

# Life Cycle of Electronics

**What is E-waste?** Discarded electronics—generally referred to as 'e-waste'—can include any of our electronic waste items such as CDs, DVDs and DVD players, computers, television sets, video games and cell phones. In 2003, the United States had over 3.2 million tons of electronic waste! The e-waste pile is growing around the world and statistics show that it runs into millions of tons annually. More and more countries are drafting legislation for the environmentally-friendly disposal of this waste. Disposal techniques vary widely from country to country because it includes materials which are valuable and recyclable, as well as toxic. While modern technologies allow for nearly hazard-free recycling of e-waste, precautions must be taken to control harmful emissions and toxins that cause detrimental impacts on health and the environment. Electronic circuit boards, batteries, and Cathode Ray Tubes (CRTs) can contain **hazardous materials** such as lead, mercury and chromium. If improperly handled or disposed, these toxins can be released into the environment through landfill **leachate** or **incinerator ash**. Businesses and large generators of electronic waste are already required to comply with federal and state laws concerning the proper disposal of electronics.

**Learning Objectives:** Students will be introduced to the concept of life cycle analysis and will learn about the embodied energy associated with consumption.

**Subjects:** Science, Social Studies, Environmental Education, Family and Consumer Education

**Wisconsin Model Academic Standards:**  
C H.8.2, SC C.8.2, SS D.8.11, SS A.8.11, EE A.8.2, EE A.4.4, EE A.8.2., FCE intermediate A.2, A.3.

**Grades:** 6-8

*Adapted from Scholastic and US EPA's life cycle analysis of electronics activities*

More and more countries are drafting legislation for the environmentally friendly disposal of e-waste. In 2009, Wisconsin passed an electronics law. Now everyone in Wisconsin, including businesses, schools, and households can no longer throw out their e-waste and instead can easily recycle it.

## Materials:

Electronics background information, easels with chart paper or butcher paper, markers

## Preparation:

Create a poster, slide or overhead of the following pdf:

[http://content.scholastic.com/content/collateral\\_resources/pdf/h/hp\\_poster.pdf](http://content.scholastic.com/content/collateral_resources/pdf/h/hp_poster.pdf)

but do not show it to the class until they are finished with their life cycles.



## Procedure:

1. Provide a copy of the electronics recycling background information to each student and have the students read the background information.
2. Break the class into small groups of 3-5 and distribute one piece of chart paper and marker to each group.
3. Tell the students to come up with a life cycle analysis (LCA) of a computer. Give them as much guidance as you feel necessary. You may want to tell them to try to think of all the steps that go into the process of manufacturing to disposal of a computer give them the following information:
  - a. The steps in a life cycle are: materials acquisition, materials processing, manufacturing, packaging, transportation/distribution, useful life and reuse/recycle/disposal. Keep in mind that the more guidance you give them, the more similar their life cycle analysis will be to Scholastic's.
4. Note that the students' and Scholastic's LCA could be very different, depending on the boundaries students use. If you would like the students' LCA to match Scholastic's more closely, you may want to start out with a class discussion of how far back they should go for each step of the process.
5. Once every group is finished, display the posters in front of the room. Have each group stand by their posters, and go around the room having each group answer one or two questions from students in other groups.
6. Show the students the life cycle poster developed by Scholastic.

**Afterward**, lead a class discussion asking all or some of the following questions:

- How was your life cycle analysis (LCA) different from the poster?
- What did you forget to add?
- What did you choose not to add? Why did you make this choice?
- Did you include the energy that it took to make the trucks that transported the computer? Why not? (This is referred to as defining the "scope" of the product.)
- What are some ways to decrease the environmental impact of each step in the life cycle of electronics?



# LIFE CYCLE OF ELECTRONICS

## E-WASTE WHAT?

Student Handout no.1

### WHAT IS E-WASTE?

E-waste is electronic waste (electronic equipment) that is thrown away. It includes many types of electronics from computers and their monitors, to cell phones and stereos. Unfortunately, electronic waste is among the fastest growing waste types in the United States.

