

HASTE MAKES E-WASTE: A COMPARATIVE ANALYSIS OF HOW THE UNITED STATES SHOULD APPROACH THE GROWING E-WASTE THREAT

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I. INTRODUCTION

Who could bear to live without the conveniences afforded by the multitude of electronic consumer goods available today? Once they reach the end of their useful lives and are thrown out, it is easy not to think about what happens to them beyond the dumpster. However, there is an increasing need for public concern about what happens to our discarded electronic products (“e-

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waste") because of their rapid proliferation¹ and the dangers posed by their toxic contents.²

When most Americans think of the biggest environmental problems facing our generation, discarded electronic products would hardly make it on their lists. This may be in part due to the presumption that modern, high-tech gadgets are greener than other consumer products. This misplaced faith in electronics goods is part of the reason they have become a major concern in the past decade. The rising popularity of these goods and their perceived disposable nature has led to an increased production of e-waste³ in the United States and other developed countries.⁴ It is when electronic products are disposed of that they pose the most problems. The aggregated effect of e-waste creates substantial environmental and health issues both domestically and abroad.

The problems associated with the escalation of e-waste is greatly exacerbated by the fact that electronic devices often contain a number of highly toxic substances that pose serious risks to human health and the environment. An electronic product can contain a number of hazardous substances, including *inter alia*: lead, cadmium, mercury, hexavalent chromium, and brominated flame retardants.⁵ All of these substances have a spot on the U.S. Department of Health's Hazardous Substance Priority List due to their high levels of toxicity.⁶ Exposure to these substances has

¹ SILICON VALLEY TOXICS COALITION, POISON PCs AND TOXIC TVs: CALIFORNIA'S BIGGEST ENVIRONMENTAL CRISIS THAT YOU'VE NEVER HEARD OF 8 (2004), [hereinafter POISON] (noting the rapid increase in e-waste production), <http://svtc.etoxics.org/site/DocServer/ppc-ttv1.pdf?docID=124>.

² *Id.* at 8–14 (listing some of the hazardous substances found in e-waste and related adverse health effects).

³ "E-waste" encompasses any electronic device, component, or accessory that has reached the end of its useful life (EOL), either through obsolescence, malfunction or exhaustion, and has been discarded. *See id.* at 7.

⁴ *See* OFFICE OF TECH. POL'Y, U.S. DEPT. OF COMMERCE, RECYCLING TECHNOLOGY PRODUCTS: AN OVERVIEW OF E-WASTE POLICY ISSUES 1 (2006) [hereinafter RECYCLING TECHNOLOGY] (discussing the increasing rate of e-waste production in the United States); Rachel Shabi, *The E-waste Land*, THE GUARDIAN, Nov. 30, 2002, at 36 (discussing increasing rate of e-waste production in the United Kingdom).

⁵ SILICON VALLEY TOXICS COALITION, TOXIC SWEATSHOPS: HOW UNICOR PRISON RECYCLING HARMS WORKERS, COMMUNITIES, THE ENVIRONMENT, AND THE RECYCLING INDUSTRY 9 (2006) [hereinafter SVTC, TOXIC SWEATSHOPS], available at <http://svtc.etoxics.org/site/DocServer/ToxicSweatshops.pdf?docID=321>.

⁶ AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY, U.S. DEPT. OF HEALTH AND HUMAN SERV., PRIORITY LIST OF HAZARDOUS SUBSTANCES (2005) [hereinafter ATSDR, PRIORITY LIST], <http://www.atsdr.cdc.gov/cercla/05list.html> (ranking lead, mercury, and cadmium within the top 20 out of 275 substances, based on toxicity).

been linked to severe health conditions, such as neurological damage, kidney and liver diseases, birth defects and, in some cases, cancer.⁷ E-waste that is improperly processed can release its dangerous contents into the environment, where it can find its way into groundwater supplies or spread through the atmosphere.⁸ Even with preventive measures exercised by landfills to contain leachate⁹ produced by waste products, there is a significant risk that seepage from landfills will contaminate groundwater supplies.¹⁰ In the case of incinerators, the by-products produced are even harder to contain and prevent from spreading into the air.¹¹

These hazards all add to the cost of handling e-waste for recycling, which leads to an additional set of problems. The added cost of recycling e-waste induces the e-waste stream to follow the path of least economic resistance,¹² always flowing to those recyclers that will process the waste at the cheapest cost. These will often be located in developing nations, like China, where labor costs are much lower and environmental regulations are lenient.¹³

⁷ United States Environmental Protection Agency (EPA), eCycling FAQ, [hereinafter EPA eCycling FAQ], <http://www.epa.gov/ecycling/faq.htm> (last visited Oct. 30, 2007).

⁸ See POISON PCs, *supra* note 1, at 15-17; Commission of the European Communities, *Proposal for a Directive of the European Parliament and of the Council on Waste Electrical and Electronic Equipment* 4, 347 (June 13, 2000), available at <http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2000:0347:FIN:EN:PDF> [hereinafter *European Parliament WEEE Proposal*] (discussing “hazardous content” of waste electrical and electronic equipment (WEEE) that “cause major environmental problems during the waste management phase . . .”).

⁹ “Leachate” refers to “a solution resulting from leaching, as of soluble constituents from soil, landfill, etc., by downward percolating ground water.” RANDOM HOUSE UNABRIDGED DICTIONARY (Random House 2006).

¹⁰ The landfill can be an ideal environment for some substances to propagate. It is estimated that polybrominated biphenyls (PBBs), a substance that weakens the immune system and is possibly linked to certain forms of cancer, are “200 times more soluble in leachate than in distilled water.” *European Parliament WEEE Proposal, supra* note 8, at 15, 43-44. The U.S. EPA sets out specific design requirements to manage leachate produced from landfills, but does make a certain allowance for leakage of up to 0.05 mg/l of lead, 0.01 mg/l of cadmium, and 0.002 mg/l of mercury into groundwater. UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, 2 DECISION MAKER’S GUIDE TO SOLID WASTE MANAGEMENT 937 tbl. 9-7 (1995), available at <http://www.epa.gov/garbage/dmg2/chapter9.pdf>; see also 40 C.F.R. § 261.24 (2004) (setting the maximum allowable concentration values of certain hazardous substances in solid waste before it can be considered hazardous waste).

¹¹ POISON PCs, *supra* note 1, at 15-16.

¹² JIM PUCKETT ET AL., EXPORTING HARM: THE HIGH-TECH TRASHING OF ASIA 1, 2 (Jim Puckett & Ted Smith eds., 2002) [hereinafter PUCKETT, EXPORTING HARM], available at <http://svtc.etoxics.org/site/DocServer/technotrash.pdf?docID=123>.

¹³ *Id.* at 8.

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These recyclers often employ dangerous methods for recovering materials in e-waste with little regard for worker safety.¹⁴ In addition, they are often focused on salvaging only the most valuable components and materials from the e-waste, and are not concerned with keeping the hazardous contents from being released into the environment.¹⁵ With this in mind, domestic environmental policy decisions should seek to discourage this practice.

The international community is becoming aware of the growing threat of e-waste proliferation and the problems it brings, but only a minority of developed nations have implemented measures to stem the tide within their borders. Taking the lead, the European Union (EU) has issued a package of directives to its member states that mandate they enact local legislation creating Extended Producer Responsibilities (EPRs).¹⁶ The EU's EPR approach shifts the responsibility of managing the disposal of e-waste from municipalities to the original manufacturers of those products.¹⁷ Also included in these directives is a restriction on the use of most hazardous materials commonly found in electronic goods.¹⁸ The objectives of the EU approach are to reduce the flow of e-waste into the conventional waste stream and provide incentives for manufacturers to design environmentally-friendly products.¹⁹

Currently, the United States has no national policy on e-waste disposal by households.²⁰ There are many reasons for this absence, but a significant factor is the lack of public awareness of the scope and magnitude of the problem. The escalation of household solid waste production has long been a concern of the environmentally focused, but the environmental and health impacts associated with e-waste in particular are relatively novel side effects of the information age.

¹⁴ *Id.*

¹⁵ *See id.*

¹⁶ *See* European Parliament and Council Directive 2002/95/EC, 2003 O.J. (L 37) 19 [hereinafter RoHS Directive] (on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment); European Parliament and of the Council Directive 2002/96/EC, 2003 O.J. (L 37) 24 [hereinafter WEEE Directive] (on Waste Electrical and Electronic Equipment).

¹⁷ *See* discussion *infra* Part IV.B.1.

¹⁸ *See id.*

¹⁹ *See id.*

²⁰ The current U.S. e-waste policy focuses primarily on waste products generated by large businesses and exempts waste generated by households. RECYCLING TECHNOLOGY, *supra* note 4, at 25.

Increasing pressure from environmental groups, as well as the recent shift in the political climate in the United States, may mean it is poised to change its policies in a similar fashion.²¹ Considering that e-waste is the “fastest-growing part of the municipal waste stream” in the United States,²² it is clear that some immediate action should be taken, but the approach implemented by the European Union may not be the most effective way to achieve the desired goals in the United States. The disposal management strategy of the European Union directives may not in practice provide the necessary incentives for producers to design for the environment,²³ and the express restrictions on material use may actually create additional environmental problems at the cost of both consumers and producers.²⁴ Moreover, because e-waste escalation is indeed a global threat, any analysis of domestic environmental policies must also factor in the effect they have at the international level.

Part II of this Note further explores the growing problems associated with the increasing rate of e-waste production. Part III dissects the electronic product life cycle to trace the sources of the problems, which will provide focus for an efficient and realistic so-

²¹ The rise of the political right, which has historically opposed environmental legislation, in the White House, Congress, and state houses has been associated with the current lack of major product legislation. Noah Sachs, *Planning the Funeral at the Birth: Extended Producer Responsibility in the European Union and the United States*, 30 HARV. ENVTL. L. REV. 51, 87 (drawing relation between Republican control over the executive and legislative branches, and current environmental policy). The November 2006 elections, which shifted majority control of Congress to the Democratic Party, has resulted in a dramatic change in environmental policy. See Phil Mckenna, *The Climate Changes on Capitol Hill*, NEW SCIENTIST, Mar. 29, 2007, at 12 (noting that Congress' newfound position on global warming was due to the 2006 removal of Republican control over Congress); John M. Broder, *Crossing a Threshold on Energy Legislation*, N.Y. TIMES, Dec. 5, 2007 (claiming that the passage of the Energy Independence and Security Act, which seeks to tighten energy efficiency standards for vehicles, home appliances and government buildings, was motivated by, *inter alia*, the shift in control over Congress to the Democratic Party). More recently, the 2008 presidential candidates from both parties have made environmental issues an important part of their platforms, which reflects this shift in the political climate. See CNN.com, White House Candidates and the Environment, <http://www.cnn.com/2008/TECH/02/02/eco.elections/index.html?iref=newssearch> (last visited Mar. 16, 2008).

²² Elizabeth Grossman, *Where Computers Go to Die and Kill*, SALON.COM, Apr. 10, 2006, <http://www.salon.com/news/feature/2006/04/10/ewaste/print.html>.

