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Report for Congress

Recycling Computers and Electronic Equipment: Legislative and Regulatory Approaches for "E-Waste"

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Summary

Rapid growth in the use of computers and the incorporation of electronic features in a wide array of consumer products have been among the most important driving forces of the nation's economy during the last decade; but they also pose major potential environmental problems. In addition to producing better products, the improvements in technology have created growing volumes of obsolete products to be managed as waste. According to the National Safety Council, which undertook the first major effort to gather quantitative information on electronic product recycling, 55.4 million personal computers will become obsolete in the United States in 2002. At an average weight of 70 pounds, obsolete PCs weighing 3.878 billion pounds will be added to the supply of waste needing management in 2002 alone.

Management of these products as waste is of concern in part because of their volume, but more importantly because they contain large amounts of heavy metals and other toxic substances.. A computer monitor or television set, for example, generally contains 4-10 pounds of lead. Mercury, cadmium, and other heavy metals are also commonly used in such equipment. In an incinerator or landfill, these metals can be released to the environment, contaminating air, ash, and ground water. As a result, many argue that electronic equipment should be managed separately from the municipal waste stream, and recycled whenever possible.

The United States has done little to address this problem. Unless disposed in large quantities, used computers and other electronic products are allowed to be managed as municipal solid waste (i.e., the same as ordinary household trash) in most states. In some locations, used computers have been collected for recycling on special voluntary collection days, but few jurisdictions offer frequent, comprehensive recycling opportunities for electronic waste. The exceptions are California and Massachusetts, where disposal of cathode ray tubes (i.e., television sets and computer monitors) has been banned – essentially requiring their separate collection for recycling. Collection for recycling does not guarantee environmentally responsible management, however; recent reports suggest that large volumes of electronic waste separated for recycling are being shipped to China and other developing countries, where primitive recycling methods threaten human health and the environment.

Numerous interested parties, including environmental groups, solid waste management officials, electronics manufacturers, and retailers, have begun to develop alternative approaches on a voluntary basis; and elsewhere in the world, notably in Japan and the European Union, regulations are under development that would force manufacturers and importers to take back end of life products for recycling and waste management separate from the municipal waste stream.

This report provides background on the management of discarded computers, discusses some of the initiatives undertaken in the United States and abroad, and identifies options that Congress might consider if it were to address this issue. As of mid-October, only one bill, H.R. 5158, has been introduced on this topic.

Contents

Recycling Computers and Electronic Equipment: Legislative and Regulatory Approaches for "E-Waste"

The Nature of the Problem

Rapid improvements in technology and software have made the use of computers and other electronic products nearly ubiquitous in the United States and other developed countries; but disposal of these products, when they become "e-waste" at the end of their useful lives poses major potential environmental problems.

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. In addition, electronic controls have been incorporated in a growing list of products, from autos to audio equipment to microwave ovens. On balance, particularly over the last decade, the effect of these developments has been to stimulate productivity and contribute to what was the nation's longest sustained period of economic growth.

As computers and electronic equipment have improved, however, there has been a more rapid turnover of such equipment, with growing volumes of obsolete products to be managed as waste. The National Safety Council, which undertook the first major effort to gather quantitative information on electronic product recycling, estimated the average lifespan of personal computers to be only 2.4 years in 2002; 55.4 million PCs are expected to become obsolete in 2002, according to the Council.[1] At an average weight of 70 pounds, obsolete PCs weighing 3.878 billion pounds will be added to the supply of waste needing to be managed this year.

Not all of this amount will actually *be* disposed in 2002, however. In fact, the amount disposed may be substantially smaller. Replacing an obsolete computer generally has more to do with the consumer's or business's desire for a new/improved feature of the replacement model – additional speed or memory, for example – or, in some cases, the failure of a single component of a larger system. Obsolete computers that are still in working order are often consigned to spare offices or basements, where they may occasionally be used, but more likely will sit unused for months or years. Computers needing repair of a component may suffer a similar fate, often piled in storage rooms or basements until the owner decides what to do with them. In part, this storage is motivated by a lack of information on how end-of-life computers should be disposed. Uncertain what to do, the owners let them sit.

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[1] National Safety Council, *Electronic Product Recovery and Recycling Baseline Report*, May 1999, p. 29.

Waste analysts refer to this method of managing used computers as "hoarding." There is little hard information regarding the number of computers being hoarded, but it is widely assumed that hoarding is a common practice.

PCs are only one part of the electronics waste stream. Mainframe computers, printers and other peripheral equipment, laptops, video gaming systems, televisions, VCRs, and telecommunications equipment are also changing and being replaced at a rapid rate.

This equipment and the rechargeable batteries that power increasing numbers of computers, telephones, and other portable devices pose challenges to the waste management system. At the end of their useful life, many of these devices are disposed in municipal waste systems poorly designed to handle such trash. Electronic equipment can be bulky and not easily compacted. It is largely composed of glass and metals (materials that don't burn or decompose) and that, in some cases, are hazardous: a computer monitor or television set, for example, generally contains 4-10 pounds of lead. Mercury, cadmium, and other heavy metals are also commonly used in such equipment. In an incinerator or landfill, these metals can be released to the environment, contaminating air, ash, and ground water. The presence of such materials suggests to many that electronic equipment should be managed separately from the municipal waste stream and recycled whenever possible.

Regulatory Structure for E-Waste

The United States has done little to address this problem. Under EPA regulations, much of the waste would qualify as hazardous. When disposed in sufficient quantities, it would be subject to regulations requiring generators and transporters to ship wastes to permitted hazardous waste management facilities. These facilities must comply with stringent standards governing treatment, storage, and disposal of the waste.[2]

But federal law exempts households and other small-quantity-generators from hazardous waste management requirements. Generators of up to 220 pounds per month of electronic waste may dispose of it with ordinary trash or at municipal waste management facilities in most states without any special requirements. Larger generators often escape regulation, too, by donating used equipment to educational or charitable groups for reuse. Such donations are not considered disposal from a regulatory perspective.

When electronic goods are ready for disposal, recycling can keep them out of the waste management regulatory scheme. Often, the equipment is shipped outside the United States, where U.S. regulatory authorities may have little information concerning the environmental performance of the recycling facility.

