Special Report Series

ICT and the Environment

August 2010

Report 1: *Why reuse is better than recycling*

Summary

End-of-life ICT equipment forms part of an exponentially-growing pile of global e-waste–all those unwanted televisions, kettles, washing machines, stereos, light bulbs, and myriad other electronics that have or could enter the waste stream. Europeans alone generate some 20 kg of e-waste per year[1] and according to the UN, 200 million computers and 550 million mobile phones reached the end of their life in 2008.[2]

Numerous attempts are under way to stem the rising e-waste tide. While the specifics of each country's approach differ, in the main all aim to increase the separate collection of e-waste and its recovery by reuse and recycling. However, of these two options, recycling is often the default end-of-life response, regardless of whether the equipment is at the end of its useful life.

For ICT equipment (as with other consumer goods), this is a wasted opportunity. As this first instalment in a series of special reports on 'ICT and the Environment' explains, reuse of functional equipment is the environmentally superior recovery option–and this is before we consider the additional socio-economic benefits it reaps–and should be promoted as such in any waste management programme.

Key findings

- ICT production is energy and material intensive, and ICTs contain substances that are hazardous, valuable or both, so keeping them out of landfill makes clear sense
- High levels of product replacement and the concentration of energy intensity in the ICT production rather than use phase (80 and 20 percent, respectively) means that any activity that extends the life of ICTs–such as reuse–should be prioritised
- Reusing working computers is up to 20 times more energy efficient than recycling them. Also, reuse has lower resource depletion costs than recycling. Thus, the waste hierarchy, which has reuse as more environmentally beneficial than recycling, equally applies to unwanted ICTs as to other wastes
- While ICTs are often replaced long before the end of their productive lives, their reuse brings additional benefits, such as providing access to those unable to afford them new
- The superior performance of reuse has been recognised in EU legislation. The Waste Electrical and Electronic Equipment (WEEE) Directive contains language that prioritises reuse, though a lack of specific reuse targets means that recycling often becomes the practical reality. More needs to be done in the EU and elsewhere to reap the many benefits of reuse

Recommendations

- ***Producers*** must maximise the reuse potential of their goods through effective product design and consumer education about the environmental benefits of reuse
- ***Consumers*** must maximise the use phase of ICT, either by postponing replacement or providing it to a second user
- ***Governments*** must take necessary steps to ensure that, in accordance with the waste hierarchy, reuse is prioritised by legislating reuse targets and standards

Computer Aid International

What's to be gained by reusing or recycling our unwanted ICT equipment?

All waste streams, if managed improperly, can have negative impacts on the health of humans and the environment, including via emissions to air and water. Waste also represents a loss of resources, such as the metals or other recyclable materials or energy it contains. Therefore, sound waste management is crucial to mitigate these impacts and losses.[3] In the case of end-of-life ICTs, a rapidly-increasing waste stream (Box 1), management decisions must consider the high energy and material investment involved in their production, and their toxicity.

The complexity of their parts, such as printed circuit boards and memory chips, means that ICT manufacture demands much more energy and other inputs than many other consumer products. A 2002 study suggested that ***a two-gramme memory chip requires 1.3 kilograms of fossil fuels and chemicals***.[4] Also, a 2003 analysis revealed that at least ***240 kilograms of fossil fuels, 22 kilograms of chemicals and 1,500 kilograms of water are required to produce one desktop computer***.[7] While we could expect there have since been advancements in production processes to decrease some of these material and energy requirements, efficiency improvements are likely to lag other industry innovations.[7] Thus, the implication is clear; making computers is a costly exercise.

Modern electronics can contain up to 60 elements; many of these are valuable, some are hazardous and some are both.[7] Inappropriate disposal or recovery of electronics can generate significant levels of hazardous emissions.[8] Also, many of these elements are scarce and under increasing demand. ***Supply of 14 of the minerals used in modern electronics is at critical levels***, with demand for these materials expected to triple by 2030.[9]

Raw materials for electronics are primarily supplied through mining, which demands large amounts of land and energy and generates numerous harmful emissions. For instance, 10,000 tonnes of carbon dioxide emissions are generated to produce one tonne of gold, palladium or platinum.[6] Additionally, the social impacts associated with the extraction of materials that are used in electronics are a significant concern.[10]

Diverting ICTs from landfill is clearly desirable. Recycling, using appropriate handling techniques, can help avoid hazardous emissions whilst recovering valuable materials, and may reduce the greenhouse gas emissions associated with production of new equipment and mining.[6] Reuse avoids the need to extract more valuable resources or expend energy in the manufacture of new equipment. For example, refurbishing computers and mobile phones for reuse can use up to a third less energy and is more "eco-efficient" than newly manufactured equipment.[11]

Why should reuse be prioritised over recycling?