²³ See Sachs, *supra* note 21, Part III.B.2.

²⁴ See generally Dana Joel Gattuso, *Mandated Recycling of Electronics: A Lose-Lose-Lose Proposition*, COMPETITIVE ENTERPRISE INSTITUTE: ISSUE ANALYSIS, Feb. 1, 2005, available at <http://www.cei.org/pdf/4386.pdf>; see also Part IV.B (discussing the downstream problems associated with material restrictions).

lution. After the problem and sources are identified, solutions currently being developed are examined in Part IV. This will include a discussion covering the controversial directives recently adopted in the European Union that create EPRs and design mandates. It will also discuss what measures are being taken in the United States by individual states and in Japan. Finally, Part V will conclude with a recommended regulation strategy that will offer a realistic compromise, considering the international implication of taking such action.

II. THE CURSE OF E-WASTE

In 2000, e-waste constituted between 2% to 5% of the total municipal waste stream in the United States²⁵ and is estimated to have increased four times in just the few years following.²⁶ The total amount of e-waste produced in the United States and Europe is increasing at a rate faster than any other component of the municipal waste stream. In Europe, it is estimated that the amount of e-waste being produced is increasing at three times the rate of the total municipal waste stream.²⁷ A number of factors have contributed to this increase. First, technological advancements have made electronic devices cheaper to produce, which has made them accessible to more consumers and increased the overall amount of goods sold. As an illustrative example, in the U.S., personal computer (PC) sales totaled only about 150,000 units in 1981.²⁸ This figure more than doubled by 1984 and has continuously increased at an accelerating pace.²⁹ By 1986, PC sales increased to about 600,000, representing a doubling of sales from just the year prior.³⁰ The percent increase in sales from the prior year grew to over 500% in 2002 and reached a total sale volume of over 89 million units by 2005.³¹ Technological advancement also affects the rate at which

²⁵ POISON PCs, *supra* note 1, at 2.

²⁶ GLOBAL FUTURES FOUNDATION, COMPUTERS, E-WASTE, AND PRODUCT STEWARDSHIP: IS CALIFORNIA READY FOR THE CHALLENGE?—REPORT FOR THE U.S. ENVIRONMENTAL PROTECTION AGENCY, REGION IX 13 (2001), available at <http://future500.org/documents/e-waste.pdf>.

²⁷ *European Parliament WEEE Proposal*, *supra*, note 8, at 4.

²⁸ H. SCOTT MATTHEWS ET AL., CARNEGIE MELLON UNIVERSITY, DISPOSITION AND END-OF-LIFE OPTIONS FOR PERSONAL COMPUTERS (GREEN DESIGN INITIATIVE TECHNICAL REPORT #97-10) Appendix B (July 7, 1997), available at <http://www.ce.cmu.edu/GreenDesign/compsec/NEWREPORT.PDF>.

²⁹ *Id.*

³⁰ *Id.*

³¹ *Id.*

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new technologies are developed, rendering existing devices obsolete. New technologies are brought to the market about every 18 months.³² The useful life of a PC is subject to Moore's law, which states that manufacturing technology will advance at a rate that allows for computer processing power to double every 18 months.³³ In 2001, an estimated 41 million PCs became obsolete, and nearly 500 million PCs reached obsolescence between 1997 and 2007.³⁴ Some manufacturers release new products at an even faster rate. For example, Apple releases a new iPod model about every six months.³⁵

E-waste is a relatively new environmental issue, mainly because consumer electronics did not reach a level of popularity that caused a significant e-waste stream until they reached the price point that made them feasible and affordable to the majority of consumers. But this quickly changed for a number of reasons. First, advances in manufacturing technologies have led to lower production costs for some electronic products, in turn reducing consumer prices. This has led to an overall increase in the amount of electronic products sold, which would ordinarily be seen as a sign of a nation's technological advancement.³⁶ However, this complicates the question of what to do with these products when they are eventually discarded. Second, electronic products are rarely designed to allow for simple repairs, in the event of malfunction, or for upgrades to stave off complete obsolescence. While this is mainly due to the relatively low cost of such products, it also may not be feasible to repair or upgrade certain types of products.³⁷ It is estimated that in the United States alone, five to seven million tons of electronic products become obsolete every year,³⁸ with few viable options for what to do with the products once this

³² POISON PCs, *supra* note 1, at 7.

³³ See *Happy Birthday; Moore's Law at 40*, THE ECONOMIST, Mar. 26, 2005, at 65.

³⁴ POISON PCs, *supra* note 1, at 8.

³⁵ David Pogue, *Clues to Gadget-Release Cycles*, N.Y. TIMES.COM, Oct. 13, 2006, <http://pogue.blogs.nytimes.com/2006/10/13/clues-to-gadget-release-cycles/>.

³⁶ See Catherine K. Lin et al., *Globalization, Extended Producer Responsibility and the Problem of Discarded Computers in China: An Exploratory Proposal for Environmental Protection*, 14 GEO. INT'L ENVTL. L. REV. 525, 526 (2002).

³⁷ It is difficult to repair or upgrade certain types of products, such as cameras, because of the high degree of expertise required to understand today's complex products and the specialized equipment required to complete such operations.

³⁸ POISON PCs, *supra* note 1, at 8.

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happens.³⁹ Even when a repair or an upgrade is possible, the cost-benefit ratio of doing so often makes it not worthwhile.⁴⁰ This adds to the amount of purchased electronics that are discarded into the waste stream, rather than kept in service. Finally, and most significantly, technological advancements have allowed producers to create smaller, faster, and more capable electronics products, an ability which continues to be motivated by market demands. The majority of consumers prefer the latest, “improved” products and will usually take them over older models.⁴¹ This is partially a result of marketing and the natural consumer preference for smaller, faster, and more capable products. Yet it is also a result of the lack of consumer awareness of the problems associated with e-waste that may counterbalance these compulsions. In short, new products are put out so quickly because producers can do so and because consumers demand it.

All these factors contribute to a projected three billion units of consumer electronics that will enter the e-waste stream by the year 2010.⁴² And the rapid increase is not limited to the United States. Great Britain produces about one ton of e-waste annually and this figure is projected to double by 2010.⁴³ At the current rate, an estimated 20 to 50 million tons of e-waste are produced worldwide every year.⁴⁴ This figure is expected to increase another three to five percent a year.⁴⁵

Exposure to substances commonly found in electronic products is known to cause severe health problems.⁴⁶ A number of harmful heavy metals, including lead, cadmium, and mercury are found in many common electronic components.⁴⁷ These sub-

³⁹ See UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, GREENING YOUR PURCHASE OF ELECTRONICS 1 (Dec. 2001), available at <http://www.p2pays.org/ref/13/12190.pdf>.

⁴⁰ See Shabi, *supra* note 4. Indeed, this particular cause often stems from the previously noted rapid decrease in prices. After labor costs are added to the cost of upgrades and repair, this option eclipses the cost of new products, which have dropped in price.

⁴¹ GLOBAL FUTURES FOUNDATION, *supra* note 26 at 12.

⁴² RECYCLING TECHNOLOGY, *supra* note 4, at 1.

⁴³ Shabi, *supra* note 4.

⁴⁴ ‘Worldwide Implications’ from *EU Electro-Chemical Waste Restriction*, EURACTIV.COM, Jan. 31, 2007, <http://www.euractiv.com/en/pa/worldwide-implications-eu-electro-chemical-waste-restriction/article-160700> [hereinafter *Worldwide Implications*] (quoting UN Environment Program).

⁴⁵ *Id.*

⁴⁶ See EPA eCycling FAQ, *supra* note 7; POISON PCs, *supra* note 1, at 9-14.

⁴⁷ EPA eCycling FAQ, *supra* note 7; POISON PCs, *supra* note 1, at 9-14.

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stances, along with many others found in electronics components, are ranked high on the Center for Disease Control’s Priority List of Hazardous Substances⁴⁸ and have been linked to a number of serious health conditions, many irreversible if left untreated.⁴⁹ Of particular concern is lead because of its high toxicity⁵⁰ and ubiquity in electronic components. Until recently, lead was often found in “solder”—the “glue” that joins electronic components with printed circuit boards—which is used in nearly all electronic devices.⁵¹ Approximately four to eight pounds of lead can still be found in cathode ray tubes (CRTs), the glass display screens typically found in conventional (i.e. non-flat) computer monitors and televisions.⁵² The batteries used in many electronic devices also may contain a large percentage of lead, by weight, along with other heavy metals like cadmium.⁵³ To put this into perspective, consumer electronic products currently contribute about 40% of the lead⁵⁴ and 70% of the other heavy metals found in landfills in the United States.⁵⁵

The combination of the rapidly increasing volume of e-waste production and the hazardous materials it contains raises tough questions about proper disposal. In the United States and most other countries, a large bulk of e-waste will end up in landfills

⁴⁸ See ATSDR, PRIORITY LIST, *supra* note 6 (ranking lead, mercury, cadmium within the top 20 out of 275 substances, based on toxicity).

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⁴⁹ See EPA eCycling FAQ, *supra* note 7; POISON PCs, *supra* note 1, at 12–14.

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⁵⁰ Lead ranked second on the U.S. Department of Health’s hazardous substance priority list. See ATSDR, PRIORITY LIST, *supra* note 6. Exposure to lead has been linked to damage of the brain, nervous system, kidneys and blood system, and to developmental damage in fetuses and children. DIV. OF TOXICOLOGY AND ENVTL. MED., U.S. DEPT. OF HEALTH AND HUMAN SVCS., TOXFAQS FOR LEAD (Aug. 2007), available at <http://www.atsdr.cdc.gov/tfacts13.html>.

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⁵¹ See EPA eCycling FAQ, *supra* note 7. In July 2006, most uses of lead solder were banned from usage in the majority of electronic products sold or imported in the European Union beginning July 2006. See RoHS Directive, *supra* note 16. Many producers and suppliers have subsequently restricted their use of lead in their designs to achieve compliance with the EU RoHS, which implicitly affected many units sold in the United States. See analysis of the EU RoHS *infra* Part IV.B.1.b.

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⁵² A large majority of lead found in CRTs is impregnated in the glass matrix that makes up the front and a portion of the rear of the CRT. Hazardous Waste Management System; Modification of the Hazardous Waste Program; Cathode Ray Tubes and Mercury-Containing Equipment, 67 Fed. Reg. 40508, 40509-10 (proposed June 12, 2002).

⁵³ Cadmium is absorbed through the respiratory and digestive systems and is known to accumulate in the body and cause damage to kidneys. EPA eCycling FAQ, *supra* note 7.

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⁵⁴ See POISON PCs, *supra* note 1, at 12.

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⁵⁵ GLOBAL FUTURES FOUNDATION, *supra* note 26, at 6. The National Safety Council estimates PCs discarded in US between 1997 and 2007 will contain over 632,000 of mercury. See PUCKETT, EXPORTING HARM, *supra* note 12, at 5–6.

