POISONING THE POOR FOR PROFIT: THE INJUSTICE OF EXPORTING ELECTRONIC WASTE TO DEVELOPING COUNTRIES

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> "I think the economic logic behind dumping a load of toxic waste in the lowest wage country is impeccable and we should face up to that."[1]

I. INTRODUCTION

Technological innovation coupled with planned product obsolescence has fostered a throwaway culture that has made electronic waste the fastest growing segment of the municipal waste stream in the United States.[2] Annually, Americans discard millions of tons of electronic devices.[3] This waste contains toxic substances known to cause significant physiologic harm or death to humans upon exposure and to degrade the environment when improperly managed.

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1. Memorandum from Lawrence H. Summers to Distribution, World Bank (Dec. 12, 1991), *available at* http://www.whirledbank.org/ourwords/summers.html. The "logic" of Mr. Summer's argument was predicated on a purely economic assumption that the high cost of addressing pollution in developing nations could be offset by dumping the waste in countries whose citizens are unlikely to live long enough to suffer the diseases typically associated with exposure to toxic waste. Despite worldwide condemnation of the comment, Mr. Summer's statement exemplifies an institutionalized perspective that devalues life and encourages the transboundary movement of hazardous waste from rich, developed nations to poor, developing nations. He served until November 2010 as Director of the White House's National Economic Council for President Barack Obama.

2. *Electronic Waste and eCycling*, U.S. ENVTL. PROT. AGENCY, http://www.epa.gov/NE/solidwaste/electronic/index.html (last visited Sept. 17, 2010) [hereinafter *EPA I*] (noting that electronic waste is growing 2–3 times faster than any other waste stream). *See also*, OFFICE OF SOLID WASTE, U.S. ENVTL. PROT. AGENCY, EPA530-R-08-009, ELECTRONICS WASTE MANAGEMENT IN THE UNITED STATES APPROACH 1, at 31 (2008) [hereinafter EPA II], *available at* http://www.epa.gov/waste/conserve/materials/ecycling/docs/app-1.pdf (estimating that 2.3 million tons of TVs, cell phones, and personal computer products were ready for end of life management in 2007). Other electronic devices not covered in the report likely bring the total volume of electronic waste higher.

3. EPA II, *supra* note 2, at 31.

Approximately 82% of electronic waste generated annually in the United States is not recycled and therefore must be discarded.[4] Of the roughly 18% that is collected for recycling and reuse, approximately 50% to 80% is exported to developing countries as "recyclable" or "reusable" material.[5] However, an increasing percentage of this material is unusable and must be discarded by the importing country.[6] In many instances, the importing country lacks facilities to safely recycle or dispose of the material.[7]

Under existing U.S. law, discarded electronic devices, with one exception, are not regulated as hazardous waste.[8] As a result, these wastes have historically been discarded in landfills or incinerated despite the hazards that the wastes present to human health and the environment.[9] Heavy metals contained within the devices occasionally leach into the surrounding environment and contaminate the groundwater. It is estimated that almost half of all toxic heavy metals, including lead, mercury and cadmium, found in municipal landfills originate from electronic waste.[10] When electronic devices are incinerated, toxic materials used to insulate wires or to create the housing for the electronics are released into the atmosphere. As Americans have become more aware of the hazards that electronic waste pose to human health and the environment, an increasing number of states have responded by enacting legislation to prohibit the disposal or incineration of electronic wastes.[11] To date, more than half of the states have passed legislation either banning or significantly restricting the type of electronic waste that can be placed

4. *Id.* at 23.

5. *Id.*

6. *Undercover Operation Exposes Illegal Dumping of E-Waste In Nigeria*, GREENPEACE, http://www.greenpeace.org/international/news/e-waste-nigeria180209 (last visited Sept. 17, 2010) [hereinafter *Greenpeace I*].

7. *Id.*

8. *See* 40 C.F.R. §§ 261.39(a)(5), 261.41 (2008) (excepting the exportation of used cathode ray tubes).

9. *Greenpeace I*, *supra* note 6.

10. Stephen E. Musson et al., *RCRA Toxicity Characterization of Discarded Electronics Devices*, 40 ENVTL. SCI. & TECH. 2721 (2006) (reporting that of 13 different types of electronic devices tested using either the standard TCLP or modified versions, every device leached lead above its toxicity characteristic level). *See also*, JIM PUCKETT ET AL., BASEL ACTION NETWORK, EXPORTING HARM: THE HIGH-TECH TRASHING OF ASIA (2002), *available at* http://amath.colorado.edu/computing/Recycling/EWaste.pdf.

11. PUCKETT ET AL., *supra* note 10.

in landfills or incinerated.[12] This legislation is intended to force manufacturers to take responsibility for the end-of-life management of products they place into the market.[13] However, because the U.S. recycling industry lacks the infrastructure needed to economically recycle many types of electronic waste and because most discarded electronic devices are not regulated as hazardous waste, an increasing volume of this waste is shipped to developing countries. Much of this exported material is dumped in informal reclamation yards in poor communities where destitute migrant workers receive low wages to break electronic components apart in order to extract small quantities of precious metals, such as gold and copper.[14] Adults and children employ archaic reclamation techniques—open air burning of components to recover valuable metals housed inside, for example—which routinely expose them to some of the most toxic compounds on earth. The accumulation of cancer-causing dioxins in the bodies of those who live near these dumps, for example, is among the highest recorded in humans anywhere in the world.[15] Studies show that children working in the dumps have excess levels of lead in their blood and that pregnant women who work in the dumps for extended periods are more likely to suffer a spontaneous abortion.[16] In many areas, pollution from reclamation activities has destroyed the local environment, leaving communities with toxic legacies that pose

12. *See infra* notes 156 and 157 (identifying states with newly enacted disposal bans or restrictions).

13. *See* Substitute H.B. 7249, 2007 Gen. Assemb., Reg. Sess. (Conn. 2007). Connecticut's electronics recycling law requires municipalities to pay for and to arrange for the collection and transportation of certain covered electronic devices (computers, computer monitors, and televisions). *Id.*

14. PUCKETT ET AL., *supra* note 10.

15. *See* Janet K.Y. Chan et al., *Body Loadings and Health Risk Assessment of Polychlorinated Dibenzo-p-dioxins and Dibenzofurans at an Intensive Electronic Waste Recycling Site in China*, 41 ENVTL. SCI. & TECH. 7668, 7672 (2007) (finding that breast milk of women who worked in electronic waste recycling centers had more than twice the concentration of dioxins than women working in a control site and that their placentas had nearly three times the concentration of dioxin than women working in the control site).

16. *See* Anna O.W. Leung et al., *Heavy Metal Concentrations of Surface Dust from E-waste Recycling and Its Human Health Implications in Southeast China*, 42 ENVTL. SCI. & TECH. 2674, 2674 (2008) (finding that 81.8 percent of children aged 1–6 near electronic waste recycling centers had blood lead levels greater than 10μg/dl). *See also* Chan et al., *supra* note 15 at 7672 (finding that pregnant women living near electronic waste recycling centers were more likely to suffer from spontaneous abortion).

significant risks to future generations.[17] The practice of disposing of unwanted electronic waste abroad externalizes the true cost of consumer demand for the latest products, and may force weak, vulnerable communities to choose between pollution and poverty.

In 1994, recognizing that impoverished and minority communities have historically been targeted to host polluting facilities that cause harm to human health and the environment, President William Clinton mandated that each federal agency make the attainment of environmental justice a part of its mission.[18] In response to this mandate, the Environmental Protection Agency's Office of International Affairs created an Action Plan to integrate environmental justice into U.S. activities conducted abroad.[19] In that Plan, the EPA recognized that the "burden of a degraded environment in developing countries has been even greater to minority and low income communities—often with little or no inclusion in the decision-making processes."[20] The EPA also acknowledged that it is "committed to principals of environmental justice both at home and abroad" and declared that its policy actions would "lead to equal environmental protection for all people."[21] In 2009, EPA Administrator Lisa Jackson identified the attainment of environmental justice as one of seven key EPA priorities. She noted that the Agency "must include environmental justice principles in all of [its] decisions . . . and make the protection of vulnerable subpopulations . . . a top priority."[22]

In view of the U.S. federal government's express policy goal of eliminating environmental injustice at home and abroad, the regulatory gaps that permit entities to dump domestically–generated

17. *See* Coby S.C. Wong et al., *Trace Metal Contamination of Sediments in an E-waste Processing Village in China*, 145 ENVTL. POLLUTION 434, 441–42 (2007) (finding that sediments from two rivers near electronic waste recycling centers were contaminated with cadmium, copper, nickel, lead, and zinc). *See also* X.Z. Yu et al., *Distribution of Polycyclic Aromatic Hydrocarbons in Soils at Guiyu Area of China, Affected by Recycling of Electronic Waste Using Primitive Technologies*, 65 CHEMOSPHERE 1500, 1508–09 (2006) (finding that elevated levels of polycyclic aromatic hydrocarbons in the soil resulted from primitive electronic waste recycling activities).

18. Exec. Order No. 12,898, 59 Fed. Reg. 32 (Feb. 16, 1994).

19. OFFICE OF INT'L AFFAIRS [OIA], U.S. ENVTL. PROT. AGENCY, ACTION PLAN FOR INTEGRATING ENVIRONMENTAL JUSTICE (2003).

20. *Id.* at 2–3.

21. *Id.* at 2.

22. Memorandum from Lisa P. Jackson, Adm'r, U.S. Envtl. Prot. Agency, to All EPA Employees (Jan. 12, 2010), *available at* http://yosemite.epa.gov/opa/admpress.nsf/e77fdd4f5afd88a3852576b3005a604f/bb39e443097b5df5852576a9006a5a86!OpenDocument.

electronic waste in poor, vulnerable communities abroad must be closed. Section II of this article briefly examines the current state of electronic waste management in the United States, identifies materials used to manufacture electronic devices that are potentially harmful to human health and the environment, and considers the emerging public health issues associated with improper disposal of electronic waste. Section III explores the existing national and international regulatory schemes governing the management of electronic waste and identifies gaps within existing regimes. Section IV explains the impetus behind the transboundary movement of electronic waste, explores the harm that results from improper management of electronic waste, and provides insight into the current disposal and reclamation practices abroad. Section V explores the management of electronic waste from an environmental justice perspective and explains why environmental justice principals support regulatory change. Section VI provides recommendations for action.

II. ELECTRONIC WASTE: A MOUNTING PUBLIC HEALTH ISSUE

Increasing demand for consumer electronics; the use of toxic chemicals in components; and the lack of widespread, affordable recycling or reuse opportunities in the United States have combined to create significant end-of-life management issues for electronic waste.[23] The United States is the largest consumer of electronic products, yet remarkably little is known about the quantity of the waste generated by the electronics industry or its ultimate fate because there is not a coding system in place to track electronic wastes.[24] However, it is clear that the volume of waste is substantial and growing.[25]

A. Volume of Electronic Waste

As the global market for electronic goods expands, and the lifespan of many of those products shrinks, there has been a rapid growth in the amount of electronic waste being created. The United Nations estimates that 20 to 50 million metric tons, or approximately 22 to 55 million tons, of electronic waste are produced globally each

23. EPA II, *supra* note 2.

24. Paula M. Boland, *E-Waste: The New Face of Transboundary Pollution*, 34 ENVTL. L. REP. 10234, 10243 (2004), *available at* http://www.elr.info/articles/vol34/34.10234.pdf; Carolyn Nunley Cairns, *E-waste and the Consumer: Improving Options to Reduce, Reuse and Recycle*, 2005 PROC. INT'L SYMP. ON ELECTRONICS & ENV'T 237, 240–41.

25. *EPA I*, *supra* note 2.

year.[26] The United States, despite its relatively small population, is a leading contributor to the global electronic waste stream. Americans own approximately 3 billion electronic products.[27] On average, the typical American household contains twenty-four electronic products.[28] Every year, owners discard millions of tons of electronic devices as they become irreparable, broken, or obsolete. Other devices accumulate in storage for later disposal, creating an impending "wave" of obsolete devices that will require proper end-of-life management once the devices enter the waste stream.[29] In 2007, the EPA reported that approximately 2.3 million tons of electronic waste was ready for end-of-life management.[30] However, a later study conducted by Greenpeace reported that the U.S. volume is probably closer to 7.89 million tons.[31] Both studies calculated volumes of waste for only certain types of devices; therefore, the actual volume of electronic waste is likely much larger. Based on the data available, the EPA estimates that consumer electronics currently make up almost 2% of the municipal solid waste stream in the United States and that that percentage is rising quickly.[32]

B. Domestic Recycling of Electronic Waste

Despite having a mature consumer electronics market, one study has shown that the United States has an under-developed collection

26. UNITED NATIONS ENV'T PROGRAMME, E-WASTE, THE HIDDEN SIDE OF IT EQUIPMENT'S MANUFACTURING AND USE (2005), *available at* http://www.grid.unep.ch/product/publication/download/ew_ewaste.en.pdf.

27. U.S. ENVTL. PROT. AGENCY, EPA 530-08-014, FACT SHEET: MANAGEMENT OF ELECTRONIC WASTE IN THE UNITED STATES (2007) [hereinafter EPA III].

