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NEWS & ANALYSIS

E-Waste: The New Face of Transboundary Pollution

by Paula M. Boland

I. Introduction

The electronics industry is one of the world's largest and fastest growing manufacturing industries.[1] However, the dynamism of electronic manufacturing that has transformed life in the second half of the 20th century has also resulted in serious environmental and health impacts.[2] Both technological innovation and market expansion continue to accelerate the replacement process and new applications for electronic equipment are continually increasing.[3] These trends have led to the rapid obsolescence of electronic products. Consumers now rarely repair broken electronics since replacement is often cheaper and more convenient and better products are continually emerging. A consequence of this growth, combined with rapid product obsolescence, is that discarded electronics is now the fastest growing waste stream in the industrialized world.[4] Computers, monitors, microwaves, stereos, copiers, television sets, and cellular phones discarded by both the consumer and business are the inevitable byproduct of the technological revolution. The common name for this waste stream is E-waste.

The management of electronic waste has become a national and international concern as the volume of this particular waste stream continues to grow.[5] The same entrepreneurs and companies that benefitted from the technological revolution have failed to apply their brilliance and resources to find the solution for the rapidly growing waste piles. Instead, they are passing along the costs to the public and the environment in the form of delayed cleanup, environmental contamination, destruction of natural resources, and health consequences that will last for generations.[6] Recent studies and news articles have pointed to the dangers to human health and the environment posed by the hazardous substances found in many electronic components.[7] A computer or television set, for instance, generally contains 4-10 pounds of lead. Mercury, cadmium, and other heavy metals are also commonly used in such equipment.[8] The presence of these and other dangerous substances in electronic products has rendered conventional methods of waste disposal environmentally unsuitable.[9]

To date the export of electronic waste to developing countries has been a commonly used alternative. Developing countries have increasingly become the recipients of E-waste because they usually have less stringent pollution control regulations and are often willing to accept the waste as a means to raise revenues. The cost of disposing of E-waste in developing countries is usually significantly lower than either instituting waste minimization techniques at the source or utilizing an approved disposal facility located in the generating country.[10] Factors such as the limited availability of local disposal sites, strong community opposition to industrial facility sitting practices, stringent legislation, and the emergence of multilateral trading systems have facilitated and encouraged exports of E-waste. This may seem to be an ideal market solution because it appears to fit the economic supply and demand framework perfectly. However, this is not an effective solution to the problems associ-

Paula Boland is an attorney specialized in environmental and international affairs. Although born in the United States, she received most of her academic and professional experience in Argentina. Paula worked for three years on regulatory and corporate compliance issues at the law firm of Klein & Franco in Buenos Aires. Her strong interest in the protection of the environment led her to the LL.M. program in Environmental Law at Vermont Law School, from which she graduated *cum laude*. Following a clerkship with the Environmental Enforcement Section of the U.S. Department of Justice, Paula has assisted a number of environmental nongovernmental organizations in the development of conservation projects to be carried out in Latin America. In October 2002, Paula joined the United Nations (U.N.) Association of the National Capital Area, a nonprofit, nonpartisan organization dedicated to strengthening and enhancing U.S. participation in the U.N. system. Since May 2003, she has been serving as the Chair of the Young Professionals for International Cooperation.

1. *See* Office of Compliance, U.S. Environmental Protection Agency (EPA), EPA Office of Compliance Sector Notebook Project: Profile of the Electronics and Computer Industry (1995) (EPA/310-R-95-002), *available at* http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/elecmpsn.pdf (last visited Dec. 29, 2003).
2. *See generally* Charles W. Schmidt, *E-Junk Explosion*, Envtl. Health Persps., Apr. 2002, at A188-94, *available at* http://ehpnet1.niehs.nih.gov/docs/2002/110-4/focus.html (last visited Dec. 29, 2003).
3. *See* Silicon Valley Toxics Coalition (SVTC), *Fourth Annual Computer Report Card* (Jan. 9, 2003), *at* http://www.svtc.org/cleancc/pubs/2002report.htm (last visited Dec. 29, 2003).
4. *See* SVTC, *Why Focus on Computers?* (Aug. 11, 2002), *at* http://www.svtc.org/cleancc/focus.htm (last visited Dec. 29, 2003).
5. *See* Scripps Howard News Service, *Disposing of Computers Becoming a Global Concern* (Aug. 5, 1999), *available at* http://www.geocities.com/szczepanczyk/compenv.html (last visited Jan. 14, 2004). *See also* Pollution Prevention Regional Information Center, *Electronic Waste: Background and Overview* (Feb. 16, 2003), *at* http://www.p2ric.org (last visited Dec. 29, 2003).
6. *See* Leslie Byster, International Campaign for Responsible Technology, SVTC, Poison PCs: The Growing Environmental Problem, Part of a Paper Presented at the Waste Not Asia Conference (July 2001), *available at* http://www.no-burn.org/regional/pdf/poisonpcs.pdf (last visited Jan. 14, 2004).
7. For a comprehensive list of research studies and news articles about the high-tech impacts on human health and the environment, visit the SVTC website on the Internet at http:/www.svtc.org/hu_health/index.html (last visited Dec. 29, 2003).
8. *See* Bette K. Fishbein, Waste in the Wireless World: The Challenge of Cell Phones ch. 3 (INFORM, Inc., 2002) (describing the toxic content of cell phones and other electronic devices). *See also* SVTC, *Just Say No to E-Waste: Background Document on Hazards and Waste From Computers* (Nov. 1999), *at* http://www.svtc.org/cleancc/pubs/sayno.htm (last visited Dec. 29, 2003).
9. *See* Global Futures Foundation, Computers, E-Waste, and Product Stewardship: Is California Ready for the Challenge? (2001), *available at* http://www.globalff.org (last visited Dec. 29, 2003) (report prepared for EPA, Region IX).
10. Lakshman Guruswamy & Brent Hendricks, International Environmental Law in a Nutshell 207-08 (1997).

ated with exports of hazardous waste because it merely transfers the environmental cost from industry to a group of people less qualified to bear it.[11]

Trade in electronic waste may create deplorable conditions in developing countries. A recent report prepared by a coalition of environmental organizations showed that significant amounts of electronic wastes are being exported to Asian countries, where they are either dumped or recycled by primitive methods that threaten human health and the environment.[12] Recipient countries and bordering nations may experience soil contamination, groundwater pollution, air pollution, and threats to natural resources and biodiversity.[13] While trade in electronic waste may provide short-term jobs and capital, it can come at the expense of human health and even lives when improperly regulated. The immediate capital received by importing nations may fall far short of what is ultimately necessary to deal with the long-term social, health, and environmental harms caused by the waste imports.[14]

The United States plays a critical role in the effective control of the electronic waste crisis. The current regulatory scheme in the United States discourages in-country recycling of discarded electronics and facilitates their export overseas. Accordingly, between 50% to 80% of the E-waste collected for recycling in the United States is exported, primarily to Asian countries.[15] There are several gaps in the federal government's authority to effectively control hazardous waste exports. For instance, once a foreign government consents to receive hazardous waste, no provisions exist in U.S. law for monitoring the environmental adequacy of the disposal in the receiving country or stopping the shipment if there is serious doubt as to the manner of treatment or disposal.[16] In addition, the range of hazardous wastes currently regulated under U.S. law is narrower than those wastes covered by existing international agreements. Over the years, many toxic substances have been exempted from regulation under U.S. law simply because they are claimed to be destined for recycling operations.[17]

The E-waste pollution problem is global in nature and as such requires the cooperation of all nations. Most countries have accepted and adopted the definitions and policies of the Basel Convention, which makes no distinction between wastes bound for recycling and final disposal in its hazardous waste definitions and controls.[18] However, it is critical that the United States, as the major consumer of electronic products and consequent generator of vast amounts of E-waste, join the rest of the international community in its efforts to control transboundary movements of hazardous wastes. U.S. participation is crucial to preserve the health of the global environment. The Basel Convention will only achieve its ultimate goal if the United States, the world's largest industrialized nation, decides to cooperate by becoming an active member and by amending its domestic laws and regulations to better address and control the threats posed by the export of electronic waste.

This Article concludes that the only way to effectively address the E-waste crisis is for the United States to join the international community by ratifying and fully implementing the Basel Convention. However, the growing generation of electronic waste may require a solution beyond even Basel. Domestic regulations that force the internalization of disposal costs by industry may be the only way to reduce hazardous waste generation in an essentially free market economy. Pollution prevention is one such potential approach and it can be achieved through clean production substitution with nonhazardous materials. Many foreign governments have already developed legislation encouraging the electronics industry to design its products with less hazardous materials. The shift in responsibility from local government to private industry has the potential to encourage innovation in electronic design, recycling technologies, and collection systems. The development of cleaner production technologies would indubitably help the United States reduce its generation of electronic waste and, consequently, its exports to the developing world.

