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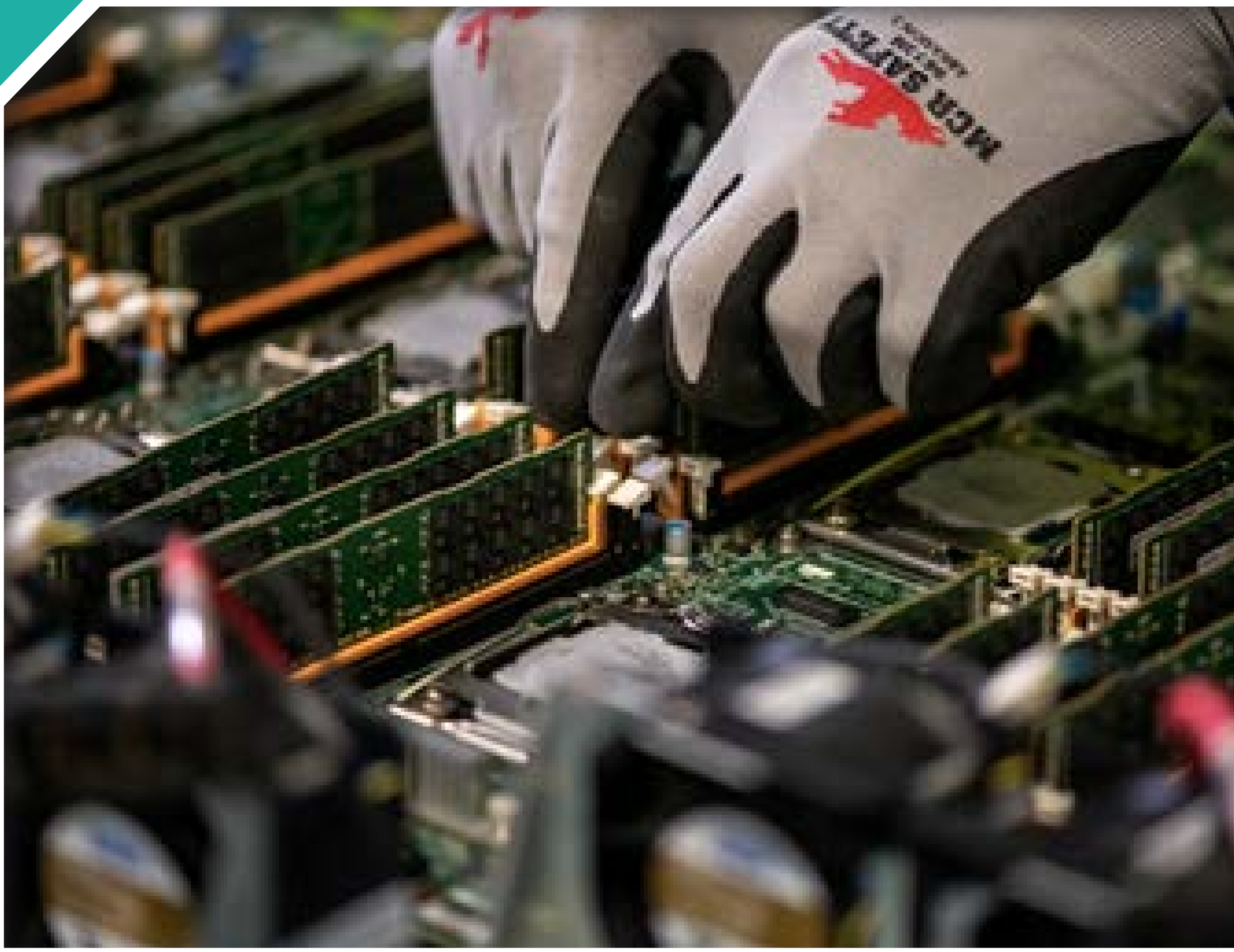
epa Research

# Estimating the Quantity of Electrical and Electronic Equipment (EEE) Exported from Ireland As Used EEE

Authors: Kathleen McMahon, Chidinma Uchendu and Colin Fitzpatrick

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**ENVIRONMENTAL PROTECTION AGENCY**

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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 2021–2030**

# Estimating the Quantity of Electrical and Electronic Equipment (EEE) Exported from Ireland As Used EEE

## (2018-RE-DS-11)

## EPA Research Report

Prepared for the Environmental Protection Agency

by

Department of Electronic and Computer Engineering, University of Limerick

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This report is based on research carried out/data from June 2019 to March 2020. 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

This report assesses the potential role of used electrical and electronic equipment (UEEE) export in meeting Ireland's waste electrical and electronic equipment (WEEE) collection targets. It examines UEEE export in two areas: mixed UEEE exported by private citizens by way of roll-on roll-off (RoRo) vehicles on cargo ships and used professional information technology (IT) equipment exported for the purpose of refurbishment and sale for reuse abroad. The key points and findings are:

- All Irish RoRo vehicles require documentation to certify that neither the vehicle nor its contents, often UEEE, are waste. A random selection of vehicles is selected for in-depth inspection by officials for compliance with regulatory and shipping requirements.
- Through monthly on-site inspections of all vehicles present on the day of inspection, the research team identified 20 categories of UEEE based on United Nations University (UNU) categorisations.
- Irish imported UEEE is in high demand in West African countries. UEEE exported from Ireland to West Africa was valued in this report at nearly €150,000 annually in destination markets.
- The UEEE found in RoRo vehicles over the course of the project amounted to 5542 kg, or an annual estimate of 17,319 kg.
- This annual estimate is not currently significant to Irish WEEE collection or other targets.
- Representatives of a total of 13 Irish companies involved in the production of EEE or information technology asset disposition (ITAD) services were interviewed to characterise Ireland's professional IT and related flows of exported UEEE.
- UEEE exported for reuse is not reported under current policy structures, as it is not classified as waste. Specific gaps in reporting were identified in the sector.
- Quantities of UEEE exported for refurbishment and reuse were reported to the research team by a total of eight major Irish producers and ITAD companies.
- Professional IT equipment exported for refurbishment and resale for reuse abroad was reported as a total of approximately 455 t, an amount equal to 7% of WEEE collected in Ireland in 2018.

# 1 Introduction

Increased demand, high obsolescence rates, innovation and shorter product lifespans contribute to the growth of discarded electrical and electronic equipment (EEE) (Perkins *et al.*, 2014; Baldé *et al.*, 2015a). Commonly referred to as the fastest growing solid waste stream, around 54 million metric tonnes of waste EEE (WEEE) is generated globally each year, an estimated 6 kg per person, projected to rise to up to 111 million tonnes per annum by 2050 (Parajuly *et al.*, 2019). If handled incorrectly, WEEE can be extremely hazardous, causing major health and environmental problems, yet it also contains many precious and critical raw materials which are strategically important to the development of European industry as part of the circular economy and the European Green Deal. High levels of WEEE and the resulting resource depletion, added to ethical concerns and adverse effects on health and the environment, have led to rising concern and regulatory focus around WEEE treatment (Ongondo *et al.*, 2011). For these reasons, the collection and treatment of WEEE has been a high priority for national and European policymakers for many years and has resulted in more ambitious collection targets in the revised WEEE Directive. In particular, the transboundary flows of both used EEE (UEEE), shipped for the purpose of reuse, and WEEE are the subject of growing research (Song *et al.*, 2017).

The export of both WEEE and UEEE from developed countries to developing countries, with China, India, Pakistan and Nigeria being leading destinations (Sthiannopkao and Wong, 2013; Cucchiella *et al.*, 2015; Odeyingbo *et al.,* 2017), has the potential to undermine set collection and recycling targets, as the materials are no longer available for treatment in the locations where they were originally placed on the market. For instance, only 22% of e-waste generated in the USA is collected, whereas European countries collect up to 35%, with 16% estimated to be exported, largely in undocumented exports (Baldé *et al.*, 2017; Parajuly *et al.*, 2019). Furthermore, with the present focus on advancing a circular economy, the transboundary shipment of WEEE may lead to loss of recoverable materials, as the destination countries may lack the capacity for advanced recycling and processing. The Ban Amendment to the Basel Convention, in effect from December 2019, by prohibiting the movement of hazardous wastes from developed to developing nations, aims to ensure that developed countries with the capacity and ability to process their own hazardous wastes in a responsible way do not dump waste (Secretariat of the Basel Convention, 2019). However, communities in developing countries also benefit from the import of non-waste UEEE in terms of improved access to equipment and quality of life.

On the other hand, EEE is also shipped among developed countries, and increasingly between developing countries, for the purposes of refurbishment and resale. In some cases, assuming similar regulatory environments, concerns in the original exporting countries are related less to the health and environmental impacts of EEE export, and more to reaching targets for WEEE collection.

Prior to the WEEE Directive coming into force there was no formal electrical or electronic recycling system in Ireland. Given this low base as a starting point, it could be argued that Ireland did remarkably well in achieving, and far exceeding, the target within a short time period. However, the flat 4 kg/person/year target was criticised in the review of the WEEE Directive as not providing any incentive for further improvement, particularly in Western European countries that could exceed this target comfortably due to high levels of consumption. The revised targets set by the recast WEEE Directive, implemented in 2016, required EU Member States to recycle either 45% of the average weight of EEE placed on the market in the previous 3 years (rising to 65% by 2019) or 85% of WEEE arising by 2019 (Figure 1.1).

The revised collection targets in the WEEE Directive since 2019 present a challenge for many EU Member States, including Ireland, as indicated by Figure 1.2. UEEE exported for refurbishment and resale on another country's market, which could be a significant percentage, is no longer available for collection and, therefore, will never arise as WEEE in Irish treatment channels, yet targets are still based on the average amounts of EEE placed on the market.

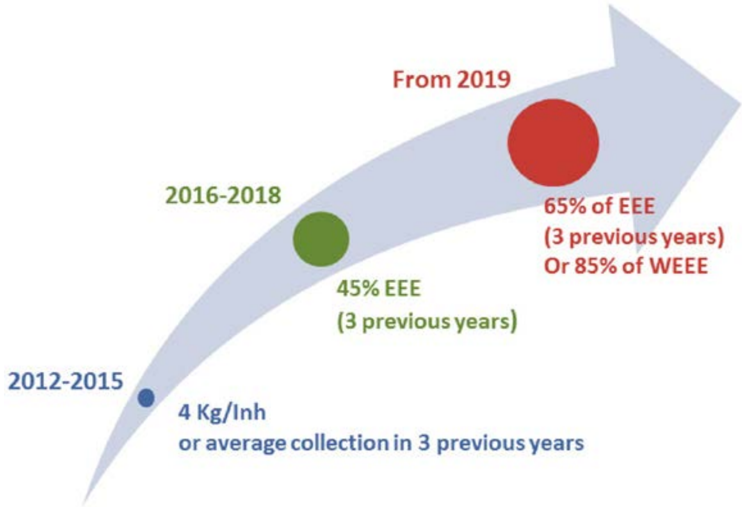


**Figure 1.1. Targets under the Revised WEEE Directive. Inh, per inhabitant.**

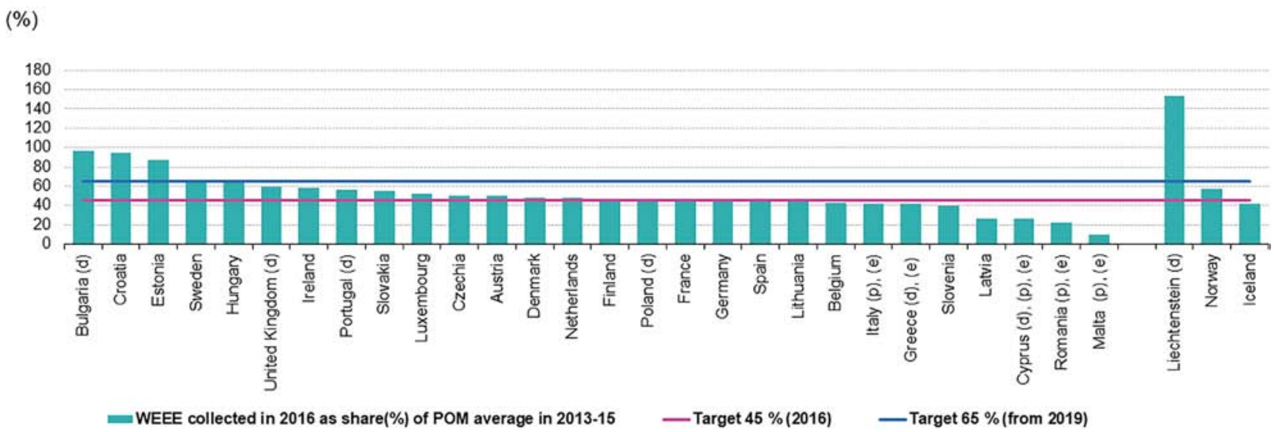


**Figure 1.2. WEEE collected targets and reported collections across the EU in 2016 in relation to the average weight of EEE put on the market in the preceding 3 years (2013–2015). Ranked on "Share of WEEE collected..." data. Source: Eurostat (online data code: env_waselee). (d), definition differs (see metadata); (e), estimated; (p), provisional.**

