MINNESOTA'S MULTI-STAKEHOLDER APPROACH TO MANAGING ELECTRONIC PRODUCTS AT END-OF-LIFE

Tony Hainault*, Douglas S. Smith, David J. Cauchi,
David A. Thompson, Michael M. Fisher, PhD, Colleen Hetzel*

Minnesota Office of Environmental Assistance*, Sony Electronics Inc., Waste Management-Asset Recovery Group, Matsushita Electric Corporation of America, American Plastics Council

Abstract

A public-private multi-sector team collaborated to test a variety of management strategies to remove end-of-life (EOL) electronic products, primarily residential, from municipal waste in Minnesota. Objectives for the project included:

- Evaluate a series of collection techniques sponsored by local governments and retailers.
- Test the cost effectiveness of private sector market-based infrastructure to recover value from the material collected.
- Identify infrastructure development needs.
- Use the findings as a basis for influencing future direction and policy-making decisions in Minnesota

Two primary goals were identified: 1) evaluate collection and processing costs for a targeted stream of used electronic products; and 2) evaluate scrap markets for secondary materials generated by this product stream. The project highlighted the strengths of each organization to create the first large-scale multi-stakeholder effort to remove used electronic products from municipal waste in North America. Various collection strategies were employed during a three month period to remove used electronic products from multiple sites. Used electronic products collected during the project were processed, evaluated and sold to existing secondary material markets as well as to "high end" recovery markets. This paper presents the results of this effort as of January 2000.

Introduction

This paper is a summary of a recycling demonstration project for removing used electronic products from municipal waste in Minnesota. It presents the results of this effort as of January 2000. The Minnesota Office of Environmental Assistance (OEA) sought private sector participation in the project to achieve optimal planning, scope and results from the effort, and to ensure private sector participation in identifying how best to capture and recycle used electronic products from residents. A partnership ensued among Sony Electronics Inc., Waste Management-Asset Recovery Group (WM-ARG), Panasonic-Matsushita and the American Plastics Council. Each of these partners pledged a minimum of $25,000 to the project. Initial planning for the project began in the fall of 1998. In early 1999, the OEA issued a Request for Participation to identify potential collection sites. The selected site hosts conducted collections between July 31 and October 31, 1999. WM-ARG transported used products from the collection sites or regional storage depots to a central processing facility where the company completed processing in January 2000. The project partners attempted to draw on the collective experience of previously reported data from used electronics collection programs. These efforts included those by Hennepin County, Minnesota, and those reported by the Common Sense Initiative (CSI) of the United States Environmental Protection Agency (US EPA)[1].

How Partnership Formed

Historically, Minnesota has attempted to manage residential wastes for resource potential or for its potential to contaminate

This paper first appeared in the proceedings of the 2000 IEEE International Symposium on Electronics and the Environment, May 8-10, 2000, San Francisco, sponsored by the Institute of Electrical and Electronic Engineers.

municipal waste. The state also attempts to remove products containing heavy metals and other undesirable substances from waste prior to processing or disposal. The OEA is concerned about the disposal of a variety of electrical and electronic products because of components or substances that contain: cathode ray tubes; printed wire boards; embedded batteries; mercury; lead; cadmium; polychlorinated biphenyls (PCBs)[2]; and other materials. The OEA also has concerns about the wise use of resources and increasing pressure in the state on existing disposal options. Similarly, industry seeks to identify EOL management strategies in North America that may offer alternatives to government mandates emerging in Europe and elsewhere.

The partnership for the project evolved from numerous conversations held over the last several years during which time Minnesota's OEA sought voluntary initiative from industry to help address environmental concerns about the disposal of used residential electronic products in municipal waste. These discussions between the OEA and industry centered on the use or design of municipal and private collection infrastructures for used electronic products, recycling market development efforts for secondary material derived from these products once processed, and voluntary design initiatives by industry to spur recycling and reduce the use of hazardous materials in products.

Project Scope

From the onset, partners identified specific questions they sought to answer from the project and worked to maintain a narrowly directed focus for the work. While intuitive, the nature of the project lent itself to intense interest, speculation and suggested scope of work from non-participating private and public organizations. For example, outside parties expressed considerable interest for the project to explore options for product repair and reuse. While the partners recognize repair and reuse as important, it was considered to lie outside the objectives of the intended work and not incorporated into the scope of the project.

