Policy Approaches to the Recycling and Disposal of Electronic Waste.

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ABSTRACT

Disposal of personal computers, televisions, cell phones, and other consumer electronics has developed into a new and rapidly expanding waste stream in most developed and developing nations. Electronic wastes not only compete for landfill space with conventional solid waste, but also contain numerous toxic components which may pose significant environmental and human health implications for traditional disposal and incineration practices. Efforts to minimize, ensure proper disposition, and encourage recycling of electronic waste have two major objectives: 1) to optimize the environmentally sound disposal of the toxic elements of electronic waste, and 2) to optimize the recycling of the valuable elements of electronic waste. This paper examines various public policy approaches to the issue of electronic waste and explores the market-based forces acting on producers, consumers, and recyclers of electronic waste.

(Keywords: electronic components, e-waste, computer disposal, public policy, toxic waste, recycling)

INTRODUCTION

As consumer electronics technology (HDTVs, lap-tops, cell phones, flat-screen monitors, etc.) advances and renders previous generation hardware obsolete at an increasingly rapid rate, consumers, business owners, and policymakers are confronted with a significant environmental and human health problem: managing over 50 million tons of electronic waste generated each year world-wide (ENS 2006).

The issue of electronic waste is a modern market phenomenon that has serious environmental implications, and should fall under the rubric of *waste management* (both in terms of solid and hazardous waste). The solutions, or mitigating responses, to handling the increasing amounts of electronic waste are of a multi-disciplinary nature. A combination of command-and-control regulation, private sector innovation, tax incentives, and consumer education are evolving as responses towards finding appropriate ways of either disposing of, recycling, or re-marketing obsolescent electronics. This is an issue whose resolution requires cooperation between consumers, public sector policymakers, and retail and manufacturing enterprises.

ESTABLISHING A BASELINE OF SCOPE AND SCALE OF ELECTRONIC WASTE

According to an US Environmental Protection Agency (USEPA) report (2008) electronic waste in the United States accounts for less than 2% of solid waste flow, yet that 2% amounts to over 2 million tons of so-called "tech trash" (NRDC 2008). The USEPA report states that cathode-ray-tube (CRT) televisions and monitors made up approximately two-thirds of the subset of electronic waste between 2003 and 2005. The report also states that the vast majority of US electronic waste disposed of in municipal or industrial landfills, while only about 20% is recycled. The amount of televisions that reached their end-of-life during this period is measured at 841,100 tons (112,500 tons were recycled, while 709,100 were landfilled, and 20,200 tons were incinerated).

An estimate of the composition of the US electronic waste stream, based on percentage weight, is represented in Figure 1. In 2005 alone, it was estimated that over 163,000 computers and 274,000 cell phones were disposed of daily in the US. Based on conservative estimates, another 650 million computers will be sold in the US between now and 2015.

In a recent study of the electronics waste recycling infrastructure, Kang and Schoenung (2005) report that the average life-expectancy for computers is shortening, adding to the disposal problem (Figure 2).

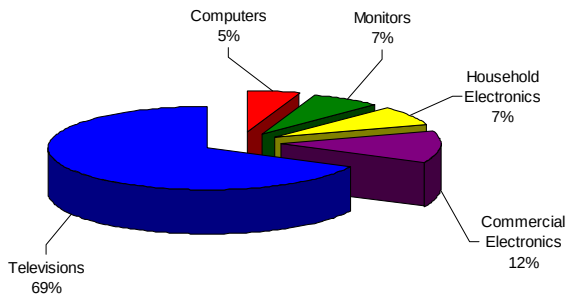

Figure 1: Relative Composition, by Weight, of US Electronic Waste Stream. (Source: USEPA 2002)

Note: Percentage weights do not include packaging materials.