II. The Problem of E-Waste

A. General Background

Since the industrial revolution, thousands of types of industrial wastes have been produced, most of them hazardous for both the environment and humans. Nevertheless, only recently have people become aware of the problems associated with these wastes. Large quantities of almost any chemical substance can harm humans, living organisms, and the environment. Toxic and hazardous substances, on the other hand, can cause significant damage in small, even minuscule, amounts.[19] Despite the fact that industrial wastes are among the pollutants responsible for transboundary air and water pollution, as well as land-based pollution, there is no universally adopted or accepted definition of a hazardous or toxic industrial waste.[20] Hazardous wastes can range from materials contaminated with dioxins and heavy metals, such as mercury, cadmium, or lead, to organic wastes. The waste may take many forms, from barrels of liquid waste to sludge, old computer parts, used batteries, or incinerator ash.[21]

11. *Id*. at 208.
12. *See* Basel Action Network & SVTC, Exporting Harm: The High-Tech Trashing of Asia (2002), *available at* http://www.svtc.org/cleancc/pubs/technotrash.htm [hereinafter High-Tech Report].
13. *See* Mary Critharis, *Third World Nations Are Down in the Dumps: The Exportation of Hazardous Waste*, 16 Brook. J. Int'l L. 311, 315 (1990).
14. For discussions about the health and safety impact of electronic production in Asia, see Shruti Rana, *Fulfilling Technology's Promises: Enforcing the Rights of Women Caught in the Global High-Tech Underclass*, 15 Berkeley Women's L.J. 272 (2000).
15. High-Tech Report, *supra* note 12, at 1.
16. *See* Mary Tiemann, *Waste Trade and the Basel Convention: Background and Update*, Cong. Research Serv. Rep., 98-638 (Dec. 30, 1998), *available at* http://www.ncseonline.org/NLE/CRS/abstract.cfm?NLEid=16322.
17. High-Tech Report, *supra* note 12, at 28.
18. *Id*.
19. For a general background on hazardous waste, see Barry L. Johnson, Impact of Hazardous Waste on Human Health: Hazard, Health Effects, Equity, and Communication Issues (Lewis Publishers 1999). *See also* R. Allan Freeze, The Environmental Pendulum: A Quest for the Truth About Toxic Chemicals, Human Health, and Environmental Protection (University of California Press 2000).
20. Guruswamy & Hendricks, *supra* note 10, at 190.
21. Jonathan Krueger, *The Basel Convention and the International Trade in Hazardous Wastes*, *in* Yearbook of International Cooperation on Environment and Development 43 (2001/2002).

The electronics industry is a significant generator of hazardous wastes. The production of electrical and electronic equipment is also one of the fastest growing manufacturing sectors in the western world.[22] The improvements in technology and software have stimulated new applications, simplified computer use, and lowered cost, bringing computers within reach of more and more consumers.[23] In addition, electronic controls have been incorporated in a growing number of products, from autos to audio equipment to microwave ovens to cellular phones. Over the last decade, the effect of these developments has been to stimulate productivity and to contribute to many nations' longest sustained periods of economic growth.[24] In 1965, Gordon Moore observed that computer-processing power was doubling every 18 months and could continue into the foreseeable future.[25] Rapid improvements in technology have produced better products, but also growing volumes of obsolete products to be managed as waste.

According to the National Safety Council, the average life-span of a personal computer (PC) central processing unit declined from 4.5 years in 1992 to 3.1 years in 1999 and is projected to level off to 2 years by 2005.[26] At this rate, the report estimates, during the year 2002 alone the number of computers becoming obsolete will outstrip the number of new computers entering the market by 3.4 million. By the year 2004, the United States will have over 315 million obsolete computers in need of disposal.[27] Statistical modeling performed by a Carnegie Mellon University project predicted that cumulatively 680 million computers will be sold and 143 million computers will be recycled in the United States by 2005.[28] According to the National Recycling Coalition, 500 million computers will be obsolete by 2007, while in 1998 alone over 20 million computers were taken out of service. Of those 20 million, only 10% were recycled and 14% sent to municipal landfills and incinerators, with the remainder presumably warehoused for future disposal.[29]

This trend is not limited to the United States. According to the European Commission, the generation of waste from electrical and electronic equipment (WEEE) is increasing precipitously in Europe.[30] In 1998, the 6 million tons of WEEE generated constituted 4% of the European Union's (EU's) total municipal waste stream. The growth of WEEE is about three times higher than that of the average municipal waste growth and is one of the major contributors of heavy metals and halogenated substances to the municipal waste stream. With the expected annual increase of 3% to 5% in WEEE generation, the European Commission anticipates that in 5 years 16% to 28% more WEEE will be generated and in 12 years that amount will have doubled. Presently, 90% of WEEE is landfilled, incinerated, or recovered without any pretreatment.[31] A similar situation is unfolding in Japan. In 2000, Japan is estimated to have generated 80,000 tons of used computers, up from 45,000 tons in 1998.[32] According to the Japanese Ministry of Economy, Trade, and Industry, after the discarded computers are collected by retailers or municipalities, "almost [one-]half of them are dumped into landfills without being crushed. The other half is crushed by shredders without prior removal of economically valuable or environmentally hazardous materials."[33] In Taiwan, the number of discarded computers reached 212,338 units in the year 2000, a fourfold increase from the previous years.[34]

While the benefits derived from the technological revolution are well known, the health and environmental impacts of the waste generated by electronic products are not. The environmental impact of electronic waste is just beginning to be realized.[35] Electronic equipment is estimated to be one of the largest sources of heavy metals and organic pollutants in the waste stream. The negative aspects of high technology are polluted drinking water, birth defects, waste discharges that harm fish and wildlife, and significant rates of miscarriages and cancer clusters among workers.[36] The electronics industry uses vast amounts of dangerous chemicals and significantly depletes natural resources for its global expansion and rapidly changing product lines. There are few other products for which the sum of the environmental impacts of raw material extraction, industrial refining and production, use, and disposal is so extensive.[37]

22. *See* European Environmental Bureau, *Waste From Electrical and Electronic Equipment* (Sept. 7, 2002), *at* http://www.eeb.org/activities/waste/weee.htm (last visited Dec. 29, 2003). For more detailed information, see ELENA LYMBERIDI, EUROPEAN ENVIRONMENTAL BUREAU, TOWARD WASTE-FREE ELECTRICAL AND ELECTRONIC EQUIPMENT (2001), *at* http://eeb.org/publication/Towards_waste-free.pdf (last visited Jan. 14, 2004).
23. James E. McCarthy, *Recycling Computers and Electronic Equipment: Legislative and Regulatory Approaches for "E-Waste,"* Cong. Research Serv. Rep., 02-31505, at CRS-1 (Oct. 18, 2002).
24. *Id.*
25. *See* Gordon E. Moore, *Cramming More Components Onto Integrated Circuits*, ELECTRONICS, Apr. 19, 1965, *available at* ftp://download.intel.com/research/silicon/moorespaper.pdf (last visited Jan. 14, 2004).
26. *See* ENVIRONMENTAL HEALTH CENTER, NATIONAL SAFETY COUNCIL, ELECTRONIC PRODUCT RECOVERY AND RECYCLING BASELINE REPORT (1999), *available at* http://www.nsc.org/ehc/epr2/reports.htm (last visited Jan. 14, 2004).
27. By one estimate, the dumping of 315 million obsolete computers into landfills would be tantamount to dumping 1.2 billion pounds of lead, 2 million pounds of cadmium, 400,000 pounds of mercury, 1.2 million pound of CrVI, and 350 million pounds of brominated flame retardants. *See* SVTC, *Just Say No to E-Waste*, *supra* note 8.
28. *See* H. Scott Matthews et al., *Disposition and End-of-Life Options for Personal Computers*, *reprinted in* CARNEGIE MELLON UNIVERSITY, GREEN DESIGN INITIATIVE TECHNICAL REPORT NO. 97-10 (1997).
29. See the National Recycling Coalition, Inc., website at http://www.nrc-recycle.org (last visited Dec. 29, 2003).
30. *See* COMMISSION OF THE EUROPEAN COMMUNITIES, EXPLANATORY MEMORANDUM FROM PROPOSAL FOR A DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL ON WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT, COM(00)347 final, *available at* http://europa.eu.int/eur-lex/en/search/search_lip.html (last visited Dec. 29, 2003) [hereinafter EUROPEAN COMMISSION PROPOSAL TO PARLIAMENT].
31. *Id.* at 4.
32. *See Japan to Mandate Supplier Disposal of Home PCs*, COMPUTERWIRE, July 2001, *available at* http://www.jeita.or.jp/english/public/index.htm (last visited Dec. 29, 2003) (based on data compiled by Japan Electronics and Information Technology Industries Association).
33. MINISTRY OF ECONOMY, TRADE, AND INDUSTRY, LAW FOR RECYCLING OF SPECIFIED KINDS OF HOME APPLIANCES (1999), *available at* http://www.meti.go.jp/english/information/data/cReHAppre.html (last visited Dec. 29, 2003).
34. *See Computer Disposal Brings Dangerous "E-Waste,"* CHINA POST, Apr. 2001, *available at* http://www.chinapost.com.tw/archive (last visited Dec. 29, 2003).
35. Schmidt, *supra* note 2, at 1.
36. Byster, *supra* note 6, at 1.
37. *Id.*

In general, electronic wastes contain over 1,000 different substances, many of which are highly toxic. E-waste contains substances such as lead,[38] cadmium, mercury, chlorinated and brominated substances, toxic gases, toxic metals, biologically active materials, acids, plastics, and plastic additives.[39] Among the adverse effects caused by these toxic substances on human health and the environment, the following can be mentioned:

