



2013 Minerals Yearbook

RECYCLING—METALS [ADVANCE RELEASE]

RECYCLING—METALS

By John F. Papp

Survey data and tables were prepared by Charles S. Anderson, E. Lee Bray, Mark Brininstool, Michael D. Fenton, George M. Bedinger, David E. Guberman, Peter H. Kuck, Paula R. Neely, and Amy C. Tolcin.

In 2013, the United States recycled 65.1 million metric tons (Mt) of selected metals, an amount equivalent to 55% of the apparent supply of those metals (table 1). More than 91% of recycled metal was steel, and more than 90% of apparent supply was steel. By gross weight, the United States exported 23.5 Mt of scrap metal and imported 5.6 Mt of these same metals (table 2).

Metals are important, reusable resources. Although the ultimate supply of metal is fixed by nature, human ingenuity determines the quantity available for use by developing economical processes to recover metal from the Earth and recycle metal from the use/process stream. The reusable nature of metals contributes to the sustainability of their use. Recycling, a significant factor in the supply of many of the metals used by society, provides environmental and economic benefits such as energy savings and reduced volumes of waste.

The term “primary” is used to indicate materials from ore deposits, and the term “secondary” indicates materials from scrap, including used products and residuals from manufacturing. Recycling practices vary substantially among the metal industries. Generally, scrap is categorized as “new” or “old.” “New” indicates preconsumer sources, and “old,” postconsumer sources. The many stages of industrial processing that precede formation of an end product are the sources of new scrap. For example, when metal is converted into shapes—bars, plates, rods, or sheets—new scrap is generated in the form of cuttings, trimmings, and off-specification forms. When these shapes are converted to parts, additional new scrap may be generated in the form of cuttings, stampings, turnings, and off-specification parts. Similarly, when parts are assembled into products, new scrap may be generated. A wide variety of descriptive terms, many duplicative, including external scrap, home scrap, internal scrap, mill scrap, prompt scrap, and purchased scrap, have evolved to describe scrap generated by diverse industry practices.

Once a product completes its useful life, it becomes a postconsumer material, often called junk, which is recycled into scrap and reuse material streams. For example, a junked motor might be refurbished for reuse. If it cannot be refurbished, it could be deconstructed to recover its metal constituents, primarily copper and steel. Used appliances, automobiles, and beverage cans are examples of sources of old consumer scrap; used jet engine turbine blades and vanes, junked machinery

and ships, and metal recovered from commercial buildings or industrial plants are examples of old industrial scrap. The material flow of recycled metal commodities in the United States has been documented in a series of reports published by the U.S. Geological Survey (Sibley, 2006–11).

The global recycling industry as it relates to the United States was described by Minter (2013, p. 6–7, 224) who noted that in 2012, recycling 75.19 Mt of iron (contained in iron and steel scrap) would have required 94 Mt of iron ore and 52 Mt of coal. In 2012, about 60% of U.S. steel production came from iron and steel scrap, and 5.45 Mt of recycled aluminum saved more than 76 million megawatt hours of electricity (recycled aluminum used about 8% as much energy as aluminum produced from ore). Minter (2013) identified four important economic scrap recycling factors: availability, shipping cost, labor cost, and a consumer market, which means that metal scrap is shipped from where it is available to where it is processed to where it is consumed. Ideally, those places would coincide; however, they frequently do not. In recent years, metals-intensive infrastructure growth in China and large quantities of obsolete automobile scrap in the United States contributed two factors: a consumer market and scrap availability, respectively. The introduction of the automobile shredder in the United States permitted the generation of steel scrap from an abundance of junked cars while manufacturing in China set the stage for importation of metal scrap from the United States using the otherwise empty shipping containers China used to ship goods to the United States. Ingenuity, opportunity, and economic improvement motivated Chinese scrap processing and reuse industries.

Individual annual reviews for each of the metals listed in the tables are included in the respective chapters in this volume of the U.S. Geological Survey Minerals Yearbook, volume I, Metals and Minerals.

