WEEE Reuse Trials in Ireland

Maurice O'Connell, Colin Fitzpatrick, Stewart Hickey

***Abstract*— Reuse/refurbishment trials for WEEE in Ireland are undertaken to establish the potential for reuse that exists using the established waste management systems. Preliminary findings have clearly shown two WEEE categories with the highest potential for reuse: (1) white goods (B2C) and (2) IT and telecoms (B2B). Early indications show white goods from retailers having a larger portion of appliances with potential for reuse compared to other sources, i.e. civic amenity sites and kerb side collections. ICT equipment source is generally three to four years old with a high potential for reuse.**

***Index Terms*— ICT, Reuse ,WEEE, White Goods**

I. Introduction

Electronic and electrical appliance consumption has increased significantly in last decade, leading to explosive growth in electronic waste (e-waste). Globally e-waste is growing at a rapid rate, with an estimated 200 million tonnes being generated annually and only between 25% to 40% being accounted for within the EU. E-waste is potentially extremely environmentally hazardous if handled inappropriately, usually occurring in informal channels. [1] Examining the electronics and electrical industries in a holistic fashion, looking at the whole system rather than just concentrating on individual parameters, will create a more transparent and accountable system.

E-waste is proving to be the key problem but potentially the solution to these challenges. Optimisation of e-waste potential could reverse or mitigate the challenges facing the electronic sector.[2] For this to occur methods have to be developed and integrated into the design phase of appliances, taking into account the refurbishing, remanufacture, and recycling to maximise the resource conservation and minimising life cycle impact of the appliance whilst benefiting the producer finically.

Given the complexity, uncertainty and diversity of the e-waste problem, a rigorous multidisciplinary approach is necessary to develop and implement systems that effectively utilize the embodied energy and maintain the material value.

This work was supported by the Environmental Protection Agency *(EPA under the* Science, Technology, Research & Innovation for the Environment *(STRIVE) programme; Project Re-evaluate 2008-WRM-MS-4-S1).*

M.O.Connell is with the Department of Electronic and Computer Engineering, University of Limerick, Limerick, Ireland. Phone: +353872734753; e-mail: maurice.w.oconnell@ul.ie

C. Fitzpatrick is with the Department of Electronic and Computer Engineering, University of Limerick, Limerick, Ireland. e-mail: colin.fitzpatrick@ul.ie

S. Hickey is with the Department of Electronic and Computer Engineering,University of Limerick, Limerick, Ireland. e-mail: stewart.hickey@ul.ie

Therefore in order to maximise the sustainably of the electronic industry, reuse is a fundamental aspect.

Reuse has benefits on many levels [3-4]

- it conserves embodied energy and water;
- it is a more efficient use of scarce materials, (rare earth material)
- it can reduce the amount of transportation required in putting product back on the market;
- it can possibly provide jobs for disadvantaged people;
- it reduces the amount of pressure on underdeveloped recycling infrastructure, particularly in developing countries

.

II. Directives and Standards

For building a supportive structure for reuse, directives and standards could potentially have the capability for developing this underutilised sector. Directives initiate a transformation which enables a particular result to be achieved, whilst standards ensure quality and consumer confidence.

A. Recast of weee directive

The recast of the WEEE directive aims to clarify the scope and definitions and improve the compatibility with other EU directives such as the Waste Framework Directive and Reach directive. An alternative collective collection based target is proposed from the current 4kg per person per year. The Commission proposes to differentiate the targets by setting mandatory collection targets equal to a percentage of the average weight of electrical and electronic equipment placed on the market over the two previous years in each Member State. The council recently proposed that countries should collect 45% of the average weight of electrical and electronic equipment in their national markets by 2016, with the target rising to 65% by 2020.This is a significant reduction from a previously suggested by the commission in 2008 that member states should be required to collect 65% of the average weight of e-waste from 2016 and to 85 % by 2020. [5]

While a strong emphasis has been set for recycling targets, with reuse targets being partially neglected. It has been proposed that the recycling and recovery target will include the re-use of whole appliance with a target of 5% across all WEEE categories being anticipated. While the introduction of a reuse target will stimulate reuse, it could also be wasteful forcing targets on appliances which have no potential for reuse. Determining whether an appliance has a potential for

reuse, a number of factors have to be taken into account. StEP recommends carry out a product specific analysis for determining a products potential for reuse.[6] Potential for reuse is broken down into five dimensions: (1) Technologic,(2) economic,(3) ecologic (4)social and cultural and (5) legal. This methodical approach enables a clear decision to determine the reuse potential weighing up the benefits and disadvantages. Enabling reuse to be added to the recycling target in conjunction with other incentives, instead of an individual category reuse target, is perceived as more of a practical solution for stimulating sustainable reuse practices.