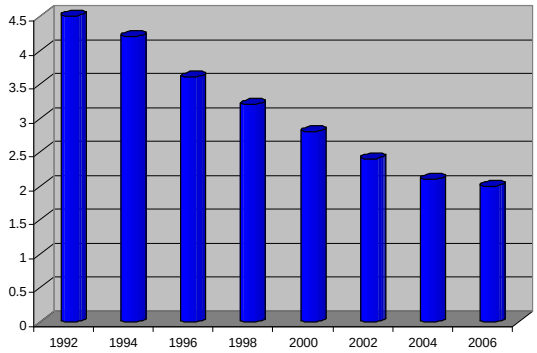

Figure 2: Average Life-Span of Computers (years) in the United States.
(Source: Kang and Schoenung 2005)

The principal concerns associated with this issue pertains to the effects of improper disposal of the toxic elements (lead and cadmium) of electronic waste, as well as the waste of the usable and non-renewable elements of this waste (gold, copper, glass, and various types of plastics). The former affects human and environmental health, while the latter is a question of optimal resource utilization (the energy expenditures involved in mining new materials is greater than the energy required to recycle old materials).

The environmental and human health risks posed by the improper disposal of electronic waste occurs principally in cases where the waste is incinerated (air contamination) or disposed of improperly in landfills or improvisational garbage dumps (soil and water contamination). The heavy metal elements contained in this waste which are toxic are principally lead, chromium, and mercury, which are found in circuit boards, batteries, and cathode ray tubes. When such waste is burned at low temperatures, these elements are released into the air, thereby posing risks to exposed human and animal populations.

A recent report by National Geographic provides anecdotal accounts of dangerous exposure in the underground market of scavenging electronic waste. In one instance a 15 year-old boy working at a makeshift dump hoists a "tangle of copper wire off the old tire he's using for fuel and douses the hissing mass in a puddle. With the flame retardant insulation burned away - a process that has released a bouquet of carcinogens and other toxics - the wire may fetch a dollar from a scrap metal buyer" (Carroll 2008). Accounts such as these illustrate not only the health issues associated with ill-planed or ill-executed electronic waste management, but also address the second and third order economic aspects of this waste management issue.

When these wastes are deposited in a landfill or improvisational garbage dump, they can potentially leach into the soil and enter the water cycle, thereby harming marine and riparian ecosystems, and potentially human populations who depend on the water for everyday uses. Though many landfills in countries such as the United States are designed to properly contain heavy metal leachates, the global dynamic is such that the majority of electronics are disposed of in landfills that are not as effective in preventing these substances from entering the soil or water supply.

The trade dynamics of electronic waste trade and disposal is currently such that collectors in the United States simply export the disposal of these hazardous wastes to developing countries where environmental protection laws are less stringent, and where there is a greater demand for the materials of value contained within those wastes.

The scale of the volume of waste and the environmental and human health hazards intrinsic with this risk have not been well-defined. The question now is which market dynamics and policy-based measures can improve what the USEPA refers to as "end-of-life-management" of

these electronic devices. The extent to which old computers, television sets, and cell phones can be repaired, re-used, re-marketed, or recycled will depend on coordination between consumers, manufacturers, policymakers, and other market actors so that they can minimize the negative environmental effects and maximize resource utilization.

DISCUSSION

1. State and Regional Level Initiatives

California and Minnesota are two states that are regarded as quite progressive in establishing policies to address this issue, though they are distinct. California's program relies on a fee system that is burdened by the consumer at the point of purchase, while Minnesota's program places the onus on manufacturers by requiring them to recycle a designated percentage of what they produce.

California: Electronic Waste Recycling Act (2003)

In California, the Integrated Waste Management Board and the Department of Toxic Substances Control collaborate in managing a fee-based program that is intended to promote the collection and recycling of electronic waste. Initiated by the "Electronic Waste Recycling Act (2003)", the program is similar in some respects to the California Redemption Value used with beverage containers in that the consumer pays an up-front "electronic waste recycling fee" of $6 - $10 when they purchase what is referred to as a "covered electronic device" or CED.

The difference is in where the money collected from that fee is allocated. In the case of the "electronic waste recycling fee", the monies collected fund a program that in-turn distributes "recovery and recycling payments" to "qualified entities" to cover the costs of collecting and recycling electronic waste.