To reach and exceed these targets, Irish WEEE stakeholders must address a number of reasons for WEEE not arising in the compliant WEEE treatment system, including improper disposal in household waste and recycling collections or in scrap metal facilities, dumping, illegal export and long-term storage of end-of-life equipment (consumers commonly hold on to unused equipment because of its perceived residual value or because they lack of awareness of or access to suitable collection sites). These inhibiting factors to WEEE treatment are likely to be addressed by increasing awareness of and access to proper WEEE disposal and enforcement of regulations. However, legal export may also be a significant contributor to WEEE not arising in Irish compliant treatment facilities. Legal export of UEEE for refurbishment and resale, often within the EU, contributes to resource efficiency and the sustainable benefits thereof through reuse and the lifetime extension of EEE. Only quantities of equipment classified as waste are reported under the current target attainment methodology. UEEE exported for reuse and therefore no longer available for collection at end of life in the Irish system, despite being place on the Irish market, is classified as product at all times and is not captured under the current reporting model. To calculate the appropriate quantities of WEEE required to meet collection and recycling targets it is necessary to quantify, and potentially deduct, UEEE exported for reuse.

## 1.1 Objectives and Scope

This report sets out to assess the potential role of UEEE export in meeting Ireland's WEEE collection targets. To do so, the report examines UEEE export in two areas: (1) mixed UEEE exported by way of roll-on roll-off (RoRo) vehicles on cargo ships (Chapter 2) and (2) professional information technology (IT) equipment exported for the purpose of refurbishment and sale for reuse abroad (Chapter 3). Each chapter addresses the first section of this research, the compiling of all existing literature on UEEE exports and the methods employed in a detailed literature review.

The initial objectives of the first part of the project were to assess the potential for quantification of UEEE exported in RoRo vehicles and to develop a profiling methodology adapted to quantify UEEE in these export vehicles at ports in Ireland in partnership with the National TransFrontier Shipment Office. As these objectives were successfully achieved, an additional objective, to quantify UEEE for export through the primary collection and analysis of data from Ireland's main port for RoRo exports, was set.

Objectives of the second part of the project were to characterise the professional refurbishment sector in Ireland and to explore the extent to which equipment placed on the market in Ireland is exported for refurbishment. In this work package the research team developed a comprehensive description of the nature, scale and practices of several major actors in the professional refurbishment sector in Ireland, including non-profit and for-profit organisations, by conducting a range of interviews and site visits across Ireland to gather data on sources and destinations of equipment and current reporting practices. This project was also able to develop and pilot a method for future reporting of exported professional IT equipment.

The conclusions of the report have been used to develop a set of recommendations for conducting estimates on exported UEEE moving forward. These recommendations are based on the quantities of UEEE estimated from primary data, as well as the experience of interacting with stakeholders.

# 2 Roll-on Roll-off Vehicle Export

Significant attention has been focused on the movements of UEEE and WEEE from developed to developing nations, and, increasingly, between developing nations. On the one hand, there exists the potential detrimental environmental and health impacts on workers in the informal waste treatment sector and their communities when waste or equipment that is approaching end of life is imported. On the other hand, the communities that gain access to affordable electronics may benefit from improved quality of life or greater access to employment opportunities.

The most recent high-profile work has been published by United Nations University (UNU), which inspected incoming shipments to Lagos, Nigeria, to estimate the quantities of UEEE. Interestingly, this study ranked Ireland as the eighth largest source of UEEE into Nigeria, contributing 6.15% of imports. More than 98% of Irish UEEE was found to have been imported via RoRo shipments (Odeyingbo *et al.*, 2017, 2019). For this reason, the scope of this section of the project focused on RoRo shipments. The term RoRo shipments, used throughout the remainder of this paper, refers to shipments of individual fully loaded vehicles that are driven on and off cargo vessels, in contrast to container shipments, in which goods are loaded into containers that are then transferred onto vessels.

As will be seen in sections 2.1 and 2.2, data quantifying the transboundary movements of UEEE and WEEE, particularly from origin ports, are limited in the academic literature. In the case of those studies that do exist, the methodology used is often unclear, as there is no consistent standard, something also discussed by Odeyingbo *et al*. (2019). This research sought to generate unique primary, on-the-ground data on the quantities of UEEE exported from Ireland, particularly UEEE contained in RoRo vehicle shipments, and to examine the financial factors driving these exports. The resulting quantitative data provide a deeper understanding of transboundary shipments of UEEE from Ireland to other countries, especially developing nations. This is important, as well-collated data assist authorities to effectively reduce the generation of e-waste, prevent illegal shipments, promote recycling, create green jobs and curb global emissions (Baldé *et al.*, 2017). Furthermore, at the national level, the lack of quantification of transboundary movements of UEEE and WEEE creates difficulty in addressing issues such as the proper estimation of collection and recycling to meet legislative targets (Forti *et al.*, 2020).

The main objective of this study was to quantify shipments of used electronics by inspecting RoRo vehicles for the purpose. This involved an investigation on the types of UEEE contained in the vehicles and a quantitative analysis of the volume. The research also went further, by estimating the value of shipped UEEE in the Nigerian online reuse market. In the following sections, we describe our examination of the existing literature, particularly relating to the generation and flows of used and waste electronics, explain the adapted “person in the port” methodology undertaken to quantify used electronics in RoRo exports and outline the results, and draw conclusions from the key findings.

## 2.1 Literature Review

In both literature and practice, the distinction between UEEE and WEEE can often be quite difficult to determine, and the transboundary movement of WEEE disguised as UEEE contributes to this difficulty (Li *et al.*, 2013; Song *et al.*, 2017). UEEE is defined as EEE that, although used, is still workable in its original form or can be repaired, modified or reconditioned for use in the same original purpose for which it was designed (Odeyingbo *et al.*, 2017). WEEE refers to EEE, inclusive of its parts, that has been discarded by the owner as waste without the intention of reuse (StEP Initiative, 2014). In the context of this definition of WEEE, one may assume that the reason discard arises is defect or lack of functionality; however, reasons for disposal are varied and include age and the desire for newer and “trendier” models (StEP Initiative, 2014). Therefore, EEE does not need to be non-functional to be deemed waste, and this highlights the subtle distinction between used electronics and waste electronics.

### *2.1.1 Export of UEEE to West Africa*

Currently, the proliferation of reuse policies and innovative initiatives such as collection events are promoting the reuse market in developed countries (Coughlan and Fitzpatrick, 2020). Initiatives such as Computers for Schools in Canada and businesses such as Camara Education and GreenIT in Ireland, by providing low-cost refurbished equipment, are helping to meet the demand for affordable electronics from schools and individual students who might otherwise be unable to access these products. However, despite substantial price differences, many individual consumers in developed countries continue to favour new electronics, whereas the opposite remains the case in developing countries (Williams *et al.*, 2008). Owing to such disparities in economic situation, discarded electronic equipment often has high reuse value in developing regions, where the lower cost of used equipment improves the access of individuals or communities to information and communication technology (ICT) (Williams *et al.*, 2008). The demand for UEEE in developing countries such as Nigeria is on the rise. Despite the availability of new and relatively cheap EEE from countries such as China, demand for UEEE persists, as consumers tend to favour UEEE from Europe, popularly referred to as "UK used", "tokunbo" or "second-hand electronics" in Nigeria. With the current growth in ICT, the demand for such products will only grow. Kahhat and Williams (2009) also found that used computers exported from developed countries to developing countries (in their case Peru) are largely intended for direct reuse rather than recycling. Similarly, in an assessment of the repair sector in Ghana, Groscurth *et al.* (2020) found that imported EEE devices were intended for further use and the lifetime of a product could be tripled by up to four repairs. An analysis to determine the lifespan of flatscreens showed that the median age was 4 years at import, 8 years at the repair shop and 12 years when scrapped (Groscurth *et al*., 2020).

Although local generation of e-waste in West African countries is rising (Forti *et al.*, 2020), it remains the case that many items of e-waste come from imports. West Africa serves as a major trading route of used electronics, with Nigeria and Ghana being the main import hubs for equipment shipped in containers and Nigeria and Benin being the main import hubs for RoRo vehicles (Secretariat of the Basel Convention, 2011; Asante *et al.*, 2012; UNEP, 2015). Various attempts have been made to quantify the amount of UEEE/WEEE imported into West Africa, especially Nigeria and Ghana, but often the methodologies employed in these studies have limitations in terms of their replicability and consistency, discussed further in section 2.2. In its report *The Digital Dump: Exporting Re-use and Abuse to Africa*, the Basel Action Network (2005) estimates that around 400,000 used computer scraps are imported into Nigeria monthly in containers. However, the methods for estimating numbers in this report are not shared in depth, as they were not the focus of the study. By using logistic modelling and material flow analysis, Yu *et al.* (2010) have estimated that the growth of obsolete personal computers (PCs) in developing countries will increase to between 400 and 700 million units, compared with 200–300 million units in developed countries. As mentioned in Chapter 1, research by Odeyingbo *et al*. (2017) identified Ireland as a significant contributor to UEEE and WEEE entering Lagos in Nigeria, with an estimated 3660 t of UEEE arriving from Ireland in RoRo vehicles and 40 t in container imports (Odeyingbo *et al.*, 2017). During the period of assessment, 105 out of 170 imported vehicles were observed to contain UEEE. The items imported in these shipments were mostly of screens and large and small household appliances, of which 60% was reported to be clean and suitable for direct reuse and 40% improperly packaged and dirty (Odeyingbo *et al.*, 2017).

Studies of the transboundary shipment of UEEE by Bisschop (2012), Lepawsky (2014, 2015) and Amankwah-Amoah (2016a,b) have identified the push factors, or drivers, that underlie the export of WEEE from source countries, and the pull factors, or attractants, behind the import of UEEE in destination countries. Push factors include recycling costs and regulatory constraints while pull factors from destination countries include trade and access to improved EEE (Amankwah-Amoah, 2016b). Several studies consider that the exports of WEEE from developed countries stem largely from push factors. It is argued that WEEE is illegally exported to developing countries under the guise of humanitarian aid or UEEE to bridge the digital gap (Cucchiella *et al.*, 2015).

Other studies, although also exhibiting the limitations of methodology mentioned previously, reveal that the pathways of UEEE from formal to informal sectors are facilitated by brokers and traders (Secretariat of the Basel Convention, 2011) ranging from small, family-based networks to large trading firms. This sector is largely driven by immigrants or temporary residents engaged in creating trading businesses serving the European–African routes (Secretariat of the Basel Convention, 2011). Findings from *the Basel Convention E-waste Africa Programme* (Secretariat of the Basel Convention, 2011) showed that about 150,000 t of UEEE is imported into Ghana annually, of which 85% was subsequently repaired and resold while the other 15% was irreparable. In Nigeria, of the 100,000 t UEEE imported into the country illegally in 2010, 30% was non-functional (Ogunbuyi *et al.*, 2012). Such imports have led to a flourishing industry in informal recycling in West Africa (UNEP, 2015). In addition to imports, the growing demand for new ICT in developing countries contributes to the increasing amounts of locally generated WEEE, and given the correlation between growth of gross domestic product and generated WEEE, it is projected that generated WEEE will increase threefold by 2050 (Parajuly *et al.*, 2019).

