Toxic Tech:
Not in our Backyard

Uncovering the hidden flows of e-waste

SUMMARY

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Creating a Toxic-Free Future

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Executive Summary

A dangerous new waste stream is rapidly emerging

Greenpeace has commissioned the report, *Toxic Tech: Not in Our Backyard*, to investigate the global sales of electrical and electronic products and assess the amount of waste arising from this. The findings of this report are presented here in summary version.

The UN estimates that some 20 to 50m tonnes of e-waste are generated worldwide each year, comprising more than 5% of all municipal solid waste. The fate of large quantities of this so-called e-waste is unknown. This "hidden flow" is the e-waste that escapes responsible collection, reuse and recycling systems and as such is unaccounted for.

While some might be found stored in attics or garages or disposed of with mixed waste in landfills and incinerators, thousands more electrical and electronic products that have reached the end of their lives are exported, often illegally, for dumping in Africa or for rudimentary recovery by Asian informal recyclers. There, workers at scrap yards - some of whom are children – are exposed to a cocktail of toxic chemicals when the products are broken apart, and as water, air and soil are polluted.

The quantities of e-waste generated are predicted to grow substantially in the future, both in industrialised countries and in developing countries, which are expected to triple their e-waste by 2010. The rich countries often legally or illegally divert this problem from their own backyards. The hidden flow of e-waste that results causes environmental damage in the backyards and scrapyards of poorer countries.

Ultimately, the principle of producer responsibility, which requires producers to take financial and/or management responsibility for their products when they reach the end-of-life phase, needs to be at the core of any measures to address the e-waste problem. The escalating e-waste problem makes it imperative to also address the source, the design of electrical and electronic products.

Greenpeace continues to push the major electronics makers to:

- Embrace the principle of 'Individual Producer Responsibility'; where companies take financial responsibility for their products once discarded by customers. Individual producer responsibility calls for the cost of waste management to be incorporated into the product price, enacting the "polluter pays" principle and by differentiating between companies it motivates them to improve the environmental design of the products.
- Design out toxics; clean up their products by eliminating hazardous substances, replacing harmful ingredients through use of safer alternatives or design changes. Greenpeace believes that the e-waste crisis should not be regarded only as a waste management issue but that the solution also lies in product design.

Greenpeace is challenging manufacturers of electronic goods to take responsibility for the entire lifecycle of their products, from production, through manufacture and to the very end of their products' lives. Only in this way can we ensure that the dangerous tide of toxic e-waste can be stemmed, and that the hidden flow of e-waste does not become a problem in *anybody's* backyard.

1. Introduction

Waste from electrical and electronic equipment (WEEE) – also known as e-waste - is one of the fastest growing types of hazardous waste globally. WEEE is classified as hazardous waste because it contains many toxic ingredients, including heavy metals and harmful, persistent chemicals, with the potential to pollute the environment and damage human health when it is processed, recycled or disposed of. At the same time the development and introduction of appropriate reuse, recycling and recovery technologies is not keeping pace with this growth. This will have a big impact on how the hazards inherent in e-waste are dealt with, as far as the effects on human health and the environment that will result from reuse, recycling and disposal are concerned. Nevertheless, the growing quantities of e-waste also represent a huge resource potential.

The objective of this study is to provide a picture of the amount of waste electrical and electronic equipment arising in selected countries and where it ends up, with a focus on the 'hidden flows' of e-waste that are escaping any form of treatment/management. The study considered both industrialised countries, such as the US and the EU and the newly industrialised countries China, India, Thailand and Argentina.

Specific focus was given to TVs, PCs, and mobile phones (and in some cases also large household appliances); remaining categories of e-waste are grouped together in the category "other" where appropriate.

What's in electronic devices?

Electronic devices are a complex mixture of several hundred materials. A mobile phone, for example, contains 500 to 1000 components. Many of these contain toxic heavy metals such as lead, mercury, cadmium and beryllium and hazardous chemicals, such as brominated flame retardants. Polluting polyvinyl chloride (PVC) plastic is also frequently used.