> *Lead* can damage the nervous system of humans. Effects on the endocrine system have also been observed. In addition, lead can adversely affect the cardiovascular system and the kidneys. Lead accumulates in the environment and has acute and chronic toxic effects on plants, animals, and microorganisms. The relative importance of any single source of exposure is difficult to predict and will vary with geographic location, climate, and local geochemistry. Consumer electronics constitute 40% of lead found in landfills. The main concern regarding the presence of lead in landfills is the potential for the lead to leach and contaminate drinking water supplies. Approximately 1.2 billion pounds of lead are expected to be generated by electronic products by the year 2004.[40]
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> *Cadmium* is classified as toxic with a possible risk of irreversible effects on human health. It accumulates in the human body, in particular in the kidneys, which in time may lead to damage. Cadmium is absorbed through respiration but is also taken up with food. Due to its long half-life (30 years), cadmium can easily be accumulated in amounts that cause symptoms of poisoning. With prolonged exposure cadmium chloride may cause cancer. Cadmium shows a danger of cumulative effects in the environment due to its acute and chronic toxicity. Approximately two million pounds of cadmium are expected to be generated by electronic products by the year 2004.[41]
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> *Mercury* has chronic effects and can cause damage to the brain. The developing fetus can also be highly susceptible to the effects through maternal exposure to mercury. When inorganic mercury spreads out in the water it is transformed to methylated mercury in the bottom sediments. Methylated mercury easily accumulates in living organisms and concentrates through the food chain, particularly via fish. It is estimated that 22% of the annual world consumption of mercury is used in electrical and electronic equipment. Approximately 400,000 pounds of mercury are expected to be generated by electronic products by the year 2004.[42]
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> *Hexavalent Chromium (CrVI)* is considered a significant risk for the environment in industrialized countries. It can easily be absorbed through cell membranes, producing various toxic effects within the cells. Furthermore, CrVI may cause severe allergic reactions such as asthmatic bronchitis. Small concentrations of this toxic substance in the environment might lead to an increase of allergies. CrVI is also considered genotoxic, potentially damaging the deoxyribonucleic acid (DNA). In addition, CrVI compounds are assumed to be toxic for the environment. Approximately 1.2 million pounds of chromium are expected to be generated by electronic products by the year 2004.[43]
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> *Plastics* make up 13.8 pounds of an average computer. It is estimated that the total electronics plastic scrap amounted to more than one billion pounds per year (580,000 tons per year). The largest volume of plastics (26%) used in electronic manufacturing has been polyvinyl chloride (PVC). PVC creates more environmental and health hazards than most other type of plastic. While many computer companies have recently reduced or phased out the use of PVC, there is still a significant amount in the computer scrap that continues to grow potentially up to 250 million pounds per year. The production and burning of PVC within a certain temperature range generates dioxins and furans. This plastic, commonly in packaging and household products, is a major cause of dioxin formation in open burning and garbage incinerators. In addition, PVC is difficult to recycle and it contaminates other plastic in the recycling process. Approximately four billion pounds of plastic are expected to be generated by electronic products by the year 2004.[44]
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> *Brominated Flame Retardants (BFRs)* are regularly designed into electronic products as a means of reducing fire risk. More than 50% of BFR usage in the electronics industry consists of tetrabromo-bis-phenol, 10% is polybrominated diphenyl ethers, and 1% is polybrominated biphenyls. BFRs have a high affinity for fats that accumulate in human, animal, and fish tissues. Animal experiments have shown that a number of these chemicals affect thyroid function, have estrogenic effects,

38. Analysis using the U.S. EPA Toxicity Characteristic Leaching Procedure (TCLP) show that electronic equipment containing printed circuit boards or cathode ray tubes (CRTs) exhibit the characteristic of toxicity for lead. Accordingly, the regulatory level for lead in the United States is a TCLP of 5.0 milligrams per liter (mg/l). TCLP levels for monitors due to lead concentrations in the glass test out to be on average about 18.5 mg/l for lead. Circuit boards are far higher in leachable lead content. *See* Florida Center for Solid and Hazardous Waste Management, State University System of Florida, Characterization of Lead Leachability From Cathode Ray Tubes Using the Toxicity Characteristic Leaching Procedure (Report No. 99-5, 1999).

39. For detailed information on toxics contained in computer and monitors, see SVTC et al., Poison PCs and Toxic TVs (2001), *available at* http://www.svtc.org/cleancc/pubs/poisonpc.htm (last visited Dec. 29, 2003). *See also* substances listed in EPA's toxic release inventory for the electronics/computer industry *in* Profile of the Electronics and Computer Industry, *supra* note 1.

40. *See, e.g.*, Office of Pollution Prevention & Toxics, U.S. EPA, *Chemicals in the Environment: OPPT Chemical Fact Sheets*, *at* http://www.epa.gov/chemfact (last visited Dec. 29, 2003). *See also* Occupational Safety & Health Administration, U.S. Department of Labor, *Technical Links to Safety and Health Topics*, *at* http://www.osha.gov/SLTC/index.html (last visited Dec. 29, 2003); Agency for Toxic Substances & Disease Registry, U.S. Department of Health & Human Services, *Toxicological Profile Information Sheet*, *at* http://www.atsdr.cdc.gov/toxpro2.html (last visited Dec. 29, 2003); and National Safety Council, *Chemical Backgrounders*, *at* http://www.nsc.org/library/chemical/chemical.htm (last visited Dec. 29, 2003).

41. *Id.*

42. *Id.*

43. *Id.*

44. *Id.*

> and act through the same receptors-mediated pathways as does dioxin, which is among the most potent animal carcinogens known. The presence of these chemicals in plastic makes recycling dangerous and difficult. Approximately 350 million pounds of BFRs are expected to be generated by electronic products by the year 2004.[45]

Due to the presence of these and other hazardous substances, electronic products may cause major environmental problems during the waste management phase if not properly pretreated.[46] This fact may render the conventional methods of waste disposal environmentally unsuitable for discarded electronic products. The risks relating to landfilling electronic waste are due to the variety of different substances contained in electronic products. About 70% of the heavy metals found in landfills come from electronic equipment discards.[47] Leaching of mercury takes place when certain electronic devices, such as circuit breakers, are destroyed. The same is true for PCBs from condensers. When BFRs or cadmium-containing plastics are landfilled, both polybrominated diphenyl ethers and cadmium may leach into the soil and groundwater.[48] As no landfill is completely watertight throughout its lifetime, the leaching of metals and chemical substances is a virtual certainty. The vaporization of metallic mercury and dimethylene mercury, both part of the electronic waste stream, is also of concern. In addition, uncontrolled fires may occur at the landfills emitting metals and other chemical substances, such as toxic dioxins and furans.[49]

Incineration leads to the atmospheric emission of heavy metals, and the burning of PVC and BFRs generate dioxins, furans, and endocrine disrupters while concentrating heavy metals from electronic wastes in the fly ash, flue gas, filter cake, and slag.[50] More than 90% of the cadmium put into an incinerator can be found in the fly ash and more than 70% of the mercury ends up in the filter cake.[51] Smelting can also present dangers similar to incineration. However, the most dangerous form is the open-air burning of plastics in order to recover copper and other metals. These practices are documented primarily in developing Asian countries. The toxic fallout from open-air burning affects both the local environment and broader global air currents, depositing highly toxic byproducts in many places throughout the world.[52] The presence of such materials and problems suggests to many that electronic products should be managed separately from the municipal waste stream and recycled whenever possible. Separate collection and treatment of this particular waste is likely to contribute to a cleaner municipal waste stream and thereby a reduction in the emissions caused by the incineration or the smelting of electronic products containing heavy metals and halogenated substances.[53]

With respect to the recycling of electronic products, doubts exist as to whether this would be the right approach. Since discarded electronics contain precious metals such as gold, silver, palladium, and platinum, 95 to 99% of which can be recovered, recycling and material reclamation appears to be an attractive option for end-of-life management of electronic products and their waste.[54] In addition, increased recycling preserves resources and disposal capacities. In spite of these positive aspects, recovery operations might add to environmental pollution if the waste is not properly processed.[55] Both dioxins and furans are generated as a consequence of recycling the metal content in most electronic products. Halogenated substances contained in electronic waste, in particular BFRs, are also of concern during the extrusion of plastics, which is part of the plastic recycling.[56] Electronic waste recycling may create more problems than other methods of disposal, especially in nations without the resources or enforced obligations to recycle properly. Without proper precautions, the processes employed could easily introduce toxic substances into the environment, putting workers, nearby residents, and biota at a serious risk.[57]

Where recycling is used, collection for recycling does not necessarily guarantee environmentally responsible management. Informed recycling industry sources estimate that between 50 to 80% of the E-waste collected for recycling in the United States is not recycled domestically but placed on container ships bound for destinations like China.[58] Many companies that call themselves recyclers of E-waste actually do more waste trading than waste recycling.[59] Although recovery of the high value materials is technically feasible, the economics are such that there has been little recycling within the United States.[60] The labor costs associated with dismantling discarded electronics and separating those components containing the valuable materials appear to be a barrier.[61] Moreover, the United States lacks a national infra-

45. *Id.*

46. *See* New York State Department of Environmental Conservation Pollution Prevention Unit, Environmental Compliance and Pollution Prevention Guide for the Electronics and Computer Industry (1999), *available at* http://www.epa.gov/region02/p2/electron.pdf (last visited Dec. 29, 2003). *See also* Minnesota Pollution Control Agency, Managing Electronic Equipment (Waste/Hazardous Waste Report No. 4.15, 1999), *available at* http://www.pca.state.mn.us (last visited Dec. 29, 2003).

47. *See* Mike Flynn, Secure Environmental Electronic Recycling, Paper Presented at the EPA/Southern Waste Information eXchange, Inc., Computer and Electronic Equipment Recycling and Management Workshop, Atlanta, Georgia (Aug. 7-8, 2000).

