You've Got Waste: The Exponentially Escalating Problem of Hazardous e-Waste

Jennifer Kutz

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YOU'VE GOT WASTE: THE EXPONENTIALLY ESCALATING PROBLEM OF HAZARDOUS e-WASTE

I. INTRODUCTION

Technology designed to make life easier and more comfortable is rapidly making many lives more difficult and less comfortable. The fast dropping cost of technology has allowed people the luxury of buying new electronics instead of repairing or upgrading their existing item.\(^1\) Though our disposable culture might be convenient, this convenience comes at a cost: hazardous pollution in the form of electronic waste (e-waste).\(^2\)

E-waste is defined as any and all electronic appliances that are discarded because of malfunction, exhaustion or obsolescence.\(^3\) E-waste includes, in part, computers, TVs, PDAs, light bulbs, batteries, radios and cell phones.\(^4\) Though growing waste has always been a concern for a nation as industrialized as the United States, e-waste is a particular concern for two reasons: 1) the rapid growth of e-waste combined with 2) its high levels of toxicity.\(^5\) Electronics and appliances, unlike other products, have a very high rate of obsolescence, which is when products become outdated before they break.\(^6\) In 2000, the Environmental Protection Agency (EPA) estimated that the useful life of a computer was only three to five years and was rapidly shrinking.\(^7\) Although the exponential growth of e-waste caused by this short life span is a concern in itself, it is an even greater concern because e-waste can be extremely toxic.\(^8\)


\(^2\) See id. (noting increase in disposable products has exponentially increased amount of waste industrialized nations create).

\(^3\) See id. (defining electronic waste).

\(^4\) See id. (providing examples of common e-waste).

\(^5\) See id. at 2 (discussing what makes e-waste more of concern than other forms of hazardous waste).

\(^6\) See Poison PCs, supra note 1, at 2 (noting shorter life spans of electronics due to obsolescence).


\(^8\) See Poison PCs, supra note 1, at 3 (noting computers and televisions are hazardous waste that pose dangers to both environment and human health).
This Comment addresses the problems that e-waste causes to the public health and environment and discusses different ways to address those problems. Section II of this Comment will describe the hazardous materials used in electronics and the purposes they serve. Section III explores the negative environmental and public health effects of the chemicals found in e-waste. Section IV explains the alternatives to and prevention of e-waste. Additionally, Section V discusses different types of programs developed to address the problem of e-waste. Section VI describes what other countries have done to handle e-waste. Finally, Section VII outlines the requirements of effective e-waste legislation.

II. EXPLANATION OF HAZARDOUS MATERIALS IN E-WASTE

When disposed in a landfill, e-waste becomes an assortment of plastic, steel, circuit boards, glass tubes, wires, resistors and other materials. Though none of these items are fully benign, one component of e-waste, cathode ray tubes (CRTs), has emerged as the primary concern of e-waste disposal.

A. Cathode Ray Tubes (CRTs)

CRTs are the glass tubes, often referred to as picture tubes, in televisions, computers and other electronics that have image screens. The CRTs amplify and focus high-energy electron beams to create the images that appear on the screens. In order to protect consumers from the radiation that emanates from the electron beams, the glass in CRTs contains about twenty percent lead.

9. For an explanation of hazardous materials used in electronics, see infra notes 15-35 and accompanying text.
10. For a discussion of the public health concerns and negative environmental effects of e-waste chemicals, see infra notes 36-75 and accompanying text.
11. For a discussion of alternatives to and prevention of e-waste, see infra notes 76-111 and accompanying text.
12. For a discussion of different programs developed to handle e-waste, see infra notes 112-30 and accompanying text.
13. For a discussion of e-waste programs in other countries, see infra notes 131-58 and accompanying text.
14. For a discussion of effective e-waste legislation, see infra notes 159-88 and accompanying text.
15. See Poison PCs, supra note 1, at 8 (detailing items that combine to make up e-waste as whole).
16. See id. (stating CRTs are leading cause of hazardous waste crisis in e-waste).
17. See id. (explaining what CRTs are, how they work and why they are toxic).
18. See id. (noting how images are displayed on electronic screens).
19. See id. (stating twenty percent of CRT is made of lead which is about four to eight pounds of lead per unit).
The high amounts of lead in the CRTs have caused CRTs to be identified and classified as hazardous waste under both federal and state laws. When CRTs are crushed in landfills, the lead, which is an extremely toxic heavy metal, is released in the environment and contaminates surrounding land and groundwater. Research shows that between the years 1997 and 2004, 315 million computers became obsolete, and with each computer averaging between four to eight pounds of lead, the total amount of lead in outdated computers exceeded 1.2 billion pounds. Concerns about the amount of lead in CRTs and the possible contamination of water and soil have prompted Massachusetts and California to ban CRTs from landfills, and it is only a matter of time before other states follow suit.

B. Other Toxic Components of Computers and Electronics

Though CRTs are in the eye of the e-waste storm because of their high content of toxic metals, there are other components in computers that are highly toxic. Brominated flame retardants (BFRs) are used in printed circuit boards, cables and plastic castings on computers and other electronics. As the name suggests, BFRs are used to increase an item's resistance to fire; moreover, they also reduce both the chance of ignition and the rate of combustion. Studies have indicated that BFRs are endocrine dis-
ruptors that can affect the function of the thyroid hormone and are neurological and developmental reproductive toxicants.\textsuperscript{27}

Furthermore, computer circuit boards contain heavy metals such as lead and cadmium, and mercury can be found in switches and flat panel screens.\textsuperscript{28} Additionally, computer batteries contain cadmium, and copper cables and computer casings are coated with polyvinyl chloride (PVC), which releases highly toxic dioxins and furans when burned.\textsuperscript{29} Of all the heavy metals found in landfills, including cadmium and lead, about seventy percent come from discarded electronic equipment.\textsuperscript{30}

