of domestic processing infrastructure for recycling
	Number of collection points
	Number of retailer take-back points
	Illegal waste sites
	Penalties for improper disposal of WEEE/fly tipping
	Penalties for improper disposal of WEEE/fly tipping
	% of places at or above an acceptable standard for litter
	Costs to local authorities of WEEE litter
	Kerbside collection schemes
	Awareness of WEEE/WPB recycling opportunities
	Availability of waste treatment options per geographical area.
	Availability of waste treatment options per geographical area.
	Proportion of e-waste in illegally tipped waste
	Proportion of e-waste in illegally tipped waste
	Local authority (LA) collection point density per household.
	Number of online collection schemes in a particular region/borough.
	WEEE disposed of in residual waste.
	Incorrectly processed B2B waste.
	Percentage of UK population with access to disposal schemes, within a certain distance of registered address.
	Frequency of visits by consumers to sites with collection infrastructure.
	Number of supermarket/large hardware stores with WEEE/WPNB collection infrastructure in the car park for a particular region.
	Number of recycling points by type of collection point and items accepted
	Average distance of consumers to their nearest recycling point

Metric	**Measure**
	Recycling point density per town/local authority/region
Environmental and social impacts	Prices of secondary resources
	Number of material cycles
	Number of material cycles on equivalent level
	Trend in material value retention
	Patents related to recycling and secondary raw materials
	Carbon footprint of disposal of WEEE and batteries
	Carbon footprint of disposal of WEEE and batteries
	Carbon footprint of disposal of WEEE and batteries
	Carbon footprint of consumption of WEEE and batteries
	Carbon footprint of consumption of WEEE and batteries
	Carbon saving per capita from recycling
	Embodied material energy
	Embodied material emissions
	Process energy demand for manufacturing of different WEEE/WPB items.
	Process emissions for manufacturing of different WEEE/WPB items.
	EEE/PB product recyclability.
	Recovery of critical raw materials
	Recovery of critical raw materials
	Number of different uses for a particular recycled feedstock.
	Number of different uses for a particular recycled feedstock.
	Types of battery causing fires in treatment operation.
	Proportion of WEEE manufactured containing Persistent Organic Pollutants (POPs).
	TM66 - Creating a circular economy in the lighting industry.
	Impact on health and wellbeing of WEEE/WPB recycling.
	Hazardous waste impact and implications for landfill sites.
	Energy use (or energy efficiency) of different WEEE/WPB recycling processes.
	Carbon footprint of different types of collection models for WEEE/WPB.
	Direct and indirect CO2 emissions for different types of WEEE/WPB.
	Percentage of WEEE/WPB materials which cannot be recycled.
	Efficiency/quality/quantity of material recovery from WEE/WPBs
	CO2 emissions impact/performance of the WEEE/WPB sector
	Other greenhouse gas emissions impact/performance of the WEEE/WPB sector
	Social impact/performance of the WEEE/WPB sectors
Consumer perceptions	Circular consumer behaviour
	A green consumer index based on survey data
	Number of repair guides viewed on iFixit
	Environmental activities consumers had undertaken in last months (1 or 6)
	Environmental activities consumers had undertaken in last months (1 or 6)
	Attitudes towards buying second-hand products
	% of people perceiving litter as a problem
	Consumer awareness/perceptions of WEEE/WPB recycling/reuse/repair; communication from retailers.

Metric	Measure
	Awareness of the need to recycle electricals and batteries
	Perceived ease of recycling electricals and batteries
	Perception that recycling electricals and batteries is worth doing
	Preferred channels for recycling electricals and batteries
	Perception that recycling electricals and batteries is important
	Perception that recycling electricals and batteries is the normal thing to do
	Awareness that binning electricals and batteries is dangerous
	Claimed reuse and recycling behaviours for electricals and batteries
Product value retention and life-extension	Premature obsolescence of products
	Percentage of citizens who have chosen alternatives (remanufactured product, sharing or leasing/renting) to buying new EEE products
	Household expenditures on repair, hire and maintenance, disaggregated by product groups
	Price difference between repair and replacement
	Price difference between rental and replacement
	Time of use of product
	Trend in product lifespan
	Number of products sold on second-hand websites
	Sales of CEN EN 45553:2020 standard on remanufacturing
	Items repaired by repair cafes
	Percentage of WEEE refurbished
	Estimated product lifespan of different EEE product types and batteries.
	Estimated product lifespan of different EEE product types and batteries.
	Estimated product lifespan of different EEE product types and batteries.
	Environmental impact of refurbishment/repair versus immediate disposal of different types of WEEE items.
	Ease of repairability of different WEEE items.
	Ease of repairability of different WEEE items.
	Ease of repairability of different WEEE items.
	Use of spare parts in EEE refurbishment
	Number of leasing/sharing models for a given region/locality.
	Percentage of new WEEE/WPB products with established re-use markets.
Economic impact and innovation	Number of scientific articles concerning circular economy
	Number of circular economy initiatives (hubs, platforms, hotspots etc.)
	R&D level
	R&D level
	Careers in WEEE/WPB
	Careers in WEEE/WPB
	Cost advantage (reductions)
	Investment in EEE/WEEE innovation
	Use of innovative battery chemistries
	Non-reporting online sellers
Circular design	Products with circular attributes in e-retail

Metric	**Measure**
	Take up of maintenance for WEEE.
	Effort put into EEE/PB product design.
	Number of EEE/PB certifications on Cradle2Cradle.
	EEE product weight trends.
	Percentage of EEE using rechargeable/non-rechargeable batteries.
	Percentage of WEEE with removable/replaceable battery packs.

