Recycled Cell Phones—A Treasure Trove of Valuable Metals

Introduction

The U.S. Geological Survey (USGS) collects worldwide data on almost all mineral commodities. Recycling, a significant factor in the supply of many of the metals used in our society, provides environmental benefits, such as energy savings, reduced volumes of waste, and reduced emissions associated with energy savings. In addition, recycling reduces the amount of virgin metals that must be mined to support our lifestyle. This USGS Fact Sheet examines the potential value of recycling the metals found in obsolete cell phones.

Cell phones seem ubiquitous in the United States and commonplace throughout most of the world. There were approximately 1 billion cell phones in use worldwide in 2002 (Fishbein, 2002). In the United States (fig. 1), the number of cell phone subscribers increased from 340,000 in 1985 to 180 million in 2004 (Most, 2003; Charny, 2005).

Worldwide, cell phone sales (fig. 2) have increased from slightly more than 100 million units per year in 1997 to an estimated 779 million units per year in 2005. As shown in figure 2, sales increased from 1997 through 2000 and then leveled off through 2002. In 2003, sales began to increase again. Cell phone sales are projected to exceed 1 billion units per year in 2009, with an estimated 2.6 billion cell phones in use by the end of that year (Gartner Inc., 2005). Sales are driven by new subscribers signing up for services, by subscribers purchasing additional phones, and by subscribers replacing obsolete cell phones.

The U.S. Environmental Protection Agency estimated that, by 2005, as many as 130 million cell phones would be retired annually in the United States (U.S. Environmental Protection Agency, 2005). The nonprofit organization INFORM, Inc., anticipated that, by 2005, a total of 500 million obsolete cell phones would have accumulated in consumers' desk drawers, store rooms, or other storage, awaiting disposal (Most, 2003). Typically, cell phones are used for only 1½ years before being replaced (Fishbein, 2002). These unused (or obsolete) cell phones usually are replaced because they do not have desired features, they are not compatible with a new provider, or they no longer function.

Less than 1 percent of the millions of cell phones retired and discarded annually are recycled (Most, 2003). Of this small percentage recovered, most are refurbished and put into use or used for replacement parts. If these options are not possible, core elements (such as copper) are recycled (Heine, 2002).

When discarded cell phones are not recycled, most eventually end up in municipal solid waste facilities. Although there are cell phone collection and recycling programs, they have had little impact on this waste stream. According to INFORM, Inc. (Most, 2003), the lack of impact results from an inefficient recycling infrastructure, insufficient publicity for the programs, small-scale collection sites, and few or insufficient financial incentives. Figure 3 shows the cell phone life cycle, including the recycling option.

