

# Investigating Reuse of B2C WEEE In Ireland

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**Abstract -The environmental impact associated with electrical and electronic (EEE) equipment is relatively large throughout its life cycle when compared to other durable consumer products. Prioritisation of reuse of WEEE is one approach that has been proposed to reduce manufacturing impacts and contribute to a reduction in this lifecycle burden. This paper aims to address two key issues in the area of reuse of EEE. (1) When should an appliance be reused and (2) what general conditions must be present for a successful reuse industry to operate? Surveys were conducted for five European reuse enterprises with the aim of determining the WEEE categories/products with the most significant potential for reuse and to examine the critical success factors of these enterprises to operate. Preliminary proposals to integrate reuse/refurbishment practices into the Irish WEEE waste management structure are outlined. The social dimensions of reuse are also discussed**

## I. Introduction

Electrical and electronic equipment (EEE) are indisputably central components to the lives of billions of people with almost every household and business having some electrical element. However, the environmental impact associated with WEEE is relatively large throughout its lifecycle. The provision of appliances, and the services they offer, should consider these environmental burdens and the means by which the industrial systems (including end-of-life (EOL)) operate, should be optimized to reduce these impacts. Prioritisation of reuse of WEEE in certain circumstances is one approach that has been proposed to reduce these burdens [1]. This paper aims to address two key issues in the area of reuse of WEEE. (1) When should an appliance be reused and (2) what general conditions must be present for a successful reuse industry to operate? These issues will be addressed in the context of the business to consumer (B2C) market space.

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## II. When should an appliance be reused

### a) *LCA Analysis*

When considering reuse, environmental impacts must be examined across the whole lifecycle of the appliance. For products such as computers a very strong case for has been made in the literature [2]. A number of lifecycle assessment (LCA) studies have been carried out in an attempt to quantify the energy consumed in production [2,3]. The high energy consumption resulting from the manufacture of PC microchips is a major factor for supporting lifetime extension, to recoup the invested energy consumed in the production process [3]. A 10% extension of lifespan for PCs has been shown to reduce their lifecycle impact in the region of 5.2% to 8.6%. This contrasted with a 0.43% reduction in life cycle impact if recycling was undertaken [4]. This is just one example which illustrates the benefits of upgrading and reselling EEE from an environmental perspective

However, for the majority of EEE there is a lack of conclusive literature to support reuse outright, due to the consideration of energy efficiency of newer products. Therefore products must be assessed on a case by case basis for determining whether there are benefits for replacement.

### b) *LCA indicators comparison*

The general argument against reuse states that new appliances are more energy efficient than older appliances, therefore timely replacement is perceived as the most ecologically preferable option. This argument against reuse is usually derived from cumulative energy demand (CED) life cycle assessment, which compares the energy usage in production to the energy consumption in the use phase. However, CED analysis negates important environmental effects, which have a crucial bearing in the actual life cycle. "ECO-indicator 99" is a more environmentally comprehensive indicator which is used for LCA [5]. Comparing LCA approaches for a study of washing machines, CED LCA established a life cycle impact of 11.7% for manufacture and 83% for usage compared to an ECO-indicator 99 life cycle impact of 57.1% for manufacture and 37.8% for usage [6]. These impacts relate to a life expectancy of 15 years for the washing machine and it is apparent that continued usage is more environmentally benign in this case.

For CED, the means of energy generation is often overlooked when evaluating the use phase impact of EEE products and is an important aspect in the context of reuse

determination. A host of environmental impacts and the quantity of fossil fuels consumed have been shown to be directly related [7]. However, it is important to note that emissions from the production of energy vary depending how the energy is produced. Energy can be produced using numerous methods such as nuclear, hydro-electricity, dry natural gas, petroleum, coal geothermal, wind, solar, biomass. Each country employs different energy generation techniques with varying emissions as a result. Ireland's current electricity mix is made up of: Gas 55%, coal 18% peat 6% oil 6% combined heat and power (chp) 4% and 11 % renewable sources [8]. Ireland is currently updating its energy generation portfolio and aims to source 40% of electricity demands from renewable sources by 2020 [9]. This will result in a aggregate reduction of emissions for electricity generation, for example carbon emission will be reduced from 420 gCO<sub>2</sub>/ Kw to 240 gCO<sub>2</sub>/Kw[10]. This consequently reduces the lifecycle impact of the use phase of EEE products. Due to the high penetration of wind energy there will be times when 100% of electricity can be from renewable sources. This in conjunction with the national role out of smart meters will enable people to adjust their consumption accordingly [11]. In the Irish context this will create greater emphasis on the production phase of EEE and lifetime extension.