In late 2001, environmental engineers from the University of Florida conducted an EPA-funded study to determine what chemicals leached out of electronics, including computer monitors, PDAs, VCRs and cell phones.\textsuperscript{31} The engineers subjected the electronics to the standard EPA testing procedure known as the Toxicity Characteristic Leaching Procedure, which involved mixing the ground-up electronics with an acid solution to simulate conditions in a landfill.\textsuperscript{32} After rotating the mixture in a drum for eighteen hours, the leachate was tested and indicated that each different type of electronic device leached lead above hazardous waste levels.\textsuperscript{33} All solid waste landfills leak; even the best state of the art landfills do not completely prevent the leaching of chemicals and metals.\textsuperscript{34} It is necessary, therefore, to control the amount of hazardous materials that end up in landfills.\textsuperscript{35}

\textsuperscript{27} See McPherson, \textit{supra} note 25, at 18-19 (noting evidence from animal studies in Europe).

\textsuperscript{28} See Poison PCs, \textit{supra} note 1, at 10 (listing toxic components found in computers and electronics).

\textsuperscript{29} See id. (stating chemicals are released when products are burned).

\textsuperscript{30} See id. at 16 (stating what percentage of heavy metals in landfills is due to electronic waste).


\textsuperscript{32} See id. (noting test that EPA uses).

\textsuperscript{33} See id. (examining results of test and noting that when device has more steel, it leaches less lead).

\textsuperscript{34} See Poison PCs, \textit{supra} note 1, at 16 (noting that even though leaking still occurs in new, state-of-the-art landfills, situation is much worse for landfills that are less stringently maintained).

\textsuperscript{35} See id. (noting importance of monitoring waste that is dumped in landfills).
III. ENVIRONMENTAL & PUBLIC HEALTH CONCERNS FROM E-WASTE

A. Effects of Hazardous Material

Lead, mercury and other heavy metals found in electronics pose environmental and public health risks because they can contaminate groundwater when released into the environment.\(^{36}\) The effects of burning electronics, which occurs both when there are uncontrolled landfill fires and when other countries burn the waste intentionally, are also a great environmental concern.\(^{37}\) Burning PVC and BFRs emits extremely toxic dioxins and furans, while burning computer wires releases polycyclic aromatic hydrocarbons (PAH), a carcinogen.\(^{38}\)

The negative effects of lead on the human body are well documented.\(^{39}\) Studies have shown that lead can negatively affect the endocrine system, cause damage to the central and peripheral nervous systems, blood system and kidneys, and can impede children’s brain development.\(^{40}\)

Specifically, children under the age of six are the most vulnerable to problems caused by lead exposure because their nervous systems are still developing.\(^{41}\) Even small amounts of lead exposure can result in lower IQs, kidney damage, behavioral problems, learning disabilities, attention deficit disorders and impaired hearing, while high levels of lead exposure can cause severe mental retardation and even death.\(^{42}\) Lead exposure in adults can lead to increased blood pressure, fertility problems and nerve disorders; however, a significantly higher amount of lead exposure is required to create health problems in adults.\(^{43}\)

\(^{36}\) See id. (explaining mercury is released into environment when certain electronic devices are destroyed or crushed).

\(^{37}\) See id. (noting many countries frequently practice burning of wastes, including e-waste).


\(^{39}\) See Poison PCs, supra note 1, at 11 (stating lead is well-known hazard).

\(^{40}\) See id. (detailing negative effects e-waste hazardous materials have on humans).


\(^{42}\) See id. (explaining effects of lead on children). Furthermore, there is a noted correlation between lead poisoning and juvenile delinquency and criminal behavior. Id.

\(^{43}\) See id. (noting effects of lead on adults). Furthermore, lead can be spread from contaminated clothing, hair, tools or unwashed hands. Id.
Cadmium found in computer batteries, circuit boards and other electronics can be absorbed through the respiratory system or consumed with food.\textsuperscript{44} The danger arises when the cadmium accumulates in the kidneys and other organs where it can cause pulmonary edema, renal damage and kidney dysfunction.\textsuperscript{45} Inorganic mercury, found in electronics, becomes methylated or methyl mercury when introduced into water systems and settles into bottom sediments.\textsuperscript{46} As with lead, exposure to methyl mercury is far more hazardous to children than it is to adults, detrimentally affecting cognitive thinking, memory, attention, language and fine motor skills.\textsuperscript{47}

As noted earlier, the incineration of BFRs and PVC, which are found in electronics and coated on cords and cables, can generate extremely toxic polybrominated dioxins (PBDDs) and furans (PBDFs).\textsuperscript{48} EPA has confirmed that dioxin exposure can cause cancer, while the National Toxicology Program placed dioxin on its "known to be a human carcinogen" list.\textsuperscript{49} Furthermore, a section of the World Health Organization known as the International Agency for Research on Cancer (IARC) announced in 1997 that dioxin was a class-one carcinogen, meaning it has been proven to cause cancer in humans.\textsuperscript{50} A study conducted in June of 2002 showed a link between the exposure to dioxin and an increased incidence of breast cancer.\textsuperscript{51}

\textsuperscript{44} See Poison PCs, \textit{supra} note 1, at 11 (noting risks of exposure to cadmium).
\textsuperscript{46} See Poison PCs, \textit{supra} note 1, at 13 (noting this type of mercury easily accumulates in living organisms and can be consumed through fish).
\textsuperscript{48} See Poison PCs, \textit{supra} note 1, at 17 (stating hazards of burning computers and electronics with BFRs and PVC).
\textsuperscript{50} See id. (referencing IARC monographs on evaluation of carcinogens to humans). The IARC monographs can be found at http://www-cie.iarc.fr/monoeval/allmonos.html.
In addition to causing cancer, dioxins have been shown to disrupt reproduction by interfering with ovulation, suppressing ovarian function and causing a decrease in testosterone. Previous studies of dioxin exposure, such as those found in Agent Orange, indicate that exposure can cause birth defects in children and create a quadrupled risk of Sudden Infant Death Syndrome (SIDS). Dioxin has also been linked to interference with the immune system and alteration of glucose tolerance, which leads to diabetes.