References Cited

- Minter, Adam, 2013, *Junkyard planet—Travels in the billion-dollar trash trade*: New York, NY, Bloomsbury Press, 284 p.
- Sibley, S.F., ed., 2006–11, *Flow studies for recycling metal commodities in the United States*: U.S. Geological Survey Circular 1196–A–Z–AA, the 27 chapters are separately paged and are available at <http://pubs.usgs.gov/circ/circ1196/>. (Accessed May 29, 2012, via <http://minerals.usgs.gov/minerals/pubs/commodity/recycle/>.)

TABLE 1
SALIENT U.S. RECYCLING STATISTICS FOR SELECTED METALS¹

Year	Quantity of metal (metric tons)				Percentage recycled ⁶	Value of metal (thousands)			
	Recycled from new scrap ²	Recycled from old scrap ³	Recycled ⁴	Apparent supply ⁵		Recycled from new scrap ²	Recycled from old scrap ³	Recycled ⁴	Apparent supply ⁷
Aluminum: ⁸									
2009	1,570,000	1,260,000	2,820,000	4,890,000	58	\$2,740,000	\$2,200,000	\$4,940,000	\$8,550,000
2010	1,540,000	1,250,000	2,790,000	5,000,000	56	3,550,000	2,880,000	6,430,000	11,500,000
2011	1,640,000	1,470,000	3,120,000	5,210,000	60	4,200,000	3,770,000	7,980,000	13,300,000
2012	1,830,000	1,440,000	3,270,000	5,780,000	57	4,080,000	3,210,000	7,290,000	12,900,000
2013	1,850,000	1,630,000	3,480,000	6,380,000	55	3,840,000	3,390,000	7,230,000	13,200,000
Chromium: ⁹									
2009	NA	NA	141,000	160,000	88	NA	NA	218,000	234,000
2010	NA	NA	144,000	384,000	37	NA	NA	329,000	800,000
2011	NA	NA	147,000	471,000 ^r	33	NA	NA	334,000	825,000
2012	NA	NA	146,000	470,000	31	NA	NA	290,000 ^r	999,000
2013	NA	NA	150,000	400,000	37	NA	NA	231,000	257,000
Copper: ¹⁰									
2009	639,000	138,000	777,000	2,220,000	35	3,400,000	734,000	4,130,000	11,800,000
2010	642,000	143,000	785,000	2,400,000	33	4,930,000	1,100,000	6,030,000	18,400,000
2011	649,000	153,000	802,000	2,380,000	34	5,810,000	1,370,000	7,180,000	21,300,000
2012	642,000 ^r	164,000 ^r	806,000 ^r	2,410,000 ^r	33	5,200,000 ^r	1,330,000 ^r	6,530,000 ^r	19,500,000 ^r
2013	630,000	166,000	796,000	2,410,000	33	4,720,000	1,250,000	5,970,000	18,100,000
Iron and steel: ¹¹									
2009	NA	NA	53,500,000	69,300,000	77	NA	NA	10,900,000	12,600,000
2010	NA	NA	59,700,000	90,200,000	66	NA	NA	19,500,000	27,100,000
2011	NA	NA	62,800,000	99,300,000	63	NA	NA	25,400,000	37,000,000
2012	NA	NA	63,100,000	106,000,000	59	NA	NA	22,800,000	35,400,000
2013	NA	NA	59,000,000	106,000,000	56	NA	NA	20,100,000	33,200,000
Lead: ¹²									
2009	21,600	1,090,000	1,110,000	1,380,000	80	41,400	2,090,000	2,130,000	2,640,000
2010	24,100	1,120,000	1,140,000	1,380,000	81	57,900	2,680,000	2,740,000	3,310,000
2011	21,600	1,110,000	1,130,000	1,520,000	73	58,000	2,980,000	3,040,000	4,080,000
2012	19,200	1,090,000	1,110,000	1,490,000	74	47,100	2,680,000	2,720,000	3,670,000
2013	20,700	1,130,000	1,150,000	1,600,000	72	51,000	2,780,000	2,830,000	3,930,000
Magnesium: ¹³									
2009	47,100	20,500	67,600	118,000	57	269,000	117,000	386,000	672,000
2010	51,500	20,500	72,000	137,000	53	291,000	116,000	407,000	741,000
2011	43,100	24,100	67,200	133,000	50	228,000	127,000	355,000	702,000
2012	52,000	25,200	77,100 ^r	134,000 ^r	57 ^r	223,000 ^r	108,000	332,000	577,000 ^r
2013	54,000	25,100	79,100	136,000	58	229,000	107,000	336,000	578,000
Nickel: ¹⁴									
2009	NA	NA	79,800 ^r	174,000 ^r	46	NA	NA	1,170,000	2,540,000 ^r
2010	NA	NA	81,900 ^r	196,000 ^r	42 ^r	NA	NA	1,790,000	4,270,000 ^r
2011	NA	NA	88,800 ^r	213,000	42 ^r	NA	NA	2,030,000 ^r	4,880,000
2012	NA	NA	92,400 ^r	218,000 ^r	42	NA	NA	1,620,000 ^r	3,820,000 ^r
2013	NA	NA	88,800	199,000	45	NA	NA	1,330,000	2,990,000
Tin: ¹⁵									
2009	2,310	11,100	13,400	44,700	30	42,500	204,000	247,000	825,000
2010	2,680	11,100	13,800	44,100	31	73,400	303,000	376,000	1,200,000
2011	2,530	11,000	13,600	42,800	32	87,900	383,000	470,000	1,490,000
2012	2,380 ^r	11,200	13,500 ^r	43,100 ^r	31 ^r	67,300 ^r	316,000	383,000 ^r	1,220,000 ^r
2013	2,380	11,100	13,500	39,800	34	71,100	330,000	401,000	1,190,000
Titanium: ¹⁶									
2009	24,700 ^e	1,000 ^e	25,700 ^e	W	W	NA	NA	101,000	NA
2010	28,200	1,000 ^e	29,200	W	46	NA	NA	212,000	NA
2011	30,900	1,000 ^e	31,900	W	39	NA	NA	270,000	NA
2012	38,700	1,000	39,700	W	52	NA	NA	278,000	NA
2013	36,900	1,000	37,900	W	60	NA	NA	207,000	NA