Illegal and unlicensed export of WEEE to developing countries with ineffective recycling results in the loss of valuable metals such as palladium, gold, silver, indium and germanium (Secretariat of the Basel Convention, 2011). However, the trade of imported UEEE in good condition has the potential to provide significant socioeconomic value although the major challenge presented by the import of e-waste and near end-of-life equipment remains (UNEP, 2015). Furthermore, the market for reuse has the potential to create well-paid jobs and generate economic growth. Although the methodologies are frequently not clear, several studies suggest that the e-waste industry creates employment in developing nations. For example, it has been suggested that in Ghana the e-waste sector employs 25,000 people directly and sustains around a further 200,000 jobs (Lundgren, 2012). Similarly, in Nigeria, the refurbishment and repair of both imported and domestic-generated UEEE has been reported to provide an income to more than 30,000 people (Secretariat of the Basel Convention, 2011). The processing of and trade in UEEE such as computers enables a high degree of reuse and provides employment opportunities and, in the long term, socioeconomic benefits deriving from, for example, increased accessibility to technology for low-income earners (Kahhat and Williams, 2009).

On the other hand, processing of e-waste, if not carried out correctly, as is often the case in developing countries, can have undesired consequences, as outlined in Chapter 1. For example, skin diseases, respiratory problems, chronic nausea and serious headaches are among the common ailments reported by those carrying out informal recycling at the Agbogbloshie treatment site in Accra, Ghana (Yeung, 2019). In addition, elevated levels of iron, antimony and lead have been found in the urine of e-waste recycling workers in Accra (Asante *et al.*, 2012). In Nigeria, the improper management of e-waste, such as inappropriate disposal, has led to it being termed a "deadly time bomb", as the soil and water surrounding e-waste dumpsites are highly contaminated (Ojewale, 2018). In addition, according to Forti *et al.* (2020) other adverse effects have been reported in children living and working near informal e-waste recycling sites, including adverse outcome and effects on growth, the immune system and lung and thyroid function, with some additional published reports linking exposure to informal e-waste treatment with loss of olfactory memory, blood coagulation, hearing loss and changes in gene expression and cardiovascular regulation.

### 2.1.2 Quantitative characterisation of used and waste electronics exports

It has been suggested that, despite the amount of reporting on the transboundary shipment of UEEE/WEEE, many studies fail to employ scientific methods or to provide empirical data (Miller *et al.*, 2012; Song *et al.*, 2017). Possible reasons for this include challenges in collecting data, such as limited mechanisms in place for recording the data, undifferentiated trade codes (which do not differentiate between types of equipment, or do so inconsistently) and the fact that waste is not always labelled or categorised consistently (Miller *et al.*, 2012; Song *et al.*, 2017). Other factors include the lack of a universal definition of e-waste, the absence of trade data that clearly distinguish new EEE from UEEE and the role of illicit trade (Bisschop, 2012; Lepawsky, 2015). It is argued that the availability of quantitative data would significantly aid our understanding of the issues surrounding the transboundary shipment of e-waste (Miller *et al.*, 2012; Breivik *et al.*, 2014). E-waste data such as those reported in this paper are a necessary step towards addressing this challenge, helping to assess targets, explore best practices and improve policies (Baldé *et al*., 2017).

Miller *et al.* (2012) evaluate several approaches and data sources used to quantitatively characterise the transboundary shipment of UEEE including electronic tracking, "person in the port" (a person on the ground physically inspecting the vehicles), trade data, custom and shipment data/documents, material flow analysis, sales data, mass balance, handler surveys and enforcement data. Another approach incorporates a combination of methods, such as the person-in-the-port approach and evaluation of shipment records, as was done by Odeyingbo *et al.* (2017). It is argued that the quality of trade data and proxy trade data is low, and methodologies using such data are, therefore, flawed, hindering the production of reliable statistics (Forti *et al.*, 2018). Limitations on the use of trade data in many countries include a lack of differentiation between new and used electronics, definitional challenges and difficulty in ascertaining the functionality of equipment (Miller *et al.*, 2012). More reliable data include enforcement data and observational data from handler surveys and surveillance from inspections, as these methods involve moderate effort and the quality of the information is deemed medium to high. Other methodologies, such as electronic tracking, person in the port and material flow monitoring are ranked high, as these require significant effort and a thorough approach (Miller *et al.*, 2012; Forti *et al.*, 2018).

Several types of classification have been used in the past to characterise used and waste electronics, such as the Harmonized Commodity Description and Coding System (Harmonized System, HS) codes. However, this system is unsuitable for the measurement of exports, as the codes are not unique to e-waste and fail to distinguish between new and used EEE (Baldé *et al.*, 2015b; Forti *et al.*, 2018).

To harmonise e-waste statistical data and classification, the UNU introduced UNU-Keys in an attempt to classify EEE according to function, material composition, average weight and fate at end of life (Baldé *et al.*, 2015b). The UNU-Keys classification system groups all EEE into 54 broad categories (Baldé *et al.*, 2015b). Furthermore, this system removes discrepancies encountered in the representation of e-waste statistics between official data and academic data. This is, to date, the most reliable classification and has been employed in several high-profile studies published by the UNU, such as the *Global E-waste Monitor* by Baldé *et al.* (2017), and was also used for the research described in this paper.

### *2.1.3 Regulations on transboundary shipment of WEEE*

At present, many developing countries lack the effective legislation and infrastructure required for efficient management of solid waste, including WEEE (Parajuly *et al.*, 2019), leading to a plethora of health and environmental challenges. Findings from a systematic review (Grant *et al.*, 2013) on the health consequences of exposure to e-waste show that workers and people living in towns where WEEE is poorly managed are prone to several serious health conditions, such as changes in thyroid function and cellular expression and function, DNA mutations, decreased lung function and adverse birth outcomes (Forti *et al.*, 2020).

The principal regulations prohibiting transboundary movements of hazardous waste are the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, including the recently effective Ban Amendment and the Basel Convention Technical Guidelines, Organisation for Economic Cooperation and Development (OECD) Council Decision (2001) 107/FINAL and the European Waste Shipment Regulation (Milovantseva and Fitzpatrick, 2015). Following prominent cases of the transboundary shipment of waste from developed to developing countries in the 1980s, the Basel Convention was adopted in 1989 and came into force in 1992. To date, 187 countries are signatories to this treaty; Haiti and the USA are yet to ratify the treaty or transpose it into national laws. The principal aim of the Basel Convention is to protect human and environmental health against the adverse effects of hazardous waste by limiting its generation and strictly regulating and restricting its movement across borders.

OECD Decision C (92)39/FINAL, on the Control of Transboundary Movements of Wastes Destined for Recovery Operations, revised in 2002, regulates the movement of e-waste between OECD member countries. Based on the level of risk presented by waste, two types of control (green and amber) are used to monitor the cross-border movements of waste. The green control procedure monitors waste considered to be of low risk to human and environmental health while the amber control procedure monitors waste that presents a higher risk. The WEEE Directive is the principal regulation on the management of household and non-household WEEE in the EU (Milovantseva and Fitzpatrick, 2015; Forti *et al.*, 2018). Established as an extended producer responsibility directive, the directive promotes the reuse, recycling and recovery of WEEE by minimising disposal of WEEE in unsorted municipal waste (Sthiannopkao and Wong, 2013; Johnson and Fitzpatrick, 2016). The recast WEEE Directive, published in 2012, introduced key changes, including more ambitious collection targets, increases in recovery targets, a reorganisation of the scope of EEE (i.e. to include temperature exchange equipment, screens and monitors, lamps, large equipment, small equipment, and small IT and telecommunication devices) and the implementation of free take-back of small household appliances (Johnson and Fitzpatrick, 2016).

#### 2.1.4 Enforcement of WEEE regulations in Ireland

In Ireland, Statutory Instrument (S.I.) No. 149 (2014) ratified the WEEE Directive into national law. The Environmental Protection Agency (EPA) Office of Environmental Sustainability is responsible for the regulation of WEEE in Ireland (Johnson and Fitzpatrick, 2016). In 2017, Ireland surpassed the 45% target for the collection of WEEE by collecting 51% of the average EEE placed on the market in the 3 years prior (EPA, 2019). However, new targets set from 2019 require an increase from 45% of EEE placed on the market to 65% of equipment placed on the market. Such an ambitious target presents a challenge for Ireland and other EU Member States.

The National TransFrontier Shipment Office (NTFSO) of Dublin City Council, established in July 2007, is the national authority on the regulation of exports, imports and transit of waste shipments in Ireland. Previously, enforcement and regulation of exports was conducted by local authorities, resulting in a fragmented approach to requirements and reporting. The consolidation of authority in the NTFSO provides consistency in the regulation and enforcement of WEEE, considered a priority waste (Johnson and Fitzpatrick, 2016), and other waste transit. The Waste Regulation and Enforcement unit of the NTFSO is charged with the management of waste shipments including WEEE. To ensure that UEEE shipped in RoRo vehicles from Ireland is for direct reuse, a series of procedures and inspections in line with global, regional and national regulations are carried out by waste enforcement officers. NTFSO guidance documents (Dublin City Council, 2015) set out the pre-shipment checks that should be carried out, including checks on:

- appropriate packaging to protect equipment from damage during transport;
- accessibility (RoRo vehicles should be accessible and unsealed to allow visual inspection by waste enforcement officers);
- stated reuse market values for equipment.

Moreover, mandatory documents attached for inspection include:

- proof of ownership such as receipts;
- evidence of functionality: electrical certificates (Appendix 1);
- a detailed packing list (Appendix 1) with essential details such as type, value, quantity and serial number;
- other relevant transport documents such as a “bill of lading”.

Waste enforcement officers regularly visit the port of export, Ringaskiddy, Cork, to inspect a random selection of RoRo vehicles before they are cleared for shipment.

In addition to inspection of UEEE in RoRo vehicles, the vehicles themselves are inspected for roadworthiness and safety of contents, particularly auto parts. Vehicles with verifiable, complete and accurate documentation are cleared for shipment. Vehicles lacking one or more of these requirements are placed on hold and will not be shipped until such time that the discrepancies are addressed.

### 2.2 Methods

The use of a quantitative research method using a person-in-the-port approach, which combined with the evaluation of export documents provides a more complete overview on e-waste shipments (Forti *et al.*, 2018), was applied to this research. This has been suggested as the best approach to evaluate flows of used electronics. The use of quantitative research methods ensures that robust estimates of UEEE are attained (Miller *et al.*, 2012). The adoption of this method permits the data collected in this study to accompany data obtained through previous uses of the person-in-the-port approach for quantifying exports of UEEE. The quality of data from the research methods used is highly regarded owing to the high level of effort undertaken for the study (Miller *et al.*, 2012).

### *2.2.1 Area of study*

Ringaskiddy port in County Cork is located in the south-west of Ireland. Ringaskiddy is reported by shipment authorities to be the only major route for the export of RoRo vehicles, with flows of RoRo vehicles leaving other ports in Ireland being largely insignificant. However, further research could be conducted to verify and examine flows at other ports. The export compound for RoRo vehicles serves as the receiving location for owners to drop off vehicles to be shipped, provides secure storage of vehicles awaiting shipment and is the location of compliance inspections prior to shipment (Figure 2.1).

### *2.2.2 Data sources and collection*

As suggested by the person in the port research by Odeyingbo *et al.* (2017), RoRo vehicle shipments from Ireland serve as the principal route for the movement of used and waste EEE (Chapter 1). Based on this research, as well as interviews with waste enforcement and port officials confirming that RoRo vehicles, rather than containers, are the main carriers of UEEE, RoRo vehicles were chosen as the focus of observational inspections.