### WHY IS E-WASTE A PROBLEM?

As technology quickly develops, people get new equipment and stop using their old equipment. An electronic product may contain more than 1,000 different substances, some of which can be harmful to human and environmental health. If old equipment is not properly recycled, these substances could get into the air, soil and water.

### WHAT ARE MY OPTIONS?

If your old electronics can still be used, consider selling or donating them. Using equipment again extends the life of the product and makes it available to others who can still use it. However, sometimes reuse is not an option. E-Cycle Wisconsin is an electronics recycling program that helps Wisconsin residents recycle their e-waste. This program also ensures that electronics are recycled properly to decrease negative impacts to the environment and human health. Together, we can make a difference in the fight against e-waste!

### WHAT HAZARDOUS MATERIALS ARE IN ELECTRONIC PRODUCTS?

Electronic products such as printed circuits, Cathode Ray Tubes (CRTs) and Liquid Crystal Displays (LCDs) screens often contain a lot of heavy metals and other substances. These substances are known to cause harm to humans and the environment when thrown away and not reused or recycled. Cadmium, lead, mercury and arsenic are some of these substances.

### WHAT RECYCLABLE MATERIALS ARE IN ELECTRONICS PRODUCTS?

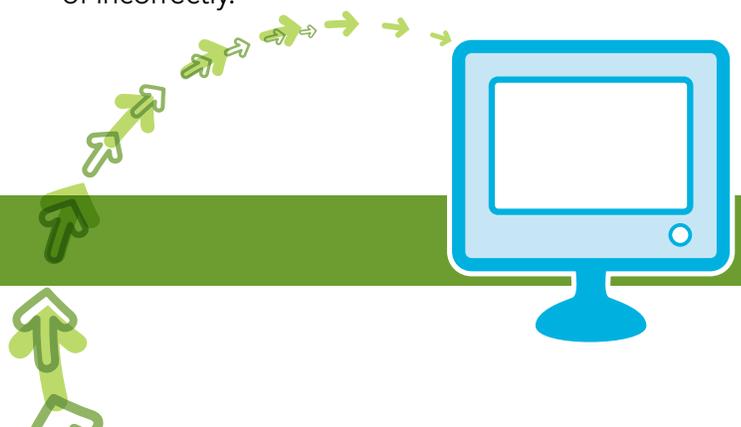
Consumer electronics contain a variety of recyclable materials like metals, glass and plastics. All of these materials can be reused to create new products, which decreases the need to mine the earth for raw resources.

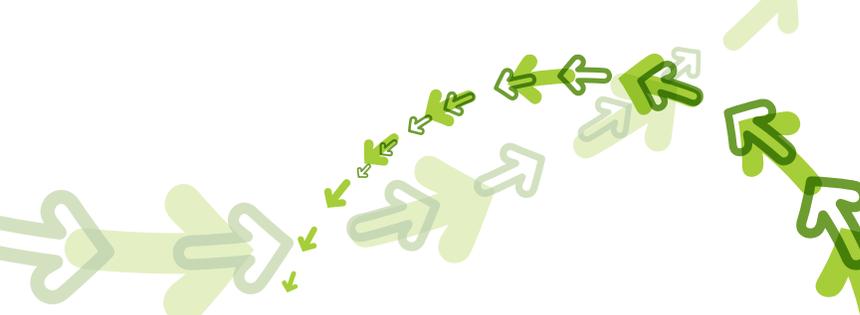
### ARE ELECTRONICS MANUFACTURERS DOING ANYTHING TO MAKE A CHANGE?