B. Reuse standards

Reuse should be regulated. Unregulated reuse of (W)EEE opens the potential for leakage of waste from properly controlled recycling, also know as sham reuse, including uncontrolled treatment and illegal shipment to developing countries. Only organisations operating to sufficiently high standards should be considered eligible to undertake refurbishment and reuse activities. A recently published standard (31st March 2011) for reuse has being developed by British Standards Institution (bsi) called PAS 141 [7]

1) PAS 141

The Publicly Available Specification (PAS) 141 was developed from the WEEE Advisory Body's Specification for the reuse of waste electrical and electronic equipment (WEEE) and used electrical and electronic equipment (EEE). The PAS 141 standard enabled a specification to be rapidly developed in order to fulfil an immediate need in industry. It covers the reuse of equipment and components. It does not cover the recycling process, although it does include requirements for assigning WEEE and UEEE for recycling.

Processes used by organizations involved in the reuse of WEEE and UEEE need to be designed to identify and minimize the impact they have upon the natural environment. This PAS 141 standard deals with the handling, reusing processing, reuse, recycling and disposal and operational management.

The aim of PAS 141 is to encourage the reuse of WEEE, which is promoted in the WEEE directive and Waste Framework directive. This standard differentiates between untested WEEE/ Used WEEE and Reused WEEE (RWEEE) assuring and protecting customers of the quality and electrical safety of the RWEEE. It also provides a tool for which certified refurbishers can identifying REEE and constituent components that have been subject to the tests set out in PAS 141 from untested WEEE and UEEE. Furthermore this will deter the exportation to the developing world of equipment misrepresented as being fit for reuse

III. REUSE WITHIN IRELAND

Currently there is a strong market and emphasis placed on the refurbishment of ICT in the B2B market place in Ireland. Rehab and Camara, are the two largest refurbishment operators for ICT within the country. However the B2C market has been neglected in terms of reuse. In terms of reaching recycling targets though, Ireland was one of the highest within the EU, recovering 9.8kg per person in 2010 which was greater than twice the required target. This market is yet to be explored from a reuse potential.

1) Re-evalute

Re-evaluate is a project developed to evaluate existing initiatives for e-waste reuse in Ireland, as well as identifying best practice in Reuse from Europe and elsewhere, in order to make and pilot recommendations for developing a reuse platform within Ireland. Re-evaluate is being conducted by the University of Limerick Department of Electronic and Computer Engineering (UL ECE)**,** Clondalkin Community Recycling Initiative **(**CCRI**)** and Rehab Enterprises Ltd

Re-evaluate is conducting Reuse/refurbishment trials for WEEE in Ireland to establish the potential for reuse that exists, using the established waste management systems. The two organisations undertaking the trials (Rehab and CCRI) are social enterprises of different scales with a history of recycling WEEE. The trials aim to assess in what circumstances priority should be given to reuse and what benefits this would bring, such as reduction in energy consumption, reduction in CO_2 emissions, reduction in raw materials and water use, reduction in pollution and other hazardous waste. Furthermore the trials will examine the job creation potential of reuse, particularly through the social economy, and how refurbished WEEE products can improve the quality of life for lower-income households and communities. Sample markets will be used for testing consumer perceptions of refurbished WEEE assisting future marketability. The WEEE reuse trials focus on B2B and B2C . B2B information is sourced from existing databases developed by Rehab who have been refurbishing IT equipment for a number of years. The B2C trials concentrate on white goods, as they have been assessed to have the most potential for reuse. Rehab recycle currently conduct ICT refurbishment and are examining the opportunities of entering white goods refurbishment. CCRI currently conduct processing of WEEE for recycling and are looking to expand into the refurbishment of white goods.