Under the federal waste management laws, states remain free to establish more stringent requirements. Two states (California and Massachusetts) have done so, banning disposal of cathode ray tubes (i.e., most television sets and computer

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[2] The regulations are found at 40 CFR Parts 260-265.

monitors) in municipal landfills and incinerators. Disposal of other electronic waste is not regulated in any state, however.

Even the materials collected for recycling (about 14% of total discards, according to the National Safety Council[3]) pose environmental and regulatory questions. According to one recent report, "Currently the cheapest e-waste recycling option in the U.S. is to send e-waste overseas: how it is used or disposed of there is largely unknown."[4]

Although there is little current regulation governing disposal of e-waste, a growing movement among environmental groups, regulatory officials, manufacturers, and retailers, both in the United States and abroad, has begun to develop alternative approaches. This report discusses some of the initiatives undertaken by these groups and identifies approaches that Congress might consider if it were to address this issue.

Voluntary Initiatives

Local waste management officials, manufacturers, and retailers in the United States have developed a number of voluntary programs to collect electronic products for reuse or recycling. These initiatives are motivated by a mix of reasons, including the desire to protect the environment from the effects of disposal, an interest in demonstrating the feasibility of separate collection and recycling, a sense that it is good business and good public relations to do so, the wish to provide a stimulus for companies pioneering "demanufacturing" and recycling technologies, and in response to the increasing discussion of regulatory approaches under development in Europe and Japan.

State and Local Government Collection Efforts. Over the past several years, many local governments have undertaken recycling collection events for computer equipment. According to the Electronic Industries Alliance, collection events are scheduled at at least 330 locations in 21 states and the District of Columbia.[5]

These events generally follow the model of household hazardous waste collection. Since the early 1980s, hundreds of local governments have organized occasional collection of hazardous waste (paints, used oil, batteries, pesticides, etc.), generally by establishing a one-day event, or a series of such events, at central locations. These events are geared toward households (rather than businesses), allowing citizens of the jurisdiction to bring such wastes to a collection point where

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[3] Ibid., p. viii. These machines are largely collected from businesses, rather than households.

[4] Global Futures Foundation, *Computers, E-Waste, and Product Stewardship: Is California Ready for the Challenge?*, Report for U.S. EPA Region IX, June 25, 2001, Executive Summary, available at [http://www.globalff.org/].

[5] For comprehensive state-by-state information on these events, see the web site of the Electronic Industries Alliance at [http://www.eiae.org/].

the wastes are separated by type for recycling or hazardous waste disposal. The objective is to keep hazardous wastes out of the ordinary municipal waste stream, protecting sanitation workers and the environment.

In the past several years, a number of jurisdictions have added computer equipment to the list of items that they will accept at such events. Other jurisdictions have staged similar events focused on computers alone. The response has indicated that many consumers will participate in separate collection programs. In Ohio, for example, the Cleveland-area's Cuyahoga County Solid Waste District collected 161 tons of old computers at two events in April and August of 2001. The events were so popular that the district decided to conduct recycling drives for old televisions and other electronic equipment.[6] In Rhode Island, the state's Resource Recovery Corporation sponsored drop-off collections on two back-to-back Saturdays, in which 87 tons of unwanted computers were collected. Thousands of the state's residents waited up to an hour in wintry weather to recycle computers. The state officials were so impressed by the turnout that they began a permanent program, with collections at a central location on the last Saturday of every month.[7]

Manufacturers' Take Back Programs. Some computer manufacturers have also begun programs in which they take back old equipment for recycling. While these programs typically charge a fee, they are broader than the municipal programs in one respect: they accept computers returned by businesses as well as individuals.

IBM, for example, is offering to manage any manufacturer's end-of-life personal computers, "including system units, monitors, printers, and optional attachments" for a fee of $29.99. The fee covers the cost of shipping.[8] Depending on the age and performance capability of the computer, IBM's recycling service will recycle and reuse parts or refurbish the computer for donation to nonprofit organizations. In the latter case, the donor will receive a receipt for potential deduction on their annual tax return. Even before announcing this program, IBM states that it "recycled more than 120 million pounds of equipment parts and machines in 1999, with less than four percent deemed unsalvageable/non-recyclable."[9] This equipment came from IBM's internal operations and from equipment the company leased to customers.

Hewlett-Packard (HP) also offers to accept for evaluation and recycling– from both businesses and individuals – a wide range of computer equipment, whether or not the company manufactured it. Their service "includes pickup, transportation, evaluation for reuse or donation, and environmentally sound recycling for products

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[6] "Recycling in Bits and Bytes," *Waste News*, September 17, 2001, p. 6.

[7] "Permanent Computer Drop-Off Program Established," Rhode Island Resource Recovery Corporation, News and Events, undated (January 2001?), at [http://www.rirrc.org/site/news/story.asp?NewsID=19].

[8] See "IBM Announces Product Recycling Programs for Consumers, Small Businesses & Enterprises," Press Release, November 14, 2000, available at [http://www.ibm.com/Press/prnews.nsf/jan/64D3E7BBB37BEF4285256997005857E0].

[9] Ibid.

ranging from PCs and printers to servers and scanners."[10] In HP's case, the fee is variable, from $13 to $34 per item, depending on the type and quantity of hardware returned.

Sony has also begun taking back equipment for recycling from some U.S. consumers. In October 2000, the company announced a five-year recycling agreement with the State of Minnesota and Waste Management, Inc. under which Minnesota consumers can return any Sony product to designated collection points for recycling at no cost.[11]

The Sony decision was preceded by a 3-month pilot program, in August-October 1999, in which 575 tons of used electronic equipment was collected and analyzed.[12] Perhaps surprisingly, televisions – not computers – made up the bulk of the items collected, by weight, accounting for 69% of the total weight of items collected. Roughly half of these televisions were manufactured before 1980, and 15% were orphan products (products whose manufacturers are no longer in business).

The waste management industry has also become involved in separate collection and recycling of electronic waste. In the past two years, Waste Management, Inc., through its Asset Recovery Group, has opened a network of eight e-scrap facilities across the country that sort and recycle more than 60 million pounds of e-scrap per year.[13]

Retailer Programs. Retailers are also becoming interested in promoting recycling of electronic equipment, although thus far, their efforts appear limited. In April 2001, Best Buy announced that it would begin periodic collections to allow consumers to drop off used electronic items for recycling. Under Phase I of their program, the company held special recycling collection events at 11 sites in 8 states across the country in the summer and fall of 2001. In later phases, the company expects to expand the service "to ensure that consumers in every Best Buy community will be close to a special electronics recycling event at least once a year."[14]

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[10] See "HP Recycling Program Helps Keep Computer Parts Out of Landfills," Press Release, May 21, 2001, available at [http://www.hp.com/hpinfo/newsroom/press/21may01a.htm].

