

United States  
Environmental Protection  
Agency

Solid Waste and  
Emergency Response  
(5306W)

EPA530-N-00-007  
October 2000  
[www.epa.gov/wastewise](http://www.epa.gov/wastewise)



# WasteWise Update

## INSIDE

**What You Need to Know . . . 4**

**Improving Future Acquisitions . . . 6**

**Managing Used Electronics . . . 7**

**Opportunities for Manufacturers . . 12**

**Actions Governments Are Taking . . . 14**

## ELECTRONICS REUSE AND RECYCLING



Preserving Resources,  
Preventing Waste

# Electronics Reuse and Recycling

**D**o you have old, outdated electronic products (e.g., personal computers and peripherals, laptops, fax machines, copiers, televisions, telephones, and audio/visual or CAD equipment) in your office or home? If so, you're not alone. According to the Institute for Local Self-Reliance, approximately 75 percent of obsolete electronics are currently being stored or warehoused until there is agreement on the best way to manage this material. As stockpiling continues, there is growing concern about the volume of used or obsolete electronic equipment that will need to be managed responsibly when it emerges from storerooms or attics.



## Why Are Used Electronics a Concern?

Besides taking up space in empty cubicles and storerooms, end-of-life electronics pose several issues regarding proper disposal and potential environmental consequences. Discarded electronics:

- **Represent a rapidly growing waste stream.** Technological advances are rapidly rendering formerly cutting-edge electronics obsolete. An estimated 20 million personal computers became obsolete in 1998. Most of these are in storage. Of the remainder, the bulk were disposed of; probably fewer than 6 percent were recycled. Currently, the useful life of a computer is only 3 to 5 years and shrinking. In 2005, more than 63 million personal computers are projected to be retired according to a recent study by the National Safety Council.
- **Waste valuable resources.** Electronic products are made from valuable resources, including precious and other metals, engineered plastics, glass, and other materials, all of which require energy to source and manufacture. Many electronic products also contain parts that could be profitably refurbished and reused with little effort. When we throw away old electronic equipment, we're throwing away these resources and generating additional pollution associated with the need to access virgin materials and manufacture new products.

- **Contain hazardous or toxic substances.** Some electronic products (notably those with cathode ray tubes or CRTs, circuit boards, batteries, and mercury switches) contain

## What Can You Do With Used Electronics?

### 1. Assess the Equipment You Have.

- What type of equipment is it? How old is it? Is any of it still working?

### 2. Explore Your Reuse Options.

- If your equipment is working, is there a nonprofit organization or school district in your area that could use it?
- Do you qualify for a tax break for donating equipment? (See box on page 5.)

### 3. Consider Repair or Upgrade.

- If your equipment doesn't work, can it be repaired, refurbished, or used for parts to build or repair other systems?
- If your equipment can't be repaired, will the servicer send unsalvageable parts to be recycled?

### 4. Select a Recycler.

- What is the recycler's disposal policy?
- Does the recycler have (or need) a permit to operate in your state?
- Who pays for transportation—you or the recycler?

hazardous or toxic materials such as lead, mercury, cadmium, chromium, and some types of flame retardants, and do so in amounts that may cause them to test hazardous under Federal law. In particular, the glass screens, or CRTs, in computer monitors and televisions can contain as much as 27 percent lead. Some estimate that since many batteries (such as car batteries) have started to be removed from waste, electronic products represent the largest remaining contributor of heavy metals to the solid waste stream. There is concern, particularly at the state and local levels, that products containing these constituents might pose some environmental risks if they are not properly managed at end-of-life.

## What Are the Benefits of Electronics Reuse and Recycling?

The most environmentally sound management of solid waste is achieved when approaches are implemented according to the U.S. Environmental Protection Agency's (EPA) preferred order: waste prevention first, recycling second, and disposal last. There are numerous environmental and societal benefits to reusing or recycling used electronics. Proper end-of-life management of electronics:

- **Diverts materials from disposal.** Electronics reuse and recycling divert bulky equipment from landfills and incinerators. Massachusetts bans CRT disposal in municipal landfills, and a few other states might consider doing the same.
- **Provides social benefits.** Reuse and donation of electronic products extends their useful life and affords individuals or organizations that could not buy new equipment the opportunity to make use of secondhand equipment.
- **Conserves natural resources and reduces pollution.** Products reconfigured or redesigned to reduce materials and use greater recycled content use fewer virgin resources and require less energy to produce. When less virgin material and energy is used, pollution is reduced. These energy savings also translate into reduced greenhouse gas emissions. When reuse is not an option, recycling electronic products creates a supply of parts and materials that can be used to refurbish older products or manufacture new ones. Many WasteWise manufacturers recycle used or off-spec electronic products internally through asset recovery programs.

This issue of *WasteWise Update* explores:

- **What you need to know before donating or recycling end-of-life electronics**, especially the need to assess and move retired products quickly into the donation stream, as well as issues surrounding recycling and disposal.

## Management Phases Defined

There are several commonly used—but often misunderstood—phases in the management of used computers and other electronics. Each phase has distinct characteristics that relate to the degree of modification the equipment must undergo:

- **Asset recovery** typically refers to a manufacturer's internal program that recovers pre- and/or postconsumer materials or components for remanufacture or use in new products.
- **Refurbishing and reusing** involves fixing and reselling or donating used electronic equipment for its original intended purpose. This often involves repairing or replacing parts, upgrading memory or other components, and installing new software. Technically, reuse is not considered "end-of-life management" because a reusable product has not reached the end of its useful life.
- **Demanufacturing or disassembling** involves manually breaking down equipment into its separate components, either to recover components for resale or reuse in other equipment, or to sort components before recycling or recovering raw materials.
- **Recycling or salvaging** refers to separating and processing raw materials such as plastics, metals, and glass for further processing or recovery.



- **Recommendations for improving future electronics acquisitions** through leasing or take-back programs and evaluating the environmental attributes of electronics before you purchase.
- **Methods for managing used electronics** through reuse (including repair, upgrade, and donation) and recycling.
- **Opportunities for manufacturers to minimize electronics waste**, including internal asset recovery programs and product redesign for ease of repair and upgrades, improved recyclability, or inclusion of greater recycled content.
- **Actions governments are taking to manage electronics waste** such as making computer donation and recycling easier from a regulatory standpoint and helping to encourage electronic product collection programs for households and small businesses.

# What You Need to Know Before Donating or Recycling End-of-Life Electronics

**M**any have the impression that retired electronic products have substantial residual value. This is probably why so much older electronic equipment remains in storage—most of us just can't believe it isn't worth something to someone. In fact, the older equipment gets, the more quickly its value fades—and the more we spend in wasted storage space and costs to hang onto it. Once you decide to retire electronic equipment, move quickly to identify potential donees or resellers to maximize the value of transferring the equipment and the potential tax write-offs you might qualify for.