48. European Commission Proposal to Parliament, *supra* note 30, at 9-10.

49. *Id.* at 10.

50. Catherine K. Lin et al., *Globalization, Extended Producer Responsibility and the Problem of Discarded Computers in China: An Exploratory Proposal for Environmental Protection*, 14 Geo. Int'l Envtl. L. Rev. 525, 532 (2002).

51. Byster, *supra* note 6, at 2.

52. *Id.*

53. *See* Solid Waste & Emergency Response, U.S. EPA, WasteWise Update: Electronics Reuse and Recycling (2000) (EPA 530-N-00-007), *available at* http://www.epa.gov/wastewise (last visited Dec. 29, 2003).

54. *See generally* Eric Volk, *Electronics Recycling: How to Recycle End-of-Life Electronic Equipment*, *at* http://www.geocities.com/ResearchTriangle/Lab/2277/preface.html (last updated Mar. 1999).

55. European Commission Proposal to Parliament, *supra* note 30, at 10.

56. *Id.*

57. Lin et al., *supra* note 50, at 533.

58. High-Tech Report, *supra* note 12, at 1.

59. *Id.* at 11.

60. *Id.* at 12.

61. *See* Environment Australia, Guidance on the Hazard Status of Waste Electrical and Electronic Assemblies or Scrap Under the Hazardous Waste Act (1999), *available at*

structure to collect and manage the electronic products being returned. Many states and local governments have no separate collection programs for computers or other electronic products, and few facilities are presently equipped to process the materials that are collected.[62] The real problem, however, is that electronic products are not designed for recycling, making their dismantling expensive and labor intensive. It is not easy to access their valuable materials because they are bound up in plastics and mixed with other contaminates that makes them difficult to separate.[63] Furthermore, traditional recycling methods for hazardous wastes provide little environmental benefit since they generally transfer hazards into secondary products that eventually have to be disposed.[64] Thus, most of what is today called electronic waste processing or recycling in the United States either ends up as exports to developing countries or is simply discarded.

B. Exports to Developing Countries

Regulatory incentives to find alternatives to traditional waste management practices can be a positive approach when they encourage waste minimization as well as reuse or recycling in an environmentally sound manner. However, they may also create an incentive to find disposal sites where regulation is less strict and less expensive. This points directly to countries where the regulatory infrastructure is limited and where the immediate need for currency produces a great opportunity for illegal dumping and recycling activities in an environmentally unsound manner.[65] Even where developing countries have stringent environmental laws and regulations, they often lack the administrative infrastructure for adequate enforcement; customs officials may even circumvent national regulations by accepting bribes and ignoring dumping activities.[66] A clear example is China, which has its own ban on imports of many types of discarded electronics, but the law is easily circumvented through payments to corrupt customs officials, according to industry sources.[67]

Exporting hazardous waste to developing countries has increasingly become the vehicle by which industrialized economies have attempted to circumvent the problems of stringent regulations, expensive disposal, and strong public resistance.[68] In the past, industrialized countries have either dumped their hazardous wastes directly into the ocean or buried it on the land.[69] Since the mid-1980s, however, there has been a dramatic increase in the shipment of hazardous waste from industrialized countries to the developing world.[70] This is a result not only of increased consumption in the developed world but also new stringent environmental controls that limit the direct discharge of wastes to the environment in the form of emissions to the air, water, or soil.[71] With increased global industrialization, the volume of waste has been growing faster than the availability of places for disposal.[72] Political as well as demographic and geological factors have prevented some developed countries from building adequate disposal facilities.[73] The significant volume of hazardous wastes requires the construction of complex facilities that, from a cost-benefit perspective, might be economically prohibitive. Another reason for international trade of hazardous waste is the potential value of secondary raw materials that maybe recovered, reused, or recycled.[74] The emergence of multilateral trading systems has also encouraged international waste trade. In the United States, increased awareness of the dangers associated with hazardous waste disposal led to the enactment of strict regulations and, as a natural consequence, the export of hazardous substances to developing countries has become an attractive solution.[75]

Frequently, transboundary waste transactions have been legal, with authorized government officials accepting the wastes, but too often the disposal and recycling has been arranged between private parties without the advice, knowledge, or consent of the recipient government. As a result, numerous incidents have occurred where wastes were illegally or inappropriately used or dumped, resulting in health and environmental problems for local communities.[76] Current exports of electronic waste to Asian countries represent a clear example.[77] Like most trade in hazardous waste, exports of E-waste are primarily motivated by market forces.[78] A pilot program that collected electronic scrap in San Jose, California, estimated that it was 10 times cheaper to ship ob-

http://www.deh.gov.au/industry/chemicals/hwa/papers/scrap.html (last visited Jan. 14, 2004).

62. McCarthy, *supra* note 23, at CRS-15.

63. High-Tech Report, *supra* note 12, at 12.

64. *Id.* at 6.

65. *See generally* Roger Batstone et al., The Safe Disposal of Hazardous Wastes: The Special Needs and Problems of Developing Countries (World Bank 1989).

66. Sejal Choksi, *The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal: 1999 Protocol on Liability and Compensation*, 28 Ecology L.Q. 509, 514 (2001). *See also* Jennifer R. Kitt, *Waste Exports to the Developing World: A Global Response*, 7 Geo. Int'l Envtl. L. Rev. 485 (1995).

67. Peter S. Goodman, *China Serves as Dump Site for Computers: Unsafe Recycling Practice Grows Despite Import Ban*, Wash. Post Foreign Service, Feb. 24, 2003, at A1.

68. *See generally* Jennifer Clapp, Toxic Exports: The Transfer of Hazardous Wastes From Rich to Poor Countries (Cornell University Press 2001). *See also* D. Kofi Asante-Duah & Imre V. Nagy, International Trade in Hazardous Waste (E & FN Spon 1998).

69. Guruswamy & Hendricks, *supra* note 10, at 207.

70. Valentina O. Okaru, *The Basel Convention: Controlling the Movement of Hazardous Wastes to Developing Countries*, 4 Fordham Envtl. L. Rep. 137 (1993). *See also* B. John Ovink, *Transboundary Shipments of Toxic Waste: The Basel and Bamako Conventions: Do Third World Countries Have a Choice?*, 13 Dick. J. Int'l L. 281, 282, 283 (1995).

71. Konrad von Moltke, International Environmental Management, Trade Regimes and Sustainability 43 (International Institute for Sustainable Development 1996).

72. Okaru, *supra* note 70, at 140.

73. *Id.* at 142.

74. Krueger, *supra* note 21, at 44.

75. Guruswamy & Hendricks, *supra* note 10, at 207.

76. Tiemann, *supra* note 16, at 1-2.

77. Much of the E-waste is now routed through Hong Kong, the Philippines, and Taiwan on container ships, and then transshipped to smaller ports in mainland China such as Jiangkou and Shantou. *See* Goodman, *supra* note 67, at A1. Water samples taken near a riverbank revealed levels of lead 190 times higher than the drinking water standard set by the World Health Organization, and sediment samples found levels of lead and other heavy metals such as chromium and barium hundreds of times higher than U.S. and European environmental standards for risk. *See* High-Tech Report, *supra* note 12, at 22.

78. High-Tech Report, *supra* note 12, at 11.

solete cathode ray tube (CRT) monitors to China than it was to recycle them in the United States.[79] Due to its composition, E-waste is likely to have positive value in an economy where labor costs are approximately $1.50 per day and environmental and health standards are lax or not enforced.[80] The potential value of recovered secondary components combined with low labor costs explains why many Asian locations remain buried under mounds of obsolete electronics. As long as a large and growing disparity in waste disposal costs exists between developed and developing countries, a market for such wastes—illegal or legal—will always exist.[81] Moreover, as domestic recyclers continue to compete with the low costs of Asian "recycling," it is unlikely that there will be sufficient incentives to invest in the necessary infrastructure for efficiently and safely recycling E-waste.[82] If end-of-life costs are not incorporated into electronic products, the only economically viable recycling that can take place is in the economies of developing countries.[83] This translates in the poorest countries having to bear a disproportionate share of the E-waste crisis.

III. Inadequacy of Existing Mechanisms to Deal With E-Waste

One goal of U.S. environmental laws regarding hazardous waste is to ensure the environmentally sound treatment and disposal of domestically generated hazardous wastes.[84] On March 1, 1994, President William J. Clinton asked the U.S. Congress to pass legislation curbing U.S. exports of hazardous waste. Former U.S. Environmental Protection Agency (EPA) Administrator Carol Browner concurred, stating that the United States "must set an example for the world by taking responsibility for our own waste. Citizens in other countries should not be asked to bear the burden of U.S. pollution."[85] From a regulatory perspective, however, the United States has done little to address this problem. As the country with the largest computer consumption, it has implemented a legal regime for managing hazardous waste that effectively discourages in-country recycling of discarded electronics while facilitating E-waste export for recycling overseas.[86] Since cost savings in other countries are due primarily to weaker environmental protections in those countries, hazardous waste exports frustrate the articulated goal of ensuring that the United States takes responsibility for its own hazardous waste.[87] Paradoxically, these exports that undermine protection of the global environment result from U.S. environmental regulations designed to protect the domestic environment.