B. Reuse Trials

1) B2B TRIALS (REHAB)

For ICT there are two major parameters for deciding on refurbishment of laptops and desktops: (1) visual assessment (2) processing power. Visual assessment is similar to that of white goods, ensuring the aesthetics of the product are suitable. Processing power of the CPU generally determines whether a market exists for the machine in question. Current in-house standards developed by Rehab, only allow machines with Pentium 4 processors or higher to be refurbished.

a) Operational flow for B2B ICT refurbishment

The technological process controls for white goods and ICT vary immensely. ICT refurbishment requires a higher level of sophistication and automation as shown Figure 1

.

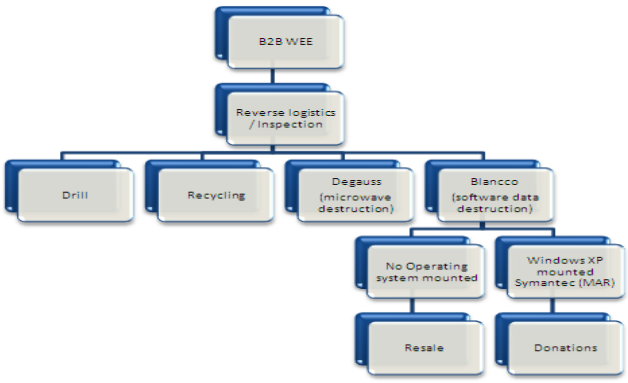

Figure 1: B2B ICT operational flow chart

(1) Asset monitoring

Rehab employ a system called ARW to enable assets to be monitored throughout the refurbishment process. Each computer system in the batch is tagged with a barcode. The barcode itself specifies a job number and an item number. The job number is linked to the clients account number on the ARW system enabling an audit trail to be conducted for each appliance throughout the refurbishment process.

(2) Data destruction

ICT refurbishment incorporates data destruction with three different options available: Blancco (software), Drill (mechanical) Degauss (electromagnetic.) Drill and degauss are two data destructive methods rendering the hard drive unusable. If either of these two options is chosen a replacement hard drive has to be sourced or the system is cannibalised for spare parts or material recovery. If blanco (software wipe certified to US military deactivation standard) is chosen, the hard drive is reusable.

(3) Operating system

Rehab is a Microsoft authorised refurbisher (MAR), Microsoft XP is mounted onto the systems using Symantec, a program capable of mounting numerous machine concurrently. Hard drives have previously being wiped in the Blancco progress. On average it takes 40 minutes to mount the operating system.

2) B2C white goods trials (Rehab, CCRI)

The trials focus on retailer and distributor take backs as it has proven to be the largest source of returned white goods. Retailers and distributors are required under the WEEE directive to provide a free take back service on a one for one basis, providing access large range of white goods with possible potential for reuse.

a) Operational flow for B2C White goods refurbishment

White goods refurbishment is a less technical process compared to ICT as shown in figure 2. Once potential for reuse has been determined, functionality testing is a manual process, determining any faults or worn parts. Remaining machines will be used as a donor machine for scavenging spare part, or recycled. Once a machine has been refurbished to (a yet to be defined) standard, they are PAT tested, an electrical safety standard for ensuring machines are functional safe for reuse.

.

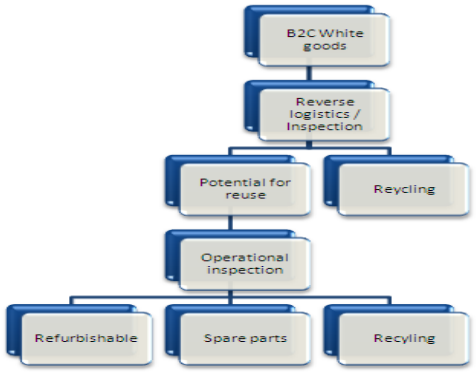

Figure 2: B2C white goods operational flow chart

An assessment matrix is necessary to determine potential for reuse. For white goods visual and operational assessment are the key parameters. Figure 3 illustrates how the grading based system would function. White goods are initially given a visual assessment grade from 1 to 5 (5 perfect, 1 very poor). Appliance receive poor scoring due to

- Incomplete external casing, i.e., missing external side panels, control panel, etc. (Score 1)
- Badly damaged external casing (Score 1)
- Rusting (Score 1)
- Anything beige (Score 2)

After visual assessment, appliances graded 3 or higher undergo operational assessment and are re-graded by a qualified experienced electro-mechanical service engineer. Any appliances re-graded 3 or higher are fit for refurbishment. System grading from 3-5 after visual and operational assessment is based on the make and model of the machine, aesthetics and energy label.