These dangerous substances cause serious pollution and put workers at risk of exposure when the products are produced or disposed of. Of particular concern is the exposure of children and pregnant women to lead and mercury. These metals are highly toxic and can harm children and developing foetuses even at low levels of exposure.

More on the health hazards of chemicals in electronics

- Some brominated flame retardants, used in circuit boards and plastic casings, do not break down easily and build up in the environment. Long-term exposure can lead to impaired learning and memory functions. They can also interfere with thyroid and oestrogen hormone systems and exposure in the womb has been linked to behavioural problems.
- As much as 1450 tonnes of a brominated flame retardant called TBBPA was used to manufacture 991 million mobile phones sold in 2006. This chemical has been linked to neurotoxicity.
- The cathode ray tubes (CRT) in monitors contain lead. Exposure to lead can cause intellectual impairment in children and can damage the nervous, blood and reproductive systems in adults.
- Cadmium, used in rechargeable computer batteries, contacts and switches and in older CRTs, can bioaccumulate in the environment and is highly toxic, primarily affecting the kidneys and bones.
- Mercury, used in lighting devices for flat screen displays, can damage the brain and central nervous system, particularly during early development.
- Compounds of hexavalent chromium, used in the production of metal housings, are highly toxic and are human carcinogens.
- PVC is a chlorinated plastic used in some electronics products and for insulation on wires and cables. Chlorinated dioxins and furans are released when PVC is produced or disposed of by incineration (or simply burning). These chemicals are highly persistent in the environment and many are toxic even in very low concentrations.

For more information and animations of what's in a computer and a mobile phone, see:
http://www.greenpeace.org/international/campaigns/toxics/electronics/what-s-in-electronic-devices

2. Summary of findings

The hidden flows of e-waste

The fate of large quantities of e-waste that arise every year is unknown, even in regions such as the EU that are beginning to be more tightly regulated.

While the current WEEE arising across the EU27 is estimated at 8.7 million tonnes a year the amount collected and treated is estimated at only 2.1 million tonnes or 25%[1]; this estimate includes all categories of e-waste defined by the legislation.

- *The remaining **6.6 million tonnes, or 75%, is the EU's general 'hidden flow';** no precise data is available on what happens to this waste, whether it is stored, disposed of otherwise within the EU, or exported, to be either reused, recycled or disposed of in Asian countries such as India and China as well as Africa.*

Furthermore, it is probable that part of the 25% collected is also exported, although it is impossible to quantify how much. It is also important to note that exports are taking place despite EU legislation that bans exports of hazardous waste to non-OECD (Organisation for Economic Co-operation and Development) countries and ratification of the Basel Ban by EU member states.

What's the Hidden Flow?

The Hidden Flow is the amount of WEEE arising based on past product sales that escapes responsible collection, reuse and recycling systems and as such is unaccounted for, but which can end up causing environmental damage, often in poorer parts of the world. Greenpeace distinguishes between the General Hidden Flow (all the e-waste that fails to be captured by recycling programmes) and the more specific Producer's Hidden Flow. The latter is the amount of ***own-branded*** WEEE arising (based on past sales) that escapes the control of a given producer (brand owner) and as such the rewards of better eco-designed products cannot be reaped by that producer.

In the USA the 'hidden flows' of e-waste are even larger. Overall, less than 20% of the e-waste categories televisions, PCs including peripherals and mobile phones were separated from other waste streams for "further processing and recovery" – and this figure includes part of the export of e-waste to countries such as India and China[2].

- *The remaining general **hidden flow of 80%** is incinerated, sent to landfill, put into 'storage or reuse', or exported.*

Figures for the recycling of PCs and TVs show that only 10% and 14% of the quantities sold in the past, respectively, were recycled in 2005[3]; the amounts of PCs recycled are also declining as a percentage of sales, which continue to increase.