28. *Green Geek: Energy-Saving Strategies for Household Electronics*, APPALACHIAN POWER, https://www.appalachianpower.com/save/eNewsletter/2-25-2010/story1.aspx (last visited Apr. 12, 2011).

29. *Statistics on the Management of Used and End-of-Life Electronics*, U.S. ENVTL. PROT. AGENCY, http://www.epa.gov/epawaste/conserve/materials/ecycling/manage.htm (last visited Sept. 17, 2010) [hereinafter *EPA IV*] (noting that of all electronic products sold between 1980 and 2007, approximately 235 million units had accumulated in storage as of 2007).

30. *Id.*

31. Madeleine Cobbing, *Toxic Tech: Not in Our Backyard, Uncovering the Hidden Flows of E-waste,* GREENPEACE (Feb. 2008), http://www.greenpeace.org/raw/content/international/press/reports/not-in-our-backyard.pdf.

32. EPA II, *supra* note 2.

and recovery system for electronic waste.[33] Of the 1.28 billion major electronic devices (computers, mobile phones, and televisions) sold in the United States in 2006, manufacturers report a voluntary recycling rate, on average, of only 9%.[34] Based on the EPA's data, approximately 18% of discarded televisions and computer products were collected for recycling in 2007.[35] Of this amount, the EPA estimates that 50% to 80% was exported for recycling and reuse.[36] However, there is currently no requirement that those devices intended for reuse or component parts pass a functionality test prior to export. As a result, waste traders frequently add unusable devices or components to shipments. For example, approximately 75% of all cathode ray tubes (CRT's) collected in the United States are exported for refurbishing or remanufacturing, but only about 30% are actually suitable for those purposes; the rest are dumped.[37] The remaining 82% of electronic waste ready for end-of-life management that is not separated for recycling or reuse is sent to landfills, incinerated, stored, or exported for disposal.[38] As the assimilative capacity of U.S. landfills continues to decline, an increasing volume of electronic waste is shipped overseas for disposal.[39]

One of the primary impediments to effective recycling is the fact that many electronic products are not designed to be recycled. Many electronic devices are housed in plastic compartments contaminated with brominated flame retardants or polyvinyl chlorides (PVC) that are so toxic that the plastics cannot be recycled for reuse in new products.[40] Most liquid crystal display (LCD) televisions use mercury lamps to light the screen.[41] A typical LCD television has twenty long, thin mercury lamps running side by side throughout the panel that must be removed before the remaining parts of the television can be

33. Cobbing, *supra* note 31, at 50.

34. *Id.* at 19.

35. *Wastes - Resource Conservation - Common Wastes & Materials - eCycling*, U.S. ENVTL. PROT. AGENCY, http://www.epa.gov/epawaste/conserve/materials/ecycling/faq.htm#exported (last visited Sept. 17, 2010) [hereinafter *EPA V*]. *See also* EPA IV, *supra* note 29 (noting that 50 to 80 percent of the waste collected for recycling is legally exported to developing nations).

36. *EPA V*, *supra* note 35; *Greenpeace I*, *supra* note 6.

37. Cobbing, *supra* note 31, at 47.

38. EPA IV, *supra* note 29.

39. *Id.*

40. *The Problem With Electronics: Not Designed For Recycling*, ELECS. TAKEBACK COAL., http://www.electronicstakeback.com/problem/not_designed_for_recycling.htm (last visited Sept 17, 2010).

41. *Id.*

recycled.[42] However, to access the mercury lamps a worker must disassemble the entire television. Because proper recycling of the lamp component is time intensive, costly, and places the worker at risk of mercury exposure, some recyclers elect to toss the entire component into a shredder without reclaiming any of the valuable components.[43] The liquid crystals used to create the display are typically one of the most expensive materials used in the television, but they are not recoverable using existing techniques.[44] In fact, the recommended method of disposal of the crystals is by incineration.[45] In addition to product design problems, electronic components utilize other toxic chemicals that can cause harm to human health and the environment when released.

C. Hazards of Electronic Waste

To meet the complex and technical requirements of today's digital environment, thousands of substances are used to manufacture electronic devices.[46] Computer circuit boards, CRTs, computer batteries, switches, displays, capacitors, transformers, and other components utilize various combinations of toxic heavy metals and other materials that have the potential to cause significant harm to human health and the environment.[47] Nearly half of all heavy metals found in municipal landfills, including lead, mercury, and cadmium, are believed to originate from discarded electronic devices.[48]

Although heavy metals occur naturally, they generally cannot be degraded or destroyed, and thus tend to bioaccumulate in organisms over time.[49] Heavy metals pose such a substantial risk to humans and the environment that 30 countries, including the United States, have

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42. *Id.*

43. *Id.*

44. *Id.*

45. *Id.*

46. NARDONO NIMPUNO ET AL., INT'L CHEM. SECRETARIAT, GREENING CONSUMER ELECTRONICS: MOVING AWAY FROM BROMINE AND CHLORINE 4 (2009), *available at* http://www.cleanproduction.org/pdf/Greening_Consumer_Electronics.pdf.

47. *What's in Electronic Devices*?, GREENPEACE, http://www.greenpeace.org/international/campaigns/toxics/electronics/what-s-in-electronic-devices (last visited Sept. 17, 2010) [hereinafter *Greenpeace II*].

48. *See generally* 1998 Protocol on Heavy Metals to the UNECE Convention on Long-Range Transboundary Air Pollution, June 24, 1998, *available at* http://www.unece.org/env/lrtap/full%20text/1998.Heavy.Metals.e.pdf [hereinafter Protocol].

49. EDITH B. WEIS ET AL., INTERNATIONAL LAW AND POLICY 714–15 (Vicki Been et al. eds., 2d ed. 2007).

agreed to reduce annual emissions of the most dangerous metals.[50] These metals, and other substances used in electronic devices, are highly toxic and can harm individuals, including children and developing fetuses, even at low levels of exposure.[51] Metals and substances of particular concern used in electronic devices are discussed below.

1. Lead

Lead has been regarded as a highly toxic chemical since the early 1900s, yet it is still used in large quantities in electronic devices.[52] It is primarily used in glass television and personal computer CRTs, and to a lesser degree in solder and interconnects.[53] CRTs, on average, contain four pounds of lead.[54] With the recent national switch to digital television signals, the number of older CRTs subject to end-of-life management is expected to increase, resulting in a significant addition of lead and other toxic chemicals to the waste stream.[55]

Lead poisoning can affect nearly every system in the body, and is known to cause learning disabilities, behavioral problems, and, at very high levels, seizures, coma, and even death.[56] Children with high levels of lead may suffer from neurological damage, slowed growth,

50. Protocol, *supra* note 48; *Status of Ratification of the 1998 Aarhus Protocol on Heavy Metals*, UNITED NATIONS ECON. COMM'N FOR EUROPE, http://www.unece.org/env/lrtap/status/98hm_st.htm (last visited Feb. 21, 2011) (identifying 30 countries that have ratified the protocol as of November 2010).

51. *Greenpeace II*, *supra* note 47.

52. Tristan Fowler, *A Brief History of Lead Regulation*, SCI. PROGRESS (Oct. 21, 2008), http://www.scienceprogress.org/2008/10/a-brief-history-of-lead-regulation.

53. *EPA V*, *supra* note 35.

54. Hazardous Waste Management System; Modification of the Hazardous Waste Program; Cathode Ray Tubes and Mercury-Containing Equipment, 67 Fed. Reg. 40,508, 40,509 (June 12, 2002) (to be codified at 40 C.F.R. pts. 260, 261, 264, 268, 270, & 273).

55. Digital Television Transition and Public Safety Act, 3 U.S.C. §§ 3001–3013 (2005) (noting that to receive a digital signal, consumers have to subscribe to a satellite or cable service, purchase a digital-ready television, or buy a set-top converter box. According to some estimates, only 14 percent of televisions are currently recovered for recycling). *See also Where Does All the E-Waste Go*?, GREENPEACE (Feb. 21, 2008), http://www.greenpeace.org/international/news/e-waste-toxic-not-in-our-backyard210208 [hereinafter *Greenpeace III*] (noting that the possibility of a new, significant influx of electronic waste from the switch has local governments concerned). *See also* Dan Miller, *Waste from Analog-to-Digital TV Switch Worries Officials*, NAT'L ASSOC. OF CNTYS. NEWS, Sep. 3, 2007, at 2.

56. *Childhood Lead Poisoning*, CTR. FOR DISEASE CONTROL & PREVENTION, http://www.cdc.gov/lead (last visited Oct. 19, 2010).

hearing impairments, and intense headaches.[57] Children under six years of age are at the greatest risk of health problems from lead exposure.[58] The risk is particularly high in developing countries where studies have linked elevated lead levels to reduced intelligence quotients (IQs) in children living in areas of high poverty.[59] According to the World Health Organization (WHO), lead poisoning reduces a child's IQ by one to three points for each 10 µg/dl lead level.[60] At higher levels, the effect may be even greater.[61]

In adults, lead may cause reproductive problems, high blood pressure and hypertension, nerve disorders, memory and concentration problems, and muscle and joint pain.[62] Based on the severe health impacts of human exposure to lead, the United Nations Commission on Sustainable Development encouraged further efforts to reduce such exposure.[63]

Lead in the environment is known to interfere with photosynthesis and reduce plant yield.[64] It can eradicate populations of bacteria, fungi and other micro-organisms needed to decompose material, and it has been shown to both impair the central nervous system of animals and to inhibit their ability to synthesize red blood cells.[65]

2. Mercury

Mercury is primarily used in small quantities in lighting devices for flat screen displays. Mercury is a well-documented toxic chemical,

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57. *Lead in Paint, Dust and Soil*, U.S. ENVTL. PROT. AGENCY, http://www.epa.gov/lead/pubs/leadinfo.htm (last visited Oct 19, 2010) [hereinafter *EPA VI*].

58. *Id.*

59. Travis J. Riddell et al, *Elevated Blood-Lead Levels Among Children Living in the Rural Philippines*. BULL. WORLD HEALTH ORG. 674, 674–680 (2007).

60. *Id.*

61. ROBERT BULLARD & DAMU SMITH, GLOBAL POVERTY, POLLUTION, AND PUBLIC HEALTH: THREATS TO WORLD SECURITY 3, *available at* http://www.ejrc.cau.edu/summit2/Globalppp.pdf.

62. *EPA VI*, *supra* note 57.

63. *See* UNITED NATIONS HABITAT, THE HABITAT AGENDA GOALS AND PRINCIPLES, COMMITMENTS AND THE GLOBAL PLAN OF ACTION ¶¶ 43(aa), 132 (2003), *available at* http://www.unhabitat.org/downloads/docs/1176_6455_The_Habitat_Agenda.pdf.

64. Hedaya Ahmed Kamel, *Lead Accumulation and Its Effect on Photosynthesis and Free Amino Acids in* Vicia faba *Grown Hydroponically*, 2 AUSTL. J. BASIC & APPLIED SCI. 438, 444 (2008).

65. Deni Greene, *Effects of Lead on the Environment*, LEAD ACTION NEWS, Winter 1993, *available* at http://www.lead.org.au/lanv1n2/lanv1n2-8.html.

even at low doses.[66] It is a non-degradable, persistent toxin known to bioaccumulate in organisms.[67] When inorganic mercury used in electronic devices contacts water, it forms poisonous methyl mercury, which can harm the brain, heart, kidneys, and lungs.[68] Methyl mercury exposure is also known to cause tremors, impair vision and hearing, decrease memory, and impair the immune system regardless of a person's age.[69] High concentrations of methyl mercury in unborn babies and young children may harm the developing nervous system and impair intellectual development.[70]

Mercury released into the environment migrates through the food chain through processes of bioaccumulation and biomagnification.[71] As a result, animals higher on the trophic level are exposed to higher concentrations of mercury that may result in death, reduced reproduction, slowed growth and development, or abnormal behavior.[72] The risks associated with mercury exposure are so significant that the release of mercury is subject to global control.[73]

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66. OFFICE OF POLLUTION PREVENTION & TOXIC SUBSTANCES, U.S. ENVTL. PROT. AGENCY, REPORT TO CONGRESS: POTENTIAL EXPORT OF MERCURY COMPOUNDS FROM THE UNITED STATES FOR CONVERSION TO ELEMENTAL MERCURY, at ix (2009), *available at* http://www.epa.gov/mercury/pdfs/mercury-rpt-to-congress.pdf.

67. AGENCY FOR TOXIC SUBSTANCES & DISEASE REGISTRY, U.S. DEP'T OF HEALTH & HUMAN SERVS., TOXICOLOGICAL PROFILE FOR MERCURY 34 (1999) [hereinafter ATSDR MERCURY], *available at* http://www.atsdr.cdc.gov/toxprofiles/tp46.html#bookmark06.

68. *Id.*

69. *Id*.

70. *Mercury, Basic Information*, U.S. ENVTL. PROT. AGENCY, http://www.epa.gov/mercury/about.htm (last visited Oct. 19, 2010) [hereinafter *EPA VII*].

