Recycle, incinerate or landfill? What are the best options for electronic goods?

Atif Syed	*Josh Ferguson*

INTRODUCTION

Electronics has played a major role in people's lives. It was like a revolution when it first started. Everything from computers to washing machine to children's toys, everywhere electrical and electronic items are found. It is all good when the electronic items are used for some purpose, but what happens when they are no longer needed? Some re-use it but many just dump it. This is where the problem arises. The dumping of electronic items is alright if it's discarded in the right way. Electronics waste is commonly known as e-waste. The National Safety Council in the United States said in 2005 that more than 63 million personal computers are projected to be considered as e-waste (Northeast Recycling Council, 2001). Another big problem with this sudden increase of e-waste is the much ignored life span of electronic items. About two decades ago, electronic items had a lifespan of about 10-15 years but this has reduced drastically in recent years to around 3-4 years. One obvious reason to it is the rapid growth of electronic industry which led to advancements in this field at a lightening speed which outdate the old models. Mobile phones currently have a life span of two years (Boghe, 2001)This report will focus on the merits and limits of recycling, incineration or landfilling electronic goods and which method is more overall preferred.

WHAT IS E-WASTE?

Around 1.9 million tons of e-waste enters the incinerators in a year. Ever wondered what lies behind the everyday used electronics items and what are they made of? All e-waste consists of leachable toxic metals. Most this waste currently ends up in landfills or incinerators (UNEP, 2004). Since electronic items have hazardous and toxic materials it can be very dangerous for the environment. The usually contain Brominated flame Retardant which are extensively used in the electronics industry to reduce the flammability of the product. Lead, Cadmium, Mercury are also widely found in electronic items (Richter H., Lorenz W., Bahadir M., 1997). Europe itself has e-waste which sums up to around 4% of the entire municipal waste (Boghe, 2001) where in UK 1 million of e-waste is collected (Feszty K., Murchison C., Baird J., Jamnejad G., 2003)

With all the harmful substances found in the e-waste can still be tackled if the root of the problem is eradicated. It won't happen overnight but the ways to tackle this problem can be figured out. For example, A Printed Circuit Board has 40% Metals, 30% plastics, 30% ceramics (Cui J., Frossberg E., 2003) and also some precious metals like Gold and Silver. Table 1 shows some major electronic and electrical components and what they consist of.

Materials and Components	**Description**
Solder	Lead/Tin
PCB	Cadmium with some other hazardous materials
LCD	Mercury
Cathode ray Tube	Lead, Cadmium, Zinc, Fluorescent coating
Batteries	Lead, Mercury and Cadmium
Electrical Switches	Mercury

Table SEQ Table * ARABIC 1: Harmful substances found in electrical and electronic equipments. Source: (Cui J., Frossberg E., 2003)

LANDFILLS AND INCINERATORS

The EPA claims that only 15-20% of the e-waste is recycled and the rest end up in landfills and incinerators (Statistics on the Management of Used and End-of-Life Electronics, 2007). Landfills in general are a way of waste disposal and treatment. Many government officials and environmentalists are against landfills. Landfills are constructed by four main elements namely: bottom liner, leachate collection system, cover, hydro geological setting. A leachate is a mixture of water with some heavy metals and chemicals like methane, carbon dioxide, hydrogen sulphide and vinyl chloride. One interesting thing to note is that one of the biggest factors behind global warming is the bio-degradable waste because of the presence of methane in it (Alison S., Keith B., Steve O., Kathryn R., Judith B., 2001). The liner can either be plastic or clay, both of which stop the leakage of toxins and harmful substances (leachate) from the waste in to the ground. The leachate system collects leachate at the bottom of the landfill through a collection of pipes; this prevents water build up at the bottom of the landfill and therefore reduces the water pressure (Maria B. Pellerano, 1995). The landfill site also has a cover built over it; this is to stop the water getting in and building up at the bottom of the landfill. If water was to get through this could cause serious issues and further build-up of contaminated water. The final part of a landfill site is the natural hydro geologic setting. A desirable setting for a landfill would be above rocks that are very tight, but also have a good idea of the geology so it is possible to predict where the leaked waste will go and solutions can be put in place to capture this leaked waste (Maria B. Pellerano, 1995). The designing and