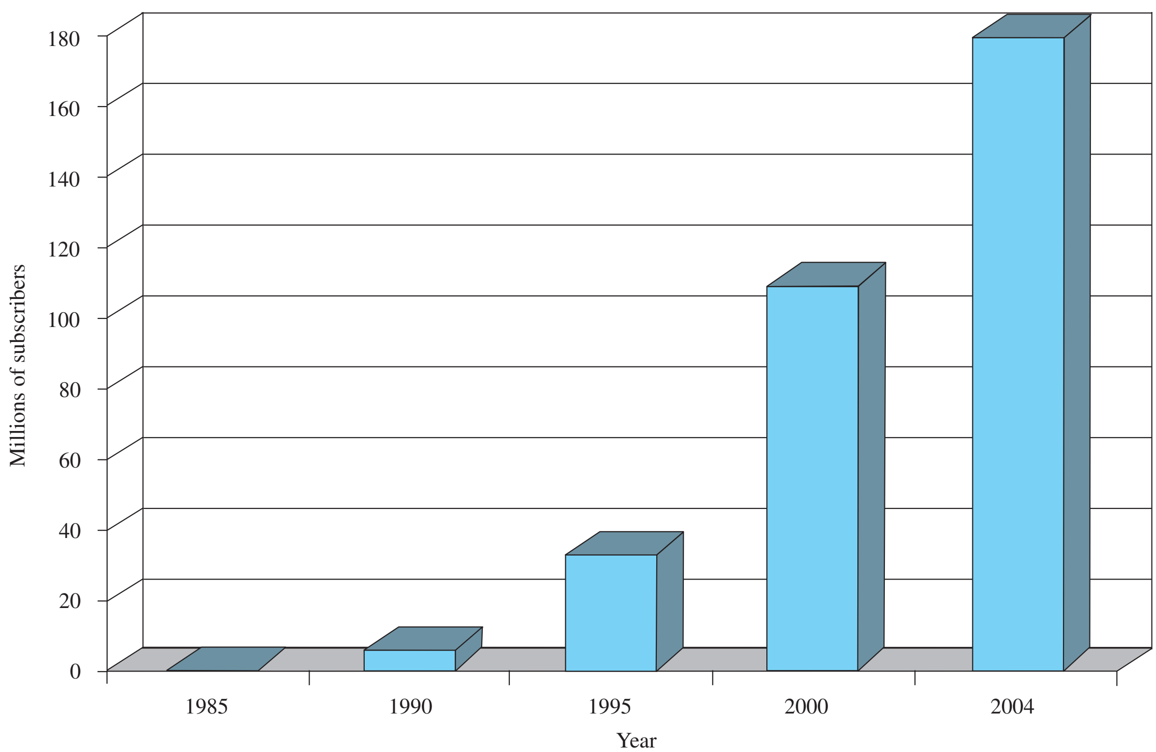

Figure 1. Growth in the number of U.S. cell phone subscribers from 1985 to 2004 (Most, 2003; Charny, 2005).

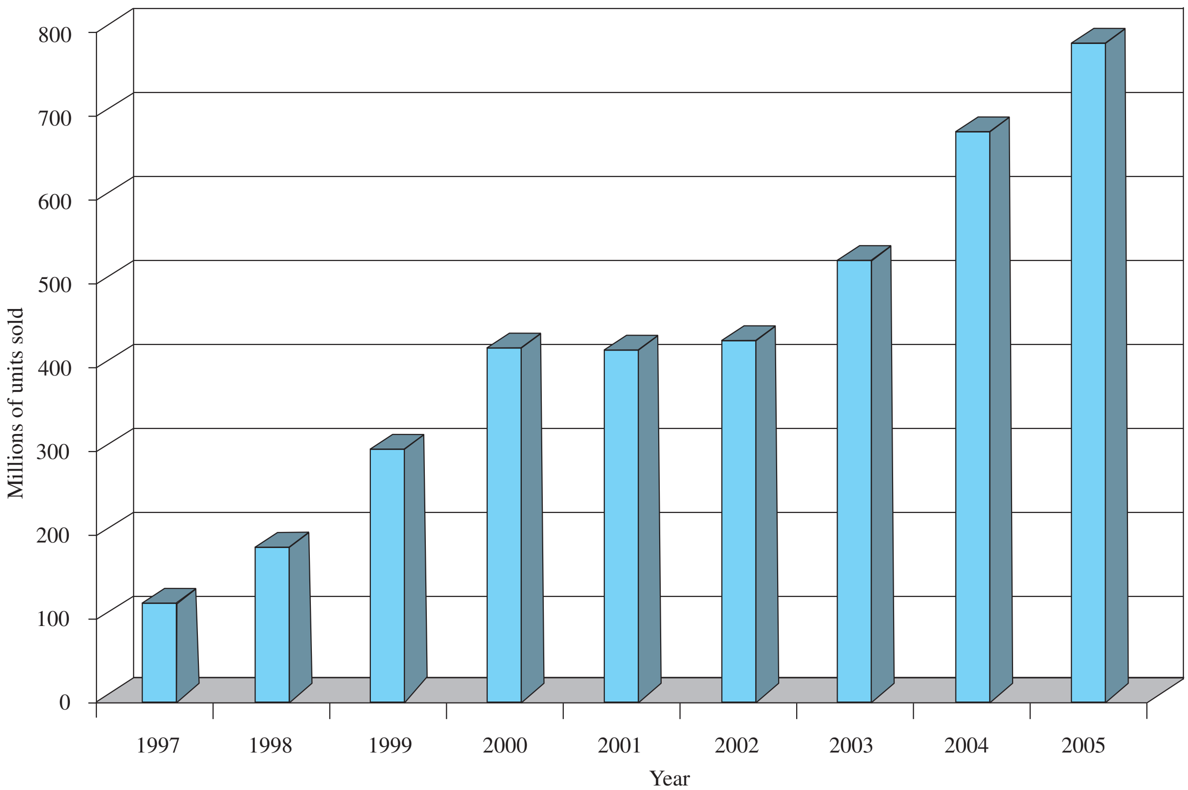

Figure 2. Trends in cell phone sales worldwide from 1997 to 2005 (Gartner Inc., 2005).