## Check Your Regulatory Obligations

If no one is interested in taking your electronics for reuse or refurbishing, recycling these products for their parts or material value is the next best option. Be aware, however, that in many cases, the material value of retired electronic equipment does not cover the cost of dismantling or preparing the component materials for market. Prices for recycling old electronic products vary widely, depending on geographic area, quantities, and other issues. For example, stripping proprietary data and

recording destruction methods for each individual machine might be an additional expense. Still, recycling can be the better course of action financially for many organizations when compared with disposal. Several Web sites listing recyclers, as well as organizations arranging for donations, are listed in the Resources section at the end of this *Update*.

The cathode ray tubes (CRTs) in color computer monitors and televisions are often hazardous when discarded because of the presence of lead. Although the lead is probably not an environmental problem while the monitor or television is intact, the lead might leach out under condi-

## Get Your Tax Breaks Here!

To boost donation and reuse of computer equipment for schools, the U.S. Congress expanded tax incentives for private companies that donate computer technology, equipment, or software to schools by passing the 21st Century Classrooms Act for Private Technology Investment, a provision to the Taxpayer Relief Act of 1997. Since the Act took effect in January 1998, companies that donate computers and related equipment to public or private schools, grades K-12, have been able to deduct their full purchase costs from their Adjusted Gross Incomes. A clause in the provision prevents the dumping of outdated equipment by requiring companies to show that their donations fit into the receiving school's curriculum needs (e.g., electronics must be no more than 2 years old at the time of donation).

Unfortunately, this tax break does not extend to individuals or sole proprietors; only large companies can claim this computer donation deduction. Companies claiming the donation deduction can still take a depreciation deduction on a computer each year for the first 2 years they own it, allowing them to effectively double-deduct the computers they donate. For assistance with the paperwork and recordkeeping necessary to take advantage of the computer donation tax deduction, visit Thomas L. Kearns' Charitable Contributions Web site at <[www.kidsource.com/kidsource/content/taxes.html](http://www.kidsource.com/kidsource/content/taxes.html)>.

tions typical of municipal landfills. Federal regulatory requirements applicable to handling these materials vary.<sup>1</sup> Facilities disposing of or recycling used CRTs should always check their state regulatory requirements, which might be different from federal regulatory requirements.

- **Households:** Used computer monitors or televisions generated by households are not considered hazardous waste and are not regulated under federal regulations.
- **Donation or Resale:** Monitors and televisions sent for continued use (i.e., resold or donated) are not considered hazardous waste.
- **Small Quantities Exempt:** Businesses and other organizations are not regulated under most federal requirements if the facility discards less than 100 kilograms (about 220 lb.) of hazardous waste, including used CRTs, per month. (These wastes must still go to a facility authorized to receive solid waste.)

- **Large Quantities:** Wastes from facilities that generate more than 100 kilograms of hazardous waste per month are regulated under federal law when disposed. CRTs sent for disposal from such facilities must be manifested as "hazardous waste" and sent to a permitted hazardous waste landfill. CRTs sent for recycling from such facilities are also currently subject to federal regulation; however, EPA is in the process of streamlining requirements to make it easier and less costly to send CRTs for recycling. A proposed rule to this effect will be issued shortly. In the meantime, some states are addressing this issue, for example, by handling these materials as "universal waste," thereby reducing the management requirements applicable to the recycling of CRTs. Therefore, organizations should consult with their state governments.

<sup>1</sup> This discussion summarizes relevant federal regulatory requirements. For the complete federal hazardous waste requirements for generators, consult 40 CFR Parts 260-262.

# Improving Future Acquisitions

**T**o minimize the environmental impacts of electronic products, consider various product attributes before purchasing. Choose products that have reduced toxics content (i.e., reduced lead, mercury, and other heavy metals), greater recycled content, higher energy efficiency, longer life expectancy, and ease of upgradability, and contain features that facilitate recycling at end-of-life. Consider whether leasing electronic equipment is appropriate for your organization. Also, consider purchasing refurbished or remanufactured electronic equipment.



When evaluating electronic equipment to determine if it can be upgraded or repaired, purchasers should look for products that:

- Have modular designs that allow for easy installation and service of hardware or memory upgrades.
- Utilize latches or snap construction to enable quick access to internal components.
- Are manufactured without glue and/or fixing tape, because they are difficult to remove.
- Do not require special tools for removing or replacing parts or batteries.

## Giving Electronics a New Lease on Life

Purchasers who don't want the responsibility of dealing with end-of-life equipment, but still prefer to use the most up-to-date products, should consider leasing instead of purchasing. This option allows them to return old equipment to the vendor for upgrades or credits toward future purchases. Leasing also eliminates consumer responsibilities for proper product disposal or management because they do not own the equipment. Another option involves selecting a dealer, retailer, or manufacturer that operates a product take-back program and allows consumers to return old equipment when purchasing new products or system upgrades.

For a case study showcasing a leasing agreement between WasteWise partners Monsanto and Dell Computer Corp., see the October 1998 WasteWise Update: *Extended Product Responsibility* at [www.epa.gov/wastewise/pub\\_c.htm#ten](http://www.epa.gov/wastewise/pub_c.htm#ten).

Purchasers also should look for product attributes that will, when the time comes, facilitate recycling through ease of dismantling and sorting. Select products that:

- Minimize the use of different types of materials (e.g., plastic resins) because products containing diverse materials are more difficult and time-consuming to sort.
- Use screws and fasteners that are made of the same type of material as the parent part so that they may be recycled together.
- Don't contain foams, coatings, or paint that can contaminate parts and prevent recycling.
- Have connections, such as breakaway joints and panels, that allow plastic housings to be removed easily.
- Eliminate labels by molding information directly onto parts, avoiding the need to use additional materials or chemicals that could contaminate plastic.
- Use internationally recognized symbols for coding plastic parts for easy sorting.

Other questions to consider when selecting new electronic equipment include:

- Is the product or its battery rechargeable?
- Does the product use replaceable parts that are readily available from the manufacturer or retailers?
- Does the product use remanufactured parts?
- Does the product contain recycled-content material?

These characteristics can help extend the life of your electronic equipment, delay the need to purchase newer equipment, and reduce the cost of recycling at end-of-life.

# Managing Used Electronics

## Repair and Donation—Extending Product Lifespans

**R**apid strides in electronics technology have improved products and increased consumer convenience. But they also have heightened desire to have the newest, fastest equipment. If your company has recently acquired—or is getting ready to acquire—new equipment, consider donating old equipment to schools, nonprofits, and charitable organizations. Some organizations even accept nonworking equipment to repair for resale or to use the parts to refurbish other systems. Understand that not all used equipment is welcomed by schools and nonprofits, however. Newer equipment is more attractive to these users than older equipment. This raises the importance of getting equipment out of storage and into the hands of potential users quickly. The longer you hang onto used electronics, the quicker they lose any potential value they might have to others.