A. U.S. Hazardous Waste Export Regulations

The Resource Conservation and Recovery Act (RCRA), enacted by Congress in 1976, establishes a regulatory program to manage solid waste, including hazardous waste, from "cradle to grave" and beyond.[88] The export of hazardous waste is regulated pursuant to the Hazardous and Solid Waste Amendments of 1984, which added §3017 to RCRA and regulations promulgated by EPA.[89] RCRA §3017 essentially creates a monitoring and consent program for the export of wastes that qualify as hazardous wastes.[90] However, where a valid international agreement regarding hazardous waste exports exists between the United States and the receiving country, the shipments must conform with the terms of that agreement.[91] Although EPA is responsible for enforcement of the procedures, its lack of direct independent authority to seize or detain shipments of hazardous waste that violate the procedures of §3017 led to a memorandum of understanding (MOU) with the U.S. Customs Service, which does have direct enforcement authority.[92] The new agreements include training for Customs officers in identification and monitoring of hazardous waste shipments. Customs officials collect manifests at the border, verify the completeness and consistency of the data on the export documents, submit them to EPA, and watch for illegal hazardous waste exports, i.e., those without the proper documents.[93]

79. *See* U.S. EPA, Analysis of Five Community/Consumer Residential Collections of End-of-Life Electronic and Electrical Equipment (1999), *available at* http://www.epa.gov/region1/assistance/solid/csifinal.pdf (last visited Jan. 14, 2004).

80. High-Tech Report, *supra* note 12, at 12-13.

81. William N. Doyle, *U.S. Implementation of the Basel Convention: Time Keeps Ticking, Ticking Away . . .*, 9 Temp. Int'l & Comp. L.J. 141, 161 (1995).

82. High-Tech Report, *supra* note 12, at 13.

83. *Id.* at 12.

84. Lisa T. Belenky, *Cradle to Border: U.S. Hazardous Waste Export Regulations and International Law*, 17 Berkeley J. Int'l L. 95 (1999).

85. *Hazardous Waste Export Curb Cited as "Example to World,"* Hazardous Waste News, Mar. 1, 1994, *available at* LEXIS, News Library, IAC Database.

86. Lin et al., *supra* note 50, at 534.

87. Belenky, *supra* note 84, at 96.

88. Resource Conservation and Recovery Act, 42 U.S.C. §§6901-6992k, ELR Stat. RCRA §§1001-11011.

89. When first enacted, RCRA did not have any export provision; it was amended to include this provision in 1984. Pub. L. No. 98-616, 98 Stat. 3262 (codified as amended at 42 U.S.C. §6938). Regulations that implement RCRA are found at 40 C.F.R. §§262.50 to 262.58 (Subpart E—Exports of Hazardous Waste) and 40 C.F.R. §§262.80 to 262.89 (Subpart H—Transfrontier Shipments of Hazardous Waste for Recovery Within the Organization for Economic Cooperation and Development (OECD)).

90. 42 U.S.C. §6938(c) (Notification to EPA administrator), 40 C.F.R. §262.52(a), and 40 C.F.R. §262.53; 42 U.S.C. §6938(a)(1)(B) (requiring written consent by receiving country), 40 C.F.R. §262.52(b); 42 U.S.C. §6938(a)(1)(c) (requiring that a copy of written consent accompany manifest of each waste shipment), 40 C.F.R. §262.52(c); 42 U.S.C. §6938(g) ("[A] report summarizing the types, quantities, frequency, and ultimate destination of all such hazardous waste exported during the previous calendar year."), 40 C.F.R. §262.52(d).

91. 42 U.S.C. §6938(f) ("Where there exists an international agreement . . . establishing notice, export, and enforcement procedures for the transportation, treatment, storage, and disposal of hazardous wastes, only the requirements of subsection (a)(2) and (g) of this section shall apply."); *id*. §6938(a)(2) (requiring that "shipment conforms with the terms of such agreement").

92. *See* Susan E. Bromm, *The U.S. Enforcement Approach to the Export and Import of Hazardous Waste*, Presented at the Third International Conference on Environmental Enforcement (Apr. 24, 1994), *available at* http://www.inece.org/3rdvol1/pdf/bromm.pdf (last visited Dec. 29, 2003).

93. Currently, Customs officials can phone EPA if they suspect a problem and hold the shipment at the border while EPA staff researches the data problems. However, there are much more complex problems that would be associated with actual inspections of the trade at the border. First, chemical testing is highly technical, not widely available, and time-consuming. Second, the volume of trade and individuals crossing the border makes it unwieldy for Customs officials to stop every truck to assure that the cargo is not hazardous waste (therefore, Customs examines only on those that self-report as hazardous waste). Third, public policy has dictated that Customs of-

The RCRA statutory definition of hazardous waste and the accompanying regulations include various exemptions that preclude effective management of E-waste. Many hazardous substances that are exempted from RCRA meet the general hazardous waste criteria but are exempt from regulations for specific reasons, but primarily to encourage recycling and recovery of industrial chemicals.[94] Generally, substances exempt from RCRA hazardous waste regulations are also exempt from the export restrictions under §3017.[95] When a hazardous product is exempt from control as waste because it is in a recycling or recovery category or because it is explicitly exempt to encourage recycling, it can be exported without any monitoring or control under RCRA §3017.[96] Some metals, for example, are exempt from hazardous waste regulation due to classification as recycled scrap metal.[97] Most recently, EPA has proposed a set of special exemptions from RCRA hazardous waste regulations for computer recycling. The proposed rule would exempt CRTs and glass removed from CRTs from being considered solid waste when sent for recycling.[98] There is no question that CRTs contain materials defined by EPA as hazardous waste.[99] However, since only wastes meeting the definition of "solid waste" may qualify as hazardous wastes, by declaring that CRTs are not solid waste, EPA would exempt them from all otherwise applicable hazardous waste regulations. The exempt substances, however, are still "regulated domestically" by EPA as solid waste in order to protect the environment, even if they are no longer defined as "hazardous wastes."[100]

Because recycling and recovery operations are exempt from even the minimal notification and reporting requirements of §3017 and there is no domestic penalty for exporting these hazardous wastes, RCRA-exempt hazardous wastes move across the U.S. border through a large loophole in the export regulations.[101] Since EPA does not keep any export data on these wastes, it is impossible to know the magnitude of waste that moves through this loophole.[102] Where applicable, the notification and consent form serves both as a tracking document and as an informative document about the nature of the waste transported. This information assists the receiving country in making an informed decision to accept or reject the shipment.[103] Under current practice, however, countries receiving RCRA-exempt hazardous waste are given no notice and thereby have less opportunity to refuse the import or to condition it on safe practices or insurance coverage. Once the waste enters a country without direct notice to the government it is much harder to trace and monitor for enforcement purposes.[104]

Even when waste is not exempt, there are other gaps in the federal government's authority to effectively control hazardous waste exports. When disposal of hazardous waste takes place outside the United States, EPA authority is severely limited. Once the importing country consents to receive hazardous waste, no provisions exist for monitoring the waste to its final disposal. Nor does RCRA authorize the federal government to consider the recipient nation's ability to control the use or disposal of the accepted waste.[105] Although EPA gathers information concerning the shipment as part of the notification process, it has no authority to evaluate the environmental adequacy of the disposal in the receiving country or to stop the shipment if it has serious doubt as to the manner of treatment or disposal.[106] Moreover, EPA is not required to warn the importing country of the potential risks or hazards the waste may pose.[107] Recycling and recovery operations are encouraged without considering the implications of exports to developing countries. In contrast to U.S. regulations, most countries have accepted and adopted the definitions and policies of the Basel Convention, which makes no distinction between wastes bound for recycling and final disposal in its hazardous waste definitions and controls.[108]

B. Basel Convention and U.S. Response

Problems associated with the export of hazardous waste do not end within the jurisdiction of the country that generates or even disposes of them. The international community has gradually understood the risks associated with this form of transboundary pollution and there have been an increasing number of international and regional efforts aimed at restricting the transportation of hazardous wastes across international borders for disposal and recycling.[109] The Basel Convention, negotiated between 1987 and 1989, constitutes the most significant and influential international treaty on

ficers' priority (especially on the U.S.-Mexican Border) be interdiction of drug traffic and illegal entry of aliens.

94. Belenky, *supra* note 84, at 104.
95. 40 C.F.R. §§262.50 to 262.89.
96. Belenky, *supra* note 84, at 106.
97. 40 C.F.R. §261.6(a)(3)(ii).
98. U.S. EPA, Modification of the Hazardous Waste Program; Cathode Ray Tubes and Mercury-Containing Equipment; Proposed Rule, 67 Fed. Reg. 40508 (June 12, 2002).
99. These materials are specifically listed and have an EPA hazardous waste number of D008 under 40 C.F.R. §261.24.
100. Under RCRA, hazardous wastes that are exempt are still regulated as solid waste.
101. Belenky, *supra* note 84, at 107.
102. *Id.* at 108.
103. *Id.* at 110.
104. *Id.* at 107-08.
105. Tiemann, *supra* note 16, at 2.
106. David J. Abrams, *Regulating the International Hazardous Waste Trade: A Proposed Global Solution*, 28 Colum. J. Transnat'l L. 801, 814 (1990).
107. Kenneth D. Hirschi, *Possibilities for a Unified International Convention on the Transboundary Shipments of Hazardous Wastes*, 10 Geo. Int'l Envtl. L. Rev. 169, 182 (1997). *See also* Peter Obstler, *Toward a Working Solution to Global Pollution: Importing CERCLA to Regulate the Export of Hazardous Waste*, 16 Yale J. Int'l L. 73 (1991); and Sean D. Murphy, *Prospective Liability Regimes for the Transboundary Movement of Hazardous Wastes*, 88 Am. J. Int'l L. 24, 32 (1994).
108. *See* Jason L. Gudofsky, *Transboundary Shipments of Hazardous Waste for Recycling and Recovery Operations*, 34 Stan. J. Int'l L. 219, 234-36 (1998) (providing detailed discussion of hazardous wastes regulated under the Basel Convention).
109. *See generally* Maureen T. Walsh, *The Global Trade in Hazardous Wastes: Domestic and International Attempts to Cope With a Growing Crisis in Waste Management*, 42 Cath. U. L. Rev. 103 (1992); Paul E. Hagen, Beveridge & Diamond, P.C., Washington, D.C., *Update on the Basel Convention and Other Agreements Governing the Transboundary Movement of Hazardous Wastes*, *in* American Law Institute-American Bar Ass'n Continuing Legal Education, ALI-ABA Course of Study (2002); and Katharina Kummer, *International Management of Hazardous Wastes: The Basel Convention and Related Legal Rules* (Clarendon Press, Oxford University Press 1995).

