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TriREUSE - Trialling the Preparation for Reuse of Consumer Laptops, Tablets and Smartphones

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Government of Ireland

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- Office of Environmental Enforcement
- Office of Evidence and Assessment
- Office of Radiation Protection and Environmental Monitoring
- Office of Communications and Corporate Services

The EPA is assisted by an Advisory Committee of twelve members who meet regularly to discuss issues of concern and provide advice to the Board.

EPA RESEARCH PROGRAMME 2014–2020

TriREUSE – Trialling the Preparation for Reuse of Consumer Laptops, Tablets and Smartphones

(2017-RE-DS-9)

EPA Research Report

Prepared for the Environmental Protection Agency

by

University of Limerick

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This report is based on research carried out/data from 1 March 2018 to 1 June 2019. More recent data may have become available since the research was completed.

The EPA Research Programme addresses the need for research in Ireland to inform policymakers and other stakeholders on a range of questions in relation to environmental protection. These reports are intended as contributions to the necessary debate on the protection of the environment.

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Executive Summary

Information and communication technology (ICT) devices contain numerous critical raw materials. Many categories of ICT products are proving very difficult to collect as part of existing recycling systems, and, if they are collected, the critical raw materials do not emerge for use within the economy owing to the limits of current recycling technology. For this reason, the Waste Framework Directive (Directive 2008/98/EC) states that European Union (EU) Member States should take measures to promote the reuse of products constituting the main sources of critical raw materials to prevent those materials becoming waste. This, and other policy positions from the EU, is creating pressure on Member States to deliver more ambitious measures to progress the circular economy.

As part of addressing the challenges to the current waste electrical and electronic equipment (WEEE) management system to promote preparation for reuse of WEEE in Ireland in the context of a wider prevention and recovery system, the TriREUSE project aimed to provide an insight into possible reuse rates for WEEE collections that specifically target consumer ICT products with reuse potential. It also examined how such promotional events could operate in practice and aimed to provide some conclusions and recommendations based on what was learned from the process.

The project involved a series of 10 dedicated collection events that encouraged people to dispose of old or unwanted data-bearing devices, specifically laptops, smartphones and tablets, with the incentive of a free data destruction service being provided. These events were supported by a promotion and information campaign employing a website, videos, infographics, posters and social media campaigns. Eight of the targeted collection events took place in workplaces and two were part of public collection events. The nature of the events undertaken during the project are by no means the only model by which devices with potential for reuse may be collected.

In total, 220 (282 kg) of the targeted devices were collected, with 64 (60 kg) being successfully reused and the remaining 156 (222 kg) being recycled. This represents a reuse rate of 21% by weight and 29% by number of devices. In addition to this, a further 308 kg of ICT WEEE outside the scope of the events was also collected.

Based on the results from the collection events the project found that:

- targeted collections demonstrate significantly higher reuse rates than those achieved from the current collection system;
- such events achieve takeback of difficult-to-collect devices that do not present in waste streams in Ireland;
- providing certified data wiping leads to promising reuse rates for difficult-to-collect devices;
- for work-based events, on-site promotion from corporate social responsibility, ICT, facilities and employee resource groups of awareness and collections days improves collection rates significantly;
- targeted collections will also attract items without a potential for reuse and products outside the scope of the collection.

Using these findings, and the experience of planning and running the collection events, the following recommendations have been generated to support the greater preparation for reuse of WEEE in Ireland:

- Working to develop a functional “preparation for reuse of WEEE” system could form part of Ireland’s response to EU policy for Member States to do more to advance the circular economy agenda. Collections targeting preparation for reuse should play a role in a sustainable WEEE management system in Ireland. Approved preparation for reuse of WEEE organisations should be permitted to operate these events.
- While a full-cost economic analysis is beyond the scope of such an embryonic set of pilots and while it would be premature to undertake such an analysis, some comments on potential cost efficiency to support the advancement of the experience curve are included.
- The potential of WEEE to Work events shows promise to achieve high rates of preparation

for reuse. In order to drive cost efficiency, the information technology asset disposal industry could run such events in conjunction with their business-to-business collections and could play a significant part in advancing preparation for reuse in Ireland. However, this is by no means the only model by which devices with potential for reuse could be collected.

- In addition, to promote cost efficiency, public recycling events could include an option for consumers to divert data-bearing devices to registered preparation for reuse organisations before being recycled. For such events, in line with the waste hierarchy, the reuse option should be offered before recycling, and contractors who are employed to conduct such events should be incentivised to do so.
- Producer responsibility organisations and the compliance obligations they oversee for their members are central to everything that occurs in WEEE management in Ireland and they would require explicit motivation to back fully any preparation for reuse of WEEE initiatives. The phased introduction of preparation for reuse of WEEE targets, as exist in Spain, would be one means by which to achieve this. One study has identified measures to increase the reuse of washing machines in Belgium and Spain by BSH (Bosch) and through these measures reuse rates of between 20% and 30% were reported.

1 Introduction

The recycling and recovery of household and dual-use waste electrical and electronic equipment (WEEE) is well established in Ireland and the collection and treatment of material is considered to be operating to a high level by European standards. Since the implementation of the WEEE Directive (Directive 2012/19/EU) in 2005, collection rates per inhabitant have been consistently high and significantly above the original 4 kg target. While the new WEEE collection target of 65% based on electrical and electronic equipment (EEE) placed on the market in the 3 preceding years is acknowledged to be more difficult to achieve, Ireland is still ranked 7th among European Union (EU) Member States according to this metric (Eurostat, 2019).

However, the situation with regard to "preparation for reuse" of WEEE is a much less successful story in Ireland and other Member States. Efforts to develop this sector through the introduction of a registration system to approve preparation for reuse of WEEE organisations, which was intended to enable them to access equipment suitable for "preparation for reuse", have thus far failed to deliver the reuse of any notable quantities of products. This is attributed largely to the fact that items with potential for reuse are not separated from general WEEE in spite of the requirement of the WEEE Directive that the collection and transport of material is carried out in a way that allows optimal conditions for preparing for reuse (Johnson *et al.*, 2015; Casey *et al.*, 2018).

The UpWEEE report (Johnson *et al.*, 2015) concluded that there was a need to align the interests of producer responsibility organisations (PROs) (achieving targets in a competitive environment) and approved preparation for reuse organisations (access to material that is economically viable to reuse) and that this can be achieved through the phased introduction of preparation for reuse targets in certain product categories, specifically information and communication technology (ICT) and large household appliances (LHAs).

The UpWEEE report also provided recommendations around removing barriers to accessing suitable equipment, which included the establishment of special collections of WEEE for material suitable for preparation for reuse and also enabling approved preparation for reuse of WEEE organisations to receive WEEE from the general public, specifically targeting items with potential for preparation for reuse.

The TriREUSE project aimed to provide an insight into how such targeted collections might operate in practice for business to consumer (B2C) ICT WEEE and whether or not the items being returned would be suitable for preparation for reuse. The project undertook a series of collection events that encouraged people to dispose of old or unwanted data-bearing devices, providing an incentive for users to return devices by offering a free data destruction service.

The project investigated the suitability of preparing B2C data-bearing devices for reuse. Data-bearing devices were selected as they are typically very difficult to collect from consumers, they contain several critical raw materials (CRMs) and the right devices can demand reasonably good prices on the second-hand market. There is currently a large second-hand market, which can provide an outlet for refurbished devices and which is well known to operators in the business to business (B2B) information technology asset disposal (ITAD) sector. These devices are also items of interest owing to the General Data Protection Regulation (GDPR), which was introduced in May 2018. The topic of data protection was prevalent through media outlets and for industry in the run-up to the implementation date for GDPR compliance. The categories of data-bearing devices that were specifically targeted based on these criteria were laptops, tablets and smartphones.

This report consists of a literature review, which provides the background and context for supporting greater levels of preparation for reuse; an overview of the events, including how they were promoted; the results that were achieved; and some conclusions and recommendations based on what was learned from the process.

2 Literature Review

2.1 Introduction

The proper treatment of WEEE is high on the global agenda regarding resource efficiency, climate change and the presence of hazardous materials. Promoting the lifetime extension of EEE is of particular importance owing to the use of numerous CRMs, which do not emerge from recycling streams. In addition, very high manufacturing energy inputs are required for these products, particularly for low entropy components. By offsetting additional production with the concomitant reduction in mining and manufacturing energy, these issues associated with the production of WEEE can be alleviated through preparation for reuse.

According to the European Commission's Staff Working Document on Critical Raw Materials and the Circular Economy (EC, 2018), electrical and electronic equipment is the largest user of CRMs in Europe (Figure 2.1).

A significant amount of research has been conducted in relation to the collection and reuse of WEEE, including CRM-rich WEEE. This literature review will summarise the findings of a selection of the most relevant reports and papers on this topic. At a national level, two Environmental Protection Agency (EPA)-funded projects, Re-Evaluate (O'Connell and Fitzpatrick, 2013) and UpWEEE (Johnson *et al.*,

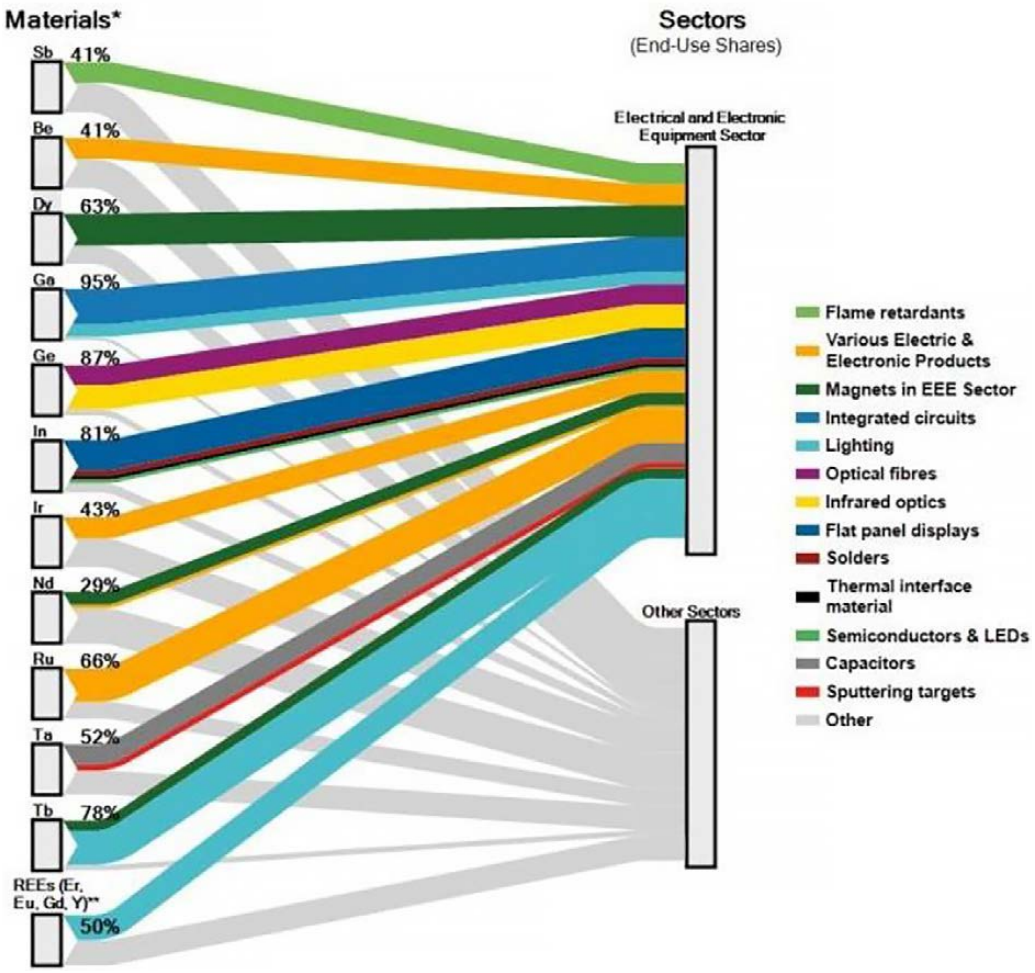

Figure 2.1. Use of CRMs by sector (EU Commission, 2018). *Only a subset of CRMs used in the EEE sector is included. Additional CRMs linked to the EEE sectors include Ce, Co, fluorspar, He, Hf, La, Mn, natural rubber, Pd, Pr, Pt, Rh, Sm, Si, W and V. **Average share for Er, Eu, Gd and Y.

2015), have laid the foundations for the embryonic preparation for reuse of WEEE system that exists in Ireland today. The most relevant conclusions from these reports are as follows:

- Reuse of WEEE is environmentally, socially and economically superior to recycling. The recycling rate of CRMs is estimated to be less than 1% (Figure 2.2 shows current recycling rates of CRMs).
- Collection should take place at the closest possible point to the user to preserve the potential for reuse.
- It is essential to have high standards of preparation for reuse of WEEE to maintain trust in the system from all stakeholders.
- Existing WEEE logistics providers should be encouraged to participate in preparation for reuse of WEEE.

Research by Allwood and Cullen (2012) and Gutowski *et al.* (2013) has demonstrated that the scope for future improvements in the efficiency of material production is limited. Therefore, in order for a reduction in industrial emissions to contribute to the mitigation of climate change, a reduction in material production through strategies such as reuse and preparation for reuse will be necessary. In particular, EEE reuse has been prioritised by a wide range of global policies and regulations as a prudent approach for conserving resources and reducing environmental pollution. The majority of legislation that regulates the movement and disposal of equipment containing potentially hazardous materials recommends the reuse of equipment.