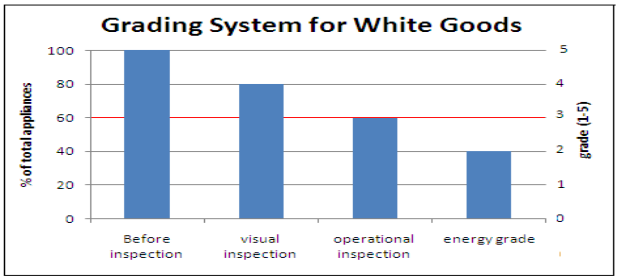

Figure 3: Grading system for white goods

IV. RESULTS

The results are split into B2B ICT and B2C white goods.
For B2B trials, refurbishment has being conducted and equipment had been remarketed. For the B2C trials, CCRI conducted visual and operational assessment of white goods, and rehab conducted visual assessment. No white goods have been refurbished. The trials are assessing the potential for reuse. Full refurbishment of white goods will be conducted in phase 2 of the Re-evaluate project

A. B2B: ICT

Data was complied for from 14/ 12/2009 to 10/12/2010 from Rehab Recycle and is shown in Table 1. The majority of machines returned are three to four years old which depends on the supplier inventory refresh protocol. Reverse logistics are conducted by Rehab predominantly, ensuring minimum damage in transit. A large amount of servers (649/663) were recorded with no potential for reuse, due to modern processing power requirements. The CRT's returned were predominately working, but had limited potential for reuse due a lack of demand. Alternatively LCD's returned had a large potential for reuse at 87%. Hard drive potential for reuse is determined by the size of the hard drive and wipe technique employed (blacno, decauss, drill)

Appliance	Total Acquired	Potential for Reuse	%age of total
Hard drives	1255	112	9%
Base units	5052	3225	64%
Crt's	945	234	25%
Data cartridge	1428	17	1%
Laptops	899	519	58%
Printers	60	21	35%
Servers	663	14	2%
LCD's	254	221	87%
Tv's	3	0	0%

Table 1: Rehab ICT refurbihsment 09-10

B. B2C: white goods

1) CCRI

a) Distributor takeback

On initial visual assessment two thirds of the reserved machines were fit for reuse. Table 2 shows the results after the operational assessment. The sample rates for the dryers, dishwashers and cookers are too low for quantitative statistical analysis. For washing machines, it can be seen that 41 % of machines had potential for reuse. Machines returned from the distributor were of the same brand, enabling remaining appliances with no potential for reuse being suitable for donor parts . Reverse logistics from the distributor are conducted by CCRI, ensuring minimum facial damage to the appliances.

.

Appliance	Total Acquired	Potential for Reuse	%age of total
Washing Machine	29	12	41%
Dryer	1	0	0%
Dishwasher	8	2	25%
Cooker	3	1	33%

Table 2: CCRI distributor take back

2) Rehab

a) Retailer 1

Retailer 1, take back comprised of fifty units predominantly washing machine and fridge freezers as is shown in Table 2. Washing machines showed a large potential for reuse after visual inspection. 62% of washing machines showed potential for reuse, with the remaining machines having spare parts potential due to similar branding. Fridge freezers had a 40% potential for reuse after visual inspection, with similar spare parts potential. Small samples of dishwashers (6 units) and dryers (1 unit) were recovered.