*c) Reuse as part of the WEEE directive*

Section II (b) illustrate that timely replacement is not necessarily advantageous and a detailed analysis must be undertaken to ensure the most environmentally beneficial options are chosen. However, due to the clear lack of emphasis on reuse in the various national implementations of the WEEE Directive the opportunity to undertake this product specific analysis for WEEE with potential for reuse is lost. For each EU member state, reuse and recycling targets are combined. The combined target can be achieved from recycling alone, which many EU member states have opted for [12]. Consequently WEEE with potential for reuse does not have to be made available to operators who are interested in preparing it for reuse. This is acutely felt in the social economy sector where most reuse activities take place and in disadvantaged communities who are generally the main beneficiaries of refurbished goods. Supply of WEEE is one of the key issues identified by interviews with refurbishers throughout the EU in this research. Without access to sufficient quantities of WEEE refurbishers are rendered ineffective as the business becomes economically unsustainable. To enable reuse to be viable and beneficial, effective means of attaining WEEE for refurbishers, through government policy and EU legislation, is a fundamental priority. This is a vital dimension for sustainability when considering reuse and should not be overlooked.

*d) Reverse logistics for accessing WEEE for reuse*

Closed loop supply chains are recognized as having huge potential for reclaiming end of use products from consumers. These concentrate on take backs and recovering value from products through reuse or material recovery. Product recovery is the key concept and includes used product acquisition, reverse logistics, remanufacture/refurbishment and parts

recovery, and remarketing. Ideally product recovery would acquire end of use products with sufficient potential to enable profitable remanufacture or refurbishment. If remanufacturing/refurbishment operations are deemed unfeasible value reclamation can be achieved in spare parts or material recovery. In the U.S the employment and sales generated from remanufacture amount to in excess of 53 billion US dollars. [13] However, designing the reverse logistics is cumbersome and requires detailed design of the waste management system to make ensure that there is no leakage and all WEEE is accounted for.

*e) Transport*

It has been shown that efficient recycling is crucial for savings in resource consumption (materials and energy), and reuse of EEE can contribute to these saving marginally, with an average 1% reduction in resource consumption [14]. This is true for large scale economies, where access to reprocessing/recycling facilities is available and efficient recycling provides higher savings in primary materials. For small remote countries this may not be the case, as the cost of recycling/reprocessing facilities may not be feasible, as the quantity of WEEE arising would not justify the cost of a reprocessing facility, in spite of very high WEEE collection rates [15]. In such a situation the lifecycle impact of EEE can vary compared to a large scale economy. Ireland is a small island, where no large scale reprocessing facilities exist. All WEEE is prepared for reprocessing/recycling then exported abroad for material reprocessing. The environmental cost of transport and shipment has to be added to the life cycle impact of EEE in such a scenario. The energy consumption and carbon emissions from long distance transport reduce the benefits of efficient recycling for such economies. Reuse and refurbishment could contribute a higher saving in resource consumption, if properly implemented and monitored.

*f) Social*

All things considered, even if the environmental argument is not conclusive for promoting reuse, the job creation and access to equipment arguments have strong social merits for the promotion of reuse. Refurbishment of WEEE provides local employment, for the long term unemployed and disabled. This gives people the opportunity to enter the workforce, promoting self-esteem and self-worth. Furthermore these refurbishment practices provide low income families with modern household necessities such as fridge freezers, washing machines and computers, which otherwise they would be unable to afford. These social benefits assist in reducing the social divide and promoting social inclusion

### III. Product specific analysis for determining reusability

WEEE is divided into ten product categories in the WEEE Directive. This section undertakes a product/category specific evaluation to determine what products/categories have the greatest potential for reuse. Reuse potential is assessed under five headings: Technical, Social, Economic, Environmental

and Legal [16]. The important findings based on semi-structured interviews with reuse centres across Europe are investigated, in relation to each of these headings are summarised in Table 1.