The research scope covers all categories of EEE listed in Annex IV of the recast WEEE Directive.

The research team was granted access to the shipment yard by NTFSO and was able to accompany waste enforcement officers on their monthly on-site inspections of RoRo vehicles in the export compound. The research was conducted between June 2019 and March 2020, during which period approximately every second shipment of vehicles was inspected, as shipments leave, on average, twice monthly, according to the shipping company. On inspection days, despite compliance officers conducting inspections on only a random selection of vehicles, the research team collected data on the presence of EEE and attached enforcement documents for every vehicle present.

Each vehicle was visually inspected to confirm that documentation, outlined in section 2.4 and Appendix 1, reasonably represented the content. Vehicles whose packing lists were found by waste enforcement officers to be not accurately representative of the contents, or containing equipment but lacking a packing list, were stopped by inspectors until the appropriate paperwork was provided. These vehicles were marked non-compliant in the data collection, as they were on hold and not being shipped at the time of data collection.

Each vehicle was given a unique identifier on sampling to prevent duplicates in the data. Unique identifiers and the collected data associated with each were then collated and analysed to ascertain the numbers of vehicles that did and did not contain


**Figure 2.1. RoRo vehicles waiting to be inspected at the export compound in Ringaskiddy port, Cork.**

UEEE and to draw up profiles of which vehicle types are likely to contain or not contain UEEE, and the types and quantities of UEEE present in shipments. Documentation was evaluated and photographed. Information recorded on packing lists includes item names with a description and the make, quantity and declared value of the item (Appendix 1). Additional paperwork includes information such as destination and, in the case of UEEE, proof of functionality. These additional documents were noted as present but not further verified.

Vehicles contain a variety of items such as clothes, furniture, vehicle parts, used tyres and UEEE. While all contents were recorded, only data relating to UEEE were analysed, in line with the aim and objectives of this research.

Data on the number of vehicles shipped the previous year were obtained and analysed to determine the appropriate sample size necessary to statistically represent the shipped vehicles. To convert units of UEEE recorded to weight, we used the indicated average weight of types of EEE found by UNU-Keys (Appendix 2). The UNU-Keys for EEE allow a consistent and publicly accessible method of weight estimation, which can be replicated by future studies regardless of where those studies are performed. Based on a rough assessment of the average age of the UEEE prior to shipment, the weight of EEE placed on the market in 2016 was considered appropriate and was used for the analysis in this study. However, it is worth noting that variation in weight over time has been observed to be minimal.

In conjunction with the methods quantifying UEEE exported from Ireland in RoRo vehicles, the value of the exported UEEE was researched on the Nigerian reuse market. The values of UEEE when resold in Nigeria were obtained from personal communications and from Nigerian websites listing used electronics, such as Jiji.com and OnlineAlaba.com. Lower- and higher-end values were obtained and the averages were computed and recorded.

## 2.3 Results and Discussion

The following section presents the results found over the period of study. A total of 308 RoRo vehicles were sampled, representing about 35% of the number of vehicles shipped annually based on the historical data provided by the shipping company. Over the year previous to this study, between 1 October 2018 and 30 September 2019, the shipping company reported a total of 868 vehicles shipped, with a breakdown of 264 cars, 374 vans and 230 trucks. When broken down into vehicle types, the study sample represents 28% of cars and vans and 44% of trucks. The statistical significance of the sample size was based on these historical data collected from the shipping company and was largely determined by the schedule of the waste enforcement inspections and the corresponding dates of shipment, as the number of vehicles varied by the proximity of an inspection date to shipment.

### *2.3.1 Quantities of UEE*

Of the sampled vehicles during the period of study, 29 vehicles, comprising 27 cars or vans and 2 trucks, were found to be noncompliant by waste enforcement officers and were placed on hold. Therefore, these vehicles were not shipped at the time sampling occurred and the UEEE they contained was not included in the totals. Additionally, vehicles falling into neither the category of trucks nor cars or vans comprised < 1% of the sample and were not found to have contained UEEE. These vehicles are also discounted from the following totals and were not included in historical data provided by the shipping company. The results of data collection on the remaining 279 sampled vehicles is given in Table 2.1.

Cars and vans accounted for 63% of RoRo vehicles and trucks for 37%. On inspection of these vehicles, 18.6% were found to contain some form of UEEE; the remainder either contained only other used goods, such as clothing, furniture or car parts, or were empty. Although trucks accounted for roughly one third of the sample size, cars and vans were more than five times more likely to contain UEEE, with 90% of vehicles that contained UEEE being cars or vans. Cars and vans also contained approximately 87% of the documented UEEE by weight. These data show a further narrowing of exports likely to contain UEEE. As found by Odeyingbo *et al.* (2017), Irish RoRo vehicles have been shown to contain significantly more UEEE than containers; this research identifies that, within shipments of RoRo vehicles, cars and vans are far more likely to contain UEEE and contain significantly more UEEE than trucks.

**Table 2.1. Sampling data by type of vehicle and weight of UEEE per vehicle**

| Sampling data | Type of vehicle | | Total |
|---|---|---|---|
| | Cars/vans | Trucks | |
| Number of vehicles sampled | 177 | 102 | 279 |
| Number of vehicles containing EEE | 47 | 5 | 52 |
| Weight of EEE sampled (kg) | 4834 | 707 | 5542 |
| | | | Per vehicle of any type |
| Average weight of UEEE per vehicle (kg) | 27 | 7 | 17 |
| Average weight of UEEE per vehicle containing EEE (kg) | 102 | 141 | 106 |

Notably, these data suggest that one in five of all RoRo vehicles exported from Ireland (cars, vans and trucks) contain used electronics, with each vehicle that contains UEEE carrying approximately 106 kg. The total weight of UEEE recorded in the study was found to be 5542 kg, from approximately 300 units of UEEE. Based on the number and size of annual shipments found in the historical data, this gives an estimate of 17,319 kg shipped from Ireland per year in RoRo vehicles. These figures indicate that export in RoRo vehicles is unlikely to have a significant effect on collection and recycling targets in Ireland. On the other hand, the mass of UEEE and the proportion of vehicles containing UEEE indicate a significant change in export behaviour on the route between Ireland and West Africa since 2017, when three in five Irish vehicles were found to contain UEEE entering the port in Nigeria (section 2.1; Odeyingbo *et al.*, 2017).

The decreasing number of shipments can potentially be attributed to the strict enforcement of regulations by NTFSO and the shipping companies. Following two successive fire incidents on board cargo vessels, shipping companies have reportedly introduced new regulations, such as the prohibition of car batteries and personal effects in RoRo vehicles (Chambers, 2019). Interviews with waste enforcement officers indicated that shipping of UEEE in Ringaskiddy has dramatically reduced recently, probably because of the increasingly meticulous inspections that make the shipment of waste EEE more difficult and may lead many exporters to ship vehicles empty.

### *2.3.2 Types of UEE*

A total of 20 types of UEEE were identified in the samples based on the UNU-Keys, including most commonly large equipment, temperature exchange equipment, screens, small equipment and small IT and telecommunications equipment. Flat panel display televisions accounted for the largest number of UEEE items (100 televisions), representing one third of the total figure. Refrigerators represented the single category of UEEE with the highest weight, with a total of 1346 kg recorded in the samples. Figure 2.2 highlights the distribution. Categories with less than 50 kg each have been merged for the purpose of this figure; however, further detail of all categories can be found in Appendix 2.

This study highlights the need to use an integrated categorisation of UEEE, such as the UNU-Keys, that covers all types of waste electronics, not just small IT and telecommunications equipment. This stands in contrast to the findings of similar studies which have suggested that the bulk of shipments of UEEE from developed countries to developing countries consist mostly of IT and telecommunications equipment.

Often, studies on the flows of WEEE focus mainly on the streams of televisions, monitors and computers due to the presence of valuable metals and ease of refurbishment and reuse (Baldé *et al.*, 2016). For this reason, this research is unique, as it does not focus specifically on electronics and IT equipment such as laptops, desktops, mobile phones and televisions, but encompasses all categories of WEEE. This approach is especially feasible in the examination of RoRo vehicles as each type of UEEE is travelling in the same stream. The trend observed in this research shows that, had the scope been limited to the popular streams of computers and mobile phones, significant flows of UEEE could have been missed. This is often highlighted as one of the drawbacks of similar studies, along with the fact that there is no internationally agreed classification that distinguishes between exports of UEEE and exports of WEEE (Baldé *et al.*, 2016; Odeyingbo *et al.*, 2019). In addition, the need to

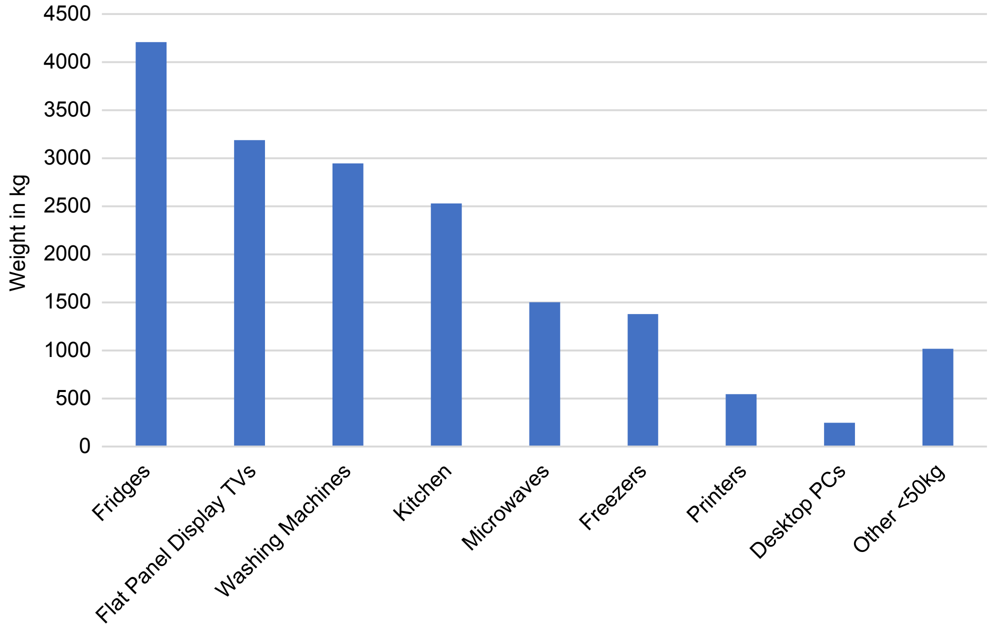


**Figure 2.2. Distribution of total weights of UEEE (in kg) by UNU-Keys classification.**

broaden the scope of related research is highlighted in the *Global E-waste Monitor*, which indicates that large electrical appliances are the second most important category of e-waste by weight (Forti *et al.*, 2020). As export of this type of used electronics increases, in time this will have a significant influence on the weight of WEEE generated in the destination countries.

### 2.3.3 Quality of equipment shipped

In their similar study, Odeyingbo *et al.* (2019) pointed out that a recurrent issue surrounding transboundary shipment from developed countries is the lack of functionality tests in the countries of origin. In Ireland, the NTFSO requires UEEE shipments to be accompanied by electrical certificates, completed and signed/stamped by an electrician or technician after testing, to ascertain the functionality of equipment. Electrical certificates are issued only when the UEEE is proven to be shipped with an intent of reuse, hence UEEE primarily shipped for recycling or major refurbishment works is controlled. As mentioned in section 2.4, vehicles containing UEEE but without a certificate are placed on hold by waste enforcement officers and cannot leave the port.

Inspection of RoRo vehicles also includes checking that equipment is in good condition and that measures were taken to prevent damage of equipment in transit. Electronics, such as televisions, are required to be properly placed and secured to avoid damage (Figure 2.3).

Based on the indications of stricter enforcement by shipping agents and waste enforcement officers in recent months, the quality of UEEE is likely to have improved as non-functional WEEE and improperly packaged equipment that is likely to become WEEE on the journey. However, further investigation into the presence and accuracy of electrical certificates would be required to assess the changes in functionality since 2017, when 60% of EEE exported to Nigeria from Ireland was found to be functional and ready for reuse (section 2.1; Odeyingbo *et al.*, 2017).