Waste management is often conceptualised in terms of a 'waste hierarchy', which ranks the different ways in which we can manage waste in order of relative environmental benefit (Fig. 1). This hierarchy is reflected in various legislative frameworks, such as in the EU, where current policy first aims to prevent waste, then to reduce waste disposal through reuse, recycling and other waste recovery operations.[12]

Box 1: ICT boom…waste, bust?

Rapid product innovation and replacement, plus economies of scale that have driven down prices means that there is burgeoning global demand for ICTs. For instance, by 2008 the billionth PCs was installed, a figure that could double by 2014.[5] Emerging markets are increasingly contributing to this demand. For instance, some 14 million PCs were sold in China in 2005, adding to the more than 48 million TVs and nearly 20 million refrigerators sold there in 2001.[6] Clearly, when these goods are no longer wanted, we have a significant waste challenge to meet.

Reuse is a form of upstream management, or "source reduction", which refers to those strategies that reduce the size of the incoming waste stream.[13] ***Reuse sits higher up the hierarchy than recycling because the latter can demand high amounts of energy and other inputs (for transport, disassembly, destruction and other processing) to recover the desired product fractions. Recycling does not always recover all of the raw materials, creating residual wastes that will require disposal***.[14] Also, even if a recycling process recovered 100 percent of materials from a product, this does not account for wastes generated during its manufacture, which can be considerable.[15]

In the case of e-waste, recycling is often the favoured management method, though it is not necessarily the best one. This is particularly so when we consider one part of the e-waste supply chain–unwanted PCs. Compared to some other waste electronics, ***for PCs, the environmental "payback" of recycling is relatively small***.[13] This is due to the concentration of energy intensity in PC production and typically short life spans of their actual use, fuelled by rapid product innovation and high levels of replacement.

For instance, for a refrigerator, 88 percent of total energy use goes into running the device, so activities that improve use-phase energy consumption, like designing a newer, more efficient machine, makes the most environmental sense. On the other hand, ***only 20 percent of total energy use goes into running a computer; the rest is in its manufacture***.[7]

This means that any activity that extends the life span of a PC to avoid superfluous manufacture is a key strategy to mitigate its environmental impacts. Indeed, a 2003 study suggests that ***reuse is 20 times more energy efficient than recycling***.[13] One could expect that innovations in recycling technologies may have become at least partially more efficient since this study. Yet, there appears to be no more recent studies that contest this claim.[16] Also, the slower rate of efficiency improvements in manufacturing processes relative to ICT product innovations means that in terms of energy demand alone, one could safely assume that reuse maintains a higher position than recycling in the e-waste hierarchy.

Increasing the life span of ICTs, such as through reuse, is also beneficial when we consider the depletion of the many resources that go into their manufacture. A recent analysis that modelled the ***resource depletion costs of computers and mobile phones demonstrated a significant decrease in costs when their average in-use life span was extended***.[17]

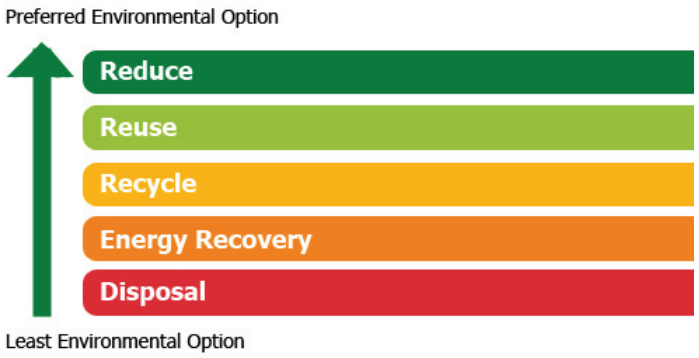

Figure 1: The 'waste hierarchy', which ranks different waste management options, in order of relative environmental benefit. (SOURCE: Zero Waste Scotland)

The ***same benefit was not at all evident under scenarios of increased recycling***. This is likely due to the complex composites in ICTs (like semiconductors) that require high tech partitioning processes, and the fact that mineral recovery can be inefficient and imperfect (creating residual materials that require other treatment), and often creates lower grade minerals as output.[17] Such outputs are not necessarily suitable for the manufacture of new electronics; here, demand for new ICTs will contribute to overall demand for new raw materials. Thus, any activity that delays this, such as reuse, should be prioritised.

