PROFILE The iron and steel sector[4] manufactures the steel used in the production of thousands of manufactured products, ranging from toasters to automobiles to defense applications. Steel is also a key material in infrastructure such as office buildings and bridges. Construction, automotive, and industrial equipment account for more than 75% of total U.S. steel consumption, with construction representing 22% of total steel shipments.[5]

The highest geographic concentration of steel mills is in the Great Lakes region, including Indiana, Illinois, Ohio, Pennsylvania, Michigan, and New York. Approximately 80% of U.S. steelmaking capacity is in these states.[6]

To produce steel, facilities use one of two processes, which utilize different raw materials and technologies.

- Integrated steel mills use a blast furnace to produce iron from iron ore, coke, and fluxing agents. A basic oxygen furnace (BOF) is then used to convert the molten iron, along with up to 30% steel scrap, into refined steel.
- Minimills use an electric arc furnace (EAF) to melt steel scrap and limited amounts of other iron-bearing materials to produce new steel.

Sector At-a-Glance

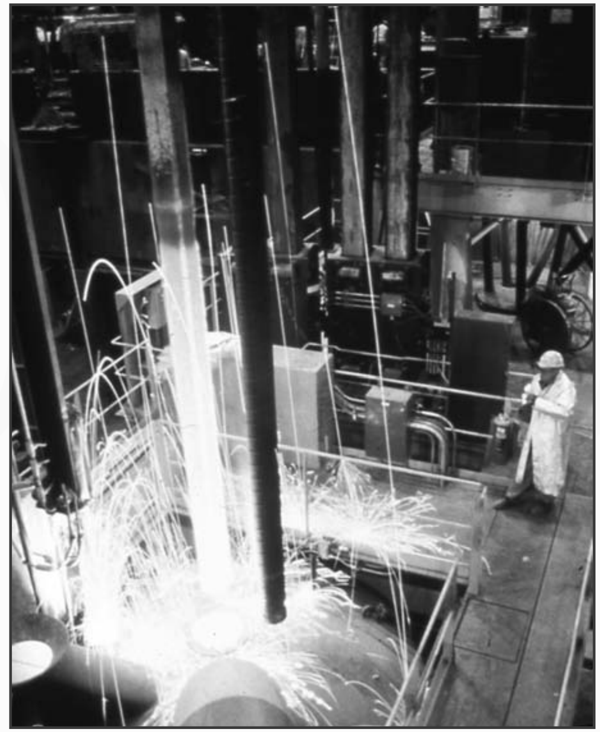
Number of Facilities:	87[1]
Value of Shipments:	$43.3 billion[2]
Number of Employees:	123,543[3]

TRENDS Advances in technology, changes in markets, and global competition have led to significant restructuring in the iron and steel sector. Between 2000 and 2003, high levels of imports and other factors caused many U.S. steel companies to declare bankruptcy. For example, more than 30 companies declared bankruptcy during 2001 and 2002. As a result, the domestic steel industry now has fewer companies and fewer steel mills.[7]

- From 2000 to 2003, labor productivity in the U.S. iron and steel sector increased by an average of nearly 6% per year. Over the same period, the sector's workforce declined by nearly 22,000 employees to approximately 124,000 in 2003.[8]
- To better compete in the global market, the U.S. steel industry is developing new process technologies and expanding into new markets. Steel producers anticipate increasing their capital spending by 30% over the next two years.[9]

KEY ENVIRONMENTAL OPPORTUNITIES For the iron and steel sector, the greatest opportunities for environmental improvements are increasing energy efficiency, managing and minimizing waste and toxics, and reducing air emissions.

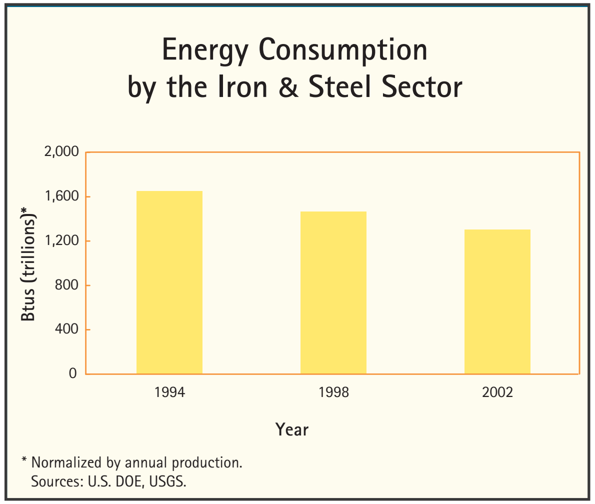
The iron and steel sector is working to generate better data on the sector's environmental performance. For example, the American Iron and Steel Institute (AISI) collects data for five indicators of sustainability: energy intensity, greenhouse gas (GHG) emissions, material efficiency, steel recycling, and implementation of environmental management systems.