The European Commission (2017) has also commissioned research on the feasibility of including preparation for reuse targets in the WEEE Directive. This study concludes that, at this time, a universal target across all Member States is not recommended but it encourages individual Member States to pursue actions that support preparation for reuse of WEEE, which could include targets. Similarly, the Waste

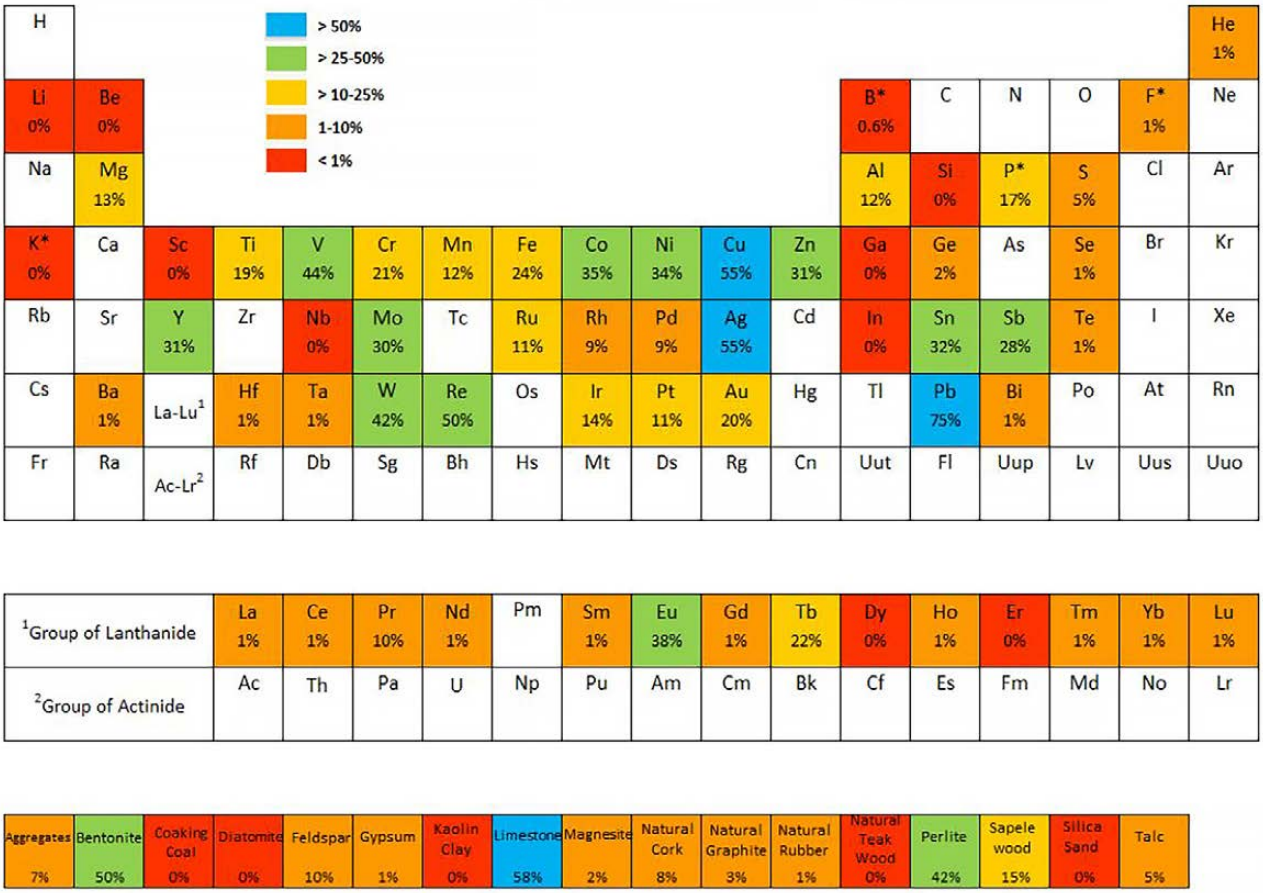

Figure 2.2. End-of-life recycling rates of metals (European Commission, 2018). *B = borates; F = fluorspar; K = potash; P = phosphate rock; Si = silicon metal.

Framework Directive (Directive 2008/98/EC) states that Member States should take measures to promote the reuse of products constituting the main sources of CRMs to prevent those materials from becoming waste.

In addition to this, the Circular Economy Action Plan (EC, 2020) has identified a range of measures that can support preparation for reuse, including ease of disassembly and repair and the availability of reasonably priced spare parts; these will be implemented through a range of instruments including the Eco-Design Directive and eco-modulation of fees for extended producer responsibility through the Waste Framework Directive.

Similarly, the recent conclusions in the report *More Circularity – Transition to a Sustainable Society* from the Council of the European Union (2019) emphasise that minimising the negative environmental impacts of electronics requires targeted actions covering the entire value chain that address, among other things, the increasing use of electronics and batteries containing CRMs, and recognise that the growing use and the short life cycles of ICT products increase the demand for energy and CRMs. The report also encourages Member States to apply economic instruments to promote more sustainable and circular production and consumption patterns and to improve waste management consistently with the waste hierarchy.

Kissling *et al.* (2012) have defined the operating models for reuse of WEEE as follows: ICT asset management, networking equipment recovery, social enterprises and bridging the digital divide. Kissling *et al*. (2013) have also identified success factors and barriers for the reuse of WEEE as follows.

- success factors:
  - product and process quality;
  - stakeholder relationships;
  - documentation and reporting;
  - costs and revenues;
- barriers:
  - access to sufficient volumes of used equipment;
  - competition from illegal operators;
  - product designs that are not compatible with refurbishment;
  - costs.

Milovantseva and Fitzpatrick (2015) have examined the role of trans-frontier shipment regulations as an impediment to the reuse of WEEE. They conclude that the broad areas for concern are:

- definitions, classifications, operating procedures and enforcement;
- evaluation of shipments;
- requirement for functionality testing.

To help eliminate these barriers they recommend:

- appropriate legislative amendments;
- the inclusion of reuse in national policies;
- the establishment of more international co-operation and standardisation;
- the introduction of a regulated green e-waste trans-boundary channel.

Gonzalez *et al.* (2017) have calculated the social benefits of personal computer (PC) reuse in Spain and concluded that it reduces environmental costs by over €45 per unit reused.

Coughlan *et al*. (2018) have reported that 9% of laptops found in Irish B2C waste that had not been separately collected for reuse were suitable for repurposing as thin client computers. (A thin client is a lightweight computer that is designed to operate in a server-based environment and does not require a hard disk drive.)

A recent study from Germany (Messmann *et al.*, 2019) found that between 13% and 16% of WEEE, used furniture and used leisure goods could be prepared for reuse immediately. The study also stated that there was further potential for 13–29% preparation for reuse with changes to the collection, storage and overall treatment of such items. The most identifiable damage was caused by the weather (86%) owing to a lack of suitable weatherproof coverings.

2.2 Waste Hierarchy

The EU Waste Framework Directive provides a legal requirement for countries to observe the waste hierarchy. The Directive provides a general framework for waste management requirements and sets basic waste management definitions for the EU. The waste hierarchy has two categories: waste prevention (non-waste) and waste treatment (waste). The waste

hierarchy positions direct reuse as waste prevention at the top of the hierarchy for EEE, and where a product becomes waste (WEEE) it is followed by preparation for reuse as a waste treatment.

The updating of the WEEE Directive in 2012 positioned "preparation for reuse" as an important part of the waste hierarchy for WEEE treatment and stated that higher priority should be given to preparation for reuse of WEEE and its components, sub-assemblies and consumables than to recovery (EC, 2015). The waste hierarchy is presented in Figure 2.3; the hierarchy is divided between non-waste and waste.

2.3 Waste Prevention – Reuse

The waste hierarchy places reuse as the most favourable option for non-waste or EEE. Reuse extends the lifetime of a product by providing a second life. This lifetime extension is environmentally more favourable as it keeps products in use, which helps to offset the embodied energy. The embodied energy is the total energy required by that product over its life cycle and includes both the energy from the manufacturing processes and the embedded energy present in the raw materials (Zero Waste Europe, 2017). The reuse of electronic devices has grown in recent years through the popularity of online marketplaces. This growth has provided a stimulus for an increase in reuse. Items such as smartphones and tablets are popular devices for resale as they have a high intrinsic value, which creates a vibrant market for second-hand devices. Reuse is categorised as a waste prevention measure as the device or appliance does not enter a waste stream and thus does not become waste. Reuse is often referred to as direct reuse as it does not require any treatment or refurbishment.

Figure 2.3. The waste hierarchy.

2.4 Waste Treatment – Preparation for Reuse

The waste hierarchy determines that when a product becomes waste it is required to be treated. The different levels of treatment are positioned so that disposal is the least favourable option, followed by recovery, recycling and then the most favourable option, which is preparation for reuse. Preparation for reuse is defined as the best waste treatment option for suitable waste. Certain electronic products are regarded as suitable candidates for preparation for reuse because of their high initial and subsequent secondary values. The WEEE Directive has prioritised preparation for reuse and recycling of waste electronics over the disposal and landfilling of these devices. The current system in operation in Ireland remains primarily focused on recycling, with practically 0% reuse being reported.

2.5 Preparation for Reuse in Ireland

The process to become a "preparing for reuse" organisation in Ireland requires that several measures are fulfilled before access to WEEE is granted. An organisation must be approved and registered with the Producer Register Ltd (PRL). The PRL is tasked with maintaining a register of all producers, determining market shares, verifying financial guarantees, and tracking and reporting non-compliance.

In order to register preparation for reuse organisations, the PRL requires proof of waste collection permits, waste facility permits/licences, preparation for reuse certification, product indemnity insurance and warranty confirmation.

The current preparation for reuse sector in Ireland is represented by a small number of companies that identify themselves as recycling and recovery waste operators that provide reuse and preparation for reuse services for ICT devices. Some of these companies operate as social enterprises. These types of enterprises facilitate the employment of people with disabilities and those who are long-term unemployed. These entities are certified as "preparation for reuse" organisations and have obtained British Standards

Institute (BSI) Publicly Available Specification (PAS) 141 certification. McMahon *et al*. (2019) state that many of the factors required for a successful preparation for reuse system, such as quality standards, access to material at point of surrender and positive relationships between stakeholders, are largely absent in Ireland.

2.6 Standards on Preparation for Reuse

Standards on preparation for reuse have been developed in recent years to validate the quality of the refurbishment process and to increase consumer confidence in the product offering. The PAS 141 standard has been the main standard used in the UK and Ireland. The BSI introduced the PAS 141 standard in 2011 and was commissioned by the Department for Business, Innovation & Skills in the UK. The aims of the PAS 141 certification, as outlined in the original document (BSI, 2011), are to:

- encourage the reuse of WEEE as promoted by the WEEE Directive;
- reduce the amount of WEEE sent to landfill and incineration by diverting WEEE to be prepared for reuse;
- provide a framework for customer quality assurance and safety of reused electrical and electronic equipment (REEE) as being different from WEEE and used electrical and electronic equipment (UEEE) that has not been prepared for reuse;
- provide a framework for assuring original equipment manufacturers that the placing of products on the market for reuse will not adversely affect their brands or reputation for safety and quality;
- deter the illegal export of WEEE under the guise of sham reuse;
- provide a tool for identifying REEE that has been subject to the preparing for reuse process set out in this PAS;
- encourage job creation in organisations involved in preparing WEEE and UEEE for reuse.

The Public Waste Agency of Flanders (OVAM) in Belgium has developed a preparation for reuse policy document to provide guidance for organisations that want to become reuse centres (OVAM, 2012). OVAM requires such organisations to undertake an inspection by an International Organization for Standardization (ISO) 17020-accredited inspection body and registration and licensing, and to document the process for preparation for reuse. The OVAM policy document outlines the steps to be taken as part of the process of preparing for reuse. Organisations need to comply with the conditions set out below:

- preselect for reuse by visual inspection;
- test an appliance's electrical safety;
- test the functionality of an appliance;
- test of an appliance's energy consumption;
- repair the appliance;
- remove personal data;
- software removal/installation;
- meet all reuse criteria;
- provide consumers with a warranty.

The WEEE Forum developed a set of standards for the collection, logistics and treatment of WEEE in 2011. These standards were referred to as the WEEELABEX standards and will be superseded by the CENELEC standards as part of a move towards unifying all standards under one European-based specification. The relevant standard for preparation for reuse of WEEE, EN50614, was published in January 2020. This standard is similar in design to the PAS 141 and OVAM standards. EN50614 is expected to supersede the previous standards and become the de facto preparation for reuse standard in the EU.

2.7 Preparation for Reuse Process

The process for preparation for reuse is outlined in the PAS 141 certification. The process for undertaking a preparation for reuse activity for WEEE is detailed in Figure 2.4. The process begins with sorting, and any items that are suitable for preparation for reuse undergo a process that determines suitability by visual inspection, a safety test, a functionality test, data erasure, software removal/installation, disassembly, repair and cleaning.

2.8 Information and Communication Technology

The upsurge in demand for ICT devices in the business (B2B) and consumer (B2C) sectors – laptops, tablets and smartphones – and advances in technology have contributed to an increase in electronic waste (e-waste). The initial and residual

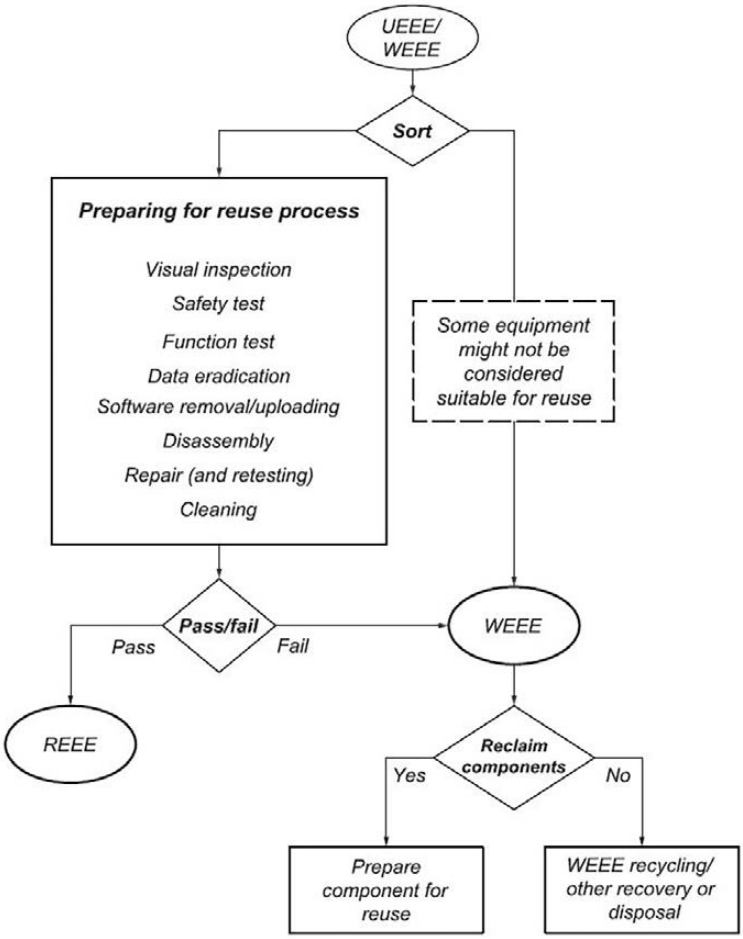

Figure 2.4. An overview of the preparing for reuse process (BSI, 2011). Permission to reproduce this figure from British Standards is granted by BSI. British Standards can be obtained in PDF or hard copy formats from the BSI online shop – www.bsigroup.com/Shop – or by contacting BSI Customer Services for hard copies only – tel: +44 (0)20 8996 9001, email: cservices@bsigroup.com.

values of many of these types of devices render them suitable for reuse. The robustness and quality of these devices enables them to retain their value and operation for a second life.