hazardous wastes presently in effect.[110] It was crafted to maintain flexibility for safe transboundary movements of waste among nations with existing environmental protection programs, but to prevent the shipment of waste to inappropriate facilities in countries without the means to control management and disposal activities.[111] The convention covers all wastes defined as hazardous by the importing, exporting, and transit countries.[112] At its Fourth Session, the Basel Convention dealt with lists of wastes that could be exported and those that would be banned from export.[113] Included in the list of hazardous waste specifically banned for export under the Basel Convention are waste electrical and electronic assemblies or scrap (E-waste), which have been assigned to list A of Annex VIII.[114]

To achieve its objectives, the convention imposes specific obligations on Member states, such as: ensuring that transboundary movements of hazardous waste are reduced to a minimum and consistent with environmentally sound management[115]; recognizing and observing the rights of states to prohibit the import of hazardous wastes[116]; prohibiting the export or import of hazardous wastes to or from a non-Party[117]; permitting movement of waste only where the state of export does not have the technical capacity or facilities to dispose of the wastes in an environmentally sound manner unless the wastes are required as raw materials for recycling in the state of import[118]; obtaining the prior informed consent of the importing country and each state of transit before shipment[119]; preventing exports or imports of hazardous wastes if there is reason to believe that the wastes in question will not be managed in an environmentally sound manner[120]; re-importing the wastes or finding another method of disposal if the importing country is unable to dispose of the waste in an environmentally sound manner[121]; and imposing criminal sanctions for illegal trafficking in hazardous wastes.[122] Although Parties are generally prohibited from exporting covered wastes to, or importing covered wastes from, non-Parties to the convention, an exemption exists when Parties and non-Parties have entered into bilateral or multilateral agreements as long as these agreements are as stringent as the Basel Convention.[123]

While much has been written and debated about the effectiveness of the Basel Convention, the most salient factor is that the United States has not yet ratified it. Although the United States has entered into a number of bilateral waste trade agreements, it has not yet joined the international community in its broadest effort to control transboundary movements of hazardous waste.[124] The United States remains a signatory but is not a Party to the Basel Convention.[125] In order to become a Party, Congress must adopt certain amendments to RCRA that would allow the United States to enforce the commitments set forth in the convention.[126] Although there have been many attempts to ratify the convention in the United States, all of them have failed. As early as 1988, the Waste Export Control Act was introduced in Congress.[127] The bill would have broadened the class of wastes subject to RCRA export restrictions and imposed the condition that treatment standards of importing facilities be "no less strict than" U.S. standards for treatment of hazardous wastes. The bill would also have imposed cleanup liability on waste exporters, required insurance or bond, and guaranteed EPA access to foreign facilities for inspections.[128] The bill failed to pass in 1988, but was re-introduced in 1989 and again failed to win support. In 1992, President Clinton presented the treaty to the U.S. Senate for ratification along with a document describing the steps that would be necessary to change existing U.S. laws to conform with the treaty.[129] Though the Senate debated giving "advice and consent" on the Basel Convention, the ratification was not achieved.[130] In 1994, the Waste Export and Import Control Act (Synar-Swift Bill) was introduced to Congress, but also failed to pass into law.[131] Again, in 1997, Rep. Edolphus Towns (D-N.Y.) introduced the Waste Export and Import Prohibition Act in the U.S. House of Representatives where it died in committee.[132] All of these bills have essentially the

110. Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, Mar. 22, 1989, 28 I.L.M. 657 [hereinafter Basel Convention]. *See* Theodore Waugh, *Where Do We Go From Here: Legal Controls and Future Strategies for Addressing the Transportation of Hazardous Wastes Across International Borders*, 11 Fordham Envtl. L.J. 477 (2000).

111. Tiemann, *supra* note 16, at 3.

112. Basel Convention, *supra* note 110, art. 1.1(b).

113. *See* Report of the Fourth Meeting of the Conference of the Parties to the Basel Convention, Mar. 18, 1998, UNEP/CHW.4/35, *available at* http://www.basel.int/meetings/cop/cop1-4/cop4repe.pdf (last visited Jan. 14, 2004).

114. Basel Convention, *supra* note 110, Annex VIII, A1180. Wastes listed in Annex VIII are characterized as hazardous pursuant to Article 1, ¶ 1(a) of the Convention. Glass waste from CRTs is an example of a waste that would be exempt from RCRA §3017 export controls but considered hazardous waste under the Basel Convention (Annex VIII, A2010).

115. Basel Convention, *supra* note 110, art. 4(2)(d).

116. *Id*. art. 4.1(a), (b), (e).

117. *Id*. art. 4.5.

118. *Id*. art. 4.9.

119. *Id*. arts. 6 & 7.

120. *Id*. art. 4.2(e), (g).

121. *Id*. art. 8.

122. *Id*. art. 9.5.

123. *Id*. art. 11.

124. The United States has already in place bilateral waste trade agreements with Canada and Mexico, which have traditionally been its largest waste trade partners. It also maintains agreements with two less significant partners, Costa Rica and Malaysia. Moreover, by virtue of the Organization for Economic Cooperation and Development (OECD) Council Decision on the Control of Transfrontier Movements of Wastes Destined for Recovery Operations, the United States is able to continue trade in recyclable wastes with OECD countries that have ratified the Basel Convention.

125. The Basel Convention cannot become legally binding on the United States until it is submitted to the Senate, the Senate gives its advice and consent, and the President signs and deposits the appropriate instruments of ratification with the Basel Secretariat. The Senate gave its advice and consent to ratification of the Basel Convention on August 11, 1992. The U.S. Department of State, however, recommended to the president that the United States not deposit its instrument of ratification until necessary implementing legislation was approved.

126. Legislation implementing the Basel Convention would have to provide EPA additional authority in a number of respects.

127. Waste Export Control Act, S. 2598, 100th Cong. (1988); H.R. 3736, 101st Cong. (1988).

128. Thomas R. Mounteer, *Codifying Basel Convention Obligations Into U.S. Law: The Waste Export Control Act*, 21 ELR 10085, 10088 n.47 (1991).

129. S. Exec. Rep. No. 102-36, at 15 (1992).

130. S. Treaty Doc. No. 102-5, at V (1992).

131. H.R. 3965, 103d Cong. (1994) (introduced Mar. 7, 1994).

132. H.R. 360, 105th Cong. (1997) (introduced Jan. 7, 1997). *See also* Amy Porter, *Administration Commits to Begin Process of Imple-*

same contours and any of them would have served to ratify the Basel Convention into law.[133]

To date no legislation has been introduced in the 108th Congress.[134] Therefore, the treaty continues to lack the force of law within the United States, the world's largest single producer and exporter of hazardous wastes.[135] The 1995 Ban Amendment is a crucial issue blocking U.S. support for ratification of the Basel Convention.[136] The main reason for opposition relates to the economic impact of a total ban on exports of hazardous waste for recycling and recovery.[137] The United States has an economic disincentive in supporting a total ban since current hazardous waste regulations create a very favorable trade surplus through trade in recyclable wastes.[138] During the debate on the ban, the United States generally supported a ban on exporting wastes destined for disposal, but took the position that a ban on the shipment of wastes destined for recycling could be a nonenvironmentally based barrier to trade and that legitimate trade in recyclable materials should be permitted under the Basel Convention.[139] The United States, however, is not the only country opposing the Ban Amendment. Even some developing countries have begun to consider the negative impacts that the ban could have on their economic development.[140]

In accordance with principles of international law, states have a responsibility to one another not to act in a manner that will damage the environment of another state.[141] The Stockholm and Rio Declarations refer to this obligation as follows:

> States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and 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.[142]

As mentioned previously, current U.S. regulations encourage export of E-waste to developing countries where it is often managed in an environmentally unsound manner. By exempting toxic electronic components destined for recycling and recovery operations from RCRA's regulatory scheme, the United States is contributing to environmental harm in the receiving countries where the waste is not subject to effective control.

As the largest consumer of electronic products and consequent generator of E-waste, the United States has the responsibility of adopting stringent export control regulations. Only with the support of the United States will the current international regime effectively ensure the environmentally sound treatment of hazardous wastes.[143] It is also important for the protection of its own interests that the United States has the means to reduce this form of polluting activity abroad.[144] In an era marked by rapid globalization, new systems of global economic and environmental governance are emerging that require the full engagement and participation of the world's largest economy. Environmental degradation is no longer a domestic or regional issue; rather, it is a global issue demanding a global response.

IV. Solution to the E-Waste Crisis

Once the United States acts to control its exports through the implementation and ratification of the Basel Convention, it

menting Treaty on Waste Transport, 29 Int'l Envtl. Rep. (BNA) 848, 849 (Aug. 28, 1998) (administration planned to propose new legislation to implement parts of Basel in 1999).