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alongside the rest of the municipal solid wastes (MSW).⁵⁶ Although some states have banned the most dangerous e-waste, such as CRTs and batteries, from landfills,⁵⁷ this option remains the most attractive and convenient for many consumers looking to dispose of their e-waste who are unaware of the dangers associated with landfill disposal. However, when dealing with products known to contain a high level of hazardous materials, this practice cannot continue over the long term. Landfilling e-waste presents a significant risk of these hazardous materials being released into the environment, thus increasing the chance of exposure to residents in the areas surrounding landfill sites. Even the most modern landfills are expected to leak a certain amount of leachate into the surrounding groundwater supply⁵⁸ and landfills that incinerate e-waste greatly increase the opportunity for the release of toxic substances into the air.⁵⁹ With the expected increase of e-waste and the high toxicity of the substances found in e-waste, these risks should not be taken as a matter of course and safer alternatives should be explored. These alternatives are discussed in detail below.

A. Weaknesses of the Recycling Solution

One solution gaining popularity in some states is the implementation of a recycling program dedicated to e-waste.⁶⁰ These programs take in e-waste through existing municipal waste collection systems or from drop off areas where consumers can dispose of their end-of-life (EOL) electronic goods. Recycling the EOL electronic products prevents the hazardous materials found in e-

⁵⁶ Overall, only 2-3% of all e-waste is recycled, as of 1997. POISON PCs, *supra* note 1, at 8. Only about 10% of e-waste from discarded computers is recycled. Stefanie Olsen, *High Tech: Anything But Green*, NEWS.COM, July 5, 2006, http://news.com.com/High+tech+Anything+put+green/2008-1041_3-6090899.html.

⁵⁷ Five states currently ban CRTs from landfills: California, Maine, Massachusetts, Minnesota, and New Hampshire. See RECYCLING TECHNOLOGY, *supra* note 4, at 117. Twenty-six states currently ban certain types of batteries from landfills. See *id.* at 130. Other states ban some of the hazardous substances found in e-waste from landfills. See *id.* at 110-17.

⁵⁸ See POISON PCs, *supra* note 1, at 15.

⁵⁹ Currently, Maine has enacted a ban on incineration specifically for computer monitors, televisions, and central processing units (CPUs). See generally RECYCLING TECHNOLOGY, *supra* note 4, at 113 (citing *An Act to Protect Public Health and the Environment Through the Collection and Recycling of Electronic Waste*, 2003 Maine Legis. Doc. 743).

⁶⁰ California, Maine, Maryland and Washington have enacted statewide recycling programs; many others have legislation to investigate recycling options for possible future programs. RECYCLING TECHNOLOGY, *supra* note 4, at 110-20. These programs are discussed further *infra* at Part IV.B.2.

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waste from entering the MSW stream and reduces the contamination risks discussed above. In addition, like any recycling or other waste reduction program, valuable landfill space that would have otherwise been taken up by the recycled waste is preserved, thereby extending the life of existing landfills. Finally, reusing the recovered material reduces the consumption of the virgin materials when producing new products. This results in what one commentator calls “resource benefits,” which includes the reduction in material resource usage as well as the energy saved from harvesting and processing the raw materials.⁶¹

These benefits notwithstanding, recycling e-waste can be a substantial financial undertaking,⁶² which will lead those bearing financial responsibility to employ the cheapest recycling alternative available. These alternatives may create other problems, discussed below, and do not ultimately address, and may even aggravate the primary issue of hazardous materials being released into the environment.

The hazardous materials content in e-waste coupled with the complex construction and lack of standardization in electronic product designs make for an extremely difficult product to recycle.⁶³ A typical electronic product is an intricate composition of various plastics, metals, and glass. When these products are recycled, they are first dismantled into their individual components and sorted based on material composition;⁶⁴ the base materials are then recovered by raw material producers and incorporated back into new products. The process is both time and labor intensive,⁶⁵ which increases the exposure of the workers performing the dis-

⁶¹ Sachs, *supra* note 21, at 64.

⁶² This point is not undisputed, yet the overall argument sustains—those who must pay for recycling costs will arguably make attempts to use the lowest cost solution. Electronics producer Hewlett-Packard reported that the cost of recycling their products as part of their implementation of the WEEE Directive in some European Union nations is lower than initially feared due to recycling market competition. Press Release, Real Consumer Costs For Electronic Recycling As Low As 1 Euro Cent In Europe, HP.COM, (June 6, 2006), http://www.hp.com/hpinfo/globalcitizenship/environment/pdf/nr_costofrecycling.pdf.

⁶³ See GLOBAL FUTURES FOUNDATION, *supra* note 26, at 19 (noting these difficulties faced in processing PCs for recycling); POISON PCs, *supra* note 1, at 17 (pointing the design of PCs as making disassembly difficult); Shabi, *supra* note 4 (quoting Gary Griffiths, an environmental manager for computer refurbishers RDC, as describing the recycling process as “like unbaking bread back to its ingredients”). The successive levels of dismantling and sorting may occur in multiple steps and through multiple entities. See Grossman, *supra* note 22.

⁶⁴ Lin, *supra* note 36, at 533–34.

⁶⁵ See *id.*

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mantling and sorting tasks to the hazardous materials. In the United States, workers exposed to such hazards are required by law to take extra precautionary measures.⁶⁶ The additional labor costs and safety requirements add to the cost of processing e-waste for recycling in the United States. As a result, many “recyclers”⁶⁷ that initially receive e-waste pass off the bulk of the actual processing labor to third parties who buy the e-waste from the recycler.⁶⁸

A niche market for e-waste has developed from this practice; successive recyclers buy e-waste, harvest the most valuable components and materials⁶⁹ for resale and sell off the remaining components and materials to the next recycler. The e-waste stream will flow “downhill” on an economic path of least resistance passing between different entities depending on labor and other costs associated with extraction, as well as market demand for the recovered materials and components.⁷⁰ The journey ends with the recycler who can process the e-waste at the lowest cost, often in developing countries where labor is cheap and environmental regulations are lax.⁷¹ It is estimated that the cost of recycling e-waste in the United States is \$ 0.40-.50 per pound compared to \$ 0.15-.30 per pound if the same e-waste is “recycled” overseas.⁷² This cost discrepancy is one of the reasons why about 80% of all e-waste received to be recycled will actually be exported to Asia through the “waste trade.”⁷³ Another portion of recycled e-waste ends up in

⁶⁶ The U.S. Occupational Health and Safety Administration sets nationwide standards for worker safety, including stringent limitations on worker exposure to toxic and hazardous substances. See generally, 29 C.F.R § 1910, subprt. Z (setting exposure limits for a number of toxic substances, including lead, cadmium, and chromium).

⁶⁷ The term “recycler” is used loosely to describe an entity that performs any one of a number of waste management processes in the recycling chain, including consolidation, sorting, dismantling, and reselling. RECYCLING TECHNOLOGY, *supra* note 4, at 25.

⁶⁸ See generally, PUCKETT, EXPORTING HARM, *supra* note 12.

⁶⁹ Computers and other e-waste often contain highly-valued metals, such as aluminum and copper, and precious metals like gold, silver, and palladium. See Lin, *supra* note 36, at 532. The products and components themselves may also be refurbished and/or resold. RECYCLING TECHNOLOGY, *supra* note 4, at 25.

⁷⁰ PUCKETT, EXPORTING HARM, *supra* note 12, at 2. This process can occur through several entities and sometimes directly from the initial receiver.

⁷¹ *Id.* (discussing the exportation of hazardous e-waste to poorer Asian countries such as China).

⁷² GLOBAL FUTURES FOUNDATION, *supra* note 26, at 24 (fig. 1).

⁷³ PUCKETT, EXPORTING HARM, *supra* note 12, at 12–13. Another reason why the bulk of recycling is outsourced overseas is because most consumer electronics manufacturers, who provide the market for recycled e-waste, have moved their production facilities overseas. RECYCLING TECHNOLOGY, *supra* note 4, at 27.

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federal prison labor programs for final dismantling and sorting.⁷⁴ In both circumstances, workers are afforded inadequate—if not completely lacking—protection from the hazardous materials found in e-waste and have no power to voice any objection to the unsafe working conditions.⁷⁵

Beyond the human rights issues implicated, the “recycling” processes typically found in these programs are less about recovering hazardous materials for proper disposal as they are about salvaging only the most valuable components and precious metals for resale.⁷⁶ As such, there is often little regard for worker exposure to hazardous materials and even less concern for these substances being released into the environment.⁷⁷ Sometimes the so-called recycling methods employed to extract valuable parts are themselves a cause for environmental concern. Since there is little demand for recycled plastics and proper identification and sorting of plastics is labor intensive, whole products and wiring are often burned or bathed in strong acid solutions to extract the precious metals within them.⁷⁸ Open air burning of the flame-retardant plastics often found in electronic products releases harmful heavy metals, dioxins, and beryllium into the environment,⁷⁹ and used acid liquids are often dumped into nearby water bodies.⁸⁰ The hazardous materials themselves are often not worth the recovery effort⁸¹ and after all the valuable components are extracted, the remainder, including the hazardous materials, is sent to the landfill, or, in the case of developing countries that do not have landfills, dumped out in the open or burned into contaminated ash.⁸² This end result clearly contradicts one of the ultimate goals of an e-waste recycling

⁷⁴ See SVTC, TOXIC SWEATSHOPS, *supra* note 5.

⁷⁵ See *id.*, at 5–7 (discussing unsafe working conditions in federal prison labor programs); PUCKETT, EXPORTING HARM, *supra* note 12 (discussing unsafe working conditions typical in recycling centers found in developing countries).

⁷⁶ See generally SVTC, TOXIC SWEATSHOPS, *supra* note 5.

⁷⁷ *Id.*

⁷⁸ Lin, *supra* note 36, at 553.

⁷⁹ PUCKETT, EXPORTING HARM, *supra* note 12, at 26.

⁸⁰ Lin, *supra* note 36, at 553.

⁸¹ In a typical PC there can be salvaged: steel structural components worth \$0.25, gold from the central processing unit (CPU) worth \$1.00, precious metals from the motherboard (gold, silver and copper) worth \$2.00, copper from the cabling worth \$0.09, aluminum from the hard drive worth \$0.10, and other copper worth \$0.80. However, there is little demand, if any, for the lead, cadmium, mercury, or any of the other heavy metals found in e-waste. PUCKETT, EXPORTING HARM, *supra* note 12, at 8.

⁸² See *id.* at 21; Shabi, *supra* note 4.

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program, which is to reduce the amount of hazardous material being released into the environment. In effect, the cure here is more harmful than the illness because without these recycling programs the e-waste would at least be landfilled in the arguably more controlled environment of a U.S. landfill.

Despite these unfavorable results, recycling programs funded entirely by the government may not have much choice but to choose the lowest bidder, and will often produce this outcome. In short, it is clear that it is not feasible to sustain a traditional recycling program that actually achieves the goals that justified its creation in the first place. A realistic approach to the problem is needed that will address the e-waste epidemic while acknowledging the domestic and global effects of such action.