The growth online of marketplaces in Ireland such as eBay, Facebook Marketplace, Adverts.ie and DoneDeal.ie has provided a trading platform for second-hand or end-of-life devices to be sold on and reused. A key impediment to great trade through online platforms is the protection of data when a device is being forwarded for a second or third life. Bricks and mortar stores such as CeX provide an offline outlet for electronic devices. CeX operates around 40 stores in Ireland. The high residual value of modern electronic devices has also seen the expansion of pawnbroking services capitalising on this second-hand market. Although these bricks and mortar stores sell second-hand electronics, they do not carry out any collection and refurbishment of WEEE.

Retailers in Ireland such as DID Electrical, Currys and Harvey Norman sell large numbers of ICT devices, from laptops to tablets and smartphones, and are obliged to take back electronics under the WEEE Directive.

Information and communication technology devices, from personal computers to smartphones, suffer from a phenomenon known as the “closet effect” whereby users store their devices at home long after they have ceased to use them. Hickey and Fitzpatrick (2008) presented data that highlight the “closet effect” in Ireland, with respondents storing personal computers for anything from a couple of weeks to 8 years before disposal. The “closet effect” has been highlighted in the literature on WEEE as a barrier to increased reuse and recycling (Hickey and Fitzpatrick, 2008; Williams *et al.*, 2008; UNEP, 2011).

The WEEE Directive states that WEEE from private households, often referred to as B2C, means WEEE that comes from private households and WEEE from commercial, industrial, institutional and other sources that because of its nature and quantity, is similar to that from private households. Waste from EEE that is likely to be used by both private households and users other than private households shall in any event be considered WEEE from private households.

The WEEE Directive states that the directive covers all EEE used by consumers and EEE intended for professional use. The collection of B2C has traditionally been carried out through retailer collection points, local authority civic amenity (CA) sites and special collection days. The collection of B2B has until recently been carried out by ITAD companies. This function is normally outsourced by other companies under stringent conditions to protect any data that may be on the equipment. Many of the data-bearing components (hard disk drives) are destroyed on site to protect data-sensitive commercial interests. The WEEE Directive recast in 2012 incorporated dual-use devices, which can be B2C or B2B and can be disposed of in CA sites.

The recent publication of the GDPR in Europe has highlighted the responsibilities that organisations have when they are in the business of storing consumer and business data. The ITAD sector provides data destruction and sanitisation services to companies that require complete security in the destruction of their data. The presence of company data on a device can have many ramifications for the user and the organisation. The services of the ITAD sector tend to operate only in the B2B sphere owing to data protection issues; the cost of destroying company data and hard drives is offset by the value of the remaining equipment that can be reconditioned and sold on. Reconditioned equipment tends to be high-value servers, rackmount equipment, laptops, desktops, tablets and smartphones. There is no current universal solution in the B2C area. B2C consumers are required to maintain and store their own personal data on any devices they own. Apple and Google, for example, provide cloud storage services for users of iOS and Android devices. The benefit of these services is that the data can follow the user and not their device. Older devices did not have the benefit of cloud storage and, therefore, personal data remained on these devices unless removed by the owner or removed when the devices were reset to factory settings.

The issue of data protection is high on consumers' minds when it comes to disposing of EEE. Casey *et al.* (2018) identified two groups of consumers when it comes to hoarding EEE at home. The report found that the first group of consumers store EEE (WEEE) at home and their connection is with the contents of the device and the object itself is not relevant, while the second group wish to protect their personal data. Casey *et al.* (2018) noted that both groups are distinguished by a depreciated consumer/artefact relationship. The lack of cloud storage for older devices may hinder the divestment of these devices, but the proliferation of cloud services for more modern devices may have allayed consumers' data protection concerns.

The current method of disposing of WEEE with or without personal data present is entirely at the discretion of the person discarding WEEE in the facility, etc. The lack of a secure ICT WEEE return channel can prove to be a barrier to returning suitable data-bearing devices. Data protection for WEEE needs to be understood in the context of delaying returns of devices for preparation for reuse and recycling. The current system requires WEEE in the form of small household appliances to be stored in unsecure cages and exposed to the weather.

A secure and transparent process of returning devices and protecting data on devices at CA sites needs to be reviewed in terms of protecting the integrity of the WEEE takeback process.

2.9 Conclusion

The waste hierarchy positions prevention and repair, reuse and preparation for reuse above recycling and recovery. There are many issues facing the environmental management of EEE before and after it becomes waste. Collection rates will need to be increased to meet the targets set by the EU, which are a benchmark for a functioning management system in each Member State. The recast of the WEEE Directive in 2012 incorporated preparation for reuse targets but issued a preference for Member States to set their own targets. The treatment of WEEE has centred on collection volumes and recovery rates as measures of success across Europe.

3 Collection Events

3.1 Introduction

Research has shown that the reuse of EEE in Ireland is more successful when the collection of devices takes place at the closest point to the user (Johnson *et al.*, 2015). With this in mind, the TriREUSE project undertook a series of collection events located at workplaces. The events were created using existing networks from our project partners and by no means represent the only model for collection events targeting devices with potential for reuse.

The events focused on the collection of ICT devices, specifically laptops, tablets and smartphones. These devices were selected for several reasons: many of these devices are subject to the “closet effect”, they do not present at takeback facilities, and they may contain personal data or have a sentimental value to the user. These devices can have a high intrinsic value but need to be sold on as soon as the user decides that the device is no longer required.

Within the limited duration of the project it was necessary to focus on one model of collection. The collection events were conducted in a manner similar in structure to WEEE to Work events, which had been undertaken previously with compliance schemes and workplaces. WEEE to Work-type events were selected as the best method for collecting these data-bearing devices as they allowed a more efficient and direct targeting of employees for raising awareness of the benefits of reuse. WEEE to Work events were also selected as they could provide a synergy with B2B collection for future events. The collection events were a mix of public and private collaborations. Public collection events were also undertaken with European Recycling Platform (ERP) Ireland and WEEE Ireland. The private collection events were undertaken directly on company sites. Other models of collection, including using parcel logistics or charity shop collections, for example, also offer possibilities and could be developed in further work. The emphasis of the events was on establishing reliable operating procedures and establishing reuse rates rather than operating at scale.

3.2 Communications and Promotion

The promotion of TriREUSE was designed to build a trust model to communicate the authenticity and formal nature of the project. The trustworthiness and security of the offering was a key component in communicating to the end user that the service was controlled and safe, unlike the informal sector.

The promotion of the TriREUSE project was developed along two strands. Awareness and dissemination of the project details was delivered through a custom-built website, aligned with the relevant social media strategy.

A website was commissioned that featured information on the project, such as the environmental, societal and economic benefits of preparation for reuse. The website introduced our project partners and presented their credentials for involvement in the TriREUSE project. Figures 3.1 and 3.2 present content from the TriREUSE website.

A social media strategy was developed and the decision was made to create Facebook and Twitter accounts for the TriREUSE project. The purpose of the social media output was to disseminate the purpose of the project through video and infographics and to increase awareness of the project and the preparation for reuse strategy. Social media were used to raise awareness of the collection events and to promote the benefits of preparing devices for reuse. Figure 3.3 presents a screenshot of the Facebook page for the TriREUSE project, while Figure 3.4 presents a screenshot of the Twitter account.

Infographics and custom commissioned and templated video content were developed to raise awareness of the TriREUSE project. Physical items such as pull-up banners and balloons were commissioned to highlight and provide exposure for the collection events (Figure 3.5).

Vehicle signage was used as another method of delivering the TriREUSE message, as well as for highlighting the collaboration of its partners. A sign writer was commissioned to provide signage on two

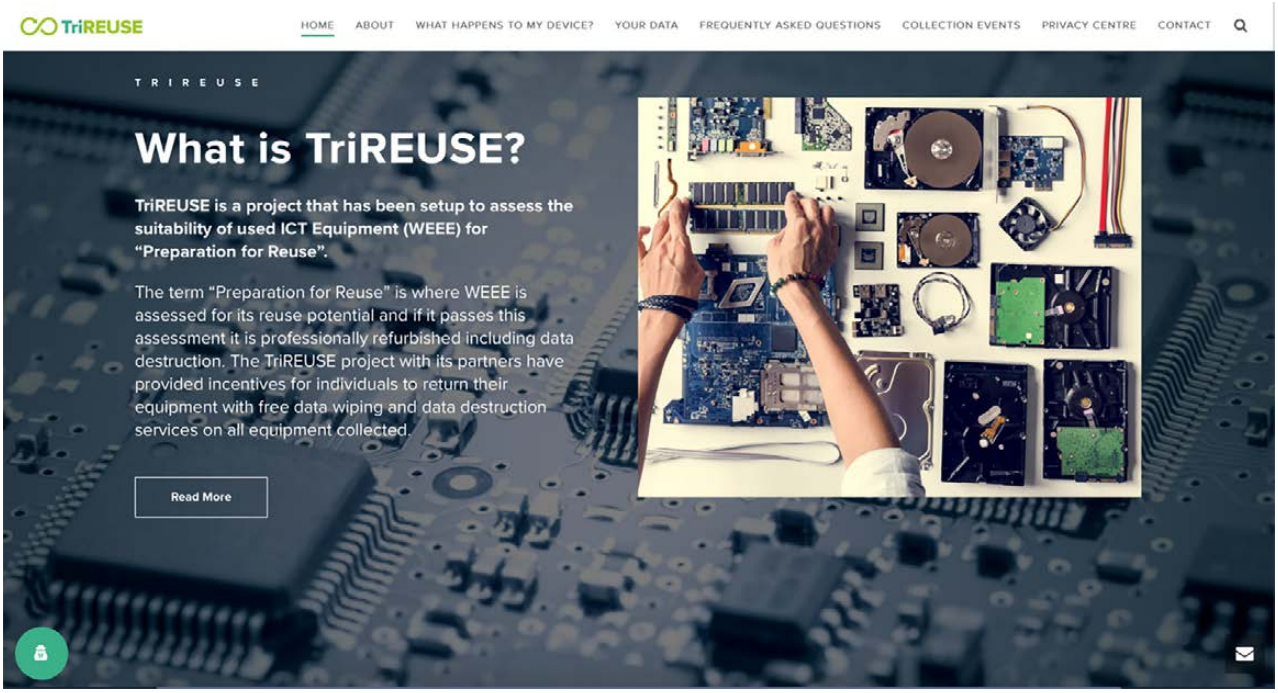

Figure 3.1. Screenshot of the TriREUSE website.

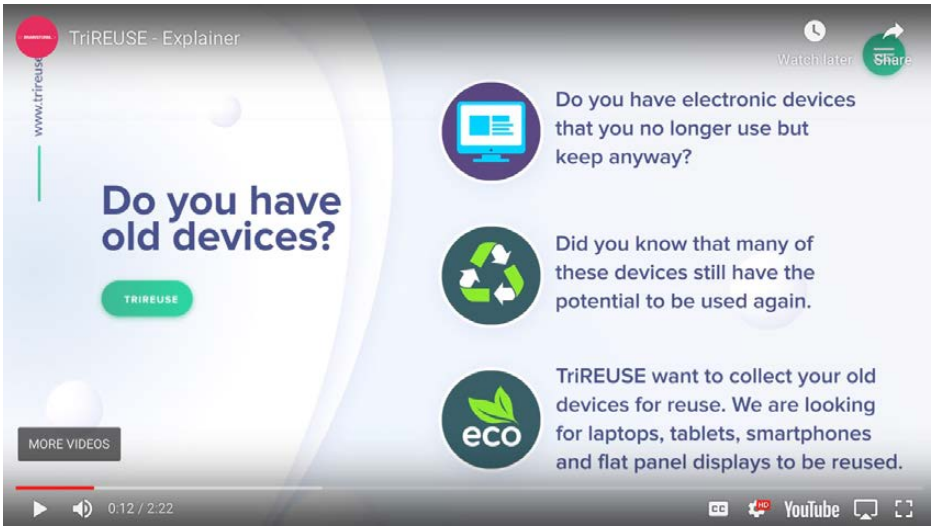

Figure 3.2. Screenshot of the TriREUSE explainer animation.

PhoenixRM vehicles, which would be used as part of the logistics network (Figure 3.6).

The TriREUSE project was aided and promoted by the Southern Region Waste Management Office (SRWMO) through Margaret Murphy, which in turn led to further awareness events with Ian O'Driscoll from Impact Energy. The SRWMO is responsible for the Southern Region Waste Management Plan, coordination with local authorities and proactively promoting reuse and recycling in the region. The SRWMO is tasked with providing these services for 10 local authorities with a population of 1.5 million people. Impact Energy hosts energy and environmental awareness events with companies throughout Ireland as part of the ISO 14001 standards for an environmental management system.