Reuse has additional social and economic benefits. For example, PCs are vital for modern business function and can increase access to education and health services. The 'digital divide' contributes to the wealth gap and the expense of ICT is one major contributor to this divide.[18] ***The lower purchase cost of refurbished equipment can make it available to those that could not afford it new***, and can contribute to achieving economic and social development goals. Also, the reuse industry can create income-generating opportunities. UN estimates show that compared to PC disposal, reuse creates 296 more jobs for every 10,000 tonnes of material disposed of annually.[2]

Indeed, in terms of e-waste management, ***the superior environmental performance of reuse has already been recognised in legislation. The EU's Waste Electrical and Electronic Equipment (WEEE) Directive*** aims to minimise the impact of electrical and electronic goods on the environment, by increasing reuse and recycling and reducing the amount of e-waste going to landfill. In line with the waste hierarchy, preference is given to reusing whole appliances of collected WEEE:

> *Where appropriate, priority should be given to the reuse of WEEE and its components, subassemblies and consumables.*[19]

However, while this wording suggests reuse is a *policy* priority, a lack of specific reuse targets means that there is no regulatory incentive to monitor or report on volumes of appliances reused. Thus, recycling often becomes the *practical* priority, with take-back systems in EU member states concentrating on low-cost recycling.[20] Also, the lack of standards for refurbished and tested equipment makes difficult both the promotion of reuse and the policing of trade in sub-standard equipment (particularly illegal dumping of non-functional e-waste falsely traded as equipment for reuse). There is clearly much work to do to reap the many benefits of ICT reuse.

Conclusion

Like other waste streams, there are environmental and human health benefits to be gained by diverting unwanted ICTs from landfill. These benefits are particularly relevant to ICTs, given the high energy and material intensity involved in their production. When equipment has reached the end of its productive life, recycling–when using appropriate techniques that protect the health of humans and the environment–is certainly a part of a responsible e-waste management chain, inasmuch as it can help avoid harmful emissions from the hazardous fractions of electronics and recover valuable resources.

However, the reality is that ***often unwanted ICTs are not actually end-of-life; many have a productive lifespan that far exceeds typical use***.[21] These artificially short life spans drive additional, unnecessary production and waste generation, magnifying the environmental impacts associated with the manufacture of ICTs.[7]

Given that energy and material intensity of computer use is concentrated in the production phase, and that resource depletion costs of recycling ICTs are large, any activity that extends their life, such as reuse, makes clear environmental sense, as it reduces demand for the production of new equipment in the first place.

In this case, the waste hierarchy certainly applies to ICT. Thus, there is a policy imperative to ensure that there are legislative and infrastructure mechanisms in place to improve global volumes of reuse in the e-waste management chain. The EU has recognised the benefits of reuse in law, and has made tentative steps in its promotion, however more needs to be done to incentivise reuse in the EU and beyond.

Recommendations

To realise the many benefits of reuse, various stakeholders involved in the management of end-of-life ICTs (and other e-wastes) need to ensure the following:

- ***Producers*** need to reduce waste and environmental pollution by designing reuse into their products. Resulting products would have clear upgrade paths and could be easily taken apart for repair and recycling. Too many products have obsolescence designed in. Product instructions should promote reuse over recycling.
- ***Consumers*** need to maximise product life by postponing replacement until equipment has reached the genuine end of its productive life. Consumers can prioritise reuse over recycling by donating working equipment for reuse and only recycling equipment when it has genuinely reached the end of its productive life.
- ***Governments*** need to introduce targets and standards for reuse and monitor their attainment. Public education about the waste hierarchy and the environmental importance of prioritising reuse over recycling would be a valuable contribution as would mandating the segregation of reusable equipment at waste collection sites.

Notes and references

(1) Euractiv 2010. MEPs want curbs on illegal e-waste shipments. [html] Available at www.euractive.com (Accessed 24 June 2010).