In economic terms, this approach passes the costs of funding a public works project onto the consumer. The consumer provides funds to the state, who in turn takes some of that funding to finance the administration of the program, and what remains theoretically goes towards compensating the collectors for the costs incurred by them for collecting and recycling the materials. One of the most apparent differences between this program and Minnesota's program is that in California, the manufacturers and retailers are left out of the equation.

Minnesota Electronics Recycling Act (2007)

On May 8, 2007, Governor Tim Pawlenty of Minnesota signed a Bill (HF 854) that would effectively put the responsibility for electronics recycling on manufacturers and retailers of electronics. The Bill aims to increase the rate of electronics recycling by requiring manufacturers to pay an annual $2,500 registration fee (with initial registration costing $5,000), plus a variable recycling fee ranging between 30 to 50 cents for each pound manufactures fall short of their recycling targets (CTBC 2007).

From a policymaking standpoint, this approach might best be characterized as a producer-fee, or *polluter pays* economic principle. Presumably, this is an approach which is consumer-friendly, so long as the costs of compliance are not excessively passed onto the consumer by the manufacturers and retailers. From the standpoint of the manufacturer and retail agents, this policy creates an incremental cost, which could be argued as internalizing a cost that was previously an externality. The related fees go towards funding program administration costs and other pollution-control activities associated with disposal.

Another effect of the policy is the stimulation of private-sector entities that are the collectors and recyclers of the electronic waste. It is similar to the California approach in that the state administers a program which is funded by an outside entity, except that in the case of Minnesota, it is the producers and not the consumers who are essentially "taxed" in order to fund the program. Given that the program has been in existence for only a year, it would be difficult to draw any statistical analysis of what the effects of this policy have been.

One of the effects of this policy was to create a demand for recycling and collection services. Private sector enterprises responded to this demand. One such enterprise is Asset Recovery Corporation (ARC) based in St. Paul, MN. ARC is a company that qualifies as both a collector and recycler within the state program. Most of what ARC does is to "re-market" materials that are

gleaned from old electronics. They are essentially harvesting readily available materials, such as copper, and selling it on the commodity market. They are compensated at the market rate.

Another service-providing entity that came into being immediately subsequent to the enactment of the Minnesota legislation is the MRM, also known as Electronic Manufacturers Recycling Company, LLC. This is an entity that was formed as a joint venture by Panasonic Corporation of North America, Sharp Electronics Corporation, and Toshiba America Consumer Products, three giants in the electronics industry.

In a press release dated January 6, 2008, the new company's first activities are described as "focused on providing cost-effective services to manufacturers who must satisfy the recently enacted requirements in Minnesota for the recycling of used electronic products" (PR Newswire 2008). From an academic point of view, this is an interesting example of both economic concerns and environmental interests converging, or as an example of a public policy stimulating an activity that the market rewards.

These companies saw an opportunity to provide a service that had an economic value. Economic logic dictates that once a firm is burdened by the state with an economic responsibility, such mandates will effectuate an increase in the demand for the provision of a service that helps the manufactures to comply with the mandate. The overall economic and environmental benefit of these activities remain to be seen, but in theory, it seems to be a positive step towards mitigation of the electronic waste problem and stimulating a market for an economically viable service provision.

Regional Private-Sector Initiatives

Private sector initiatives on the part of computer manufacturers have arisen both independently and in compliance with regulatory and legislative initiatives. One example of a corporate entity taking a leadership role in an effort to increase recycling and re-using of electronic waste is Dell, the computer manufacturer. Dell has implemented a plan dedicated to meeting the requirements of the European Union's WEEE (Waste from Electrical and Electronic Equipment) Directive, a policy which seeks to reduce waste arising from electrical and electronic components, and improve the environmental performance of everything involved in the life cycle of electrical and electronic equipment (Dell 2008).The effectiveness of their program is not examined, so it is possible that this is an instance where the public relations aspect of their efforts precede and exceed the achievements of their efforts.

