

DEMANUFACTURING WHITEPAPER

WHAT IS DEMANUFACTURING

Demanufacturing refers to the dismantling of electronic equipment for scrap metals reclamation and component recovery. Recovery of these hazardous components reduces the toxicity of the waste and ensures proper disposal or recycling for the residual waste stream. Raw materials are recovered and are ultimately reused for manufacturing metals, plastics, and glass. All materials are sorted by plastic, metal, circuit boards, wire, etc. The materials are processed and then re-introduced back into the manufacturing process as raw materials.

An Official governmental definition is listed at the end of this whitepaper.

THE ORIGIN/ CASE FOR DEMANUFACTURING.

According to the U.S. Environmental Protection Agency (EPA) an estimated 30 to 40 million personal computers will be ready for "end of life management" in each of the next few years. Advancements in the technological world make it necessary to replace computers every three or four years. It is not always easy to find a business which specializes in computer disposal to remove the unused units. If they are just tossed in a dumpster they become quite a large problem for the environment. There are a couple of choices that work well when the old computer systems have to go to make room for new updated equipment.

The first option would be to find a business which specializes in computer disposal services. This can be a relatively inexpensive operation. It will also save the environment a lot of waste that cannot be broken down. The disposal service has a couple of options. They may rebuild computers and be able to use the old computers for parts and repairs. They may then be resold or donated for charitable services. However, what happens when neither of these are a viable option?

This is when we turn to demanufacturing. This is an involved process which basically breaks the computer down into parts which can be used or recycled.

There are about five different plastics used in the manufacturing of computers. These plastics can be separated out when a computer is demanufactured. Different types of wires can be sorted out as well. Metals can be separated into three categories: steel, aluminum and copper. All of these are reusable.

Whether the company takes on the task of demanufacturing computers or hires a computer disposal company the environment is benefited. Before just throwing away old computers, be sure to explore all the possible options. Choosing the right option can make a major difference in saving the environment.

These days, it seems like electronic equipment becomes obsolete in no time flat. No matter if you buy the latest and greatest electronic device, in a matter of a few years it's old and slow, and its performance leaves a lot to be desired. This is doubly true of computers. New computers outperform their older counterparts by an astounding margin.

And this rapid turnover of computers and electronic equipment is why computer waste disposal is becoming such a compelling industry.

You cannot just dump an old computer in a landfill and forget about it.

Computers contain a lot of toxic materials. There is the lead content in all the solder found on the circuit boards. And there are toxins in the batteries.

While Computers have transformed from big, bulky to small, convenient, recycling is just starting its transformation to becoming the ultimate way to dispose old computers. Computer Disposal Businesses will become more aware to computer buyers. While the demand for computers goes up so will the demand to recycle them safely. Going green is an old thought leading a new way to recycling future. Demanufacturing-In order to guarantee the downstream waste will come more to the forefront as a part of responsible recycling.

Computer recycling is the best way to make your old electronics disappear without causing undue damage to the environment. When a computer and its components are thrown out in the trash, they become part of the larger problem of landfill waste when they can be recycled and made into new items for purchase.

Items such as computers, CRT monitors, printers, networking gear, cell phones, cartridges, parts and cords contain valuable materials in them like plastic, metal and glass which can be reused to make new products. Many manufacturers are starting to use recycled products at an increasing rate for its ability to save the money on producing an item and not having to extract as many natural resources from the environment. Computer monitor recycling is especially important as many of the older and bulkier models are starting to appear in landfills.

E-waste contains a large amount of the plastic it can be reused to make items such as trash cans, kitchenware, file bins and even new monitors and computers. By allowing your old computers and their parts to be demanufactured you will also feel better about your role in protecting the environment. The savings that manufactures get from using recycled material will also be passed on to you as lower prices in the products you purchase.

Here is a brief listing of some of the items that should be Demanufactured on a regular basis.