Manufacturers are taking action to help with e-waste in a number of ways, from changing product designs to offering reuse and recycling programs. Many manufacturers are working to "design out" hazardous materials and "design in" environmentally-sound materials, including recycled content. They are also always changing product designs in order to make electronics easier to recycle. Finally, many manufacturers offer recycling services free of charge or for a small fee. Manufacturers who sell electronics in Wisconsin must pay a fee to help make recycling electronics easier and less expensive for Wisconsin residents.

### WHERE DOES E-WASTE GO NOW?

In Wisconsin, people are not allowed to throw out most electronic devices. 37 percent of non-working computers are recycled, 25 percent are donated or reused and 23 percent of non-working computers are stored. Wisconsinites only throw out 6 percent of their old computers. We should try to decrease the number of computers and other electronics thrown in the garbage or sent to incinerators. According to a US Environmental Protection Agency (EPA) report from 2002, up to 70 percent of heavy metal (lead, mercury, cadmium, etc.) contamination in US landfills comes from electronic products that are disposed of incorrectly.





### HOW MUCH E-WASTE IS PRODUCED EACH YEAR?

There are over 4 million computers, 7 million TVs and 5 million cell phones in Wisconsin. Many of these will become useless very soon and will be replaced by newer models.

Source: DNR Household Electronics Recycling Survey, 2010

### WHAT ELECTRONIC EQUIPMENT IS RECYCLABLE?

Many components of electronic equipment—including metals, plastic, and glass—can be reused or recycled, while others may present environmental hazards if not managed correctly. Many places in Wisconsin recycle old electronics including computers, printers, cell phones, DVD players and computer accessories.

## WHAT CAN I DO ABOUT IT?

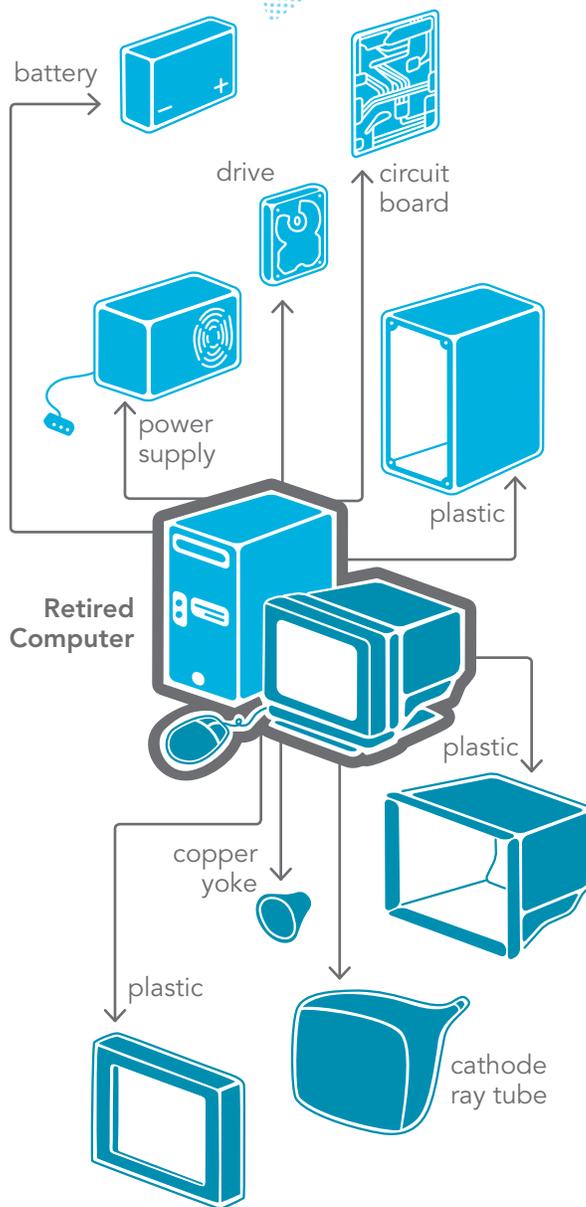
**Reduce:** Maintain and keep equipment as long as possible. A typical computer's life span is 2-3 years, but can be extended by 1-2 years with some upgrading. Buy a good monitor; it can last 6-7 years or more, and keep it for use with your next computer. Consider leasing a computer so you can trade it in for a new one at the expiration of the lease. Be sure to always use a surge protector power strip with all electronic equipment.