71. Bioaccumulation is defined as an increase in the concentration of a pollutant from the environment to the first organism in a food chain. *Bioaccumulation & Biomagnification*, MARIETTA COLL. (Apr. 3, 2002), http://www.marietta.edu/~biol/102/2bioma95.html. Biomagnification is the bioaccumulation of a substance up the food chain by transfer of residues of the substance in smaller organisms that are food for larger organisms in the chain. It generally refers to the sequence of processes that result in higher concentrations in organisms at higher levels in the food chain (at higher trophic levels). *Toxic Substances Hydrology Program: Biomagnification*, U.S. GEOLOGICAL SURVEY, http://toxics.usgs.gov/definitions/biomagnification.html (last modified June 4, 2010).

72. *EPA VII*, *supra* note 70.

73. UNITED NATIONS ENV'T PROGRAMME CHEMS. BRANCH, THE GLOBAL ATMOSPHERIC MERCURY ASSESSMENT: SOURCES, EMISSIONS AND TRANSPORT 1 (2008), *available at* http://www.chem.unep.ch/Mercury/Atmospheric_Emissions/UNEP%20SUMMARY%20REPORT%20-%20CORRECTED%20May09%20%20final%20for%20WEB%202008.pdf.

3. Cadmium

Cadmium is used in rechargeable computer batteries, circuit boards, contacts, switches, and the phosphor coating inside most color CRTs.[74] Cadmium is released into the environment from the incineration of municipal waste, and it is extremely toxic, even at low concentrations.[75]

Developmental studies on animals suggest that cadmium may cause skeletal malformations, interfere with fetal metabolism, and impair neurological development.[76] Cadmium exposure may also cause low birth weight.[77] Cadmium targets the kidneys, and high-dose chronic cadmium exposure can cause renal tubular and glomerular damage.[78] Long-term pulmonary and bronchial impairment can result from a single acute exposure to high levels of cadmium.[79] Although the data is limited, the EPA has identified cadmium as a probable carcinogen.[80]

Cadmium bioaccumulates in aquatic and terrestrial organisms.[81] It is toxic to a wide variety of microorganisms, particularly fungi.[82] In fact, exposure to cadmium may completely eliminate certain types of fungi from soils.[83] Fungi play a critical role in ecosystems by transferring nutrients from the organic matter they decompose to other plants by way of the plants' root systems.[84] Cadmium also

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74. Cobbing, *supra* note 31; *see also*, U.S. GEOLOGICAL SURVEY, CADMIUM (2006), *available at* http://minerals.usgs.gov/minerals/pubs/commodity/cadmium/cadmimcs06.pdf.

75. AGENCY FOR TOXIC SUBSTANCES DISEASE REGISTRY, U.S. DEP'T OF HEALTH & HUMAN SERVS., TOXICOLOGICAL PROFILE FOR CADMIUM (2008), *available at* http://www.atsdr.cdc.gov/toxprofiles/tp5.pdf. [hereinafter ATSDR CADMIUM]; *Cadmium Compounds Hazard Summary*, U.S. ENVTL. PROT. AGENCY, http://www.epa.gov/ttn/atw/hlthef/cadmium.html (last updated Nov. 6, 2007).

76. *Cadmium Compounds Hazard Summary*, *supra* note 75.

77. *Id.*

78. *Id.*

79. *Id.*

80. *Integrated Risk Information System: Cadmium*, U.S. ENVTL. PROT. AGENCY, http://www.epa.gov/iris/subst/0141.htm (last visited Oct. 19, 2010).

81. ATSDR CADMIUM, *supra* note 75.

82. INT'L PROGRAMME ON CHEM. SAFETY, ENVIRONMENTAL HEALTH CRITERIA 135: CADMIUM—ENVIRONMENTAL ASPECTS § 3.4, (1992), *available at* http://www.inchem.org/documents /ehc/ehc/ehc135.htm#SectionNumber:3.4.

83. *Id.*

84. *See* F. W. Went & N. Stark, *The Biological and Mechanical Role of Soil Fungi*, 60 PROC. NAT'L ACAD. SCI. 497, 499 (1968), *available at* http://www.ncbi.nlm.nih.gov/pmc/articles/PMC225075/pdf/pnas00120-0153.pdf.

affects the growth of plants and impairs the stomatal opening, transpiration, and photosynthesis.[85]

4. Bromine and Chlorine Based Compounds

Compounds containing bromine or chlorine are used in electronic devices as flame retardants, solvents, dyes, adhesives, and plastic resins.[86] To meet national fire safety standards, manufacturers of electronic devices typically use materials that have high concentrations of brominated flame retardants.[87] Chlorine is used in polyvinyl chloride (PVC) plastics, which are used on internal and external cables or to insulate copper wire.[88]

Bromine- and chlorine-based compounds tend to bioaccumulate in humans and animals, and to disperse as air, water, soil, and sediment pollutants.[89] These compounds are persistent and toxic.[90] When waste containing these compounds is incinerated, highly toxic dioxins and other problematic chemicals are released.[91] Dioxins can cause cancer, endocrine disruption, endometriosis, neurological damage, and birth defects.[92] They may also impair child development and cause reproductive system damage.[93] Because dioxins concentrate in breast milk, newborns are at greatest risk because they receive high

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85. *Id.*

86. NIMPUNO ET AL., *supra* note 46, at 4.

87. *Id.*

88. *Id.*

89. *Id.*

90. *Id.*

91. *Id.*

92. *Id.*; NAT'L TOXICOLOGY PROGRAM, U.S. DEP'T OF HEALTH & HUMAN SERVS., *2,3,7,8-Tetrachlorodibenzo-*p*-Dioxin (TCDD)*, *in* REPORT ON CARCINOGENS (12th ed., 2011), *available at* http://ntp.niehs.nih.gov/ntp/roc/twelfth/profiles/Tetrachlorodibenzodioxin.pdf.

93. *See* M.J. DeVito et al., *Comparisons of Estimated Human Body Burdens of Dioxinlike Chemicals and TCDD Body Burdens in Experimentally Exposed Animals*, 103 ENVTL. HEALTH PERSP. 820 (2000); G. Lebel et al., *Organochlorine Exposure and the Risk of Endometriosis*, 69 FERTILITY & STERILITY 221 (1998); P. Mocarelli et al., *Clinical Laboratory Manifestations of Exposure to Dioxin in Children: A Six-Year Study of the Effects of an Environmental Disaster Near Seveso, Italy*, 256 J. AM. MED. ASS'N 2687 (1986); Paolo Mocarelli et al., *Dioxin Exposure, from Infancy Through Puberty, Produces Endocrine Disruption and Affects Human Semen Quality,* 116 ENVTL. HEALTH PERSP. 70 (2008); A. Pauwels et al., *The Risk of Endometriosis and Exposure to Dioxins and Polychlorinated Biphenyls: A Case-Control Study of Infertile Women*, 6 HUMAN REPROD. 2050 (2001); D. Pelclová et al., *Biochemical, Neuropsychological, and Neurological Abnormalities Following 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) Exposure*, 56 ARCHIVES OF ENVTL. HEALTH 493 (2001).

concentrations directly from the mother's milk.[94] Dioxins are so dangerous that in 1994 the EPA stated in a draft report that there is no safe level of human exposure.[95]

5. Other Hazardous Components

Hexavalent chromium is primarily used in the production of metal housings and to protect electronic devices from corrosion.[96] Inhalation of the material is linked to lung cancer and may cause damage to the nose, throat, or lungs.[97] Dermal contact can result in irritation or damage to the skin or eyes.[98]

Beryllium is a lightweight metal that, due to its ability to conduct heat and electricity, forms a significant part of electrical connectors and battery contacts in many electronic devices.[99] Long-term exposure to beryllium may cause cancer or a fatal condition known as Acute Beryllium Disease.[100]

Barium is a metal used primarily in CRT tubes.[101] Barium exposure can cause a wide range of respiratory, cardiovascular, gastrointestinal, hematological, musculoskeletal, and renal effects.[102] Other toxic materials, including arsenic and antimony, are also used in integrated circuits (i.e. computer chips) that are used in electronic devices.[103]

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94. M. Lorber et al., *Infant Exposure to Dioxin-like Compounds in Breast Milk*, 110 ENVTL. HEALTH PERSP. A325 (2002).

95. 3 U.S. ENVTL. PROT. AGENCY, EPA/600/BP- 92/001B, HEALTH ASSESSMENT DOCUMENT FOR 2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN (TCDD) AND RELATED COMPOUNDS 9-85 (1994). The EPA's assessment of dioxin is still under review.

96. Cobbing, *supra* note 31.

97. *Hexavalent Chromium*, OCCUPATIONAL HEALTH & SAFETY ADMIN., http://www.osha.gov/SLTC/hexavalentchromium/index.html (last visited Dec. 28, 2010).

98. *Id.*

99. *Beryllium Disease*, CLEVELAND CLINIC, http://www.clevelandclinic.org/health/health-info/docs/4300/4308.asp (last visited Oct. 19, 2010).

100. *Id.* (noting that the disease causes respiratory disorder and can be induced when beryllium dust or fumes are inhaled).

101. INDUS. COUNCIL FOR ELEC. EQUIP. RECYCLING, A NEW APPROACH TO CATHODE RAY TUBE (CRT) RECYCLING 7 (2003), *available at* http://www.icer.org.uk/IcerDtiCrtFinal.pdf.

102. AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY, U.S. DEP'T OF HEALTH & HUMAN SERVS., TOXICOLOGICAL PROFILE FOR BARIUM 23–27 (2007) [hereinafter ATSDR BARIUM], *available at* http://www.atsdr.cdc.gov/toxprofiles/tp24.html.

103. F. Paoletti et al., *Fate of Antimony in Municipal Solid Waste Incineration*, 42 CHEMOSPHERE 533, 533–543, (2001) (noting that antimony concentrations in landfill are higher than natural occurring areas).

Exposure to the metals and chemicals used in electronic devices, alone or in combination, presents significant human health and environmental hazards. Despite regulating many of these materials as hazardous substances, the EPA does not regulate the materials as hazardous when they are encased within an electronic component. In theory, the metals and other substances are non-dispersible while incorporated in the component and, therefore, do not pose a risk of harm when the component is disposed of properly. However, the EPA's approach fails to account for the realities of improper electronic waste management that occurs when the waste is shipped to developing countries.

III. REGULATION OF ELECTRONIC WASTE

When the concept of environmental stewardship was taking root in the 1970s and 1980s, the cost of properly disposing of hazardous waste was dramatically increasing.[104] Industrialized countries burdened with large quantities of hazardous waste found a cheap solution in the relatively pristine environments of developing countries that lack regulation.[105] So-called "toxic traders" exploited regulatory gaps within the United States and other developed countries to profit from shipping hazardous waste to developing countries.[106] When the international community became aware of the practice, social outrage provided the impetus to formulate an international solution.[107] However, more than two decades later, the practice continues.

A. Basel Convention and Basel Ban Amendment

The Basel Convention on the Transboundary Movement of Hazardous Waste (the Convention) is the primary multilateral agreement for controlling the movement of hazardous wastes across

104. *Introduction to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal*, SECRETARIAT OF THE BASEL CONVENTION, http://www.basel.int/convention/basics.html (last visited Dec. 26, 2010) [hereinafter *Basel Introduction*]; Jack Lewis, U.S. Envtl. Prot. Agency, The Spirit of the First Earth Day (Jan./Feb. 1990), http://www.epa.gov/history/topics/earthday/ 01.htm (discussing the emergence of the environmental movement in the late 1960s and early 1970s).

105. *See Basel Introduction*, *supra* note 104.

106. *Id.*

107. *Id.*

international boundaries.[108] Its main goal is to ensure that movement of hazardous wastes and other categories of wastes between countries occurs in an environmentally sound manner.[109] Under the Convention, states may only export hazardous waste to another state after receiving the importing state's written consent along with confirmation of the existence of a contract for disposal.[110] Each state is required to take "appropriate measures" to "[p]revent the import of hazardous wastes and other wastes if it has reason to believe that the wastes in question will not be managed in an environmentally sound manner."[111] The importing state, even after providing consent, retains the right to refuse to accept the waste if the waste cannot be disposed of in an environmentally safe manner.[112] Thus, an exporting state may be obligated to re-import its waste if the importing country refuses to accept its shipment.[113] Parties to the Convention cannot engage in the trade of hazardous waste with non-parties absent an agreement that is consistent with the Convention.[114]

Pursuant to the terms of the Convention, states have agreed to reduce the amount of hazardous waste generated and to dispose of hazardous waste that is generated as close to its source as possible.[115] In 1991, the signatory states agreed to a comprehensive liability and compensation scheme to address the transboundary movement of hazardous wastes, including illegal transport.[116] States are required to introduce domestic legislation to prevent and punish illegal traffic in hazardous waste. The Convention also requires that states take "all practical steps to ensure that hazardous waste or other wastes are managed in a manner which will protect human health and the environment against the adverse effects which may result from such

108. Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, Mar. 22, 1989, 28 I.L.M. 657 (1989).

109. *Id.* at art. 2(8) (defining environmentally sound management of hazardous wastes or other wastes as taking all practicable steps to ensure that hazardous wastes or other wastes are managed in a manner which will protect human health and the environment against the adverse effects which may result from such wastes).

110. *Id.* at arts. 4(1)(c), 6(2), 6(3).

111. *Id.* at art. 4(2)(g).