- Personal Computers
- Mainframe Computers
- Monitors
- Printers
- Networking Hardware
- Modems
- Typewriters
- Telephones
- Telephone Switches
- Audiovisual Equipment
- Any Cable Television Products or Byproducts

THE PROCESS

The primary activity of demanufacturing is the breakdown of electronics (E-WASTE) into different commodities. Commodities produced from the demanufacturing process are:

Crushed glass
Circuit boards
Scrap metal
Wire
Hard drives and other drives
Power supplies
Copper yokes

Fluorescent tubes
Batteries
PCB materials
Ink jet and laser cartridges

When equipment is thrown away, these resources cannot be recovered and additional pollution will be generated to manufacture new products out of virgin materials. The following are contaminants of concern found in old electronics that adversely effect on the environment and human health.

Cr Chromium
Cd Cadmium
Hg Mercury
Zn Zinc
Pb Lead
Li Lithium
Pcb Polychlorinated Biphenyls

Reclaiming these materials helps save our landfills and our environment.

Material tracking and accounting has become an important aspect of modernization efforts to reduce costs, avoid waste, and minimize pollution. The following sections are included in the process:

1. Handling—controls the movement of material within the demanufacturing facility.
2. Disassembly—entail dismantling electronic equipment into more basic subassemblies or components that can be either recovered for reuse or further processed for materials recovery. Although disassembly can be performed using basic hand tools, more sophisticated disassembly techniques are incorporated into the disassembly process to reduce labor costs.

3. Testing—identifies equipment, subassemblies, and components that have reuse potential or may have marketable value in the commercial marketplace.
4. Glass Recovery—separates unleaded from leaded CRT glass and then prepares the CRT glass for reuse. Processed CRT glass is in the form of recyclable cullet, which can be used by CRT glass manufacturing facilities.
5. Metals Recovery—uses a more cost-effective and environmentally friendly process to separate metals and nonmetal materials from CPU's (central processing units) printed wiring boards. The process yields improved precious metal recovery at a lower processing cost to increase revenue.
6. Plastics Recovery—uses a novel processing system wherein engineering plastics are separated into high-purity concentrations of compatible types, suitable as replacement for raw material.

Upon receipt, material is sorted into two streams: cathode ray tube (CRT) containing and non-CRT containing material is stored in large boxes or shrink-wrapped onto pallets. Inventory of material is accomplished by a unique tracking system. The entire facility, inside and out, is monitored by a camera surveillance system allowing for material tracking and security.

- Hazardous components (i.e. batteries on circuit boards, portable equipment, mercury switches, toxic capacitors, fluorescent lamps, leaded glass from monitors, etc.) are removed from the equipment and are marketed as commodities.
- Non-hazardous materials are recycled as a plastic or metallic commodity.
- All end-markets for hazardous component disposal are audited and are for review.
- Job progression is documented as each pallet is processed.
- Customers will be provided a certificate of destruction which outlines the make, model, S/N, and asset tag if applicable.

This service significantly reduces the amount of e-waste that enters our landfills and your participation in this program gives assurance in your role of protecting the environment.

BENEFITS AND ADVANTAGES

- Reduces solid waste generation
- Removes hazardous components for proper disposal to avoid present and future liability
- Guarantees that any downstream waste is collected and accounted for in the United States. Furthermore, there are no additional downstream partners to manage or be liable for.
- Demonstrates that reuse and recycling of electronic waste is viable

Economic Benefits

Demanufacturing generates significant economic benefits for communities. In fact, the Office of the Federal Environmental Executive estimates that recycling and remanufacturing industries account for approximately one million manufacturing jobs and more than \$100 billion in revenue. Demanufacturing employs low-, medium-, and highly-skilled workers in a variety of jobs—from materials handling and processing to high-quality product manufacturing. The drive for efficient handling and use of demanufactured materials spurs innovation, a key to long-term economic growth. Investments in demanufactured equipment and the companies themselves also filter through the economy and contribute to economic growth.