The dangerous nature of dioxins and furans led the German chemical industry to stop the production of the chemicals almost twenty years ago. Sweden’s National Chemicals Inspectorate called for a ban on furans and dioxins in May of 1998 and urged the Swedish government to work for a European-wide ban on the chemicals. Additionally, the European Union (EU) recently adopted the Restriction on Hazardous Substances Directive (RoHS), which included the phase out of dioxins and furans by prohibiting the use of specific BFRs. These electronics, therefore, create serious health problems that must be addressed to protect the public welfare as well as the environment.

B. E-Waste Trade

The rising pressure about e-waste has led many companies in the United States to employ a low-cost escape valve by sending their waste abroad, primarily to Asia. Huge quantities of scrap electronics are sent from the United States to impoverished areas of the world, including China and India, where workers often breathe hazardous chemicals and little attention is paid to occupational health and safety. A survey of electronics supply companies in the United States that send waste to China found that 96% do not follow safety and environmental standards. Additionally, a survey of 39 factories in China found that 80% of workers do not receive any protective gear at all.


54. See American People’s Dioxin Report, supra note 52 (noting conclusions from recent studies on dioxin’s effect on humans).

55. See Poison PCs, supra note 1, at 18 (stating German chemical companies halted production of dioxins and furans in 1986).


57. See Poison PCs, supra note 1, at 18 (noting EU directive included PBBs and PBDEs in phase out provision).

58. See id. (stating e-waste not only endangers environment, it also endangers public health and well-being).

Asia, where workers use primitive ways to remove valued materials, which are highly dangerous to both the health of the worker and the environment.\(^{60}\) Exporting electronic scrap is profitable because, like sweatshop labor, the costs are low and regulations are lax compared to those in the United States.\(^{61}\) Managers of programs handling electronic waste estimate that shipping e-waste to China is ten times cheaper than handling the same waste in the United States.\(^{62}\)

Sadly, companies send much of this waste to Asia by way of "recyclers" in the United States, who have led consumers to believe they are being socially responsible by recycling their electronics.\(^{63}\) In reality, it is estimated that fifty to eighty percent of e-waste turned in for "recycling" in the United States is shipped to Asia.\(^{64}\) Most recyclers will remove certain parts because they are still in demand, and then send the rest to wholesale brokers who, after removing a few additional items, will ship the remains to Asian countries.\(^{65}\) Recyclers claim that eight percent of e-waste they receive is exported to Asian countries, and as recycling costs are expected to increase eighteen percent each year, one can only expect the amount of exports to increase.\(^{66}\) Since there are no restrictions in the United States on exporting e-waste and because United States recyclers cannot compete with the low prices of Asian "recycling," it is doubtful there will be sufficient incentives for compa-

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\(^{60}\) See id. (noting toxic trades have long been suspected but never before documented).

\(^{61}\) See Poison PCs, supra note 1, at 19 (stating reasoning for why exporting waste is so common among developed nations).

\(^{62}\) See id. (stating that recycling monitors in pilot program in San Jose, California would be ten times more expensive than exporting it).

E-waste exports to Asia are motivated entirely by brute global economics. Market forces, if left unregulated, dictate that toxic waste will always run 'downhill' on an economic path of least resistance. If left unchecked, the toxic effluent of the affluent will flood towards the world's poorest countries where labor is cheap, and occupational and environmental protections are inadequate. A free trade in hazardous wastes leaves the poorer peoples of the world with an untenable choice between poverty and poison - a choice that nobody should have to make. See Puckett, supra note 38, at 2.

\(^{63}\) See Norr, supra note 59 (exposing that many companies are claiming to recycle when they are shipping waste to poor Asian countries).

\(^{64}\) See Poison PCs, supra note 1, at 19 (providing statistics of how much e-waste United States ships to Asia).

\(^{65}\) See Norr, supra note 59 (explaining how many who send e-waste to Asian countries can still be deemed recyclers).

\(^{66}\) See Puckett, supra note 38, at 11-12 (indicating e-waste exporting will only get worse because of rate increases unless action is taken to prevent it).
companies to invest in American companies that would efficiently and safely recycle e-waste. 67

The international community has been aware of the problem of toxic trade for many years now, and in 1989, created an international treaty known as the Basel Convention. 68 The Basel Convention was an effort to counteract the untenable and unjust effects of free trade in toxic wastes, calling for all countries to reduce their exports of hazardous wastes and to handle their own waste problems within national borders, as much as possible. 69 In 1994, the international community increased the regulation of the Basel Convention by agreeing to adopt the Ban Amendment, which is a total ban on hazardous waste exports from rich to poor countries under any circumstances, including exporting under the guise of recycling. 70

To date, the Basel Convention and the Ban Amendment, which identify e-waste as hazardous waste, have been signed and ratified by all developed nations except the United States. 71 Not only has the United States government not ratified or complied with the Basel Convention, it has created policies that have actually encouraged the exportation of waste. 72 The United States government passed the Resource Conservation and Recovery Act, through which it has intentionally exempted e-waste from the few laws that do exist to protect poor countries from American waste. 73 The United States has also lobbied Asian governments to create bilateral trade agreements to allow the continued exportation of e-waste after the Ban Amendment went into effect. 74 Currently, there is no ban in the United States on the exportation of e-waste to foreign

67. See id. at 12 (noting that there are no incentives for companies to recycle responsibly).

68. See id. at 2 (noting steps international community has taken to prevent toxic trade).

69. See id. (stating requirements of Basel Convention of 1989).

70. See id. (noting recycling would not be excuse for shipping toxic substances from rich to poor countries).

71. See Norr, supra note 59 (stating Basel Convention and Ban Amendment clearly consider e-waste to be hazardous waste, which is prohibited from being sent from rich countries to poor countries).