## Aspen Skiing Company Lifts Students' Classroom Experience

In a small town, word spreads fast. When WasteWise partner **Aspen Skiing Company's** Environmental Affairs Director Chris Lane heard that local schools needed computers, he says "it was an easy decision." After a recent computer upgrade, the company found itself with 60 perfectly good 486-microprocessor computer systems. "It wasn't practical to sell them because we wouldn't get much in return," says Information Systems Manager Joe Zazzaretti. "So we donated them, and the feedback from that was great."

Basalt Elementary School was one of the benefactors of the company's donation, receiving 12 computers. In October 1999, the school received a small grant from a local educational foundation to create the *Basalt Bugle*, a student magazine aimed at improving and showcasing students' creative writing skills. The students now use the computers to write and edit the publication. "The addition of the computers donated by the Aspen Skiing Company will enable a greater number of students to participate in publishing the *Basalt Bugle*," says former Basalt Elementary School Principal Bill Vitany.

The local press wrote about the donations, and soon Aspen Skiing began receiving requests from other organizations, including a local police department. Currently, Aspen Skiing is partnering with a local Internet service provider to refurbish the computers and make them available to the community's low-income residents to help their children compete in school. For more information on Aspen's donation program, contact Chris Lane at <crlane@skiaspen.com>.

## Donation Done Right at Public Service Enterprise Group

What began as a small component of the lifecycle management program at WasteWise partner **Public Service Enterprise Group's** (PSEG) Resource Recovery Center in Paulsboro, New Jersey, has grown into an award-winning operation. Over a 3-year period, this large power company has donated more than \$1 million worth of computers, technology, and training to urban educational facilities and organizations in New Jersey. In 1999 alone, PSEG's computer



## Getting Over the Software Hurdle

Due to copyright issues, operating systems—such as WordPerfect® or Microsoft Windows®—are often removed from computers prior to donation. Many schools and nonprofit organizations do not have the resources to purchase new software. As a result, these “empty” computers are essentially useless to them. Recently, more generic operating programs have been developed that can be loaded onto computer equipment and remain with the system following donation, even if proprietary programming or other software applications are removed. One example of this so-called “spare-tire” software is made by NewDeal, Inc. NewDeal’s comprehensive suites of communication, productivity, and curriculum software include a word processor, spreadsheet, database, Internet browser, and email and can run on any PC, from a 286 to a Pentium III. For more information, visit the company’s Web site, <[www.newdealinc.com/](http://www.newdealinc.com/)>.



recovery operations prevented nearly 120,000 pounds of electronics, or the equivalent of more than 1,500 desktop computer systems, from entering the waste stream. Of this amount, PSEG donated \$220,000 in equipment to more than 80 organizations and sold \$105,000 in equipment to more than 300 customers, avoiding almost \$57,000 in disposal costs. This program earned PSEG the New Jersey Department of Environmental Protection’s Environmental Excellence Award in the Safe and Healthy Communities category in June 2000.

### DETERMINING WHETHER AND WHEN TO DONATE

How does a company determine whether a computer should be reused internally, donated, or sold? The Information Technology (IT) group at PSEG tests all “retired” equipment to see if it meets the company’s corporate standard. If not, the group looks at whether the equipment might meet the needs of less technology-intensive businesses, educational facilities, or personal residences. PSEG has committed a large space to evaluate and test its equipment. Equipment that does not meet the corporate standard for reuse within the company is considered for resale or donation. PSEG tries to sell enough high-end computers to balance the cost of refurbishing computers prior to donation. This effort provides used computers that are still

high in value, so recipients do not feel they are getting second-tier products. The cost of reconditioning and donating computers is roughly \$160 per system, while the sale of one high-end computer might generate as much as \$500. Proper demanufacture and recycling, on the other hand, would have cost \$35 per system in processing and recovery fees.

### DONATION DO’S AND DON’T’S

According to Tom Costantino of PSEG’s Resource Recovery Center, the key steps in implementing a solid computer recovery and donation program include:

- Establishing criteria for determining how equipment will be handled (i.e., upgraded, remanufactured, donated, sold, or demanufactured and recycled).
- Removing all sensitive information and personal files from the hard drives.
- Finding recipients with whom you are comfortable.

A common mistake companies make, Costantino says, is dropping equipment off at a donation site without making sure it will function and be reused properly. PSEG goes to some effort to make sure its computers are reused to their fullest potential. At the Resource Recovery Center, the company cleans the hard drives, removes sensitive and personal



information, and adds Microsoft Windows® operating software through a cooperative agreement with Microsoft Corp. Microsoft provides older versions of software that will not be competitive on the market. (See box on page 8.) At the donation site, PSEG technicians evaluate whether the recipients are able to accommodate and make use of the equipment, then finally set up and test the computers to ensure they are operating properly before releasing them.

“A financial commitment is vital to implementing a successful computer donation program, but that financial commitment will pay dividends,” Costantino says. Bulk sale is a tempting option because it requires less of a capital investment. But, Costantino cautions, “It has its environmental perils. PSEG avoids compromising its environmental ethic by selling quality equipment and by not selling to people who are not going to properly recycle the equipment.”

For more information on PSEG’s electronics donation program, contact PSEG’s Manager of Resource Recovery Al Fralinger at 856 224-1638 or by e-mail at <Albert.Fralinger@pseg.com>.

## Electronics Recycling— Going for the Gold (or Silver, or Platinum...)

Electronics recycling is a new industry emerging to manage the growing volumes of discarded electronics. In the past, scrap dealers collected used or discarded electronic products to recover precious metals such as gold, silver, platinum, and palladium contained within. Today, electronic products contain fewer precious metals, but electronics recyclers are finding ways to repair, reuse, and recycle more of the materials in used electronics. Many use innovative techniques and high-tech instruments (coupled with old-fashioned manual labor) to pinpoint malfunctions and repair products, to dismantle electronic equipment into component parts for reuse or recycling, and to separate commodities for further processing or recycling.



## Recycling Electronics in Large Organizations: The USPS’s First-Class Plan

How does an organization with more than 35,000 locations in the United States, each connected to the second largest electronic communications network in the world (behind the Internet), deal with the sheer volume of electronic equipment arising from rapid turnover in technology? The U.S. Postal Service (USPS) found that an organization-wide approach to recycling outdated electronic products made economic sense. Used equipment in storage represents frozen assets. “The longer it sits out of use, the more value it loses,” says USPS—Northeast Area Environmental Compliance Coordinator Charlie Vidich. Two years ago, USPS headquarters selected the USPS—Northeast Area, a 1999 WasteWise Partner of the Year, for a feasibility study on electronics recycling.