112. *Id.* at art 9.

113. *Id.*

114. *Id.* at art 11.

115. *Id.* at art 4(1), 4(2).

116. Basel Protocol on Liability and Compensation for Damage Resulting from Transboundary Movements of Hazardous Wastes and Their Disposal, art. 1 (1991), *available at* http://www.basel.int/meetings/cop/cop5/docs/prot-e.pdf.

wastes."[117] However, a major shortfall of the Convention is its failure to ban the exportation of hazardous waste. Under the Convention, exporting countries are only required to provide notice to, and receive consent from, countries of import prior to shipping hazardous waste abroad. As a result, the Convention has had the practical effect of legalizing the trade in hazardous waste.

The Convention has been ratified by 170 countries.[118] To date, the United States has not ratified the Convention, in part because of the requirements imposed on members with regard to the control of hazardous waste.[119] Under Annex I, any waste containing lead, mercury, cadmium, beryllium, hexavalent chromium, arsenic, or other listed metals is regulated as hazardous waste.[120] Under Annex III, wastes that are "capable, by any means, after disposal, of yielding another material, e.g., leachate, which possess any of the [hazardous] characteristics listed" are also regulated as hazardous waste.[121] Arguably, these provisions subject most electronic waste to control as hazardous waste. The Convention does not distinguish between recyclable and non-recyclable wastes: the requirements apply to waste subject to final disposal, which is defined to include wastes exported for recycling or re-use.[122]

In 1995, bowing to pressure from environmental groups, parties to the Convention adopted an amendment (Basel Ban Amendment) that prohibited members of the Organization for Economic Co-operation and Development (OECD) from shipping hazardous waste to non-OECD states for any purpose, including recycling and reuse, absent a bilateral agreement.[123] The amendment sought to eliminate the economic pressure placed on poor, non-OECD countries to accept hazardous waste from rich, developed OECD countries. The

117. Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, *supra* note 108, at art. 2(8).

118. *Basel Introduction*, *supra* note 104.

119. WEIS ET AL., *supra* note 49, at 686 (noting that the Senate has given its advice and consent to ratification, but the United States has not deposited its instrument of ratification on the grounds that the necessary implementing legislation to bring the United States into compliance with the agreement has not yet been passed by Congress.

120. Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, *supra* note 108, Annex I.

121. *Id.* at Annex III.

122. *Id.* at art 2(1).

123. *Ban Amendment*, SECRETARIAT OF THE BASEL CONVENTION, http://www.basel.int/pub/baselban.html (last visited Dec. 28, 2010).

United States, an OECD member, vigorously opposed the amendment.[124] Given the restrictions on where and how it would be allowed to transfer its mounting hazardous waste problem, perhaps it is not surprising that the United States refused to ratify the Convention. Instead, the United States adopted a less stringent OECD Council Decision (OECD Decision) governing hazardous waste.[125]

B. OECD and the National Electronic Waste Regulatory Framework

In lieu of ratifying the Basel Convention, the United States opted to sign—along with the twenty-nine other OECD member countries—an agreement that governs the trade in wastes.[126] The list of wastes subject to control under the OECD decision is identical to the list of wastes controlled under the Basel Convention. However, wastes are categorized differently. Under the OECD approach, waste is categorized under green, amber, and red control strategies. Wastes deemed to pose negligible risks for human health and the environment during transboundary movement for recovery are placed in the green category.[127] These wastes are not controlled under the OECD Decision, are not subject to notice and consent provisions, and, therefore, are traded freely as commodities.[128] All electronic wastes, except CRTs, are listed as green wastes and are not subject to

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124. WEIS ET AL., *supra* note 49, at 688.

125. Org. for Econ. Co-operation and Dev., Decision of the Council Concerning the Control of Transfrontier Movement of Wastes Destined for Recovery Operations (C)(92)39 (Mar. 30, 1992) [hereinafter OECD I], *available at* http://sedac.ciesin.org/entri/texts/oecd/OECD-4.18.html.

126. *Id.* There are currently 34 OECD Member countries: Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Slovenia, South Korea, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States. The United States ratified the OECD convention on April 12, 1961, and thereby became bound by council decisions. *See List of OECD Member Countries—Ratification of the Convention on the OECD*, ORG. FOR ECON. CO-OPERATION & DEV., http://www.oecd.org/document/58/0,2340,en_2649_201185_1889402_1_1_1_1,00.html (last visited Jan. 29, 2011).

127. OECD I, *supra* note 125, at App. 3.

128. ORG. FOR ECON. CO-OPERATION & DEV., GUIDANCE MANUAL FOR THE CONTROL OF TRANSBOUNDARY MOVEMENTS OF RECOVERABLE WASTE 11 (2009), *available at* http://www.oecd.org/dataoecd/57/1/42262259.pdf [hereinafter OECD GUIDANCE].

control.[129] Antimony, arsenic, beryllium, cadmium, lead, and mercury are all individually regulated under the more stringent notice and consent provisions of the amber controls, but unlike under the Basel Convention, metals under the OECD Decision are considered non-dispersible and are not controlled once placed into an electronic device.[130] Ironically, CRTs, which are regulated under the amber control provisions, contain lead encased in glass that remains in non-dispersible form until broken down. To date, only CRTs have moved as hazardous waste under amber control strategies. Other materials, including circuit boards, continue to move freely as commodities without additional hazardous waste restrictions.[131] Like the Basel Convention, the OECD decision allows a member to determine whether a waste is hazardous based on its own procedures.[132] Thus, because member countries differ in how they define waste, a material may be considered a waste in one country but a commodity or raw material in another country.[133]

The OECD decision, which is considered a Basel-consistent agreement and therefore legally binding, allows the United States to trade hazardous waste with a party to the Basel Convention as long as the party is also an OECD member.[134] As a result, the United States continues to ship a portion of its hazardous wastes to Mexico.[135] By adopting the OECD Decision the United States is allowed to engage in the trade of hazardous waste largely on its own terms because it is not bound by the Basel Ban and remains free to determine which materials are hazardous and subject to regulation.[136]

Under the OECD decision, a domestic regulated community is subject to the national regulations that implement the agreement.[137]

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129. *Id.* at App. 3 (listing electrical assemblies consisting only of metals or alloys; and electronic scrap, e.g. printed circuit boards, electronic components, wire, etc.; and reclaimed electronic components suitable for base and precious metal recovery).

130. *Id.* at App. 2.

131. *EPA V*, *supra* note 35.

132. OECD GUIDANCE, *supra* note 128.

133. *Id.*

134. WEIS ET AL., *supra* note 49, at 690.

135. *See* COMM'N FOR ENVTL. COOPERATION, TRACKING HAZARDOUS WASTE: IMPROVING THE TRANSBOUNDARY TRACKING OF HAZARDOUS WASTE IN NORTH AMERICA: A REGIONAL APPROACH TO A GLOBAL EFFORT (2007), *available at* http://www.cec.org/Storage/88/8531_hazwaste_tracking_en.pdf.

136. OECD GUIDANCE, *supra* note 128.

137. OECD I, *supra* note 125.

Thus, in the United States, exporters of hazardous wastes must comply with applicable U.S. laws and regulations, which are incorporated in the Resource Conservation and Recovery Act (RCRA).[138] Each country also designates an agency to control its international trade in hazardous waste. For the U.S., that agency is the EPA. This designation charges the EPA with the responsibility for defining what constitutes a hazardous waste. Under the EPA's current approach, most electronic waste escapes regulation as hazardous material.

1. Resource Conservation and Recovery Act

RCRA, Subtitle C is the primary federal law regulating the management and disposal of solid waste, including electronic waste.[139] Under RCRA, the regulation of solid wastes depends on whether the waste is classified as hazardous or non-hazardous. If a waste is classified as hazardous, it is controlled under RCRA through a complex manifest reporting system at the point of generation, during transport, treatment, storage, and disposal to prevent harm to human health and the environment.[140] For solid wastes that are not classified as hazardous, RCRA requires a less rigorous procedure.

Under RCRA, the export of hazardous waste is prohibited unless: 1) the importing country is notified of the shipment and consents to accept the materials; 2) a copy of the EPA Acknowledgment of Consent form accompanies the waste; and 3) the waste conforms to the terms of the consent.[141] The exporter must notify the EPA sixty days before the initial shipment. The EPA examines export notifications and forwards them to the receiving nations and the transit countries.[142]

These requirements do not apply when the United States exports waste to OECD countries for purposes of recovery, which is defined as "activities leading to resource recovery, recycling, reclamation, direct re-use or alternative uses."[143] Moreover, RCRA export provisions only apply when the waste is classified as a hazardous

138. U.S. ENVTL. PROT. AGENCY, EPA-305-K-98-001, INTERNATIONAL TRADE IN HAZARDOUS WASTE: AN OVERVIEW (1998) [hereinafter EPA VIII].

139. Resource Conservation and Recovery Act, 42 U.S.C. § 6901 et seq. (2006).

140. *See generally id.*

141. 40 C.F.R. § 262.52(a), (d) (2009).

142. EPA VIII, *supra* note 138.

143. 40 C.F.R. § 262.58(a) (2009); *id.* § 262.81(k).

waste under RCRA[144] and the waste is subject to RCRA manifesting procedures or to federal (or state equivalent) universal waste management standards.[145] Under the existing domestic regulatory regime, the majority of electronic waste does not meet the first provision and thus most electronic waste escapes more demanding RCRA hazardous waste regulations.

RCRA defines the term "hazardous waste" to include:

> any solid waste "which because of its quantity, concentration, or physical, chemical, or infectious characteristics may: (A) cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible illness; (B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed.[146]

In determining whether a waste qualifies as hazardous, the EPA considers the waste's toxicity, persistence, degradability in nature, potential for accumulation in tissue, flammability, corrosiveness, and other characteristics.[147] The EPA Administrator is required to list a material as hazardous if, inter alia*,* the waste contains any listed toxic constituent and the Administrator makes a finding that the waste is capable of posing a substantial present or potential hazard to human health and the environment when improperly treated, stored, transported or disposed with consideration of the following factors:

> (i) The nature of the toxicity presented by the constituent.
>
> (ii) The concentration of the constituent in the waste.
>
> (iii) The potential of the constituent or any toxic degradation product of the constituent to migrate from the waste into the environment under . . . improper management . . .
>
> (iv) The persistence of the constituent or any toxic degradation product of the constituent.
>
> (v) The potential for the constituent or any toxic degradation product of the constituent to degrade into non-harmful constituents and the rate of degradation.
>
> (vi) The degree to which the constituent or any degradation product of the constituent bioaccumulates in ecosystems.[148]

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144. *See* Wastes - Hazardous Wastes - Waste Types*,* U.S. ENVTL. PROT. AGENCY, *available at* http://www.epa.gov/osw/hazard/wastetypes/listed.htm (last visited Dec. 27, 2010) (listing materials that are not subject to import and export requirements).

145. EPA VIII, *supra* note 138.

146. 42 U.S.C. § 6903(5) (2006).

147. *Id.* § 6921(a).

148. 40 C.F.R. § 261.11(a)(3) (2010).

Although most electronic components contain toxic materials that meet one or more of these requirements, the EPA has elected not to regulate electronic components as hazardous wastes when discarded. This decision is based on the Toxicity Characteristic Leaching Procedure (TCLP) that the EPA uses to assess whether a material is hazardous.[149] The test is designed to simulate what will happen to the waste once it is placed into a landfill and subjected to natural processes. Under the TCLP procedure, a solid waste is considered hazardous if "an extract from a representative sample of the waste contains any listed contaminant in excess of a listed amount."[150]

This approach to defining hazardous waste represents a fundamental departure from the approach used under the Basel Convention. Under the Convention, wastes are deemed hazardous based on intrinsic characteristics—i.e., the presence or absence of a listed toxic material. That is, if a waste contains a listed hazardous substance or is mixed (contaminated) with a listed hazardous substance, the material is regulated as hazardous waste and is subject to notice-and-consent requirements. Conversely, under RCRA, even if a waste contains toxic substances, it will be treated as non-hazardous waste as long as the substance does not leach a listed toxic substance in an amount that exceeds the accepted toxicity characteristic profile amount for that substance.

While the TCLP helps identify wastes that are likely to leach concentrations of contaminants that may be harmful to human health or the environment, the procedure is not applicable to electronic devices because toxic substances of concern are encapsulated within the shell of the electronic component and typically will not leach until the device is broken apart. Thus, under existing testing protocol most electronic devices do not exceed the EPA's toxicity characteristics immediately upon disposal and therefore are not classified as hazardous. However, the TCLP does not address the risks associated with municipal waste incineration, open burning, and shredding—processes that routinely occur during the end-of-life management of electronic waste.

RCRA has incorporated the OECD provisions regarding green, amber, and red controls. Wastes on the green list are subject to

149. *Id.* § 261.24.
150. *Id.*

existing controls normally applied to commercial transactions.[151] Any waste classified as hazardous waste is subject to amber-list controls.[152] Wastes on the amber list are subject to the more stringent notice and consent, and reporting requirements for hazardous waste.[153] Currently, all electronic components, with the exception of CRTs, are listed as green waste and are traded freely as commodities.