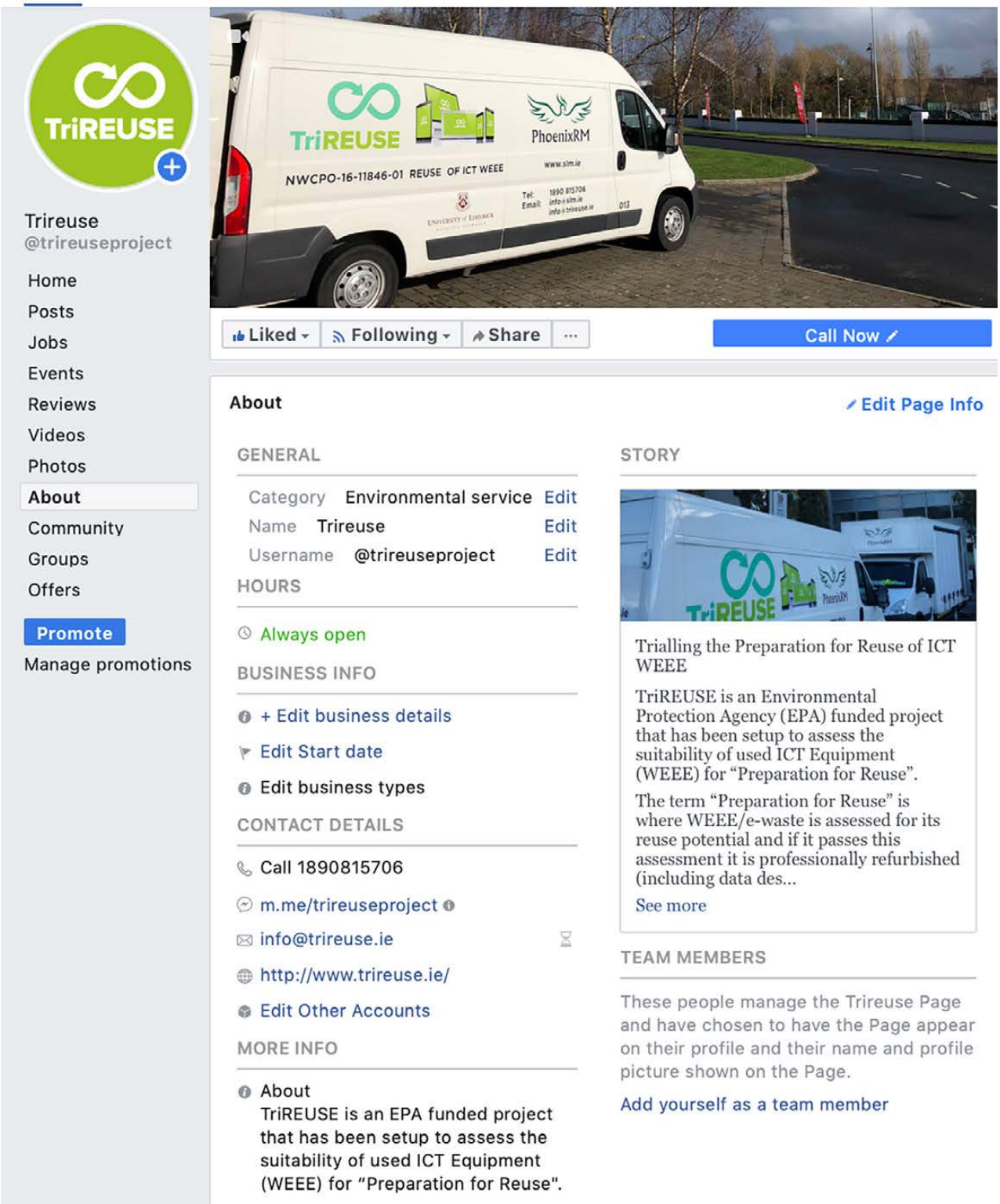

Figure 3.3. Screenshot of the TriREUSE Facebook presence.

Figure 3.4. Screenshot of the TriREUSE Twitter presence.

Figure 3.5. Promotional balloons for TriREUSE event – EPA Wexford.

Figure 3.6. TriREUSE partner PhoenixRM's logistics fleet at the Kildare County Council collection event.

Figures 3.7–3.11 present images from the various TriREUSE collection events.

Figures 3.12 and 3.13 provide examples of the infographics used in the promotion of TriREUSE events. These images were distributed to participants and the graphics were communicated by email or through communication portals within the organisations.

The promotion of the TriREUSE events by email, on-site displays and print media was important to advise employees on the upcoming events.

Figure 3.7. Public collection event with KMK Recycling at Confey Gaelic Athletic Association Club, Co. Kildare, April 2019.

Figure 3.8. TriREUSE at an IBM collection event, Co. Dublin, March 2019.

Figure 3.9. Department of Housing, Planning and Local Government collection event, Wexford, January 2019.

Figure 3.10. Collection event at the University of Limerick, October 2018.

Figure 3.11. Collection event at Kildare County Council, October 2018.

Figure 3.12. Infographic for a TriREUSE public event.

3.3 TriREUSE Events

The TriREUSE project used awareness and collection events to make the public aware of the benefits of preparation for reuse. The events were aimed at public and private organisations.

Public organisations were identified and approached and asked to consider hosting a TriREUSE event. The events were based on two models: the first model was an awareness event followed by a collection event on separate days and the second model was an awareness and collection event on the same day. The public organisations chosen ranged from local authorities to government departments and educational institutions.

Private organisations were identified and approached to host events using personal and business contacts. The events were similar in set-up to the public events. There was a mix of awareness and collection events depending on a client's needs and availability. The

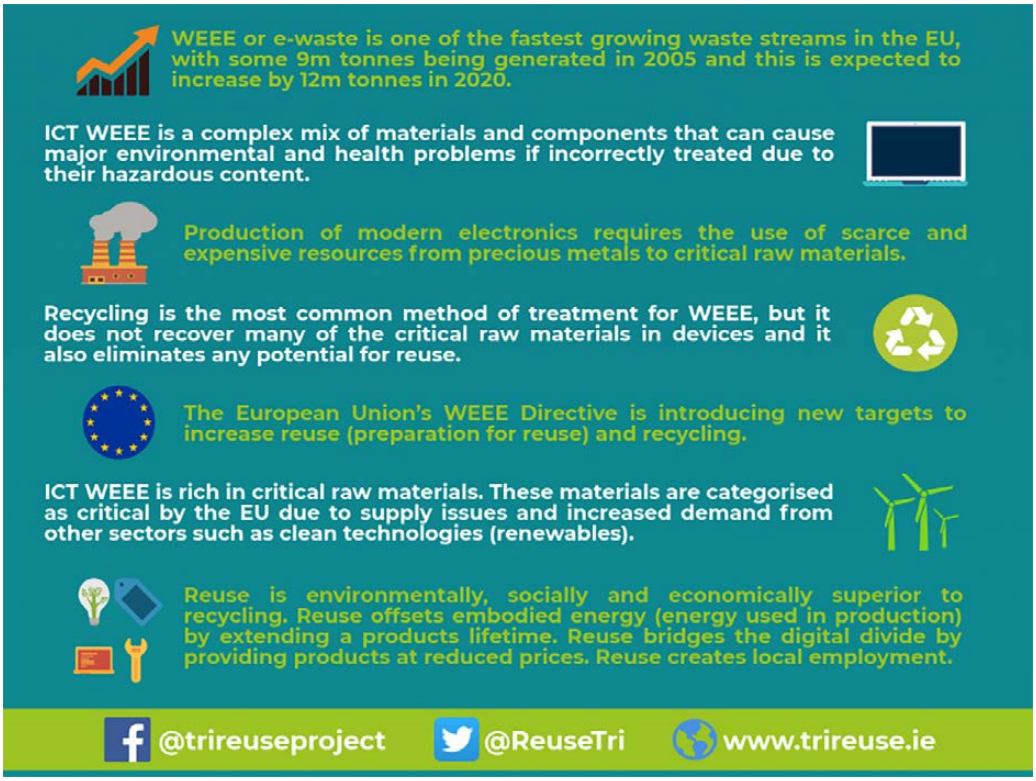

Figure 3.13. Infographic on WEEE and preparation for reuse.

events were run as 2-day (awareness day followed by a collection day) or 1-day (collection and awareness over one day) events.

3.4 TriREUSE Collection

The collection events utilised our project partner PhoenixRM's logistics resources. Devices were collected on the day and stored carefully in tote boxes or in caged trolleys to minimise damage and protect the integrity of the products. PhoenixRM is a certified preparation for reuse organisation and advised on all steps of the process.

3.5 Assessment and Testing

All collected devices were returned to PhoenixRM's facility in Naas, County Kildare, where the devices were weighed and sent for processing. The process for assessing the devices followed the PAS 141 methodology. Any devices that were collected but were considered outside the scope of the project were diverted for recycling.

Figure 3.14 presents the process flow for a device when it is returned to the preparation for reuse facility. In step 1 the user returns their device to us at a collection event. In step 2 a device is assigned an identification tag and is safely and securely placed in a collection box or cage. In step 3 the device is returned to our preparation for reuse partner, which receives and logs it. In step 4 the device undergoes inspection testing to determine if it is suitable for preparing for reuse.

If the device is not suitable it goes forward to step 5, in which the data are destroyed by mechanical means. From here the device and destroyed hard disk drive are removed for recycling by our recycling partners (step 6).

Step 7 is the next stage of the process if a device is suitable for reuse. The data are wiped using industry standard ITAD erasure software. We have provided a facility whereby if the owner of the device requires a data destruction certificate we can provide the certificate after the device is erased.

Step 8 is the final stage of preparing for reuse. The device is rebuilt with the loading of an operating system (OS) such as Microsoft's Windows 10 or Google's Chrome OS. The device is also cleaned during this stage and made presentable for sale.

In step 9 the device is sold as a refurbished item and the data are recorded for national waste statistics.

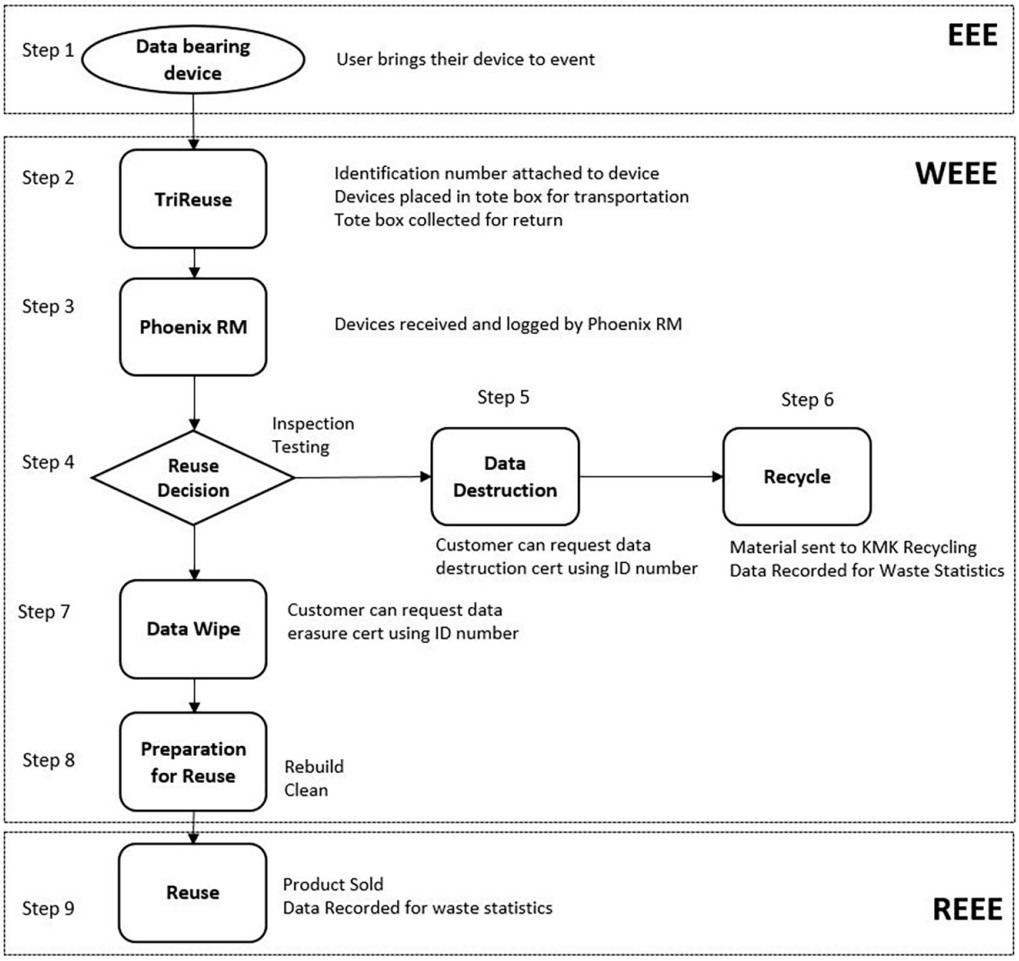

Figure 3.14. Preparation for reuse process flow.

4 Results

This section of the report will present and discuss the results of the TriREUSE project. The TriREUSE project results are presented in the context of social media impact, weights, devices, collection rates and returns from sites.

4.1 Promotion

The promotion of the TriREUSE project was undertaken using social media and a website. Social media allowed for better exposure of the events and the ability to target various demographics to promote the project. The website served as a placeholder for the project name and provided a more extensive background into the project.

4.1.1 Twitter

A Twitter account with the handle @ReuseTri was created in June 2018 in anticipation of the project starting in September 2018. Over the course of the project 48 tweets were posted, which gained 36,903 impressions and 728 engagements. Figure 4.1 displays the impressions by tweet from October 2018 to April 2019 and Figure 4.2 displays the engagements by tweet over the same time period. By the end of the project the Twitter account had 79 followers.

4.1.2 Facebook

The social media strategy for the TriREUSE project included the creation of a Facebook account to highlight events and promote awareness for preparation for reuse. By the end of the project, the Facebook page had 56 likes, as shown in Figure 4.3. Over the course of the project 32 posts were created on Facebook. Facebook was used to promote TriREUSE with nine paid-for advertisements. These nine advertisements resulted in 17,834 people being reached, with 22,555 impressions.