<b>Product specific analysis to determine reusability</b>	
<b>Technical</b>	This involves an examination of the technical equipment and skills necessary to undertake the refurbishment process, and also an assessment of the availability of spare parts
<b>Social</b>	The benefits the refurbished product can provide to low income households
<b>Economic</b>	Determining whether there is a demand for the refurbished appliance The economic return from refurbishment of the appliance Involves a cost assessment of refurbishment operations with the secondary value of an appliance taken as 1/3 of the current market value of an equivalent new product.
<b>Environmental</b>	An examination of how extension of life affects the lifecycle impact of the appliance through LCA comparisons
<b>Legal</b>	Determining whether there are any legal barriers restricting/prohibiting the refurbishment of the specific appliance

**Table 1: Product specific analysis to determine reusability**

The results of this analysis show that reuse is highly beneficial in the context of Category (1) Larger household appliances (washing machines, dryer, fridge-freezers) and Category (3) IT and telecommunications (computers and mobile phones). For Category 3 this is predominately business to business (B2B) and B2C shows much less potential. This outcome reflects the current state of reuse practice in the EU. These categories have a relatively high importance from a social perspective with secondary markets currently in existence for these products.

#### IV. What general conditions must be present for a successful reuse industry to operate in Ireland

In order to conceptualize a more efficient reuse sector in Ireland, research was conducted by means of questionnaires and visitations to reuse/refurbishment enterprises throughout Europe. All visitations referred to in this section took place from November 2008 to December 2009. The visitations evaluated the refurbishment facility, refurbishment techniques, refurbishment certifications and the marketing of refurbished products. Operational logistics were also examined, focusing on the acquisition of WEEE and reverse logistics. The refurbishment enterprises chosen for the study included: R.U.S.Z(Austria), Kringerwingel/The Recycle Hangerland (Belgium), Bryson (Belfast) and Berlin Reuse Network (Germany). Rehab (Dublin) was also visited to establish a comparative benchmark. Refurbishment is being carried out on different scales throughout all institutions, mainly in social enterprises with the exception of the Berlin reuse network, which is a private enterprise. The semi-structured interview used was identical for all visitations and analysed the five keys aspects of their operations: (1) technical, (2) social, (3) economic, (4) environmental and (5) legal. Of the visits conducted, the situation in Flanders was considered to be the best model for Ireland to examine due to the similarities

between the systems: population density, way in which the WEEE directive is transposed and how the B2C compliance schemes are structured.

#### a) Technical

Of the countries visited the Recycle Center Hageland (Belgium refurbishment network) was considered the most technically advanced in the refurbishment of WEEE. This institution has developed their own operating standards and maintains these standards throughout their refurbishing premises and outlets. WEEE categories are broken down into 5 categories for testing: (1) Fridges and freezers (2) TVs and monitors (3) Washing machines and dryers (4) Ovens and cookers and (5) Small appliances. Each category has their own unique refurbishment area, catered for each respective category's specialised test requirements. Each part of the refurbishment process is documented and uploaded to a server, which can be accessed by the entire Recycle Centre Hageland network. Refurbishment was being carried out on a larger scale when compared with the other institutions, with 10 refurbishing premises, 31 reuse centres which feed the refurbishing premises and 103 outlet stores for remarketing the refurbished appliances.

Technical problems/experiences experienced by all refurbishers concerned included:

- Existence of a repair manual
- Availability of spare parts
- Uniqueness and integrated nature of newer appliances

#### b) Social

As previously stated, the majority of refurbishment enterprises chosen for the study were social enterprises. These use non-profit and for-profit business models depending on their mission. For example, R.U.S.Z (Austria) and Kringerwingel (Belgium) incorporate programmes for training the long term unemployed providing employees with the necessary skills to specialise in one specific area of refurbishment. This contrasts with Bryson (Belfast), social enterprise employing a skilled work force that provides low cost high quality Portable Appliance Testing (PAT) tested appliances.

In all instances the reuse operations demonstrated an enormous social benefit. Refurbishment businesses provide local employment and generate positive community moral. Standard of living increases by providing low income families access to equipment considered necessary for modern day living.

#### c) Economical

In certain instances profit margins are so low that refurbishment operations are economically unfeasible. Three major factors were highlighted by refurbishers regarding the economic viability of refurbishment practices.

Firstly, supply of WEEE for refurbishment is an ongoing concern. Bryson (Belfast), refurbishes white goods and indicated for every 10 machines they receive at their refurbishment facility, 3 turn out to be refurbishable. Constant

and consistent supply of equipment is crucial for profitability and sustainability in the industry.