72. See Puckett, supra note 38, at 2 (referring to policies within Resource Conservation and Recovery Act which do not regulate e-waste).

73. See id. (noting irony that United States was first country in world to recognize and uphold principle of environmental justice).

74. See Poison PCs, supra note 1, at 19 (noting that amount of e-waste exported will only continue to grow with increased obsolescence).
countries, so it seems inevitable that the problem will continue until the government takes remedial action.  

IV. CORRECTING THE PROBLEM

A. Dealing with Current Waste

Responsible recycling is one way of dealing with currently existing e-waste. Some American businesses are starting to recycle e-waste responsibly; an example of this is Seattle’s Total Reclaim program. The Total Reclaim program calls for the breakdown of collected computer monitors and requires the crushed leaded glass to be sent to a company called Envirocycle, which cleans and reuses the leaded glass in the manufacture of new monitors. Unfortunately, Total Reclaim is one of the only true domestic recycling programs that exists in the United States.

Companies, such as eBay and Best Buy, have also tried to address the problem by raising awareness of e-waste and increasing disposal alternatives in hopes of increasing the use of responsible recycling and refurbishing of electronics. On January 6, 2005, the online auction site, eBay, launched a computer reuse and recycling initiative called Rethink. The Rethink initiative joined leading technology companies, such as Intel, Apple and Gateway, with governmental agencies, environmental groups and millions of eBay users to confront the rapidly increasing problem of e-waste. The Rethink site allows consumers to take advantage of educational resources and disposition tools. The initiative offers assistance in the sale or donation of working computers, while providing lists of

75. See Puckett, supra note 38, at 2 (noting lack of American legislation to prevent e-waste export).
76. See id. at 10 (explaining responsible recycling).
77. See id. (stating that owner of Total Reclaim went into business as both businessman and environmentalist).
78. See id. (noting this program manages all glass domestically, not relying on foreign labor).
79. See id. (stating Total Reclaim is only domestic recycling program for CRTs in Washington state area).
81. See eBay, supra note 80 (stating initiative brings together different companies, agencies and consumers to solve e-waste problem).
82. See id. (noting other companies involved are HP, IBM and Ingram Micro).
83. See id. (stating site provides comprehensive information of options available to consumers and offers full range of responsible disposal options).
responsible recycling companies for obsolete and non-working computers.\textsuperscript{84}

Additionally, the electronics retailer, Best Buy, created a pilot program that sponsored events where, for a fee, consumers could drop off electronics for recycling.\textsuperscript{85} The events, however, are sporadic and Best Buy charges ten dollars for recycling monitors and TVs up to twenty-seven inches and twenty dollars for screens larger than twenty-seven inches, thus making the programs less consumer-friendly.\textsuperscript{86} Office Depot tried to remedy this problem by teaming up with Hewlett Packard in the fall of 2004 to offer consumers free electronic recycling.\textsuperscript{87} Though American companies are starting to take steps in the right direction by offering recycling opportunities, they need to be more widespread and consumer-friendly to significantly reduce e-waste.

B. Preventing e-Waste

Though recycling and refurbishing are ways to handle the e-waste that consumers produce, the real key to solving the e-waste crisis is to prevent the waste before it starts.\textsuperscript{88} There are three major concepts that must be employed to increase the efficacy of prevention efforts: 1) phase out the use and need for hazardous materials such as lead and mercury; 2) create machines that are more environmentally friendly and use materials that can be easily broken down; and 3) decrease the rate of obsolescence by making machines easier and cheaper to update and upgrade.\textsuperscript{89}

1. Green Design

Green design is the practice of manufacturing items with fewer hazardous chemicals and more recyclable or biodegradable prod-

\textsuperscript{84} See id. (noting that eBay has drop-off options, trade-in programs and charity donations for working computers).

\textsuperscript{85} See Best Buy, supra note 80 (noting this is first time consumer electronics retailer has committed to providing customers with national recycling programs).

\textsuperscript{86} See Suzanne Choney, Getting Rid of Tech Gear Easier This Time Around, SAN DIEGO UNION-TRIBUNE, July 26, 2004, at C-1 (noting cost that consumers are charged for recycling).

\textsuperscript{87} See Samar Farah, Environmentalists Push for a 'Greener' iPod, CHRISTIAN SCI. MONITOR, Feb. 9, 2005, at 11 (discussing contributions of electronic manufacturers and retailers).

\textsuperscript{88} See Poison PCs, supra note 1, at 25 (noting need to create products that will not create problematic e-waste).

\textsuperscript{89} See id. (noting minimums that should be instated in e-waste legislation).
Green design, therefore, is a double faceted concept that requires both the minimization of the use of toxins and the increased use of recyclable components.

i. Limited Use of Hazardous Chemicals

One component of preventing hazardous e-waste through greener design is to phase out the use of dangerous chemicals in electronics. The European Union Directives call for the phase out of six different chemicals in electronic equipment, and the Directives will ban the use of these chemicals by 2006. The six chemicals to be phased out and eventually banned include the following: lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBBs) and polybrominated diphenyl ethers (PBDEs).