See footnotes at end of table.

TABLE 1—Continued
SALIENT U.S. RECYCLING STATISTICS FOR SELECTED METALS¹

Year	Quantity of metal (metric tons)				Percentage recycled ⁶	Value of metal (thousands)			
	Recycled from new scrap ²	Recycled from old scrap ³	Recycled ⁴	Apparent supply ⁵		Recycled from new scrap ²	Recycled from old scrap ³	Recycled ⁴	Apparent supply ⁷
Zinc: ¹⁷									
2009	194,000	78,900	273,000	1,050,000 [†]	26	334,000	135,000	469,000	1,800,000 [†]
2010	208,000	123,000	332,000	1,120,000	30	468,000	277,000	746,000	2,510,000 [†]
2011	213,000	123,000	336,000	1,140,000 [†]	29	500,000	288,000	788,000	2,680,000 [†]
2012	205,000	129,000	335,000 [†]	1,090,000 [†]	31	433,000 [†]	273,000	706,000 [†]	2,300,000 [†]
2013	153,000	113,000	267,000	1,070,000	25	323,000	238,000	562,000	2,260,000

[†]Estimated. [†]Revised. NA Not available. W Withheld to avoid disclosing company proprietary data.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²Scrap that results from the manufacturing process, including metal and alloy production. New scrap of aluminum, copper, lead, tin, and zinc excludes home scrap, which is scrap generated and recycled in the metal producing plant.

³Scrap that results from consumer products.

⁴Metal recovered from new plus old scrap.

⁵Apparent supply is production plus net imports plus stock changes. Production is primary production plus recycled metal. Net imports are imports minus exports. Apparent supply is calculated on a contained-weight basis.

⁶Also referred to as recycling rate.

⁷Same as apparent supply defined in footnote 5 above but calculated based on a monetary value.

⁸Quantity of metal is the calculated metallic recovery from purchased new and old aluminum-base scrap, estimated for full industry coverage. Monetary value is estimated based on average U.S. market price for primary aluminum metal ingot. Series revised by removing imported scrap to avoid double counting.

⁹Quantity of chromium metal recycled was estimated as chromium content of stainless steel scrap receipts (reported by the iron and steel and pig iron industries). For the calculation of apparent supply, trade includes reported or estimated chromium content of chromite ore, ferrochromium, chromium metal and scrap, a variety of chromium-containing chemicals, and stainless steel mill products and scrap. Stocks include estimated chromium content of reported and estimated producer, consumer, and Government stocks. Recycled monetary value estimated as recycled quantity times the average import value of high-carbon ferrochromium. Apparent supply monetary value estimated like apparent supply quantity with monetary value substituted for chromium content.

