



**When we choose to recycle electronics,  
we can make a world of difference.**





## Mining

Many of the raw materials used in our electronics come from open-pit mines like this one. Gold, silver, copper and iron (among many other materials) are extracted from open-pit mines found all over the world. Mining cannot avoid environmental impacts because land must be disturbed to extract the minerals. To reach valuable materials, land is logged and then blasted with dynamite or other explosives to loosen massive quantities of earth. Often the material that miners are seeking is buried under tons of dirt and rock. After this "overburden" is removed, excavators scoop up the valuable earth and haul it to a processing facility where the ore or minerals are separated out. In addition to the mine, an adjacent area is set aside for disposal of the overburden and tailings (the non-desirable materials separated from the ore). Electronics also contain materials extracted from underground mines, drilling operations, small panning operations, and dredging and sluicing operations.

## Sale

Warehouses like the one pictured here store electronic devices before they are sold. Some devices are sold through physical stores (pictured) while others are sold through online stores. People will continue to buy new electronics every year to replace devices that are broken or outdated. In fact, the electronics industry depends on devices becoming broken and outdated to continue selling newer devices. This is called "designed obsolescence" or "planned obsolescence." It is by design that many batteries cannot be replaced and that older devices cannot run newer software programs. Frequent innovations create new features that many consumers want. Most people keep computers for only three or four years and TVs for only five to seven years, although these devices may still be in working condition.

## Dumping

A significant portion of the e-waste in the United States is tossed into the garbage can. The trash in garbage cans is taken away by trucks to landfills or incinerators around the country. Once our electronics are dumped, the valuable materials in them are no longer available to us. The gold, silver, copper, palladium, aluminum, plastics and other materials go entirely to waste. In addition, we are potentially exposed to toxic materials like mercury, lead and cadmium when our trash is burned in an incinerator or if a landfill is not properly maintained. Trashing our electronics is a waste of energy, water, labor, materials and space. The increasingly large stream of e-waste has huge implications for global human and environmental health.

## Recycling

Electronics recycling facilities are high-tech businesses that require skilled labor and heavy machinery. E-waste must be carefully disassembled and sorted into components that can be sold on the global market. Electronics contain many materials considered treasures—such as gold, silver and copper—but also many toxic elements, such as mercury, lead and cadmium. When carefully separated, nearly all of these materials can be reused. Recycling electronics saves huge amounts of energy, water and labor by avoiding the mining of new materials and reducing the amount of processing needed to make materials ready for use. Recycling 1 million cell phones, for example, yields 50 pounds of gold, 550 pounds of silver and 20,000 pounds of copper—but no overburden, tailings or toxic by-products. More than 90 percent of the materials in our e-waste can be used to make new products—in many cases, new electronics.

## Poster Key

### Processing/Smelting

Most materials in our electronics do not come out of the ground in the form that manufacturers need. The raw materials must be processed into the metals, plastics and glass that are assembled into electronics. In many cases, turning materials into usable components is a hugely water- and energy-intensive process that produces a variety of pollutants. Aluminum, for example, is made from bauxite ore in a process that uses about 197 million BTUs of energy (the equivalent of burning about 10 tons of coal) per one ton of aluminum produced. Much of the refining and smelting done worldwide happens in large-scale factories. The smelting in this picture, however, is an example of an unregulated "backyard" operation. Refining processes produce waste by-products that can be harmful to humans and the environment if not disposed of properly. After materials are refined into usable commodities, they are sold on a global market.



## Manufacturing

Once all of the components of electronics are created, they must be assembled into devices. Manufacturing is a many-step process that takes place in locations all over the world. In some cases, a finished product may come from one factory. In other cases, different parts of a device have been assembled in different countries. Many of our electronic devices are assembled in Asia, where labor is often cheap and abundant and workers are experts in electronics work. This picture shows a near-final step in the assembly of TVs, but it represents the entire manufacturing process from design to completion.

## Transportation

The ship, train, semi-truck, dump truck and garbage truck on the poster represent the transportation that is required at every step in the life cycle of an electronic device. Materials are transported from mines to refineries, from refineries to factories, from one factory to another, from factories to stores and from stores to people's homes. Transportation uses energy and creates air pollution each step of the way. Once we are through using a device, it is transported to a recycling facility—or to a landfill or an incinerator.

## Use

Electronic devices are part of our daily lives. The Consumer Electronics Association estimates that the average U.S. household has 24 electronic devices. Americans use electronics to do everything from simple chores like brushing teeth to complicated tasks like video chats between people who live thousands of miles apart. While we often use electronics for entertainment, our devices also perform vital tasks that help us save resources, stay healthy and report emergencies. Electronics are likely to continue to play a key role in our lives in the future.

## Disposal

Each year Americans dispose of enough electronic devices, called "e-waste," to fill more than 85,000 semi-trucks (3.4 million tons). This number continues to rise. Each time we dispose of an electronic device, we face a choice—toss it in the trash or take it to a recycling collection site. In Wisconsin, it is illegal to throw most electronics in the trash. Wisconsin's electronics recycling program uses funding from electronics manufacturers to make recycling electronics cheaper and more convenient than it is in many other states.