As shown in Figure 4.4, the reach of these advertisements was made up of 54% women and 45% men. The impressions of these advertisements were

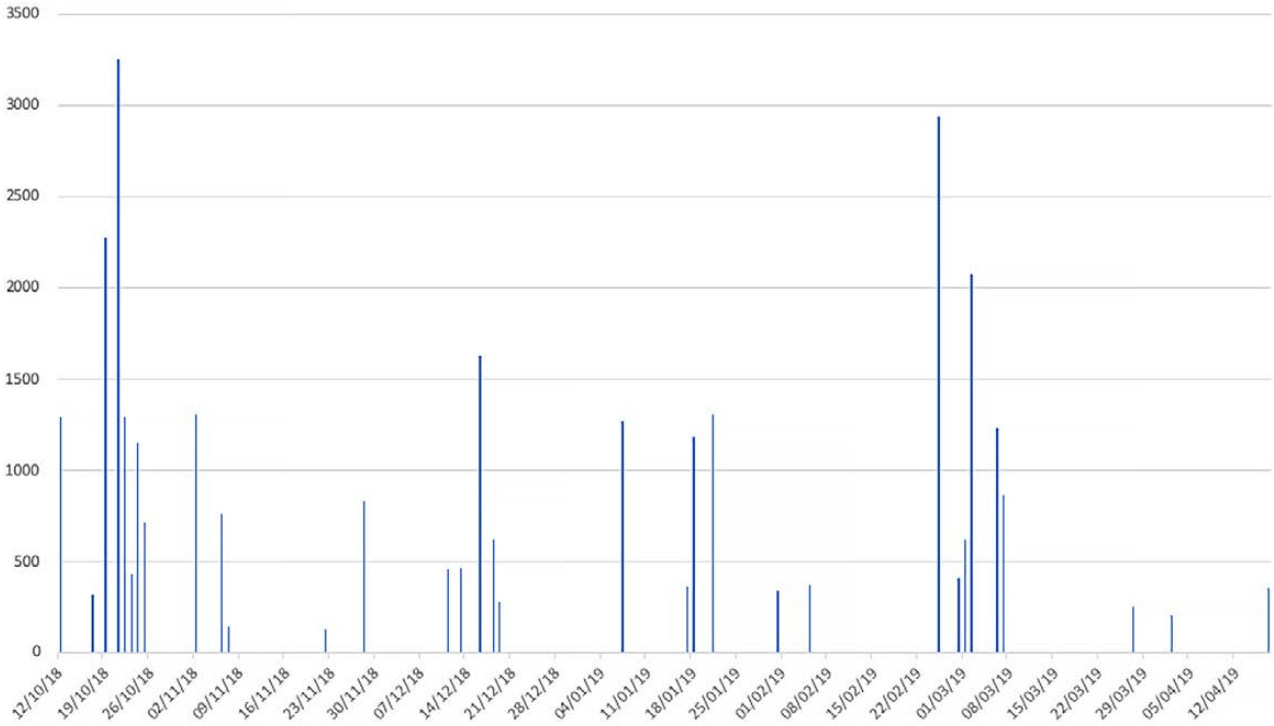

Figure 4.1. Impressions by tweet for TriREUSE account.

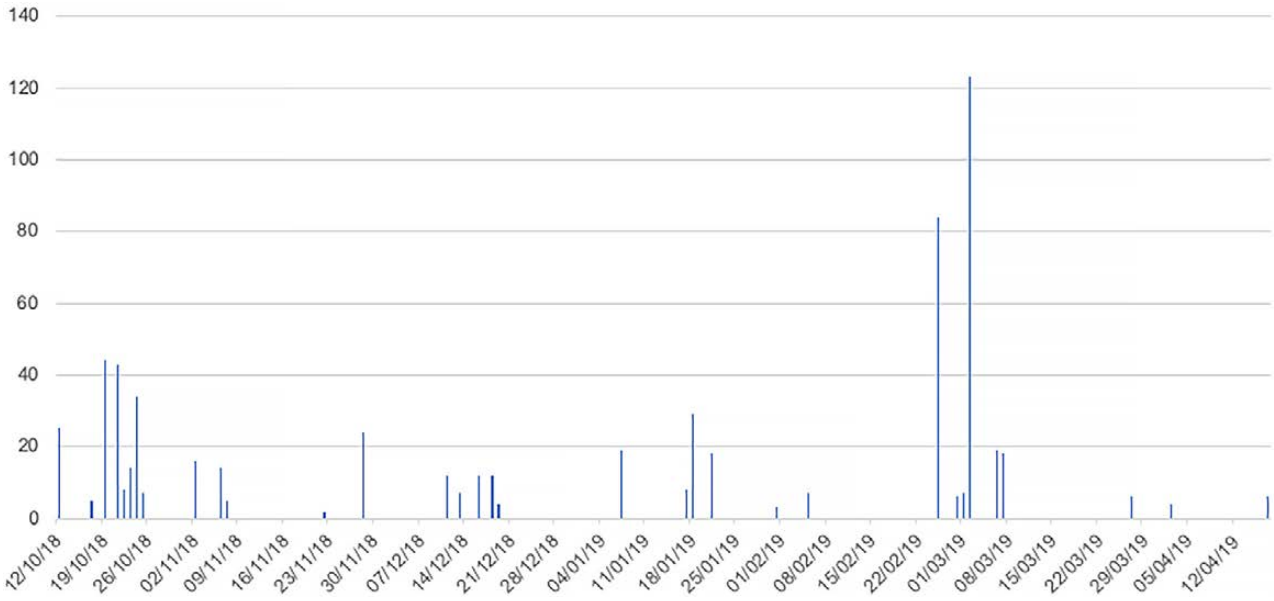

Figure 4.2. Engagements by tweet for TriREUSE account.

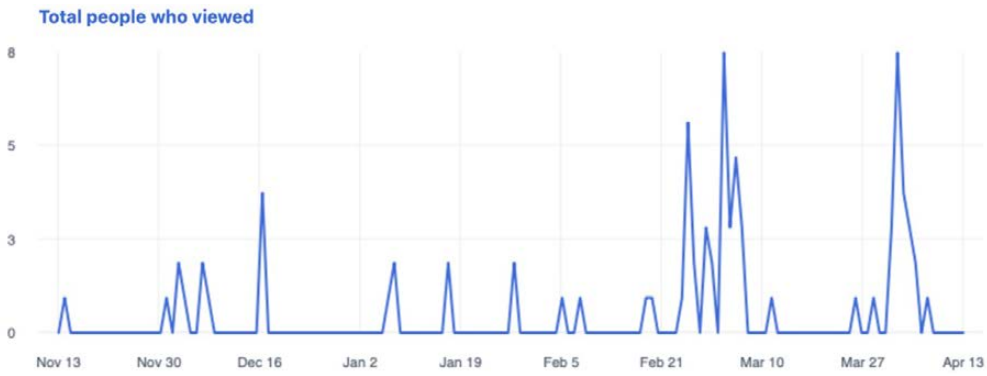

Figure 4.3. Total number of people who viewed the Facebook page.

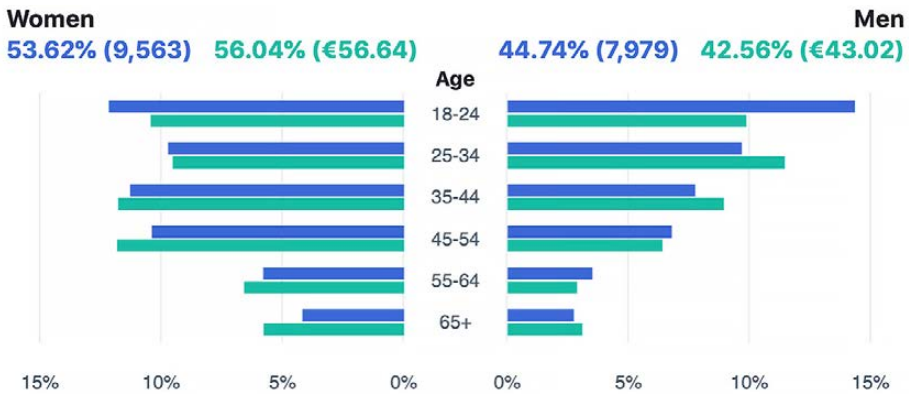

Figure 4.4. Facebook advertisements data on age and gender.

distributed according to the following proportions: 55% women and 44% men.

4.1.3 Website

A website was commissioned to act as a placeholder and a central information point for the TriREUSE project and background. Visits to the website remained low throughout the duration of the project as social media performed as a better vehicle for raising awareness and generating interest. The website had over 643 page views, with an average time of 1 minute and 10 seconds spent on the website. Figures 4.5–4.7 present the Google Analytics reporting on traffic, source and referrals on the TriREUSE website, respectively.

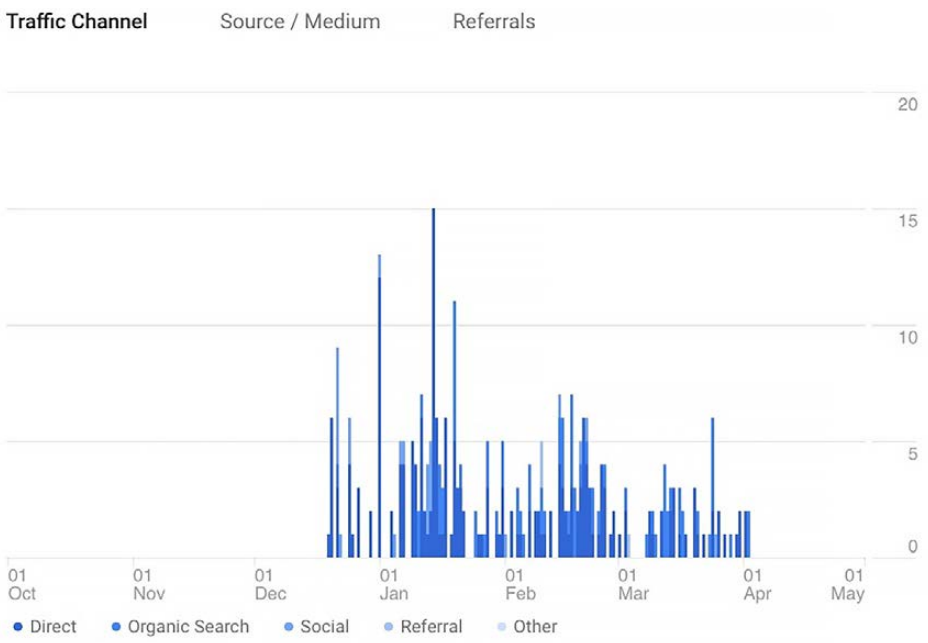

Figure 4.5. Google Analytics – traffic.

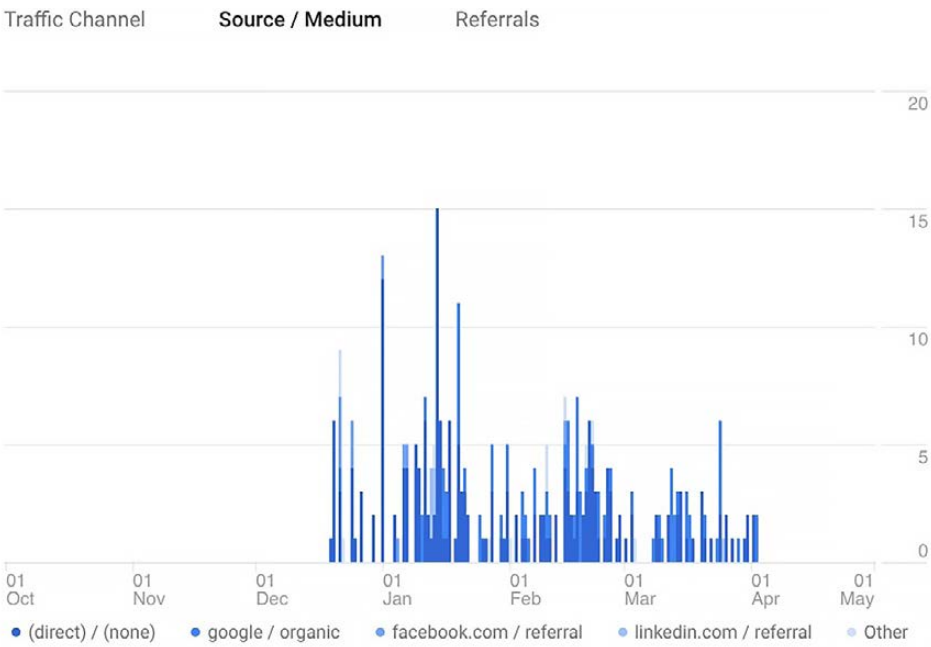

Figure 4.6. Google Analytics – source.

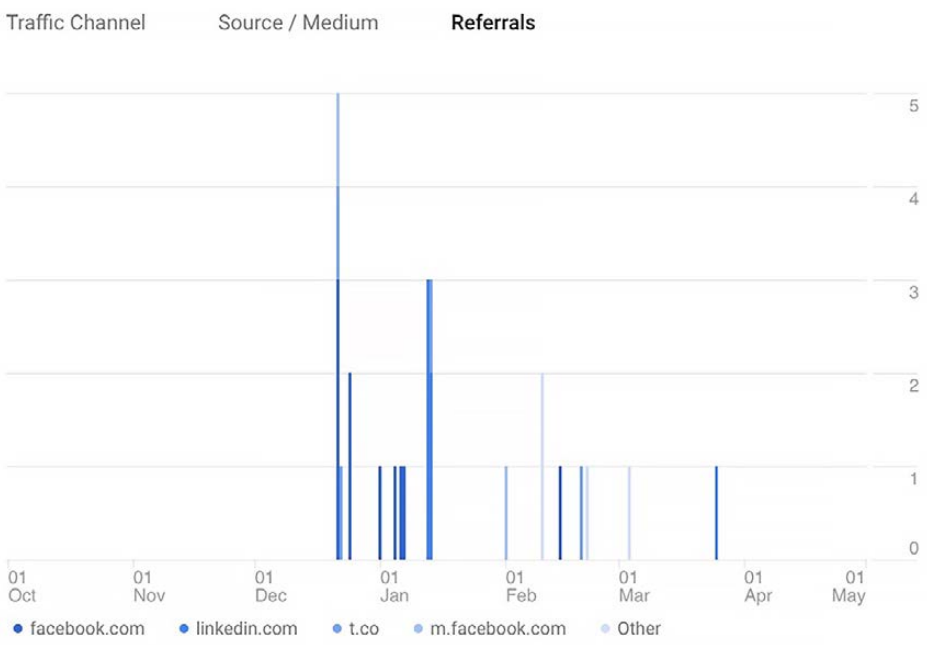

Figure 4.7. Google Analytics – referrals.

4.2 Collection Sites

The collection events took place at 10 sites throughout Ireland. The events were split between two public WEEE collection events and eight private collection events (Table 4.1).

The eight private collection events took place in the following organisations: Kildare County Council, University of Limerick, Meath County Council, Department of Housing, Planning and Local Goverment (Wexford), Department of Communications, Climate Action and Environment (Wexford), the EPA (Wexford), IBM (County Dublin), Irish Distillers (County Cork) and Symantec (Dublin).