### GETTING STARTED

Vidich suggests a team approach to evaluating recycling facilities. In the case of USPS, this means drawing input from various departments, such as environmental, purchasing, materials management, and information technology.

- **Establish a baseline.** First, the USPS cataloged existing methods of collection, storage, and disposal. Most of its equipment was being taken to storage facilities in each of its nine postal districts. Districts reused or donated equipment whenever possible, but the system was not centrally coordinated.
- **Determine reuse and recycling strategies.** During the second phase, USPS established reuse and recycling strategies for various types of electronics equipment, including PCs, keyboards, laptops, integrated retail terminals, fax machines, and telephones.
- **Screen potential recyclers.** USPS hired a firm to study the electronics recycling industry in the Northeast. To help standardize evaluation of the companies, the USPS team required potential recyclers to complete an audit questionnaire. The team then evaluated the recyclers’ compliance records; pollution prevention and recycling practices; potential Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) liabilities; and environmental management systems.
- **Conduct site visits.** Vidich advises site visits to electronics recyclers. “It’s not possible to fully evaluate the liabilities of doing business with these companies without

visiting their facilities, and in some cases, visiting their subcontractors or affiliated businesses that manage their waste streams,” he says. One concern for many organizations is that some companies might landfill the materials that cannot be reused, resold, or recycled.

### HOW THE USPS RECOVERY SYSTEM WORKS

Empty mail trucks deliver the outdated equipment to a central collection facility in each of the nine Northeast postal districts. Recycling companies under contract to the USPS collect the equipment from these warehouses for recycling. The USPS pays recyclers for their services based on the costs to pick up, transport, and recycle the equipment. If the recycler successfully resells valuable parts or materials, it shares the revenue with the USPS, which has a special account to track these transactions.

For more information about the USPS—Northeast Area’s electronics recovery efforts, contact Charlie Vidich at <cvidich@email.usps.gov>.

## Electronics Recycling Means Business for DMC

Every week, WasteWise partner **DMC The Electronics Recycling Company** receives truckloads of outdated electronics—ranging from televisions and personal computers to mainframes—from *Fortune* 500 companies, government agencies, manufacturers, and service companies. DMC processes 750,000 pounds (375 tons) of equipment per week—that’s equivalent to 39 million pounds (19,500 tons)

per year—at its facilities in Newfields, New Hampshire, and Hagerstown, Maryland.

When the electronics arrive at DMC (customers are responsible for transporting used equipment), everything is weighed and separated according to the appropriate disposition method for that material. While DMC can refurbish approximately 10 to 15 percent of the components for resale, everything else is demanufactured to its original parts and sold to the appropriate materials dealer. “DMC has a buyer for every type of material except batteries, which are managed as hazardous waste,” says Rick Campbell, DMC’s director of corporate relations. “DMC continually strives to improve our service to ensure that we reuse what we can and recycle the rest without landfilling.”

DMC has a strong commitment to end electronics disposal in the United States and abroad, so the company takes time to educate the public and work with environmentalists and industry leaders to avert the accumulation of millions of tons of scrap and surplus electronic equipment. “We participate in many speaking engagements to educate corporations about the importance of recycling electronics,” Campbell says. The company is also ISO 14000-certified.

The electronics industry shows no sign of slowing production, and consumer demand is expected to grow, so the market for electronics recycling will most likely continue, keeping demand for DMC’s services humming for some time to come. Contact Rick Campbell at 603 772-7236, or send e-mail to <rcamp@dmcrecycling.com>. For more information on electronics recycling or selecting an electronics recycler, visit DMC’s Web site at <www.dmcrecycling.com>.



# How Are Computers Recycled?

Some products destined for recycling, such as aluminum cans and newspapers, find themselves reborn as like products. But tracing the path of recycled electronic products is considerably more complicated. What follows are some of the steps a typical computer could undergo during recycling:

## CIRCUIT BOARDS

Most circuit boards and some hard drives can be marketed for resale as operational parts. Unusable circuit boards are chopped into a powder and separated into fiberglass, metals, and precious metals through a process called fire assay.

## PLASTIC HOUSINGS

Plastic housings are separated from the electronic equipment, and materials such as labels and foam insulation are removed through air classification. Unfortunately, plastic housings on computers and monitors will not fit on newer equipment. At present, these plastics are difficult to market because they contain mixed or unmarked resins that cannot be readily identified or separated, as well as some additives such as flame retardants that complicate recycling. Some near-term uses of these plastics include use in roadbed fill. Efforts are under way, however, to find higher value applications for these plastics in products such as flooring, computer, and automotive parts.

## SMALL PLASTIC COMPONENTS

The small plastic parts inside computers are typically made from uniform-colored, high density polyethylene (HDPE). This makes them easier to remove, grind, and process. Recyclers must take great care not to mix other materials (e.g., metals) or different resins in with these plastics. Even a small amount of contamination can cause a buyer to reject an entire load. If ground plastic resins appear to have contamination from mixed resins, the recycler can hydroseparate them because of their varying densities.

## SCREWS, CLIPS, SMALL METAL PARTS

Screws, clips, and small metal components are sorted and separated magnetically into ferrous and nonferrous groups. The metals are sold as scrap.

## MONITORS

Monitors are handed over to a separate demanufacturing line, where workers remove the plastic housings, metal supports, and circuit boards. The cathode ray tube (CRT) itself is a funnel-shaped, leaded glass tube with a metal frame inside. The worker separates the funnel from the front panel glass. The CRT is then crushed, and the leaded glass and metal are separated. The glass is screened, processed, and inspected for contaminants. Much of it can be sold to CRT manufacturers for use in new CRT glass. The metal is sold for its scrap value.



# Opportunities for Manufacturers to Minimize Electronics Waste

**M**ost older electronic equipment is difficult to upgrade and hard to disassemble for reuse and recycling because it was never designed with these ends in mind. But public policy trends and industry initiatives are increasingly promoting “greener” products—those with lower lifecycle environmental impacts, including impacts at product end-of-life. As a result, more manufacturers are designing for the environment (DfE). This includes reducing toxic constituents in products, using more recycled materials, and designing products to be more easily upgraded and recycled. Some manufacturers are also beginning to offer “asset management services” to their clients, including product take-back and recycling.

Producers of high-tech products face multiple challenges in the design process. In this fast-paced and highly competitive field, they must meet consumers’ performance and cost expectations at the same time they strive to minimize lifecycle environmental impacts. Some manufacturers are addressing this challenge by taking environmental considerations into account at the earliest stages of product design. What follows are some of the design changes that are making a difference:

- **Standardization of material types.** Standardizing material types not only facilitates product recycling by minimizing the different types of plastics and parts that need to be sorted, but also reduces manufacturing costs. WasteWise partner **Sharp Electronics Corp.** incorporated material reduction techniques into a number of its products, including televisions that use 50 percent fewer types of plastics and 33 per-

cent fewer parts than traditional sets.