The second major factor highlighted by respondents' concerned availability and cost of spare parts. Spare parts sourced from the manufacture are expensive and difficult to obtain, as experienced by the recycle Hageland (Belgium refurbishment network). If spare parts are sourced, refurbishment is usually carried out at a loss. This problem is reduced by creating a spare parts inventory over time, from non-refurbishable WEEE.

Thirdly the level of subsidy available to social economy enterprises also had an impact on the viability of operation.

#### d) Environmental

Reuse of EEE is being achieved by all refurbishment organisations involved in the study. The main environmental issues attributable to lifetime extension of used equipment have been discussed in more detail in Section II and include potential

- Reduction in e-waste
- Reduction in energy and water used in the manufacture
- Reduction in carbon emissions
- Reduction in LCA impact of appliances

R.U.S.Z (Austria) has further attempted to enhance the benefits of lifetime extension with ongoing R&D efforts into reducing the energy consumption of their refurbished washing machines.

#### e) Legal

Legal difficulties experienced by all refurbishers include the following:

- WEEE permits for handling WEEE
- P.A.T certification for refurbished products
- Appropriate insurances

### V. The role of the WEEE directive in supporting reuse

Throughout the study it was seen that legislation plays a critical role in promoting reuse of WEEE. The WEEE directive 2002/96/EC is founded on the principle of "producer responsibility" [17] and with regard to reuse its general objectives are:

1. To prevent waste of electrical and electronic equipment (WEEE) and to promote the reuse, recycling and recovery of such wastes
2. To improve the environmental performance of all operators involved in the life cycle of electrical and electronic equipment, e.g. producers, distributors and consumers and in particular those operators directly involved in the treatment of waste electrical and electronic equipment.
3. To ensure that Member States shall give priority to the reuse of whole appliances (art.7.1). It also states

that collection and transport shall be carried out in a way which optimizes reuse and recycling of those components or whole appliances capable of being reused or recycled (art. 5.4)

The WEEE directive has been interpreted differently by each EU member state and transposed into their member state's own specific legislation. The implementation of the directive in each reuse enterprise's locality (i.e. Belgium, Germany, Northern Ireland and Austria) are compared to assess how reuse is incorporated into each region's respective waste management structure. Difficulties and barriers experienced by the current legislation and proposed amendments to the directive for benefiting reuse are outlined in the following paragraphs.

Northern Ireland was the only country in the aforementioned group that added the reuse of WEEE to their recovery target. Furthermore, the UK has put direct emphases on the reuse of WEEE products indicating "Where appropriate, priority should be given to the reuse of WEEE and its components, subassemblies and consumables [18]". In Belgium, Germany and Austria reuse is not counted towards recovery targets. In this instance the legislation has been transposed in each of these countries instance to focus on achieving recovery targets through recycling. Changes to the WEEE directive which have been proposed by the surveyed refurbishers include:

- 1) Mandatory separation of WEEE with possible potential for reuse at all collection sites.

Where refurbishment is deemed feasible refurbishers should be able to request separation of WEEE with potential for reuse. Where there is no refurbishment option viable, all WEEE should be prepared for recycling.

- 2) Introduction of a reuse target to stimulate reuse across the EU.

It is the opinion of the authors that due to the complex nature of reuse and changing markets, setting targets for reuse could be economically very inefficient. Allowing reuse to be subtracted from the recycling targets is perceived as a much more viable approach.

- 3) Guarantee access by accredited refurbishers to WEEE collection centres

Refurbishers need to be certified to ensure WEEE is handled appropriately and leakages are minimised in the system. Accredited refurbishers should then be able to request access to WEEE collection centres.

- 4) Access to free technical information from manufactures for accredited refurbishers

Providing such information will assist in the refurbishment process, reducing repair times and costs, ultimately leading to a more sustainable refurbishment business model