2. National Level Attempts

At the National, or Federal level, various policies have been proposed, but not yet implemented, to mitigate the improper disposal and increase recycling of electronic waste. The principal logic behind developing legislation at the Federal level is to set standard practices that will hopefully lead to efficiencies and reduce costs entailed in managing so many different programs. Most solid waste is collected at the municipal level, and managed at the state level, but having standards that were compatible might lead more states to adopt measures given that they don't have to invest as much time and energy in policy design, allowing local governments to focus more on policy implementation.

The National Computer Recycling Act (H.R. 1165, H.R. 233)

One policy that was proposed, but failed to pass, was *The National Computer Recycling Act* (H.R. 1165). This legislation would have established a grant/fee program through the USEPA to encourage and promote the recycling of used computers. Sponsored by Rep. Mike Thompson (of California) and Rep. Louise Slaughter (of New York), the bill failed to pass through the House of Representatives.

One of the more controversial sticking points of the proposal was that it would assess a fee of up to $10 dollars on new computers assessed to the *consumer* in order to fund the program. Charging the consumer at the point-of-purchase seems not only politically impractical, but economically inhibitive. Setting up an additional hurdle between the consumer and was seen by bill opponents as a heavy-handed manner of internalizing environmental costs to the consumer.

Another objective of this bill was to establish a unified, national standard for recycling electronic waste, given that this is an issue has, until

recently, been addressed exclusively by governments and municipalities at the state and local level. The scenario surrounding electronics recycling is an interesting example of how state policy seems to be ahead of national policy. Admittedly, this may not be a problem that is best addressed through a one-size-fits-all regulatory solution, but on the other hand, there is something to be said for attempting to avoid a "50-state patchwork" of potentially contradictory policies (Hachman 2005).

Perhaps a reasonable middle way might be for the USEPA to offer guidelines and models for states to emulate if they so choose, but to allow for each state to craft their own policies in accordance with consumer and manufacturer interests in their respective states. This would allow for the solutions to be a more "organic", bottom-up approach rather than a top-down scenario which may not factor the information and preferences inherently available at the municipal and state levels.

The Electronic Waste Recycling and Consumer Protection Act

An alternate tax-based approach was offered by a US Senate bill that would have offered tax incentives for businesses and individuals who safely disposed of computers and other worn-out electronic devices. “The Electronic Waste Recycling Promotion and Consumer Protection Act” of 2005 offered an $8-per-piece tax credit for companies that recycle at least 5000 monitors or computer units per year. Individuals who used qualified recyclers to dispose of computers or TV sets would receive a $15 tax credit. The bill would also "prohibit the disposal of any electronic equipment containing a display greater than 4 inches...in the municipal solid-waste landfill" (Gross 2005).

The premise of this bill seems attractive in that it economically rewards, rather than punishes, the consumer. It also is benign from the standpoint of producer interests in that it doesn't burden them with any additional costs. However, one of the disadvantages of tax breaks is that they are a deferred economic benefit and require incremental efforts at accounting on the part of the consumer. Practically speaking, at the end of the tax year, an individual may not remember or prepare to factor in a credit of that sort. In principle, this approach makes sense, but in practice, it is likely to be a negligible factor in driving individual behavior, although on a corporate level, it may prove more effective due to the volume consideration.

Neither of the aforementioned bills made it into legislation, but they are two stark examples of different policy approaches to the same environmental problem. While one bill proposed economically rewarding consumers for a positive action (recycling), the other proposal economically punished consumption by charging up-front for an activity that had no assurance of even taking place (recycling). Between the two proposals, it would seem that the former proposal of a tax credit would be a more benign approach; and while $15 may not be enough to motivate someone to take alter their disposal behaviors and take a computer to a proper recycler, it would seem palatable to voters and constituents, and may in fact be a first step in changing public attitudes.

3. International Law: The Basel Convention

A salient dynamic of the global waste management cycle is that many electronic products which are deemed useless by the first world are either sold to or disposed of by developing nations, particularly in Asia and Africa. As regulation of hazardous waste disposal has increased in the US and European Union (EU), the equivalent of pollution havens have arisen in parts of the world where there is less regulation governing the disposal of the toxic substances, and a higher utility value on substances that can be reused.