Increasing Energy Efficiency

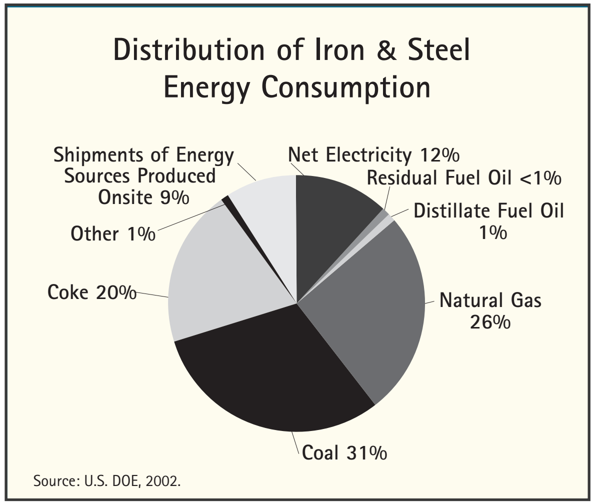
The iron and steel industry is one of the most energy-intensive industries in the U.S.[10] As shown in the *Energy Consumption* bar chart, in 2002, the iron and steel sector consumed 1,308 trillion Btus of energy, accounting for almost 6% of total U.S. manufacturing energy consumption. When normalized for production, this represents a 21% decrease over the eight-year period from 1994 to 2002. As shown in the *Distribution of Iron & Steel Energy Consumption* pie chart, the iron and steel sector is primarily fueled by coal (31%), natural gas (26%), coke (20%), and net electricity (12%).[11]

The energy intensity of producing steel via the two types of steelmaking technology differs. In a 1994 study, the U.S. Energy Information Administration estimated the average intensity of producing semi-finished steel at integrated mills using BOF steelmaking to be about 20 million Btus/ton, versus about 8 million Btus/ton for EAF steel producers.[12] When making steel with scrap rather than virgin materials (iron ore, coal, and limestone), steelmakers save natural resources and reduce annual energy consumption by an amount that would power 18 million households for one year.[13]



The iron and steel sector is continuing to search for new ways of improving the energy efficiency of its operations. In 2003, AISI joined Climate VISION, a voluntary program administered by the U.S. Department of Energy (DOE) to reduce GHG intensity (the ratio of emissions to economic outputs). Because of the close relationship between energy use and GHG emissions, the steel industry has set energy targets and is actively funding research of energy-efficient technologies to help achieve this goal.[14]

As part of its Climate VISION commitment, AISI has committed to improving its members' energy efficiency by 10% by 2012 (from 2002 levels).[15]



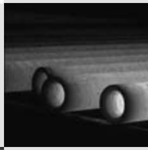
Between 2002 and 2003, the industry reduced its energy intensity per ton of steel shipped by approximately 7%. The industry's aggregate carbon dioxide (CO_2) emissions per ton of steel shipped were reduced by a comparable percentage during this same period.[16]

The following case study illustrates efforts by the sector to improve the energy efficiency of automobiles, an end user of steel products.

Case Study: Improved Fuel Economy Through Steel Innovation *An international consortium of steel companies recently completed a series of research projects to help automakers improve the energy efficiency of automobiles by reducing their weight. Reducing vehicle weight is one way to improve fuel economy, but it is very challenging to do so while maintaining vehicle safety and affordability (as was done in this study).*

This research effort involved 35 steel manufacturers representing 22 countries. More than $60 million was dedicated over nine years to developing new types of advanced high-strength steel (AHSS) for vehicle applications. The research culminated in prototype vehicles that incorporated innovations in the use of steel for auto bodies, closures, and suspensions. The mid-size design achieved combined city-highway gas mileage of over 50 miles per gallon while meeting or exceeding crash safety requirements and affordability criteria.