Similarly, Sharp reduced the product weight of its VCRs by 27 percent and the number of parts by 15 percent.

## Leading by Example

### The Electronic Industries

**Alliance** (EIA), a trade association representing the electronics industry and a WasteWise endorser, is encouraging its members to design for the environment (DfE). EIA’s Environmental Issues Council has published a summary of steps its members are taking to improve the environmental attributes of their products and processes. See EIA’s Web site at [www.eia.org/download/eic/21/dfe-comp.html](http://www.eia.org/download/eic/21/dfe-comp.html) for more information. Other organizations active in electronics recycling and DfE are listed in the *Update’s* Resources Section.

- **Use of recycled-content materials.** Who will use all the materials recovered from end-of-life electronics? Some manufacturers are helping to boost the market for these materials by looking for ways to use recycled content in their new products. WasteWise partner **Pitney Bowes Inc.’s** plastic injection operations integrate an average of 5 percent preconsumer plastic into its components, and purchases of components from outside vendors contain up to 3 percent recycled content.
- **Use of refurbished/reconditioned parts.** Voluntary asset recovery programs reuse or refurbish equipment that may no longer serve the needs of the original customer, but that retains value and might be beneficial to other users. For example, WasteWise

## From Drawing Board to Circuit Board

WasteWise partner **Motorola, Inc.**, is making efforts to design its products with the environment in mind. In addition to manufacturing products, Motorola has braved new territory—electronics demanufacturing.

Motorola's Plantation, Florida, facility is the company's main center for electronics demanufacturing and reuse. The demanufacturing program started in 1993 when the company faced a semiconductor shortage. The company decided to recycle assembled, pre-consumer circuit boards. Four years in the making, Motorola's asset recovery program relies on engineering overruns of preconsumer circuit boards as a principal source of valuable components.

Numerous rounds of rigorous tests were performed to prove that products made with recovered components perform just as well as products made with virgin components. The success of Motorola's semiconductor recovery and reuse program prompted the company to extend recovery efforts, reaching out to manufacturing facilities worldwide and encompassing reuse and recycling of all product components.

For more information, contact Jaime A. Santiago, manufacturing manager at Motorola's Material Demanufacturing Center, at 954 723-4744, or e-mail him at <ejs020@email.mot.com>.

- **Remanufacturing.** Used electronics can be disassembled and remanufactured into new products, thereby reducing production costs and minimizing waste generation. In 1999, WasteWise partner **Xerox Corp.** remanufactured equipment and parts from more than 30,000 tons of returned machines, reducing energy consumption and diverting valuable equipment from disposal. Because products are designed with remanufacturing in mind, the company offers the same guarantees for remanufactured equipment as for all-new equipment. The company reports that the financial benefits of these efforts amount to several hundred million dollars each year.
- **Recyclability.** Labeling materials (such as plastic resins) used in products and reducing reliance on paints and coatings (which can contaminate secondary materials streams) help make sorting and recovering secondary materials more cost-effective. WasteWise partner **Hewlett Packard Company**, for example, uses material identification codes and marks all plastic parts according to ISO 11469. Additionally, the company molds user instructions into the plastic rather than using a paper label.

For a more detailed discussion of DfE, see the October 1998 *WasteWise Update: Extended Product Responsibility* (EPA530-N-98-007) at <[www.epa.gov/wastewise/pub\\_c.htm#ten](http://www.epa.gov/wastewise/pub_c.htm#ten)>.



partner **Sun Microsystems, Inc.**, has a comprehensive reuse program that accepts used systems from customers and separates materials according to a "save list" that outlines key components for reuse. Returned systems that are unsuitable for remanufacture or components not included on the "save list" continue to circulate and perform other useful functions.



# Actions Governments Are Taking to Manage Electronics Waste

**A**s the pace of new product development and obsolescence steadily accelerates, policy-makers across the United States are focusing on how to manage the growing waste from electronic products. More and more state and local governments are experimenting with collection, donation, and recycling of used electronics products, as well as ways to involve producers of electronics in helping to recover these products at end-of-life. Some states, as well as the federal government, are working to make their policies less burdensome for generators of used electronic products to encourage donation and recycling instead of disposal. Businesses and others who are considering donation, recycling, or disposal of electronic products should check their state regulations and policies. These policies vary widely from jurisdiction to jurisdiction. Some of the major initiatives are summarized below:



- **Streamlining regulatory status of cathode ray tubes (CRTs) bound for recycling.** Most CRTs (especially color monitors for computers or televisions) are considered hazardous under federal and state regulations because of the presence of lead. To encourage more collection and recycling of CRTs, EPA will be proposing rulemaking changes to streamline existing federal management requirements, which currently add expense and paperwork to CRT recycling. EPA has already made similar rule changes to encourage the recycling of certain batteries, thermostats, hazardous waste lamps, and pesticides. Several states currently have or are considering changes to do the same for CRTs.
- **Banning disposal of CRTs.** WasteWise partner the Commonwealth of Massachusetts recently banned disposal of CRTs in its municipal waste landfills. For program details, visit the Massachusetts Department of

Environmental Protection's CRT Reuse and Recycling Web site at <[www.magnet.state.ma.us/dep/recycle/crt/crthome.htm](http://www.magnet.state.ma.us/dep/recycle/crt/crthome.htm)>. Florida also might consider doing the same, but only after ensuring that an adequate recycling infrastructure exists. Information on Florida's strategy for end-of-life electronics is available at the Florida Department of Environmental Protection's Web site at <[www.dep.state.fl.us/dwm/programs/electronics](http://www.dep.state.fl.us/dwm/programs/electronics)>.

- **Setting up local collection sites.** In recent years, an increasing number of communities have experimented with various ways of collecting end-of-life electronics. There are now periodic or ongoing electronics collection and/or drop-off programs in many states. Some of these experiences are profiled in an EPA report called *Analysis of Five Community Consumer/Residential Collections of End-of-Life Electronic and Electrical Equipment*. This report is available on USEPA-New England's Web site at

<[www.epa.gov/region01/steward/electcol/index.html](http://www.epa.gov/region01/steward/electcol/index.html)>. For information on additional collection pilots, check the National Recycling Coalition's Web site at <[www.nrc-recycle.org/Programs/electronics](http://www.nrc-recycle.org/Programs/electronics)> and EPA's Extended Product Responsibility Web site, under Electronics, at <[www.epa.gov/epr](http://www.epa.gov/epr)>.