Japanese electronics companies such as Sony and Panasonic have started to reduce or eliminate the use of lead in their electronics. Another company, Sylvania, recently created a flat panel lamp that was completely mercury-free. The use of fewer toxins in the production of electronics is beneficial not only for the environment when the electronics are disposed of, but also protects workers from exposure to these chemicals when the electronics are being assembled or disassembled.

ii. Use of Biodegradable/Recyclable Items

Most plastic waste is not biodegradable and will never decompose. As stated earlier, plastics in electronics create carcinogenic

91. See id. (noting requirements of green design).
92. See id. (stating green design requires use of nontoxic, biodegradable products).
fumes when they are burned or exposed to high temperatures.\textsuperscript{98} Though some plastics are recyclable, most are not recycled because it is cheaper to make new plastic than use recycled plastic, resulting in a limited market for recycled plastics.\textsuperscript{99} In response to this situation, companies are developing new plastics known as “bioplastics,” which are biodegradable, reusable and compostable.\textsuperscript{100}

Corporations are also becoming increasingly creative in their designs to make products more environmentally friendly.\textsuperscript{101} One example of this creativity is a cell phone cover being researched and developed by Motorola, which is biodegradable and decomposes into a sunflower seed.\textsuperscript{102} Additionally, Swedx, a company based in Sweden, created an eco-friendly alternative to the standard computer by making their computer screens, keyboards and mice encased in timber.\textsuperscript{103}

2. Reduced Obsolescence

High-tech entrepreneurs have created amazing wealth and growth in the United States economy; however, this growth and increased wealth comes at the expense of long lasting design.\textsuperscript{104} The short-sighted thinking and design of technology has caused a waste problem that passes the indirect costs along to the public and the environment in the form of health consequences and environmental contamination.\textsuperscript{105}

The short-sighted design of technology, which has quickly decreased the life span of most electronics, is often referred to as planned obsolescence.\textsuperscript{106} As stated above, obsolescence refers to products that are still in good working order but are outdated and therefore no longer useful.\textsuperscript{107} Planned obsolescence is a marketing

\textsuperscript{98} See \textit{Poison PCs}, supra note 1, at 16 (stating consequences of burning plastics and other materials in electronics).

\textsuperscript{99} See \textit{id.} (explaining need for new biodegradable plastic).

\textsuperscript{100} See Aftandilian, supra note 97 (noting benefits of new bioplastics).

\textsuperscript{101} See Farah, supra note 87, at 11 (stating creative companies will succeed in future).

\textsuperscript{102} See \textit{id.} (noting though design is still in research phase, its idea alone puts electronics into new perspective).


\textsuperscript{104} See \textit{Poison PCs}, supra note 1, at 8 (stating technological revolution is causing increased amount of obsolescence).

\textsuperscript{105} See \textit{id.} (stating costs of obsolescence will last for generations).


scheme that creates long-term sales volume by decreasing the useful life of technology, thus reducing the time between repeat purchases.\footnote{108}

Electronics companies can slow the rate of obsolescence by designing electronics for durability, upgradeability and disassembly, thus no longer designing disposable products.\footnote{109} Furthermore, the electronics industry should design products that are easily repairable and upgradeable to extend their usefulness.\footnote{110} Increasing the life of a product by curbing obsolescence helps the environment on two different levels: doubling the lifespan of a product cuts the need for raw materials and energy production in half, while halving the amount of waste that would end up in landfills contaminating the environment.\footnote{111}

V. INTERNATIONAL PROGRAMS

Countries such as Japan, Taiwan, Korea and Canada, as well as numerous sub-national governments, have created legislation dealing with the concerns of e-waste, yet, the EU has gone the farthest in preventing and handling e-waste.\footnote{112}

A. Europe

The EU Parliament approved two directives in 2003 dealing with the scope and urgency of the e-waste problem.\footnote{113} The two main pieces of the legislation are the Waste from Electrical and Electronic Equipment (WEEE) and Restrictions on the Use of Certain Hazardous Substances on Electrical and Electronics Equipment (RoHS), both of which deal with cleaning up legacy waste while preventing future e-waste.\footnote{114}

\begin{thebibliography}{99}
\footnotesize
\item \footnote{108}{See id. (explaining types of planned obsolescence in business).}
\item \footnote{109}{See PoisoN PCs, supra note 1, at 28 (stating ideas for designs to help environment).}
\item \footnote{110}{See id. (noting if items were easier to repair it would be cheaper to fix items than to discard them).}
\item \footnote{111}{See Beverley Thorpe & Iza Kruszewska, Strategies to Promote Clean Production: Extended Producer Responsibility, CLEAN PRODUCTION ACTION (Jan. 1999), www.svtc.org/cleancc/pubs/strat.htm (detailing benefits of increasing product life through better design).}
\item \footnote{112}{See id. (stating these countries have enacted extension of producer responsibility throughout product cycle).}
\item \footnote{113}{See id. (stating when EU parliament approved e-waste directives).}
\item \footnote{114}{See id. (noting differences between two directives and which each covers).}
\end{thebibliography}
1. **WEEE Directive**

The goals of the WEEE directive are to prevent e-waste by improving the reuse, recycling and other forms of recovery while improving the environmental performance of electronics.\(^{115}\) The WEEE directive affects all those involved in manufacturing, selling, distributing, recycling or treating electrical and electronic equipment.\(^{116}\)

The directive has two different sets of goals.\(^{117}\) The first set must be accomplished by January 1, 2006, while the other set must be met by December 31, 2006.\(^{118}\) Beginning January 1, 2006, consumers will be able to return their WEEE to collection facilities free of charge, and producers will be responsible for financing this collection, as well as the treatment, recovery and disposal of the consumer WEEE under the WEEE directive.\(^{119}\) The second set of goals requires producers to achieve a series of recycling and recovery targets by the end of 2006.\(^{120}\)

2. **RoHS Directive**

The RoHS directive goes farther in preventing e-waste by banning the use of lead, mercury, cadmium, hexavalent chromium, PBBs and PBDEs in electronics by the year 2006.\(^{121}\) The goal of the RoHS directive is to reduce harmful substances from the source, ensuring that these hazardous substances are not leached into the environment by non-recycled equipment.\(^{122}\) Although RoHS only requires companies in the EU to meet these standards, manufacturers of electronic and electrical equipment outside Europe must also abide by this legislation if the equipment they produce is to be imported into an EU member state.\(^{123}\)

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117. See id. (noting goals of directive).

