



ARIC

appliance recycling
information center

□ refrigerators □ ranges □ ovens □ freezers □ clothes washers □ clothes dryers □ dishwashers □ disposers □ compactors □ room air conditioners □ dehumidifiers □ microwaves □ refrigerators □ ranges □ ovens □ freezers □ clothes washers □

1111 19th St. NW ▲ suite 402 ▲ washington, dc 20036
tel 202 □ 872 □ 5955 ▲ fax 202 □ 872 □ 9354 ▲ e-mail aric@aham.org

INFOBulletin #1

RECYCLING MAJOR HOME APPLIANCES

Introduction

The Average American family owns half a dozen major appliances. Nearly every household has a refrigerator and range. More than 90% own clothes washers and dryers. Many have dishwashers, microwave ovens, freezers or dehumidifiers. US manufacturers ship nearly 65 million major home appliances annually -- more than 249,000 appliances every day¹.

Major Home Appliances

- refrigerator/freezers
- ranges/ovens/cooktops
- clothes washers and dryers
- dishwashers
- microwave ovens
- dehumidifiers
- room air conditioners
- trash compactors

Used Appliances Are A Recycling Resource

Major home appliances, often referred to collectively as "white goods," have long useful lives, typically 10 to 16 years. When they finally reach the end of these lives and are replaced, major appliances take on new value as an important manufacturing raw material -- scrap steel.

Scrap steel can be processed and remelted repeatedly to manufacture new products. New steel made from scrap is equivalent in every way to that made from virgin iron ore. In fact, more than half of all steel produced in the United States today is made using recycled material. The same steel products can be manufactured from iron ore, recycled scrap, or a combination of both, and provide identical performance².

Benefit Of Using Recycled Steel

The US Environmental Protection Agency has identified six major benefits of using scrap instead of virgin materials -- iron ore and coal -- in making new steel:

97% Reduction in mining wastes

¹ Sales data provided by the Association of Home Appliance Manufacturers, Washington, DC 2000.

² *Recycling Scrap Iron and Steel*, Institute of Scrap Recycling Industries, Inc., Washington, DC, 1993.

90%	Savings in virgin materials use
86%	Reduction in air pollution
76%	Reduction in water pollution
74%	Savings in energy
40%	Reduction in water use

Steel is the most abundant recyclable component in appliances, but not the only one. Major home appliance also contain other metals like aluminum, zinc and copper, as well as recyclable plastics and CFC refrigerants.

Appliance Recycling Facts and Figures

- An estimated 41 million appliances in 2000 reached their end of useful life and over 34 million were sent for recycling or disposal. Those that enter the municipal solid waste stream comprise about 1% of total municipal solid waste³.
- Nationwide, 84.1% of major appliances were recycled in 2000³. The percentage is higher still in states with landfill bans or other restrictions on disposing of appliances. The percentage of major appliances declined slightly in 1998 due to a drop in steel prices worldwide. The recycling percentage is calculated at the time the scrap steel is reconverted. Due to the drop in steel prices, many metals scrap processors stockpiled ferrous materials and the recycling percentage began to return to its upward trend again in 2000 as the ferrous material passed through the system.
- Major home appliances make up about 10 percent of the steel processed by the recycling industry (cars make up 80 percent, other industrial and commercial scrap the remaining 10 percent²).

End-of-Life Appliance Management Methods

Used major appliances are managed by landfilling, resale, and recycling. Landfilling is the least common, and the resale market for used appliances is limited in most areas.

Recycling is the most widely used method of end-of-life appliance management, because of the value of the steel and other recyclable components.

Average Steel Content of Major Home Appliances

refrigerators	123 lb
clothes washers	97 lb
clothes dryers	100 lb
dishwashers	50 lb
room air conditioners	45 lb
ranges (gas)	155 lb
ranges (electric)	84 lb
microwave ovens	27 lb

Data based on ARIC tear-down study of new appliances in 1997..

³ Appliance recycling data provided by the Steel Recycling Institute, Pittsburgh, Pennsylvania, April 2001.

The Appliance Recycling Process

Households provide the majority of end-of-life appliances. A smaller number come from appliance retailers and servicers, who typically take back old major appliances when installing new ones. A third source of used appliance are so-called "demand side management" or "early turn-in" programs where electric utilities give their customers incentives to turn in older, less efficient appliances (primarily refrigerators and freezers). Currently, there are over 11,000 locations in the United States where appliances may be delivered for recycling.