- **Charging a recycling fee at point of sale.** South Carolina's Recycling Market Development Advisory Council (RMDAC) is seeking industry input and legislative support for an electronic equipment recycling program in that state. The council has proposed a fee on the purchase of new electronic equipment containing CRTs, such as televisions and computer monitors, to help develop a state infrastructure for scrap electronic equipment recovery and recycling. The monies would provide grants and loans to local governments and businesses that collect, transport, process, and recycle discarded electronics. South Carolina continues to pursue this initiative by gathering information and additional support from industry allies. Watch the RMDAC Web site at <[www.callsouthcarolina.com/recycling/Default.htm](http://www.callsouthcarolina.com/recycling/Default.htm)> for the latest developments.
- **Labeling products containing hazardous substances.** Vermont requires manufacturers of certain mercury-containing products to label these products for sale in the state. To discard labeled mercury-added products, consumers must drop them off at a designated collection point or a facility authorized to accept such items. The Northeast Waste Management Officials Association's (NEWMOA's) "Model Mercury Legislation" calls for this type of labeling as well as other requirements, including producer take back, for mercury-containing products. For more information on this model legislation, see <[www.newmoa.org/Newmoa/htdocs/prevention/mercury/](http://www.newmoa.org/Newmoa/htdocs/prevention/mercury/)>.
- **Investigating extended product responsibility.** Some states are looking at ways to engage producers of electronic products in the collection and recycling of these products at end-of-life. New York has proposed take-back legislation for electronic equipment that would require manufacturers to establish collection and/or disassembly centers for recovery of at least 90 percent of the waste equipment. Manufacturers would be required to accept such equipment at no charge to consumers.<sup>2</sup> Minnesota's Office of Environmental Assistance (OEA) initially proposed a product stewardship policy that would mandate producer responsibility for CRTs and some other products.<sup>3</sup> The state, however, is currently investigating the

degree to which voluntary assistance partnerships with industry can address this waste stream (see article below for details on this initiative). For more information on OEA's product stewardship efforts in general, go to <[www.moea.state.mn.us](http://www.moea.state.mn.us)>. The NEWMOA states are considering model legislation to mandate producer take back of mercury-containing products (see the previous bullet).

## Public-Private Partnership Proves Positive for Recycling

Growing concern over the disposal of electrical and electronic products in the municipal solid waste stream prompted the Minnesota OEA to sponsor a recycling demonstration project targeting residential and small business electronic discards. WasteWise partner **Matsushita Electric Corporation of America** (Panasonic) and WasteWise endorser the **American Plastics Council** partially funded the demonstration project along with Sony Electronics, Inc., and the Waste Management-Asset Recovery Group (WM-ARG). The pilot compared various collection techniques and costs and assessed collection and recycling infrastructure development needs. It encompassed 65 recycling centers serving approximately one-third of Minnesota's residents. Recognizing that no single collection strategy (e.g., curbside, dropoff, or retail collection centers) could provide the solution, the project partners tested several strategies to see which were most successful at capturing material or reducing costs. During a

(Continued on Page 16)

### King-Size Local Effort

One of the newest programs of WasteWise Partner **King County**, Washington, Department of Natural Resources is a 4-month pilot Computer Recovery Project. The project aims to collect, among other things, computer central processing units (CPUs), monitors, keyboards, and mice from county residents and small- to medium-sized businesses. King County is currently working with 16 computer repair/resale vendors and nonprofit organizations to serve as collection points. These collection sites will sort equipment and decide what can be resold as is, repaired for resale, or recycled. For more information about King County's Computer Recovery Project, contact Lisa Sepanski at 206 296-4489, or send e-mail to <[lisa.sepanski@metrokc.gov](mailto:lisa.sepanski@metrokc.gov)>. Information is also available on the Internet at <<http://dnr.metrokc.gov/swd/crp.htm>>.

2 Kadas, Madeleine Boyer, and Paul E. Hagen. Beveridge & Diamond, P.C. Electronics Take-Back and Recycling Update on Recent U.S. State Initiatives. February 29, 2000. p. 11.

3 Ibid. p. 8

## Government (continued from page 15)

3-month timeframe from July 31 to October 31, 1999, centers collected nearly 700 tons of used electronic products. WM-ARG spent the next 3 months processing the collected materials. After segregating the electronics into five broad product categories (TVs, monitors, PC units, consumer electronics, and mixed electronics), WM-ARG identified eight scrap materials to be extracted from the products. Project partners chose to evaluate the secondary markets for glass and plastics, which are the two materials that retain the most value at the end-of-life.

Initial evaluation of the pilot indicated the following needs: 1) improvements in recycling technologies; 2) increased procurement of secondary materials for the manufacture of new products; and 3) regulatory relief for legitimate electronics recyclers. The study concluded that these changes will help facilitate expansion of electronics recycling.

For more information, contact Mark Sharp, assistant general manager of Panasonic's Corporate Environmental Department, at 202 223-2575 or <sharpm@panasonic.com>. To contact Minnesota regarding this project, call Tony Hainault, Minnesota OEA, at 612 215-0298; e-mail him at <tony.hainault@moea.state.mn.us>; or go to <www.moea.state.mn.us/plugin/index.cfm>.

**If you have received this publication in error or want to be removed from the WasteWise Update mailing list, please call the WasteWise Helpline at 800 EPA-WISE (372-9473) or send a copy of this page, with the mailing label, back to WasteWise at the address below. Many WasteWise publications, including the WasteWise Update, are available electronically on the WasteWise Web site at <www.epa.gov/wastewise>.**

## A New WasteWise Challenge for Today's Technology—Electronics

To help partners reduce the growing waste stream of used electronics, WasteWise designed a new initiative—the WasteWise Electronics Challenge. This is

the second in a series of WasteWise Challenges. The Transport Packaging Challenge, introduced last year, focused on items such as pallets, wraps, and totes, and resulted in substantial cost savings and waste reduction for participating partners. Here's an opportunity to extend the life of electronic products and perhaps qualify for tax write-offs. In addition, WasteWise will offer Challenge participants technical assistance and opportunities for recognition and networking.

Some examples of electronics waste reduction activities include:

- Refurbishing and/or upgrading existing electronics equipment instead of buying new equipment.
- Buying remanufactured or recycled equipment.
- Contracting with suppliers to lease electronics or to take back and reuse/recycle equipment that is no longer needed.
- Donating reusable electronics equipment (e.g., to schools or other nonprofit groups).

Call the WasteWise Helpline at 800 EPA-WISE (372-9473) to request a pledge card, or sign up electronically on the Partner Network section of the WasteWise Web site at <www.epa.gov/wastewise>.