Equally important are the social and environmental benefits of demanufacturing. Demanufacturing promotes the sustainable use of our natural resources. Working together, demanufacturing activities around the country promote community development while reducing the need for new landfills, preventing pollution, saving energy, and reducing greenhouse gas emissions.

What is the connection between jobs and recycling?

Across America, more businesses and government agencies are collecting materials for recycling than ever before. In fact, demanufacturing is now helping to recover more than one quarter of all waste generated in the United States. But keeping valuable resources out of landfills is only part of the recycling story. Recycling also creates new businesses that haul, process, and broker recovered materials, as well as companies

that manufacture and distribute products made with demanufactured content. These businesses put people to work.

Recycling is estimated to create nearly five times as many jobs as land filling. One study reported that 103,000 jobs, or 2.7 percent of all manufacturing jobs in the Northeast region of the United States, are attributed to recycling. The jobs created by recycling businesses draw from the full spectrum of the labor market (ranging from low- and semi-skilled jobs to highly skilled jobs). Materials sorters, dispatchers, truck drivers, brokers, sales representatives, process engineers, and chemists are just some of the jobs needed in the recycling industry. Recycling and demanufacturing is actively contributing to America's economic vitality.

Additional information on the connection between jobs and recycling is offered in EPA's Recycling Means Business (PDF) (20 pp, 1.7MB, about PDF) publication.

What is E-Waste

E-waste is defined as anything with a circuit board and or cathode ray tube (CRT). Examples of these items include: computer monitors and CPUs, televisions, printers and networking gear.

E-waste contains heavy metals, plastics, and organic compounds. Additionally, electronics are made with valuable resources such as precious metals, engineered plastics, glass, and other materials—all of which require energy to manufacture.

E-Waste Facts

- Approximately 220 million tons of E-Waste is generated annually in the U.S.
- The average life span of a computer today is two years.
- Consumers have, on average, two or three obsolete computers in their garages, closets or storage spaces.
- According to the EPA, the volume of E-Waste is rising 3-5 percent each year - almost three times faster than the municipal waste stream.
- The average computer monitor or TV may contain up to 7lbs. of lead, as well as cadmium, mercury and chromium in its circuit boards.

- Recycling these products removes these toxins from our municipal waste stream.

For most of us, it's been very confusing to figure out what to do with used electronics. Charitable programs, resellers, retailer and manufacturer take-back programs, and even free collection events have all popped up in the past decade in response to the well-publicized problems with recycling used electronics.

But no matter which you choose, it has been impossible to tell what really happens to your e-waste. Every take-back program, charitable program, or collection event has to use an electronics recycling company at some point. A charity or take-back program is not a responsible way to dispose of e-waste if it is only another path to an unscrupulous recycler.

While all recyclers say they only use responsible methods, there's been no way for them to prove it until recently now. Tracing and ultimately guaranteeing the downstream waste by demanufacturing solves this problem.

The key to responsible e-waste recycling is knowing where your stuff will end up. The industry term for this "Guaranteeing Downstream Waste". Watch out for any recycler who ships discarded electronics to developing countries for processing. Avoiding sending our garbage overseas saves on greenhouse gas emissions and helps protect workers and the environment in developing countries. As reported in a 2006 OnEarth magazine article, upwards of 80 percent of the world's e-waste is transported to Asia, and most of it winds up in China. Workers who disassemble consumer electronics by hand are exposed to toxic substances, which also contaminate groundwater.

PROOF OF THE PROBLEM

Not long ago, CBS' "60 Minutes" program broadcast a story on e-waste and global dumping. The reporters followed a trail of electronic recycling items from a Denver-based company all the way to Hong Kong, China and caught the so-called "recycling" company red-handed engaging in global e-waste dumping.

With over 80% of recycled electronics and computers ending up as high-tech e-waste in developing countries such as China, India, and Africa, we need to step up as responsible citizens of the world and choose computer and electronics recycling companies very carefully. We must support only those electronics recycling companies that are running both a socially and an environmentally sound operation, end-to-end. To understand how

global dumping occurs, it helps to first understand the business model for electronic recycling.