118. See id. (noting two different timelines stated in WEEE).

119. See id. (defining producers as manufacturers, sellers and distributors).

120. See id. (noting different time scales applied in WEEE directive).

121. See POISON PCs, *supra* note 1, at 21 (noting by prohibiting use of these toxins, industries will be forced to find better, less toxic ways to produce products).

122. See *RoHS Simplified*, *supra* note 94 (noting motive of RoHS directive as opposed to WEEE directive).

123. See id. (noting other non EU countries must comply with these restrictions if their products are to be imported into any EU member country).
B. Other Countries

Japan is the leading country in development and manufacturing of electronic equipment, and it has taken steps since 1998 to reduce the amount of lead in manufacturing.124 The Japan Electronics and Information Technology Association (JEITA), formed on November 1, 2000, is an industry organization in Japan that involves both the electronics and information technology fields.125

Japan also adopted the Japan Green Procurement Survey Standardization Initiative (JGPSSI), which prepared guidelines for companies that implement greener design theory.126 The guidelines “apply to the green procurement survey related to chemical substances mainly contained in electric and electronic appliances and their parts and materials.”127 Additionally, in 2001, the Japanese government revised its Law for Promotion and Effective Utilization of Resources, which requires manufacturers to design products that promote the 3Rs (reduce, reuse and recycle) to include personal computers, small accessories, such as the mouse and keyboard, and copy machines.128

In addition, Canada has a not-for-profit organization, Electronics Product Stewardship Canada (EPS Canada), which is developing a national electronics end-of-life program.129 Finally, Taiwan has a take-back system for computers, among other appliances, which requires retailers to accept used electronics from consumers regardless of when they were sold.130 With other countries leading the path to an e-waste solution, the United States has the benefit of observing these programs in action to determine which would be

127. See id. at 2 (noting purpose of initiative is aimed at electronics specifically).
130. See Thorpe & Kruszewska, supra note 111, at 10 (stating other countries efforts on take back of electronic scrap).
the best program for the United States to implement to help solve the e-waste crisis.

VI. POTENTIAL SOLUTIONS

There are two main systems of legislation currently used around the world to combat the problem of e-waste. The first type of program uses advance recovery fees, which is a front-end financing system where consumers fund the recycling efforts. The second program, extended producer responsibility plans, places the financial burden of waste efforts and recycling on the producers of the products that create the waste.

A. Advance Recovery Fees (ARFs)

ARF systems allow the government to collect deposits paid by consumers when purchasing an electronic item and then redistribute those funds in grants to public and private entities that recycle electronics. The most common example of other markets where ARFs are used is the bottling industry where a certain fee is paid in advance by the consumer to pay for the reuse and recycling of the bottles.

ARF legislation concerning e-waste is used in California, where consumers pay an advance disposal fee when they purchase any device with a CRT, and the funds collected are distributed to government and private agencies that handle recycling. Electronics organizations and producers generally prefer this sort of program because they do not bear the cost of handling the e-waste. ARF systems are simple because they provide the money for all waste,


132. See id. (explaining how advance recovery fee systems work to fund recycling).

133. See Thorpe & Kruszewska, supra note 111, at 1 (noting that EPR is emerging principle for new generation of pollution prevention policies that focus on product systems instead of production facilities).

134. See Advance Recovery Fees, supra note 131, at 1 (explaining how ARFs fund recycling of electronics).

135. See id. (describing AFR systems in bottle industry).

136. See Norr, supra note 59, at 3 (noting how ARFs are currently implemented in United States legislation dealing with e-waste).

orphan, historic, or otherwise, and the collection is considered voluntary.\footnote{See id. (noting pros of ARF systems compared to other viable systems of waste management).} One problem with programs that rely on ARFs is that if not enough money is collected from the fees to handle the cost of the waste, then the burden falls on the taxpayers to pay the difference.\footnote{See id. (noting ARF addition costs that had not been collected would be passed down to taxpayers).}

B. Extended Producer Responsibility (EPR)

EPR legislation, also referred to as “take-back,” “product liability,” “product responsibility” or the “Polluters Pay Principle,” is based on the principle that producers must bear a certain amount of responsibility for all environmental impacts of their products.\footnote{See Thorpe & Kruszewska, supra note 111, at 1 (stating overall goal of Extended Producer Responsibility principle).}

Under this type of legislation, manufacturers are responsible for the planning and implementation of a comprehensive take-back system, and for the costs of the system which are absorbed as part of the cost of doing business.\footnote{See Front End Financing, supra note 137, at 4 (noting how EPR is supposed to work in theory).} Under this system, retailers and customers would not have any required financial responsibility.\footnote{See id. (stating roles and responsibilities of each party in EPR legislation).}