The two public events took place at Confey Gaelic Athletic Association club in County Kildare and at Castletroy College in County Limerick. County Kildare is under the remit of WEEE Ireland and County Limerick is under the remit of ERP Ireland. The two compliance schemes (WEEE Ireland and ERP Ireland) in Ireland operate on the basis of a geographical split based on market share for servicing local authorities. In total, seven events took place in WEEE Ireland-serviced counties while three events took place in ERP Ireland-serviced counties.

4.3 Weight

The weights of the devices returned for collection were categorised using the United Nations University (UNU) keys, which assign a weight to each device category. The weights are reviewed and updated to represent the changing weights of current devices. The UNU keys calculated for 2010 were used as the basis for all weights and device categories:

- a total of 590.38 kg of devices were collected from the collection events;
- 282.96 kg were devices within the scope of the project, i.e. laptops, tablets and smartphones;
- 307.42 kg were forwarded for recycling.

4.4 Overall Collection Rates

The 10 collection events gathered 377 electronic devices. This accounted for a total of 590.38 kg of WEEE (Figure 4.8). The scope of the TriREUSE project was specified as the collection of data-bearing devices, laptops, tablets and smartphones. A total of 93 laptops, 36 tablets and 91 smartphones were collected. A total of 220 data-bearing devices were collected that were within the scope of the project. The 220 data-bearing devices equated to 282.96 kg using UNU keys from 2010.

Table 4.1. TriREUSE collection events

Location	Site	Address	Event type
Kildare County Council	A	Naas, Co. Kildare	Private
University of Limerick	B	Castletroy, Co. Limerick	Private
Meath County Council	C	Navan, Co. Meath	Private
DCCAE/DHP	D	Wexford Town, Co. Wexford	Private
EPA	E	Johnstown Castle, Co. Wexford	Private
Castletroy College	F	Castletroy, Co. Limerick	Public
IBM	G	Damestown Industrial Park, Mulhuddart, Co. Dublin	Private
Confey GAA Club	H	Leixlip, Co. Kildare	Public
Irish Distillers	I	Midleton, Co. Cork	Private
Symantec	J	Ballycoolin Business Park, Dublin	Private

DCCAE, Department of Communications, Climate Action and Environment; DHP, Department of Housing, Planning and Local Government; GAA, Gaelic Athletic Association.

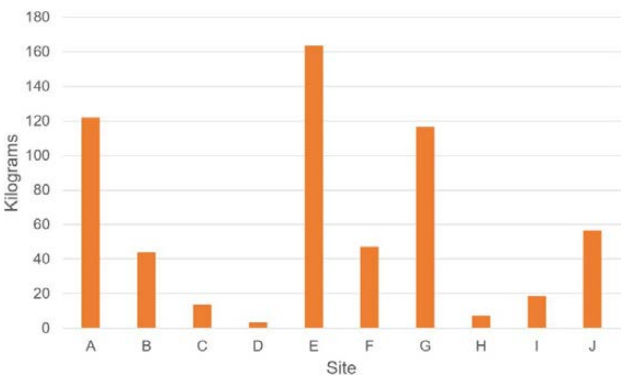

Figure 4.8. Total WEEE (all devices) collected by site in kilograms.

Various other types of devices that can be categorised as data bearing were collected. These included mobile phones (105 devices), desktop personal computers (20 devices) and other items such as external hard drives and MP3 players. These other devices remain outside the scope of the project and were not counted in the reuse figures. It is worthwhile noting the large quantities of other and older electronics that were presented at the collection events.

4.5 Results by Device

This section presents the results of the collection events by device type. The three categories of devices are laptops, tablets and smartphones. Other devices such as mobile phones and desktop personal computers have been included in the results as they can also be classed as data-bearing devices owing to personal data being present. Figure 4.9 presents the number of devices collected within and outside the scope of the project. The graph is a useful indicator of the types of devices presented at these events.

4.5.1 Laptops

Laptops are common electronic devices that do not always appear at normal WEEE collection points. The main reasons for this are that they are easily stored at home, value has been attached to the device and the presence of personal or work data.

Laptops accounted for 25% of all WEEE returned through the collection events. This was the largest category of devices collected. A total of 93 laptops were returned through the TriREUSE collection events, with one site returning 21 laptops for assessment. Five sites returned 10 or more laptops at the events. A total of 19% ($n = 18$) of the laptops were prepared for reuse by our partners. The remaining 81% ($n = 75$) were forwarded for recycling. Figure 4.10 shows the reuse and recycle split for collected laptops by site.

4.5.2 Tablets

The return of tablets through the collection events accounted for 10% of all the devices collected. Within the scope of the project, tablets accounted for 16% or 36 of the data-bearing devices. This was the smallest quantity of devices collected within the scope of the project. A total of 25% ($n = 9$) of the tablets went for reuse while the remaining 75% ($n = 27$) went forward for recycling. The results also indicate that Apple iPads were the most popular tablet that was suitable for reuse, with three such devices being suitable.

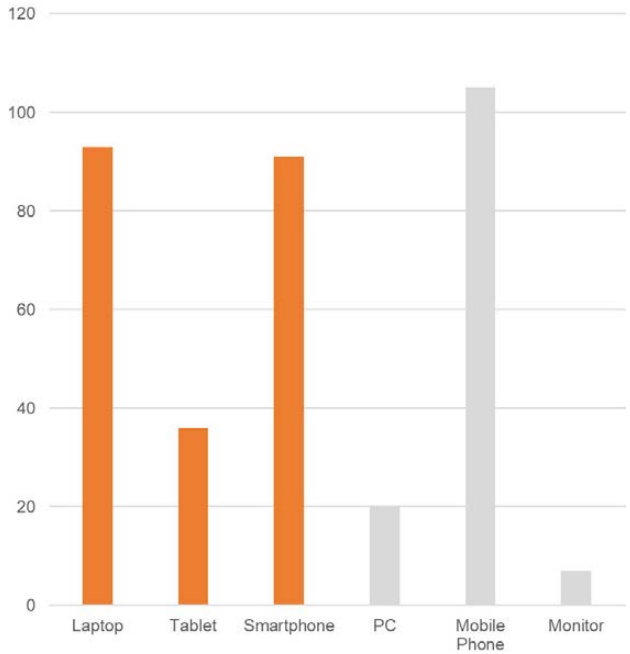

Figure 4.9. Number of devices collected within and outside the scope.

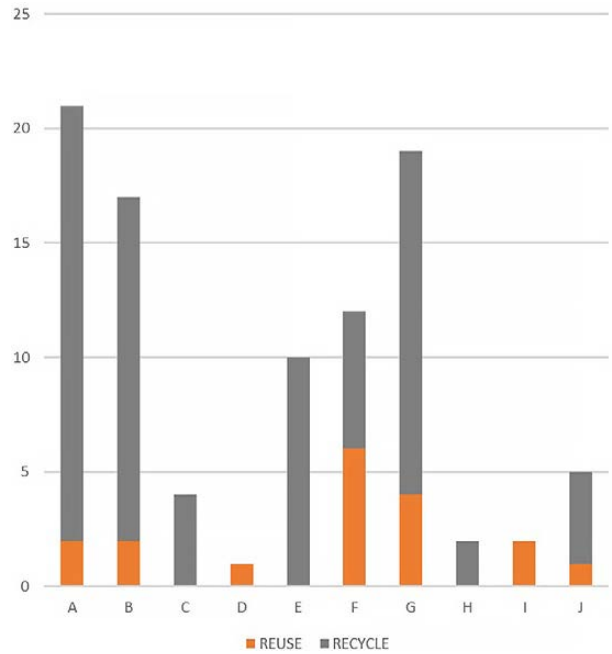

Figure 4.10. Reuse and recycle numbers by site – laptops.

Figure 4.11 presents the number of tablets reused and recycled by site.

4.5.3 Smartphones

Smartphones were categorised as any phone device that used a touchscreen and had Android or iOS as the proprietary operating system. Smartphones accounted for 24% of all devices returned through the collection events. Within the data-bearing scope of the project, smartphones accounted for 41% of the devices. This was the second largest group of data-bearing devices. Figure 4.12 presents the number of smartphones that were reused and recycled by site.

4.5.4 Desktop personal computers

While desktop personal computers were not included in the final figures for data-bearing devices, these devices do have economic value potential for refurbishment businesses. They also provide a feedstock of spare parts for other computers.

4.5.5 Mobile phones

Mobile phones represented a large percentage of the devices returned by the collection events, but they have little residual value. The popularity of the mobile phone has declined with the take-up of smartphones as communications devices.

Mobile phones are data-bearing devices and, owing to their relatively small size, they tend to be stored in homes and apartments. Mobile phones contain data such as contact details, photos and messaging. Mobile phones accounted for 28% ($n = 105$) of the devices returned at the events.

4.5.6 Other devices

Other devices accounted for 8% of the total devices collected. The other devices grouping contained items such as MP3 players, BlackBerry phones, digital picture frames, games consoles, hard disk drives and other computer peripherals.

4.6 Results by Site

The TriREUSE project collection events were conducted over a period of 8 months. The 10 sites that hosted the collection events represented a cross-section of workplaces throughout Ireland. The nature of WEEE to Work collection events tends to elicit various types of electronic and electrical items. Table 4.2 presents the return of devices and percentages within the scope of the project by site.

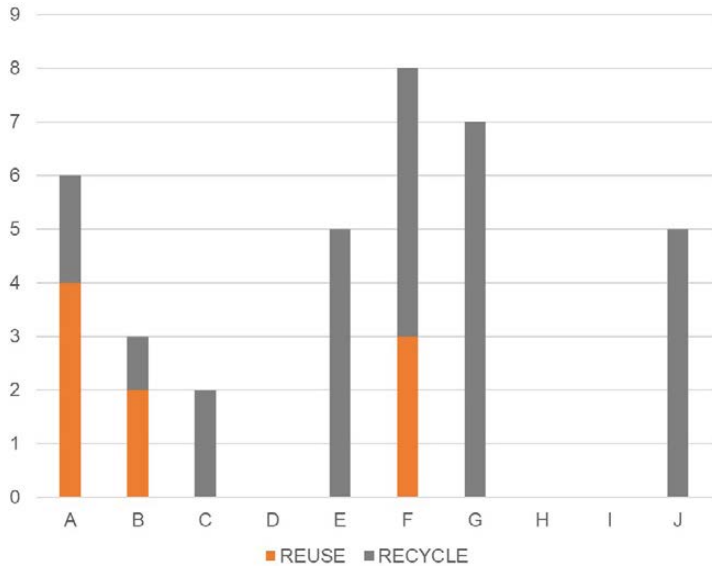

Figure 4.11. Reuse and recycle numbers by site – tablets.

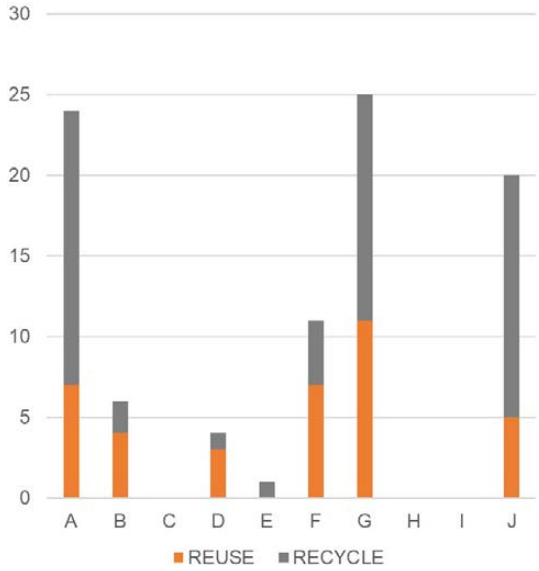

Figure 4.12. Reuse and recycle numbers by site – smartphones.

Table 4.2. Data-bearing devices collected at TriREUSE events

Site	Devices returned	Laptop	Tablet	Smartphone	Total DBDs	% in scope
A	62	21	6	24	51	82
B	32	17	3	6	26	81
C	13	4	2	0	6	46
D	12	1	0	4	5	42
E	52	10	5	1	16	31
F	70	12	8	11	31	44
G	80	19	7	25	51	64
H	10	2	0	0	2	20
I	5	2	0	0	2	40
J	41	5	5	20	30	73
Total	377	93	36	91	220	

DBD, data-bearing device.

The number of suitable devices collected through these events varied, with site A returning 62 devices, of which 51 were data-bearing devices of interest and within the scope of the project, accounting for 82% of the total devices collected, and site H returning 10 devices, of which only two were within the scope of the project. The rate of collection for data-bearing devices is dependent on several factors, such as promotion on the ground, timing, holidays, etc. The average percentage of data-bearing devices in scope was 52% across all the events. Figure 4.13 presents the ratio of devices collected to devices of interest.

Figure 4.14 presents the reuse and recycle split in kilograms of the WEEE that was collected at each event.

Site A hosted two collection events 3 months apart. These collections have been categorised as sites A1

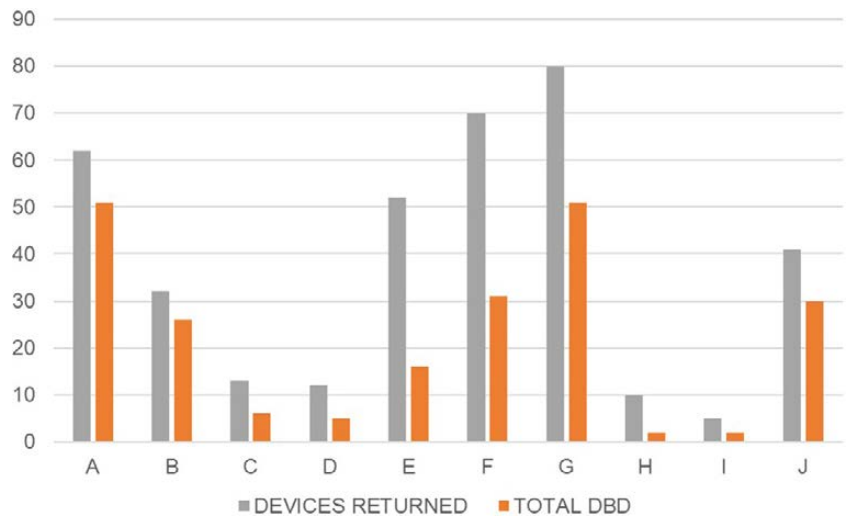

Figure 4.13. Total number of devices returned and number of data-bearing devices (DBDs) received.