6.2 INITIAL SHORTLISTED METRICS

Metric	Measure
Product flows Where is all the stuff?	New EEE and batteries placed on the market and by channel sold (measured in items and tonnes, including physical retailers, online marketplaces, household and business, etc.)
	Used EEE and batteries sold by channel (measured in items and tonnes, including charity shops, online platforms etc)
	Donated/reused electricals and batteries (measured in items and tonnes)
	Hoarded electricals and batteries (measured in items and tonnes)
	Repaired electricals and batteries (measured in items and tonnes)
	Recycled electricals and batteries (measured in items and tonnes)
	Binned electricals and batteries (measured in items and tonnes)
	WEEE and WPB in fly tipping/illegally tipped waste in waste sites
	Electricals recycled by non AATFs (substantiated estimates in tonnes and items)
	Illegal export of EEE/WEEE and batteries
Disposal options How easy is it to do the right thing?	Number of drop of points by type and items accepted
	Average distance of consumers to their nearest drop off point
	Drop off point density per town/local authority/region
	Availability of household collection services
Environmental and social impacts Are we helping the planet and people?	Efficiency/quality/quantity of material recovery from WEEE/WPBs
	CO2 emissions impact/performance of the WEEE/WPB sector
	Other greenhouse gas emissions impact/performance of the WEEE/WPB sector
	Success of digital inclusion programmes - devices, data and skills
	Social impacts - numbers of households (and £ value) supported through reuse network partners
Consumer perceptions What do we really think?	Awareness of the need to recycle electricals and batteries
	Perceived ease of recycling electricals and batteries
	Perception that recycling electricals and batteries is worth doing
	Preferred channels for recycling electricals and batteries
	Perception that recycling electricals and batteries is important
	Perception that recycling electricals and batteries is the normal thing to do
	Awareness that binning electricals and batteries is dangerous
	Claimed reuse and recycling behaviours for electricals and batteries
	Attitudes to buying second hand and refurbished products

6.3 STAKEHOLDER SURVEY QUESTIONS

[Mandatory screening question: dropdown list except for 'other' which is free text, can select multiple options] Which of the following stakeholder groups do you represent?

- Producer / manufacturer of electrical goods and/or portable batteries
- Producer/ manufacturer trade association for electrical goods and/or portable batteries
- Producer compliance scheme for electrical goods and/or portable batteries
- Distributor/ retailer of electrical goods and/or portable batteries
- Online selling platform/ marketplace including electrical goods and/or portable batteries
- Individual / user of electrical goods and/or portable batteries
- Repair service provider for electrical goods and/or portable batteries
- Charity and/or reuse organisation receiving donations and selling electrical goods and/or portable batteries
- Local authority collector of electrical goods and/or portable batteries
- Commercial waste contractor collector of electrical goods and/or portable batteries
- Recycling treatment facility operator for electrical goods and/or portable batteries
- Other waste treatment facility operator handling electrical goods and/or portable batteries
- Regulator and/or policy maker for electrical goods and/or portable batteries
- Academic researcher
- Other (please specify)

There is no universal definition of the Circular Economy at present, but the EU states: "The circular economy is a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible. In this way, the life cycle of products is extended. In practice, it implies reducing waste to a minimum. When a product reaches the end of its life, its materials are kept within the economy wherever possible. These can be productively used again and again, thereby creating further value. This is a departure from the traditional, linear economic model, which is based on a take-make-consume-throw away pattern."

Source: https://www.europarl.europa.eu/news/en/headlines/economy/20151201STO05603/circular-economy-definition-importance-and-benefits"

During this research, we are developing a number of metrics that we feel could be helpful in better understanding the overall circularity performance of the UK's waste electricals and waste portable batteries systems. These will include (but are not limited to), the following:

<u>Metrics concerning flows of goods (WEEE and WPBs)</u>

- New EEE and batteries placed on the market (measured in items and tonnes, by channel sold, including physical retailers, online marketplaces, household and business, etc.)
- Used EEE and batteries sold by channel (measured in items and tonnes, including charity shops, online platforms etc)
- Donated/reused electricals and batteries (measured in items and tonnes)
- Hoarded electricals and batteries (measured in items and tonnes)
- Repaired electricals and batteries (measured in items and tonnes)
- Recycled electricals and batteries (measured in items and tonnes)
- Binned electricals and batteries (measured in items and tonnes)

<u>Metrics concerning availability of disposal options</u>

- Number of recycling points by type of collection point and items accepted
- Average distance of consumers to their nearest recycling point
- Recycling point density per town/local authority/region