- *This leaves a general **hidden flow of 90% and 86%** for these two product categories, not considering the fact that some of the remaining 10-15% of e-waste that has been separated for processing and recovery is also likely to have been exported.*

For newly industrialised countries like China and India with large informal recycling sectors, it is just not possible even to estimate the percentage of the "hidden flow" of e-waste. In these countries collection rates are determined by the informal recycling sector, where the focus is on the recovery (albeit inefficient reclamation) of valuable raw materials and not on the health and environmental hazards inherent in e-waste, resulting in environmental pollution and exposure of workers to hazardous substances from the recycling of e-waste. These primitive treatment methods result in lower end-of-life costs than in OECD countries. This 'cheap' form of recycling drives the import of e-waste from developed countries such as the US and the EU, which add to the growing e-waste problem in non-OECD countries such as India, China and West African countries. As domestic sales of electrical and electronic appliances are set to escalate in non-OECD countries, the quantities of e-waste will be much higher in the future. If electronic products continue to contain hazardous ingredients and the current methods of recovering raw materials carry on this will lead to further environmental and health problems from the recycling of e-waste.

- *When looking at the authorised treatment facilities in India the general **hidden flows** can be considered **to be over 99%**, representing 143,000 tonnes[4].*

Producer responsibility

Ultimately, the principle of producer responsibility, which requires producers to take financial and/or management responsibility for their products when they reach the end-of-life phase, needs to be at the core of any measures to address the e-waste problem. The EU's WEEE Directive (Art. 8.2) makes each producer responsible for **its own-branded discarded products brought on the market since August 2005** (Individual Producer Responsibility). The aim is to provide producers with an incentive for product eco-design and prevention of the problem of e-waste at source. Products designed after August 2005 are increasingly expected to take recycling problems into account. The key question in this context is: *what portion of the amount of own-branded end-of-life products is actually already controlled globally by the producers either financially and/or physically?* The principle of producer responsibility is based on the assumption that the bigger this portion is, the greater the incentive to improve the design of products and product systems, e.g. by designing out toxic ingredients to reduce end-of-life costs by offsetting the costs of collection and reprocessing with the revenues from reclaiming valuable materials like precious metals. Brand owners that are seriously improving product design by using higher value, recyclable and less toxic materials will not want to see their branded e-waste escape their stewardship; for example Apple's new Macbook Air uses a highly recyclable aluminum enclosure, rather than flame retarded plastics[5].

In several cases and in a number of non-EU countries, manufacturers do (or try to) also take responsibility voluntarily for the end-of-life phase of their products. However, this sometimes takes the form of temporary or isolated actions (e.g. in the USA); this means that the consumer does not have a constant and reliable way to deliver end-of-life appliances to recovery facilities. The consumer is often required to temporarily store the waste appliances until he is able to deliver it for recovery. A systematic and comprehensive approach of producers taking responsibility for their end-of-life products has been found predominantly in those countries where it is required by legal frameworks (such as the EU) or where public awareness is high.

In the EU, the WEEE Directive is underpinned by (individual) producer responsibility, although poor transposition means that so far implementation varies across the various Member States. Given some more time and sufficient support from the EU executive and proactive initiatives on the part of some producers there is no reason not to believe that the implementation will improve. Despite some hiccups in its implementation the WEEE Directive is providing an important model for addressing the e-waste problem globally, with WEEE type legislation now being adopted in various forms in other countries.

Hidden flows of own-branded e-waste

The figures provided by four PC producers suggest that global responsibility is currently taken for between 8.8% to 12.4% of own-branded end-of-life products that are available for collection and recovery; these producers have also developed take back and recycling activities within certain quality standards. Recycling rates for own-branded mobiles are much lower, at about 2-3%[6].

- *This information means that for those few brands that are reporting on the collection and recycling of their own brand PCs and mobile phones as a percentage of past sales, the* ***'hidden flow' of e-waste branded products currently amounts to an average of 91% of past sales.***

The exception is Sony, where a recycling rate of 53% has been achieved in Japan, where WEEE legislation is in force, leaving a hidden flow of 47%. This shows that higher take-back and recycling targets can be achieved with a combination of government legislation and company practice.