United States  
Environmental Protection Agency  
(5306W)  
Washington, DC 20460

Official Business  
Penalty for Private Use \$300



# R e s o u r c e s

## for Electronics Waste Management

### National Directories And Databases



#### ▼ International Association of Electronics Recyclers (IAER)

[www.iaer.org/search](http://www.iaer.org/search)

The trade association for the electronics industry has several resources available electronically, including a comprehensive list of electronics recyclers. The Web site also contains information about the Electronics and the Environment Summit, held May 2000.

#### ▼ National Recycling Coalition's Electronics Database

[www.nrc-recycle.org/programs/electronics/search/getlisting.asp](http://www.nrc-recycle.org/programs/electronics/search/getlisting.asp)

This section of the National Recycling Coalition's Web site hosts a database of electronics recyclers, reuse organizations, and municipal programs that accept old electronic equipment.

#### ▼ National Safety Council's Electronic Product Recovery & Recycling (EPR2) Directory

[www.nsc.org/ehc/epr2/recycler.htm](http://www.nsc.org/ehc/epr2/recycler.htm)

This Web site contains a list of electronics recycling and donation organizations.

#### ▼ Parents-Educators-Publishers (PEP) National Directory of Computer Recycling Programs

[http://microweb.com/pepsite/Recycle/recycle\\_index.html](http://microweb.com/pepsite/Recycle/recycle_index.html)

This directory lists organizations throughout the U.S. and the world that accept and prepare computers for donation.

#### ▼ Share the Technology

<http://sharetechnology.org/>

This nonprofit corporation's national database lists computer donation offers and requests from all over the United States and from other countries.

### Other Web Sites



#### ▼ Carnegie Mellon Green Design Initiative

[www.ce.cmu.edu/GreenDesign/index.html](http://www.ce.cmu.edu/GreenDesign/index.html)

This Web site provides a comprehensive international resource list for information about end-of-life options for electronic products. It includes links for computer, software, component, and diskette recycling; federal, state, and local recycling/donation programs; electronics manufacturers' programs;

dealers of used and refurbished equipment; school and charity donation coordinators; and academic and research institutions.

#### ▼ CompuMentor

[www.compumentor.org/cm/resources/articles/108.html](http://www.compumentor.org/cm/resources/articles/108.html)

This volunteer computer training and support organization's Web site provides a list of electronics recycling and reuse organizations nationwide.

#### ▼ Computers for Learning

[www.computers.fed.gov](http://www.computers.fed.gov)

This Web site allows schools and educational nonprofits to register to request surplus federal computer equipment. Federal agencies use the Web site to donate computers based upon indications of need.

#### ▼ Electronic Industries Alliance (EIA)

[www.eia.org](http://www.eia.org)

EIA's Environmental Issues Council serves as a forum for industry executives. The site has information about various environmental issues, including end-of-life management of products. Read about Design for the Environment examples in "Addressing End-of-Life Electronics Through Design."

The mention of any company, product, or process in this publication does not constitute or imply endorsement by the U.S. Environmental Protection Agency.

▼  
**Goodwill Industries International, Inc.**

[www.goodwill.org/](http://www.goodwill.org/)

Gateway Country stores will give a \$100 discount off a new PC to anyone who donates a functioning, 386-class or better computer of any brand to Goodwill.

Goodwill might take 286 or newer computers, but you need to check with your local Goodwill chapter for complete details.

▼  
**National Cristina Foundation**

<http://cristina.org>

This organization brings donated computers to the disabled, economically disadvantaged, and students at risk. The Web site contains donation instructions and answers to tax benefit questions.

▼  
**National Recycling Coalition's Electronics Recycling Initiative**

[www.nrc-recycle.org/programs/electronics/index.htm](http://www.nrc-recycle.org/programs/electronics/index.htm)

This Web site contains information about electronics recycling and donation, policies and programs, reports and publications, and transcripts from past online chats about electronic product recovery.

▼  
**National Safety Council's Electronic Product Recovery and Recycling (EPR2) Project**

[www.nsc.org/ehc/epr2.htm](http://www.nsc.org/ehc/epr2.htm)

This section of the EPR2 Project Web site includes EPR2 conference summaries and an order form for the *EPR2 Baseline Report: Recycling of Selected Electronic Products in the United States*. The report provides results of the first large-scale survey and analyses of end-of-life electronics recycling and reuse.

▼  
**Recycler's World**

[www.recycle.net/computer](http://www.recycle.net/computer)

This Web site lists computer and telecommunications equipment recyclers and refurbishers, and hosts a worldwide electronics materials exchange.

▼  
**Southern Waste Information eXchange**

[www.wastexchange.org](http://www.wastexchange.org)

This Web site is a clearinghouse for information about recycled products, market development, and current legislation and regulations. It contains a resource guide about used televisions and computer recycling management in Florida. This site will soon link to an electronics equipment exchange program.

▼  
**U.S. EPA's Extended Product Responsibility (EPR) Page**

[www.epa.gov/epr](http://www.epa.gov/epr)

This site is dedicated to EPR, a product-oriented approach to sustainable development. Currently, it features examples of public and private sector initiatives to promote EPR in electronic and packaging products.

▼  
**The Wireless Foundation**

[www.wirelessfoundation.org](http://www.wirelessfoundation.org)

This organization collects and distributes cellular phones for neighborhood crime prevention, domestic safety, and education programs.



▼  
**Analysis of Five Community Consumer/Residential Collections: End-of-Life Electronic and Electrical Equipment**

**U.S. EPA. 1999.**

This publication is a collection of data from five electronics recycling pilots and ongoing programs.

[www.epa.gov/region01/programs/csifinal.pdf](http://www.epa.gov/region01/programs/csifinal.pdf)

▼  
**Designing for the Environment: A Design Guide for Information and Technology Equipment**

**American Plastics Council. 1999.**

This guide provides a synopsis of basic environmental design considerations applicable to computers and other information technology equipment.

[www.plasticsresource.com/reading\\_room/reports/report\\_enviro\\_design.html](http://www.plasticsresource.com/reading_room/reports/report_enviro_design.html)

▼  
**Eco-Design Checklists**

**Surrey Institute of Art and Design—The Centre for Sustainable Design. 1999.**

This is a guide for electronics manufacturers, "systems integrators," and suppliers of components and sub-assemblies in planning for environmental design.

[www.cfsd.org.uk/nepd/etmuel/checklist.htm#ecodcheck](http://www.cfsd.org.uk/nepd/etmuel/checklist.htm#ecodcheck)

▼  
**End-of-Life Computer and Electronics Recovery Options for the Mid-Atlantic States**

Mid-Atlantic Consortium of Recycling and Economic Development Officials.  
March 2000.

As computers quickly become outdated, electronics disposal is becoming a major issue. This report discusses electronics recovery options and models, plus markets and economic development. It identifies key issues to consider for policy development and makes recommendations for further investigation.