If the EPA considered the characteristics of an electronic component when broken apart, the agency would likely recognize that the component presents major risks to human health and the environment. In a disassembled state, most electronic devices meet one or more of the characteristics of a hazardous waste, and many constituents within electronic waste have been shown to present significant health and environmental risks. Until the EPA recognizes the gap in its existing testing procedures, significant quantities of hazardous materials will continue to escape regulation, degrade the environment, and harm human health.

The absence of federal action to stem the rising tide of electronic waste in the United States has placed enormous financial pressures on local governments to find cost-effective and environmentally friendly methods of disposing of the waste. Over the last five years, an increasing number of states have responded by banning or limiting local disposal and by pressuring manufacturers to take greater responsibility for electronic waste they sell within the state.

C. State Response to Electronic Waste Disposal

The EPA has delegated primary responsibility for implementing RCRA hazardous waste requirements to the individual states.[154] While state programs are required to provide at least the minimum level of protection against hazardous waste disposal provided in the federal rules, states are permitted to adopt more stringent disposal requirements. Recently, states have exercised this option by enacting legislation that bans or significantly restricts the disposal or incineration of electronic waste within the state.[155] To date, twenty-four states have passed legislation mandating statewide electronic

151. *Id.* § 262.82.
152. *Id*. § 262.82(i).
153. *Id.* § 262.82(ii); *see also id.* § 262.83(2).
154. EPA VIII, *supra* note 138.
155. *Id.*

waste recycling.[156] In 2010, six additional states introduced similar legislation.[157] The type of electronic waste subject to these recycling laws and manufacturer requirements varies by state, and these differences have led to friction among interested parties that has limited the success of state programs.[158]

Most state electronic waste legislation bans land disposal of CRT monitors, and some go much further. In California, for example, it is illegal to discard desktops, laptops, CRTs, TV monitors, flat-panel televisions, and other electronic devices.[159] California also requires purchasers to pay a fee at the time of purchase that will be used to offset the future recycling or disposal costs of the device. Other states ban "electronic waste" in general or have banned the disposal of certain types of electronic components. Alternatively, some states have passed legislation that creates a future ban on disposal of certain wastes.[160]

The practical effect of recent state activity is to place greater pressure on manufacturers and brokers to collect electronic components that they placed into the market. Because it is much cheaper to ship the waste overseas for processing than it is to recycle or dispose of it domestically, an unintended result of state activity has been to encourage the export of waste to developing countries that are not capable of safely handling the waste.

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156. California, Connecticut, Hawaii, Illinois, Indiana, Maine, Maryland, Michigan, Minnesota, Missouri, New Jersey, New York, New York City, North Carolina, Oklahoma, Oregon, Rhode Island, Texas, South Carolina, Vermont, Virginia, Washington, West Virginia, and Wisconsin currently have some form of electronic recycling legislation enacted. *See Brief Comparison of State Laws on Electronics Recycling*, ELECTRONICS TAKEBACK COAL. (June 22, 2010), http://www.electronicstakeback.com/wp-content/uploads/Compare_state_laws_chart.pdf.

157. Arizona, Georgia, Kentucky, Massachusetts, Ohio, and Utah passed electronics recycling legislation in 2010. *Id.*

158. *Id.* For example, in California, laptops, monitors, televisions, and digital video recorders are covered. In Illinois, the law is much broader and subjects to regulation computers, laptops, monitors, televisions, printers, fax machines, keyboards, Mp3 players, DVD players, VCRs, cell phones, scanners, PDAs, video games, and Zip drives.

159. *See* CAL. CODE REGS. tit. 22, § 66261.9 (2011) (identifying electronic devices, mercury containing devices, cathode ray tubes, and others as universal waste); *id.* § 66273.31 (prohibiting the disposal of universal waste); *see also* CAL. DEP'T OF TOXIC CONTROL, UNIVERSAL WASTE FACT SHEET 1 (2010), *available at* http://www.dtsc.ca.gov/HazardousWaste/UniversalWaste/upload/UW_Factsheet1.pdf (defining universal waste to include electronic devices such as televisions, computer monitors, cell phones, VCRs, computer CPUs, portable DVD players, and other wastes such as CRT's and mercury switches).

160. *See* Electronic Products Recycling and Reuse Act, 415 ILL. COMP. STAT. 150/10 (2011); *id.* at 150/16; *id.* at 150/95 (identifying electronic waste subject to landfill ban beginning in 2012)

IV. TRANSBOUNDARY MOVEMENT OF THE TOXIC WASTE

Historically, the transboundary movement of electronic waste has been justified by economic interests in both the exporting and importing countries, and by the need for technology transfer and information exchange from developed to developing countries. Close inspection of these justifications reveals, however, that the dual goals of allowing developing countries to exploit their comparative advantage and to bridge the digital divide have not been met.

A. Distorted Comparative Advantage

Under conventional economic theory, a country has a comparative advantage in producing a good or processing something if it can do so at a lower cost than any other country, taking into consideration the opportunity costs—i.e., the value of what is given up to do the processing at the lower cost.[161] On the surface, the gain from trade in electronic waste is a strong motivator for both developing and developed countries to engage in such trade. Typically, the cost of complying with domestic regulations for electronic waste disposal in developed nations exceeds the cost of disposal in developing countries that lack similar regulatory regimes.[162] Through trade, developed nations are able to dispose of their wastes at lower cost. Developing countries, in turn, substitute their assimilative capacity for waste to obtain money or other commodities deemed to have high marginal utility in the country's social welfare function.[163]

In some instances, importing countries receive payments for accepting the waste material that exceed the country's gross national product.[164] These facts suggest that wealth is maximized in both countries through trade in waste. Accordingly, large for-profit and

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161. *See generally Comparative Advantage*, LIBRARY OF ECON. & LIBERTY, http://www.econlib.org/library/Topics/Details/comparativeadvantage.html (last visited Dec. 27, 2010).

162. WEIS ET AL., *supra* note 49, at 684.

163. Yuqing Xing & Charles D. Kolstad, *Environment and Trade: A Review of Theory and Issues* 25 (Univ. of Santa Barbara, Dep't of Econ., Working Paper No. 02-96, 1996). Trade may occur based upon the respective marginal utilities (the utility gained (or lost) from an increase (or decrease) in the consumption of that good or service) of the goods that each party has or desires to have. For developing nations, preserving abundant land likely has a lower social utility than using the land for waste assimilation in return for obtaining money or other commodities that are in low supply in that country.

164. WEIS ET AL., *supra* note 49, at 684.

non-profit markets for electronic wastes have emerged in developing countries that are driven by a demand for raw materials.[165]

Trade is a major instrument of economic change in developing countries, and trade in electronic waste can provide significant benefits when that waste is properly reused or recycled. In the United States, the impetus for trade in electronic waste is different but no less compelling. Much electronic waste cannot be economically recycled within the United States, primarily because the domestic collection and recycling industry has not yet developed the capacity to handle the type and volume of waste generated and key recycling facilities have relocated overseas.[166] For example, of the five copper and precious metal smelters in the world equipped to minimize dioxin release, none are located in the United States.[167] Moreover, there are currently no CRT glass furnaces in the United States.[168] Additionally, almost all plastic recycling markets are located overseas.[169] As the collection of electronic waste in the United States increases, and states continue to restrict local disposal, the option to export waste and save money in the process will become more enticing. These facts, coupled with the high costs associated with complying with existing domestic environmental regulations, suggest that it is more beneficial for U.S. entities to export electronic waste to developing nations than to dispose of it within the United States. The emergence of free trade agreements has lowered trade costs, making trade in electronic waste even more financially attractive.[170] When viewed through this financial lens, trade in electronic waste appears both financially sound and morally acceptable because it appears to provide benefits to both parties. However, this view fails to take account of two key problems—lost opportunities for reclamation in

165. ROBERT TONETTI, OFFICE OF SOLID WASTE, U.S. ENVTL. PROT. AGENCY, EXPORT OF USED & SCRAP ELECTRONICS: WHAT YOU NEED TO KNOW 3 (2007), *available at* http://www.epa.gov/epawaste/conserve/materials/ecycling/docs/exports.pdf (noting that smelters exist in Canada, Belgium, Sweden, Germany, and Japan).

166. *See id.*

167. *Id.* at 4.

168. *Id.* at 3.

169. LINDA LUTHER, CONG. RESEARCH SERV., R40850, MANAGING ELECTRONIC WASTE: ISSUES WITH EXPORTING E-WASTE 12 (2010), *available at* http://www.fas.org/sgp/crs/misc/R40850.pdf.

170. *See* Joseph Stiglitz, *Globalism's Discontents*, AM. PROSPECT (Jan. 1, 2002), http://www.prospect.org/cs/articles?article=globalisms_discontents (discussing how the trade-liberalization agenda set by special interests in the North have negatively impacted less-developed countries); *see also* LUTHER, *supra* note 169, at 9–12 (explaining why it is often less expensive to export electronic wastes than to recycle the waste domestically).

the United States and the significant human health and environmental impacts that result from dumping electronic wastes in developing countries that are ill equipped to properly manage or dispose of the waste.

By exporting its electronic waste, the United States abandons the opportunity to recover precious metals and other materials that can be recycled at a net benefit to the U.S. economy and the environment. The U.S. recycling industry remains in its infancy with regard to electronic waste in large part due to its failure to invest in new technology. However, with proper infrastructure development the unique problems posed by electronic waste can be solved.

For example, a small company in Tampa, Florida recently invested $3 million to develop a revolutionary new electronic waste-processing machine.[171] At full capacity, the machine can process 150 million pounds of electronic waste per year without releasing hazardous emissions into the environment or exposing workers to toxins. This system saves a significant volume of virgin natural resources. For example, the automated recycling process recovers 25,000 ounces of gold per year. This, in turn, saves more than 500,000 tons of waste that would have resulted from gold mining activities which, in turn, preserves valuable ecosystem services that would have been destroyed as a result of the mining activities.[172] The machine also processes large volumes of silver, palladium, copper, aluminum, steel, plastic and glass.[173] This small venture, and others like it, demonstrate that technology currently exists to address the growing electronic waste problem.[174]

While developing countries may receive some benefit from importing electronic wastes, the true costs may far exceed any short-

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171. Dave Simanoff, *Recycling Behemoth*, TAMPA TRIB., Nov. 16, 2006, at 1, *available at* 2006 WLNR 19972332.

172. *See Maximum Asset Recovery*, CREATIVE RECYCLING SYS., http://www.crserecycling.com/main.php?p=asset-recovery (last visited Oct. 19, 2010). For example, a single gold ring generates, on average, twenty tons of mine waste. *Id. See also*, *Creative Introduces Revolutionary Electronics Recycling System*, CREATIVE RECYCLING SYS. http://www.crserecycling.com/main.php?p=technology (last visited Jan. 26, 2011) (noting, "[a] complete dust collection and control system attached to a high efficiency particulate air (HEPA) filter ensure a pristine atmosphere" in the recycling process).

173. *Maximum Asset Recovery*, *supra* note 172.

174. *See Responsible Recycling Practices*, U.S. ENVTL. PROT. AGENCY, http://www.epa.gov/osw/conserve/materials/ecycling/r2practices.htm (last visited Dec. 28, 2010).

term financial gains unless the country invests in technology to control pollution. In developing countries, open land has a lower marginal utility compared to cash or other commodities. However, trading assimilative capacity for hazardous waste in exchange for other forms of wealth is beneficial only when the country understands the nature of the risk and has the ability and resolve to manage the waste in an environmentally appropriate manner.[175] Electronic waste reclamation activities introduce a host of persistent, bioaccumulative contaminants that leave a toxic legacy certain to burden future generations. Environmental contamination will likely cause significant cultural shifts, particularly in agrarian communities, as communities are forced to find new means of obtaining safe food and clean water. When viewed through an environmental lens, the exportation of electronic waste to countries that lack the infrastructure to properly dispose of the material is both financially imprudent and morally wrong. Any real benefit that a developing country may receive from accepting electronic waste will accrue only when that country is capable of obtaining economic and social gains from such trade without placing future generations at risk.

B. Bridging the Global Digital Divide

The exchange of technology and scientific knowledge plays a critical role in combating poverty, hunger, disease, illiteracy, and other societal problems on a global scale.[176] Differential access to these drivers of change represents a major cause of the expanding socio-economic gap between rich and poor nations, and poses a major challenge for developing countries.[177] Communications technologies are increasingly becoming the primary global engine of knowledge and expertise redistribution.[178] The internet is central to expanding the global economy, and countries whose people have widespread

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175. The assimilative capacity of an ecosystem relates to the ability of the system to degrade or disperse chemical substances. Where the rate of introduction of pollutants exceeds the system's assimilative capacity for these pollutants, habits and wildlife within the system can suffer adverse results. *See e.g., Water Terms*, BATTLE CREEK WATERSHED CONSERVANCY, http://www.battle-creek.net/glossary.html (last visited Jan. 28, 2011).

176. *See* U.N. Secretary-General, *Bridging The Technology Gap Between And Within Nations*, ¶¶ 1–4, Comm'n on Sci. & Tech. for Dev., U.N. Doc. E/CN.16/2006/2 (Mar. 31, 2006).

