



**American
Iron and Steel
Institute**



**American Iron and Steel Institute
and Steel Manufacturers Association**

TECHNICAL REPORT

**Determination of Steel Recycling
Rates in the United States**

July 27, 2021

INTRODUCTION

Steel is widely recognized as the most recycled material on the planet. Recycling of steel has long benefited the industry by saving on raw material costs, reducing the environmental footprint of steel production, and providing feedstocks of benefit to the metallurgical needs of steel producers.

The concept of the Circular Economy has also gained prominence in recent years, bringing attention to many aspects of material end-of-life (EOL) including prolonging product lifespans, improving material efficiency, reuse, remanufacturing and product recycling.

Accordingly, the American Iron and Steel Institute (AISI) and the Steel Manufacturers Association (SMA) retained Franklin Associates, A Division of ERG (Eastern Research Group) to conduct research to better understand: 1) the robustness of the current approach to calculating steel recycling rates, and 2) whether there are ways to improve upon how these rates might be calculated and expanded to represent various market sectors such as construction and automotive. The research project was completed in November 2020, with follow-up research completed in May 2021. This report will summarize the results from both phases of the research.

STEEL SCRAP DEFINITIONS

Home scrap – Scrap generated within a steel production facility and captured prior to exiting the facility. In this report, home scrap quantities are excluded from recycling rate calculations. (Note: Scrap generated by a downstream process in the same facility may be classified as “new scrap.”)

New scrap – Scrap generated by manufacturers of steel-containing products and removed from the system prior to end use. (Note: New scrap may also be called “prompt scrap” or “manufacturing scrap.”)

Old scrap – Scrap that entered service as a consumer product and is captured for recycling at end of life (EOL). (Note: Old scrap may also be called “obsolete scrap” or “EOL scrap.”)

LITERATURE REVIEW

The original phase of the project included a review of relevant research and technical articles on recycling of steel and other metals. Most of the studies compared the amount of material recycled to the total amount of steel available for recycling, with the

recycling rate then being calculated by dividing the amount of material recycled by the total amount of steel. (Imports, exports and stock changes of scrap are also considered.) It is the denominator that differs across various published methods for calculating recycling rates. In some cases, the consumed scrap is reported as a percentage of the total amount of new steel entering the market (production), while in others, it is reported as a percent of the total amount of steel scrap generated (new scrap + old scrap). The two basic calculation approaches are therefore: 1) **$[(\text{scrap consumed})/(\text{steel produced})]$** and 2) **$[(\text{scrap consumed})/(\text{scrap generated})]$** .

STEEL RECYCLING INSTITUTE METHODOLOGY VS. CURRENT METHODOLOGY

The Steel Recycling Institute (SRI) was formed in 1988 with the goal of increasing the U.S. recycling rate for steel cans. In order to measure progress toward that goal, SRI began reporting annual recycling rates for steel cans, using the first of the two methodologies described above. The use of a basic **$[(\text{scrap consumed})/(\text{steel produced})]$** approach made sense for this purpose, since the lifespan of a steel can is very short. This short lifespan means that the two possible denominators (steel produced vs. scrap generated) would be nearly equivalent in a given year. However, SRI eventually began reporting annual overall steel recycling rates as well as recycling rates for specific sectors in addition to cans, such as appliances, construction and automotive. The same basic methodology was used to calculate these rates, but since the lifespans of these products were often much longer, the use of the **$[(\text{scrap consumed})/(\text{steel produced})]$** approach resulted in recycling rates of over 100 percent in some cases (e.g., 2008-2009). The research by Franklin Associates concluded that the use of the alternate methodology, i.e., **$[(\text{scrap consumed})/(\text{scrap generated})]$** , is more appropriate for calculation of steel recycling rates, especially when applied to longer lifespan steel products.

Therefore, for the purposes of this report, the basic calculations for overall and sector rates (which also consider imports, exports and net trades of scrap) can be described as follows:

$$\text{new scrap recycling rate} = \frac{(\text{new scrap consumed} \pm \text{net trades of new scrap})}{(\text{new scrap generated})}$$

$$\text{old scrap recycling rate} = \frac{(\text{old scrap consumed} \pm \text{net trades of old scrap})}{(\text{old scrap generated})}$$

$$\text{total recycling rate} = \frac{(\text{new} + \text{old scrap consumed} \pm \text{net trades})}{(\text{new} + \text{old scrap generated})}$$

DATA REQUIREMENTS AND SOURCES

Implementation of the recommended recycling rate calculations requires a considerable amount of data, not all of which is readily available when attempting to develop recycling indicators for specific product categories. This section provides information on data availability and sources.

At a high level, the data requirements for recycling rate calculations are relatively straightforward. Information is required on:

- Steel production and shipments
- Scrap generation and consumption, and steel entering EOL
- Trade of steel products

Data on the domestic production and shipment of semi-finished and intermediate steel products is available primarily from AISI. Additionally, data on the end-use sectors that consume steel mill products are reported by AISI and the United States Geological Survey (USGS).

Steel scrap data is available from several entities. AISI reports scrap consumption data noting that the data is derived from information collected by the USGS. Scrap consumption refers to scrap recycled in domestic steel furnaces and includes scrap of both U.S. and international origin (i.e., imported scrap). The USGS issues several publications that report scrap generation and consumption data, including the “Mineral Commodity Summaries” and the “Minerals Yearbook.” USGS scrap production values include all scrap generated in the U.S. as well as scrap that is ultimately exported to international markets.