There are several types of responsibility within the range of EPR programs.\footnote{See id. (detailing types of responsibility in EPR programs).} For example, a plan requires manufacturers to exercise physical responsibility, which means the producer is involved in the physical management of products, as well as economic responsibility, where the producer must cover the costs of managing the waste at the end of the product’s life.\footnote{See Thorpe & Kruszewska, supra note 111, at 2 (noting that costs include collection, processing treatment or disposal of products).}

Furthermore, an EPR plan places liability on the shoulders of the producers so that all responsibility for environmental damage caused by a product is borne by its producer.\footnote{See id. (noting producers have both liability and informative liability for products they create).}

EPR programs are used to shift the burden of e-waste from the public sector to the private sector.\footnote{See id. (stating this policy changes burden to force producers to pay for what they have created).}

Presently, in the United States, the responsibility for the disposal of e-waste rests on local
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governments and general taxpayers. Additionally, by requiring producers to pay for their environmentally damaging products, EPR legislation encourages the development of better and cleaner product designs. The EU directives (WEEE and RoHS) are based on the ideals of EPR since they require producers to stop using certain materials and control waste. The directives put full financial responsibility on producers to set up collection systems, and state distributors must accept returns of similar end-of-life electronic equipment from private households when distributing a new product.

There are several benefits of the EPR system of legislation: 1) consumers and taxpayers do not have to pay for the disposal of e-waste; 2) retailers do not need to collect upfront fees which could be insufficient to cover the costs of e-waste; 3) it pays for both new and historic wastes; and 4) manufacturers are given incentives to create designs that are less hazardous to the environment.

C. Less Common Programs

EPR and ARF programs are the two most common legislative schemes currently in use to deal with e-waste; however, there is also a less used combination of the two programs called the hybrid approach. For example, Washington State established a dual system in which an EPR system is in place for five years and then switches to an ARF system where a fee is collected. The Washington program established that manufacturers are responsible for planning, implementing and financing the system for twenty percent of their products by 2007 and an additional ten percent for the next five years. The benefit of this sort of plan is that no party must bear the burden alone; however, it does not guarantee that all costs will be covered as they would under an EPR plan.

147. See id. (noting how current United States system works in terms of responsibility for e-waste disposal).
148. See id. at 2 (stating overall goal of EPR legislation).
149. See Thorpe & Kruszewska, supra note 111, at 2 (stating EU directives create new era of environmental accountability).
150. See id. (detailing responsibilities EU directives place on producers).
151. See Front End Financing, supra note 137, at 5 (noting pros and cons of EPR).
152. See id. at 7-10 (introducing concept of combined ARF and EPR programs).
153. See id. (explaining Washington hybrid model and how it combines both ARF and EPR programs).
154. See id. (stating companies could do this individually or collectively as an industry).
155. See id. (noting pros and cons of using hybrid approach).
Some jurisdictions utilize another program involving the use of end-of-life (EOL) fees. This plan is straightforward because it merely requires consumers to pay fees to collectors to handle their wastes. EOL fee systems are basically the status quo in most of the United States where consumers decide what they want to do with their waste based on attitudes, costs and conveniences, which often results in illegal dumping.

VII. FIXING THE PROBLEM

A. Need for EPR System

For legislation to be successful, solving the e-waste problem must be based on the EPR system, because it is the only program that provides incentives for companies to create cleaner, better designs. The EPR system also places the burden on companies that continue to use older, toxic products with shorter life spans. ARF systems are only patch jobs that attempt to fix the current problem, but do not encourage cleaner production; therefore, these systems result in increased volume of toxic waste.

Engineers need to take into account the end-of-life implications of their products in their design and material choices. The only way for reform to be successful and expedient is to make producers financially responsible if they opt not to make their products greener. Producers would quickly realize that creating and selling short-life, toxic, disposable goods would not be economically feasible, and, therefore, a company's bottom line would force producers to create greener products. Innovation would occur

156. See Front End Financing, supra note 137, at 11 (noting this is not a true system in that components are not completely linked).
157. See id. at 11 (stating processors charge fees and consumers are responsible for paying fees).
158. See id. (noting options to consumers under this program include: legal or illegal disposal, donation, paying for recycling, storage and stockpiling).
159. See id. (noting EPR is only system created to date that provides incentives for companies to change their mode of production and disposal).
160. See id. (noting EPR has built in incentives for companies to create better products to save money in long run).
161. See Advance Recovery Fees, supra note 131, at 1 (stating ARF is good attempt to fix e-waste issue but ignores dozens of other e-waste issues).
162. See id. (pointing out if producers continually make bad products, e-waste issues will only grow and increase cost to consumers and taxpayers while creating higher profits for producers and designers).
163. See id. (stating that for most part, today's engineers do not take into account end-of-life ramifications of products they create).
164. See id. (stating EPR creates effective feedback loops to recover materials safely and promote cleaner design).
quickly under an EPR system because companies that innovate rapidly would have a competitive advantage over companies that delay improvement.  

An EPR plan also ensures all waste will be paid for, whereas the fees collected by an ARF system might not be enough to cover the amount of waste created. If there is not enough money to pay for the disposal, it would fall on the backs of the government or waste would possibly be exported to poorer countries, as is the current situation.

Furthermore, electronics producers have made billions of dollars on their products at the expense of the environment and taxpayers. Local governments have been saddled with the responsibility of cleaning up producers' waste and they can do little to prevent it. Unlike the manufacturing industry, consumers and local governments do not have the capability to solve this issue on their own, as do producers; it is the industry that should bear the cost which would lead it to fix the problem. Additionally, given that it is the producers who make money from the sale of an environmentally unsound product, they should pay for the damage they have caused, not the consumer or the taxpayer. When implementing an EPR system, not only will consumers and taxpayers not have to bear the financial burden of e-waste, but manufacturers will also be more responsible in their designs in hopes that e-waste will diminish over time.