Metal Contents in Cell Phones

The Environmental Literacy Council (2004) reported that the weight of a typical cell phone in the early 1990s was 10.5 ounces (298 grams; for comparison, a paperclip weighs about 1 gram) and in 2000 was 7.7 ounces (218 grams). In 2005, a typical cell phone weighed about 4 ounces (113 grams) (Nokia, 2005), exclusive of batteries and battery charger; this weight was used as the basis for the analyses that follow.

Figure 4 (based on data modified from Mobile Takeback Forum, 2005) shows estimated materials content in the average cell phone in 2000 (the data do not include the material in batteries or chargers). Metals included in the estimate are primarily copper, iron, nickel, silver, and zinc, with small amounts of aluminum, gold, lead, manganese, palladium, platinum, and tin.

More recent information from Falconbridge Limited was used to construct table 1. Falconbridge recycles cell phones for their metal content. The company estimated that, in 1 metric ton of obsolete cell phones (exclusive of batteries), the average copper content was 140 kilograms; silver, 3.14 kilograms; gold, 300 grams; palladium, 130 grams; and platinum, 3 grams (Rob Bouma, Falconbridge Ltd., written and oral communs., 2005).

In 2004, there were approximately 180 million cell phone subscribers in the United States (Charny, 2005). If each subscriber used only one phone and if an average active cell phone weighed 113 grams, then the minimum total weight of cell phones in use was about 20,000 metric tons. Table 1 shows that

Table 1. Weight and gross value of selected metals in cell phones in the United States.

[The average weight (wt) of a cell phone is estimated to be 113 grams (g), exclusive of batteries and charger (Nokia, 2005). Metal contents are weights in metric tons (t), unless otherwise noted. Values in U.S. dollars are calculated by using the average of prices for 2002–2004 from USGS Mineral Commodity Summaries 2005 (Amey, 2005; Edelstein, 2005; Hilliard, 2005a,b). The gross values do not include costs of recycling. Data may not add to totals shown because of independent rounding]

	Metal content and value estimated for a typical cell phone		Metal content and value for 180 million cell phones in use in 2004[2]		Metal content and value for 130 million cell phones retired in 2005[2]		Metal content and value for 500 million obsolete cell phones in storage in 2005[2]	
Metal	**Wt[1] (g)**	**Value**	**Wt[3] (t)**	**Value**	**Wt[3] (t)**	**Value**	**Wt[3] (t)**	**Value**
Copper	16	$0.03	2,900	$6.2 million	2,100	$4.6 million	7,900	$17 million
Silver	0.35	$0.06	64.1	$11 million	46	$7.9 million	178	$31 million
Gold	0.034	$0.40	6.2	$72 million	3.9	$52 million	17	$199 million
Palladiun	0.015	$0.13	2.7	$22.7 million	2.0	$16 million	7.4	$63 million
Platinum	0.00034	$0.01	0.06	$1.4 million	0.04	$1 million	0.18	$3.9 million
Total			2,973	$113 million	2,152	$82 million	8,102	$314 million

[1]Metal content (wt) calculated from weight of a typical cell phone (Nokia, 2005) and data from Rob Bouma, Falconbridge Ltd., written and oral communs., 2005.

[2]Number of cell phones in use in 2004 from Charny, 2005. Number of cell phones retired in 2005 from U.S. Environmental Protection Agency, 2005. Number of obsolete cell phones projected to be in storage in 2005 from Most, 2003.

[3]Metal content (wt) calculated from data from Rob Bouma, Falconbridge Ltd., written and oral communs., 2005.

there were about 2,900 metric tons of copper, 64 metric tons of silver, 6 metric tons of gold, almost 3 metric tons of palladium, and 0.06 metric ton of platinum in these phones.