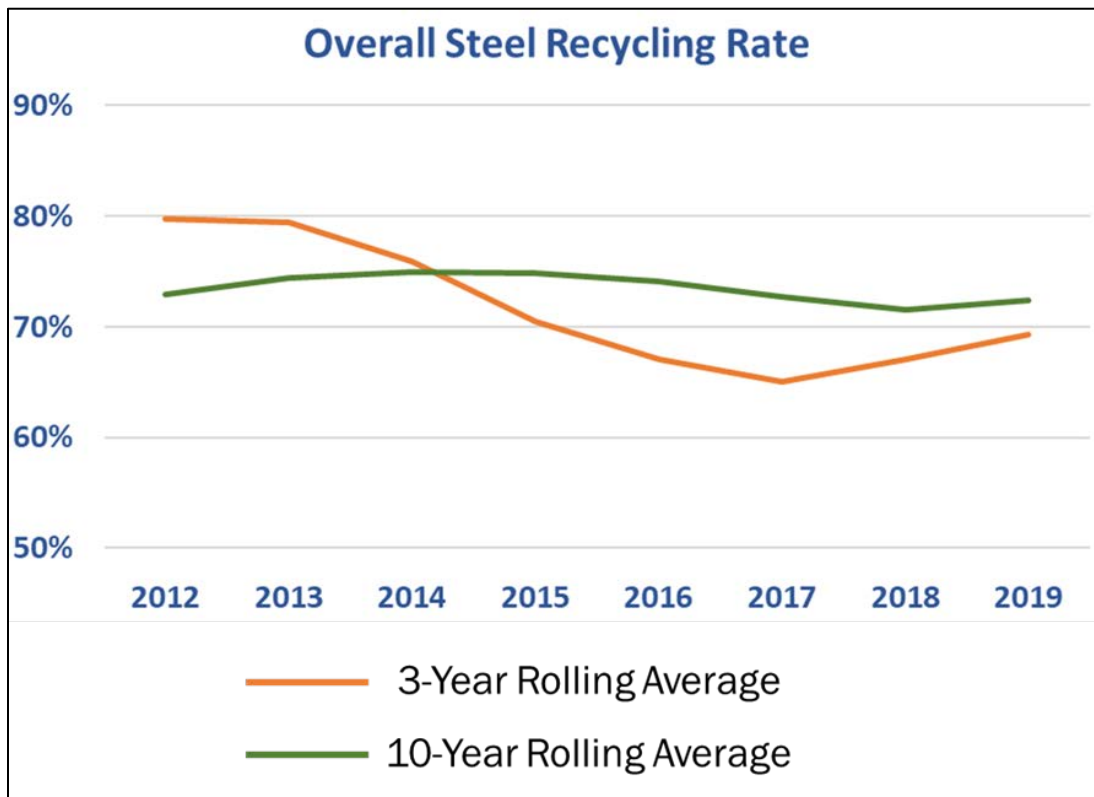
Scrap consumption data from AISI represents the portion of scrap consumed by manufacturers of pig iron and raw steel. Scrap consumption values reported by AISI include both home and purchased scrap, while purchased scrap includes both new and old scrap.

Trade data, with some overlapping scope, is available from several sources including AISI, USGS, the World Steel Association (worldsteel) and numerous national and non-governmental trade bureaus and institutions. AISI and USGS import/export data is compiled by the U.S. Census Bureau within the Department of Commerce.

OVERALL STEEL RECYCLING RATE (U.S.)

The general formula for total recycling rate has been described previously. The following formula is more specific to the final calculation of a total recycling rate for steel in the U.S.:

$$\text{recycling rate} = \frac{[\text{Scrap Consumption (U.S.)} - \text{Home Scrap Consumption} + \text{Scrap Exports} - \text{Scrap Imports}]}{[\text{EOL Steel} + \text{New Scrap} \pm \text{Stock } \Delta]}$$



As shown in the graph above, the overall U.S. recycling rate for 2019 is calculated at 69 percent, based on a three-year rolling average, with rates ranging from 65 percent to 80 percent since 2012. If a ten-year rolling average is used instead, the overall U.S. rate ranges between 71 percent and 75 percent since 2012.

SECTOR-SPECIFIC RECYCLING RATES

Sector recycling rates are calculated for several product sectors including light-duty automotive, construction, appliances, containers, and “other” for the year 2019. These rates include the recycling of both EOL scrap and new scrap:

| | |
|-----------------------------------|-----|
| Construction, structural sections | 97% |
| Construction, rebar | 59% |
| Construction, other | 68% |
| *Construction, general | 74% |
| Automotive | 96% |
| Appliances | 78% |
| Containers | 62% |
| Misc./Other | 46% |

*This category is a weighted average of the previous three construction sector categories.

The calculation of sector recycling rates is subject to some degree of uncertainty since it requires data from a wide variety of sources, some of which is not readily available. The calculated rates in the table above represent the researchers’ best estimates based on multiple data sources, and they should therefore be considered reasonable and credible values for steel recycling in the specified sectors.

AVERAGE RECYCLED CONTENT

Industry reports of average recycled content for BOF and EAF production were available from the Steel Recycling Institute for the years 2011, 2007, 2005 and 2000. Calculation of the average recycled content of raw steel for the period from 2000-2019 was based on these SRI-calculated recycled content values as well as relevant USGS reports of scrap consumption by furnace type. For 2019, average recycled content of steel produced in the U.S. is estimated at 82 percent for EAF production and 23 percent for integrated/BOF production. These values are representative of all steel production. Recycled content within specific end-use sectors will be higher or lower than the average value.