(2) UNIDO 2009. Reuse and Recycle: growing green businesses. [pdf] Available at http://bit.ly/aTuf4p (Accessed 6 July 2010).

(3) EEA 2010. About waste and material resources. [html] Available at http://bit.ly/dxe8E9 (Accessed 31 July 2010).

(4) Williams, E. et al. 2002. The 1.7 kg microchip: Energy and chemical use in the production of semiconductors. Enviro Sci Tech 36(24): 5504-10.

(5) Reuters 2008. Gartner says more than 1 billion PCs in use worldwide and headed to 2 billion units by 2014. [html] Available at http://bit.ly/bmZPr8 (Accessed 8 July 2010).

(6) Schulep M. et al. 2009. Recycling: from E-waste to Resources. StEP Initiative, UN University-UN Environmental Programme.

(7) Williams E. 2003. Environmental impacts in the production of personal computers. In Williams, E. et al. (Eds) Computers and the Environment: Understanding and Managing their Impacts. Dordrecht: Kluwer Academic Publishers, pp. 41-72.

(8) See, e.g: Tong S. et al. 2000. Environmental lead exposure: a public health problem of global dimensions. Bull WHO 78(9): 1068-77; and, Zhang J.Q. et al. 2010. Elevated body burdens of PBDEs, dioxins and PCBs on thyroid hormone homeostasis at an electronic waste recycling site in China. Enviro Sci Tech 44(10):3956–3962.

(9) European Commission 2010. Critical raw materials for the EU. [html] Available at http://bit.ly/aXAc91 (Accessed 6 July 2010).

(10) Raise Hope for Congo 2010. Conflict Minerals. An Enough Project. [html] Available at http://www.raisehopeforcongo.org (Accessed 6 July 2010).

(11) Quariguasi Frota Neto, J. and Bloemhof-Ruwaard, J.M. 2009. Is remanufacturing effective and eco-effcient? An analysis of the eco-effciency of personal computers and mobile phones. [pdf] Available at http://ssrn.com/abstract=1367023 (Accessed 10 July 2010). Here, 'eco-efficiency' as the ratio of welfare to environmental impact generated in the production process.

(12) EEA 2010. Waste and material resources – policy context. [html] Available at http://bit.ly/9iOFuv (Accessed 31 July 2010).

(13) Williams E. and Sasaki T. 2003. Strategizing the End-of-Life Handling of PCs. In Williams, E. et al. (Eds) Computers and the Environment: Understanding and Managing their Impacts. Dordrecht: Kluwer Academic Publishers, pp. 183-196.

(14) EPA 2009. Reduce and reuse. [html] Available at http://bit.ly/dcjTEc (Accessed 30 July 2010).

(15) Leonard A. 2007. The story of stuff. Referenced and footnoted script [pdf]. Available at http://bit.ly/9renCt (Accessed 30 July 2010)

(16) A more recent review on the topic showed no significant change in this assessment. See Williams, E. et al. (2008) Environmental, social and economic implications of global reuse and recycling of personal computers. Enviro Sci Tech 42: 6446-54.

(17) Soneji, H 2009. Connected consequences: resource depletion and North-South inequities of the global material intensity of the internet and mobile Telephony. Lund University Lumes Masters Thesis. [pdf] Available at http://bit.ly/9YduzR (Accessed August 2010)

(18) Williams, E. et al. (2008) Environmental, social and economic implications of global reuse and recycling of personal computers. Enviro Sci Tech 42: 6446-54.

(19) Directive 2002/96/EC on waste electrical and electronic equipment.

(20) See EC Eurostat 2009: http://bit.ly/9v3cvI (Accessed 30 July 2010). As at June 2010, the EU Environment Committee had approved a report that recommends a discrete five percent target for reuse. This has yet to be approved in European Parliament plenary on the issue, planned for late 2010.

(21) Kuehr, R. et al. 2003. Computers and the environment–an introduction to understanding and managing their impacts. In Kuehr R. and E. Williams (Eds.) Computers and the Environment: Understanding and measuring their impacts. Dordrecht: Kluwer Academic Publishers, p. 1-16.

Contact

Computer Aid International
10 Brunswick Industrial Park
Brunswick Way
London, N11 1JL
Web: www.computeraid.org
Phone: 020 8361 5540
Email: enquiries@computeraid.org
Registered charity no. 1069256
Registered company no. 3442679

Computer Aid International