The project partners identified various collection strategies for used electronic appliances they hoped to evaluate and compare for relative cost and participation. A variety of collection strategies were tested to acknowledge the possibility that a sole collection approach will not solve the collection needs of a community or region. Collected material would be staged for transport or shipped directly to a central processing facility, depending on type of collection and local circumstance. Various alternative processing techniques would be explored to compare current costs with potential future alternative costs, such as CRT glass-to-lead smelting compared to returning CRT glass to CRTs. A vintage analysis of the televisions collected by the project would provide insight on how much old product may be available for future collection and management.

The project targeted used products generated by residents because they:

- Contain large amounts of identifiable contaminants.
- Are not regulated under the federal Resource Conservation and Recovery Act.
- Are less uniform and therefore more costly for recyclers to process.
- Have similar characteristics to other reusable and recyclable materials.
- Are currently costly to recycle or manage separately from municipal waste and are therefore difficult to capture as a separate material stream.
- Used electronic products from residents are generally not collected in Minnesota at this time.

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For a variety of reasons there was interest to allow small businesses and institutions to bring used electronic products to collection events. Interest was especially strong among some collection site hosts responding to local pressure. Therefore, the partners agreed to include these participants in some collection events. Small businesses and institutions that brought products to collection sites were given a fact sheet prepared by the Minnesota Pollution Control Agency describing the regulatory status of used electronic products from businesses and institutions.

In trying to identify what products to collect, the partners chose to target "anything with a cord or embedded battery," as it was publicized to people who brought used products to collection sites. This was decided because the partners wanted to test the hypothesis that the value of some products might help to offset the cost of managing others. Large appliances, or "white goods," were excluded from the collection, along with microwave ovens and air conditioners, because a collection infrastructure already exists for these products in Minnesota.

All participants in the project who brought used products to collection sites were asked to complete a survey. The survey was one of three data sources identified for the project. The project tracked:

- Information from all those who brought products to collection sites.
- Costs to collect products.
- Costs to process and market secondary materials.

Collecting Used Electronic Products

The partners agreed there was probably no single collection strategy that would achieve a satisfactory recovery rate of used electronics from municipal waste. With this in mind, they decided to test a variety of strategies to try to learn if some strategies were more successful than others at capturing used products or for reducing costs. The OEA published a Request for Participation (RFP) in the State Register and mailed it to all known potential applicants in February 1999; eight regional collection site finalists were requested in May to participate in the project based on geographic and demographic diversity and their ability to enhance project results.

The finalists represented various government and nonprofit collection programs for recyclable materials, household hazardous wastes and general municipal garbage. In most circumstances, collection site hosts did not have extensive experience collecting used electrical and electronic appliances from households. Several retail stores reviewed the RFP, and one retailer requested additional time to consider participation. In late August, Circuit City informed the partners of its intent to participate.

The OEA provided each local collection site host with:

- Suggested safety procedures.
- Packing requirements from WM-ARG.
- A program "cost and tracking form" for uniform reporting of expenses, staff requirements and other details to the OEA upon completion of collection activities.
- Separate fact sheets for residents and businesses to inform everyone who brought products to collection events about proper disposal options for electronic products.
- Media assistance.
- Surveys to administer to everyone who brought used electronics to collection events.

The OEA provided assistance to local collection site hosts for publicity with suggested taglines for radio and a generic

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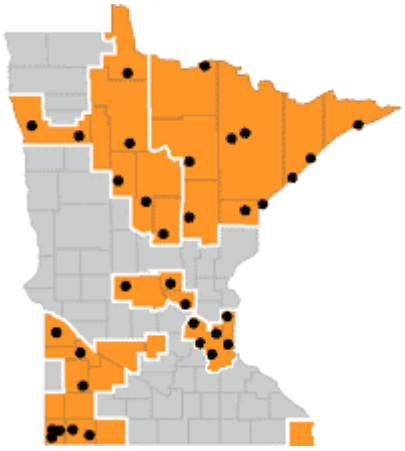
poster or advertisement for print media. This was intended to help standardize the message received by the public as well as to provide assistance to local program hosts.