133. Belenky, *supra* note 84, at 122-23.

134. EPA is currently engaged in interagency discussions regarding this issue. According to an EPA official, "at this point, we have not progressed to the point that we have developed proposals for circulation." E-mail from Patti Whiting, U.S. EPA, Office of Solid Waste, to Paula M. Boland (Mar. 26, 2003) (on file with author).

135. The United States is the largest hazardous waste generator both as defined by the Basel Convention and under the narrower §3107 definition.

136. Once the Basel Convention entered into force in May 1992, various decisions about restricting trade were adopted at the 1992 and 1994 conferences, culminating in 1995 with Decision III/1, known as the "Ban Amendment." This decision intended to amend the Basel Convention to prohibit the export of waste for final disposal and recycling from Annex VII Parties (OECD Members, the European Community, and Liechtenstein) to non-Annex VII Parties (largely developing countries). The entering into force of the amendment requires the ratification by three-fourths of the Parties present at the time of its adoption (62 Parties). As of April 2003, there are a total number of 36 ratifications. The decision is available on the Secretariat of the Basel Convention's website at http://www.basel.int/pub/baselban.html (last visited Dec. 29, 2003).

137. *See generally* William Schneider, *The Basel Convention Ban on Hazardous Waste Exports: Paradigm of Efficacy Exercise in Futility*, 20 Suffolk Transnat'l L. Rev. 247 (1996). *See also* Maria Isolda P. Guevara, *The Basel Convention Export Ban Amendment: Arguments Against Ratification*, *available at* http://www.ban.org/Library/icme.html (last visited Jan. 14, 2004).

138. After the ban decision, the U.S. Chamber of Commerce opposed ratification on the ground that a ban on recyclables would cost the United States $2.2 billion a year. *See Chamber of Commerce Withdraws Support for Treaty on Waste Movement*, 25 Env't Rep. (BNA) 194 (1994).

139. Tiemann, *supra* note 16, at 4.

140. The ban's restriction may present some side effects that should be taken into account in order to determine its potential effectiveness. It cannot be denied that some importing countries may rely heavily on imported hazardous waste as an important source for their economies. In fact, for many developing countries recycling constitutes an acceptable way to earn substantial amounts of needed foreign exchange, helping them to become more developed. Establishing a ban on recycling is likely to increase disposal needs in industrialized nations as well as the need among developing countries for extracting virgin materials, which is not in the overall global environmental interest. Countries dependent on imports because of insufficient resources or prohibitively high costs of primary production may be seriously affected by a restriction on recyclable waste exports. In addition, trading with industrialized countries may provide the income necessary to develop environmentally sound recycling capabilities and a greater opportunity for technology transfer. If trade in recyclables is restricted, developed countries may have less of an incentive to transfer effective technology to developing countries. Finally, an export ban may increase the chances of illegal traffic. From an economic perspective, a total ban on toxic trade may make the wastes more attractive in the international market and consequently result in hazardous waste smuggling.

141. David Hunter et al., International Environmental Law and Policy 419-24 (Foundation Press 2002).

142. Stockholm Declaration of the United Nations Conference on the Human Environment, Principle 21, June 16, 1972, 11 I.L.M. 1416; Rio Declaration on Environment and Development (1992), princ. 2, June 13, 1992, 31 I.L.M. 874.

143. Rebecca A. Kirby, *The Basel Convention and the Need for U.S. Implementation*, 24 Ga. J. Int'l & Comp. L. 281 (1994). *See also* Donna Valin, *The Basel Convention on the Control of Transboundary Movements of Hazardous Waste and Their Disposal: Should the United States Ratify the Accord?*, 6 Ind. Int'l & Comp. L. Rev. 267 (1995).

144. Mark Bradford, *The United States, China, and the Basel Convention on the Transboundary Movements of Hazardous Wastes and Their Disposal*, 8 Fordham Envtl. L.J. 305 (1997).

must still focus on finding a way to effectively deal with the growing generation of E-waste, which ultimately is the core of the problem. Merely ceasing exports without an effective disposal alternative would likely cause more problems in the United States than it would solve. The risks associated with the disposal of electronic products could be significantly reduced by replacing the respective materials with less polluting substances and by means of proper pretreatment of the waste they generate.[145] Preventing waste in the first place is usually preferable to any waste management option, including recycling. Effective technologies for waste management have to be developed and industry has a crucial role to play when it comes to reducing the volume of E-waste because it can take action during the design and manufacture of electronic products. The liability potential and environmental and health consequences from continuing to treat electronics as disposable waste are real and serious. It is time to reexamine current policy and regulation to manage electronic waste out of the solid waste stream and to prevent it from finding its way to developing countries.

A. The Extended Producer Responsibility Approach

Traditional environmental regulation has focused on controlling end-of-pipe pollution outputs from individual facilities without regard to the hazards of other stages of the product chain. While this approach has changed in the area of hazardous waste, by changing the focus from end-of-pipe to pollution prevention and toxic use reduction, it has not yet been extended to the disposal of the discarded product after the end of its useful life.[146] Waste management has been traditionally considered to be the responsibility of the individual household and local governments. Even waste reduction programs have usually focused on what the homeowner or consumer can do to reduce waste, not on what the producer should be doing to reduce the generation of waste. Product design is the most critical step in determining the nature and quantity of pollution created by a product and the pollution outputs by the product through its entire life cycle and at the end of its useful life. Pollution prevention can be achieved by increasing the life of products through better design.[147] Therefore, the most efficient and effective point at which to reduce waste and encourage reuse, reduction, and recycling is at the product development stage. It is at that point in the product's life cycle that decisions can be made to minimize the environmental impact of products.

The problems associated with waste generation and disposal have led a number of industrialized countries to adopt an innovative management policy, Extended Producer Responsibility (EPR), which is a market-oriented policy that focuses on the environmental impact of product systems instead of end-of-pipe regulation at production facilities.[148] The main objective of EPR is to encourage producers to prevent pollution and reduce resource and energy use through changes in product design and through taking responsibility for the product after the end of its useful life. As such, EPR shifts the responsibility for discarded materials that would otherwise be managed by government to private industry, thereby internalizing the costs of recycling or disposal into product price and creating an incentive for the adoption of waste prevention measures.[149] When taxpayers pay for recycling and waste management, industry has little incentive to invest in making products less wasteful and more recyclable. By extending producer responsibility to the post-consumer stage, EPR creates an important and necessary link between the end of life of products and product design.[150] Most EPR policies have also mandated recycling targets, data collection, and reporting requirements and have defined the technologies that count as recycling.[151] EPR thus can be viewed not only as a mechanism to divert materials from disposal but also as an important tool for achieving sustainability.

Preference for this policy instrument has been manifested when addressing the disposal problems created by the growing generation and rapid obsolescence of electronic products. EPR can be an effective tool by diverting electronic waste from landfills and incinerators and redirecting them toward reclamation and recovery of economically valuable materials and energy content. Indeed, electrical and electronic products are becoming a major focus of EPR policies in several industrialized countries, including the EU, Japan, the Netherlands, and Switzerland.[152] The regulatory systems of these countries have the same general objective: by imposing responsibility for waste management on producers and importers, they aim to affect manufacturer decisions regarding product design, reuse, and recyclability.[153] Producers of electronic equipment design the product, determine its specifications, and select its materials. Thus, only producers can develop approaches to ensure the longest possible product life and the best methods of recovery and disposal.[154] The efforts of the EU have been the principal focus of discussion among participants and observers of the electronic industry.[155]

145. *See generally* World Wildlife Fund, Rethinking the Materials We Use: A New Focus for Pollution Policy (Ken Geiser & Frances H. Irwin eds., 1993). *See also* Gary A. Davis et al., U.S. EPA, The Product Side of Pollution Prevention: Evaluating the Potential for Safe Substitutes (1994).

146. *See generally* Committee on Institutional Considerations in Reducing the Generation of Hazardous Industrial Wastes et al., Reducing Hazardous Waste Generation: An Evaluation and a Call for Action (National Academy Press 1985). *See also* Serious Reduction of Hazardous Waste: For Pollution Prevention and Industrial Efficiency (U.S. Congress & Office of Technology Assessment 1986).

147. *See* Beverley Thorpe & Iza Kruszewska, *Strategies to Promote Clean Production: Extended Producer Responsibility* (Jan.1999), *at* http://www.grrn.org/resources/BevEPR.html (last visited Dec. 30, 2003). *See also* Gary A. Davis et al., U.S. EPA, Extended Product Responsibility: A New Principle for Product-Oriented Pollution Prevention (1997); and Gary Davis et al., Extended Product Responsibility: A Tool for a Sustainable Economy, Environment (1997).

148. *See* Bette K. Fishbein et al., Extended Producer Responsibility: A Materials Policy for the 21st Century (INFORM, Inc., 2000).

149. *Id.* pt. II, ch. 1, at 60.

150. *Id.* at 62.

151. *Id.* at 61.

152. For detailed information on EPR policies adopted in these countries, see McCarthy, *supra* note 23, at CRS-8 to CRS-11. *See also* U.S. EPA, *Electronics, International Initiatives*, *at* http://www.epa.gov/epr/products/eintern.html (last visited Dec. 30, 2003).