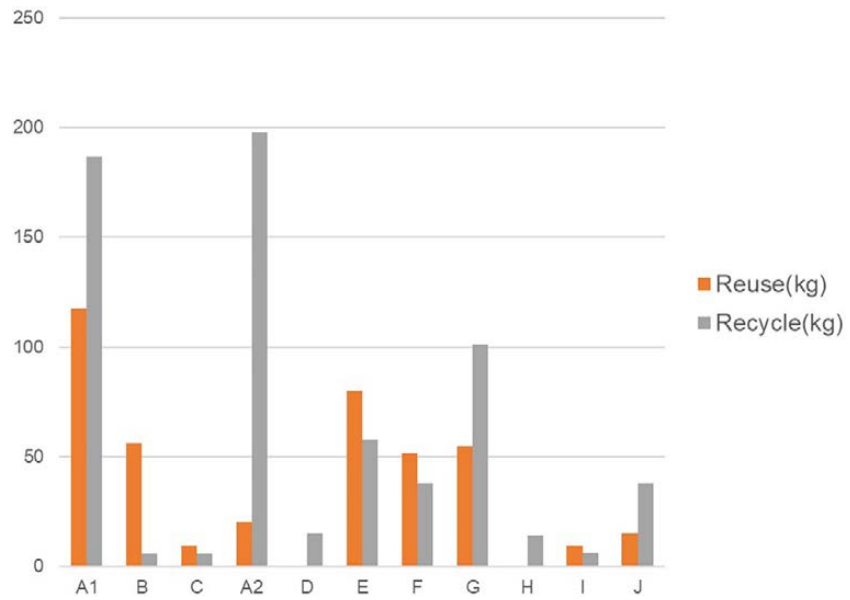

Figure 4.14. WEEE collected by site with reuse/recycle split.

and A2 to identify the quantities collected on each date. The site A collection returned 62 devices, 51 of which qualified within the scope of the project.

Site B hosted three events over 3 days. Events were hosted over 3 days because of the nature of the site campus, which was large and dispersed. The event collected 32 devices and 26 of these were within the scope for preparation for reuse, which accounted for 81% of the total devices collected. Site C returned 13 devices, with only six being in scope for the project (46%). Site D returned 12 devices, with only five being within scope for assessment; this accounted for 42% of the total devices collected. Site E returned 52 devices, with 16 being within the scope, and site F returned 70 devices, of which 31 were in scope. Site G returned the highest number of devices at the collection event and 51 were within the scope of

the project. Sites H and I returned 10 and 5 devices, respectively, with only two devices from each site being within the scope. Site J returned 41 devices, with 30 devices within the scope for the project.

Further analysis of the collection data was undertaken to identify the quantity collected per employee headcount. This analysis indicated that site A and site E had the highest returns per employee. All of the remaining sites had much lower levels of returns per employee. The data can provide a useful indicator of a baseline return level. Figure 4.15 presents the results of the collection per employee in kilograms.

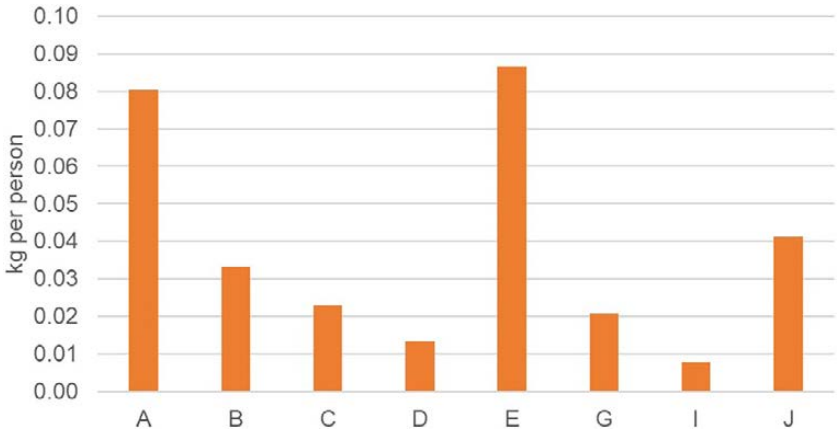

Figure 4.15. Collections per person by site.

5 Findings, Discussion and Recommendations

As outlined in the introduction and literature review sections, the preparation for reuse of WEEE sector in Ireland has been limited by several factors, which need to be addressed if this sector is to play a bigger role in WEEE management in Ireland. One of the key recommendations from the UpWEEE report was to enable approved preparation for reuse of WEEE organisations to access equipment directly from the general public. In light of this, the TriREUSE project explored the targeted collections of consumer ICT items with potential for reuse to establish what reuse rates would be possible for the selected devices. The outcome is based on the experience of running such collections and the results achieved. The conclusion and recommendations will be outlined in this chapter and will provide insight into how the findings can inform the direction of preparation for reuse of WEEE in Ireland. This chapter will begin with an overview of the findings and then provide some discussion and recommendations based on these.

5.1 Findings

- Targeted collections demonstrate significantly higher reuse rates than are obtained from the current collection system. The events achieved an overall reuse rate of 22% by weight and 29% by number of items for the products targeted (laptops, tablets and smartphones). These numbers indicate that targeted collections offer significant potential to generate sufficient quantities of products that are technically and economically reusable; this is clearly better than the current mechanism for making suitable equipment available for approved preparation for reuse of WEEE organisations, which has essentially failed to produce any preparation for reuse of ICT devices in Ireland.
- Providing certified data wiping leads to promising return rates of typically difficult-to-collect devices. Small products and, in particular, data-bearing devices have typically proven to be very difficult to collect from the general public by WEEE recycling programmes. It was observed at collection events that there was a lack of understanding by participants of the difference between reuse and recycling of WEEE, but the results of these targeted collections and feedback from the people who returned devices indicate that the offer of certified data wiping is a significant incentive for people to return items. The implementation of the GDPR through the EU has raised awareness of the need to protect data on devices at end of life and ongoing promotion of such a service would further support public awareness.
- For work-based events, on-site promotion from corporate social responsibility, ICT, facilities and employee volunteer programmes of awareness and collections days improves collection rates significantly. A very wide range of mass of WEEE was obtained at the collection events, with the most successful event collecting almost nine times more WEEE per employee than the smallest event. This was largely attributed to the extent to which the event was promoted within the organisations. While promotional materials, including websites, videos, social media, infographics, posters, etc., are essential resources, it is absolutely necessary to have internal champions for work-based events.
- Targeted collections will attract items without a potential for reuse and products outside the scope of the collection. While the events specifically targeted the collection of laptops, smartphones and tablets, it is interesting to note that significant numbers of items outside this scope were presented, including PCs, mobile phones and monitors. Smaller numbers of items including microwave ovens, vacuum cleaners and printers were also presented at events.

5.2 Discussion and Recommendations

- In general terms the findings of the project indicate that collections targeting preparation for reuse should play a role in a sustainable WEEE management system in Ireland as they seem to have the potential to offer access to sufficient volumes of items with potential for reuse. There is a willingness from the public for increasing reuse,

especially for high-value devices such as laptops, tablets and smartphones, in exchange for certified data destruction. This supports the requirement of the Waste Framework Directive that Member States should take measures to promote the reuse of products constituting the main sources of CRMs to prevent those materials from becoming waste. Approved preparation for reuse of WEEE organisations should be permitted to operate these events.

- Until now, access to WEEE through CA and retail sites has encountered problems between the relevant stakeholders. The WEEE to Work events for the collection of devices for preparation for reuse may serve as a useful tool to supplement the reuse sector until such stakeholder issues are resolved. The potential of WEEE to Work events is important as they have a number of benefits over normal takeback facilities, including promotion of the event within an organisation's communications network.
- The ITAD industry may be able to play a significant part in advancing this in Ireland and could potentially be offered in conjunction with other B2B ICT asset management or disposal services as it would offset the cost of running the event. For accessing WEEE through WEEE to Work events to take place, the company conducting the collection would, of course, need to be an approved preparation for the reuse of WEEE organisation, but this should not be a major barrier for organisations operating in this space.
- As the general public becomes more aware of and cautious about data on end-of-life products this will probably affect collection rates of such devices. In general, the WEEE management systems need to incorporate a secure method of returning devices if high collection rates are to be achieved. Public recycling events should offer a choice to consumers to divert data-bearing devices to registered preparation for reuse organisations before being recycled. Existing collection and recycling operators should be encouraged to expand their activity into preparation for reuse to utilise the experience and scale at which they currently operate.
- This project explored a limited number of models for collection and by no means represents the only possible means by which devices with potential for reuse could be pursued. Other models for collection of devices with potential for reuse should also be examined, including partnering with charity shops and involving parcel logistics.
- In line with the recommendations of the UpWEEE report, the evidence shows that a national-level preparation for reuse of WEEE target for specific product categories, as exists in Spain, is necessary to stimulate any of the actions outlined above. In particular, there is no incentive to invest in becoming an approved preparation for reuse of WEEE organisation unless access to suitable equipment can reasonably be assumed. Owing to the extended producer responsibility system, PROs and the compliance obligations they oversee for their members are central to everything that occurs in WEEE management in Ireland and they will require explicit motivation to back fully any preparation for reuse of WEEE initiatives.

References

Allwood, J.M. and Cullen, J.M., 2012. *Sustainable Materials with Both Eyes Open*. UIT Cambridge Ltd, Cambridge, UK.

BSI (British Standards Institution), 2011. *Publically Available Specification No 141. Reuse of Used and Waste Electrical and Electronic Equipment (UEEE and WEEE). Process Management. Specification*. BSI, London.

Casey, K., Lichrou, M. and Fitzpatrick, C., 2018. *A Community-based Social Marketing Approach for Increased Participation in WEEE Recycling (ColectWEEE).* Available online: http://www.epa.ie/pubs/reports/research/waste/research262.html (accessed 3 June 2020).

Coughlan, D., Fitzpatrick, C. and McMahon, M., 2018. Repurposing end of life notebook computers from consumer WEEE as thin client computers – a hybrid end of life strategy for the circular economy in electronics. *Journal of Cleaner Production* 192: 809–820.

Council of the European Union, 2019. *More Circularity – Transition to a Sustainable Society – Council Conclusions* 12791/19 (October), pp. 1–6.

EC (European Commission), 2015. *Study on WEEE Recovery Targets, Preparation for Re-use Targets and on the Method for Calculation of the Recovery Targets: Final Report*. EC, Brussels. Available online: https://ec.europa.eu/environment/waste/weee/pdf/16.%20Final%20report_approved.pdf (accessed 3 June 2020).

EC (European Commission), 2017. Report from the Commission to the European Parliament and the Council on the re-examination of the WEEE recovery targets, on the possible setting of separate targets for WEEE to be prepared for reuse and on the re-examination of the method for the calculation of the recovery targets set out in Article 11(6) of Directive 2012/19/EU on WEEE. European Commission, Brussels. COM(2017) 173 final, 18.4.2017, Brussels. Available online: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52017DC0173&from=EN (accessed 3 June 2020).

EC (European Commission), 2018. *Commission Staff Working Document – Report on Critical Raw Materials and the Circular Economy*. EC, Brussels.

EC (European Commission), 2020. *EU Circular Economy Action Plan*. Available online: https://ec.europa.eu/environment/circular-economy/ (accessed 8 June 2020).

Eurostat, 2019. Total collection rate for waste electrical and electronic equipment, 2017. Available online: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Total_collection_rate_for_waste_electrical_and_electronic_equipment,_2017_(%25_of_the_average_weight_of_EEE_put_on_the_market_in_the_three_preceding_years_(2015-2017)).png&oldid=480127 (accessed 3 June 2020).

González, X.M., Rodríguez, M. and Pena-Boquete, Y., 2017. The social benefits of WEEE re-use schemes. A cost benefit analysis for PCs in Spain. *Waste Management* 64: 202–213. https://doi.org/10.1016/j.wasman.2017.03.009

Gutowski, T.G., Sahni, S., Allwood, J.M., Ashby, M.F. and Worrell, E., 2013. The energy required to produce materials: constraints on energy-intensity improvements, parameters of demand. *Philosophical Transactions. Series A, Mathematical, Physical, and Engineering Sciences* 371: 20120003. https://doi.org/10.1098/rsta.2012.0003

Hickey, S.W. and Fitzpatrick, C., 2008. Combating adverse selection in secondary PC markets. *Environmental Science and Technology* 42: 3047–3052. https://doi.org/10.1021/es071706x

Johnson, M., McMahon, K. and Fitzpatrick, C., 2015. *Research of Upcycling Supports to Increase Re-use, with a Focus on Waste Electrical and Electronic Equipment (UpWEEE).* Available online: http://www.epa.ie/researchandeducation/research/researchpublications/researchreports/research241.html (accessed 29 June 2020).

Kissling, R., Fitzpatrick, C., Boeni, H., Luepschen, C., Andrew, S. and Dickenson, J., 2012. Definition of generic re-use operating models for electrical and electronic equipment. *Resources, Conservation and Recycling* 65: 85–99. https://doi.org/10.1016/j.resconrec.2012.04.003

Kissling, R., Coughlan, D., Fitzpatrick, C., Boeni, H., Luepschen, C., Andrew, S. and Dickenson, J., 2013. Success factors and barriers in re-use of electrical and electronic equipment. *Resources*, *Conservation and Recycling* 80: 21–31. https://doi.org/10.1016/j.resconrec.2013.07.009

Longmuss, J. and Dworak, C., 2019. Focus on reparability. Paper presented at the Product Lifetime and the Environment Conference, Berlin, 18–20 September, p. 6.

McMahon, K., Johnson, M. and Fitzpatrick, C., 2019. Enabling preparation for re-use of waste electrical and electronic equipment in Ireland: lessons from other EU member states. *Journal of Cleaner Production* 232: 1005–1017. https://doi.org/10.1016/j.jclepro.2019.05.339

Messmann, L., Boldoczki, S., Thorenz, A. and Tuma, A., 2019. Potentials of preparation for reuse: a case study at collection points in the German state of Bavaria. *Journal of Cleaner Production* 211: 1534–1546. https://doi.org/10.1016/j.jclepro.2018.11.264

Milovantseva, N. and Fitzpatrick, C., 2015. Barriers to electronics reuse of transboundary e-waste shipment regulations: an evaluation based on industry experiences. *Resources, Conservation and Recycling* 102: 170–177. https://doi.org/10.1016/j.resconrec.2015.07.027

MITECO (Ministry for Ecological Transition and Demographic Challenge), 2015. Spanish legislation on waste of electric and electronic equipments (WEEE): Royal Decree 110/2015 of 20 February. Available online: https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/prevencion-y-gestion-residuos/flujos/aparatos-electr/Royal-Decree-on-wastes-electronic-electric-equipments.aspx (accessed 3 June 2020).