III. A CLOSER ANALYSIS OF THE PRODUCT "CYCLE"

Any analysis of solutions to the e-waste problem should include some discussion about the typical life cycle of an electronic product and its environmental impact along the way. A regulatory policy that does not adequately take into account the real consequences of its approach may only shift the cost to different entities in the product cycle rather than resolving the root of the problem. Any benefit thus realized would be merely cosmetic and short lived.

The traditional product "cycle" actually follows a linear route from "cradle to grave." For the purposes of this discussion, costs associated with labor are not relevant and will not be considered. The cycle starts with the harvesting of the raw materials used in production processes from natural resources. Environmental costs during this phase vary according to the material harvested, but often involve high energy consumption, natural resource depletion, and pollution from the harvesting process.⁸³ A manufacturer⁸⁴ then converts the raw materials into finished goods, parts or components to be later incorporated into finished goods. A large amount of energy is expended through production, which also produces waste products and pollutes the area surrounding the manufacturing facility.⁸⁵ Finished goods are then packaged and

⁸³ See Sachs, *supra* note 21, at 64, 67.

⁸⁴ The terms "manufacturer" and "producer" are used interchangeably in this Note. Both refer to the entity responsible for placing goods in the market for sale. This entity may or may not be the actual factory that assembles the goods.

⁸⁵ See Sachs, *supra* note 21, at 67.

distributed to consumers, either directly or through various supply chains. Packaging later discarded by consumers enters the MSW stream,⁸⁶ and the transportation of goods consumes energy and emits pollution. The consumption phase occurs after the consumer receives the product and uses it.⁸⁷ In the context of electronic products, there tends to be very low energy consumption and rarely any pollution emitted during normal use. Finally, once the product reaches the end of its useful life, it is disposed of or placed into storage.⁸⁸

The environmental costs of disposal depend on the method which is used. If the EOL product is sent to a landfill, as most are,⁸⁹ it will consume landfill capacity and create a risk of environmental contamination.⁹⁰ If the EOL product is recycled for material, energy is consumed during the recycling process. However, a negative resource cost is realized in the recovered materials.⁹¹ For EOL goods which are recycled for energy the opposite is true—material resources are consumed and energy is produced. A true product cycle is created only when materials in discarded EOL products are recovered by their makers for incorporation into their new products, thus creating a closed loop of material usage.⁹²

IV. ELEMENTS OF A SOLUTION

With the issues clearly identified, a realistic solution can be developed which addresses all of these issues. While a “silver bullet” solution which completely resolves all of the problems outlined in the preceding discussion may not be feasible, defining the goals

⁸⁶ Some nations have enacted packaging restrictions to minimize the use of packaging materials in order to reduce the impact on MSW streams. *See, e.g.*, European Parliament and Council Directive 94/62/EC 1994 OJ (L 365) 10, available at <http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31994L0062:EN:HTML> (EU Packaging Directive mandating Member States implement packaging material recycling programs that employ EPR principles similar to the WEEE Directive, discussed *infra* in Part IV.B.1.a).

⁸⁷ Note that the product may or may not pass through multiple consumers who make use of the product.

⁸⁸ POISON PCs, *supra* note 1, at 8 (stating that a large amount of e-waste is currently held in storage limbo).

⁸⁹ GLOBAL FUTURES FOUNDATION, *supra* note 26, at 13.

⁹⁰ *See supra* note 10 and accompanying text.

⁹¹ Some critics of the virtues of recycling argue that the recycling process itself often emits a large amount of pollution to the surrounding area. GATTUSO, *supra* note 24, at 13.

⁹² In a pure sense, the product cycle is still not complete unless the recovered materials are returned to the manufacturer that produced the discarded product and incorporated into the same product line as the discarded product.

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of an ideal solution helps to set a benchmark with which to compare existing solutions and to develop a policy which works towards achieving the ideal end result.

A. *Ideal Goals and Strategies*

The main goal of any comprehensive e-waste policy should be a reduction, if not complete elimination, of the proliferation of hazardous materials into the environment through the e-waste stream. This is achievable at different stages in the product cycle. At the producer level, use of hazardous materials in electronic devices can be restricted, gradually phased out, or completely banned.⁹³ Ideally this would reduce the amount of those substances which enter the product stream in the first place and save the cost of recovering them downstream. Alternatively, at the consumer level, disposal of EOL electronic devices could be regulated to prevent e-waste from being landfilled with non-hazardous MSW. Consumers wishing to dispose of products containing hazardous materials would be required to drop them off with qualified collection centers which would properly process the hazardous materials.⁹⁴

Preventing e-waste from being landfilled mitigates the risk of these substances being released into the environment through landfill incineration or leachate leakage. Proliferation of hazardous materials could also be addressed at the recycler level. Additional oversight, either through government involvement or industry self-enforcement, could be implemented to ensure that only environmentally sound recycling practices which safely process and contain the hazardous substances in e-waste are employed or developed. Producers may also facilitate safer and simpler recycling by designing their products for easier recycling.⁹⁵

⁹³ The European Union has taken the latter route by enacting the European Commission RoHS Directive, which is discussed in further detail in Part IV.B.1.b. *See also* RoHS Directive, *supra* note 16.

⁹⁴ Several states already employ this strategy with respect to CRTs, including: California, Maine, Maryland, Massachusetts, Michigan, Minnesota, Nebraska, Oregon, Pennsylvania, Vermont, Virginia, and Washington. GATTUSO, *supra* note 24, at 18.

⁹⁵ Designing for ease of recycling, or "design for environment" as it has been labeled by the product manufacturer industry, involves simplifying and decontaminating product construction so that EOL products can be deconstructed with minimal labor and with minimized exposure to hazardous material. *See generally* UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, Design for the Environment Partnership Highlights, available at <http://www.epa.gov/dfe/pubs/about/dfe-highlightso0b.pdf> (Mar. 2006). The European Union sought to encourage this by enacting EC WEEE Directive, which is discussed in further detail in Part IV.B.1.a.

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Another important and related goal is to end the harmful practices currently employed by the e-waste trade. These harmful practices include the use of “sweatshop” labor in the processing of recycled e-waste, which occurs either through exports to developing countries or the use of prison labor programs. This goal dovetails with the strategy of encouraging greener design; if the difficulty and risks involved with recycling e-waste are negligible, then the cost of recycling would theoretically be substantially reduced. Doing so would negate, to some extent, the cost advantage of utilizing sweatshop labor alternatives; reducing their use significantly. The government could also intervene to discourage the use of sweatshop labor in the processing of e-waste.⁹⁶ There is, however, a flip side to this policy argument. It could be argued that the e-waste trade is an important means for developing nations to obtain much needed resources and foreign capital to encourage growth in their own economies.⁹⁷ However, improving the safety of processing e-waste does not restrict access to the e-waste industry for these developing nations. Furthermore, those nations would still maintain some cost advantage in labor alone in comparison to labor costs in the United States.

B. *E-waste Policy Strategies Currently in Force and Proposed*

The problems associated with e-waste are only recently becoming a prominent issue in many policymakers’ minds. Therefore, there are relatively few regulatory measures in place both domestically and abroad that are devoted to their resolution. When considering how the United States should approach the problem at a nationwide level, it is helpful to analyze their strategies and results.

⁹⁶ The Basel Convention Treaty and its amendments restrict the overseas transport of hazardous waste to developing countries. See Basel Convention on the Control of Transboundary Movements of Hazardous Waste and Their Disposal, 28 I.L.M. 649 (1989) [hereinafter Basel Convention]. Currently there are 166 nations party to the Basel Convention, not including the United States, which remains only a signatory. Basel Action Network Country Status—Waste Ban Agreements, http://ban.org/country_status/country_status_chart.html (last updated 1/4/2007). The treaty focuses only on the export of hazardous waste and not its production, which is the primary focus of this Note.

⁹⁷ See GATTUSO, *supra* note 24, at 9–10 (noting that e-waste trade creates jobs in developing countries).

1. *E-Waste Legislation in the European Union*

The European Union has taken the approach of shifting a substantial part of the burden of managing e-waste from the government to the producer by introducing two important directives: the Directive on Waste and Electronic Equipment (WEEE Directive)⁹⁸ and the Directive on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS Directive).⁹⁹ Both these directives attempt to address the e-waste problem, but employ two very different methods. They are worth considering because of the substantial impact they have had on the electronics industry worldwide, and the influence they have had on other markets to take similar measures.

a. The WEEE Directive

The WEEE Directive requires the European Union Member States (Member States) to set up e-waste collection systems so that consumers may dispose of their electronic goods free of charge.¹⁰⁰ The WEEE Directive also sets out minimum e-waste recovery rate targets for each Member State to meet¹⁰¹ and mandates that Member States set up waste treatment facilities capable of handling e-waste that meet specific criteria intended to reduce risks to human health and the environment.¹⁰² Most significantly, the directive places the financial burden of “collection, treatment, recovery, and environmentally-sound disposal” of e-waste squarely with the producers.¹⁰³

The WEEE Directive has its roots in Extended Producer Responsibility (EPR) theory.¹⁰⁴ EPR theory adopts the “polluter pays” principle¹⁰⁵ for costs associated with the pollution created

⁹⁸ WEEE Directive, *supra* note 16. Note that EU legislative materials use the term, “waste electrical and electronic equipment,” when referring to e-waste generally, but may also include high voltage electrical equipment in addition to consumer electronics.

⁹⁹ RoHS Directive, *supra* note 16.

¹⁰⁰ WEEE Directive, *supra* note 16, art. 5.

¹⁰¹ *Id.* art. 7. “Recovery” in EU legislation includes operations that, *inter alia*, reclaim materials or energy and storage of materials for such purposes. Council Directive 91/156/EEC, 1991 OJ (L 078) 32, Annex IIB (amending Directive 75/442/EEC on waste).

¹⁰² WEEE Directive, *supra* note 16, art. 6.

¹⁰³ *Id.* art. 8.

¹⁰⁴ EPR theory, which is sometimes also referred to as regulating from “cradle to cradle,” was first proposed by Thomas Lindqvist. Lin, *supra* note 36, at 536.

¹⁰⁵ The Polluter Pays Principle is a central theme found in numerous international environmental agreements and mandates that the entity that produces the pollution (i.e. the “polluter”) should bear the costs associated with the pollution. Sachs, *supra* note 21, n.55.

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and extends the principle to encompass any products placed on the market by the polluter.¹⁰⁶ The objective is to “make the manufacturer of the product responsible for the entire lifecycle of the product and especially for the take-back, recycling and final disposal of the product.”¹⁰⁷ The argument for EPR works on multiple fronts. First, by mandating that producers internalize the costs associated with recycling their products, producers will have an incentive to design their products for ease in recycling in order to minimize their future costs.¹⁰⁸ Along the same lines, the competitive market creates additional incentive to reduce recycling costs because most internalization of costs by producers will be ultimately felt by consumers through higher purchase costs. Conversely, any reduction in these costs would allow the producer to keep its product costs low and potentially attract more consumers. Finally, shifting responsibility of managing e-waste from the government to producers relieves much of the financial burden on municipalities to handle and process e-waste.¹⁰⁹ Essentially, EPR theory works by changing the traditional “cradle to grave” product “cycle” discussed above into a true closed looped, “cradle to cradle” cycle.