The consortium has communicated its findings globally and has assisted automakers in replicating these innovative applications in their own vehicles. These innovative steel applications can now be found in nearly every vehicle on the road today..[17]



MANAGING AND MINIMIZING WASTE All new steel is made using at least some recycled steel, allowing steel to remain America's most recycled material.[18] At the same time, the sector generates hazardous waste.

Steel Recycling The Steel Recycling Institute announced a recycling rate for steel of 71% in 2004, with total tons of steel recycled increasing by more than 7 million tons from 2003. In addition, the composition of the steel recycled in 2004 contained almost 35% more post-consumer scrap than in 1980.[19] To achieve this recycling rate, the steel industry has become an efficient user of raw materials and has increased its demand for post-consumer scrap. The industry is now one of the largest consumers of recycled materials in the world.[20] Even with this success, however, steelmaking continues to present a variety of opportunities to further improve the recycling stream, increase reuse of co-products and byproducts, and reduce releases to the environment.

Obsolete automobiles are the most recycled consumer product. Each year, the steel industry recycles more than 14 million tons of steel from end-of-life vehicles. This is equivalent to nearly 13.5 million new automobiles.[21] In 2003, the recycling rate for automobiles was 103%, indicating that the steel industry recycled more steel from automobiles than was used in the domestic production of new vehicles.[22]

The following case study highlights efforts to reduce mercury emissions resulting from automotive recycling.

Case Study: Reducing Mercury in the Recycling Stream *One pressing problem in the use of scrap from vehicles is the presence of mercury. Automakers use mercury in various applications. Until recently, the most prevalent use was in hood and trunk convenience light switches and anti-lock braking systems (ABS) in domestic automobiles.*

In 2003, automakers phased out the use of mercury-containing switches in new vehicles. However, few automotive dismantlers currently remove these switches from the retired vehicles they receive before the vehicles are flattened or shredded, so mercury is being carried into the recycling stream.[23]

To address this problem, several states have passed laws or created voluntary programs prompting the recovery of mercury switches from end-of-life vehicles. EPA, steelmakers, automakers, recyclers, states, and other stakeholders are now trying to address the problem nationally in order to recover mercury switches and reduce associated emissions from steelmaking in the short-term and to reduce the use of toxic materials in new products in the future.[24]

Hazardous Waste EPA hazardous waste data on large quantity generators, as reported in the *National Biennial RCRA Hazardous Waste Report*, indicate the iron and steel sector accounted for 4% of the hazardous waste generated nationally in 2003.

In 2003, 79 facilities in the iron and steel sector reported 1.3 million tons of hazardous waste generated. More than 83% of this waste consisted of residuals from air pollution control devices. The waste management method most utilized by this sector was deepwell or underground injection, although one facility accounted for the majority of the waste reported as managed by this method. Other common methods included metals recovery, landfill or surface impoundment, and stabilization or chemical fixation.

When reporting hazardous wastes to EPA, quantities can be reported as a single waste code (e.g., spent pickle liquor) or as a commingled waste composed of multiple wastes. Quantities of a specific waste within the commingled waste are not reported. The iron and steel sector reported more than half of its wastes as individual waste codes. Of the individually reported wastes, the predominant hazardous waste types reported in 2003 included emission control dust or sludge (629,100 tons), spent pickle liquor (72,800 tons), cadmium, and chromium. Additional quantities of these wastes were also reported as part of commingled wastes.[25]

MANAGING AND MINIMIZING TOXICS Iron and steel facilities use a variety of chemicals and report on the release and management of many of those materials through EPA's Toxics Release Inventory (TRI).

In 2003, 82 facilities in the iron and steel sector reported 636 million pounds of chemicals released (including disposal) or otherwise managed through treatment, energy recovery, or recycling. Of this quantity, 62% was managed, while the remaining 38% was disposed or released to the environment, as shown in the *TRI Waste Management* pie chart. Of those chemicals disposed or released to the environment, 96% were disposed and 4% were released into air and water.