The appliance recycling process has four major steps:

- 1) Collection
- 2) Processing
- 3) Shredding
- 4) Sale

Collection: End-of-life major appliances are picked up by municipal waste collection services and special haulers, who often charge a disposal fee of \$15 - \$20 per major appliance. Homeowners and others may also take used appliance directly to a solid waste facility (landfill, material recovery facility, etc.) or scrap processor. In a recent survey, over 97% of retailers remove older appliances when delivering new ones.

Appliances delivered to landfills are rarely disposed of there. Instead they are stockpiled until there is a large enough quantity to sell to a scrap metal processor for recycling. Utilities frequently stockpile obsolete refrigerators and freezers collected through "early turn-in" programs at their own temporary storage locations.

When a large number of old appliances has been collected, they are transported to a scrap metal dealer. Scrap processors sometimes charge individuals to accept a single appliance. However, where large quantities of used appliances are involved, scrap dealers often pay for the scrap metal value (typically \$1.00 - \$1.25 per used appliance⁴).

Processing: Appliance processing involved removing components such as motors and compressors, compressor oil, copper tubing and wiring, and refrigerant chemicals, for separate recycling. Processing practices vary from one recycling facility to another. CFC refrigerants are required by law to be recovered. Some older appliances have switches containing mercury, and a few "ancient" appliances may contain ballasts and small capacitors with PCBs (see ARIC Bulletins #4 and #5). These may be removed during processing, depending on state requirements.

Scrap metal processors and recyclers often perform this appliance processing at their own locations, or hire an outside service to do it. Or the appliance processing service may remove the refrigerants and other components at the utility storage yard, landfill, or other location where used appliances are stockpiled before sale to scrap processors and recyclers.

Following the removal of CFCs and other components, scrap metal processors recycle the appliance to recover the materials by crushing, baling and/or shredding.

Shredding: At a metal shredding facility, vehicles and appliances are fed to a hammermill (also called a shredder or fragmentizer) which turns them into fist-sized pieces of scrap. The pieces are transported by conveyor belts over magnets that separate the iron and steel from other metals and other materials. Typical shredder output is about 80 percent ferrous metal (iron and steel) with smaller proportions of non-

⁴ *Managing Discarded Major Appliances*, Office of Solid Waste Management, University of Illinois at Chicago, July 1993.

ferrous metals (which are often recycled) and non-metallic durable shredder residue ("fluff"), which is mostly plastics.

Materials: Metal shredding facilities sell their product primarily to steel "minimills." Minimills differ from conventional steel mills. Conventional mills have basic oxygen furnaces while minimills use electric arc furnaces to make steel. Minimills use 100 percent scrap metal and require 74 percent less energy to make steel from scrap than from virgin ore⁵.

CFCs and PCBs

Chlorofluorocarbons (CFCs): Household refrigerators and freezers made prior to 1994 used a chemical called CFC-12 (also known as R-12 and Freon, a brand name) in their cooling systems. Auto air conditioners also used CFC-12. Because CFCs are believed to harm the Earth's ozone layer, US Environmental Protection Agency (EPA) regulations require that all CFC's be recovered from refrigeration equipment before it is disposed of or recycled.

Technicians must be certified (starting November 1994) and use EPA-approved equipment approved to recover and reclaim CFC-12 from refrigerators and freezers prior to recycling. Penalties of up to \$25,000 for releasing CFCs to the atmosphere insure that proper procedures are followed⁵.

Recovered CFC-12 is another potentially recyclable material of obsolete refrigerators and freezers. Although the *Clean Air Act Amendments of 1990* ban the manufacture of CFCs after 1994, they can still legally be used to maintain and repair existing refrigerators, freezers, and auto air conditioners. The manufacturing phase-out of CFCs means that reusable CFC-12 is in high demand. Prices for recovered CFCs are already rising, from an average \$1.00 per pound in 1992 to \$25.00 - \$30.00 per pound in 1998⁶.

Polychlorinated biphenyls (PCBs): Major home appliances with motors and compressors often contain small electrical devices called capacitors, which aid motor starting and running efficiency. Prior to 1979, some small capacitors were manufactured using PCBs. According to the EPA, less than 5% of recycled white goods contain PCB capacitors in 1988 and far less today.⁷

The Toxic Substances Control Act of 1968 prohibited the use of PCBs after 1978, and regulates the disposal of large devices containing three pounds or more of PCB. While no federal regulations apply to the disposal of small PCB capacitors and ballasts, some state waste handling statutes require that they be removed from end-of-life appliances.

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⁵ 58 *Federal Register* 28712, May 14, 1993.

⁶ *The Air Conditioning, Heating and Refrigeration News*, May 16, 1994.

⁷ US Environmental Protection Agency, letter from Office of Pesticides and Toxic Substances to state environmental agencies, October 1988.