### 2.3.4 Economic drivers and destination

In section 2.1, the major differences in the factors responsible for transboundary movement of UEEE were noted as push or pull factors. Findings from this research identify pull factors guiding the export of UEEE in RoRo vehicles from Ireland. Traders in used vehicles play a significant role, as UEEE is loaded into used vehicles and frequently shipped to exporter’s home town, in this case mostly in West Africa. A key reason for this may be that the cost of shipping a vehicle depends on its dimensions, rather than its weight; this means that there is no additional fee for shipping goods contained in a vehicle, regardless of their weight.

**Figure 2.3. Improperly packaged UEEE placed on hold by waste enforcement officers (Dublin City Council, 2015).**

Almost all vehicles shipped in the year preceding this study (94%) were destined for Lagos, which serves as a major import hub of used electronics owing to increasing demand in the destination country. This also reflects the breakdown of African immigration to Ireland. The initiators of these exports are largely Nigerians, who use the opportunity of shipping used vehicles to include UEEE for personal use or resale.

### 2.3.5 *Value of used electronics*

As discussed in section 2.1, the demand for used electronics in Nigeria is growing. The availability of UEEE allows people of lower economic means to improve their standard of living. For example, the EEE we observed included appliances considered essential in developed countries but not always affordable to those in developing countries, such as refrigerators, particularly useful to prolong the lifespan of foods in the humid weather conditions experienced in tropical regions such as Nigeria, and IT equipment, which permits internet access. By having a cheaper option, people can more readily afford electronic goods to improve their social status and quality of life. Additionally, as reported in section 2.1, the reuse market also improves the standard of living of some individuals in developing countries by creating jobs and thus providing an income. The data we collected on the value of exported UEEE show that the products identified in this research as among the most frequently exported, such as televisions, refrigerators and washing machines, are those for which there is a strong demand and ready market in Nigeria. Figure 2.2 shows that, in terms of both numbers of units and weight, refrigerators, televisions, freezers, washing machines and cookers dominate UEEE exported from Ireland to Nigeria. On this basis, the market for these items was examined further and the associated values on the Nigerian resale market were determined (Table 2.2).

**Table 2.2. Price range of select used electronics based on demand in Nigeria**

| UEEE type | Value as declared on shipment (€) | Value as declared on shipment (NGN) | Used market price Nigeria (€) | Used market price Nigeria (NGN) |
|---|---|---|---|---|
| Television | 112–131 | 45,000–52,915 | 242–372 | 97,500–150,000 |
| Washing machine | 124–326 | 50,000–131,271 | 199–273 | 80,000–110,000 |
| Fridge | 50–76 | 20,000–30,605 | 118–186 | 47,500–75,000 |
| Freezer | 87–184 | 35,000–74,178 | 100–112 | 40,000–45,000 |
| Cooker | 112–165 | 45,000–66,442 | 131–149 | 52,500–60,000 |

**Note: 1 euro = 402 NGN.**

Prices differ depending on manufacturer, model, size and second-hand value. A comparison of the values of UEEE exported from Ireland and used goods offered for sale in Nigeria shows that resale of the most frequently exported electronic goods is potentially profitable. The total value of sampled UEEE, amounting to €47,112, can be adjusted, based on the historical number of shipped vehicles to an annual value of €147,225. However, the asking prices listed on online Nigerian reuse markets tend to be higher than the average values at origin declared on shipment packing lists. In some cases, the difference may result from poor estimations of value placed on the packing lists by the exporter. However, the large and consistent differences illustrate the high demand for used products in the destination market and the financial incentive for exporters to place these products for sale on Nigerian markets rather than Irish ones. This is particularly true owing to the low cost of shipping UEEE, as the cost of shipment is based only on the size of vehicle and not on the value or weight of its contents. Therefore, the only cost associated with shipping vehicle contents is the cost of obtaining certificates of functionality.

## 2.4 Conclusions

This study presents the first comprehensive estimation of UEEE shipments exported from Ireland in RoRo vehicles conducted at the port of origin. The data provide a unique insight into the shipment of UEEE from Ireland to West Africa and suggest that export behaviour changed radically in the years between Odeyingbo *et al*.'s 2017 study, carried out using person-in-the-port methodology, and the current study, which ended in March 2020. As shown in section 4.1, in 2017, 60% of RoRo vehicles exported from Ireland and entering the port in Lagos were found to contain UEEE, whereas in this study, carried out in, 2020, less than 20% of vehicles leaving Ireland contained UEEE. This change in behaviour is speculated to arise from increasingly stricter regulatory requirements over the intervening years. These findings present a number of opportunities for further research into the stark behavioural changes observed, as well as unidentified pathways of UEEE and WEEE export.

Further results illustrate that the potential value of UEEE on the resale market in Nigeria continues to drive demand for imports, with exported UEEE having an estimated value of nearly €150,000. With low costs for certifying functionality with electrical certificates and no added cost for shipping vehicle contents, this economic value in Nigeria, where used goods are in higher demand than in Ireland, is a significant driver of export. An opportunity for further research exists in an examination of the process, and cost, of obtaining and verifying electrical certificates. Furthermore, surveys of the perspective and behaviour of the exporters and owners of the RoRo vehicles would also provide valuable insight in future studies.

The methods developed and employed in this study permit future estimation of UEEE exports in Ireland based on number of vehicles and vehicle types in a particular shipment or over a period of time. Additionally, the straightforward methods could be extended to EU and global shipments to provide a better understanding of UEEE flows, data on which are currently limited. This would be of significant value to all stakeholders concerned with the regulation, enforcement and safety of UEEE shipment. The results of this study contribute valuable data enabling the calculation of WEEE collection targets, as would future studies using the same methods, and these targets could be adjusted up or down based on quantities of EEE exported and therefore no longer available for collection.

# 3 Professional IT Export

With a growing focus on the ethical management of WEEE, particularly in relation to transboundary shipments, as well as on promoting a circular economy, evaluating information technology asset disposition (ITAD) management is increasingly important. Consequently, despite its growing popularity and importance, it remains an extremely understudied area in WEEE management and, as such, existing literature is scarce (Schiller *et al*., 2016). More research studies involving collaborations between scholars and practitioners are encouraged, and it is essential that these cover the two core components of the ITAD industry: process and policy (Schiller *et al*., 2016). This will help policymakers evaluate and improve policies that enhance the life cycle management of IT assets (Schiller, 2016).

As previously mentioned in Chapter 1, exported UEEE may present a challenge to reaching upcoming collection targets should large amounts of UEEE be removed from the Irish market through export for refurbishment and reuse. Although the amounts found in RoRo vehicles were not likely to be significant in future calculations of targets, the professional IT sector holds a bigger capacity for affecting national targets. Ireland's professional IT sector is currently thriving, with an increasing necessity for computers and equipment, new technology and security of data in modern business practices. With its temperate climate Ireland is also attractive to the developers of large data centres seeking energy efficiency.

This research aimed to develop and utilise a method to quantify the amount of professional IT equipment being exported from Ireland, and investigate whether or not exported professional IT equipment may significantly affect the ability of the Irish WEEE sector to meet collection and recycling targets. The following sections outline the development and execution of the study methodology, and characterise and present the results of data collection from Irish companies that export professional IT equipment, providing discussion, conclusions and recommendations on the future reporting of exported UEEE, and the appropriateness and application of adjustments to WEEE collection targets.

## 3.1 Literature Review

Although academic literature that specifically investigates ITAD reuse business operations is scarce, a couple of relevant studies have been carried out in this subject area.

A survey conducted by DIGITALEUROPE in 2014 found that approximately 118,000 t of ICT equipment is shipped annually across borders for the purpose of repair and reuse globally, of which 28,000 t is shipped within Europe (DIGITALEUROPE, 2017).

Whalen *et al*. (2018), finding that a comprehensive evaluation of the ICT reuse business models and policies is lacking, carried out an in-depth study of the gap exploiter model using case studies in Sweden. Gap exploiters are third-party firms that maximise the value of existing products through reutilisation. Their research revealed the barriers to ICT reuse business operations, such as labour costs and reverse logistics. Whalen *et al*. (2018) found that this is also an under-researched subject, and the little research that has been carried out is characterised by general approaches. It is argued that in-depth exploratory studies of the ICT refurbishment sector are essential in the academic sphere (Whalen *et al*., 2018).

A survey undertaken in the USA by Sabbaghi *et al*. (2017) evaluated the status of the repair sector, but the survey was largely aimed at the business-to-consumer (B2C) market and focused on consumer electronics of all types, not exclusively ICT equipment. Sabbaghi *et al*. (2017) also state that research on repair and refurbishment business operations is lacking.

Ongondo *et al*. (2013) also found that empirical research on the activities of the ICT reuse organisations is limited. They evaluated the ICT reuse operations of socioeconomic enterprises in the UK and found that, although ICT has a high reuse value, operators in this market face challenges of marketing and legislative difficulties. They recommend that reuse operations be clustered in "reuse parks" to boost sales and consumer trust and .

Kissling *et al*. (2012) investigated the formal ICT reuse business operations and proffered an analytical framework to categorise the existing models:

1. the networking equipment recovery model;
2. the IT asset management model;
3. the close the digital divide model;
4. the social enterprises model.

The first two are not-for-profit models and the last two are for-profit operating models. Kissling *et al*. (2012) noted that, although some studies have attempted to evaluate the ICT reuse sector, there is nothing specifically relating to the IT asset management model.

In this report, we attempt to characterise the professional IT refurbishment sector using Ireland as a case study. It specifically analyses the business-to-business (B2B) model of ITAD operations. The scope is limited to ITAD organisations and excludes the informal reuse and refurbishment sectors. Furthermore, to provide a detailed analysis, the focus is solely on ICT equipment.

In the following sections, we set out the pathways of UEEE and the processes it undergoes, as well as the compliance and regulatory environment surrounding UEEE with the aim of understanding the movement and treatment of UEEE in Ireland.

### 3.1.1 ITAD processing

The goal of ITAD services is to minimise the negative impacts associated with WEEE (environmental and social), recover value from disposed assets, obtain cost savings and, in most cases, generate returns, as well as to maximise value, guarantee data security and protection from environmental liability (Schiller *et al*., 2016). While the ITAD process can be carried out by the affected business that used or owned the equipment, considerations such as logistics, environmental hazards and confidential data handling require a well-planned strategy that typically only specialised ITAD companies can offer (CompuCom, 2020). Around the world, sustainability is becoming a strategic priority for businesses, and a well-managed ITAD programme can promote corporate sustainability or corporate social responsibility (CSR) initiatives and, as such, can be viewed as an essential activity of an enterprise.

The use of a third-party ITAD service provider successfully addresses two major challenges faced by enterprises: the rapid growth of ageing and obsolete IT assets generated and compliance with complex regulations and data security regulations, as penalties for defaulters can be severe (Schiller *et al*., 2016). According to a study conducted by Grand View Research, Inc., the IT asset disposition market is projected to be worth US$27.9 billion by 2025 with annual growth of 10.8% (Grand View Research, 2019). North America is the global leader in the cloud data centre ITAD market owing to the size of the IT industry and number of cloud data centres in the region.

The key factors that boost the market include:

- promises of low-carbon footprint processes by ITAD companies;
- strict compliance with environmental and other applicable regulations;
- rising awareness regarding the benefits associated with proper disposition of assets;
- an ongoing shift from housing IT infrastructure on-premise to deploying, for example, cloud computing (Patil, 2020).

Given the above factors, third-party disposition companies should thrive. ITAD companies, in addition to complying with legislation, need to operate their business in a way that conserves natural resources, protects the environment, generates value back from the item, contributes to the company's CSR and, importantly, ensures the safety of sensitive data as safely to avoid risks of data not being protected or non-compliance and fines (Asset Management Ireland Ltd, 2018).