To sustain as a business, electronic recyclers must generate enough revenues from all its recycling and reuse services and the reclamation of precious metals and other recycling materials, minus operating costs and the cost of de-manufacturing those items that yield no value (yet harm the environment).

The difference between an environmentally responsible computer and electronics recycling company and an irresponsible one can be broken down as follows: a) the way they generate reuse revenues; b) how they reclaim precious metals and recycling materials; c) how they manage the de-manufacturing process of low-value, toxic elements.

Consider the precious metal reclamation process for a moment. A responsible company would need to invest in having a safe working environment with proper protective gear for its workers and proper waste treatment procedures to prevent environmental contamination. In addition, a responsible electronics recycling company will operate using specialized de-manufacturing equipment that protects the workers from the harmful materials or dust that escapes during the de-manufacturing process.

An irresponsible recycling company avoids any investment in the de-manufacturing area. In fact, irresponsible recycling companies never lay eyes on the workers who eventually break apart the leftover electronic parts. As seen in the "60 Minutes" program, those workers are typically low-paid laborers from remote villages, who use bare hands and primitive tools such as chisels and hammers to pry the precious materials from the discarded items. The final discarded parts are then dumped anywhere – in rivers or streams or burned in a swamp – causing major public health issues.

The most hazardous materials found in e-waste are not the reclaimed precious metals, but the low-value, toxic materials such as Mercury found in switches and flat screens and the brominated flame retardants used on printed circuit boards, cables and plastic casings. These are the materials that require major investment in the de-manufacturing process. In summary, the cost to operate a safe operating de-manufacturing facility makes responsible electronic recycling much more difficult than the much used alternate: global dumping.

Yielding to the higher reclaim prices offered by the irresponsible global dumpers, many so-called recycling collectors send their materials to irresponsible recyclers, who in turn "sell" the recycling cargo to exporters. A few handshakes later and the e-waste cargo

arrives at the ports of the global village's poorest countries. Since the U.S. prohibits dumping of electronic waste in other countries, most of the e-waste cargo is shipped under the label "Used Equipment," whereas in fact most of the recycled electronic waste is either too old or too out-of-order to have any reuse value.

In order to identify a responsible recycling company, one must first be able to pinpoint the telltale signs that a recycling company engages in global dumping.

Irresponsible recycling companies:

1. Avoid educating the public about the e-waste crisis either on their company Web site or in their company marketing collateral. Irresponsible electronics recyclers make it look very easy so that the consumer won't ask any questions.
2. Omit details about how they track and manage the recycling process to avoid global dumping. Again, the less the consumer knows, the easier it is for an irresponsible electronics recycler to engage in some form of global dumping
3. Host greenwash events with reputable nonprofits that don't understand the proper recycling process. By making the electronics recycling process sound easy and by hiding under the guise of fundraising for schools, chambers of commerce, police association leagues and other nonprofits, these electronics recyclers further disarm the general public about "donating" their unwanted electronics at "fundraising" events.

Electronics recyclers participating at a greenwash fundraiser do not charge any recycling fees, yet generate enough funds to donate to the nonprofit and can still pay the high costs of de-manufacturing toxic elements. This business model doesn't exist because it is simply too good to be true. It's also an abuse of the goodwill of the nonprofits involved.

The truth is, these fundraising "recyclers" collect items that can be reclaimed for cash and then dump the rest on developing countries. They incur minimal handling costs by selling them as "exports." That is how 80% of computer and electronics recycling materials in the U.S. end up as e-waste in developing countries.

4. Fail to provide either a permanent address for their electronics recycling facility or a proper permit to operate as a recycler. Many use a P.O. Box or just a phone number that they publish during neighborhood pick-up campaigns. When you

call, it always goes directly to an answering machine. There is no one available to tell you more about their services.

Now that you know how to identify an irresponsible electronic recycling company, let's review what a responsible electronics recycling company looks like.