177. *Id.* ¶ 5 (noting that almost 60 percent of the differences in income levels between sub-Saharan African and the industrialized countries can be attributed to differences in the stock of knowledge).

178. *See generally* SAKIKO FUKUDA-PARR ET AL., U.N. DEV. PROGRAMME, HUMAN DEVELOPMENT REPORT 2001: MAKING NEW TECHNOLOGIES WORK FOR HUMAN DEVELOPMENT (2001), *available at* http://hdr.undp.org/en/media/completenew1.pdf.

access to it continue to reap enormous benefits from rapid information exchange. Developing countries lag far behind in access to technology, but there is hope. As one commentator has said, "in poorer villages and isolated communities, a well-placed computer, like a communal well or an irrigation pump, may become another development tool, providing essential information about storm warnings and crop prices for farmers, or medical services and legal land records for villagers."[179] However, it is the strong desire for access to technology that makes developing countries acutely vulnerable to exploitation by nations who export large quantities of unusable electronic components under the guise of bridging the digital divide. Frequently, importers must accept shipments primarily composed of unusable waste suitable for disposal in order to obtain a few working computers.[180] One report, for example, suggests that between 25% and 75% of "reusable" electronic equipment imported into Africa cannot actually be reused.[181]

Incapable of reuse, the waste is discarded into the environment or disassembled in reclamation yards prior to disposal.[182] This practice is troubling, yet it continues even though many of the same countries that import electronic waste have experienced explosive growth in domestic sales of electronics. For example, the number of new personal computers sold in China between 1999 and 2007 quadrupled from 5 million to 20 million units.[183] In India, sales of new personal computers rose from 1.6 million in 2001 to 5.4 million in 2006.[184] Between 1994 and 2009, the number of new personal computers sold in Thailand increased from about 10,000 to 1.1 million units.[185] The entry of electronics manufactures into emerging markets has resulted in a corresponding increase in electronic waste. For example, in 2005 China generated approximately 2.5 million tons of domestic

179. PIPPA NORRIS, DIGITAL DIVIDE: CIVIC ENGAGEMENT, INFORMATION POVERTY, AND THE INTERNET WORLDWIDE 40–41 (2001).

180. Jo Kuper & Martin Hojsik, *Poisoning the Poor, Electronic Waste in Ghana,* GREENPEACE (Aug. 2008), http://www.greenpeace.org/raw/content/international/press/reports/poisoning-the-poor-electonic.pdf (noting that in Ghana traders report that to get a shipping container with a few working computers they must accept broken junk like old screens in the same container from exporters in developed countries).

181. *Id.* at 10.

182. Chris Carroll, *High-Tech Trash, Will Your Discarded TV End Up in a Ditch in Ghana*?, NAT'L GEOGRAPHIC (Jan. 2008), http://ngm.nationalgeographic.com/2008/01/high-tech-trash/carroll-text.

183. *See* Cobbing, *supra* note 31, at 21.

184. *Id.* at 28.

185. *Id.* at 34.

electronic waste and is projected to reach 3 million tons in 2010.[186] By exploiting emerging markets in developing countries, electronics manufacturers have exacerbated the existing waste problem by placing additional components into the market that will eventually enter the waste stream. The direct sale of electronics within the emerging markets of developing countries has eliminated any remaining rationale for using those countries as electronic waste dumping grounds. Shipping electronic waste to developing countries under the guise of promoting economic and technological growth is both unwarranted and unjustified. Yet, the practice continues and is likely to increase absent change.

C. Poisoning the Poor for Profit

In addition to toxic metals, many electronic components contain valuable metals such as copper, iron, nickel, aluminum, copper, gallium, gold, manganese, palladium, platinum, silver, and zinc.[187] Historically, the primary economic incentive for recycling used electronics was to recover these precious metals. In a recent effort to cut costs, however, manufacturers have reduced the amount of valuable metal used in electronic components.[188] This, in turn, has made it economically inefficient for recyclers using anything but the most advanced technologies to reclaim the metals in the United States.[189] To reclaim these valuable metals, informal "recycling" dumps have sprung up in developing countries to extract the material.[190] Electronic waste dumps, once concentrated in China, are emerging in Nigeria, Ghana, Pakistan, and India.[191] There, low-paid, migrant workers, including children, use primitive recycling techniques that include breaking components apart, open air burning, and dissolving component parts in strong acids, in order to obtain small quantities of

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186. ALAN WATSON ET AL., TOXIC TRANSFORMERS: A REVIEW OF THE HAZARDS OF BROMINATED & CHLORINATED SUBSTANCES IN ELECTRICAL AND ELECTRONIC EQUIPMENT 6 (Greenpeace Research Labs., 2010), *available at* http://www.greenpeace.to/publications/Toxic-Transformers-2010.pdf

187. *Computer Recycling*, ENCYCLOPEDIA OF EARTH, http://www.eoearth.org/article/Computer_recycling (last updated Aug.29, 2008); *see also Human Health: Nickel and Its Uses—Questions and Answers*, NICKEL INST. (2005), http://www.enia.org/index.cfm/ci_id/14305.htm.

188. *Computer Recycling*, *supra* note 187.

189. *Where Does E-waste End Up?*, GREENPEACE (Feb. 24, 2009), http://www.greenpeace.org/international/en/campaigns/toxics/electronics/the-e-waste-problem/where-does-e-waste-end-up/ [hereinafter *Greenpeace IV*] (noting "the cost of glass-to-glass recycling of computer monitors in the US is ten times more than in China.").

190. *Id.*

191. Cobbing *supra* note 31; Kuper & Hojsik, *supra* note 180, at 5.

valuable metals.[192] Because there are no safety measures in place, the workers are routinely exposed to chemicals—through skin contact and inhalation—that are known to cause physiologic harm or death.[193] The reclamation process results in extreme, localized contamination followed by migration of the contaminants into receiving waters and food chains.[194] Surrounding communities are also exposed to contaminants in toxic smoke, dust, drinking water, and food.[195] Samples from surface water and soil obtained near one electronic waste facility in China revealed elevated concentrations of copper, nickel, cadmium, lead, mercury, and arsenic. For example, concentrations of copper in surface waters were 2.4 to 131 times greater than reference background standards. [196]Concentrations of copper in sediment samples were 3.2 to 429 times the reference background levels. (i.e levels in samples from areas without recycling facilities).[197] Other studies showed that exposure to cancer-causing dioxins and furans—two toxic substances released when wires and cables are burned—from dust and soil around electronic waste recycling facilities were two to three orders of magnitude greater than the exposures from dust and soils in reference locations.[198] Air samples taken from the reclamation areas revealed high concentrations of dioxins and furans.[199] Some samples contained

192. Brett H. Robinson, *E-waste: An Assessment of Global Production and Environmental Impacts*, 408 SCI. TOTAL ENV'T. 183, 188 (2009).

193. *Id.* at 183.

194. *Id.; see also* Wong et al., *supra* note 17, at 434 (finding that trace heavy metals increased in contaminated sediments near electronic waste facilities and exhibited potential to be transported downstream).

195. Wong et al., *supra* note 17, at 434.

196. Yan Guo et al., *Heavy Metal Contamination from Electronic Waste Recycling at Guiyu, Southeastern China*, 38 J. ENVTL. QUALITY 1617, 1620 (2009).

197. *Id.* at 1625.

198. Jing Ma et al., *Concentrations, Profiles, and Estimated Human Exposures for Polychlorinated Dibenzo-p-dioxins and Dibenzofurans from Electronic Waste Recycling Facilities and a Chemical Industrial Complex in Eastern China*, 42 ENVTL. SCI. & TECH. 8252, 8252 (2008) (finding greater health risk for humans from dioxin exposure at electronic waste recycling facilities); *see also* Wong et al., *supra* note 17, at 441–42.

199. *See generally* Huiri Li et al., *Severe PCDD/F and PBDD/F Pollution in Air Around an Electronic Waste Dismantling Area in China*, 41 ENVTL. SCI. & TECH. 5641 (2007).

chemicals known to interfere with sexual development.[200] Studies also have shown that in comparison to women working in a control site, women working in electronic waste recycling areas had more than twice the concentration of dioxins in their breast milk and that their placentas had nearly three times the concentration of dioxin.[201] Other studies revealed that pregnant women living near electronic waste facilities were more likely to suffer a spontaneous abortion.[202] Studies have also shown that children living in an electronic waste recycling area have higher levels of lead in their blood than children living in neighboring areas.[203] Approximately 82% of children one to six years of age living near one electronic waste facility had blood lead levels greater than 10 μg/dl—levels known to negatively impact IQ.[204] The nature and extent of contamination was similar to that found at other open electronic burning sites in China, India, and Russia.[205]

In Guiyu, China, the most studied electronic waste dump site to date, an electronic waste recycling center was established in the middle of a rural, rice-growing community.[206] As large quantities of waste were broken apart and burned, workers routinely inhaled toner, fumes from open air burning of wire housing and desoldering of circuit boards, and acid gases from chip stripping.[207] Children played among the ash heaps that resulted from the open air burning of materials that emit dioxins.[208] The toxins ultimately reached the groundwater, and within five years the groundwater was so contaminated that it became unsafe to drink.[209] Although some water is now trucked into the community, workers still drink and cook with the groundwater.[210] Chromium and barium found in soil samples were 1,338 and 10 times greater, respectively, than the EPA threshold

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200. *See* K. BRIGDEN ET AL., RECYCLING OF ELECTRONIC WASTES IN CHINA & INDIA: WORKPLACE & ENVIRONMENTAL CONTAMINATION 1, 2 (2005), *available at* http://www.greenpeace.org/raw/content/india/press/reports/recycling-of-electronic-wastes.pdf.

201. *See* Chan et al., *supra* note 15, at 7670.

202. *See id.* at 7669.

203. Kuper & Hojsik, *supra* note 180, at 8.

204. Leung, *supra* note 16, at 2674.

205. *See* BASEL ACTION NETWORK, *supra* note 10; *see also* Kuper & Hojsik, *supra* note 180, at 8.

206. BASEL ACTION NETWORK, *supra* note 10, at 15.

207. *Id.* at 17–21.

208. *Id.* at 18.

209. *Id.* at 16.

210. *Id.* at 16, 18.

limits. Once the metals were reclaimed from the electronic devices, the remnants of the device were discarded in irrigation canals once used for rice farming.[211]

Despite increasing public attention and attempts to ban the exportation of electronic waste by some countries, increasing volumes of waste continue to arrive in developing countries, exposing more and more people to harmful toxins.[212] In India, approximately 25,000 workers are employed at electronic waste scrap yards in Delhi alone.[213] Other waste scrap yards have recently been identified in Meerut, Ferozabad, Chennai, Bangalore, and Mumbai.[214] Absent change, workers will continue to be exposed to hazardous materials released from electronic waste during reclamation activities.

As the amount of electronic waste in the United States grows, the trade in hazardous waste is expected to increase.[215] By exporting electronic wastes, manufacturers externalize the true costs of their products at the expense of some of the most vulnerable communities on Earth. In the process, manufacturers retain significant profits that would otherwise be lost to cover the cost of proper recycling and disposal activities. This practice runs counter to principles of environmental justice and must be eliminated.

V. ENVIRONMENTAL JUSTICE AND ELECTRONIC WASTE

According to the United Nations, there is an established link between poverty and the increased risk of exposure to toxic and hazardous chemicals.[216] Worldwide, members of poor communities face an "unacceptabl[y] high risk of poisoning because of their occupation, living location and lack of knowledge of proper chemicals management."[217] This occurs because hazardous wastes generally follow the path of least resistance—that of lower costs and lower

211. *Id.* at 22.

212. *See Greenpeace IV*, *supra* note 189.

213. *Id.*

214. *Id.*

215. *Id.* (noting that there is a growing trade in hazardous waste from Europe to the developing world due to electronic companies' failure to take responsibility for recycling their products).

216. *Scope of the "Harmful Substance and Hazardous Wastes" Sub-Programme*, U.N. ENV'T PROGRAMME, http://www.unep.org/hazardoussubstances/Introduction/tabid/258/language/en-US/Default.aspx (last visited Oct.19, 2010).

217. *Id.*

standards.[218] As a result, activities that emit toxic chemicals into the environment have historically been carried out in areas where land values are depressed; where the residents are poor, uneducated, or otherwise marginalized; and where businesses are likely to encounter little resistance to proceeding. These realities of the political system have taken a heavy toll on vulnerable segments of the world's population, particularly children.[219] One fifth of the world's population lives on less than $1.00 per day and lacks access to adequate food, safe water, clothing, shelter, and health care.[220] These individuals are subjected to a multitude of factors that decrease their life expectancy and degrade their quality of life, yet these are the people that are increasingly targeted by multi-national corporations to be the recipients of the remnants of human prosperity—toxic waste.

It is estimated that more than one quarter of global disease is linked to environmental factors such as chemical exposures.[221] In developing countries, approximately 200,000 accidental deaths occur annually as a result of excessive exposure to, and inappropriate use of, toxic chemicals.[222] The actual number of deaths attributed to chemical exposure is likely much higher because workers exposed to toxic chemicals in developing countries often do not receive appropriate medical care capable of revealing the cause of sickness or death. The transboundary movement of hazardous waste from rich nations to poor nations has the potential to become a major cause of death and disease in developing countries. For example, the environmental and health crisis (contaminated drinking water, untreated human excrement, and air pollution) in South Africa has been blamed, in part, on the importation of hazardous waste.[223]

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218. *See* JENNIFER CLAPP, TOXIC EXPORTS: THE TRANSFER OF HAZARDOUS WASTES FROM RICH TO POOR COUNTRIES 2 (2001).