### 3.1.2 The ITAD process and steps

ITAD enterprises need certain relevant certifications and are frequently audited and reviewed to ensure their compliance with appropriate sustainability practices (Schiller, 2016). Violations can cost the company not only money but also credibility (Schiller *et al*., 2016), so strict standards and controlled processes are essential (Figure 3.1).

In detail, the ITAD process laid out in Figure 3.1 involves:

1. **Receipt and triage.** This first step involves the collection of equipment by the ITAD processor,

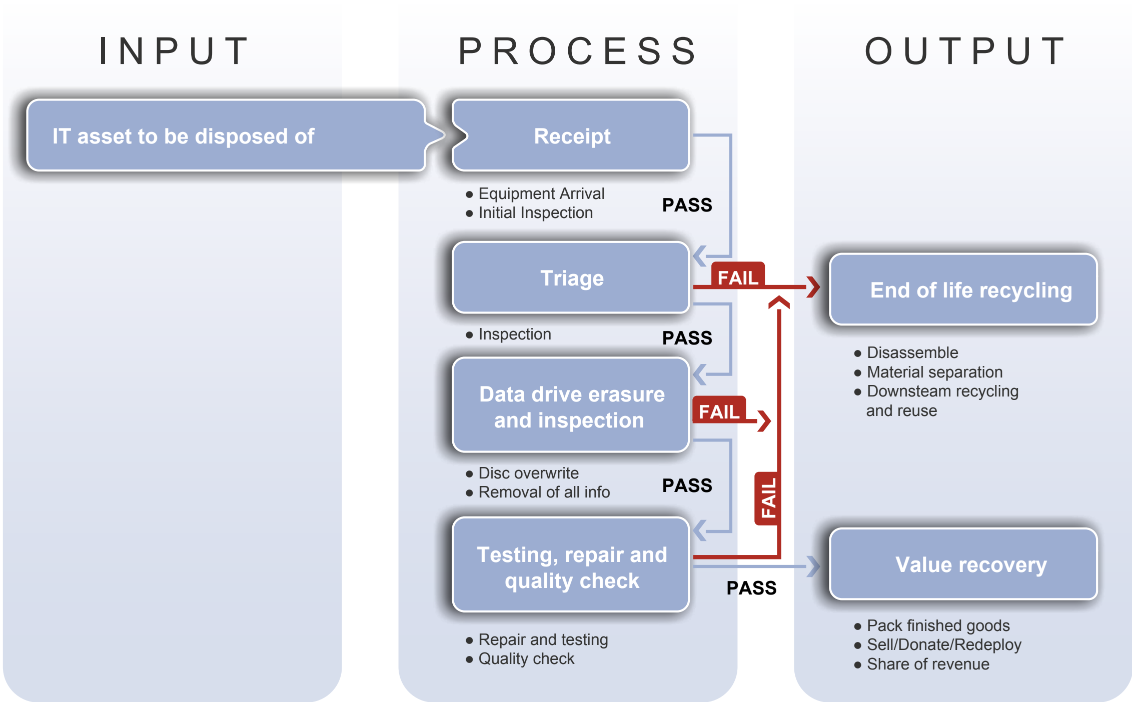


**Figure 3.1. Representative ITAD process. Adapted from Schiller (2016).**

which is then sorted to separate out unacceptable or hazardous materials. The remaining pieces of equipment are then labelled with a unique individual code that is generated by a tracking system. Trained personnel inspect each item to determine if it meets the minimum criteria required for reuse and resale and also assess technical [processor speed, random access memory (RAM), equipment age], functional (media drives and power supplies) and cosmetic criteria (for retail purposes). Equipment considered unsuitable for reuse is routed for destruction and end-of-life recycling.

2. **Data-driven erasure and inspection.** In some cases, the client organisation may already have removed or attempted to remove the data contained in IT assets. However, it can be challenging to completely remove data effectively, so the ITAD provider employs standard procedures to ensure efficient data sanitisation. For instance, a minimum of three overwrite passes may be conducted to guarantee elimination of confidential information. The data removed are destroyed to ensure confidentiality and security of information, which ITAD processors guarantee.

3. **Testing, repairs and quality check.** After data sanitisation, the items undergo a series of tests to determine if technical repairs are required, such as replacement of media drives, the addition of RAM and major repairs. Once repairs are complete, a quality check is carried out. Again, equipment that passes this stage of inspection is considered for resale or reuse, whereas equipment that fails is disassembled and its materials separated for downstream recycling.

4. **Pack finished goods.** Once items have been refurbished, they are repackaged in new wrapping material, updated on the internal tracking system and marked for resale. Before an item leaves the facility, it is rescanned by the tracking system to maintain security of assets, and the scan provides information that enables the originating organisation to track the final disposition of the asset. This also affords the organisation the data required to measure and report on corporate sustainability and CSR initiatives.

5. **Value recovery.** Value can be recovered via a variety of channels. The majority of equipment for reuse goes is sold through various channels, including websites, auction sites, direct retail, local and regional value-added resellers, and overseas brokers. Some of the money recovered from the resale is given back to the client. Other equipment is donated to charity organisations,

with the donation credit attributed to the originating enterprise. The pathways include secondary markets, donations, purchase by internal employees, or return of equipment back to the enterprise. The recovered value provides a revenue stream for the organisation and can fund the ITAD procedure, covering costs of transportation and processing fees.

6. **End-of-life recycling.** Equipment that has failed examination and testing at various stages is forwarded to a recycling facility for recovery of raw materials used in manufacture, such as plastic, steel, aluminium and copper. Recovered materials are sent to downstream recycling partners for further processing.

### *3.1.3 ITAD regulatory compliance*

Regulatory policies and legislation surrounding the ITAD process are numerous and complex and vary at global, regional and national levels. Such regulations mostly relate to data security and environmental laws, such as the management of toxic components in retired assets. Obtaining a thorough understanding of these laws can be daunting for organisations; hence, outsourcing this task to a specialist ITAD company with knowledge and extensive experience of the laws surrounding these processes is becoming rapidly the most feasible option (Schiller, 2016). The most relevant regulations are those relating to corporate governance and privacy and environmental protection, while others concern worker safety and export, copyright and contract law (Schiller, 2016). For the purpose of this review, environmental protection and export laws are of importance. The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal is the globally accepted legislation aiming to protect human health and the environment against the adverse effects of hazardous waste by limiting its generation and placing strict restrictions on its movement across borders. Owing to the Basel Convention, WEEE export is prohibited globally (Song *et al.*, 2017). Specifically, Canada applies the Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations and, in Europe, it is the WEEE Directive (Schiller, 2016).

The WEEE Directive (2012/19/EU) is the principal regulation on the management of WEEE in Europe. The WEEE Directive aims to promote reuse, recycling and recovery of WEEE by improving collection rates in EU Member States. Like the Basel Convention, the WEEE Directive also discusses transboundary e-waste shipments. The ITAD process can be carried out in the country where the WEEE is generated or after it has been exported across borders. Although the transboundary shipment of WEEE is prohibited under global, regional and state legislation, it can be legitimate to do so under certain circumstances. Within the WEEE Directive, transboundary shipments of assets are permitted within the framework of a B2B transfer arrangement with the appropriate derogations outlined in Annex VI (2a–c) of the directive. First, assets deemed defective for repair under warranty can be dispatched back to the producer or a third party (across borders) with the intention of reuse. Second, in countries where the OECD control system for waste recovery applies, under a valid contract and with the intention of reuse, the assets are sent to the producer or a third party for refurbishment or repair. Third, the asset can also be shipped with the intention of carrying out analysis, such as root cause analysis, especially where such analysis can be done only by the producer or a third party situated across a border.

The ITAD industry prioritises reuse and recycling in the management of disposed assets. To carry out effective operations, ITAD businesses must follow standards that earn them certifications. A certified ITAD provider requires third-party certifications in three major categories, namely international management standards, ITAD best practices and data security standards (Investment Recovery Association, 2019). International management standards include International Organization for Standardization (ISO) standards, such as the ISO 9000 standard for quality management and quality assurance and ISO 14000, which ensures that organisations adhere to environmental management standards. The Occupational Health and Safety Assessment Series (OHSAS) 18001 also helps organisations monitor and enhance environmental and occupational health and safety performance.

To show that they follow best practice, ITAD vendors often seek certification from initiatives such as e-Stewards or Responsible Recycling (R2) or the Recycling Industry Operating Standard (RIOS). The e-Stewards are a global team of actors that include individuals, organisations and governmental agencies with a mission to uphold safe, ethical and globally responsible standards for the recycling and refurbishment of WEEE, largely through the provision of certifications and audits. The associated standard also prohibits the illegal export of WEEE to developing countries. Similarly, the R2 standard is focused on safeguarding the environment, as well as workers' health and safety in the electronics refurbishing and recycling industry. Another best practice standard, RIOS provides a systematic framework for recycling plants to maintain constant development based on the ISO 9001, 14001 and OHSAS 18001 platforms (Investment Recovery Association, 2019).

The importance of data security in ITAD management cannot be overemphasised and, therefore, data organisations require data security certifications that mandate heightened facility and logistics security, employee background and drug checks, and business continuity plans (Investment Recovery Association, 2019). ISO 27001 requires that an information security management system (ISMS) is in place to guard sensitive information, while the National Association for Information Destruction (NAID) AAA certification verifies ITAD company compliance via audits carried out by accredited security professionals. Other standards include those from the Asset Disposal and Information Security Alliance (ADISA), which covers all the ITAD stages and undertakes audits; WEEELABEX, which provides a set standard for the collection, sorting, storage, transport and preparation of reuse of WEEE, as well as conducting thorough audits; the Transported Asset Protection Association (TAPA), which sets security standards to prevent cargo crime during freight handling; and the Microsoft Authorised Refurbisher (MAR) programme, which certifies and audits companies that install Microsoft programs into refurbished assets.

## 3.2 Methods

### *3.2.1 Characterise the sector*

To establish the most functional approach to quantifying Irish export of professional IT equipment, it was first necessary to identify the stakeholders and companies exporting materials, whether exporting for or after refurbishment. This was achieved through a mixture of interviews and snowball sampling, by which identified companies suggested, and provided contact information for, other companies conducting similar business activities. Using this method of sampling it was possible to achieve good coverage of the Irish market. Interviews and site visits were also conducted during this stage for the purpose of refining data collection and contact points. Pathways of material flow through identified stakeholders were then mapped and are presented in section 3.3.1.

### *3.2.2 Determine the reporting capabilities and assess motivation*

The research team collaborated with the EPA waste statistics office to examine existing WEEE declaration forms for applicability to the reporting of exported professional UEEE and to ensure that new methods of reporting would not duplicate data that are already reported. Initial interviews with the EPA waste statistics office also served the purpose of determining the current reporting environment for the export of WEEE and UEEE.

In addition to discussing reporting with the EPA, the receiving body for reported data, interviews and site visits were also conducted with the reporting companies.

### *3.2.3 Develop and roll out pilot voluntary data collection*

Interviews revealed an existing reporting system currently used in the Netherlands to voluntarily report UEEE export. The existing form from the Dutch system (Appendix 3) was shared with the research team and adapted to suit the Irish system based on results from ITAD service provider interviews.

The piloted form was subsequently rolled out to all identified companies nationally. The data and feedback obtained from returned voluntary declaration forms were anonymised, consolidated and summed to protect the confidentiality of the participating organisations. Collated data were separated by type of equipment and reported in units. Each equipment type was assigned a weight per unit based on the associated UNU-Key. This system was utilised for consistency and to facilitate replication in future studies.

## 3.3 Results

### 3.3.1 *Sector characterisation*

Irish businesses were found to acquire and relinquish possession of necessary IT equipment via several pathways (Figure 3.2). In many cases, equipment was reported by companies to be classified as product throughout its movement and refurbishment and never as a waste. For this reason, in certain cases end-of-first-use is a more fitting description of the stage at which a company "disposes" of, or relinquishes ownership of, IT assets. Figure 3.2 illustrates a non-exhaustive chart of acquisition and disposal pathways Irish companies take with regard to IT equipment; the manner by which a company procures IT assets also influences how the asset is disposed of.