¹⁰Includes copper recovered from unalloyed and alloyed copper-base scrap, as refined copper or in alloy forms, as well as copper recovered from aluminum-, nickel-, and zinc-base scrap. Monetary value based on annual average refined copper prices.

¹¹Recycled scrap reported from consuming manufacturers. Apparent supply measured as shipments of iron and steel products plus castings corrected for imported semifinished products. Recycled unit value is the U.S. annual average composite price for No. 1 heavy-melting steel calculated from prices published in American Metal Market. Unit value for the year used to calculate values of recycled scrap and apparent supply of scrap.

¹²Monetary value of scrap and apparent supply estimated based upon average quoted price of common lead.

¹³Includes magnesium content of aluminum-base scrap. Monetary value based on the annual average Platts Metals Week U.S. spot western magnesium price.

¹⁴Nickel statistics were derived from the following:

Production, consumption, receipts

- Reported nickel content of products made from reclaimed stainless steel dust, spent nickel-cadmium batteries, plating solutions, and other products.
- Estimated nickel content of reported net receipts of alloy and stainless steel scrap.
- Reported nickel content of recovered copper-base scrap.
- Reported nickel content of obsolete and prompt purchased nickel-base scrap.
- Estimated nickel content of various types of reported obsolete and prompt aluminum scrap.

Trade data

- Reported nickel content of International Nickel Study Group (INSG) class I primary products, including briquets, cathode, flake, pellets, and powder.
- Reported or estimated nickel content of INSG class II primary products, including ferronickel, metallurgical-grade nickel oxide, and a variety of nickel-containing chemicals.
- Estimated nickel content of secondary products, including nickel waste and scrap and stainless steel scrap.

Stock data

- Reported or estimated nickel content of all scrap stocks, except copper.
- Reported nickel content of primary products held by world producers in U.S. warehouses.
- Reported nickel content of primary products held by U.S. consumers.
- Reported nickel content of U.S. Government stocks.

Monetary value based on annual average cash price for cathode, as reported by the London Metal Exchange.

¹⁵Monetary value based on Platts Metals Week composite price for tin. Apparent supply excludes withheld stock changes.

¹⁶Percentage recycled based on titanium scrap consumed divided by primary sponge and scrap consumption.

¹⁷Monetary value based on annual average Platts Metals Week metal price for North American Special High-Grade Zinc.