About 130 million cell phones are retired annually in the United States (U.S. Environmental Protection Agency, 2005). Collectively, these cell phones weigh about 14,000 metric tons. Table 1 shows that annually retired cell phones contain almost 2,100 metric tons of copper, 46 metric tons of silver, 3.9 metric tons of gold, 2 metric tons of palladium, and 0.04 metric ton of platinum.

The number of obsolete cell phones stored in drawers and closets by 2005 was forecast to be 500 million (Most, 2003). For these analyses, it was assumed that the average obsolete cell phone also weighs 113 grams. At this weight, 500 million obsolete cell phones would have a collective weight of more than 56,000 metric tons. As shown in table 1, these cell phones would contain approximately 7,900 metric tons of copper, 178 metric tons of silver, 17 metric tons of gold, 7.4 metric tons of palladium, and 0.18 metric ton of platinum.

The Value of Metals in Cell Phones

Cell phones are small, and so the quantity of metals contained in each cell phone is also small. When many phones become obsolete, however, the quantity and value of the metals contained in those phones become significant.

Copper.—If the 2,100 metric tons of copper in cell phones retired annually and the 7,900 metric tons in cell phones in storage were recycled in the United States, then the copper recovered from cell phones would amount to 1 percent and 3.5 percent, respectively, of the 225,000 metric tons of copper recovered from obsolete scrap in the United States in 2004 (Edelstein, 2005). The average price of copper for 3 years, 2002 through 2004, was about $0.98 per pound (about 454 grams) (Edelstein, 2005). At this price, a cell phone contains about 3.5 cents worth of copper. The total value of the copper in cell phones retired annually, without accounting for the recovery costs, is approximately $4.6 million; the value for obsolete cell phones in storage is $17 million.

Silver.—If the 46 metric tons of silver in cell phones retired annually and the 178 metric tons of silver in cell phones in storage were recycled, then the silver recovered from cell phones would amount to almost 3 percent and 10 percent, respectively, of the 1,700 metric tons of silver recovered from scrap from U.S. recycling activity in 2004 (Hilliard, 2005a). The price of silver averaged from 2002 through 2004 was $5.33 per troy ounce (about 31.1 grams) (Hilliard, 2005a). At this price, a cell phone contains about 6 cents worth of silver. The total value of silver in cell phones retired annually, without accounting for the recovery costs, is $7.9 million; the value for obsolete cell phones in storage is $31 million.

Gold.—If the 3.9 metric tons of gold in cell phones retired annually and the 17 metric tons of gold in cell phones in storage were recycled, then the gold recovered from cell phones would amount to 4 percent and 18 percent, respectively, of the 95 metric tons of refined gold recovered from recycled materials in the United States in 2004 (Amey, 2005). The price of gold averaged from 2002 through 2004 was $362 per troy ounce (Amey, 2005). At this price, a cell phone contains slightly more than 40 cents worth of gold. The total value of the gold in cell phones retired annually, without accounting for the recovery costs, is $52 million; the value for obsolete cell phones in storage is $199 million.