1. Look for an electronics recycler who states a corporate commitment to addressing the global e-waste crisis.
2. Use computer and electronics recycling companies that actively educate the public about the e-waste crisis and the socially responsible way to recycle and de-manufacture.
3. Make sure your electronics recycling company can demonstrate its thorough process in evaluating reuse items, items for de-manufacturing and also its monitoring system to keep track of the entire de-manufacturing process.
4. Support electronics recyclers who use only U.S.-based de-manufacturing facilities that have the proper permits, de-manufacturing machines and processes and safety and health monitoring system for their workers.
5. Use computer and electronics recyclers that generate enough revenues from services to be able to allocate the proper budget toward responsible processing of toxic materials.
6. Choose an electronics recycler that is well respected by environmentalists who have been focused on the e-waste crisis. These environmentalists have seen firsthand how dumping occurs and are very knowledgeable about how to identify responsible recyclers.

When you throw out an electronic product like an old computer, monitor, printer, etc, do you ever wonder where it goes? If you don't ensure proper recycling, the product could end up in landfill where it will sit for centuries, possibly seeping pollution in our groundwater, or it could be shipped on a slow boat to China.

According to a CBS report we throw out over 130 computers a day in the U.S. alone. This is part of what we call "e-waste", a term loosely applied to consumer and business electronic equipment that is near or at the end of its useful life.

E-waste has devastated a village in China where laborers (often children) work for pennies a day to capture commodities from old products that we've discarded, such as tiny threads of copper. By doing so, they expose themselves to lead, mercury and

other harmful substances that are inherent in these products. This practice is also happening in Nigeria. The carcasses of the e-waste are left in makeshift graves, where they contaminate the landscape, making groundwater undrinkable. Rivers run black, and pollution spreads. So much harm for what seems like so little return, but as long as there is profitability in our junk, there's temptation to exploit cheap labor.

E-waste Exporters

The export-related practices extend the recycler's responsibility for focus materials by having them get assurances from downstream vendors both domestically and internationally. Demanufacturing is indeed one of these assurances. These assurances will show that the materials are being handled properly and legally by downstream vendors throughout the recycling chain. The practices extend to all recycling processes, including demanufacturing, refurbishment, repair, and recycling of electronic material.

There are many ways to recycle, but only one works—GUARANTEEING DOWNSTREAM WASTE. Demanufacturing guarantees the ultimate destination of downstream waste

Things to Look For in a Demanufacturer:

A Demanufacturer should be able to provide an overview of their procedures for:

- Demanufacturing
- Disposal and waste handling
- Storage
- Experience & Expertise
- Chain of Custody
- Environmental Protection
- Financial Safeguards
- High Levels of Insurance
- Responsible Recycling Practices (R2)
- Properly permitted facilities
- Materials tracking systems for transportation ,processing and reclamation
- Cradle-to-grave accountability materials (ISR Exclusive)

Responsible Recycling Practices (R2)

The Environmental Protection Agency, (EPA) supports and will continue to push for further safe and protective recycling efforts and encourage improvements in best management practices for recyclers. There are existing recycling certification programs, such as R2 and eStewards that EPA believes advance environmentally safe practices and includes standards for use in third party certification of such efforts.

Responsible Recycling (R2) Practices for Use in Accredited Certification Programs

The Responsible Recycling (R2) Practices for Use in Accredited Certification Programs (PDF) (15 pp, 51K, about PDF) is a set of guidelines for accredited certification programs to assess electronics recyclers' environmental, worker health and safety, and security practices. Since January 2006, EPA has facilitated a multi-stakeholder group to develop this document.

The voluntary R2 practices include general principles and specific practices for recyclers demanufacturing or reclaiming used electronics equipment including those electronics that are exported for refurbishment and recycling. The practices are set forth below.