[11] "Sony Electronics Teams with State of Minnesota and Waste Management, Inc. to Kick Off New Electronics Recycling Program," Press Release, October 18, 2000, available at [http://64.35.93.160/companynews/press/index?start=10&view=archive].

[12] For a discussion of this pilot program, see "Recycling Used Electronics," Report on Minnesota's Demonstration Project, July 2001, at [http://www.moea.state.mn.us/plugin/report.cfm].

[13] "Waste Management Announces Electronics Recycling Program With Sony Electronics, State of Minnesota," Press Release, October 18, 2000, available at [http://www.wm.com/press/PR/2000/press0080.asp].

[14] "Best Buy Electronics Recycling Program," program introduction, undated, available at [http://www.e4partners.com/Best%20Buy%20Electronics%20Recycling.htm].

Under the Best Buy program, recycling collections were two-day events. Consumers could bring computers, monitors, keyboards, printers, fax machines, TVs, stereos, camcorders, cell phones, rechargeable batteries, VCRs, and small household appliances of any brand to the designated location (generally a Best Buy store). Drop-off was generally free, except for computer monitors and TVs, for which there were handling fees of $10 and $15 respectively. The company's web site notes that, in every location, they received substantial amounts of publicity, including television news coverage, and, in one case, the web site commented that the "event had a noticeable and positive reaction on store sales that weekend."[15]

Effects of Voluntary Programs

Data concerning the results of voluntary programs (whether run by municipalities, manufacturers, or retailers) indicate that there is substantial interest in electronics recycling. In addition, the programs have demonstrated a number of models for how larger (possibly mandatory) programs might be organized. Overall, however, the availability and use of such programs has only scratched the surface of what is available to be recycled, with little impact on overall recycling rates.

For example, the IBM take-back program – perhaps because it charges consumers nearly $30 to recycle a computer – was reported to have handled fewer than 1,000 computers (0.03% of the company's annual sales) as of June 2001 (i.e., after 6 months of operation).[16] Best Buy, while reporting returns of 257,243 pounds (128 tons) of scrap electronics in the first year of its program, offered recycling events at only 9 of its 415 retail locations. Overall, according to Ted Smith, Executive Director of the Silicon Valley Toxics Coalition, "while millions of computers have been 'junked' over the past few years, the rate of recycling has decreased due to a lack of effective systems or policies."[17]

The rate of electronic product recycling, estimated at 14% by the National Safety Council, relies heavily on the return to manufacturers of leased equipment. Such returns used to be standard practice in the computer industry: customers leased equipment, and as they traded up to newer, faster models, manufacturers took the older models in return. As the price and size of computers became smaller, leasing gave way to outright purchase in most cases, and with that transition, manufacturer responsibility for end-of-life products disappeared.

State Regulations

As noted earlier, two states have promulgated regulations to deal with aspects of electronic waste disposal.

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[15] "Event Results (December 5 Update)," at Ibid.

[16] Silicon Valley Toxics Coalition, *Poison PCs and Toxic TVs: California's Biggest Environmental Crisis that You've Never Heard Of*, June 19, 2001, p. 3. The report is available at [http://www.svtc.org/cleancc/pubs/poisonpc.htm].

[17] Ted Smith, "Should PC Makers Recycle Wares?" June 24, 1999, as quoted in Ibid., p. 1.

Massachusetts. Massachusetts banned the disposal of cathode ray tubes (CRTs) in landfills and incinerators as of April 1, 2000, and established a grant program that helped develop an infrastructure for recycling them. CRTs are the picture tubes that form the bulk of most televisions and computer monitors. According to the Massachusetts Department of Environmental Protection (DEP), a wide array of organizations, including the University of Massachusetts, non-profits (such as the Salvation Army and Goodwill Industries), for-profit companies, and municipalities established an infrastructure to collect, repair, reuse, and recycle CRTs as Massachusetts implemented its ban on disposal. The state encouraged the development of the collection and recycling infrastructure through grants. Measured by the number of collection programs, this effort appears to have been wildly successful. Of the nationwide total of 330 electronics collection programs identified by the Electronic Industries Alliance in early 2002, 255 (77%) were in Massachusetts.

The collected monitors and televisions have multiple uses. A high percentage (perhaps 4 in 10, according to a DEP official) are still useable or repairable, and can be resold. In other cases, the face plate of the picture tube is removed from the CRT for reuse. In still others, the CRT is crushed and the glass is sent to a smelter for recycling.

One problem Massachusetts had in implementing its program was obtaining approval from EPA. Under the Resource Conservation and Recovery Act (RCRA), EPA is given authority to regulate hazardous waste, but may authorize states to run the program if the state can demonstrate that its regulations are equivalent to and consistent with EPA's. As discussed earlier, CRTs are considered hazardous waste under EPA regulations, because of the high amount of lead they contain. Massachusetts wanted to exempt CRTs from hazardous waste management regulations in order to avoid regulatory requirements that would increase the cost of its program to entities handling the CRTs. After prolonged negotiations with EPA, Massachusetts rewrote its hazardous waste regulations to provide a conditional exemption from the hazardous waste program provided that the CRTs are managed according to specific regulations that, among other things, prohibit disposal.

EPA granted the state only an interim, 3-year authorization to run the CRT program, but the state now expects an additional interim or permanent authorization from EPA after the initial three years.

In part because of the experience with Massachusetts, and in part because of a desire to stimulate recycling throughout the United States, EPA has now proposed a set of special exemptions from the hazardous waste rules for computer recycling. The proposed changes were published in the Federal Register on June 12, 2002.[18]

California. In California, "the disposal of waste CRTs in municipal landfills has always been prohibited," according to Peggy Harris, Chief of the State

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[18] 67 Federal Register 40508, June 12, 2002.