TABLE 2
SALIENT U.S. RECYCLING TRADE STATISTICS FOR SELECTED METALS¹

Year	Exports			Imports for consumption		
	Quantity		Value (thousands)	Quantity		Value ² (thousands)
	Gross weight (metric tons)	Contained weight (metric tons)		Gross weight (metric tons)	Contained weight (metric tons)	
Aluminum:						
2009	1,660,000	NA	\$2,120,000	433,000	NA	\$503,000
2010	1,910,000	NA	3,190,000	504,000	NA	763,000
2011	2,140,000	NA	4,050,000	579,000	NA	1,020,000
2012	2,040,000	NA	3,490,000	589,000	NA	905,000
2013	1,870,000	NA	3,290,000	565,000	NA	847,000
Chromium:³						
2009	1,130,000	192,000	778,000	124,000	21,200	138,000
2010	937,000	159,000	937,000	196,000	33,700	307,000
2011	656,000	111,000	959,000	170,000	29,400	297,000
2012	624,000	106,000	804,000	156,000	26,800	238,000
2013	644,000	110,000	743,000	226,000	38,600	211,000
Copper:⁴						
2009	843,000	633,000	2,010,000	71,800	56,300	234,000
2010	1,030,000	788,000	3,550,000	95,800	75,000	399,000
2011	1,240,000	981,000	4,980,000	110,000	87,600	547,000
2012	1,200,000	945,000	4,400,000	105,000	83,800	533,000
2013	1,160,000	909,000	4,080,000	106,000	84,700	525,000
Iron and steel:						
2009	22,400,000	22,400,000	7,120,000	2,990,000	2,990,000	814,000
2010	20,500,000	20,500,000	8,380,000	3,780,000	3,780,000	1,420,000
2011	24,300,000	24,300,000	11,400,000	4,010,000	4,010,000	1,650,000
2012	21,400,000	21,400,000	9,430,000	3,720,000	3,720,000	1,590,000
2013	18,500,000	18,500,000	7,570,000	3,930,000	3,930,000	1,470,000
Lead:⁵						
2009	140,000	140,000	72,000	11,200	7,160	8,520
2010	43,500	43,500	33,800	20,100	13,300	21,700
2011	31,100	31,100	36,800	25,400	16,100	23,700
2012	25,900	25,900	30,600	19,900	13,100	18,300
2013	34,900	34,900	45,400	9,450	6,160	8,490
Magnesium:						
2009	2,280	2,280	5,200	20,900	20,900	40,300
2010	481	481	802	22,100	22,100	56,500
2011	1,680	1,680	3,960	22,000	22,000	48,700
2012	2,100	2,100	5,290	20,900	20,900	47,800
2013	471	471	1,420	17,500	17,500	43,300
Nickel:⁶						
2009	2,420,000	95,100	1,710,000	699,000	20,000	442,000
2010	1,870,000	84,000	1,870,000	954,000	26,700	711,000
2011	1,630,000	68,600	1,670,000	983,000	24,500	794,000
2012	1,370,000	62,600	1,460,000	631,000	24,100	759,000
2013	1,190,000	63,300	1,240,000	664,000	28,000	561,000
Tin:⁷						
2009	9,430	NA	25,600	80,600	NA	16,200
2010	10,700	NA	26,500	57,300	NA	18,300
2011	14,800	NA	31,300	57,700	NA	23,400
2012	10,300	NA	27,200	72,500	NA	24,800
2013	5,020	NA	17,300	63,700	NA	23,100
Titanium:⁸						
2009	4,200	NA	14,000	4,770	NA	17,600
2010	3,480	NA	19,200	10,700	NA	75,500
2011	5,150	NA	33,300	13,900	NA	116,000
2012	8,760	NA	45,300	14,400	NA	98,500
2013	4,700	NA	21,800	12,700	NA	63,500

See footnotes at end of table.

TABLE 2—Continued
 SALIENT U.S. RECYCLING TRADE STATISTICS FOR SELECTED METALS¹

Year	Exports			Imports for consumption		
	Quantity		Value (thousands)	Quantity		Value ² (thousands)
	Gross weight (metric tons)	Contained weight (metric tons)		Gross weight (metric tons)	Contained weight (metric tons)	
Zinc: ⁹						
2009	47,100	NA	54,300	9,100	NA	8,800
2010	77,900	NA	85,300 ^r	15,600	NA	19,400
2011	85,200 ^r	NA	93,400 ^r	18,500	NA	23,400
2012	90,400 ^r	NA	107,000	20,000	NA	24,600
2013	88,000	NA	105,000	21,000	NA	25,300

^rRevised. NA Not available.

¹Contained weight equal to gross weight, unless otherwise specified.

²Imports value is customs value.

³Includes stainless steel scrap and chromium metal waste and scrap. Contained weight for import and export quantities of Harmonized Tariff Schedule of the United States (HTS) code 7204.21.0000 is 17% of gross weight; 8112.22.0000 is 100% of gross weight.

⁴For HTS codes 7404.00.0045, 7404.00.0062, and 7404.00.0080 contained weight for import quantity is 65% of gross weight. For HTS codes 7404.00.3045, 7404.00.3055, 7404.00.3065, 7404.00.3090, 7404.00.6045, 7404.00.6055, 7404.00.6065, and 7404.00.6090 contained weight for import quantity is 72%.

⁵Includes lead content of waste and scrap obtained from lead-acid batteries HTS codes 7802.00.0030 and 7802.00.0060.

⁶Contained weight for import and export quantities is 0.4% of gross quantity for HTS code 7204.29.0000, 50% for HTS code 7503.00.0000, and 7.5% for HTS code 7204.21.0000.

⁷Includes tin waste and scrap HTS code 8002.00.0000.

⁸Includes titanium waste and scrap HTS code 8108.30.0000.

⁹Includes zinc waste and scrap HTS code 7902.00.00.