The WEEE Directive appears to be aimed squarely at creating this closed loop system to achieve the resource benefits of reduced material use, as well as create a market incentive for producers to design for recyclability and relieve a large part of the e-waste management burden from municipalities. However, a closer look at the implementation of this strategy and empirical data suggest that the WEEE Directive may have missed the mark in some areas.¹¹⁰ As mentioned previously, a key element of EPR theory is creating an incentive for manufacturers to design for ease of recyclability. It is thought that manufacturers, always looking to increase individual profits, will make an effort to reduce the cost of producing

¹⁰⁶ Sachs, *supra* note 21, at 62.

¹⁰⁷ Lin, *supra* note 36, at 536 (*quoting* Thomas Lindqvist).

¹⁰⁸ Lin, *supra* note 36.

¹⁰⁹ Even though harmonization is one of its goals, under the WEEE Directive, individual Member States of the European Union have considerable latitude in allocating burdens between municipalities, consumers, and producers when transposing the directive into local legislation. Sachs, *supra* note 21, at 71. Individual transpositions take into account “national priorities, relative political power of industry, and the state of recycling markets.” *Id.*

¹¹⁰ *See id.* Part III.B.2.

goods by reducing the recycling costs¹¹¹ that have been internalized with the manufacturer through EPRs.¹¹² This is not achieved, however, unless the closed-loop product cycle holds a manufacturer responsible for recovering and recycling only the e-waste generated from its own products.¹¹³ By having manufacturers take “individual responsibility” for their own products, a feedback loop is created where the manufacturer realizes recycling cost savings from its design changes, which also provides incentive to continue to make design changes in the future.¹¹⁴

This exposes a key weakness in the WEEE Directive. While it only requires producers to meet the financial obligations for the management of e-waste created by their own products,¹¹⁵ it gives Member States considerable leeway in how this is affected through their local transpositions of the directive.¹¹⁶ The same article in the directive creating the minimum financial obligations allows producers, in lieu of taking individual responsibility for their own products, to participate in collective e-waste management schemes with other producers.¹¹⁷ Under such a scheme, one or more producers take “collective responsibility”¹¹⁸ by paying into a common fund that goes to a third-party who in turn takes on the recycling obligations for the participating producers.¹¹⁹ From an economic efficiency perspective, this makes a lot of sense because it allows producers to avoid the burden of creating and managing an entire recycling program and to shift the recycling tasks to a dedicated recycler, who is arguably better suited to handle such tasks. It also consolidates similar recycling tasks—collection, sorting and processing e-waste—amongst more than one producer and allows these producers to focus their resources on their primary function, the production of goods. However, this provision may defeat the

¹¹¹ Costs associated with recycling collected e-waste can be saved by reducing labor costs associated with recycling (i.e. designing products that are simpler to disassemble and sort, as well as reduce the hazardous material content).

¹¹² Sachs, *supra* note 21, at 75–80.

¹¹³ *See id.*

¹¹⁴ *Id.*

¹¹⁵ WEEE Directive, *supra* note 16, art. 8.

¹¹⁶ The WEEE Directive was enacted under Article 175 of the European Community Treaty, which merely states that “Member States shall finance and implement the environment policy.” *See* WEEE Directive, *supra* note 16, preamble; EC Treaty (Treaty Establishing the European Community) art. 175, 1997 OJ (C340) 255.

¹¹⁷ WEEE Directive, *supra* note 16, art. 8.

¹¹⁸ Sachs, *supra* note 21, at 76.

¹¹⁹ *Id.*

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key element to EPR theory—encouragement of designing for recyclability¹²⁰—because, unless the participants' financial responsibility is somehow proportional to the actual recycling costs related to their products, the essential feedback loop that communicates any recycling cost savings realized to the producers is severed.¹²¹

Accurately predicting recycling costs and any changes thereof for an electronic device would be difficult, if not impossible, given the complex construction and variety of materials used.¹²² Without accurate recycling cost data, producers will be discouraged from investing in the desired design changes unless they would patently result in recycling cost savings because they have no assurance that they will realize any return on their investment. Even then, an accurate profile of an individual producer's contribution to the collective burden cannot be achieved unless those products entering the e-waste stream that were placed on the market by that producer are identified.¹²³ A producer's contribution to the e-waste collected would give some indication of the rate of obsolescence, reparability, and upgradeability of its products, which would facilitate educated design decisions to optimize these parameters. As Noel Sachs points out, this tracking requirement creates the primary weakness in implementing the WEEE Directive to achieve the goals of EPR theory because an accurate tracking system would substantially increase the transaction costs of a collective scheme.¹²⁴ The additional cost and complexity of managing such a system, which would require the collection entity to not only identify and record the manufacturer of the products received, but also the particular product model and version, would easily dissuade many from doing so. Indeed, many collective schemes implemented thus far have instead opted for flat fees per unit placed on

¹²⁰ Sachs, *supra* note 21, Part III.B.2. This element is also stated as a broad policy mandate in the WEEE Directive. WEEE Directive, *supra* note 15, art. 4(1) ("Member States shall encourage the design and production of electrical and electronic equipment which take into account and facilitate dismantling and recovery . . ."). However, the WEEE Directive does not specify in any more detail how Member States should implement this policy.

¹²¹ Inform, Inc., a leading supporter of WEEE-type legislation in the United States, identifies this as an implementation challenge. See INFORM, INC., THE WEEE AND ROHS DIRECTIVES: HIGHLIGHTS AND ANALYSIS (2003), available at http://www.informinc.org/fact_WEEE.pdf.

¹²² *Id.*

¹²³ Sachs, *supra* note 21, Part. III.B.2, at 75–80.

¹²⁴ See *id.* at 80. This also holds true if the municipal or producer itself performed the collection duties.

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the market according to product class, which are structured to take into account the estimated costs associated with collecting and processing products in those classes.¹²⁵ Thus, it is apparent that these schemes prevent market incentives from encouraging producers to make design changes for ease of recyclability.

Furthermore, because of the freedom Member States have in implementing the WEEE Directive, a “complete chaos” of inconsistent compliance requirements has resulted from the twenty-five different transpositions of the directive.¹²⁶ The nightmare of navigating through more than one compliance scheme further encourages producers to pay into a collective scheme, which, as previously noted, will likely distance the producer from the actual costs of recycling. On top of this, if a producer places its goods “on the market”¹²⁷ in a plurality of Member States (which arguably most do), even the use of collective schemes in each one may not alleviate the burden of ensuring it is in compliance with each state’s local legislation. It could employ a third-party consulting firm, which would take on the administrative burden of registering with and managing duties with each collective or individual scheme in which the producer participates. This of course comes at an additional cost to the producer.

All of these additional compliance costs may drive producers and recyclers to employ illegal e-waste exports through waste brokers, the practice discussed in Part II of this Note. Article 6 of the WEEE Directive specifically allows for the export of e-waste to treatment facilities outside of EU, provided that the exporter can prove the “recovery, reuse and recycling” operation took place in accordance with the directive.¹²⁸ Also, all Member States are parties to the Basel Convention,¹²⁹ which would also restrict the ex-

¹²⁵ *See id.* at 79.

¹²⁶ HUISMAN ET AL., WHERE DID WEEE GO WRONG IN EUROPE? PRACTICAL AND ACADEMIC LESSONS FOR THE US Ch. III (2006).

¹²⁷ A product is placed “on the market” when it is first made available for transfer of ownership in the European Community. This is after a particular unit leaves the manufacturing phase and enters into the distribution phase, either through intermediate distributors or importers, or directly to the end user. It is at this point when the producer is responsible for complying with the active laws of the Member State where the product was first placed on the market. EUROPEAN COMMISSION, GUIDE TO THE IMPLEMENTATION OF DIRECTIVES BASED ON THE NEW APPROACH AND THE GLOBAL APPROACH 18–20 (2000) available at http://ec.europa.eu/enterprise/newapproach/legislation/guide/document/1999_1282_en.pdf.

¹²⁸ WEEE Directive, *supra* note 16, art. 6.

¹²⁹ *See supra* note 96.

portation of hazardous wastes, but it has been suggested that these control measures are largely unenforced.¹³⁰

b. The RoHS Directive

The RoHS Directive forms the other arm of the European Union's package of legislation aimed at reducing hazardous e-waste at the producer level. The directive restricts most uses of lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls, and polybrominated diphenyl ethers in electronic goods.¹³¹ Most electronic and electrical equipment are included in the scope of the directive,¹³² but certain product applications hold tentative exemptions due to technological constraints in developing feasible substitutes for the banned substances.¹³³

Whereas the WEEE Directive utilizes a passive strategy of encouraging green design through EPR, the RoHS Directive takes a "command-and-control"¹³⁴ approach by setting immediate material content restrictions on any qualified goods entering the European Union market.¹³⁵ This decidedly more hard line approach makes sense when dealing with substances that are ubiquitous in electronic goods and pose a high risk to the environment and human health. Waiting for WEEE-based market incentives, if any, to spur producers to make those same material substitutions in their product designs would allow more high-risk products to enter the waste stream during the lag time. Also, as noted above, the WEEE Directive alone may not effectively encourage producers to reduce or eliminate the hazardous substance content in their products at all. Indeed, the RoHS Directive was enacted because the European Parliament and Council recognized the high risk the banned substances posed and because, in spite of the WEEE Directive, "significant" portions of e-waste will find their way into the MSW

¹³⁰ Shabi, *supra* note 4.

¹³¹ RoHS Directive, *supra* note 16, arts. 2, 4.

¹³² Only two whole categories of such products are generally exempted from the RoHS ban: medical devices, and monitoring and control instruments (e.g. smoke detectors, thermostats, etc.). See RoHS Directive, *supra* note 16, art. 4; see also WEEE Directive, *supra* note 16, Annex IA, IB.

¹³³ RoHS Directive, *supra* note 16, art. 4, Annex. Most notably, lead used in the glass of CRTs and electronic components is exempted. *Id.*

¹³⁴ Sachs, *supra* note 21, at 82.

¹³⁵ See RoHS Directive, *supra* note 16, art. 4. The same "on the market" approach under WEEE is used as the triggering event in RoHS. See *supra* note 127.

stream.¹³⁶ It was also created to facilitate the implementation of the WEEE Directive by making e-waste less hazardous to handle.¹³⁷

Given the ubiquity of the banned substances in electronic products, RoHS is tough medicine indeed. Not surprisingly, the directive was not easily swallowed by the electronics industry, which were forced to reconfigure its factories and reevaluate its suppliers to ensure their products bound for the EU market were in compliance.¹³⁸ Industry groups have argued that the directive goes too far in “straitjacketing innovators,”¹³⁹ claiming that the design restrictions impede technological progress and could lead to inferior products.¹⁴⁰ These groups further argue that the result of placing such restrictions on the industry conflicts with the overall environmental goal of the directive—to reduce the environmental and health impact of e-waste. They explain that the rush to achieve and maintain compliance diverts limited research and development resources that could have otherwise been devoted to developing greener and more efficient technologies.¹⁴¹ It is also claimed that the substitute materials likely to be used may have an even greater impact on health and the environment than the banned substances.¹⁴²

The possible impact on public health and safety is of particular concern. Mandating drastic design changes forces product engineers to rely on alternative, unproven technologies in their products, which affect their reliability. And while a malfunction in an iPod linked to the use of a substitute material may not pose an immediate threat to one’s safety, that same malfunction occurring in an airplane’s control system certainly does. One illustrative example stems from the restriction on the use of lead.¹⁴³ Lead was

¹³⁶ See RoHS Directive, *supra* note 16, Preamble.