Regulatory Programs Division, Hazardous Waste Management Program.[19] But this fact was not widely appreciated until March 2001, when the state's Department of Toxic Substances Control responded to a letter from the Materials for the Future Foundation (MFF). MFF, which has hosted several working group meetings to promote the development of recovery and recycling infrastructures for electronic products, asked the state for clarification of how its hazardous waste regulations applied to disposal of CRTs. The response, dated March 20, 2001 (and subsequently revised, April 3, 2001) received substantial attention in environmental, industry, and regulatory circles, and in the press.

In the letter, the Department stated that CRTs are considered hazardous waste under both federal and state law, when discarded. Unlike federal law, the letter went on, California law does not contain exemptions for household or small quantity generators. Therefore, in California, persons that generate hazardous waste at their home, or who are small generators, must transport their hazardous waste (including CRTs) to a household hazardous waste collection facility for disposal.[20]

International Regulatory Developments

Computers and consumer electronics have long been among the most international of industries. Japanese, Korean, Taiwanese, European, and American companies sell products worldwide, with production facilities and component manufacturing plants in many different countries. As a result, developments in Europe and the Pacific Rim – where numerous countries are developing legislation and regulations that would reduce the volume of electronic waste, shift the burden for its management from the public sector to industry, and reduce the toxicity of materials used in production – are being closely watched by executives in this country. This section discusses developments in several major countries, including Switzerland, the Netherlands, Japan, and the European Union.

Switzerland. Switzerland was the first country to enact broad legislation: on January 14, 1998, the Swiss enacted an ordinance on separate collection and recycling of electronic waste.[21] The ordinance, which went into effect on July 1, 1998, requires separate collection and recycling of electronic waste, including electronic equipment used at home as well as office equipment, computer equipment, communications equipment, and household appliances. According to the ordinance, consumers are required to take used equipment back to a manufacturer, an importer, or a retailer. Retailers are required to take back old equipment if they offer the same sort of product for sale. Wholesalers and intermediaries likewise have an obligation

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[19] Letter of Peggy Harris to Sheila Davis, MFF, April 3, 2001, available at [http://www.materials4future.org/ELECTRONICS/DTSCresponse3-20.html].

[20] Ibid.

[21] This section is based on the Ordonnance sur la Restitution, la Reprise et l'Elimination des Appareils Electriques et Electroniques of January 14, 1998, available in French on the Swiss Federal Government website at [http://www.buwal.ch/abfall/f/elektronikschrott.htm]. According to the Swiss Embassy, the ordinance has not been translated into English, although information on the recycling requirements is available in English on the government's website.

to accept returns, although they can arrange for waste equipment to be delivered directly to a waste-handling facility.

Manufacturers and importers are only required to take back equipment of their own brand (or, in the case of importers, of brands that they import). This reinforces one of the ordinance's primary objectives, which is to serve as an incentive to manufacturers to consider the question of waste management during the design of a product. Manufacturers who produce equipment that is easily disassembled and made of materials easily recycled and causing little pollution can thus reduce their costs vis-a-vis their competitors.

The ordinance leaves most details of the recycling and management of returned items to industry or to state-level (canton) governments. Regulations on the recycling and management of the returned items and permitting or authorizing the necessary facilities, for example, are left to the cantons. The ordinance contains no requirements on financing; determining how to finance and structure the return system is left to industry and the markets to decide. The Swiss federal government does have one other role, however: the regulation of exports, in order to insure that disposal in other countries is in accord with those countries' regulations and is respectful of the environment.

In many respects, such as the required take-back provisions and the flexibility given industry to devise its own collection and recycling schemes, the Swiss system is similar to regulations established elsewhere in Europe to encourage recovery and recycling of packaging waste. These regulatory systems 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.

Netherlands. Shortly after the Swiss enacted their ordinance, the Dutch government issued a Decree on the Removal of Electric and Electronic Appliances (also referred to as the Disposal of White and Brown Goods Decree), April 21, 1998.[22] The decree requires retailers, manufacturers, and importers of electric and electronic appliances to finance the collection and to take back end-of-life equipment, including computers, from consumers. It prohibits incineration and landfilling of the products.

The decree applied to large appliances (televisions, video and sound equipment, computers, printers, and telecommunications equipment, as well as refrigerators, freezers, washers, dryers, and stoves) as of January 1, 1999. Smaller appliances were covered as of January 1, 2000. The decree requires retailers to accept used appliances in trade, and requires local authorities to provide separate collection of such appliances from households, as well as a place to which retailers may take equipment traded in. Manufacturers and importers must take back products of their

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[22] An unofficial translation of the decree and an explanatory memorandum can be found on the Netherlands Ministry of Housing, Spatial Planning and Environment website at [http://www2.minvrom.nl/pagina.html?id=5003].

brand from retailers and local authorities and must reimburse retailers, repair companies, and local authorities for the cost of collecting their products.

The Dutch system, which is the only one for which we were able to obtain data, "works well after two years of operation," according to a Dutch source; it has "recycling rates higher than anticipated" and "costs lower than anticipated."[23] The system captured 76% of end-of-life televisions in its first two years, for example, and processing costs for TVs were lower than budgeted, allowing the recycling fees charged on new televisions to be lowered from $10 to $7.[24]

In general, electrical and electronic products are sorted and processed by an industry-funded recycling organization (known by its Dutch initials, NVMP), rather than being taken back by individual manufacturers and importers. NVMP is funded by fixed recycling fees imposed on the sale of new products. These range as high as $15 for refrigerators, freezers, and air conditioners; small items like radios and CD players initially had fees of $2.00, but as of July 2001 are not subject to fees.

Dutch computers are collected through a separate system, not through NVMP. There are no recycling fees paid directly by consumers in this system; rather, producers and importers are paying the costs of computer recycling, in proportion to each company's share of the products returned. About 25% of the products returned are orphans (i.e., the manufacturer is no longer doing business in the Netherlands). The cost for managing these products is split among companies still in business according to each company's share of the recycled products. One potential inequity of this system is that it places a heavier burden on companies that had a large market share in the past, irrespective of their current sales. New entrants to the market, by contrast, do not pay for the management of historic or orphan waste, even if they have a significant share of current sales.[25]

Another criticism of the Dutch system is that, as currently structured, it provides little incentive for companies to design their products for recycling, since all products of a given type are charged the same recycling fee.