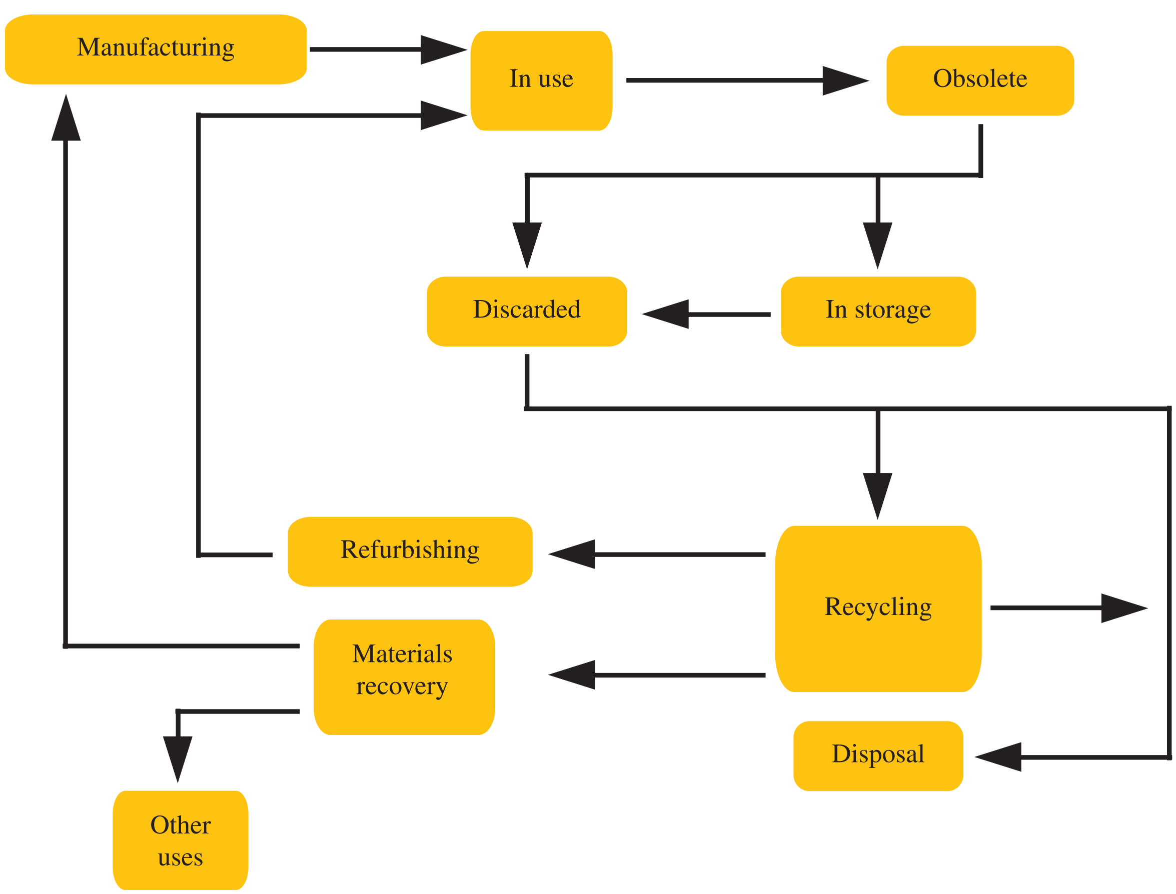

Figure 3. Cell phone life cycle.

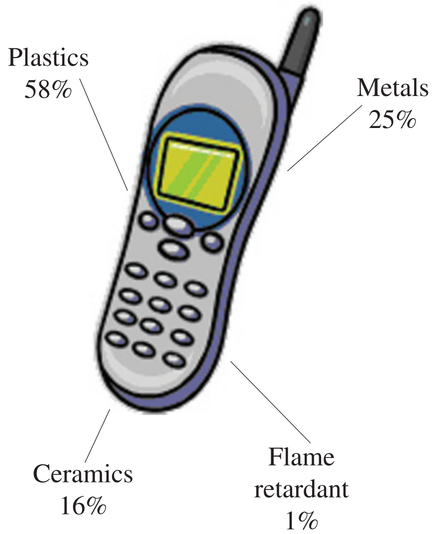

Figure 4. Components (in weight percent) in a typical cell phone in 2000 (data modified from Mobile Takeback Forum, 2005).

Palladium.—The average price of palladium for the period 2002 through 2004 was $265 per troy ounce (Hilliard, 2005b). At this average price, a cell phone contains almost 13 cents worth of palladium. The total value of palladium in cell phones retired annually, without accounting for the recovery costs, is $16 million; the value for obsolete cell phones in storage is $63 million.

Platinum.—The average price of platinum for the period 2002 through 2004 was $696 per troy ounce (Hilliard, 2005b). At this average price, a cell phone contains less than 1 cent worth of platinum. The total value of platinum in cell phones retired annually, without accounting for the recovery costs, is nearly $1 million; the value for obsolete cell phones in storage is $3.9 million.

These values illustrate that, when large numbers of cell phones become obsolete, large quantities of valuable metals end up either in storage or in landfills. The amount of metals potentially recoverable would make a significant addition to total metals recovered from recycling in the United States and would supplement virgin metals derived from mining.

Summary

Recovery and recycling of cell phones are in the early stages of development, as is the case for recycling of electronics in general. For cell phone recycling to grow, recycling must become economically viable. Efficient recovery infrastructure, product designs that simplify dismantling, and other changes are needed to facilitate the growth of cell phone recycling.

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