O'Connell, M. and Fitzpatrick, C., 2013. *RE-Evaluate Re-use of Electrical and Electronic Equipment (Evaluation and Mainstreaming)*. Environmental Protection Agency, Johnstown Castle, Ireland. Available online: https://www.epa.ie/pubs/reports/research/waste/strive110-re-evaluate-re-useofelectrical andelectronicequipment.html (accessed 3 June 2020).

OVAM (Public Waste Agency of Flanders), 2012. *Code of Good Practice for the Re-use of (W)EEE*. OVAM, Mechelen, Belgium.

UNEP (United Nations Environment Programme), 2011. *Recycling Rates of Metals: A Status Report*. Available online: https://www.resourcepanel.org/reports/recycling-rates-metals (accessed 3 June 2020).

Williams, E., Kahhat, R., Allenby, B., Kavazanjian, E., Kim, J. and Xu, M., 2008. Environmental, social, and economic implications of global reuse and recycling of personal computers. *Environmental Science & Technology* 42: 6446–6454. https://doi.org/10.1021/es702255z

Zero Waste Europe, 2017. *Embodied Energy – A Driver for a Circular Economy?* Zero Waste Europe, Brussels.

Abbreviations

B2B	Business to business
B2C	Business to consumer
BSI	British Standards Institute
CA	Civic amenity
CRM	Critical raw material
EEE	Electrical and electronic equipment
EPA	Environmental Protection Agency
ERP	European Recycling Platform
EU	European Union
GDPR	General Data Protection Regulation
ICT	Information and communication technology
ISO	International Organization for Standardization
ITAD	Information technology asset disposal
LHA	Large household appliance
OS	Operating system
OVAM	Public Waste Agency of Flanders
PAS	Publicly Available Specification
PC	Personal computer
PRL	Producer Register Ltd
PRO	Producer responsibility organisation
REEE	Reused electrical and electronic equipment
SRWMO	Southern Region Waste Management Office
UEEE	Used electrical and electronic equipment
UNU	United Nations University
WEEE	Waste electrical and electronic equipment

AN GHNÍOMHAIREACHT UM CHAOMHNÚ COMHSHAOIL
Tá an Ghníomhaireacht um Chaomhnú Comhshaoil (GCC) freagrach as an gcomhshaol a chaomhnú agus a fheabhsú mar shócmhainn luachmhar do mhuintir na hÉireann. Táimid tiomanta do dhaoine agus don chomhshaol a chosaint ó éifeachtaí díobhálacha na radaíochta agus an truaillithe.

Is féidir obair na Gníomhaireachta a roinnt ina trí phríomhréimse:

Rialú: *Déanaimid córais éifeachtacha rialaithe agus comhlíonta comhshaoil a chur i bhfeidhm chun torthaí maithe comhshaoil a sholáthar agus chun díriú orthu siúd nach gcloíonn leis na córais sin.*

Eolas: *Soláthraímid sonraí, faisnéis agus measúnú comhshaoil atá ar ardchaighdeán, spriocdhírithe agus tráthúil chun bonn eolais a chur faoin gcinnteoireacht ar gach leibhéal.*

Tacaíocht: *Bímid ag saothrú i gcomhar le grúpaí eile chun tacú le comhshaol atá glan, táirgiúil agus cosanta go maith, agus le hiompar a chuirfidh le comhshaol inbhuanaithe.*

Ár bhFreagrachtaí

Ceadúnú
Déanaimid na gníomhaíochtaí seo a leanas a rialú ionas nach ndéanann siad dochar do shláinte an phobail ná don chomhshaol:
- saoráidí dramhaíola *(m.sh. láithreáin líonta talún, loisceoirí, stáisiúin aistrithe dramhaíola)*;
- gníomhaíochtaí tionsclaíocha ar scála mór *(m.sh. déantúsaíocht cógaisíochta, déantúsaíocht stroighne, stáisiúin chumhachta)*;
- an diantalmhaíocht *(m.sh. muca, éanlaith)*;
- úsáid shrianta agus scaoileadh rialaithe Orgánach Géinmhodhnaithe *(OGM)*;
- foinsí radaíochta ianúcháin *(m.sh. trealamh x-gha agus radaiteiripe, foinsí tionsclaíocha)*;
- áiseanna móra stórála peitril;
- scardadh dramhuisce;
- gníomhaíochtaí dumpála ar farraige.

Forfheidhmiú Náisiúnta i leith Cúrsaí Comhshaoil
- Clár náisiúnta iniúchtaí agus cigireachtaí a dhéanamh gach bliain ar shaoráidí a bhfuil ceadúnas ón nGníomhaireacht acu.
- Maoirseacht a dhéanamh ar fhreagrachtaí cosanta comhshaoil na n-údarás áitiúil.
- Caighdeán an uisce óil, arna sholáthar ag soláthraithe uisce phoiblí, a mhaoirsiú.
- Obair le húdaráis áitiúla agus le gníomhaireachtaí eile chun dul i ngleic le coireanna comhshaoil trí chomhordú a dhéanamh ar líonra forfheidhmiúcháin náisiúnta, trí dhíriú ar chiontóirí, agus trí mhaoirsiú a dhéanamh ar leasúchán.
- Cur i bhfeidhm rialachán ar nós na Rialachán um Dhramhthrealamh Leictreach agus Leictreonach (DTLL), um Shrian ar Shubstaintí Guaiseacha agus na Rialachán um rialú ar shubstaintí a ídíonn an ciseal ózóin.
- An dlí a chur orthu siúd a bhriseann dlí an chomhshaoil agus a dhéanann dochar don chomhshaol.

Bainistíocht Uisce
- Monatóireacht agus tuairisciú a dhéanamh ar cháilíocht aibhneacha, lochanna, uiscí idirchriosacha agus cósta na hÉireann, agus screamhuiscí; leibhéil uisce agus sruthanna aibhneacha a thomhas.
- Comhordú náisiúnta agus maoirsiú a dhéanamh ar an gCreat-Treoir Uisce.
- Monatóireacht agus tuairisciú a dhéanamh ar Cháilíocht an Uisce Snámha.

Monatóireacht, Anailís agus Tuairisciú ar an gComhshaol
- Monatóireacht a dhéanamh ar cháilíocht an aeir agus Treoir an AE maidir le hAer Glan don Eoraip (CAFÉ) a chur chun feidhme.
- Tuairisciú neamhspleách le cabhrú le cinnteoireacht an rialtais náisiúnta agus na n-údarás áitiúil *(m.sh. tuairisciú tréimhsiúil ar staid Chomhshaol na hÉireann agus Tuarascálacha ar Tháscairí)*.

Rialú Astaíochtaí na nGás Ceaptha Teasa in Éirinn
- Fardail agus réamh-mheastacháin na hÉireann maidir le gáis cheaptha teasa a ullmhú.
- An Treoir maidir le Trádáil Astaíochtaí a chur chun feidhme i gcomhair breis agus 100 de na táirgeoirí dé-ocsaíde carbóin is mó in Éirinn.

Taighde agus Forbairt Comhshaoil
- Taighde comhshaoil a chistiú chun brúnna a shainaithint, bonn eolais a chur faoi bheartais, agus réitigh a sholáthar i réimsí na haeráide, an uisce agus na hinbhuanaitheachta.

Measúnacht Straitéiseach Timpeallachta
- Measúnacht a dhéanamh ar thionchar pleananna agus clár beartaithe ar an gcomhshaol in Éirinn *(m.sh. mórphleananna forbartha)*.

Cosaint Raideolaíoch
- Monatóireacht a dhéanamh ar leibhéil radaíochta, measúnacht a dhéanamh ar nochtadh mhuintir na hÉireann don radaíocht ianúcháin.
- Cabhrú le pleananna náisiúnta a fhorbairt le haghaidh éigeandálaí ag eascairt as taismí núicléacha.
- Monatóireacht a dhéanamh ar fhorbairtí thar lear a bhaineann le saoráidí núicléacha agus leis an tsábháilteacht raideolaíochta.
- Sainseirbhísí cosanta ar an radaíocht a sholáthar, nó maoirsiú a dhéanamh ar sholáthar na seirbhísí sin.

Treoir, Faisnéis Inrochtana agus Oideachas
- Comhairle agus treoir a chur ar fáil d'earnáil na tionsclaíochta agus don phobal maidir le hábhair a bhaineann le caomhnú an chomhshaoil agus leis an gcosaint raideolaíoch.
- Faisnéis thráthúil ar an gcomhshaol ar a bhfuil fáil éasca a chur ar fáil chun rannpháirtíocht an phobail a spreagadh sa chinnteoireacht i ndáil leis an gcomhshaol *(m.sh. Timpeall an Tí, léarscáileanna radóin)*.
- Comhairle a chur ar fáil don Rialtas maidir le hábhair a bhaineann leis an tsábháilteacht raideolaíoch agus le cúrsaí práinnfhreagartha.
- Plean Náisiúnta Bainistíochta Dramhaíola Guaisí a fhorbairt chun dramhaíl ghuaiseach a chosc agus a bhainistiú.

Múscailt Feasachta agus Athrú Iompraíochta
- Feasacht chomhshaoil níos fearr a ghiniúint agus dul i bhfeidhm ar athrú iompraíochta dearfach trí thacú le gnóthais, le pobail agus le teaghlaigh a bheith níos éifeachtúla ar acmhainní.
- Tástáil le haghaidh radóin a chur chun cinn i dtithe agus in ionaid oibre, agus gníomhartha leasúcháin a spreagadh nuair is gá.

Bainistíocht agus struchtúr na Gníomhaireachta um Chaomhnú Comhshaoil
Tá an ghníomhaíocht á bainistiú ag Bord lánaimseartha, ar a bhfuil Ard-Stiúrthóir agus cúigear Stiúrthóirí. Déantar an obair ar fud cúig cinn d'Oifigí:
- An Oifig um Inmharthanacht Comhshaoil
- An Oifig Forfheidhmithe i leith cúrsaí Comhshaoil
- An Oifig um Fianaise is Measúnú
- Oifig um Chosaint Radaíochta agus Monatóireachta Comhshaoil
- An Oifig Cumarsáide agus Seirbhísí Corparáideacha

Tá Coiste Comhairleach ag an nGníomhaireacht le cabhrú léi. Tá dáréag comhaltaí air agus tagann siad le chéile go rialta le plé a dhéanamh ar ábhair imní agus le comhairle a chur ar an mBord.

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TriREUSE - Trialling the Preparation for Reuse of Consumer Laptops, Tablets and Smartphones

Authors: Damian Coughlan and Colin Fitzpatrick

Identifying Pressures

The introduction of the Waste Electrical and Electronic Equipment (WEEE) Directive has enabled Ireland to achieve high levels of WEEE recycling. Recycling is important for WEEE, but, with the adoption by the European Commission of a European Union action plan for the circular economy, there is a focus on more sustainable methods of extending product lifetimes in line with the implementation of the circular economy.

The action plan states that, in tandem with legislative proposals on waste and in accordance with the waste hierarchy (to establish a priority order), long-term targets should be set to increase preparation for reuse, as well as recycling of key waste streams and the reduction of landfilling. The current preparation for reuse sector in Ireland is beset by issues and, in line with current European Union policy, there needs to be more focus on how best to increase reuse in Ireland.

European Union policy has highlighted reuse and preparation for reuse as targets for future legislation in the WEEE Directive. Current rates of preparation for reuse in Ireland are low and alternatives to the existing system are needed to increase collection rates.

Informing Policy

This project presented a preparation for reuse trial, which utilised free data erasure and destruction for data-bearing devices, including laptops, tablets and smartphones. These types of devices do not present at normal WEEE takeback facilities owing to the "closet effect", whereby consumers hoard devices at home but no longer use them. It has been shown that consumers have a connection to the content on these devices. Content such as photographs, videos or music creates a barrier to returning devices for reuse and recycling, and consumers also expressed concerns about the data protection of their devices.

These barriers to returning devices for reuse were investigated during this trial using a trust model to encourage and incentivise owners of WEEE to return their devices using a safe and secure process.

These data-bearing devices are important in that, if returned within a shorter time frame, they will:

- Provide employment through preparation for reuse certified organisations;
- Have an economic potential for resale;
- Have a lesser environmental impact for reuse over recycling;
- Enable takeback of devices that contain many critical raw materials, such as rare earth elements.

The current Information Technology Asset Disposal (ITAD) sector in the main deals with businesses for the collection of electrical and electronic equipment. The TriREUSE project proposed the adoption of preparation for reuse certification by ITAD companies, which will allow the collection of consumer WEEE and has the potential to kickstart and increase preparation for reuse targets in Ireland in line with current European Union policy.

Developing Solutions

Preparation for reuse can provide an environmental and economic benefit for Ireland. A barrier to sending devices for preparation for reuse is the presence of personal data; this is particularly the case for difficult-to-collect devices (laptops, tablets and smartphones). These devices can have a high intrinsic value and can enjoy a second life but they also contain many important critical raw materials, as designated by the European Commission. The research identified the following solutions:

- Targeted collections demonstrate significantly higher reuse rates than the current collection system.
- Providing certified data wiping leads to promising return rates of typically difficult-to-collect devices.
- For work-based events, on-site promotion from corporate social responsibility, information technology, facilities and employee volunteer programmes of awareness and collections days improves collection rates significantly.
- Targeted collections will attract items without the potential for reuse and products outside the scope of the collection.

The research provides recommendations for the growth of preparation for reuse in Ireland as follows:

- Collections targeting preparation for reuse should play a role in a sustainable WEEE management system in Ireland.
- Approved preparation for reuse of WEEE organisations should be permitted to operate these events.
- The potential of WEEE to Work events is important for collections.
- The ITAD sector may be able to play a significant part in advancing preparation for reuse in Ireland.
- Public recycling events should offer a choice to consumers to divert data-bearing devices to registered preparation for reuse organisations before being recycled.
- A national-level preparation for reuse of WEEE target for specific product categories, as exists in Spain, is necessary.

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