In light of all of this, the United States needs to create national legislation similar to the EU directives to address this problem. National legislation on this issue should have some key elements, listed below, in order for it to be successful.

165. See Poison PCs, supra note 1, at 26 (noting plans have been successful in Europe and Asia).
166. See Front End Financing, supra note 137, at 3 (noting fees are not resilient or adaptable to actual costs of system).
167. See id. (noting that cost of fixing problem is currently borne solely by United States government).
168. See Thorpe & Kruszewska, supra note 110, at 2 (stating solid waste facilities have become major political battle grounds when dealing with this issue).
169. See id. (noting today in United States responsibility for e-waste disposal rests ultimately on shoulders of local governments and therefore taxpayers).
170. See id. (referring to this idea as Polluters Pay Principle).
171. See Front End Financing, supra note 137, at 7 (outlining pros of EPR and cons of ARFs).
173. See id. (listing proponents of effective e-waste legislation).
B. Requirements for Effective Legislation

First, effective legislation requires electronic equipment to be defined more broadly; it should not simply encompass current forms of electronics, but should also anticipate new gadgetry that will likely be sold in the future. This is an imperative part of any legislation but is especially important in a rapidly changing market such as technology. The goal is to avoid legislation that becomes obsolete when producers create products that fit into loopholes and therefore are not covered by the legislation.

Second, as explained earlier, effective legislation must be based on EPR principles where producers bear financial responsibility for products entering the marketplace. Manufacturers should be responsible for meeting specific recovery and recycling goals. Additionally, producers should be responsible for educating consumers and the public about any public health threat their products may create.

Third, like the EU’s RoHS directives, effective legislation must call for a reduction of toxins, if not an overall ban. This approach, just as with the EPR style WEEE directives, has worked in Europe and other countries, such as Japan. Fourth, the exportation of e-waste to poorer countries and the dumping of electronic equipment in landfills and incinerators must be prohibited.

174. See id. (stating definition of electronic equipment should include anything with circuit board, complex circuitry, signal processing, or that contains one or more hazardous substances).

175. See id. (noting technology is rapidly changing market).

176. See id. (stating legislation needs to be flexible to remain effective over time).

177. See Essential Elements, supra note 172 (noting legislation should state non-specific requirement for producers to develop systems for financing environmentally superior collection and recycling without including specific details that should be left to companies).

178. See id. (noting legislation must have applicable rates and dates for recovery and recycling of e-waste).

179. See Poison PCs, supra note 1, at 25 (stating legislation at minimum should require that all computer monitors, TV sets and other electronic devices with hazardous materials must be clearly labeled and identified as to environmental hazardous and proper materials management).

180. See Essential Elements, supra note 172 (noting effective legislation must require phase out of certain toxic materials from production of electronic equipment).

181. See Poison PCs, supra note 1, at 25 (claiming that requiring manufacturers to pay for cost of disposal create incentive to develop better products).

182. See id. (noting landfill bans have been put in place by several states such as California, but there needs to be national bans to be truly effective).
Fifth, legislation must ensure that taxpayers are not held liable for any costs associated with the collection, transportation, handling, storage, recycling or disposal of electronic waste.\textsuperscript{183} Currently, local taxpayer-funded programs are overburdened and under-funded and should not bear the costs of additional e-waste, which would be the case if ARFs or a hybrid approach were implemented.\textsuperscript{184}

The final, and arguably most important aspect of effective e-waste legislation, is providing means for ensuring compliance and enforcement of the legislation.\textsuperscript{185} This element is of the utmost importance because without an enforcement element, the legislation would lack teeth and essentially would be an ineffective, voluntary program.\textsuperscript{186} Legislation should provide for periodic reporting by producers and all reports should be available to the public.\textsuperscript{187} For further safeguarding, legislation could prohibit a company from selling its products if it failed to abide by the terms of the legislation.\textsuperscript{188}

\section*{VIII. Conclusion}

The amount and toxicity of e-waste is growing to epic proportions and will cause irreversible harm to the environment as well as to the public welfare.\textsuperscript{189} National legislation must be created and enforced to allow consumers to make smarter electronic purchases created by environmentally responsible producers.\textsuperscript{190} Only when the federal government implements a comprehensive EPR initiative

\begin{itemize}
\item \textsuperscript{183} See \textit{Essential Elements}, supra note 172 (noting also taxpayers must be held harmless form all costs associated with oversight and enforcement of systems established to handle these systems).
\item \textsuperscript{184} See \textit{Poison PCs}, supra note 1, at 25 (explaining for short term purposes where there is no other collection opportunity, local waste programs should be allowed to charge back manufactures for cost of managing their waste).
\item \textsuperscript{185} See \textit{Essential Elements}, supra note 172 (detailing different methods to ensure compliance and enforcement of legislation).
\item \textsuperscript{186} See \textit{id.} (noting without proper enforcement, companies would not be compelled to comply with legislation).
\item \textsuperscript{187} See \textit{id.} (explaining public availability would serve as extra incentive for producers to be responsible).
\item \textsuperscript{188} See \textit{id.} (recommending legislation provides for advisory board to review reports and make suggestions and recommendations).
\item \textsuperscript{189} For a discussion of the health risks associated with e-waste, see \textit{supra} notes 36-58 and accompanying text.
\item \textsuperscript{190} For an explanation of the need for EPR legislation in the United States as opposed to other types of systems, see \textit{supra} notes 131-88 and accompanying text.
\end{itemize}
will the detrimental effects that e-waste has on the environment and public health begin to be curbed.\textsuperscript{191}

\textit{Jennifer Kutz}

\textsuperscript{191} For a discussion about the needs of effective legislation based on a Polluters Pay Principle, see \textit{supra} notes 159-73 and accompanying text.