Figure 1. Location of collection sites in Minnesota. State demographics: population 4.7 million, ranked 20th among states, Twin Cities ranked 15th largest among U.S. cities[3]; average personal income $27,667[4]; gross State product $149 billion[5].



Collection events varied from one day to more than one month, and were held as special events and in cooperation with permanent programs. Collection strategies included curbside collection and various drop-off opportunities at household hazardous waste (HHW) sites, recycling centers, garbage transfer stations, neighborhood clean-up events, and retail stores. Collection sites were distributed throughout the state (see Figure 1) and included rural and urban populations. Approximately 1.3 million Minnesota residents had easy access to a collection site during the three-month demonstration project. This represents a conservative estimate of population served; advertising was confined around collection hubs, especially in metropolitan Minneapolis-St. Paul.

Collection Results

Nine regional groups cooperated to sponsor more than 65 collection sites during three months in 1999. During that time, the sites operated single day or multiple day events and collected nearly 700 tons of used electronic products. Roughly one third of all Minnesota residents had access to collection events during the program. Fewer than ten percent of all project participants who brought used electronics to collection sites represented businesses or institutions.

Local collection site sponsors reported spending about $168,000 on the project, or slightly less than $300 per ton (see Figure 2). Costs to implement this one-time demonstration event are higher than would be expected under routine operating conditions. Many of the reported costs are recognized as more typical for a one-time event, or costs associated with new program activity. In other words, they were costs that would otherwise not be incurred, or could be reduced substantially if collections were conducted as permanent programs. Yet costs are high enough to pose significant barriers for many communities to consider future collections. The cost to manage these products after collection would compound these cost barriers. In the months ahead, the project partners will be evaluating local collection costs with the collection site hosts to identify realistic opportunities for reducing future costs associated with collecting used electronic products.

The principal partners for the collections structured them so that local collection site hosts would not incur costs related to transportation to the processing facility, processing and marketing of any reclaimed secondary material. Capital and operating costs for new programs are often reduced once a program has been in place for a while. The partners will attempt to evaluate the costs for this demonstration project against start-up costs for the collection of

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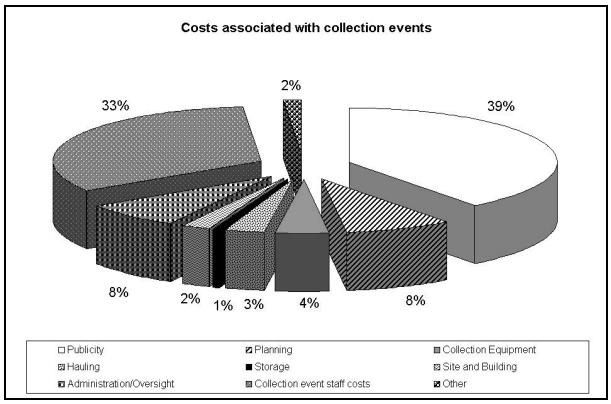
other recyclable materials. They will also attempt to compare these collection costs with the collection costs of other ongoing programs to collect used electronics from residents to identify opportunities to reduce costs.

Figure 2. Costs incurred by local collection site hosts by activity, expressed as a percent of total reported costs.



Processing the Material

WM-ARG shipped 700 gross tons of material collected from the various sites to its processing facility in Inver Grove Heights, Minnesota, in either semi-trailers or roll-off containers. In general, roll-off containers were used at one-day collection events held relatively near the WM-ARG processing facility and trucks were used for multi-day events or events further away. Material collected at sites further from the processing facility and during multi-day events were generally transported by truck, and when possible, was stored locally to make full use of truck capacities. Transportation from collection events to WM-ARG represented more than half of all costs to WM-ARG, which incurred net processing costs of slightly more than $100 per ton.

WM-ARG completed processing material in late January 2000. Upon receipt at the processing facility, WM-ARG weighed the material and recorded it by site. Then products were segregated by five broad categories (see Table 1). The age and brand of televisions were recorded prior to processing as part of the vintage study. More operable computers and computer monitors were collected during the project than expected, so WM-ARG sold some products for reuse to overseas markets. No other product stream was captured for reuse. Eight scrap categories were identified and recorded by product category (see Table 2). WM-ARG reported operating costs of approximately $145,000 thousand dollars and revenues from recovered secondary materials of approximately $43,000.