Japan. In Japan, a Law for Recycling Specified Kinds of Home Appliance (also referred to as the Home Appliances Recycling Law) was enacted in June 1998. The law requires that retailers collect – and that manufacturers and importers recycle – four types of household appliances: televisions, refrigerators, washing machines, and air conditioners. The law's inclusion of televisions has encouraged the development of a TV and CRT recycling industry in Japan, where substantial

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[23] Ab Stevels. "Experiences with the Take-Back of White and Brown Goods in The Netherlands," *Sustainable Development International,* available at [http://www.sustdev.org/Features/DelftUni.pdf]. The author is affiliated with Delft University of Technology and Phillips Consumer Electronics.

[24] Ibid., p. 3.

[25] Personal communication, Alan Phipps, Product Stewardship Initiative, University of Massachusetts (Lowell). Mr. Phipps has researched the Dutch electronics recycling program for the National Electronics Product Stewardship Initiative, which is described elsewhere in this report.

research has gone into the development of TV dismantling and recycling technologies since the early 1990s. On its web-site, for example, Sony reports that it has developed automated recycling lines that open the television cabinet, remove the CRT, separate the front panel from the rear funnel, and pulverize the glass for recycling. Sony has cooperated with other companies to establish 190 take-back sites and 15 recycling plants in Japan since enactment of this law.

Japan began compulsory recycling of business computers in April 2001, and will expand the requirement to PCs in the summer of 2003. In anticipation of this requirement, the Japanese PC manufacturing industry and the Ministry of Economy, Trade, and Industry are reported to have agreed to add recycling fees to the price of new computers when the requirement goes into effect. The fees are expected to range from $30 - 40 for desktop units to $10 - 15 for laptops.[26]

European Union. While the above countries have already implemented take-back and recycling requirements for electronic products, the efforts of the 15-nation European Union (EU), whose regulatory program is still under development, has aroused far greater interest. The size and importance of the European Union (376 million consumers in some of the world's wealthiest economies) and the broad sweep of the requirements under discussion have made EU developments the principal focus of discussion among participants and observers of the electronics industry.

The European Union Directive on Waste Electrical and Electronic Equipment (WEEE),[27] which was agreed to October 10, 2002, will establish comprehensive take-back and recycling requirements for retailers, manufacturers, and importers of electrical and electronic products. The directive contains a two-and-a- half-page list of covered products, including household appliances, computer and telecommunication equipment, consumer electronics (TVs, radios, VCRs, etc.), lighting equipment, tools, toys, medical equipment, monitors and controls, and vending and ATM machines.

EU directives are somewhat different from federal law in the United States. Unlike U.S. federal laws, which can bind individuals and corporations directly, EU

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[26] "Japan to Require Computer Recycling Starting in Summer 2003, Agency Says" *Daily Environment Report*, March 6, 2002, p. A-6.

[27] Finding the current version of the directive is a complicated process, particularly if one is not familiar with European Union institutions. The full text of the directive as first proposed, including a 55-page Explanatory Memorandum, can be found on the European Union's EUR-Lex website, under "Legislation in preparation" [http://europa.eu.int/eur-lex/en/search/search_lip.html]. The original proposal, Document COM (2000) 0347 (01), can be found there by entering the year 2000 and document number 0347. As of October 2002, the most recent related document, which lists all earlier versions, is COM (2002) 0353, which can be found by entering the year 2002 and document number 0353. On October 10, 2002, representatives of the European Council and the European Parliament reached agreement on the final text, which must now be formally approved by both the Parliament and the Council. This text had not been posted as of October 18, but an October 11 press release describing the agreed text can be found at [http://europa.eu.int/rapid/start/cgi/guesten.ksh?p_action.gettxt=gt&doc=IP/02/1463|0|RAPID&lg=EN&display=].

directives are implemented and enforced indirectly, by requiring that the Member States of the Union enact legislation meeting the directive's requirements. In this case, the Member States would be required to have a legal and regulatory framework in place 30 months after the entry into force of the directive.

The directive on WEEE provides, among other requirements, that Member States shall: 1) ensure that systems are set up so that consumers can return WEEE for reuse, recycling, or disposal free of charge; 2) ensure that retailers (termed "distributors" in the directive) offer to take WEEE back free of charge when they supply a new, similar product; 3) ensure that producers and importers provide for collection of WEEE from holders other than households; 4) regulate collection and treatment of WEEE to ensure its suitability for reuse and recycling; and 5) meet a separate collection target from households of at least 4 kilograms (8.8 pounds) per person per year by the end of 2006.

In Article 6, the directive sets targets for collection and recycling of the various categories of products. For computer and telecommunications equipment (category 3) and consumer electronics, including televisions, VCRs, and audio equipment (Category 4), the target rates of recovery would be 75 - 85%, with reuse and recycling of the components, materials, and substances collected to be 65% by weight. Additional targets are to be set for the years beyond 2008, but are not specified in the directive.

The directive requires that producers and importers finance the separate collection of waste electronics either on their own or through collective systems financed by themselves and other members of the industry. The cost of managing waste from products put on the market before the directive's entry into force (historical waste) is to be shared by all existing producers based on their market share. Producers will be able to recoup this cost through a "visible fee" sales tax on new products for 8 - 10 years. Users other than private households may be made partly or totally responsible for financing the costs of management of their historic waste.

The directive provides for labeling and consumer information, and for submission of annual reports on quantities placed on the market, as well as collection and recycling.

The EU also has addressed the issue of hazardous substances in electronic waste. In Annex II of the WEEE draft, the directive requires that certain hazardous substances (including PCBs, mercury, batteries, printed circuit boards, toner cartridges, plastic containing brominated flame retardants, asbestos, CRTs, CFCs, liquid crystal displays, and components containing radioactive substances) be removed from waste electrical and electronic equipment and treated separately. There is also a separate draft directive on the Regulation of Hazardous Substances (RoHS), in which the EU proposes that 6 hazardous substances (lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls [PBBs], and polybrominated diphenyl ether [PBDE]) be replaced by other substances in electrical and electronic equipment by July 1, 2006. The directive provides a list of exemptions, however, including use of lead in the glass of cathode ray tubes and in solder, mercury in fluorescent lighting, and lead as radiation protection. In addition,

the prohibited substances may continue to be used in spare parts for equipment that was placed on the market before July 1, 2006.