## VI. Introducing reuse into Ireland's WEEE waste management structure

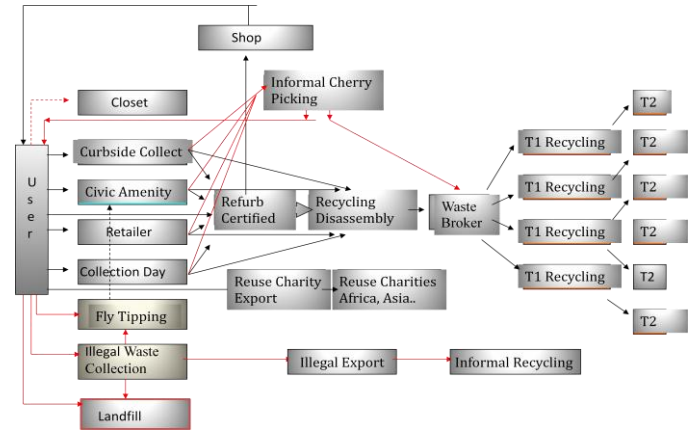
In Ireland, refurbishment is not presently incorporated into the B2C waste management system. An assessment of the current system is required to understand how refurbishment operations could be best introduced. Currently all B2C WEEE responsibilities are being carried out by two compliance schemes European Recycling Platform (ERP) [19] and WEEE Ireland [20]. Both organizations work in a similar way, each subcontracting WEEE management to certified recycling contractors, who collect and prepare WEEE for reprocessing. WEEE prepared for reprocessing is then exported for recycling using waste brokers. A visible environmental management cost (VEMC) exists for all B2C EEE put on the market. The VEMC is part of the price the consumer pays for the product at point of sale. This money goes into the WEEE black box which is managed by the WEEE Register and ultimately pays for equipment EOL management which is claimed by the two compliance schemes [21]. Ireland currently recovers more than double the required amount of WEEE, with an average of 9kg per person per capital. [22]

Designing a waste management system to better facilitate reuse & refurbishment adds considerable complexity to the system. One crucial aspect is that WEEE with potential for reuse must be recovered as early as possible. A case study from Finland shows that careless handling and improper storage of WEEE with potential for reuse, seriously reduces the possibility of reuse [23]. Designing the reverse logistics system to ensure adequate channels are created as upstream as possible, protects WEEE with possible potential for reuse from uncontrollable factors such as weather corrosion, facial damage and possible theft.

Figure 1, shows a conceptualised view of the WEEE management system in Ireland with reuse channels incorporated into the existing architecture. WEEE is generally returned to four specific areas; civic amenity site, retailers, open collection days and curbside collection. These are the earliest channels which WEEE with possible potential for reuse would be accessed.

WEEE with potential for reuse would be recovered by accredited refurbishers and the remaining is sent for recycling. Refurbished EEE would be certified and re-introduced into the market through retail outlets.

WEEE without potential for reuse would follow the existing channels. Waste brokers act as the conjugate between the recycling/disassembly facility and the various tiers of recycling usually carried out in various locations across the UK and mainland Europe. Tier one (T1) is where initial processing of the disassembled materials take place. Virgin materials are extracted downstream at T2, T3 etc.



**Figure 1: Proposed WEEE management flow stream for B2C in Ireland**

Figure 1 also accounts for blockages and leakages in the waste management system. The closet affect refers to the temporary storing of EEE equipment away by the original owner until the equipment is technologically incapable of satisfying anyone's needs anymore and is consequently discarded. It is a major problem facing the development of secondary markets both in Ireland and abroad. Fly tipping is the illegal dumping of equipment on the side of roadways etc. This equipment frequently ends up at the CA site at the cost to local authorities who don't benefit from visible environmental management costs. In addition to fly tipping, leakage in the system results from illegal landfill, illegal waste collection and illegal export.

## VII. Conclusion

Based on the study so far the following conclusions have been drawn and areas for further study identified.

- Recycling targets set in the WEEE directive should not deter reuse, instead reused WEEE should be subtracted from the recycling target to incentive and stimulate reuse.
- Refurbishers should require certification for the access to WEEE, to ensure WEEE is correctly treated and is actually refurbished. Leakage is always a concern.
- Certified refurbishers, should have access to sufficient equipment to be economical viable. These would include the four main access points: civic amenity site, retailers, open days and curb side collections. Current reuse trials will help to evaluate which of the reuse sources have the best potential.
- Category 1: Large household appliances, have the most potential for B2C refurbishment as the market
- Refurbishers should produce certification for the refurbished products, proving it has undergone all the

require safety checks including electrical safety testing (PAT Testing)

- An economic viability study has to be conducted, to determine the amount of throughput of white goods necessary for the refurbishment enterprise to be sustainable. This study is reserved for future work
- Branding and Marketing of the refurbished goods within a certified refurbishers network is also important and will be an area for future work.

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