Table 1. Categories for products delivered from collection sites to WM-ARG central processing facility.

Incoming Materials	Pounds (1000s)
TVs	780
Monitors	82
PC Units	61
Consumer Electronics	141
Mixed Electronics	85
Packaging	250
Total	**1,399**

Marketing the Secondary Material Streams

A principal assumption of the project was that secondary materials have different value depending on the end-user of the scrap commodity. The project goals sought to evaluate the differences for some of the scrap, depending on whether it was sold to low-end or high-end markets. Low-end markets were considered markets reclaiming raw material; high-end markets were defined as those markets capturing some of the added value from previous processing

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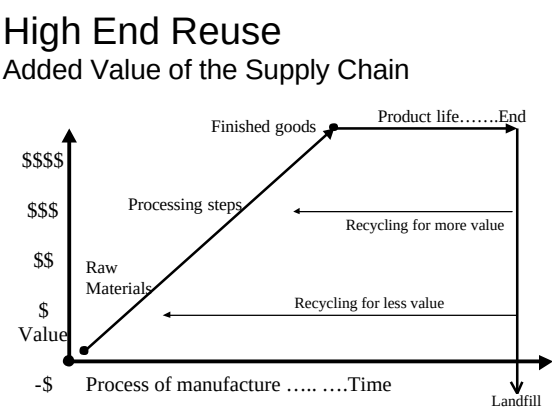
Figure 3. Value-added potential for secondary materials in the supply chain.



inherent in the scrap, thereby reducing the energy and labor required to make a new finished goods from the secondary material (see Figure 3). The partners chose to evaluate plastics and glass in this manner because engineered plastics have the greatest potential to add value to a recycling process at EOL and glass poses the greatest opportunity to reduce costs at EOL.

Plastics Recycling and Evaluation

Plastics were collected and sorted into three categories. Older TV sets with simulated wood grain covers were disposed due to the known difficulties of cleaning and purifying this problem waste plastic. Monitor plastic of lighter color was sorted and baled. TV and black plastic was sorted and baled. One full truckload of this was shipped to MBA Polymers, Inc, in Richmond, California, for purifying and analysis which includes a mechanical specification sheet prepared on the resulting batch. It was the experience of the partners that many product design engineers are not interested in experimenting with used plastic unless a physical properties spec sheet is available to review. The American Plastics Council is evaluating a mixed stream of the non-television, non-computer plastics in a separate but related study.

CRT Glass Recycling

Glass from CRTs collected during the project was sold to two markets: a traditional smelting market for glass-to-lead recycling; or to intermediary processors working with CRT manufacturers to return the glass to CRTs, in a glass-to-glass loop.

Table 2. WM-ARG secondary materials processed.

Outbound Materials	Pounds (1000s)
Plastics	61
Cu Bearing	46
CRT Glass to Glass	45
CRT Glass to Lead	226
Printed Circuit Boards	83
Steel Breakage	360
Export Reusable	63
Export Scrap	82
Solid Waste Disposal	183
Packaging	250
Total	**1,399**

CRT glass recovered in Minnesota has traditionally been managed in a glass-to-lead loop through various smelting operations. CRT glass recycling markets that return CRT cullet to the CRT manufacturing process are located on the east coast of North America and are costly to ship product to. Comparing the cost of glass-to-glass recycling against glass-to-lead recovery was one of the objectives of the project. WM-ARG reported costs of $90 per ton to manage CRT glass in a glass-to-lead loop, whereas CRT glass managed in a glass-to-glass loop cost $50 per ton. The comparative costs to manage glass in a glass-to-glass loop represented significant savings to WM-ARG. This management strategy will be further evaluated to add value to future recycling efforts and reduce recycling costs.

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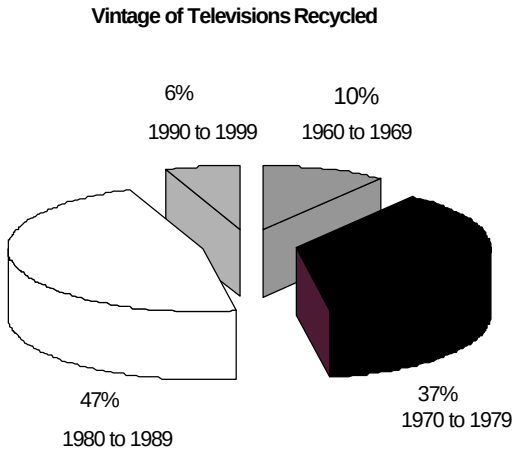
Figure 4. Percent of televisions recovered during project corresponding to model year.