153. McCarthy, *supra* note 23, at CRS-9.

154. European Commission Proposal to Parliament, *supra* note 30, at 11.

155. McCarthy, *supra* note 23, at CRS-11.

B. The EU Example

In response to concerns over the growing amount of electrical and electronic waste, and in an attempt to harmonize existing national policies to allow industry to operate uniformly throughout Europe, the European Parliament and the Council of the EU have recently adopted two significant directives.[156] The Directive on Waste Electrical and Electronic Equipment (EU Directive) is intended to regulate electronic waste by application of the principles of prevention, recovery, and safe disposal of waste.[157] The main objectives of the EU Directive are: to protect soil, water, and air from pollution caused by current management of electronic waste; to avoid its generation; and to reduce its harmfulness.[158] It also seeks to preserve valuable resources, in particular energy, and to improve the environmental performance of all operators involved in the life cycle of electronic waste.[159] These objectives are to be achieved by means of a wide range of measures, including the establishment of systems for separate collection,[160] waste treatment,[161] and recovering of E-waste.[162] Moreover, the EU Directive mandates the establishment of a financing system that incorporates the principle of producer responsibility as one of the means of encouraging the design and production of electrical and electronic equipment that facilitate their repair, possible upgrading, reuse, disassembly, and recycling.[163] The other directive is intended to restrict the use of certain hazardous substances contained in electronic products in order to promote recycling and to reduce impacts on human health, wildlife, and the environment.[164] Although many key implementation-related details are left for the Member states to address when adopting the requirements into their respective national laws,[165] the EU Directive can be considered as a template for take-back schemes being contemplated today by many countries around the world.

In the United States, most business leaders are adamantly opposed to EPR mandates and their will has prevailed at the federal level.[166] Instead, preference has been given to the concept of "product" responsibility.[167] This concept, however, differs from "producer" responsibility in several major respects.[168] By not focusing on the post-consumer stage, this policy does not allocate any industry responsibility for this critical part of the product life cycle. Despite the lack of a federal EPR policy, there has been considerable interest at the state level, where waste management is a more immedi-

156. Directive 2002/96/EC of the European Parliament and of the Council of 27 January 2003 on Waste Electrical and Electronic Equipment, 2003 O.J. (L 37) 24.

157. The EU Directive applies to all producers placing these products into the EU market. Suppliers and manufacturers of components and subassemblies are excluded from the definition of "producer." Where companies market these products under their own brand but other companies originally manufactured them, only the brand name companies would be subject to the directive. *Id*. art. 2.

158. European Commission Proposal to Parliament, *supra* note 30, at 6.

159. *Id.*

160. The EU Directive mandates the establishment of a collection system under which final holders and distributors of electrical and electronic equipment can return such equipment from private households free of charge. Distributors supplying a new product must offer to take back E-waste, free of charge, from private households provided that the equipment is free from contaminants. Producers are allowed to set up and operate individual and/or collective take-back systems for E-waste from private households provided that these are in line with the objectives of the directive. Producers must also provide for the collection of waste other than from private households. E-waste must be transported to recognized treatment facilities. A minimum rate of separate collection of four kilograms on average per inhabitant per year of E-waste must be achieved by December 31, 2006. Directive 2002/96/EC, *supra* note 156, art. 5.

161. The EU Directive mandates the establishment of waste treatment systems using best available treatment, recovery, and recycling techniques. Any facility carrying out waste treatment operations must obtain a permit from the competent authorities and must store and treat E-waste in accordance with specific technical requirements. Member states must encourage the implementation of certified environmental management systems. E-waste may be exported for treatment outside of the EU if treatment is undertaken in compliance with certain standards. Accordingly, producers must deliver E-waste only to those facilities that comply with the treatment and recycling requirements mandated by the directive and must verify compliance through adequate certifications. *Id*. art. 6.

162. The EU Directive mandates the establishment of systems for recovering E-waste and the achievement by Member states of specific recycling targets. It also encourages the development of new recovery, recycling, and treatment technologies. *Id*. art. 7.

163. The EU Directive mandates the establishment of a financing system for the management of E-waste, including producer-financing of the collection, treatment, recovery, and environmentally sound disposal of household E-waste deposited in the corresponding collection facilities. Each producer must be responsible for financing these operations for products put on the market later than August 13, 2005. The producer can choose to fulfill this obligation either individually or by joining a collective scheme. Member states must ensure that each producer provides a guarantee when placing a product on the market showing that the management of all E-waste will be financed. The responsibility for financing the management costs of E-waste from products put on the market before August 13, 2005, must be provided by one or more systems to which all producers contribute proportionately. Producers must also finance the management costs of E-waste from users other than private households. As an alternative, member states may provide that users other than private households also be made partly or totally responsible for this financing. Producers and users other than private households may conclude agreements stipulating other financing methods. *Id*. arts. 8 & 9.

164. Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the Restriction of the Use of Certain Substances in Electrical and Electronic Equipment, 2003 O.J. (L 37) 19. The directive mandates the replacement of lead, mercury, cadmium, CrVI, polybrominated biphenyls, and polybrominated diphenyl ether by other substances. *Id*. art 4.1. Prohibition of other hazardous substances and their substitution by more environmentally friendly alternatives will be examined as soon as scientific and technical evidence become available. *Id*. art. 4.3.

165. Member states are required to bring into force the laws, regulations, and administrative provisions necessary to comply with both directives by August 13, 2004. Directive 2002/96/EC, *supra* note 156, art. 17; Directive 2002/95/EC, *supra* note 164, art. 9.

166. An attempt was made to include an EPR provision for packaging in a RCRA reauthorization bill submitted to Congress in 1992. This failed, ending EPR legislative initiatives at the federal level. *See* Fishbein et al., *supra* note 148, pt. II, ch. 5, at 103.

167. The major national policy discussion of EPR occurred at the President's Council on Sustainable Development. In 1996, this multistakeholder group issued a report called *Sustainable America*, which recommended policies to "achieve national environmental, economic and social goals." When the subject of EPR was introduced it generated a significant debate, with industry representatives strongly against to the concept of "producer" responsibility. Consequently, the original designation was changed and a new policy was recommended on extended "product" responsibility, a much broader definition than the European definition of producer responsibility. For a concise definition of extended product responsibility, see U.S. EPA, Extended Product Responsibility: A Strategic Framework for Sustainable Products (1998) (EPA 530-K-98-004), *available at* http://www.epa.gov/epr/about/printed.html (last visited Dec. 30, 2003).

168. There is no focus on the post-consumer stage; responsibility is voluntary and is shared among consumers, government, and all industry actors in the product chain; responsibility is not required to be physical or financial, and may be satisfied by providing consumer education.

ate concern.[169] In fact, legislation has been introduced in several states that would establish some form of EPR requirement for the management of electronic waste.[170]

The truth is that EPR programs are proliferating around the world in many different product sectors, including the electronics sector. Regardless of whether or not EPR is adopted at the national level, programs implemented abroad are likely to have an impact in the United States as well. In a globalized world in which multinational corporations are being affected by EPR mandates of different countries, changes in product design that produce costs savings as well as environmental benefits may certainly influence future policy in the United States.[171] With the largest economy in the world, the United States not only uses a disproportionate amount of the world's resources, but also generates a disproportionate amount of waste per capita. Waste management is still being funded in grand part by general taxpayer revenues, which do not provide incentives for a change in product design.[172] EPR could change this situation by encouraging industry to design products that reduce waste and facilitate recycling. Not only would it provide the United States with an effective tool for dealing with its growing generation of E-waste, but more importantly, it would indubitably help to reduce its exports to developing countries.

V. Conclusion

E-waste is a growing problem and is likely to continue growing for the foreseeable future as technological advances continue to increase the rapid obsolescence of electronic products. The United States is the largest producer and consumer of electronic products and, consequently, the largest generator of E-waste. The problems generated by the E-waste crisis cannot effectively be addressed without the cooperation of the United States. The current regulatory structure of the United States does not effectively deal with the problems associated with the management and disposal of electronic waste. With its exemptions for recycling purposes, which often result in the scrapping of E-waste rather than the recovery of usable products, the lack of regulatory oversight for hazardous materials shipped overseas, and the disparity in waste disposal costs at both domestic and international levels, U.S. regulations are ineffective in preventing harm to less developed countries caused by its exports of hazardous wastes.

Although it may be economically expedient for the United States to shift the burden of environmental, health, and social impacts associated with E-waste to less developed countries, the United States has an obligation under international law to deal with its waste in a manner that does not cause harm to less developed countries. Further, as a signatory of the Basel Convention, the United States has an obligation not to undermine the goals of the treaty. Formal U.S. ratification and implementation of the Basel Convention and adoption of stringent export controls would be a step in the right direction of protecting less developed countries from harms associated with E-waste exports but may not be enough. The continuing generation of hazardous materials is the core of the problem and it certainly requires a different approach: the development and implementation of cleaner production technologies. The ultimate goal of eliminating hazardous substances requires a substantial change in manufacturing practices, which is unlikely to be achieved in the United States without a serious commitment to the principle of EPR. It is time for the United States to face up to its responsibilities under international law and as a world leader. It is time for the United States to set an example that the rest of the world can respect, live with, and live up to.

169. FISHBEIN ET AL., *supra* note 148, pt. II, ch. 3, at 77.

170. For detailed information on E-waste legislation at the state level, see an interactive map developed by the SVTC on the Internet at http://www.svtc.org/cleancc/usinit/initsmap.htm (last visited Dec. 30, 2003).

171. FISHBEIN ET AL., *supra* note 148, pt. II, ch. 5, at 105.

172. *Id.* pt. II, ch. 1, at 64.