To appropriately illustrate the movement and refurbishment of UEEE in Ireland, a number of pathways have been identified in B2B scenarios. In addition, current reporting capabilities have been highlighted, with particular attention to pathways through which the movement of UEEE is not reported at this time.

EEE placed on the market in Ireland follows one of several potential pathways at end of first use. These include sending it to domestic refurbishers (which receive UEEE both directly from companies and from producer collection schemes), to leasing companies before UEEE is sent abroad to collection hubs or, perhaps presenting a larger challenge, to international refurbishers that accept UEEE from Irish companies. Interviews with Irish producers and ITAD companies indicated that the UEEE exported is then sold to either businesses or individual consumers, often in a third country, and is very unlikely to return to the Irish market.

### 3.3.2 *Voluntary declaration data collection and analysis*

Examination of EPA reporting documents confirmed that existing reporting requirements apply only to

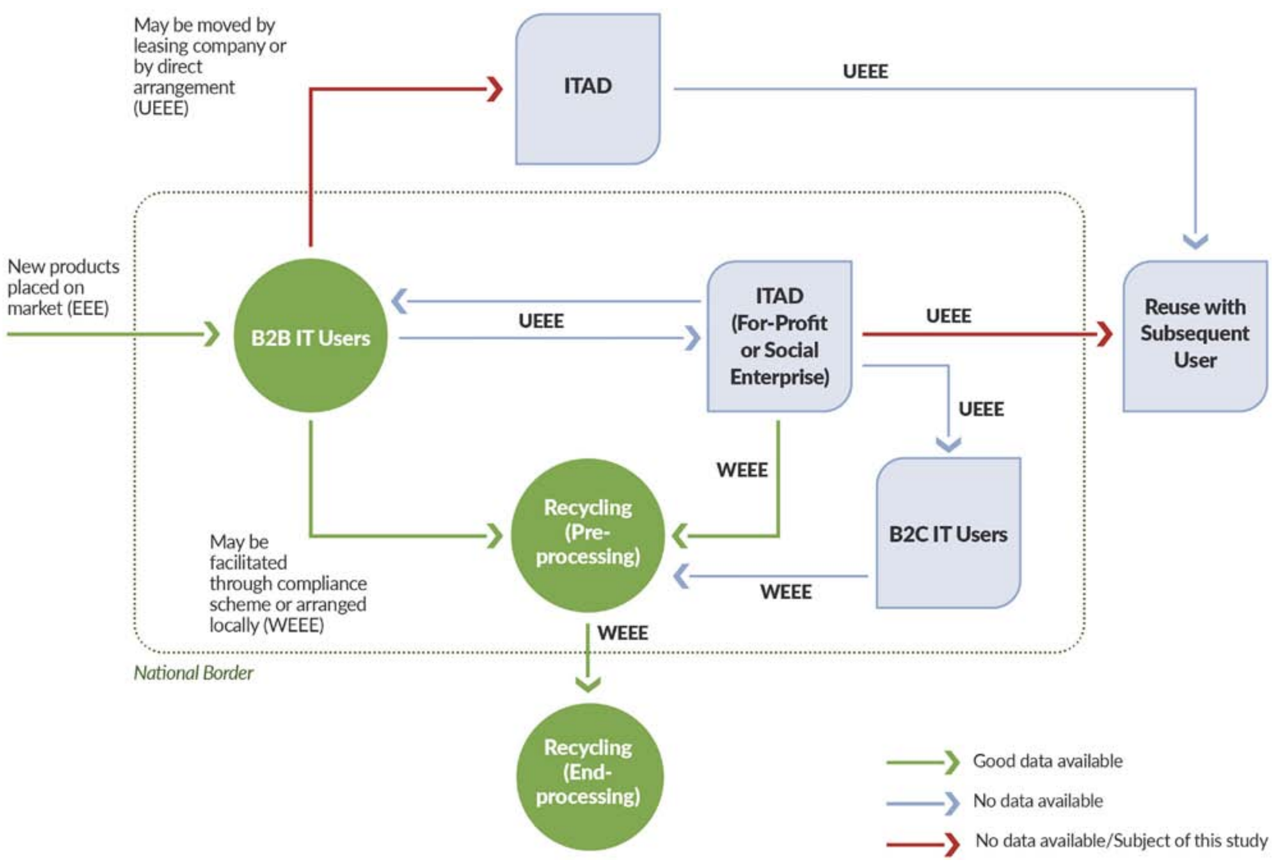


**Figure 3.2. Potential pathways of acquisition and disposal of IT assets, including existing reporting of EEE movement between stakeholders.**

WEEE. This is a crucial point, as it was universally affirmed by companies that material exported for refurbishment is classified as product at all times, and never as waste. Thus, quantities of EEE exported for or after refurbishment are not previously reported in existing documentation requirements.

A total of 13 companies completed the voluntary declaration form for reporting exported UEEE; an additional three companies were identified but did not provide a response to the survey. In all cases, the company indicated that the data reported were the most recent available, and were for 2019. Table 3.1 consolidates the inputs of returned voluntary declaration forms for UEEE exported in 2019 by participating Irish companies.

## 3.4 Discussion and Conclusion

The characterisation of the movement of used professional IT equipment has identified the known and unknown in the pathways that EEE, UEEE and WEEE follow through the Irish B2B sector. In particular, this analysis confirms that, while WEEE is well recorded through the majority of pathways, much less information is available on the movement of UEEE. Interviews with businesses and stakeholders revealed several ways in which this UEEE moves within and out of Ireland.

The traditional ownership model involves a company purchasing and maintaining its own IT resources, which comes with high up-front costs and the

**Table 3.1. Mass of UEEE reported by Irish companies to be exported for the purpose of refurbishment and reuse abroad**

| Product type | UNU-key | UNU weight per unit (kg) | Total mass reported (kg) |
|---|---|---|---|
| Servers | 0307 | 40.00 | 94,280 |
| Desktop computers | 0302 | 8.77 | 72,738 |
| Server chassis | – | – | 65,640 |
| Monitors | 0309 | 5.50 | 45,337 |
| Routers | 0307 | 40.00 | 40,120 |
| Switches | 0307 | 40.00 | 39,440 |
| Hard disk drives | 0301 | 0.40 | 14,711 |
| Printers | 0304 | 10.32 | 12,621 |
| Memory | – | – | 11,356 |
| Server racks | – | 100.00 | 10,000 |
| Laptop computers | 0303 | 1.26 | 9841 |
| Peripherals (docking stations, cables, keyboards, etc.) | 0301 | 0.40 | 21,090 |
| Power supplies | – | – | 5350 |
| Transceivers | – | – | 3662 |
| Printed circuit boards | – | – | 3188 |
| Copying equipment | 0304 | 10.32 | 1548 |
| Storage | – | – | 980 |
| Tablets | 0303 | 1.26 | 867 |
| Battery | – | – | 775 |
| Scanners | 0304 | 10.32 | 630 |
| CPU | – | – | 394 |
| Controller | – | – | 103 |
| Mobile phones | 0306 | 0.09 | 102 |
| **Total** | | | **454,773** |

**–, no code/not applicable; CPU, central processing unit.**

responsibility to choose and organise a disposal method, such as using the producer representative compliance scheme, or delegating disposal to a social enterprise or another private service. On the other hand, leasing equipment from manufacturing companies and other agents has lower initial costs than purchasing the equipment outright, with flexible options such as payment in instalments. Leasing often comes with added benefits, such as free servicing, ease of upgrade and sustainable disposable measures. At the end of a leasing contract, users are given the option to continue payments, return products and either end the contract or upgrade to new products, or to purchase the products and therefore enter into the aforementioned ownership model.

In either of these models, disposal of assets may occur at the end of life in the case of malfunctioning, broken or obsolete equipment. At the time of writing, there is no pathway by which equipment that has reached its true end of life and is classified as waste can be prepared for reuse, and is all sent for recycling. However, assets are also relinquished simply to upgrade for the newest model, or as part of a contract at the end of a lease. Functional equipment and functional spare parts of non-functional but whole equipment are often reused rather than recycled or otherwise disposed of.

Our results found that the total B2B UEEE exported from Ireland for the purpose of refurbishment amounts to approximately 455 t for the year. A very high percentage of this exported UEEE was reported by stakeholders to be successfully refurbished and sold for reuse outside Ireland, in line with the Waste Framework Directive’s prioritisation of reuse over recycling and other disposal methods. However, this material is no longer available for collection and treatment in Ireland, where it was placed on the market. As targets are based on the amount placed on the market, it is important to consider the amount of UEEE that has left the country when calculating what the targets should be.

According to EPA records, 62,714 t of WEEE was collected in 2018. A total of 10% of WEEE collected (6271 t) was identified as professional IT equipment. Professional IT equipment exported for reuse was measured to amount to less than 1% of total WEEE collected in 2018. However, the results of this study suggest that, in the narrowed-down category of professional IT, equipment exported for reuse could account for an increase of 7% in collection of professional IT equipment. This is especially true with regard to the high likelihood that this equipment, having been taken back by producers, leasing agents or ITAD companies, would reach appropriate collection and recycling channels. Additionally, the figures reported here are likely to be conservative estimates, given the lack of response from three companies identified and contacted, as well as the existence of thus far unidentified companies engaging in transboundary shipment of UEEE for the purpose of refurbishment and reuse.

The movement of WEEE within and away from Ireland is carefully reported to the EPA in line with the treatment requirements laid out by the WEEE Directive and S.I. 149. However, the characterisation of the UEEE sector conducted in this study revealed a lack of current reporting of exported UEEE. Equipment exported for or after ITAD treatment is most often classified not as waste, but rather as product. This is an important distinction, as UEEE that remains classified as product is not subject to waste treatment regulations or reporting. Currently, only EEE classified as waste (WEEE) is reported for use in target calculations. Owing to this distinction of equipment as product when exported, certain pathways of EEE travelling out of the Irish market, as indicated in Figure 3.2, are not required to be reported and are therefore missed under the current structure. The methods utilised in this study offer a solution to fill these gaps through the introduction of voluntary reporting, which interviews with producers and ITAD companies in Ireland have indicated would be well received, particularly as several companies already participate in such a system in the Netherlands.

# 4 Overall Recommendations

Based on the conclusions from the examination of exports for reuse in RoRo vehicles and B2B export of professional IT equipment, the authors have developed a set of recommendations that will facilitate policymakers, enforcement authorities, producers and other stakeholders to further quantify and report UEEE exported from Ireland in these channels.

- **The legitimate export of UEEE in RoRo vehicles and by professional IT producers and refurbishers for the purpose of reuse should not be inhibited.**

  Reuse activity is prioritised by the Waste Framework Directive as an important method of lifetime extension and facilitator of resource efficiency. Given that the majority of UEEE in RoRo vehicles entering Nigeria from Ireland was found by Odeyingbo *et al*. (2017) to be in working order, and that each unit leaving Ireland is accompanied by an electrical certificate of functionality under current inspection policies, this research found that shipments in RoRo vehicles are sent largely for reuse, and similarly found no evidence that the export of UEEE in RoRo vehicles poses any significant risk of serving as a significant pathway for illegal WEEE shipment. The professional IT equipment exported for the purpose of reuse was reported by companies to be not WEEE and, importantly, was successfully refurbished and sold for reuse in large amounts – in some cases over 90% – with additional spare parts reused from equipment that was not repairable.

- **The estimated amounts of used professional IT equipment exported from Ireland for the purpose of resale and reuse abroad should be reported and considered in the calculation of regulatory targets.**

  While the amounts of UEEE leaving Ireland in RoRo vehicles, estimated to be in slight excess of 17 t annually, are not currently significant enough to affect targets, the export of professional IT equipment is more likely to affect target calculations. The value of exported professional IT equipment calculated in this study, 455 t, equates to 7% of professional IT equipment collected WEEE in 2018. This amount could contribute significantly to targets for the collection and recycling of this particular category of WEEE and, notably, could help Ireland to achieve upcoming reuse targets.