Vintage Analysis

WM-ARG conducted a vintage analysis of the televisions collected by the project (see Figure 4). The model year and manufacturer was recorded for each television delivered to the processing site during the project. This data will be evaluated to provide insight on how much old product may be available for future collection and management, and who manufactured it. It will also be useful in determining secondary recovery streams and relative costs to manage old televisions remaining to enter the waste stream.

Conclusions

The following are preliminary conclusions on the project based on limited review of data as of January 2000. These conclusions may vary from those published in the final report based on more extensive analysis of project results.

- While a reverse infrastructure to collect and process used electronic products exists, collection and transportation account for more than 80 percent of all costs to collect, process and return secondary materials to the supply chain. Future efforts need to address methods for reducing these costs.

- Many small businesses and institutions do not understand their legal requirements as generators of used electronic products to properly management these products at EOL. If more of these generators recycled products, recycling costs could be reduced through fees and the kind of material recycled. Used electronics from small businesses tend to have higher value and be more uniform and therefore less time-consuming to disassemble.

- Costs to conduct local collection efforts for the demonstration project were high. Ways to reduce these costs and simplify the collection effort must be identified before any realistic expectation that such collections can be affordable. Savings may be found by evaluating labor, transportation, packaging and storage costs. Conducting collections in conjunction with other programs will also provide additional savings.

- Collection costs for the project should be evaluated against similar historical efforts for other recyclable materials. Collection costs for new programs are often high because of one-time capital and operating expenses and prior to adopting more efficient program methods.

- There is a high cost associated with handling used products. Reducing the number of times products must be handled from the point of collection to the point of sale as secondary material will reduce overall operating program costs.

- Recycling technologies are needed to recover higher value. In some cases, recycling market development is an obvious need to entice manufacturers to

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experiment with re-processing raw materials.

- Adopting clear, consistent commodity specifications, especially for used cullet from CRT glass and recovered streams of thermoplastics, will assist recovery of this secondary material stream. Commodity specifications communicate clearly to recyclers about how to process material and can signal manufacturers that quality assurance will be met.

- To help spur recycling market development for CRT glass and plastics, manufacturers and others in the manufacturing supply chain must begin to procure more secondary material for the manufacture of new product. Accomplishing greater procurement will require attention to specification standards and greater communication along the supply chain as well as within corporate structures, from design to manufacture to utilities and maintenance personnel. As much as can be put back into product will change financial outlook for processing and collection opportunities.

- Continued efforts must be made to provide regulatory relief to legitimate recyclers for used electronic products. For example, RCRA Subtitle C includes feedstock and recycling provisions that can be used for some hazardous wastes that are destined for manufacturing and recycling processes, provided that certain requirements are met. Such provisions eliminate or streamline some regulatory requirements for materials destined for recycling. This has been successful for printed wire boards. CRT glass-to-glass recycling can be done economically, but regulatory hurdles may complicate recycling if intermediate reclamation processing is involved. Expanding the Universal Waste Rule to cover electronics and electronic components could spur recycling of these products. Expediting US EPA efforts to adopt the CSI recommendation to exempt CRT glass from full hazardous waste regulation in a "glass-to-glass" loop is another useful example of promoting regulatory relief.

Acknowledgments

The project partners wish to thank each collection site host for their dedication and commitment to the project. This work could not have been done without their efforts.

[1] Analysis of Five Community Consumer/Residential Collections: End-Of-Life Electronic and Electrical Equipment. United States Environmental Protection Agency, Region 1. Common Sense Initiative Computer and Electronic Sector. EPA-901-R-98-003. April 1999.
[2] Management of Waste Electronic Appliances. Minnesota Office of Environmental Assistance. August 1995.
[3] US Census Bureau, 1998 estimate.
[4] US Department of Commerce Bureau of Economic Analysis.
[5] 1997. Minnesota Department of Trade and Economic Development.

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