¹³⁷ See *id.*

¹³⁸ The RoHS Directive was enacted on January 27, 2003 and went into effect when it was published in the *Official Journal of the European Union* on March 2, 2003. See RoHS Directive, *supra* note 16. The directive affected those goods placed on the market beginning July 1, 2006. *Id.* art. 4.

¹³⁹ *Worldwide Implications*, *supra* note 44.

¹⁴⁰ GATTUSO, *supra* note 24, at 17.

¹⁴¹ *Id.* at 13–14; *Worldwide Implications*, *supra* note 44.

¹⁴² GATTUSO, *supra* note 24, at 14–16 (illustrating the higher emissions from several substances banned by the RoHS Directive compared to popular substitutes, as well as the increase in energy consumption during the manufacturing process).

¹⁴³ This example is also especially pertinent because of the electronic industries heavy reliance on the substance, especially in soldering applications. *Id.* at 14.

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commonly used in soldering and plating applications because it helped prevent the formation of “tin whiskers” in tin-lead alloy solders.¹⁴⁴ Tin whiskers are tiny, hair-like protrusions that are believed to form on pure or mostly pure tin surfaces and can cause failures in electronic circuits if they grow long enough.¹⁴⁵ One such failure precipitated the accidental shutdown of a Connecticut nuclear power plant in 2005.¹⁴⁶ The phenomenon presents such a significant risk to electrical failure that NASA has been investigating it since the 1940s and maintains a log of major failures linked to tin whiskers in the aeronautics and aerospace, military, power and telecommunications industries.¹⁴⁷ Without lead, designers are left without the only proven preventative measure against tin whiskers and possible catastrophic failure. The other banned substances present similar problems, for they were chosen by manufacturers for their optimal performance characteristics.¹⁴⁸

Some producers could seek solace in the RoHS Directive’s exemption provision, which allows for interested parties to request to exempt an application from the material ban where substitution is “technically or scientifically impracticable” or will result in “negative environmental, health and/or consumer safety impacts [that] are likely to outweigh such benefits from the ban.”¹⁴⁹ These requests are reviewed during periodic, public stakeholder consultations where interested parties¹⁵⁰ can support or oppose the request

¹⁴⁴ NASA, Basic Information on Tin Whiskers, <http://nepp.nasa.gov/whisker/background/index.htm> (last visited Mar. 15, 2007).

¹⁴⁵ *Id.*

¹⁴⁶ Patricia Daddona, *Reactor Shutdown: Dominion Learns Big Lesson From A Tiny ‘Tin Whisker’*, THE DAY, July 4, 2005. Technicians investigating the incident could only detect the presence of the tin whisker that caused the failure using a high-powered microscope. *Id.*

¹⁴⁷ NASA, TIN WHISKERS: A HISTORY OF DOCUMENTED ELECTRICAL SYSTEM FAILURES, A BRIEFING PREPARED FOR THE SPACE SHUTTLE PROGRAM OFFICE (2006), available at http://nepp.nasa.gov/whisker/reference/tech_papers/2006-Leidecker-Tin-Whisker-Failures.pdf.

¹⁴⁸ Another example is the brominated flame retardants previously used in plastic housings to slow the spread of fire. The RoHS Directive prohibits the use of these substances, and so the risk of fire outbreak is substantially increased until a viable substitute is developed. See GATTUSO, *supra* note 24, at 15–16.

¹⁴⁹ RoHS Directive, *supra* note 16, art. 5. The directive already excludes from its scope most high-reliability applications, such as medical and military devices, most likely for the reasons pointed out *supra*. See *id.* art. 2 (defining the scope of products effected by the directive, which does not include medical devices or military applications).

¹⁵⁰ *Id.* art. 5. “[P]roducers . . . , recyclers, treatment operators, environmental organizations and employee and consumer associations,” are consulted during a stakeholder meeting. *Id.*

using technical or scientific evidence before they are considered for incorporation into the RoHS Directive exemption list.¹⁵¹ The exemption allowance appears to provide a fair compromise to producers, giving their suppliers and factories time to catch up with the material restriction.¹⁵² It also may resolve the risks associated with material substitutions by accounting for scientific and technical progress when new exemptions are proposed.

Unfortunately, the directive still falls short in implementation. The granted exemptions apply to generic applications, not specific products,¹⁵³ which can lead to producer uncertainty regarding whether its product falls within an exemption category.

[T]he categories of product considered to fall within the scope of the legislation are very broad—it is impossible to list every conceivable product that must comply, so the available guidance is often very generic in nature and occasionally ambiguous. . . . [T]he European Court of Justice, the only legal body able to provide an authoritative ruling on RoHS, has yet to judge a test case for “grey area” equipment—no one really knows precisely what may be regarded as “in” or “out.”¹⁵⁴

Adding to the uncertainty of achieving compliance is the RoHS Directive’s complex system of measuring prohibited material content. Because the European Commission recognized that the “total avoidance of [banned substances] is in some instances impossible to achieve, certain concentration values [of banned substances] in materials should be tolerated.”¹⁵⁵ The maximum allowable concentration of banned substances is measured on a percentage by weight basis of any homogenous material found in a single product.¹⁵⁶ This means that the content of each material used in a product must be scrutinized. Under this system, one miniscule piece of “homogenous material” that is non-compliant can render an entire product non-compliant, regardless of total weight. The purpose of this system is clear; imposing a restriction that scru-

¹⁵¹ *Id.* Annex, at 23.

¹⁵² See Pb-free.info, *RoHS Exemptions*, <http://www.pb-free.info/rohsexemptions.htm>.

¹⁵³ See, e.g., RoHS Directive, *supra* note 16, Annex, at 23 (exempting applications of “[m]ercury in straight fluorescent lamps for special purposes.”)

¹⁵⁴ Pb-free.info, *RoHS Exemptions*, <http://www.pb-free.info/rohsexemptions.htm>.

¹⁵⁵ Commission Decision 2005 O.J. (L 214) 65, para.(1) (amending Directive 2002/95/EC).

¹⁵⁶ *Id.* art. 1. A maximum concentration value of 0.1% by weight is allowed for lead, mercury, hexavalent chromium, polybrominated biphenyls and polybrominated diphenyl ethers and 0.01% by weight for cadmium. *Id.*

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tinizes each component of a product forces producers to closely examine each of their suppliers and demand compliant parts from them, thereby extending the reach of the ban throughout the supply chain.

The additional effort and uncertainty in achieving RoHS compliance adds to the cost of placing goods on the market, which may ultimately be felt by the consumer through higher product prices.¹⁵⁷ This may be justified, however, if the consumer is recognized as contributing to the e-waste problem by creating the demand for electronic products. In effect, placing some or all of the financial burden of redesigning electronic products on the consumers is an extension of the “polluter pays” principle, with the consumer being one of the “polluters.”¹⁵⁸

A positive result of the RoHS material restriction is that it evoked an international, industry-wide effort to remove some of the most harmful substances from electronic products.¹⁵⁹ Whether this result justifies the higher product cost and possible safety threats from premature substitutions remains to be seen.

2. *Environmental Policies and Legislation in the United States*

The United States’ national environmental policy as it pertains to e-waste is not nearly as comprehensive as the EU’s. Currently, there is no national legislation in place that mandates EPR’s or material restrictions for producers of electronic products,¹⁶⁰ but the U.S. Environmental Protection Agency (EPA) engages in several voluntary programs aimed at reducing the environmental impact of electronic products.¹⁶¹ A few individual states have also taken the

¹⁵⁷ GATTUSO, *supra* note 24, at 12–13 (citing an electronic industry study that estimates achieving compliance with RoHS will cost European producers \$18 billion and add \$10 to the price of PCs).

¹⁵⁸ *See supra* note 105.

¹⁵⁹ Given the size of the EU market—nearly 500 million citizens with a market of about \$ 11 trillion—most larger, multinational firms produce or sell goods in the EU. Henrik Selin & Stacy D. VanDeveer, *Raising Global Standards: Hazardous Substances and E-Waste Management in the European Union*, 48 no. 10 ENVIRONMENT 7, 14 (Dec. 2006). Even though the EU RoHS Directive only regulates those products bound for the EU market, these firms will more than likely design their all of their goods to comply with the EU standard. *See id.*

¹⁶⁰ Sachs, *supra* note 21, at 86.

¹⁶¹ *See generally*, United States Environmental Protection Agency, Product Stewardship, <http://www.epa.gov/epaoswer/non-hw/reduce/epr/products/electronics.htm> (last visited Mar. 21, 2007).

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initiative of enacting local legislation targeting e-waste and more have proposed similar legislation.¹⁶²

U.S. environmental law as it pertains to products has primarily focused on toxic emissions created during the manufacturing phase of the product cycle.¹⁶³ Historically, "U.S. environmental law has rarely regulated how products should be made, or the materials that should be used."¹⁶⁴ In 1976, Congress enacted the Resource Conservation and Recovery Act (RCRA), which established a framework for the national policy on the management of solid wastes.¹⁶⁵ The RCRA sets strict guidelines and extensive requirements for the disposal, transport, storage, and treatment of hazardous wastes,¹⁶⁶ but the EPA regulations implementing the act exempts small-scale and household generators of such wastes.¹⁶⁷ This means under federal law, households can freely dispose of their hazardous wastes, including electronic products, with the non-hazardous MSW.¹⁶⁸ The inconsistency between the regulation of mid- to large- scale generators, and households reflects a general environmental policy in the United States that tends to focus primarily on industrial contributors to the national environmental impact rather than individuals.¹⁶⁹ By failing to make individual contributions to hazardous waste a priority, the United States' environmental policy has allowed hazardous e-waste to slip through the cracks and into American landfills.¹⁷⁰

¹⁶² GATTUSO, *supra* note 24, at 18.

¹⁶³ Sachs, *supra* note 21, at 88.

¹⁶⁴ *Id.*

¹⁶⁵ Resource Conservation and Recovery Act, 42 U.S.C. § 6902 (setting out RCRA's objectives and national policy).

¹⁶⁶ *See id.* §§ 6902-39(e).

¹⁶⁷ *See* 40 C.F.R. § 261.5(f)(3) (2004) (exempting small-scale generators producing 2.2 pounds of acute hazardous waste or 220 pounds or less of residue or material contaminated by acute hazardous waste per month); 40 C.F.R. § 261.4(b)(1) (2004) (exempting households).