- Develop and use a management system that covers environmental, worker safety and public health practices on-site and downstream management of end-of-life (EOL) equipment and materials;
- Establish a policy that promotes reuse and materials recovery for EOL equipment and materials;
- Comply with environmental, health, and safety legal requirements, both domestically and internationally, that are applicable to the recyclers' operations;
- Use practices to reduce exposures and emissions during recycling operations;
- Export (or arrange for the export of) focus materials only to foreign countries that accept them.
- Focus materials are: cathode ray tubes (CRTs) and CRT glass; circuit boards (unless they have had batteries and mercury-containing items removed and are lead free); batteries; and items containing mercury and/or polychlorinated biphenyls (PCBs), both in EOL equipment and when separated as components;

- Send EOL equipment and all material derived from this equipment, that contain focus materials only to facilities that are properly licensed to receive these materials, and use technology designed to safely and effectively manage these materials - whether in the U.S. or another country;
- Ensure that an electronics recycler does not use energy recovery, incineration, or land disposal as a management strategy for focus materials or equipment and components containing focus materials. However, if circumstances beyond the control of the R2 recycler disrupt its normal management of a focus material, it may consider these technologies to the extent allowed under applicable law;
- Exercise due diligence in ensuring that downstream recyclers and processors manage recycled materials appropriately, throughout the downstream recycling chain;
- Ensure that materials going for reuse are refurbished and tested for functionality, and residual focus materials are managed responsibly;
- Ensure that personal data on EOL electronics going to reuse or recycling are cleared or destroyed; and
- Track throughput and keep records; store and transport material securely and safely; and possess insurance, closure plans, and financial mechanisms to cover the potential risks of the facility.

The R2 practices are not legal requirements and do not replace electronics recyclers' legal obligations. Electronics recyclers that adhere to this set of R2 practices are doing so on a voluntary basis. If a requirement of this document conflicts with an applicable legal requirement, the recycler must adhere to the legal requirement.

ISR is currently in the process of becoming R2 certified.

Next Steps

The R2 working group will now identify certification programs to verify electronics recyclers who adhere to the R2 practices. Ultimately, once electronics recyclers are R2-certified, they will be able to highlight their environmentally sound practices to customers. In addition, customers, including government agencies, states,

manufactures, and the public, will be able to easily identify recyclers that use sound practices.

Upon request, EPA has agreed to help exporters of e-waste obtain documentation from non-OECD foreign governments to as to the legality of import of R2 focus materials that are contained in used electronic equipment or separated as components and sent from the US. Recyclers who would like to request EPA's assistance in getting documentation on the legality of exports from foreign countries can contact Frank McAlister (mcalister.frank@epa.gov) through e-mail or letter: Frank McAlister, USEPA (5304P), 1200 Pennsylvania Avenue, Washington, DC 20460.

This is the official definition/description of demanufacturing from the U.S. Government.

1. A method for optimally demanufacturing an electronic product to recover a largest revenue, said method comprising: providing said electronic product for demanufacturing, said electronic product having a plurality of parts, wherein each of said parts comprises one or more commodities; collecting a resale price for said electronic product; collecting one or more resale prices for one or more of said parts respectively; collecting one or more commodity prices for one or more of said commodities respectively; determining if said electronic product contains hazardous materials, and if so, determining a hazardous materials handling expense; determining a labor expense to remove said each of said parts from said electronic product; entering said resale price for said electronic product, said one or more resale prices for said one or more parts, said one or more commodity prices, said labor expense, and said hazardous materials handling expense, if any, into a computer model; executing said computer model to determine a highest commodity value irrespective of said one or more resale prices for one or more of said parts, or said resale price for said electronic product; executing said computer model to determine a highest removed parts value irrespective of said one or more commodity prices for one or more of said commodities, or said resale price for said electronic product; executing said computer model to make a determinations as to which of said resale price for said electronic product, said highest removed parts value less said labor expense, and said highest commodity value is greater and which of said parts, if any, should be removed from said electronic product so as to recover said largest revenue; and in response to said determination, either offering said electronic product for resale, or removing said parts which were

determined to be removed, if any, and offering said parts for resale, removing said hazardous materials, if any, separating any remaining parts into said commodities, and offering said commodities for resale.