As noted previously, the EU directives are broad in scope, setting aggressive collection, reuse, and recycling targets for dozens of products and industries. But the basic principles – producer responsibility for take-back and for financing collection and recovery systems, fees on new products to cover the cost of managing historical waste, recycling targets, and controls on hazardous substances – appear common to many European and Japanese recycling programs.

The NEPSI Process

Developments in other countries, the beginnings of state regulatory programs in the United States, and the desire to address what many see as an emerging environmental problem have led a diverse group of U.S. stakeholders to establish a formal dialogue called the National Electronics Product Stewardship Initiative (NEPSI). Coordinated by the Center for Clean Products and Clean Technologies at the University of Tennessee and funded by EPA, NEPSI participants include the Electronic Industries Alliance, several computer and consumer electronics manufacturers, electronic product retailers, waste management firms, EPA, 15 state governments, environmental groups, and other organizations interested in computer recycling issues.[28]

NEPSI began meeting in June 2001, and hopes to reach agreement on the framework for an electronics recycling initiative in the latter part of 2002. Discussions have centered around the establishment of a national financing system for recovery of used computers and TVs. One option under consideration is assessment of fees on the sale of new computers and TVs.

Legislative Approaches

With any environmental issue, growing interest among individuals and interest groups in what appears to be a national or international problem, frequent attention to the issue in the press, and consideration of a diverse array of legislative and regulatory options among the states are often precursors of congressional interest. Thus, although Congress has not yet held hearings on electronic waste and only one bill (Rep. Mike Thompson's H.R. 5158) has been introduced, many assume Congress is likely to take up this issue given the increasing interest by other stakeholders.

If Congress decided to address the subject, there are at least nine options that might arise during discussions: 1) a Report to Congress on e-waste issues; 2) grants for the development of recycling infrastructure; 3) legislation establishing exemptions from the hazardous waste program to facilitate recycling of computers

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[28] For information on NEPSI, including the identity of the stakeholders, timelines, and meeting notes, see [http://eerc.ra.utk.edu/clean/nepsi/].

or other e-waste; 4) labeling to encourage recycling or provide environmental information to consumers; 5) bans on disposal and/or export of e-waste; 6) regulation of the use of hazardous substances in computer equipment; 7) requiring reuse or recycled content in computer manufacture; 8) an "extended producer responsibility" system, requiring manufacturers and importers to take back computers for recycling, either as individual companies responsible for their own brands, or collectively through an industry consortium; and 9) a fee-based system for the management of "historic" waste.

An additional question that presents itself is what to include in the definition of computers (or electronic waste) that might be the subject of legislation. This question is addressed in a separate section at the conclusion of this report.

1. Report to Congress. At present, there is a dearth of information on the U.S. electronics waste stream. Such basic facts as current and projected amounts of electronic waste, the amounts and types of heavy metals and other toxic substances contained in such products, how such waste is managed, and the impact of its disposal on the environment are all essentially unknown.

Few states regulate such waste separately from the municipal waste stream, which means that it can be disposed in municipal landfills or incinerators. Under EPA's hazardous waste regulations, disposal of more than 100 kilograms (220 pounds) of such waste per month is likely to qualify as hazardous waste disposal, subject to strict regulatory requirements. It is not clear how stringently this requirement is enforced.

A Report to Congress, defining e-waste, providing basic information on the quantities and types of such waste, describing how it is currently managed, and outlining options for management of electronic products at the end of their useful lives could be a useful starting point.

2. Grants for Recycling Infrastructure. If one wanted to establish universal requirements for recycling electronic waste, implementation of such requirements would likely be thwarted initially by the absence of a national infrastructure to collect and manage the products being returned. E-waste recycling is in its infancy. Most states and local governments have no separate collection program for computers or other electronic products, and few facilities are equipped to process the materials that are collected. Much of the processing/recycling that is done occurs overseas.

Thus, the development of a recycling infrastructure through a grant or loan program may merit consideration. A model for this effort could be the program in Massachusetts. As noted earlier, Massachusetts implemented a ban on the disposal of computer monitors and televisions containing cathode ray tubes (CRTs) in April 2000. Prior to implementation of the ban, the University of Massachusetts, a variety of non-profits (such as the Salvation Army and Goodwill Industries), for-profit companies, and municipalities established an infrastructure to collect, repair, reuse, and recycle CRTs. The State encouraged the development of the collection and recycling infrastructure through a municipal grant program. The program was not large: according to the Massachusetts Department of Environmental Protection

(DEP), the state spent $800,000 combined in FY 1999 - FY 2002.[29] The grants covered the cost of processing collected materials for each of the state's 351 cities and towns for the first year in which they collected e-waste. During that year, the local governments developed programs for collection and were able to determine the amounts they would need to budget to continue the programs in succeeding years.

Extrapolating these amounts on the basis of population, a comparable program for all 50 states might cost about $10 million annually. Without specifying annual amounts, H.R. 5158 would establish such a national grant program. This bill is discussed in greater detail below under item 9 (Management of "Historic" Waste).

3. Exemptions from RCRA. A third approach, used by Congress and EPA to encourage recycling of batteries in 1996, would be to amend the Solid Waste Disposal Act (generally referred to as "RCRA"[30]) to exempt e-waste from portions of the hazardous waste management rules, *provided that the material is reused or recycled*. One model for this is EPA's "universal waste" rule, which exempts waste batteries, pesticides, and thermostats from portions of the hazardous waste management regulations in order to encourage their recycling. When a waste is listed as a universal waste, handlers can accumulate a greater quantity of the waste and hold it for a longer time without requiring a hazardous waste storage permit. Universal wastes are also exempt from the requirement that transporters carry a manifest with detailed information when handling hazardous waste, thus permitting transport by common carriers in many cases. Adding computers and/or other electronics to the universal waste stream would provide clarification as to what type of waste these items are considered to be.

One drawback of the universal waste approach is that states are not required to adopt the universal waste designations: under the hazardous waste program, states are allowed to have regulations that are more stringent than the federal requirements. If not all states adopt the designation of e-waste as universal waste, transporting end-of-life computers and other waste electronic products through states with differing regulations may become burdensome for handlers. To address this issue as regards rechargeable batteries, Congress enacted the Mercury Containing and Rechargeable Battery Management Act in 1996 (P.L. 104-142). This act established the universal waste rule for rechargeable batteries as law in all 50 states and preempted state and local laws that conflicted with or were more stringent than its requirements.