The fate of these 'hidden flows' of e-waste

There are only few cases in the countries that were analysed where the relatively systematic take back of e-waste has been achieved, as is beginning to happen in European Union, where the field of e-waste is regulated in detail by European and national law[7].

- *Even in countries with regulations there is a surprisingly large amount of waste that is not captured by the producer responsibility programmes; the key question is: what happens to this large 'hidden flow' of e-waste?*

image Caption text here

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The newly industrialised countries

China, India and Thailand have several things in common; all these countries have a typically informal recycling sector, which focuses primarily on the recovery of the valuable raw materials present in e-waste and the reuse of components for second-hand equipment. This means that there is a relatively high collection rate, as end-users often sell their old appliances for reuse or recovery. The quantities that are reused and recycled are not well documented since figures are not easily available, because this informal recycling is undertaken by very lucrative downstream businesses that are illegal and hidden.

As well as environmental and human health consequences from these recycling methods, the lower end-of-life costs in the informal sector mean that formal recyclers find it hard to compete; as a result there is a virtual lack of a formal recycling infrastructure (less than 1% of the total capacity in India in 2007[8]). Moreover, the informal sector is also 'fed' by illegal and legal imports of e-waste from industrialised countries. The legal imports are for so-called 'reuse' but very soon most of it ends up in the informal sector; the reality in India is that 99% of all WEEE, including imports, ultimately ends up in the informal sector.

Newly industrialised countries are also experiencing a rapid increase in domestic consumption of consumer electronics. However, the quantities involved in India are not yet as high as in China. For example, sales of PCs in India are estimated at about 5 million in 2006/7[9] compared to 20 million in 2007 in China[10]. Likewise, the quantities of mobile phones sold are much less – 15 million in 2004/5[11] compared to 80 million in China in the same period[12]. It is remarkable that the expected annual growth in EEE consumption in India up to 2015 is around 30%[13]. China has already experienced immense growth in EEE consumption since the mid 1990s and this is set to continue through to 2020. The newly industrialised countries are catching up fast.

- *This rapid increase in consumption means that in the future the quantities of e-waste in newly industrialised countries are projected to grow substantially. This raises serious concerns about the impacts on health and the environment from recycling and disposal of e-waste, even without taking imports of e-waste into account.*

The industrialised countries

The picture in industrialised countries is slightly different. In general, markets for electrical and electronic appliances are more saturated and where they are increasing this is much more slowly than in countries like India and China; for some products there is barely any increase, whereas others, such as PCs, continue to grow. Even so, the quantities of e-waste generated are expected to grow over the next few years; overall, sales of EEE in the EU are expected to increase by 28% by 2020[14].

The situation in the US is quite different to the EU. The US represents a large consumer market with high sales of electrical and electronic appliances, but with a relatively unsophisticated infrastructure for the collection and recycling of e-waste. This situation is now beginning to change, however, as certain US States implement their own WEEE initiatives and some of the major companies begin to take producer responsibility by setting up take-back and recycling schemes. The low levels of collection at the moment, however, mean that such schemes have a long way to go before they begin to make an impact.

Like the US, the EU also has high levels of consumption of electrical and electronic appliances and in general is a relatively saturated market, with a few exceptions in some countries where markets are still relatively undeveloped. In contrast to the US, the implementation of the WEEE Directive in the 27 EU Member States means that a relatively sophisticated system for collecting and recycling e-waste is now being set up, with the involvement of governments, producers and sometimes retailers. The evolution of these collection and recycling systems will need to keep pace with the growing quantities of e-waste that are projected to arise in the future. The continuing evolution of new technologies will ensure that sales – and e-waste - will continue to grow, for example, the move to digital TV in North America and the EU and the development of flat screen TVs is already driving sales of new TVs.