219. *See* BULLARD & SMITH, *supra* note 61, at 2.

220. *Id*.

221. *See id.*

222. World Health Org., *Strategic Approach to International Chemicals Management*, Sixty-Second World Health Assembly A62/19 Provisional Agenda Item 12.14 (April 23, 2009) *available at* http://apps.who.int/gb /ebwha/pdf_files/A62/A62_19-en.pdf

223. BULLARD & SMITH, *supra* note 61, at 4 (noting "The environmental and health crisis faced by present-day South Africans originates through the combination of poor land, forced overcrowding, poverty, importation of hazardous waste, inadequate sewage, dumping of toxic chemical into the rivers, strip mining of coal and uranium, and outdated methods of producing synthetic fuels.").

The exportation of electronic waste to developing countries represents an extension of the forms of environmental injustice that have plagued communities in the United States for decades. As Robert Bullard has noted:

> The transboundary shipment of hazardous wastes, toxic products, and risky technologies to poor communities in the developed countries of the North and developing countries of the South, the systematic destruction of indigenous peoples' land and sacred sites, the poisoning of Native Americans on reservations, Africans in the oil-rich Niger Delta, African-Americans in Louisiana's Lower Mississippi River petrochemical corridor known as "Cancer Alley," and Mexicans in the border towns along the United States border all have their roots in economic exploitation, racial oppression, devaluation of human life and the natural environment, and corporate greed.[224]

At first glance, the international trade in electronic waste appears to benefit all parties—developed countries address a significant hazardous waste problem in an economically efficient manner while developing countries obtain reusable equipment to bridge the digital divide, salvageable precious metals, and cash that helps boost their economies. However, beneath the veneer of prosperity lies a practice that devalues human life and leaves a legacy of environmental contamination from which vulnerable communities may never recover. Although developed countries are impacted by hazardous chemicals, the potential for harm is particularly acute in developing countries that lack sufficient controls and procedures to eliminate or mitigate the impacts of exposure.[225] In developing countries, toxic chemicals released into the environment contaminate the soil and groundwater. The impact can be catastrophic, particularly for subsistence farmers and agrarian economies.

The United States, on the local, state, and national levels, has a long history of elevating business interests over the welfare of vulnerable individuals.[226] Poor and minority communities have repeatedly suffered from disparate impacts to human health and from the environmental degradation that invariably results when toxic

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224. *Id.* at 5.

225. WEIS ET AL., *supra* note 49, at 707.

226. *See generally* BARRY E. HILL, ENVIRONMENTAL JUSTICE, LEGAL THEORY AND PRACTICE (2009) (analyzing examples of environmental injustice in a wide spectrum of impacted communities throughout the United States).

facilities are sited in close proximity to communities.[227] Workers in the electronic waste processing yards in developing countries share many similarities with individuals in poor communities within the U.S. who have been exploited based on their unique vulnerabilities. Individuals in impoverished communities, regardless of location, are frequently uneducated, and many individuals lack the knowledge or financial ability to make informed decisions regarding whether the low pay they receive exceeds the health and environmental risks posed by the work in which they engage.

As the United Nations has recognized, "the greatest obstacle to our safe use and disposal of chemicals is ignorance" of the risk associated with exposure to toxic substances. [228] Moreover, like disparately impacted groups in the United States, individuals working in electronic reclamation fields in developing countries bear a disproportionate burden of the negative byproducts of economic progress and are forced to internalize the true industrial costs of manufacturing and distributing products. The exportation of electronic waste has left a toxic legacy far removed from the purview of industrial responsibility.

Any short-term monetary benefit from trade in electronic waste is likely to be outweighed by the long-term costs associated with deteriorating health and the inability to utilize natural resources in a contaminated environment. Yet, with full knowledge of this problem, the United States continues to export an increasing amount of electronic and other toxic wastes overseas. This practice is particularly egregious because the developing countries where the activities occur often lack the basic medical infrastructure to respond to poisoning from toxic materials.[229] In some countries, regulatory systems designed to protect workers from harm are virtually non-existent.[230]

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227. *Id.; see, e.g.*, U.S. GOV'T ACCOUNTABILITY OFFICE, GAO/RCED-83-166, SITING OF HAZARDOUS WASTE LANDFILLS AND THEIR CORRELATION WITH RACIAL AND ECONOMIC STATUS OF SURROUNDING COMMUNITIES (1983).

228. Peter L. Lallas, *The Role of Process and Participation in the Development of Effective International Environmental Agreements: A Study of the Global Treaty on Persistent Organic Pollutants (POPs)*, 19 UCLA J. ENVTL. L. & POL'Y 83, 100 (2000/2001) (quoting the executive summary of the International Register of Potentially Toxic Chemicals, written in 1990 by the Director of the United Nations Environment Program International Register of Potentially Toxic Chemicals).

229. WEIS ET AL., *supra* note 49, at 707.

230. *Id.*

Exporting toxic waste to locations where destitute migrant workers and children accept low pay and use archaic reclamation techniques that expose them to chemicals known to significantly impact human health amounts to a form of economic servitude. The practice exploits the weak capacity that developing countries have for environmental and occupational regulation, degrades land and water resources, and represents a direct affront to the principles of environmental justice.

Domestically, the environmental injustice associated with informal processing of electronic waste is reflected in activities carried out in U.S. prisons. For decades, the U.S. prison system has enticed captive laborers to engage in the hazardous process of reclaiming precious metals from used electronic devices by paying the prisoners a slightly higher wage than that available under other prison work programs despite evidence that the activity is harmful to human health.[231] A report on occupational health risks revealed that prisoners who manually break apart CRT components from computer monitors were exposed to much higher levels of lead and cadmium and faced much more serious health risks than other prisoners who were not engaged in the recycling program.[232] The majority of the prisoners engaged in the reclamation activities are poor, uneducated black males.[233] By exploiting the ever-expanding pool of captive prison labor, the risks associated with disposing of hazardous waste are placed on individuals who have few real options. Though such activities appear to violate prisoner rights, the practice continues, largely because the interests of the individuals affected have been marginalized by virtue of their incarceration.[234] Like prisoners, migrant workers in developing countries have little meaningful choice and make decisions based on their unique circumstances and societal status. The decision to engage in harmful activities is not the result of an informed choice made after careful evaluation of available options—the choice is typically made because there are no other

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231. Gopal Dayaneni & Aaron Shuman, *Toxic Sentence: Captive Labor and Electronic Waste*, RACE, POVERTY & THE ENV'T, Spring 2007, at 45–46, *available at* http://www.urbanhabitat.org/files/RPE14-1_Dayaneni-Shuman-s.pdf (noting that the prisoners wages ranged between $0.23 and $1.25 per hour).

232. *Id.* at 46.

233. *See* ANITA S. JACKSON, CTR. FOR ENVTL. HEALTH TOXIC SWEATSHOPS: HOW UNICOR PRISON RECYCLING HARMS WORKERS, COMMUNITIES, THE ENVIRONMENT, AND THE RECYCLING INDUSTRY 28 (2006), *available at* http://svtc.svtc.org/site/DocServer/ToxicSweatshops.pdf?docID=321.

234. *Id.*

viable options. As a result, migrant workers labor with repeated exposure to toxic substances in order to subsist.[235]

A basic tenet of environmental justice is that all people and communities have the right to a healthy environment where they can live, work, learn, and play.[236] Although largely a national construct, principles of environmental justice apply to U.S.-based activities that harm human health and the environment abroad. That process must begin by incorporating environmental justice concepts into domestic environmental laws that affect activities that have an impact outside of the United States. In the context of electronic waste, the concept of hazardous waste must be reevaluated to reflect the realities of improper end-of-life management of electronic components exported to developing countries.

The human health and environmental costs associated with inadequate control of toxic materials is unacceptably high in developing countries and must be addressed.[237] Yet, the practice of disposing of hazardous waste abroad remains legal under existing regulations. The United States must recognize that improper disposal of electronic wastes poisons poor communities abroad and violates many accepted principles of international law. The practice of dumping electronic waste in poor nations is inconsistent with Principles 1 and 21 of the Stockholm Declaration, which provide:

Principle 1:

> Man has the fundamental right to freedom, equality, and adequate conditions of life, in an environment of a quality that permits a life of dignity and well being, and he bears a solemn responsibility to protect and improve the environment for present and future generations.[238]

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235. *See generally* Cobbing, *supra* note 31.

236. *See e.g.*, News Release, U.S. Envtl. Prot. Agency, EPA Hosts Historic Meeting on Environmental Justice / Obama Administration Cabinet Members Show Commitment to Healthy Environment and Strong Economy for All Americans (Sept. 22, 2010), *available at* http://yosemite.epa.gov/opa/admpress.nsf/8b770facf5edf6f185257359003fb69e/d651c10d4a83064 0852577a600583d81.

237. *See* United Nations Conference on Environment and Development, Rio de Janiero, June 3–14, 1992, *Agenda 21*, U.N. Doc. A/CONF.151/26/REV.1 (Vol. II), chs. 19 & 20 (Aug. 12, 1992) (addressing the need for environmentally sound management of toxic substances and hazardous wastes in developing countries).

238. United Nations Conference on the Human Environment, Stockholm, June 5–16, 1972, *Report of the United Nations Conference on the Human Environment* (*"Stockholm Declaration"*), U.N. Doc. A/CONF.48/14/REV.1 (1973), *available at* http://www.unep.org/Law/PDF/Stockholm_Declaration.pdf.

Principle 21:

> States have . . . the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.[239]

Exportation of electronic waste is also inconsistent with Principles 1 and 14 of the Rio Declaration on Environment and Development, which provide:

Principle 1:

> Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature.[240]

Principle 14:

> States should effectively cooperate to discourage or prevent the relocation and transfer to other States of any . . . substances that cause severe environmental degradation or are found to be harmful to human health.[241]

While these principles are largely aspirational and as yet do not constitute binding, substantive norms, 170 countries have recognized the need to reduce or eliminate the exportation of hazardous waste. As one of the largest manufacturers of consumer electronics in the world,[242] the United States must assume a leadership role in developing solutions to the global electronic waste problem.

Nearly twenty years ago, Lawrence Summers urged industrialized nations to recognize the logic of solving their mounting waste problems by dumping waste in the pristine environments of developing countries.[243] Despite worldwide condemnation of Summers' comment, industrialized countries continue to follow the

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239. *Id.*

240. United Nations Conference on Environment and Development, Rio de Janiero, June 3–14, 1992, *Rio Declaration on Environment and Development*, U.N. Doc. A/CONF.151/26/REV.1, Annex I (Aug. 12, 1992), *available at* http://www.un.org/documents/ga/conf151/aconf15126-1annex1.htm.

241. *Id.*

242. *See, e.g.*, Richard McCormack, China Replaces U.S. as World's Largest Exporter: Trade Imbalances Could Cause Financial Upheaval; MAPI Analyst Implores U.S., IMF To Act Now On China's Yuan, MANUFACTURING & TECH. NEWS, Sept. 5, 2006, *available at* http://www.manufacturingnews.com/news/06/0905/art1.html (noting that the U.S. is second only to China in exports of consumer electronics).

243. Memorandum from Lawrence H. Summers, *supra* note 1.

path of least resistance by exporting their hazardous waste to developing countries that lack the regulatory infrastructure to properly dispose of the waste or to protect individuals from harm. In the United States, strict domestic restrictions on landfill disposal, decreasing assimilative capacity, and negative public perceptions regarding local disposal of hazardous wastes have placed increasing pressure on businesses to find alternative methods of disposal. These facts, coupled with a global ban on ocean dumping, strongly suggest that absent change, the volume of electronic waste exported to developing countries will increase dramatically in the near future.[244] Existing regulations must be revised to ensure that electronics manufacturers internalize the true cost of conducting business and do not continue to elevate profit over people.

VI. RECOMMENDATIONS

A. Amend RCRA, Subtitle C to Address Exportation of Electronic Waste

An increasing volume of electronic waste generated and collected within the United States is exported to developing countries that have inadequate facilities to properly manage the waste. As a result, some of the world's most vulnerable communities are routinely exposed to toxic chemicals that impair human health and degrade the environment. This practice continues because the United States has refused to ratify the Basel Convention and because existing domestic regulations fail to recognize the inherent hazardous characteristics of electronic components. If the United States elects to ratify the Basel Convention, the export provisions contained therein will effectively replace those currently in place under RCRA. Though taking such action will bring U.S. export controls in line with those of other industrialized countries, ratification appears unlikely given that the

244. The London Convention, which entered into force in 1975, banned most forms of industrial waste dumping. Ocean incineration was banned in November 1993. *Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter*, INT'L MAR. ORG., http://www.imo.org/About/Conventions/ListOfConventions/Pages/Convention-on-the-Prevention-of-Marine-Pollution-by-Dumping-of-Wastes-and-Other-Matter.aspx (last visited Mar. 5, 2011).