<u>Metrics concerning material recovery, environmental and social impacts</u>

- Efficiency/quality/quantity of material recovery from WEE/WPBs
- CO_2 emissions impact/performance of the WEEE/WPB sector
- Other greenhouse gas emissions impact/performance of the WEEE/WPB sector
- Social impact/performance of the WEEE/WPB sectors

Metrics concerning consumer perceptions of recycling

- Awareness of the need to recycle electricals and batteries
- Perceived ease of recycling electricals and batteries
- Perception that recycling electricals and batteries is worth doing
- Preferred channels for recycling electricals and batteries
- Perception that recycling electricals and batteries is important
- Perception that recycling electricals and batteries is the normal thing to do
- Awareness that binning electricals and batteries is dangerous
- Claimed reuse and recycling behaviours for electricals and batteries

- [Mandatory: Q1 - free text answers, route to Q2 regardless of answer] Are there any other activities within the WEEE and WPB sector, under the following themes, that you feel it is important to measure to understand the system's performance? Please also explain in each case why you feel this is an important metric to measure.
    - Metrics concerning flows of goods (WEEE and WPBs)
    - Metrics concerning availability of disposal options
    - Metrics concerning material recovery, environmental and social impacts
    - Metrics concerning consumer perceptions of recycling
    - Other metrics

- [Mandatory: Q2 - free text answers, route to Q3 regardless of answer] Are there any particular types of EEE products that you think should be prioritised above others for repair and reuse and if so, why?

- [Mandatory: Q3 - free text answers, route to Q4 regardless of answer] Are there any particular types of WEEE and/or materials in WEEE/WPB that you think should be prioritised above others for recovery and if so, why?

- [Mandatory: Q4 - 1–5-point scale, 1 = not important, 5 = very important, route to Q5 regardless of answer] Stakeholders across the system are suggesting that only using the weights of WEEE and WPBs collected for recycling against product sales is not an adequate measure of the system's performance. With changes in the UK regulations WEEE and WPB regulations due to take place soon, how important do you feel it is to start measuring some of the metrics identified above?

- [Mandatory: Q5 - Yes/No - route to Q6 below if Yes, If No, route to thank you message] Would you be interested in discussing this further on the phone or through a MS Teams video call as part of a stakeholder interview?

- [Mandatory to provide both name and email if yes to Q5, free text answer, then route to thank you message] Please provide your name and email address so we can contact you:
    - Name:
    - Email address:

6.4 STAKEHOLDER INTERVIEW QUESTIONS AND INTERVIEWEES

1. What are your thoughts on the feasibility of implementing this metric in the UK and why?
2. What are your thoughts around data collection to measure against this metric and why?
3. What benefits to understanding circularity in the WEEE/WPB system can you see from using this metric and why?
4. What challenges could you see with implementing this metric and why? Please also consider the cost associated with implementation.

6.5 SWM AND LDA PROTOCOL

The SMW protocol (for stream E) can also apply to WEEE not collected from LA DCFs, providing the AATF meets the following conditions:

- The combined total of WEEE received is less than 500 tonnes annually
- You collect WEEE separately from households
- The WEEE is comparable to SMW from an LA DCF
- The WEEE collection is part of a contract with a producer compliance scheme.

If these conditions can be satisfied, the SMW protocol can be used from collections from retailer take-back schemes, kerbside collection or bring-banks (B2C) and mixed B2B SMW.

The SMW protocol for stream E presents percentages to calculate the weight of SMW received from DCFs (see Table 18). It is recommended that AATFs calculate these figures using the total tonnage of SMW received multiplied by the percentage for the category.

Table 18: Percentages to calculate the weight of SMW received from DCFs

Category	Percentage (%)
1	15.88
2	20.99
3	18.69
4	13.13
5	3.57
6	16.83
7	3.34
8	0.00
9	0.68
10	0.000
11	0.92
12	0.24
13	0.00
14	0.15
Non-WEEE	4.9
Batteries	0.68
Total	**100**

There is also an LDA protocol (for steam A in Table 19) which allows for the following percentages:

Table 19: Percentages to calculate the weight of LDA received from DCFs

Category	Percentage (%)
Category 1 LDA	97.64
Category 2 to 10 SMW	1.21
Category 12 Cooling	0.17
Non - WEEE	0.98
Total	**100**

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About us

Material Focus is a new not-for-profit organisation – our vision is of a world where materials are never wasted.

Three I's inform and guide everything we do: inspiration, investment and insight.

Inspiration

We inspire people to change their behaviour. We do this through our Recycle Your Electricals campaign by revealing the hidden value of the materials in our electricals and by making it feel both easy (and normal) to reuse and recycle them.

Investment

We work with partners to expand the number, and type of collection points, making it easier for everyone to reuse and recycle their old electricals.

Insight

We fund technical research to overcome the barriers to reusing and recycling old electricals. Insight from this research galvanises new and innovative approaches to reuse and recycling, and supports enhancements to the UK waste electrical and electronic (WEEE) system.

MATERIAL FOCUS