## Class Activity

Visit [dnr.wi.gov](http://dnr.wi.gov)

Search "e-cycle" and click on the "Information for schools" tab to access What's in our electronics? An activity designed for middle and high school students in social studies, environmental studies or chemistry classes.

## Further Research

1. Because of the international nature of mining, electronics companies often don't know exactly where all the materials in their products come from. This means that unsafe or destructive mining operations overseas may gain an unfair advantage over well-regulated, well-operated mines at the expense of workers or the environment. On the other hand, sometimes manufacturers know exactly where their materials are coming from because only a few locations have access to certain materials and everyone in the world has to use those locations as their source. This can lead to trade disputes and hoarding. Research current events related to metallic mineral mining/extraction. How are electronics manufacturers and the U.S. government responding to unsafe mining practices and/or hoarding?
2. Electronics recycling has rapidly become a high-tech industry in the United States and much of the developed world. Inventors and entrepreneurs have teamed up to create elaborate robotic machinery that can separate out, sort and collect the medley of materials in our electronics without exposing humans or the environment to the toxic materials contained within our electronics. But many of the electronics collected for recycling are not sent to these high-tech industries. Instead, they are sent overseas to places where workers extract valuable materials without any of the health, safety and environmental protections available to people in the developed world. Improper recycling of electronics can contaminate water and soil and cause harm to workers. In an attempt to prevent improper recycling, E-Cycle Wisconsin requires e-recyclers working within the program to report where they send their disassembled electronics. Electronics recyclers can also seek to be certified by R2 or E-Stewards, two programs that set standards for responsible recycling. Research current events related to responsible electronics recycling. Whose responsibility is it to make sure that electronics are safely recycled?
3. Wisconsin's electronics recycling law requires electronics manufacturers to help pay for electronics recycling in the state. This is a form of product stewardship. Wisconsin's electronics recycling law is the first product stewardship law in the state. Define product stewardship and research other products that are recycled through product stewardship systems in other states or countries. What are the pros and cons of product stewardship? Do you think it has a positive or negative environmental impact?

## Discussion Questions

1. Why did the artist include power transmission lines at the top of the poster and a wetland at the bottom of the poster? How are these elements part of the story of electronics?

There is a large energy cost to each of our electronics, not only from the transportation involved in getting them to our houses and disposing of them, but also in the mining, processing, manufacturing, selling and use of the devices. The Electronics Takeback Coalition estimates that it takes 530 pounds of fossil fuels just to make one computer and monitor. The power lines are there to remind us of the power that is used in all of the stages of an electronic device's life and the energy we can save when we recycle old electronics.

The wetland serves two purposes. First, it represents the enormous amount of water required to mine, process and manufacture our electronics (the Electronics Takeback Coalition estimates 1.5 tons of water used to make one computer and monitor). Second, it reminds us that our natural resources are at risk when we do not properly dispose of our old electronics.

2. What is the meaning of the toxin barrels, the treasure chests and the periodic table pieces?

The periodic table pieces remind us that there are many different ingredients used in making electronics. The metals and other materials used to make electronics can be toxins, treasures or both. When we recycle our electronics, most toxic materials, like mercury and cadmium, can be safely collected and reused. When we dump our electronics, all of those toxic materials have the potential to contaminate our land, air and water. The treasures contained in our electronics are separated during the recycling process and shipped back to manufacturing facilities, where they can again become useable products. When we dump or burn our electronics, the treasures within them are lost forever.

3. When you recycle a TV or computer, which parts of this poster are skipped? How does that make "a world of difference?"

The green arrow on the poster shows how recycled materials head right back into the manufacturing step, skipping the labor-, water- and energy-intensive mining and processing steps, reducing transportation, and avoiding the dump. By recycling our electronics, we conserve energy, protect natural resources, and prevent valuable and toxic materials from entering our environment. When we recycle, we make a world of difference in both the natural world and the social world. Much of the mining and processing that takes place overseas is done in countries with few environmental, labor, or worker health and safety laws. High-tech, responsible recycling is mostly done in countries with regulations that protect people, land, air and water.

4. What are some conclusions that can be drawn from this poster?

There are two main messages in this poster. One message is that recycling can make a big difference globally by reducing the need for raw materials, conserving energy and preventing toxic and valuable materials from going to waste. Another message is to show all the work that goes into getting electronics into our hands. Each electronic device is an assembly of thousands of ingredients that have been mined, refined, manufactured and transported using energy, water and human labor.

5. What actions can individuals take to reduce the impacts of their electronics?

We can reduce how often we replace our electronics. There is often marketing pressure to replace electronics, like phones and tablets, even when there is nothing wrong with our "old" versions. Keeping items as long as they are working and performing the functions we need is a very important action we can all take. Purchasing used electronics instead of new ones when practical is a form of reuse that lessens the number of new electronics that need to be made.

Recycling our electronics at the end of their useful lives keeps the materials in them circulating. We can also seek to repair our broken electronics. While many electronics are difficult to repair, websites like [ifixit.com](http://ifixit.com) and small independent repair shops can help to keep electronics working as long as possible.

When purchasing new electronics, you can research devices and companies that have a smaller environmental footprint by consulting EPEAT.net or Greenpeace's Guide to Greener Electronics. You can also look for devices with features, like removable batteries, that will make them easier to repair.



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