United States has taken no action to ratify the Convention since signing it in 1990.[245] Given this legislative resistance, and the judicial familiarity with the existing RCRA regulatory regime, amending existing RCRA provisions to address the unique problems posed by electronic waste is warranted.

Congress enacted RCRA, inter alia, to protect human health and the environment from potential hazards of waste disposal and to ensure that wastes are managed in an environmentally sound manner.[246] RCRA addresses two types of waste—solid waste and hazardous waste—and subjects each category to different requirements. Electronic waste is particularly problematic from a regulatory standpoint, because it falls in between the two types of waste. When properly managed, electronic waste exhibits characteristics of non-hazardous solid waste. However, when the waste is incinerated, subjected to open-air burning, or acid dissolution—typical end-of-life management practices in developing countries—electronic waste exhibits characteristics of hazardous waste. The EPA has failed to address this problem and has thereby allowed increasing volumes of electronic waste to escape RCRA regulation. As a result, hazardous materials contained within electronic devices are released, causing significant harm to human health and the environment. RCRA must be amended to address this problem.

RCRA should be amended to add a new subchapter regulating the end-of-life management and exportation of electronic waste. At a minimum, the new subchapter should include four primary requirements. First, the TCLP procedure used for classifying other wastes should be replaced with a test that appropriately addresses the risk of harm posed by an electronic device when it is disassembled using existing practices. Under RCRA's existing provisions, hazardous waste regulations assess only how products will react when placed in U.S. landfills. The EPA must reassess this approach for electronic waste. The determination of whether a particular electronic device or component part of a device is hazardous should be based on the inherent chemical characteristics of the device or part, not on the quantitative risk posed. Devices or component parts considered hazardous should be subject to handling and storage requirements

245. *See Parties to the Basel Convention*, SECRETARIAT OF THE BASEL CONVENTION, http://www.basel.int/ratif/convention.htm#13 (last visited Nov. 9, 2010) (noting that the United States signed the Convention on March 22, 1990).

246. *See* 42 U.S.C. § 6901(b) (2006).

similar to those used under the EPA's existing CRT rule.[247] Waste considered hazardous should be subject to handling and storage requirements similar to those imposed for other hazardous waste.

Second, the new RCRA subchapter should prohibit the exportation of any electronic device or component part that fails a functionality test. If a device or component part cannot immediately be reused for its intended purpose, it should be considered electronic waste and managed domestically. This will prevent "sham" recycling practices and ensure that importing countries receive the full benefit from trade designed to bridge the digital divide.

Third, the new RCRA subchapter should ban the exportation of all electronic waste that is characterized as hazardous waste unless the importing country has been certified as having the capacity to dispose of the waste in a manner that protects human health and the environment. While the exact certification requirements may vary to reflect the unique circumstances in each country, the certification procedure should contain minimum requirements related to exposure to, and release of, toxic substances that are, at a minimum, consistent with World Health Organization standards.

Finally, the new subchapter should create individual electronic device classification codes to ensure proper monitoring of the volume and type of wastes exported. Collectively, these changes will provide greater insight into the volume of waste generated, greater control over the transboundary movement of electronic waste, greater awareness of the risk posed by a particular waste shipment, and increased protection to individuals in the importing countries that will process the waste.

In enacting RCRA, Congress recognized that the disposal of solid waste and hazardous waste in or on the land without careful planning and management can present a danger to human health and the environment.[248] Indeed, RCRA was created to "to promote the protection of health and the environment."[249] To that end, section 2002(a)(1) of RCRA empowers the EPA Administrator to

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247. Hazardous Waste Management System; Modification of the Hazardous Waste Program; Cathode Ray Tubes, 71 Fed. Reg. 42,927–49 (July 28, 2006) (to be codified in scattered sections of 40 C.F.R.).

248. 42 U.S.C. § 6901(b).

249. *Id.* § 6902(b).

promulgate regulations "necessary" to carry out the Act's purpose.[250] While the proposed amendments to RCRA will likely pose preliminary challenges to local, state, and federal waste management, there is overwhelming evidence that such change is both necessary and warranted.

B. Require Green Engineering in Design and Materials Use

Closing regulatory gaps that allow the exportation of hazardous electronic waste to countries that lack the ability to properly dispose of the waste is only part of the solution. Such regulatory change does not address the flaws of contemporary electronics design that will continue to pose problems for proper waste management. The environmental and health risks associated with electronic waste largely result from the materials used in manufacturing and the physical design of the devices. One clear solution is to encourage manufacturers to employ green engineering principles in the design and production of electronics.

Green engineering is the "design, commercialization, and use of processes and products, which are feasible and economical while minimizing 1) generation of pollution at the source; and 2) risk to human health and the environment."[251] By incorporating concerns regarding the environment and human health early in the design and development stage of a process or product, green engineering promotes protection while maintaining overall cost effectiveness.[252] Because the use of harmful chemicals in electronics often prevents their safe recycling, the easiest solution to the mounting problem of electronic waste is to replace harmful materials with safer alternatives.

Solving the electronic waste dilemma requires a paradigm shift that recognizes the interrelationship between technological innovation and sustainability. As one advocacy group has opined, "[e]ach new generation of technical improvements in electronic products should include parallel and proportional improvements in environmental, health and safety as well as social justice

250. *Id.* § 6912(a)(10).

251. *What Is Green Engineering*, U.S. ENVTL. PROT. AGENCY, http://www.epa.gov/oppt/greenengineering/pubs/whats_ge.html (last visited Nov. 19, 2009).

252. *Id.*

attributes."[253] Some manufacturers have recognized the importance of achieving this goal. For example, Apple, Inc., has recently committed to re-engineering all of its products to remove elemental forms of bromine and chlorine.[254] Apple also replaced mercury and arsenic in many components by using mercury-free light emitting diodes (LEDs) and arsenic-free display glass.[255] Apple took a calculated risk that investing in the infrastructure changes required to reduce the use of toxic chemicals would result in high consumer demand for its environmentally friendly products. While it is still too early to determine whether Apple's decision will pay off, demand for green electronics is rising.[256]

Major electronics manufacturers have successfully addressed consumer demand for smaller, faster, and more user-friendly devices by critically re-evaluating engineering principles and design. Manufacturers have demonstrated that they have the ability to design electronic products that are more durable, more upgradeable, and fully recyclable without using many of the toxic substances that harm human health and the environment.[257] The industry has also demonstrated the ability to uphold quality while dealing with performance challenges associated with material change. In light of these advances, manufacturers should be encouraged through financial incentives or other means to find innovative ways to eliminate toxic chemicals from their products and to design components for easy recycling. Green engineering represents the most effective strategy to reach these goals.

C. Create Federal Electronic Take-back Program

The failure to design electronics for recycling, coupled with the fact that, for many devices, the cost to recycle exceeds the value that

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253. *Electronic Sustainability Commitment, adopted by the Trans-Atlantic Network for Clean Production* (May 16, 1999), *quoted at Green Design*, CLEAN PRODUCTION ACTION, *available at* http://www.cleanproduction.org/Electronics.Green.php (last visited Jan. 1, 2011).

254. *Apple and the Environment*, APPLE, INC., http://www.apple.com/environment/ (last visited Jan. 1, 2011).

255. *Id.*

256. *See, e.g.*, G*reen Electronics are in Demand*, ELEC. HOUSE (Dec. 3, 2008), http://www.electronichouse.com/article/green_electronics_are_in_demand.

257. *See generally* NIMPUNO ET AL., *supra* note 46 (profiling two major consumer electronics companies, and five component suppliers that have moved beyond compliance with regulatory mandates and have engineered environmental solutions that negate the need for most—and in some cases all—uses of brominated and chlorinated chemicals).

can be extracted, makes voluntary recycling efforts inadequate.[258] In many states, the cost of managing discarded electronic wastes is borne by taxpayers or local governments that are either unwilling or ill-equipped to pay the high costs to recycle the product. Moreover, the patchwork of state electronic waste management regulations that have emerged over the last five years has created confusion among consumers and subjected manufacturers to different, and often inconsistent, requirements.[259] Unlike other issues related to electronic waste management, a consensus is emerging among environmental advocates and industry leaders that a federal take-back program is required to maximize recycling efforts in the United States.[260] To be successful, the program should focus on five areas.

First, the federal program must expressly preempt existing state recycling programs. The patchwork of state programs creates inefficiencies and minimizes economies of scale that might otherwise be achieved under a single, unified approach.[261] Federal preemption is needed primarily because electronics manufacturers do not build devices for use in a single state. Therefore, financial and regulatory requirements related to taking back a particular device should not be dependent on location.

Second, the federal program must provide short-term financial incentives to recyclers to offset the costs associated with recycling electronic waste. Such incentives can be either direct—in the form of tax breaks—or indirect—in the form of expanded equipment depreciation programs designed to offset costs of investment in new technology. Until recycling is made more profitable, the U.S. electronic waste recycling industry will remain immature and governments will be pressured to export the problem.

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258. *See Electronic Waste: Can the Nation Manage Modern Refuse in the Digital Age*? *Hearing Before the H. Comm. on Sci. and Tech.*, 110th Cong. 34 (2008) (statement of Eric Harris, Associate Council, Institute of Scrap Recycling Industries).

259. *Id.* at 53 (statement of Michael Williams, Executive Vice President and General Counsel, Sony Electronics).

260. *Id.* (agreeing that the patchwork of state laws is not working and that federal preemption of electronic recycling is warranted); *id.* at 41 (statement of Ted Smith, Chair, Electronics Take-back Coalition) (agreeing that Congress should establish and fund a National Sustainable Electronics Initiative that, *inter alia*, requires manufacturers to take back and properly manage products they place into the market).

261. *Id*. at 53 (statement of Michael Williams, Executive Vice President and General Counsel, Sony Electronics).

Third, the federal program must expressly preempt existing RCRA provisions that allow individuals to dump household electronic components in landfills. This exemption has created tension and unpredictability in the recycling industry because recyclers cannot anticipate how much waste will be received from consumers or plan ahead based on contractual obligations.[262] Until consumer behavior changes, a sustainable market for recycling will not develop and the industry will remain unwilling to voluntarily collect, transport, and responsibly recycle electronic waste.[263] Forcing manufacturers to collect, transport, and responsibly recycle the electronic devices that they place into the market is the most direct and effective short-term means of changing consumer behavior. Although the cost of compliance with such a mandate will be high, manufacturers remain free to offset the expected cost of this activity by incorporating it into the initial price of the product or by making design changes that make recycling more cost-efficient.

The Sony Electronics Corporation has successfully used this model. Sony teamed with a major recycler to implement the first national recycling initiative that provides U.S. consumers free recycling of any unwanted Sony product.[264] Under its program, Sony takes full manufacturer responsibility for all products that bear the Sony brand.[265] Sony has remained an industry leader despite internalizing the full cost of recycling by designing devices that are easier to recycle and more environmentally friendly. As Sony's experience has demonstrated, when manufacturers are held accountable for the take-back, recycling, and reuse of their own material, manufacturers will adopt sustainable product designs. Manufacturers should be encouraged through regulation to follow Sony's lead.

Fourth, a federal take-back program must include minimum environmental stewardship goals with regard to recycling and disposal. Manufacturers should be required to use recyclers and exporters that have been certified by the EPA as meeting minimum standards for environmentally friendly recycling practices. Such

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262. *Id.* at 29 (statement of Eric Harris, Associate Council, Institute of Scrap Recycling Industries) (asserting that behavioral patterns that lead consumers to dump electronic waste in landfills limit the potential to develop a sustainable market for electronic recycling).

263. *Id.*

264. *Id.* at 50.

265. *Id.*

standards should be promulgated by the EPA and applied to all recyclers. If a sustainable and profitable electronic recycling market develops, recyclers will actively seek such certification that will, in turn, prompt greater investment in the infrastructure needed to properly address the electronic waste problem.

Finally, the new regulatory regime must be structured around effective social marketing campaigns. Consumer behavior will change if consumers are made aware of the unique health and environmental problem posed by electronic waste, and if they are presented with viable options that are easily exercised. The paucity of knowledge related to these issues has caused state recycling efforts to stall because many consumers fail to appreciate the risk of improper electronic waste management and remain unaware of how the problem can be effectively addressed. Social marketing campaigns aimed at educating the public about appropriate recycling and waste disposal practices are likely to result in greater consumer demand for a uniform, voluntary take-back program and increase consumer interest in green electronics.

VII. CONCLUSION

Technological innovation has led to the creation of electronic products that improve efficiency and increase productivity in a variety of human endeavors. High consumer demand, planned product obsolescence, and media manipulation have conspired to create a throwaway society for electronics that has made electronic waste the fastest growing segment of the municipal waste stream in the United States. When improperly managed, electronic waste causes significant harm to human health and the environment. In response to the growing electronic waste stream, recycling entities continue to export this waste to developing countries that have little or no capacity to safely recycle or dispose of the waste. This practice passes the true cost of dealing with the inherent hazards of electronic wastes to vulnerable populations already burdened by poverty, starvation, and disease. To fulfill its mandate to eliminate environmental injustice at home and abroad, the United States must take the steps necessary to close the regulatory gaps that encourage industry to elevate profit over human health and the environment.