creating of a landfill site is a one-time investment, this makes it cost effective and cheap in comparison to some recycling schemes. A Landfill site can also be renewable energy source. Decomposition occurs in landfill sites; through this a hydrocarbon called methane is released, along with other gases as well. This methane can be collected and combusted to create heat energy. Unfortunately not everything works perfect; the aspects described that make a landfill site could have major problems. Most of all the liner and the leachate collection system have serious downfalls; the liner is usually made from plastic or clay, sometimes a mixture of both. Some chemicals can actually decompose clay and it is easily fractured and cracked over time. The best quality plastic that is used as a liner is a high density polyethylene (HDPE), however some household substances such as vinegar, bleach and margarine can degrade HDPE, soften it and can make it brittle and crack. The leachate system involves a collection of pipes at the bottom of the landfill. The pipes can become blocked by either silt or mud or growth of microorganisms in the pipes. The pipes can also become weak by chemical erosion (Maria B. Pellerano, 1995). If the pipes are blocked, they will not be filtering the leachate out and there will be an increased build up. If there are major cracks and weaknesses in the liner then increased amounts of this leachate will absorb into the ground and possibly through into ground water. So if e-waste was in landfill, there many potentially harmful substances could leach through into the ground or evaporate into the atmosphere. The heavy metals such as lead and mercury possess a big threat to the environment and the public's health. Lead can damage the nervous system and affect the cardiovascular system and kidneys, electrical products account for 40% of lead found in landfill. Mercury can cause brain damage; at least a quarter of the world's mercury is used in electrical products (Envocare, 2001).

The government and others across the world are setting up legislation and schemes to prevent these hazardous toxins with huge potential threat reaching landfill but also reduce the amount of hazardous products being manufactured in the products. However, products manufactured before this legislation will still have dangerous toxins within them, these shouldn't be going into landfill.

Figure SEQ Figure * ARABIC 1: Basic Parts of landfills with labeling (Cohen, 2006)

The incinerators on the other hand was developed by a company called Basic International Inc in the United States. Scientists believe that once BFRs are released into the environment through landfill leachate and incineration they are concentrated in the food chain, accumulating in fatty tissues in a similar fashion to the bioaccumulation of methylmercury described above (Janssen, 2005). A incinirator is similar to a furnance because it burns the waste at a controlled temperature, which in turn destroys the harmful chemicals (EPA, 2002). The process of incineration follows four main steps. The first step is called the feeder step. The right combustion temperature is needed for waste with higher organic content which in turn requires more energy. So as to increase the combustability, pre-sorting and mixing is usually done (Elena Ares, Paul Bolton, 2002). The second part of the process involves the furnance where the major part of the process lies. The waste is fed into a series of furnances at around 850 degree C- 1200 degree C and usually the temperature is preferred to be at around 1200 C. The waste is then allowed to burn for 40-70 minutes. The bottom layer ash is then removed and collected for disposal or, in some cases, reused (Elena Ares, Paul Bolton, 2002).

Figure SEQ Figure * ARABIC 2: Schematic working of incinerators (Kikai, 2002)

Even though a lot of people are against incineration and landfills, some refute this by claiming incinerators help in reducing the amount of e-waste or any trash as compared to that in landfills. Landfills require more land space which is not the case in incinerators (Evans, 2010). So the question now is, are incinerators better than landfills? The answer is yes. But one cannot ignore the pollution incinerators produce especially when harmful materials like Lead and Mercury are burnt which is the case in e-wastes. Most of the chemicals are toxic and harmful in nature and also contain heavy metals. Incinerators are more harmful than the exhaust coming from cars because the low concentration of metals emitted by incinerators is very toxic for metals such as Cadmium and smaller the size of particles the more harmful it is to human health (Howard, 2008). Another very interesting point to note here is that many electronic goods contain plastic as its major element. Plastic in incinerators doesn't really go well as far as the health and cost is concerened. Plastics are organochlorines which form harmful and toxic products like dioxins when they are burnt (Howard, 2008). Burning plastics on the other hand means wasting an important resource because around 3-4% of mineral oil is used to produce plastics which can be easily reused or recylced (Howard, 2008). Recent reports have also shown an increase of crime rates due to the presence of lead in the air (Howard, 2008), which is also found in most of the e-waste. As far as cost is concerned, incinerators are the most expensive waste disposal method costing an estimate of £12 million per year to the UK government and city councils (Howard, 2008) and taxpayers unkowingly pay this and doesn't realize the adverse effects incinerators are bringing to their lives. With this said, incinerators and landfills are not really the best options for disposing e-waste

If incinerators and landfills are not the best option, what really is the best option? The answer lies in the method which is approved and supported by many, recycling/reuse method.