¹⁶⁸ *See id.*

¹⁶⁹ Sachs, *supra* note 21, at 58, 88. The disparity in treatment takes on more meaning when considering that American households generate an estimated 1.6 million tons of hazardous waste annually, compared to a reported 38.3 million tons for non-exempt generators. United States Environmental Protection Agency, Municipal Solid Waste: Household Hazardous Waste, <http://www.epa.gov/epaoswer/non-hw/muncpl/hhw.htm#Figures>; UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, THE NATIONAL BIENNIAL RCRA HAZARDOUS WASTE REPORT, exhibit 1.1 (2006), available at <http://www.epa.gov/epaoswer/hazwaste/data/br05/national05.pdf>.

¹⁷⁰ *See* UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, MUNICIPAL SOLID WASTE IN THE UNITED STATES: 2005 FACTS AND FIGURES (2006), available at <http://www.epa.gov/msw/pubs/mswchar05.pdf>.

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Without statutory authority, the EPA cannot promulgate federal regulations to create binding EPR obligations for producers to recycle their products, or RoHS-like design mandates to restrict the use of hazardous substances in products. Instead, the EPA sponsors programs that seem to have similar environmental goals as the EU's WEEE and RoHS Directives.¹⁷¹ These programs try to achieve these goals through collaboration between government, industry, and, consumer stakeholders.¹⁷² But without legal authority, these programs are entirely non-binding on the participants. The purpose of the programs is to promote voluntary action by all stakeholders to develop responsible management practices in order to reach those goals.¹⁷³

These programs are a good start towards the development of a feasible solution. They create awareness of the problem amongst stakeholders and spur debate over how each can contribute to the solution. As a result of the effort, several prominent manufacturers and retailers have already voluntarily initiated take-back programs.¹⁷⁴ One industry commentator argues that this voluntary effort is enough reason for not enacting regulations that mandate EPR or substance bans.¹⁷⁵ But this position overlooks the fact that only a handful of electronics producers have implemented such programs; even though they are some of the largest producers in the industry, ignoring what the little guy does is partly what caused the e-waste problem to begin with.

Four individual states have enacted local e-waste legislation, all of which are essentially variations on the EU WEEE and RoHS

¹⁷¹ According to the EPA website, these programs are intended to “foster environmentally conscious design and manufacturing; [i]ncrease purchasing and use of more environmentally sustainable electronics; [and i]ncrease safe, environmentally sound reuse and recycling of used electronics.” U.S. EPA Product Stewardship, *supra* note 161.

¹⁷² *Id.*

¹⁷³ See RECYCLING TECHNOLOGY, *supra* note 4, at 3–5 (discussing the National Electronics Product Stewardship Initiative); United States Environmental Protection Agency, Product Stewardship, Electronics: Federal Programs, <http://www.epa.gov/epaoswer/non-hw/reduce/ep/products/ele-programs.htm> (last visited Mar. 10, 2007).

¹⁷⁴ Sony has a well-functioning program in Minnesota to take back Sony products, for example, and Apple recently announced it will take back its iPods for recycling. Sachs, *supra* note 21, at 90. Major computer manufacturers such as Dell, IBM, and Sony, and retailers such as Best Buy, have also established voluntary programs to take back electronic waste, and in some cases they will take back products made by other manufacturers, or sold by other retailers. *Id.*

¹⁷⁵ GATTUSO, *supra* note 24, at 22–23.

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Directive.¹⁷⁶ Like the WEEE Directive, all four aim to create or encourage the creation of recycling systems that will accommodate e-waste.¹⁷⁷ The key difference between them is the approach they take to funding the programs. Both Maryland and Maine mandate that producers and the local government share the financial burden of recycling costs.¹⁷⁸ Washington follows the WEEE Directive more closely and places the entire burden on the producer.¹⁷⁹ These regulations fall victim to the same weaknesses of the EU WEEE Directive; they create EPR's that are not determined by the producer's individual environmental impact, so they do not effectively encourage the producer to improve their product's recyclability.¹⁸⁰

California introduced the Advanced Recovery Fee (ARF), an entirely different funding mechanism, where the consumer contributes program funds at the time of purchase.¹⁸¹ Only "video display device[s] containing a screen greater than four inches, measured diagonally" are covered by California's legislation¹⁸² and the calculation of the ARF only depends on the size of the screen.¹⁸³ Charging consumers up-front fees is similar to the bottle deposit approach often applied to beverage containers. Like the bottle deposit, the ARF is visible to the consumer, so it helps create consumer awareness of his product's environmental impact and encourages purchasers to recycle the product at EOL in order to get what they paid for. Despite these benefits, placing the entire financial burden of recycling a product on the consumer, without correlation to its actual recycling cost, does not allow the consumer to make the informed purchase decisions that are necessary to create a market demand for ecological products.¹⁸⁴

¹⁷⁶ See CAL. PUB. RES. CODE §§ 42460-42486 (Deering 2006) (California); ME. REV. STAT. ANN. tit. 38, § 1610 (2006) (Maine); MD. CODE ANN., ENVIR. §§ 9-1727-1730 (Lexis 2007) (Maryland); WASH. REV. CODE §§ 70.95N.010-.340, 70.95N.900-.902 (2007) (Washington).

¹⁷⁷ See *supra* note 171.

¹⁷⁸ See ME. REV. STAT. ANN. tit. 38, § 1610 (2006); MD. CODE ANN. ENVIR. §§ 9-1727-1730 (Lexis 2007).

¹⁷⁹ See WASH. REV. CODE §§ 70.95N.010-.340, 70.95N.900-.902 (2007).

¹⁸⁰ See *supra* Part IV.B.1.a.

¹⁸¹ See CAL. PUB. RES. CODE §§ 42460-42486 (2003).

¹⁸² *Id.* § 42463(f)(1).

¹⁸³ See *id.* § 42464 (2007). The ARF charged to consumers ranges from \$6 for devices with screens measuring less than 15 inches diagonally to \$10 for devices with screens measuring more than or equal to 35 inches diagonally. *Id.*

¹⁸⁴ See *supra* Part IV.B.1.a.

The California e-waste legislation also includes a substance ban that mirrors the EU RoHS Directive.¹⁸⁵ The substance ban provision makes direct reference to the directive and mandates that the same restriction be adopted for covered electronic products sold in California.¹⁸⁶ California's RoHS legislation essentially imports the design mandates of the EU RoHS into the United States. Because of its close adherence to the RoHS Directive, it also creates the same risks and problems for producers who make rushed substitutions in order to achieve compliance.¹⁸⁷ Another interesting result of California's initiative is that it further extends the EU RoHS ban to cover not only those producers selling products in the European Union, but to those who produce goods for California, regardless of their involvement in the European market. Since most producers prefer to design their goods to be compliant in many markets, rather than maintain separate product lines for individual markets,¹⁸⁸ those that sell their products in California will likely design all their U.S. products to be California RoHS compliant. In effect, it may affect change on a nationwide scale.¹⁸⁹

3. *E-Waste Legislation in Japan*

Japan has its own brand of WEEE legislation that employs EPR strategies to encourage recycling and design for recyclability. The most notable difference from the EU system is that the Japanese system WEEE system creates shared responsibility for recycling e-waste allocated between producers, retailers, consumers, and the government.¹⁹⁰ Also, the Japanese system places different obligations on consumers, depending on the product type. The Home Appliance Recycling Law (SHAR) went into effect in 2001 and targets bulkier electrical and electronic products, such as televisions, air conditioners, refrigerators, and washing machines.¹⁹¹

¹⁸⁵ See CAL. HEALTH & SAFETY CODE § 25214.10 (2007) (prohibiting sale of covered electronic products in California that are prohibited from sale in the EU market by the EU RoHS Directive due to their heavy metal content).

¹⁸⁶ *Id.*

¹⁸⁷ See *supra* Part IV.B.1.b.

¹⁸⁸ See *supra* note 159.

¹⁸⁹ See RECYCLING TECHNOLOGY, *supra* note 4, at 11.

¹⁹⁰ Lin, *supra* note 36, at 542.

¹⁹¹ *Id.* at 541. This law was formerly called the Specified Home Appliance Recycling Law. INFORM, INC., ELECTRIC APPLIANCE RECYCLING IN JAPAN 1 (2003) [hereinafter INFORM, APPLIANCE], available at <http://informinc.org/japanepi.pdf>.

The Revised Law for Promotion of Effective Utilization of Resources (Recycling Promotion Law) went into effect in 2003 and applies to discarded PCs.¹⁹²

Under SHAR, targeted goods must be disposed of at specified collection points and recycled at qualified recycling facilities. The largest producers must collaborate to develop and build an infrastructure of environmentally-sound recycling facilities to transport and process their products.¹⁹³ Other producers must contract with these producers to access their network.¹⁹⁴ The retailers and government are responsible for collecting discarded appliances by receiving goods at drop off points, either at large appliance retail stores or local post offices.¹⁹⁵ Funding for this take-back scheme comes from the consumer, in the form of end-of-life fees, which are collected when the consumer discards the product at a collection center.¹⁹⁶ The consumer must present both a collection fee set by the collection center, which pays for the collection service and a recycling fee set by the individual producer for the product, which reflects the cost of recycling that particular product.¹⁹⁷

After the Recycling Promotion Law went into effect in October 2003, discarded PCs also had to be recycled through the system mandated by the law.¹⁹⁸ The Recycling Promotion Law gives producers and government the same start-up and collection responsibilities as SHAR¹⁹⁹ and program funding still comes from the consumer, but imposes different financial obligations depending on when the discarded PC was purchased.²⁰⁰ Consumers have to pay an ARF at the time of purchase that reflects the cost of recycling for PCs purchased after the law became effective²⁰¹ and there are

¹⁹² INFORM INC., PC RECYCLING IN JAPAN 1 (2004), [hereinafter INFORM, PC] available at <http://informinc.org/japanpc.pdf>. This law amended the original Recycling Promotion Law—covering discarded PCs only from business—to include PCs discarded by households. *Id.*

¹⁹³ Lin, *supra* note 36, at 542.

¹⁹⁴ *Id.*

¹⁹⁵ See INFORM, APPLIANCE, *supra* note 191, at 1.

¹⁹⁶ *Id.* at 2. These fees are set by manufacturers for their own products and range from ¥2,400-¥4,600 (\$21-\$41). RECYCLING TECHNOLOGY, *supra* note 4, at 57.

¹⁹⁷ INFORM, APPLIANCE, *supra* note 191, at 2.

¹⁹⁸ INFORM, PC, *supra* note 192, at 1.