- *The major issue for both the US and the EU to address is that e-waste is currently exported to less industrialised countries such as China and India, where recycling and recovery takes place with little regard for the human health or environmental consequences. The key difference between these two regions is that in the US, the export of e-waste to developing countries is legal, whereas in the EU export of e-waste to non-OECD countries is banned by the Waste Shipment Regulation, based on the Basel Convention and more precisely the Basel Ban Amendment, that completely bans the export of hazardous waste from OECD to non-OECD countries even for recycling. (The US has not yet ratified the Basel Convention).*
- *In the EU the revision of the WEEE Directive[15] is an opportunity to strengthen collection and recycling targets and reinforce Individual Producer Responsibility. The revision of the RoHS Directive[16] also opens the prospect for bans and restrictions on additional hazardous substances (e.g. antimony, beryllium, arsenic) and for lifting exemptions on certain uses of the substances, like mercury that are already restricted by RoHS.*

Implementing Producer Responsibility

This snowballing e-waste problem makes it imperative to address the source, the design of electrical and electronic products. Many environmental considerations can be factored into a product at its design stage, but the most crucial issues raised by the e-waste problem are the use of hazardous substances, the durability of products and their recyclability at the end of their lives. The presence of hazardous substances such as brominated flame retardants, PVC plastic and many of the heavy metals lead to environmental and human health problems when e-waste is recycled and disposed of; as well as releasing hazardous by-products when recycled, PVC plastic hampers the recyclability of discarded products. Fortunately, some manufacturers are proving that it is possible to avoid the use of these substances altogether through product redesign[17]. As the designer of these products, the producer is the prime stakeholder responsible for the solution.

However, designing out toxics must be taken up by the majority of manufacturers in order to effect a major change to the make-up of e-waste that will arise in the future. In the meantime, the historical e-waste and products that are becoming obsolescent now contain a cocktail of hazardous substances which need to be addressed with the least possible damage to human health and the environment. However, even though the growing mountains of e-waste represent a potentially huge source of toxic pollution in the future; they also contain valuable and increasingly scarce raw materials.

Moreover, with the fast rising prices of commodities such as ferrous, non-ferrous and precious metals, e-waste recycling is becoming more and more profitable as the costs of collection and recycling are offset by the prices received for the recovered materials. However, this not always the case; when dealing with phased out technologies such as cathode ray tube TVs, hazardous materials – in this particular case leaded glass – add extra costs to recycling because the costs have been internalised. Regardless of the economics to the companies concerned, collection and recycling of e-waste has to occur to prevent these 'costs' being externalised as environmental pollution.

In countries like China and India the activities of the informal sector present a particular challenge to companies aiming to implement the producer responsibility principle. Specifically, producers will find it hard to compete economically with the performance and efficiency of the informal sector in collecting end-of-life products, which saves massively on their costs by paying little regard to human health and environmental issues at the point where e-waste is recycled or recovered.

However, the primitive recycling typical in many developing countries also squanders material resources. A recent study[18] estimates the overall efficiency of a wet chemical process to recover gold from printed wiring boards in India at a maximum of 20%. This compares to 95% in a state-of-the-art facility in the EU that can recover not only gold but also 16 other precious metals with lower total emissions.

- *The growing quantities of e-waste also represent a huge resource potential.*
- *It is essential that producers apply their resources, both technical and economic, to ensure that the treatment of collected waste in newly industrialised countries is improved. This will not only bring immediate benefits from the reduced pollution, but will reduce demand for raw materials and the environmental and human health effects that are associated with mining.*
- *In all countries, it is essential to increase the collection of e-waste and channel it towards formal recyclers; mandatory collection targets are needed based on past sales which need to increase over time.*
- *Ultimately, manufacturers should aim to 'close the loop' as far as their own brand products are concerned by designing out hazardous materials in electronic products to facilitate full 100% high quality recycling (and not down-cycling) which is safer for both production and recycling workers.*

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Greenpeace is an independent global campaigning organisation that acts to change attitudes and behaviour, to protect and conserve the environment and to promote peace.

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