<[www.libertynet.org/macredo/eprprj.htm](http://www.libertynet.org/macredo/eprprj.htm)>

▼  
**Plug into Electronics Reuse Institute for Local Self-Reliance. 1997.**

This report provides contact information on 150 computer recovery facilities as well as indepth profiles of the operating experiences of 13 that focus on computer reuse. Operations profiled are all replicable and many are interested in starting similar enterprises in other cities. \$15.

<[www.ilsr.org/pubs/pubswtow.html](http://www.ilsr.org/pubs/pubswtow.html)>

▼  
**Residential Collection of Household End-of-Life Electrical and Electronic Equipment Pilot Collection Project**

U.S. EPA. 1998.

This report features results from two EPA-sponsored residential collection pilot programs held in 1996 and 1997 in Binghamton, New York, and Somerville, Massachusetts. Copies are available by contacting Fred Friedman with the USEPA-New England RCRA Research Library at 617 918-1807 or <[friedman.fred@epa.gov](mailto:friedman.fred@epa.gov)>.

▼  
**San Jose Computer Collection and Recycling Pilot**

EPA & Vista Environmental.  
July 1998.

Prepared by Vista Environmental for EPA's Common Sense Initiative, this document discusses a pilot project that examined the potential for collecting used computer equipment at retail stores for recycling. The report identifies potential barriers and examines economic feasibility. It concludes that while the cost of recycling computer monitors is substantial, it is nevertheless lower than costs associated with landfilling used computer equipment.

<[www.vista.simplenet.com/downReport.htm](http://www.vista.simplenet.com/downReport.htm)>

**The following is a list of articles from various trade publications that cover the topic of electronics recycling and reuse. Call the WasteWise Helpline at 800 372-9473 for information on contacting the trade publications.**

▼  
**"Demanufacturing: The emergence of an urban industry"**

*Resource Recycling*. February 2000.

As technology advances, many computers once considered top-of-the-line are now technological relics. To electronics demanufacturers, however, piles of obsolete computers can turn into virtual gold mines. Each computer contains valuable components such as gold, silver, and copper that can be salvaged and recycled. This article discusses the challenges demanufacturers face and offers projections for this industry's future expansion.

▼  
**"Reach out and touch someone: Cellular telephone refurbishers foresee expanding global market"**

*Waste News*. October 18, 1999.

Two Michigan-based companies, ReCellular and Telesource, found a profitable niche market in refurbishing cellular telephones. Industrywide, an estimated \$500 million worth of cell phones will be refurbished and resold this year—more than twice the amount 5 years ago. This article discusses how the market for refurbished cellular phones works.

▼  
**"Making electronic recycling connections"**

*Recycling Today*. September 1999.

Of the estimated 14 to 20 million computers that become outdated each year, only 30 percent are resalable. The remaining 70 percent are usually thrown away if they are not recycled. This article answers the following questions: what are the benefits of recycling computers; what are some of the best electronics recycling methods; how can computer recycling become profitable; what are the dangers in recovering materials; and where is electronics recycling headed?

▼  
**"Electronic product discards"**

*Resource Recycling*. June 1999.

This article highlights public and private programs that promote electronics reuse and recycling. Topics include a "Computers for Learning" program, electronic product reuse organizations and collections, and how manufacturers handle electronic product discards. The article also includes a list of Internet resources.

▼  
**"The leasing option"**

**Governing. May 1998.**

This article highlights how leasing office equipment and computers is becoming a popular choice for governmental organizations. Because computers quickly become outdated, it is more cost-effective to replace the technology by renewing a lease rather than purchasing new equipment. Another benefit of leasing is the warranty support and services that are included.

▼  
**"Electronics recycling collection: Targeting the commercial sector"**

**Resource Recycling. December 1998.**

The Rhode Island Department of Environmental Management conducted a study to determine the feasibility of recyclable electronics collection among commercial enterprises. The study highlights collection options and strategies for improving collection efficiency and effectiveness among various commercial sectors. Recyclable electronics collectors can use the study to maximize efficiency among different sectors.

▼  
**"What to do when computers pile up"**

**Recycling Times. November 1998.**

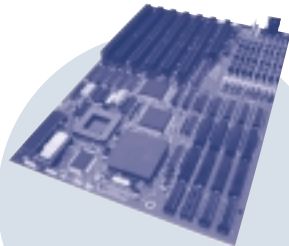
Many organizations accept old computers and fix them for reuse. This article highlights what some organizations are doing with used computers and includes a list of nationwide organizations that accept old equipment.

▼  
**"The Conundrum of Computer Recycling"**

**Resource Recycling. May 1999.**

This article discusses personal computer (PC) disposal and the effect of increased PC use and rapid technological advances on computer recycling. It also describes processing methods for used computers, regulatory issues surrounding PC disposal, local and state government activities, and strategies for reducing the number of discarded PCs in the waste stream.

<<http://vista.simplenet.com./conundrum.html>>



**Manufacturers' Asset Recovery and Recycling Programs**

▼  
**COMPAQ Computer Asset Recovery Services**

**[www.digital.com/das039hm.html](http://www.digital.com/das039hm.html)**

COMPAQ Computer Asset Recovery Services (CARS) serves as a single convenient, responsible source for disposition of any brand of computer-related equipment. Call the CARS access line at 800 580-7370 to learn more.

▼  
**Dell Financial Services (DFS) Asset Recovery Services**

**[www.dell.com/us/en/hied/services/asset\\_000.htm](http://www.dell.com/us/en/hied/services/asset_000.htm)**

DFS offers two asset disposition services—Value Recovery Services for functional equipment and PC

Recycling Services for nonfunctional or outdated equipment—to help customers manage used electronic equipment. For additional information or a quote on your equipment, e-mail Dell at <[US\\_DFS\\_AssetRecovery@Dell.com](mailto:US_DFS_AssetRecovery@Dell.com)> or call 800 955-3355, ext. 36634.

▼  
**IBM Product End-of-Life Management (PELM) Service**

**[www.pc.ibm.com/www/healthycomputing/envreport/end.html](http://www.pc.ibm.com/www/healthycomputing/envreport/end.html)**

IBM's PELM Service offers a convenient and affordable way for customers to return unused and unwanted IBM and non-IBM equipment for refurbishment and recycling. Customers in the U.S. are advised to contact their IBM representative for additional information.

▼  
**Micron Green Recycling Program**

**[www.micronpc.com/programs/mpower/ind\\_recycle.html](http://www.micronpc.com/programs/mpower/ind_recycle.html)**

Micron's Green Recycling Program allows customers purchasing new Micron equipment to return old equipment for recycling. A \$75 per system disposal fee is charged for returns of fewer than five systems—companies might qualify for a rebate on quantities of five systems or more. Customers must purchase at least as many new Micron systems as the number of systems returned.