¹⁹⁹ See *id.*

²⁰⁰ *Id.*

²⁰¹ *Id.*

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no end-of-life fees when the consumer discards a PC at a collection center, unless the PC was purchased before the effective date.²⁰²

The Japanese WEEE system has some noteworthy aspects to it. It gives at least the larger producers more individual responsibility than the EU WEEE Directive by forcing them to develop the recycling facilities that will handle their products and allows them to determine the cost of recycling an individual product. It has the efficiency advantages of a collective scheme, but preserves the recycling cost feedback loop because the producers remain physically responsible for treating their own e-waste.²⁰³ However, placing end-of-life fees and additional administrative burdens on the consumer could encourage some to resort to illegal dumping to avoid the hassle.²⁰⁴

V. RECOMMENDATION: PROPOSED STRATEGY AND
FRAMEWORK FOR U.S. E-WASTE POLICY

It is clear that there is an e-waste problem in the world. Given that the United States is one of the largest consumers of electronic products, it should adopt an effective policy to address the issue. The United States should take lessons from the implementation of similar policies in the EU and other nations when considering its own strategy. It is also important for policymakers to acknowledge that the United States is part of the global market and consider the international implication of any action taken domestically.

As shown in the example of the EU implementation of the WEEE Directive, it is important that the U.S. policy work cohesively on the national level. Inconsistency and ambiguity plagues the EU system, which can add transactional costs at every level of the product cycle. Overly burdensome compliance with a solution can quickly mitigate its cost effectiveness and likelihood of participation. Leaving it to individual states to design their own e-waste

²⁰² *Id.*

²⁰³ There is some evidence that the intended effect of encouraging manufacturers to design for ease of recycling was achieved after these laws went into effect. *RECYCLING TECHNOLOGY*, *supra* note 4, at 58.

²⁰⁴ Indeed, after Japan implemented its recycling program that charged consumers both a collection and recycling fee, there was a reported increase in illegal dumping of targeted goods. *See* Lin, *supra* note 36, at 542 (noting that illegal dumping of targeted goods increased 25% the month after SHAR went into effect) and *INFORM, APPLIANCE*, *supra* note 191, at 3. The problem was resolved when the Japanese government tightened the monitoring system. *See id.*

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legislation will likely lead to such inconsistency.²⁰⁵ Also, a “national system could realize economies of scale in many areas”²⁰⁶ by consolidating and focusing common recycling tasks in larger, more efficient recycling centers. However, it may not be initially feasible to enact a national environmental regulation, given the current opposition by influential industry groups²⁰⁷ and lack of public awareness about the problem. Instead, it may have to be sufficient for now to rely on the individual states to create local laws until public awareness and industry catches up. Inconsistencies between state legislation may have to be accepted as a temporary hindrance on national harmonization, but they also offer the opportunity for states to experiment with their own approaches and for empirical data to be collected on the effectiveness of their approaches, which can later be applied to a national system.

When the United States is ready to adopt an official nationwide policy, it should consider the international implications. The EU directives again provide a good example of how an environmental policy adopted in a large market can have a strong influence in others.²⁰⁸ The U.S. policy should address the problems associated with the e-waste trade.²⁰⁹ It may be too soon to sign onto the Basel Convention and make such exports illegal, at least until the recycling infrastructure becomes cost effective here. Until then, the most feasible solution may be to simply reduce the hazards associated with e-waste by taking steps to reduce the amount of harmful substances it contains. Making handling e-waste a safer undertaking in this way may not completely curb the flow of the e-waste trade to developing nations, but it will have several positive, indirect effects. First, it removes the most harmful element from the e-waste trade, the hazardous substances, so those developing nations that rely on the trade can continue to process the waste, but without the ill effects. Second, this will indirectly make such exports less attractive by lowering the cost of domestic

²⁰⁵ This appears to be already happening with the state legislation that has been enacted thus far. *See supra* Part IV.B.2.

²⁰⁶ RECYCLING TECHNOLOGY, *supra* note 4, at 12.

²⁰⁷ *See generally*, GATTUSO, *supra* note 24. On the other hand, there have been signs of support from retailers and recycling industry groups for a uniform national system over independent state systems. RECYCLING TECHNOLOGY, *supra* note 4, at 8.

²⁰⁸ California’s direct reference to the EU RoHS Directive in its substance ban illustrates this influence. *See supra* Part IV.B.2. *See also* Selin & VanDeveer, *supra* note 159, at 15.

²⁰⁹ *See supra* Part II.

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recycling. Lastly, as the cost imbalance gradually swings back and increases the rate of domestic recycling, those developing countries that are reliant on the e-waste trade can be slowly weaned off the inflow of resources, so they will have time to seek out alternatives.

A. Proposed Framework

Like the EU directives, the United States should adopt a policy that works at different stages of the product cycle in order to better meet its environmental goals. But unlike the EU directives, the U.S. policy should take a more moderate approach to EPR by creating shared responsibility between the industry, individual producers, consumers and the public; similar to the Japanese WEEE system, but without overly burdening the consumer with disposal fees. This will create a more equitable distribution of recycling costs between all “polluters” in the product cycle. A shared responsibility approach to handling e-waste incentivizes producers to design products ecologically on multiple fronts, but does not overly burden the producer to do so.

First, a national recycling system must be established to allow consumers to dispose of his EOL products conveniently and free of charge, either along with their MSW or at collection sites. Nothing in the disposal process should discourage the consumer from disposing their EOL products through the appropriate channels, because any additional inconvenience or cost at this stage risks an increase in illegal “midnight dumping” of e-waste.²¹⁰

The national recycling system would be managed by individual states as part of their existing sanitation management programs, but would be federally funded through a specific account comprising of fees collected from producers and consumers. Local municipalities would be in the best position to handle the e-waste collection responsibilities because the MSW collection infrastructure already exists. The actual recycling processing duties may have to be outsourced to private contractors, as is the current practice, until municipal e-waste treatment facilities can be constructed. Local state governments would manage these facilities according to

²¹⁰ This was the initial result of imposing disposal fees in Japan, before the authorities tightened their monitoring of the practice. *See supra* note 204. Monitoring illegal dumping may not be a viable option in the United States, which is geographically more difficult to monitor in terms of individual activities.

recycling guidelines for safe treatment using recycling techniques developed from federally funded research.

Second, the U.S. policy should impose administrative pressure for producers to design for recyclability in order to reduce the cost of recycling. An RoHS-like restriction on the most hazardous substances is an essential element to an effective e-waste solution. However, unlike the EU RoHS Directive, the U.S. RoHS should be gradually phased in to give manufacturers time to adapt. It should also include an immediate exemption provision similar to the RoHS Directive that would accommodate for technical and scientific progress, but decided on an individual basis in order to avoid uncertainty and ambiguity. This focuses the administrative pressure on only those that do not meet the standards and whose products have no reason to be exempted. Because only the products with the highest hazardous substance content will be affected initially, there should not be as many requests for exemptions initially. And since manufacturers are given time to adapt to the gradual lowering of the standard, future requests will likely be kept at a minimum. This would maintain the transactional costs of administering the material restriction at a manageable level.

Keeping in mind the international implications of a material ban, the substances that would be included in the ban should strive to be consistent with other nations' restrictions. This avoids companies serving multiple markets from having to face inconsistent compliance requirements. At this point, most international producers should be capable of meeting the material ban if they have already adapted to the EU RoHS Directive ban, which has been in effect since mid-2006.

Third, producers would be responsible for a large portion of the e-waste recycling costs under this proposed system. Similar to the EU WEEE scheme, any producer that places an electronic product "on the market"²¹¹ in the United States would pay into a collective fund for the management costs of the national recycling system. But in order to provide a financial incentive that achieves the goal of encouraging design for recyclability most effectively, a hybrid fee structure can be administered that captures both the individual and industry contributions to the actual recycling cost. This provides the essential recycling feedback loop necessary to

²¹¹ The criteria for goods to be considered "on the market" would follow the EU standard. *See supra* note 127.

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make EPR work by incentivizing individual design actions and industry-wide standardization.

The individual element of the producer fee must correlate to the recycling cost of the individual product. This is the most important element of the overall framework, but will likely also be the most difficult to achieve due to the complexity of accurately calculating recycling costs. Producers would have to work closely with the recycling centers to determine these costs and to understand the reasons for any changes to these costs that result from design changes. The individual fee would reflect the amount that a product's recycling cost exceeds the lowest cost of recycling similar products. By employing this cost structure, those producers with the most ecological designs would not be penalized for the non-ecological designs of other producers and creates market incentive between competitors to reduce the recycling costs of their product. The total individual obligation should represent the actual individual contribution to the e-waste stream and encourage durability in design. Therefore, it must be calculated based on the units actually recycled rather than the producer's market share.

The industry element of the producer fee would be captured through an industry-wide fee paid by all producers participating in the U.S. market. The industry fee would be calculated based on the average recycling cost of similar products and is paid per unit placed on the market. The purpose of this element of the producer fee is to create industry pressure on producers to collaborate to develop ecological design practices. By calculating this portion of the fee from the industry average, those producers that have developed successful strategies for reducing recycling costs are given incentive to share their ideas with other producers, thereby reducing the average recycling cost and consequently, their fee. As more producers incorporate similar ecological designs, those features will eventually become standard practice in the industry. Downstream, standardization and simplification of product designs also helps reduce the cost of recycling those products, which is realized both on an individual and industry-wide basis.

Finally, in order to create strong market pressure for ecological design, consumers should contribute towards the actual recycling cost for the individual products they purchase. An ARF similar to that collected in California could be added to the product purchase price charged to the consumer at the time of sale and collected from retailers for each unit sold. Collaboration with re-

tailers would be necessary to ensure that this fee would be clearly visible or otherwise available to consumers before they purchase the product so that they can make informed decisions regarding their purchases.²¹² The justification for the additional purchase cost is that consumers' buying decisions have a substantial impact on the e-waste problem, so they should bear some of the burden of the environmental consequences of these decisions. This element creates consumer awareness of the product's environmental impact, but more importantly creates market demand for ecological design. And because this ARF is calculated only as a portion of the shared responsibility of the total recycling cost, it will likely be less burdensome than California's ARF, which is based on consumer-only responsibility.

VI. CONCLUSION

It is clear that there is a growing e-waste problem and the world is in need of an effective solution. The systems in place both here and abroad are flawed because they focus too much of the burden of handling e-waste on too few parties. Overly-burdened parties will naturally seek out means of shifting some of the burden to others, which can lead to harmful results like the e-waste trade that exists today.

EPR principles present an attractive way to shift the burden of cleaning up pollution to those who are deemed responsible for creating the pollution. But as this Note illustrates, when EPR theory is applied narrowly to only hold producers responsible, the goals of the theory may not be achieved. A better way to reach these goals may be to extend EPR further to encompass all those responsible for the environmental costs of products, from the producer to the consumer. Through a wider shared responsibility approach, no one is unfairly left alone holding the bag and the ecological design goals of EPR theory remain within reach.

²¹² The notification system would be similar to the existing EPA Energy Star program, which labels certain electrical and electronic products with its estimated energy consumption rate. *See generally* EPA, Energy Star Program, <http://www.energystar.gov/> (last visited Mar. 15, 2007). Energy Star labeling must be visible to consumers before purchase so that they can make informed purchase decisions. *See generally* 16 C.F.R. § 305.11 (providing detailed descriptions of how labels should appear "for immediate consumer recognition and readability").