Without new legislation, EPA is already moving to exempt CRTs from *all* hazardous waste requirements using a different approach. On June 12, 2002, the Agency proposed a rule that would exempt cathode ray tubes and glass removed from them from being considered solid or hazardous waste when sent for recycling. While the intention of this exemption is to streamline the reuse and recycling process for

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[29] Personal communications, Peggy Harlowe, Massachusetts DEP, June 12 and October 17, 2002.

[30] RCRA refers to the title of a comprehensive set of amendments to the Solid Waste Disposal Act. These amendments, the Resource Conservation and Recovery Act (P.L. 94-580), were enacted in 1976. The statute has since been amended seven more times, however, including comprehensive amendments in 1984.

CRTs, critics fear that "less than ethical business owners will collect the computers for fees, store them in large warehouses and disappear."[31] The Agency has not yet finalized this proposal.

4. Labeling. A fourth option would be to require labeling of computers to encourage recycling or to provide environmental information to consumers. The content of such labels would be determined by the other components of the legislation. For example, the European Union intends to require labels that will identify electronic equipment subject to its requirements that manufacturers and importers take equipment back for reuse or recycling. Other types of labels might identify the percentage of recycled materials used in the product, indicate compliance with prohibitions on the use of hazardous substances, identify materials used in order to facilitate their recycling, or communicate to consumers if disposal of certain components is to be prohibited.

5. Bans on Disposal and/or Export of E-Waste. As noted earlier, because of the increasing volume of CRTs and the toxicity of some CRT components, Massachusetts and California have prohibited disposal of these products in landfills and incinerators. Although we have little information concerning the overall effects of these disposal bans, the prohibitions have apparently served as a stimulus to the development of recycling and reuse options in the two states. Similarly, a federal prohibition might serve as a stimulus at the national level, provided it gave the waste management and recycling industries sufficient time to develop alternatives to disposal.

An important issue related to this option, would be whether to regulate exports of CRTs and other e-waste, as well as prohibiting their disposal in the United States. *Exporting Harm*, a recent report by the Basel Action Network and the Silicon Valley Toxics Coalition, concludes that such exports (often identified as being for the purpose of recycling) have served as a means of escaping from U.S. regulation, and in many cases pose serious health and environmental threats in the receiving countries. According to the report, "Informed recycling industry sources estimate that between 50 to 80 percent of the wastes collected for recycling are not recycled domestically at all, but very quickly placed on container ships bound for destinations like China."[32] Thus, restrictions on disposal without accompanying controls on exports might simply transfer a greater share of the problems associated with management of the waste overseas.

On the other hand, a prohibition on the export of materials collected for recycling would cut recyclers off from many of the markets able to reuse the materials. A significant portion of the manufacture and assembly of CRTs and computers occurs in Asian countries. If recovered materials cannot be shipped there, recycling and reuse will be difficult to achieve.

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[31] "Proposed Rule to Streamline Requirements for Handling CRTs Signed by Whitman," *Daily Environment Report*, May 28, 2002, p. A-10.

[32] Basel Action Network and Silicon Valley Toxics Coalition, *Exporting Harm*, February 25, 2002, p. 2.

A possible solution might involve regulation rather than prohibition of exports, with specific record-keeping and reporting requirements, and shipment allowed only to facilities that have been certified to meet high standards for recycling, worker protection, and waste management. This option might require further development to identify the exact nature of feasible controls or prohibitions and to identify a certifying authority, before legislation along these lines could be drafted.[33]

6. Regulating the Use of Hazardous Substances in Computers. A sixth option is suggested by the European Union (EU) directive on the Regulation of Hazardous Substances (RoHS). This directive will – with some important exceptions – ban lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB) and polybrominated diphenyl ether (PBDE) from electrical and electronic equipment put on the market after a specific date. A number of items, including lead in CRT glass, will be exempt from the ban because of the lack of substitutes.

Such a ban, it is argued, will limit hazardous substances in electronics and therefore reduce the hazards of exposure to employees, recyclers and waste managers (risks of exposure to users are thought to be negligible). Consultation with industry and recyclers would be helpful to determine what non-hazardous substitutes exist for the substances to be regulated and whether the benefits of such substitution outweigh the costs.

One possible problem with this approach is that banning hazardous substances could depress the market for reuse. If hazardous materials are banned, then spare parts from older computers would no longer be able to be reused to make new computers. The European Union directive gets around this problem by exempting reused equipment and spare parts from the ban.[34]

7. Recycled Content. A seventh option would be to stimulate the markets for reuse and recycling of computer components by requiring recycled content in new computer equipment. Most recycling and waste management experts would agree that collecting material for recycling is an incomplete exercise unless markets for reuse of the material are assured; but mandating the reuse of such material poses a number of logistical problems. Computer components are manufactured in numerous locations and often assembled in locations far from the places of manufacture. The parts are made of at least 36 different materials, according to one recent analysis,[35] many of them combined in ways that may be difficult to separate for recycling or reuse.

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[33] The International Association of Electronics Recyclers began a certification program early in 2002. For information, see [http://www.iaer.org].

[34]European Parliament 2002-2003. "Hazardous Substances in Electrical and Electronic Equipment." Texts Adopted at the Sitting of Wednesday 10 April 2002 Part One. pp. 37-41. Article 2, Paragraph 2(a) and Article 4, Paragraph 2(a). Available at: [http://www3.europarl.eu.int/omk/omnsapir.so/calendar?APP=PDF&TYPE=PV2&FILE=p0020410EN.pdf&LANGUE=EN].

[35]Handy and Harmon Electronic Materials Corp., as cited in *Exporting Harm*, p. 44.

On the other hand, according to the same analysis, six components – silica (much of it used in glass), plastics, iron, aluminum, copper, and lead – account for 95.8% of the weight of a typical desktop computer. Many of the parts containing these materials can be recycled. The key might be to set recycled content or reuse requirements for some or all of the specific computer components, such as the CRT, plastic casing, or specific metals.

8. Extended Producer Responsibility. Under "extended producer responsibility" (EPR), which is at the heart of the Asian and European proposals for regulation of e-waste, manufacturers and importers of electronic products would be held responsible for the management of those products at the end of their useful life.

EPR can be imposed on producers individually or collectively. In the individual approach, a producer or importer would be responsible for the take-back and management of its own products. By placing responsibility on individual companies, this approach creates incentives to design and manufacture the products in ways that simplify recycling and reuse. And, by allowing reuse of component parts, this approach could provide potentially large cost savings in the manufacture or remanufacture of products.