**Reuse:** A more recent computer can often be fixed, upgraded and reused instead of being replaced.

**Recycle:** Electronic equipment can be recycled for the recovery of metals, plastics, glass and other materials. You can ship your equipment directly to a recycler, or you may also be able to take advantage of manufacturer trade-ins to get credit towards buying new products. Also, old, rechargeable batteries can be recycled through many stores that sell new ones.

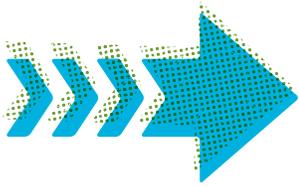
## WHAT'S INSIDE?

A BRIEF LOOK AT THE MATERIALS THAT CAN BE RECOVERED FROM YOUR COMPUTER.



### MARKETABLE MATERIALS THAT CAN BE RECOVERED FROM E-WASTE:

- |                                       |                              |
|---------------------------------------|------------------------------|
| Crushed glass                         | Power supplies               |
| Circuit boards                        | Copper yokes                 |
| Scrap metal                           | Fluorescent tubes            |
| Wire                                  | Batteries                    |
| Hard drives and other types of drives | Ink jet and laser cartridges |
|                                       | Plastic                      |



## LIFE CYCLE OF ELECTRONICS

# E-WASTE IN THE UNITED STATES

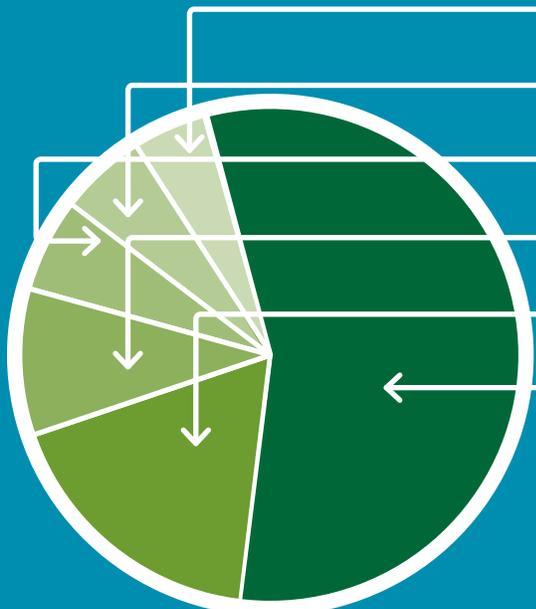
Take Home Worksheet, pg. 1

In the year 2000, over 2 million tons of electronic waste was generated in the US. These items included DVD's, cell phones, computers, and video game cartridges. If only a few castoff computers or gadgets had to be disposed of, it wouldn't be much of a problem. But by 2010, an estimated 250 million computers will become obsolete and 300 million TVs will be chucked out, creating a growing environmental and health problem.

### COMPOSITION OF E-WASTE IN THE USA

Source: Municipal Solid Waste in the United States: 2000 Facts and Figures. US EPA Office of Solid Waste and Emergency Response. June 2002. pages 150-160.

These figures are shown in percentage and in weight.



**4.40%** PC's > 93,474 tons

**5.90%** Monitors > 125,340 tons

**6.10%** Household Electronics > 129,588 tons

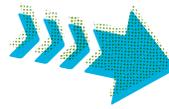
**10.10%** Commercial Electronics > 214,564 tons

**17.90%** Electronics Packaging > 380,268 tons

**55.60%** TV's > 1,181,166 tons

**Total** > 2,124,400 tons, for the year 2000

Name \_\_\_\_\_



**LIFE CYCLE OF ELECTRONICS**  
**E-WASTE IN THE UNITED STATES**  
Take Home Worksheet, pg. 2

**1**

Looking at the graph "Composition of E-waste in the USA," what were the top two categories for electronic waste in the United States for 2000?