RECYLING E-WASTE

Recycling is the most eco-friendly and cost effective method for e-waste and for any other waste. The electronics today contain around 60 different elements out of which some are useful and some are harmful (Marthias, 2009). There are various methods involved in recycling e-waste which are deemed safer than other methods. The first step is dismantling the equipments where the useful products are separated from the harmful products such as CRT (Cathode Ray Tubes) from TV, Lithium and Mercury from batteries etc (Allosop M., Satillo D., Johnston P., 2006). The second step involves smelting the items dismantled. Smelting is often discouraged due to the fact that it produces hazardous waste and brominated dioxins are produced (Allosop M., Satillo D., Johnston P., 2006). An alternate method to smelting is Mechanical Separation (Cui J., Frossberg E., 2003). In this method, some metals are separated by magnets and by electric conductivity-based separation technique such as eddy current separation (Cui J., Frossberg E., 2003). Some companies like Umicore accept mobile phones with the casing intact. They claim that the plastic casing acts like a "fuel" and plastic is a substitute for coke which is normally used as a reducing agent in the smelting process (Allosop M., Satillo D., Johnston P., 2006). One of the most important element which can be reused from recylcing are metals. With the growth of MP3 players, digital cameras, mobile phones etc a variety of these useful metals can be obtained like for example, electronic product make up 80% of the world's idium demand, 80% for ruthenium(obtained from hard disks). Metals like Selemium, Tellurium and Indium are also used to generate renewable energy. All of this will save us around $45.5 billion each year in producing these metals from scratch where the potential resources which can be extracted by the method of recyling e-waste is approximately 40 million tons per year (Marthias, 2009). Another merit of reusing/recycling method is that consumers can reuse their electronic items by giving it to others or selling it. If this is not of any interest, then donate it. There are many people in the world still without a computer or any electronic equipments which we take it for granted. With this said, it is very clear that the method of recycling is by far the best method for e-waste management until a new and better method of e-waste disposal is found.

REFERENCES

Alison S., Keith B., Steve O., Kathryn R., Judith B. (2001). *Waste management options and Climate Change.* Luxembourg: European Commission.

Allosop M., Satillo D., Johnston P. (2006). *Environemental and Human Health Concerns in the Processing of Electrical and Electronic Waste.* Exeter: Greenpeace Research Laboratories.

Boghe, D. (2001). Electronic Scrap: A Growing Resource. *MBM* , 21-24.

Cohen, P. S. (2006). *Electronic Waste Recycling Promotion and Consumer Protection Act.* Columbia University.

Cui J., Frossberg E. (2003). Mechanical recycling of waste electric and electronic equipment: A review. *Journal of Hazadous Materials* , 243-263.

Elena Ares, Paul Bolton. (2002). *Waste Incineration.* House of Commons Library.

Envocare. (2001, 07 20). *Recycling & Environment, Alternative Energy, Ethical Investment, Environmental Education, Composting and more*. Retrieved 04 02, 2011, from Envocare: http://www.envocare.co.uk/

EPA. (2002). *A Citizen's Guide to Incineration.* EPA.

Evans, D. G. (2010, 04 12). *Incineration: An Alternative to Landfill*. Retrieved 04 02, 2011, from RecyclingExpert: http://www.recyclingexpert.co.uk/incineration-alternative-landfill.html

Feszty K., Murchison C., Baird J., Jamnejad G. (2003). Assessment of the quantities of waste electrical and electronic equipement(WEEE). *Waste Management Research* , 207-217.

Howard, P. C. (2008). *The Health Effects of Waste Incinerators.* Londonderry: British Society for Ecological Medicine.

Janssen, S. (2005). *Brominated Flame Retardants: Rising levels of concern.* San Francisco: University of California at San Francisco.

Kikai, L. (2002, 06). *Basic Incinerator*. Retrieved 04 02, 2011, from Japanese Advanced Environment Equipment: http://www.gec.jp/JSIM_DATA/WASTE/WASTE_3/html/Doc_450.html

Maria B. Pellerano. (1995). *The Basics of Landfills*. Retrieved 04 02, 2011, from EJNET: http://www.ejnet.org/landfills/index.html#basics

Marthias, S. (2009). *Recyling from e-waste to resources.* UNEP.

Northeast Recycling Council, I. (2001). *Electronics Reuse & Recycling Market Information Report.* New York: Empire State Development, Environmental Services Unit.

Richter H., Lorenz W., Bahadir M. (1997). Examination of organic and inorganic xenobiotics in equipped printed circuits. *Chemosphere* , 169-179.

Statistics on the Management of Used and End-of-Life Electronics. (2007). Retrieved 04 02, 2011, from EPA: http://www.epa.gov/epawaste/conserve/materials/ecycling/manage.htm

UNEP. (2004). *E-wasters in Asia and the Pacific.* Bankok.

The 16th International Conference on Auditory Display (ICAD-2010)

June 9-15, 2010, Washington, D.C, USA

IES-Environmental Engineering Assignment

May 2nd, 2011, University of York, York, UK

IES-Environmental Engineering Assignment

May 2nd, 2011, University of York, York, UK

IES-Environmental Engineering Assignment

May 2nd, 2011, University of York, York, UK