While it has potential advantages, individual producer responsibility also has potential drawbacks. The collection and sorting of e-waste in such a system could be costly and cumbersome, given that each manufacturer's products would need to be collected or sorted separately. One way to implement such a program would be by requiring retailers to accept returns of the brands of equipment that they offer for sale, and then simply to reverse the distribution process to get the products from retailers to manufacturers. Retailers might oppose such a requirement, however, because of the burden involved in storing the used equipment. In addition, many computers are sold directly by manufacturers or distributors to consumers without the use of retail locations.

An alternative to individual EPR is the use of a collective responsibility system. Under collective producer responsibility, manufacturers and importers create a third party organization which assumes responsibility for collection, recycling, and disposal of all the regulated products. The third party organization would be financed by producers and importers in proportion to the market share of each, or in proportion to the cost of recycling the products each contributes to the total collected.

While foreign governments have taken the leadership role in developing EPR legislation, legislation has been introduced in Massachusetts, Minnesota, and New York that would establish some form of EPR requirement for the management of CRTs or computer waste. Copies of state legislation on e-waste can be found on the web site of the National Caucus of Environmental Legislators at [http://www.ncel.net/ewastelist.html].

9. Management of "Historic" Waste. Electronic products that were sold prior to the date of enactment of any new regulatory scheme could contribute a substantial amount of waste. According to the National Safety Council study, 303 million personal computers are likely to become obsolete in the United States

between 2002 and 2006.[36] While some of these will be disposed or recycled, a large number will simply be placed in long-term storage in basements, attics, or storerooms, until the owners decide what to do with them. Millions of old television sets have accumulated in the hands of consumers for similar reasons.

These "historic" products may have been manufactured by companies no longer in business, or, where the company is still in business, the amount of waste attributable to its brand may bear little correlation to the company's current market share.[37] Thus, many argue that a separate collection and recycling scheme needs to be adopted for historic waste.

Under California legislation that passed the state legislature in August 2002, but was vetoed by the Governor, a fee of $10 would have been imposed on the sale of all CRT devices (televisions, video and computer monitors, and other devices containing CRTs) beginning January 1, 2004. The proceeds would have been used to provide grants for collection and recycling of CRTs and for public education.[38] A somewhat similar approach is at the heart of Rep. Mike Thompson's H.R. 5158: a fee of up to $10 per unit would fund a grant program to assist state and local governments, nonprofit organizations, and for-profit firms involved in collection, reuse, resale, or recycling of computers. In the case of the Thompson bill, U.S. EPA would set the amount of the recycling fee, up to a maximum of $10, and fees would apply to a broader range of products – not just CRTs, but computers, monitors, and other devices designated by EPA.

Under the EU directive, the cost of managing historic waste would be shared by all current producers in proportion to their respective share of the market. While the language is different, all of these proposals are similar in requiring fees on current sales to help finance collection of historic waste.

Defining E-Waste

What types of electronic products to include in any legislative consideration of e-waste is a key issue. There is a wide range of options. The most restrictive option would include only products containing cathode ray tubes (CRTs). CRTs are the picture tubes used in most computer monitors and television sets. They are easily identified. They contain substantial amounts of lead and some other heavy metals that are considered hazardous when disposed in regulated quantities. They comprise a significant portion of the electronic waste stream, accounting for perhaps one-third

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[36] National Safety Council, *Electronic Product Recovery and Recycling Baseline Report*, May 1999, p. 29.

[37] When Minnesota conducted a pilot e-waste recycling project in 1999, historic waste was a large percentage of what was collected: by weight, 69% of what they received was television sets. "Roughly half" of the televisions were manufactured before 1980, 15% by manufacturers who were no longer in business. See Minnesota Office of Environmental Assistance, *Recycling Used Electronics*, Report on Minnesota's Demonstration Project, July 2001, Background and Highlights, available at [www.moea.state.mn.us/plugin/report.cfm].

[38] S.B. 1523 and S.B. 1619. These bills are available at [http://www.leginfo.ca.gov].

of the weight of a standard personal computer. And, as noted earlier, their disposal is already banned in two states. They also are costly to collect and recycle: most voluntary programs charge a fee of $5 - $15 to accept a television or monitor for recycling. Given this cost, it is unlikely that voluntary programs will ever handle a significant portion of the CRT waste stream.

A somewhat broader option would be to include other components of a personal computer: in addition to the monitor, they might include the CPU (the central processing unit that contains a system's memory, hard drive, disk drives, CD unit, etc.), keyboards, printers, speakers, scanners, modems, and any other peripheral equipment sold for use with a computer.

At the other end of the spectrum, the EU and other countries are taking a far broader approach. The WEEE directive contains 10 categories of equipment covered by its proposed requirements: large household appliances; small household appliances; IT and telecommunications equipment; consumer equipment; lighting equipment; electrical and electronic tools (with the exception of large-scale stationary industrial tools); toys, leisure and sports equipment; medical devices (with the exception of all implanted and infected products); monitoring and control instruments; and automatic dispensers. The directive includes a two-and-a-half page list of specific items that fall under these categories.

Those states that are considering legislation have focused primarily on CRTs and computers. Bills in California, Massachusetts, and South Carolina address only CRTs or products containing them. Minnesota legislation would address TVs, computer monitors, laptop computers, CPUs, and printers. A New York bill would direct the state's environmental agency to identify "electronic equipment"; the bill defines electronic equipment as "appliances that contain complex circuitry, circuit boards, or signal processing, as well as one or more hazardous components." An Oregon bill would regulate personal computers, defined as "a central processing unit that may or may not be combined with peripheral equipment such as hard drives, floppy drives, CD-ROM drives, internal or external modems, fans, keyboards, and monitors."

Given the rapidly changing nature of the computer and consumer electronics industries, new concerns may arise Flat screen TVs and monitors, for example, which are rapidly gaining market share, do not use CRTs; nor do laptop and handheld computers. Requiring only the older technology to be subject to regulatory requirements could provide an additional incentive for industry to phase out the technology's use. In contrast, covering a wide array of technologies, including new technologies as they are introduced, could encourage advance consideration of the environmental consequences of new technologies and the design of products for minimal environmental impact.