- **Quantities of UEEE leaving Ireland should be re-estimated periodically to account for significant future changes in export behaviour.**

  The frequency with which quantities of UEEE leaving Ireland on RoRo vehicles should be estimated should be determined. Annual estimations are unlikely to be appropriate because of the high resource requirement involved in estimating shipments as well as the very low amount of UEEE currently being exported and the relatively low capacity for change under the current system. However, data on the amount of professional IT exported from Ireland for the purpose of reuse should be collected on an annual basis.

- **The method for collecting annual reported quantities of used professional IT equipment exported for the purpose of reuse should be flexible and should not complicate or compete with the existing reporting of WEEE-related activities. The method should also ensure that the collected information is not obtained in more than one form of reporting to prevent double counting of exported amounts.**

  To meet these requirements, the authors suggest that authorities, e.g. the EPA Producer Responsibility team and the EPA office for waste statistics for those with waste licences, engage with each relevant company using a finalised version of the voluntary declaration form developed in this study (Appendix 3). Conducting estimations in this manner will allow authorities the ability to adjust the data collection form as needed, engage with a focused target audience and limit data collection to a singular, easy-to-understand declaration.

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# Abbreviations

| | |
|---|---|
| **B2B** | Business-to-business |
| **B2C** | Business-to-consumer |
| **CSR** | Corporate social responsibility |
| **EEE** | Electrical and electronic equipment |
| **EPA** | Environmental Protection Agency |
| **EU** | European Union |
| **ICT** | Information and communication technology |
| **IT** | Information technology |
| **ITAD** | Information technology asset disposition |
| **NTFSO** | National TransFrontier Shipment Office |
| **PC** | Personal computer |
| **R2** | Responsible Recycling |
| **RAM** | Random access memory |
| **RIOS** | Recycling Industry Operating Standard |
| **RoRo** | Roll-on roll-off |
| **UEEE** | Used electrical and electronic equipment |
| **UNU** | United Nations University |
| **WEEE** | Waste electrical and electronic equipment |

# Appendix 1 Inspection Documents for Roll-on Roll-off Export

## Electrical Declaration

| Electrical Contractor[1] (Name & Address):<br><br><br>Contact Details:<br>Email:<br>Safe Electric Registration No: | Customer Name & Address:<br><br><br>Contact Details:<br>Email: |
|---|---|

Make: ____________________ Model: __________________________

Serial Number:_____________ Year of Production: (if known) ____________

Detail Method of Testing:_________________________________________________

Result of test- Pass or Fail: ________________________________________

Date of Test: _____________

Estimated value of item: €________________

Name and address of testing location: ______________________________

**Declaration of Functionality:**

I declare that the electronic/electrical item specified above is in working condition and is suitable for re-use for its original purpose and meets all European Safety Standards.

Signed: __________________________ Company Stamp:

Date: __________________________

[1] Electrical Contractor: Must be a registered electrical contractor with the Register of Electrical Contractors of Ireland (RECI) in accordance with the Electricity Regulation Act 1999, as amended.

***Please note that ozone depleting substances are a prohibited export from the EU.**

***Please be aware that providing false/misleading information to an authorised officer is an offence under the Waste Management Act 1996, as amended, and the Waste Management (Shipments of Waste) Regulations 2007.**

Issued October 2019: Version 3

# Packing List

| Liable person/Sender (Name & Address): | Sender's Agent/Freight Forwarder (Name & Address): |
|---|---|
| Phone No: Fax:<br>Email: | Phone No: Fax:<br>Email: |

Consignee (Name, address, contact details):____________________________________________

__________________________________________________________________________________

Name and address of loading location:________________________________________________

__________________________________________________________________________________

__________________________________________________________________________________

<u>Additional Notes:</u>

| Item Description: make/model etc | Serial Number | Qty | Estimated value | Invoice present Y/N? |
|---|---|---|---|---|
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Estimated Total Value of shipment (Euros): €________________

**Declaration of liable person:**

- I declare that the items within this shipment have been packed individually with appropriate protection against damage during transportation, loading and unloading and in such a manner so as not to cause environmental risk.
- I declare that all of the electronic and electrical equipment within this shipment are re-useable in their current condition and are not waste as defined by Article 3(1) of Directive 2008/98/EC.
- I declare that all items of electronic and electrical equipment within this shipment have been tested and that the result of the functionality test has been attached on the outer packaging of each item.
- I declare that all vehicles in this shipment are re-useable in their current condition or in need of only minor repair.
- I declare that all used vehicle parts within this shipment are fit for direct re-use or require only minor repair and do not contain any hazardous components/substances.
- I declare that I am the legal owner of the items within this shipment, all of which are for direct re-use in their current condition.

Signature: ____________________

Block Capitals:____________________

Date: ____________________

*** Please note that ozone depleting substances are a prohibited export from the EU.**

***Please be aware that providing false/misleading information to an authorised officer is an offence under the Waste Management Act 1996 as amended, and the Waste Management (Shipments of Waste) Regulations 2007**

***Please be aware that any shipment that requires further investigation or is required to be returned to origin may incur a Return to Origin Fee of €750.**

***Please be advised that any shipment that requires a written direction to be issued by this office may incur a Monitoring Fee of €350.**

***Please be advised that the shipment of waste in contravention of Regulation (EC) 1013/2006 may result in a court appearance and if convicted fines can be issued up to €4,000 per offence and /or costs and /or 12 months imprisonment.**

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# Appendix 2 Collated Sampling Data

| UNU key | Description | Quantity | Total sampled weight (kg) | Sum of values (€) | Scaled weight estimates (kg) | Scaled value estimates (€) |
|---|---|---|---|---|---|---|
| 0103 | Kitchen | 17 | 810 | 2244 | 2531 | 7013 |
| 0104 | Washing machines | 13 | 943 | 2577 | 2947 | 8053 |
| 0108 | Fridges | 33 | 1346 | 3152 | 4206 | 9850 |
| 0109 | Freezers | 10 | 441 | 1325 | 1378 | 4141 |
| 0114 | Microwaves | 21 | 481 | 1134 | 1503 | 3544 |
| 0201 | Other small household | 9 | 9 | 1824 | 28 | 5700 |
| 0202 | Food | 10 | 33 | 445 | 103 | 1391 |
| 0203 | Hot water | 2 | 4 | 88 | 13 | 275 |
| 0302 | Desktop PCs | 9 | 79 | 1437 | 247 | 4491 |
| 0303 | Laptops | 2 | 3 | 274 | 9 | 856 |
| 0304 | Printers | 17 | 175 | 1144 | 547 | 3575 |
| 0307 | Professional IT | 2 | 80 | 569 | 250 | 1778 |
| 0403 | Music instruments, radio | 11 | 41 | 2147 | 128 | 6709 |
| 0404 | Video | 3 | 11 | 486 | 34 | 1519 |
| 0405 | Speakers | 12 | 26 | 780 | 81 | 2438 |
| 0408 | Flat panel display televisions | 100 | 1020 | 24,729 | 3188 | 77,278 |
| 0505 | LED lamps | 1 | > 1 | 54 | > 1 | 169 |
| 0506 | Household luminaires | 12 | 5 | 953 | 16 | 2978 |
| 0601 | Household tools | 14 | 35 | 1321 | 109 | 4128 |
| 0701 | Toys | 1 | > 1 | 201 | 1 | 628 |
| **Grand total** | | **299** | **5542** | **46,884** | **17,319** | **146,514** |

# Appendix 3 Adapted Declaration Form for Data Collection

Export for Re-use Voluntary Declaration 2019

UNIVERSITY OF LIMERICK
OLLSCOIL LUIMNIGH

Company Name: <Fill in Company Name>

Name of Person to Complete Form: : <Fill in Persons Name>
Contact Details of Person to Complete Form: <email & phone number>

Date : <Fill in Date>

Instructions:

- Please fill in the number of units of each category of equipment that originated and were placed on the market in Ireland that you subsequently either (i) refurbished in Ireland and then exported or (ii) exported as products for refurbishment/re-use/resale.
- If there are any categories that are not listed in the table, please add them.
- Return the form by email to Kathleen.McMahon@ul.ie & Colin.Fitzpatrick@u.ie

| **Professional IT Equipment Category** | **Units** |
|---|---|
| Desktop Computers (excluding monitors & peripherals) | 0 |
| Laptop Computers | 0 |
| Monitors | 0 |
| Tablets | 0 |
| Mobile Phones (including smart phones) | 0 |
| Desktop Printers (including multifunctional devices) | 0 |
| Large Copiers | 0 |
| Hard Disk Drives | 0 |
| Servers | 0 |
| Server Racks | 0 |
| Routers | 0 |
| Small Peripherals (keyboards, mice, docking stations) | 0 |
| Other 1 | 0 |
| Other 2 | 0 |
| **Total Exported for Re-use** | **0** |

Background information

On behalf of the Irish EPA, The University of Limerick is currently examining the quantities of used electrical and electronic equipment (UEEE), particularly professional IT equipment, that is being exported for re-use. Quantifying such exports for reuse can be used to revise downwards WEEE collection targets for producers which are based on placed on market data.

*Please note that this declaration should only include UEEE that is exported for the purpose of refurbishment and re-use and does not concern WEEE. It should also only refer to product that originated/was first placed on market in Ireland.*

**The University of Limerick research team would greatly appreciate your participation in completing as well as providing feedback on this pilot form.**

Please feel free to contact us with any questions: Kathleen.McMahon@ul.ie

**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.

EPA Research Report 393

# Estimating the Quantity of Electrical and Electronic Equipment (EEE) Exported from Ireland As Used EEE

Authors: Kathleen McMahon, Chidinma Uchendu and Colin Fitzpatrick

## Identifying Pressures

Ireland has met or exceeded collection and recovery targets for waste electrical and electronic equipment (WEEE) in recent years. However, as targets have risen, Ireland's stakeholders must identify and address challenges presented by WEEE that does not arise in collection. One largely unmeasured contributor exists in the legal transboundary shipment of used electrical and electronic equipment (UEEE) for the purpose of refurbishment and resale. Although UEEE is not waste and is, in these cases, exported for reuse, these materials will not arise as WEEE in the future and become available for collection in Ireland. Therefore, this may impact the country's ability to meet the WEEE collection target. Consequently, estimates of annual UEEE exports must be determined to be considered and accounted for in policy decisions.

This research identifies two pathways by which UEEE is exported for the purpose of reuse, namely through the shipment of roll-on roll-off vehicles and through the shipment of professional IT equipment, and it aims to quantify the amount of UEEE exported through each pathway.

## Informing Policy

Irish policies for reporting, quantifying and tracking the movements of Irish WEEE are well established. However, given its non-waste status, information on the export of UEEE is largely unmeasured and unreported and is therefore unavailable for policymakers. This research characterises the pathways of UEEE as it moves through and out of Ireland, identifying and exploring gaps where information is currently unavailable. Using these characterisations, the researchers developed and executed methods for regularly establishing estimates of UEEE exported as professional IT equipment or on roll-on roll-off vehicles. The resulting estimates, and the methods used to obtain them, will assist policymakers in closing the reporting gaps identified in the research, and will place the quantities and types of UEEE exported in context with the quantities of WEEE collected for recycling in Ireland.

## Developing Solutions

Monitoring the quantities of UEEE exports for potential impacts on, or contributions to, collection and recycling targets is an important part of continuing Ireland's record of meeting and exceeding targets. The findings and methods developed in this research provide a continuing set of tools for stakeholders and policymakers to continue estimating quantities of exported UEEE that will not subsequently arise as WEEE in Ireland. These tools and the accompanying recommendations will assist stakeholders and policymakers in continuing this legacy while supporting the objectives of the WEEE and Waste Framework Directives. The recommendations include (1) not inhibiting the legitimate export of UEEE for the purpose of reuse; (2) establishing annual voluntary reporting for the export of used professional IT equipment; (3) reconducting estimations of exported UEEE to account for changes in export behaviour; and (4) ensuring that adapted methods are careful not to compete or interfere with or duplicate existing reporting measures for WEEE.

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