**2**

How do you think these percentages will change in the next 15 years as more electronics are sold?

**3**

The total electronic waste weight for the United States was 3,160,000 tons in the year 2008. How many pounds is that?

**4**

The United States population was 308,745,538 in 2010. Using the 2008 tonnage rate listed in question #3, how many pounds of electronic waste is that per person?

**5**

If the amount of e-waste is projected to grow 60% in the US from 2000 to 2010, how many tons and pounds would that be for 2010? (use weight figure in question #3 to calculate 2010 estimate)

**6**

Name two hazardous substances that may be found inside a TV.

**7**

What effect on the environment could these substances have if not disposed of properly?

**8**

Name the electronic items on the pie chart that your family has disposed of in the last year. What are the options for your family's electronic waste disposal in your community?



## Life Cycle of Electronics: Where does it all end up?

**Learning Objectives:** Students will heighten their awareness of the number of electronic items in their homes and explore where these products go when they are done being used.

**Subjects:** Science, Social Studies, Mathematics, Environmental Education, Family and Consumer Education

**Wisconsin Model Academic Standards:** SC A.4.5, B.4.3, C.4.5, C.4.6, C.8.2, C.8.6, SS H.4.2, D.4.7, D.8.11, M A.4.2, E.4.2, E.4.3, EE A.4.1, A.4.2, A.8.2, A.8.5, B.8.20, C.4.2, C.8.2, D.4.2, D.4.3, D.4.4, D.4.5, FCE introductory A.2.

**Grades:** 4-6



### Did you know?

- Nearly 250 million computers will become obsolete between the years 2005 and 2010.
- Many people discard computers every 3 to 5 years.
- In 2001, only 11 percent of personal computers retired in the US were recycled.
- Mobile phones in the US were discarded at a rate of 130 million per year in 2005, resulting in 65,000 tons of waste.
- TVs and computers can contain an average of 4 pounds of lead (depending on their size, make, and vintage) as well as other potential toxins like chromium, cadmium, mercury, beryllium, nickel, zinc, and brominated flame retardants. These materials need to be handled carefully.

Source: US EPA, 2005



**Materials:** "Where Does It All End Up?" take home worksheet

**Procedure:** Have students predict what electronic items they'll find the most of in their homes. Then have students fill out the worksheet at home to discover how many consumer electronic products their family uses. Once students have completed their worksheets, have them bring the worksheet back to class for a group discussion.

### Pre-Activity Questions:

1. What types of electronic products do you use at your house? Make a class list. What electronic items do you think you'll have the most of at home?
2. What do you use these products for? (i.e., watching TV, calling a friend, playing video games)
3. Pick a couple of products listed and talk about what life might have been like before these products were invented. What did people use as an alternative to the product? (i.e., video games and board games)
4. Ask the students where these products go when we are done using them. What are some alternatives to throwing them away (reuse, recycle)? Talk about the different components of some of the products and what might be recyclable in them (plastic, aluminum, glass, steel, other metals).

### Post-Activity Questions:

5. What electronic items did everyone have in their homes?
6. How close were you with your predictions for what electronic items you have the most of at home?
7. Tally up your class's electronic items totals and put them on the chalkboard.
8. For each item, have students calculate the average number of products per person in the class (for example 2.4 TVs per student).
9. Using the per person average you found from your class, try to calculate how many TVs there might be in the municipality (city/town/village) you live in. Take your municipality's population and multiply it by the average number of TVs per person you found. Do the same for cell phones and computers.
10. Find out what recycling options are available in your community for used electronics items. Identify short-term and long-term solutions to the electronic waste problem and discuss the consequences (both positive and negative) of the proposed solutions.