Appliance	Total Acquired	Potential for Reuse	%age of total
Washing machine	16	10	62%
Dryer	1	1	100%
Fridge /freezer	27	11	40%
Dish washaer	6	2	33%

Table 3: Rehab retailer takeback

b) Retailer 2

Retailer 2, take back comprised of 15 units predominantly comprised of washing machine as is shown in Table 2. Washing machines showed similar reuse potential to Retailer 1. 50% of washing machines showed potential for reuse, with the remaining machines having spare parts potential due to similar branding. Dryer sample rate is low, but had relatively high potential for reuse. No fridge/freezer were collected

Appliance	Total Acquired	Potential for Reuse	%age of total
Washing machine	10	5	50 %
Dryer	3	2	66 %
Fridge /freezer	0	0	0 %
Dish washaer	2	0	0 %

Table 4: Rehab Retailets takeback

c) Retailer 3

Retailer 3, take back comprised of 35 units predominantly comprised of washing machine as is shown in Table 4. Washing machines potential for reuse showed relatively lower results compared to the other retailers. 25% of washing machines showed potential for reuse. Of the 24 washing machines acquired, there were 5 different brands, making donor parts more difficult to source. 7 dishwashers were examined with 0% potential for reuse

Appliance	Total Acquired	Potential for Reuse	%age of total
Washing machine	24	6	25%
Dryer	4	0	0 %
Fridge /freezer	0	0	0 %
Dish washaer	7	0	0 %

Table 5: Rehab retailer takeback

V. Discussion

The results from the Rehab ICT trials showed a strong reuse potential for the three main area's base units (64%), laptops (58%) and LCD's (87%). Figures represented a yearly flow of equipment from Rehab, demonstrating the strong platform developed for B2B IT. Also during this period it was shown that preparing a tonne of B2B ICT equipment for reuse employed 11 times more people than in recycling an equivalent amount of material. Reuse also generated 15 times more revenue than recycling of the equivalent quantity in the same period. One of the key success components is attributed to having control over the reverse logistics, minimizing uncontrolled transportation damage. Customer processor speeds specification was the main reason why machines weren't fit for reuse. Within the refurbishment process inventory logging through the refurbishment process is cumbersome and time consuming.

For white goods, on average 40% of washing machines and fridge freezers showed potential for reuse. The remaining machines were predominantly suitable for spare parts. Other white goods including tumble dryers and dishwashers didn't have enough of a sampling rate. But when machines were available similar reusability trend were observed.

VI. Conclusion

From the trials, it is clearly shown that there is potential for reuse within the B2B ICT and B2C white goods sectors in Ireland. Access to supply is fundamental for future development. Due to the potential for conflict of interest for producer organised compliance schemes in promoting reuse, a dedicated reuse oriented compliance scheme should be considered to run in parallel with producer run schemes. Value conserving logistics are also vital for reuse. Equipment should be segregated at the earliest possible opportunity and should never be mixed in the same containers with equipment that is destined for recycling. From an operational perspective re-use should be a regulated activity and participants should work to pre-defined standards, ensuring quality and consumer confidence

VII. References

1. Streicher-Porte, M. and J. Yang, *"WEEE recycling in China. Present situation and main obstacles for improvement,"* in *IEEE International Symposium on Electronics and the Environment*. 2007.
2. *StEP Task Force Recycling "Recycling : From E-waste to Resources"*. UNEP & UNU. **July 2009**(http://www.unep.org/PDF/PressReleases/E-Waste_publication_screen_FINALVERSION-sml.pdf).
3. Alejandra Sepúlveda, M.S., Fabrice G. Renaud, Martin Streicher, Ruediger Kuehr, Christian Hagelüken, Andreas C. Gerecke *A review of the environmental fate and effects of hazardous substances released from electrical and electronic equipments during recycling: Examples from China and India.* Environmental Impact Assessment Review, January 2010. **30**(1): p. 28-41
4. Hagelüken , C. and C. Meskers *Mining our Computers - Opportunities and Challenges to Recover Scarce and Valuable Metals from End-of-Life Electronic Devices"*, in *Electronics Goes Green*. 2008.
5. *Environment: Commission proposes revised laws on recycling and use of hazardous substances in electrical and electronic equipment.* 03/12/2008.

http://europa.eu/rapid/pressReleasesAction.do?reference=IP/08/1878.

6. StEP. *one global understanding of re-use – common definitions* 2009 [cited 2010.
7. *Reuse of used and waste electrical and electronic equipment (UEEE and WEEE). Process management. Specification.* March 2011, PAS 141:2011. **http://shop.bsigroup.com/en/ProductDetail/?pid=000000000030245346**.