The "Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (1989)" was promulgated by the United Nations Environmental Program, and counts 116 nations as signatories. The treaty distinguishes between "states of export" and "states of import", and requires the "state of import" to "consent in writing to the specific import" (Article 4, c). The treaty calls for the establishment of a baseline assortment of defined "hazardous wastes" which are then listed in Annex I and Annex II of the treaty. The treaty allows for each country to determine which of the wastes are to be deemed "hazardous" within their own national laws. The United States, the world's largest generator of e-waste, has not ratified the treaty.

In Nairobi, in 2006, the Conference of Parties decided to focus on specifically regulating the transboundary movement of electronic wastes. One of the adopted amendments was to distinguish between “used computers” and “scrap computers". The principal difference is that "used [computers] may still have a considerable life remaining, and can be used by another owner either 'as is' or after repair or upgrading" (UNEP 2006).

From an economic standpoint, clearly a used computer has after-market value to the importers, whereas with scrap computers the importer is providing a disposal service that the exporter values, given that it is presumably cheaper for the "importer" to dispose of the waste than for the "exporter". This dynamic could very well be referred to as a "pollution haven."

The "Basel Action Network" (BAN) has initiated a program called "e-stewards" which seeks to educate and inform the public about the difference between legitimate recyclers and faux recyclers who take used electronic equipment and then dump (legally or illegally) it in the third world. Anecdotally speaking, for the average US consumer, it takes a considerable effort to find a place that will accept electronic waste and then aggregate one's electronic waste to take it to the collection facility. If a store's management has not been trained to process the waste, there is no assurance that it will actually get recycled at all.

CONCLUSION

The resolution, or mitigation of the electronic waste problem has dual objectives: 1) to optimize the proper disposal of the toxic elements of electronic waste, and 2) to optimize the recycling of the valuable elements of electronic waste. The optimal approach to fulfilling these objectives will unlikely be resolved by legislation alone, but rather, will require a combination of policy parameters, private sector initiative, and consumer education.

The general principle guiding public policy on this issue should be a combination of “the carrot and the stick”, focusing on harnessing the market-based forces so that producers, consumers, and collectors are all acting in concert to divert these wastes from the solid-waste stream. Bans and heavy-handed regulation require enforcement, which in turn requires administrative costs. Small tax benefits are more benign from the consumer’s perspective and while they may not be significantly beneficial for individual or household economics, they are at least in line with the principle.

The major problem with most government-initiated policies seems to be a question of deciding who pays for then. In Minnesota, the producer pays, while in California, the consumer pays. The long-term goal should be to get the system to a point where no single entity is burdened with the responsibility of paying for the entire program.

Market actors themselves should be motivated by economic or social benefits that are intrinsic to the efforts of reducing toxic waste and increasing sustainability for non-renewable mineral resources. For corporations, a social benefit could simply be the perception of being "green", while for consumers, the benefit could come from the knowledge that they have done their part to act as good environmental stewards with regards to how they handle electronic waste.

The challenge at the level of the consumer seems to be one of information and coordination of collection. If a market value of the recycling process can be fortified by public policy, as it has been in Minnesota, then the collectors, producers, and consumers will find the most efficient way to meet in the marketplace. Educational campaigns targeted at both individual and institutional consumers are already being initiated by manufacturers, attempting to provide information on how to go about collecting used electronic equipment for recycling or disposal. At the level of the consumer, few will initiate recycling based on a small tax credit alone, although the cash incentive might very well be an inducement to dump recyclers and “dumpster divers” who patrol the city streets looking for recyclable materials.

The problem associated with electronic waste is at a stage where it is beginning to gather increasing attention from all the stakeholders whose ingenuity will be needed to improve the situation. The problem, however, is also rapidly increasing in scale and volume. Production of personal computers and associated electronics increases approximately 15% every year (Johnson 2008) and CRT televisions are being phased into obsolescence as networks go digital. The projected increase in the volume of electronic waste that will be competing for landfill

space in the next decade, underscores the urgent need for a cohesive management and public policy approach that both protects the environment and makes sound use of valuable recyclable components and materials.

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