As shown in the *Total TRI Disposal or Other Releases* line graph, the annual normalized quantity of chemicals disposed or released to the environment by the iron and steel sector increased by 171% from 1994 to 2003, with one-third of this increase occurring from 2000 to 2003. Over the same 10-year period, the sector's normalized releases to air and water declined by 42% and remained fairly steady between 2000 and 2003.

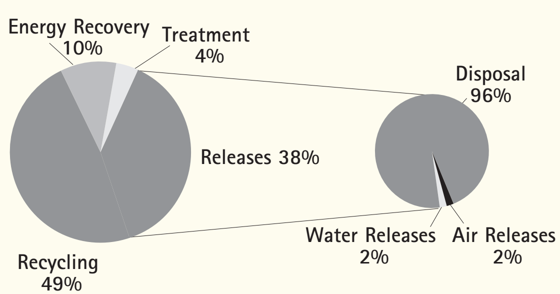
These contrasting trends occurred during a period of time in which numerous steel mills installed or upgraded air pollution control equipment, which often results in the generation of additional pollution control residues, such as EAF dust and filter cakes. The disposal of the toxic chemicals in these residues must be reported to TRI.[26] Although many pollution control dusts can be recycled, economic factors can make disposal more likely. For example, zinc prices reached record lows in the mid-1990s and in 2002, making the recycling of EAF dust less economical.[27]

In 2003, metals accounted for the majority of the total pounds of chemicals disposed or released by the sector. Zinc accounted for 72%, and manganese accounted for another 16%. Along with lead and chromium, these metals accounted for 93% of all pounds reported to TRI as disposed or released by the iron and steel sector.[28]

Data from TRI allow comparisons of the total quantities of a sector's reported chemical releases across years, as presented below. However, this comparison does not take into account the relative toxicity of each chemical. Chemicals vary greatly in toxicity, meaning they differ in how harmful they can be to human health. To account for differences in toxicities, each chemical can be weighted by a relative toxicity weight using EPA's Risk-Screening Environmental Indicators (RSEI) model.

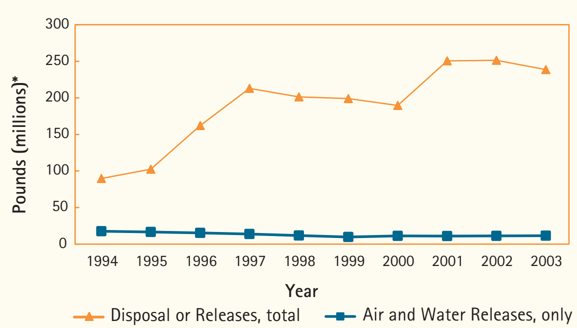
The *TRI Air and Water Releases* line graph presents trends for the sector's air and water releases in both reported pounds and toxicity-weighted results. When weighted for toxicity, the sector's normalized air and water releases show a 69% decline from 1994 to 2003.

TRI Waste Management by the Iron & Steel Sector



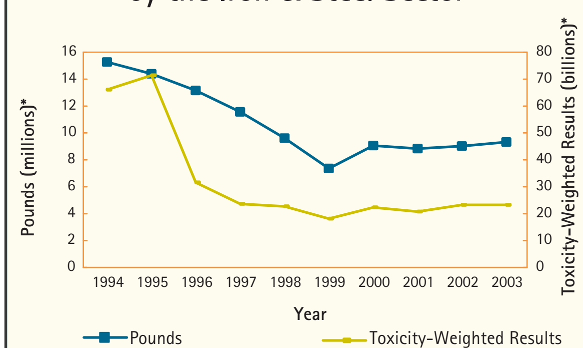
Source: U.S. EPA, 2003.

Total TRI Disposal or Other Releases by the Iron & Steel Sector



* Normalized by annual production.
Sources: U.S. EPA, USGS.

TRI Air and Water Releases by the Iron & Steel Sector



* Normalized by annual production.
Sources: U.S. EPA, USGS.

The table below presents a list of the chemicals released that accounted for 90% of the sector's total toxicity-weighted releases to air and water in 2003. More than 99% of these results were attributable to air releases, while discharges to water accounted for less than 1%. Therefore, reducing air emissions of these chemicals represents the greatest opportunity for the sector to make progress in reducing the toxicity of its releases.

Top TRI Chemicals Based on Toxicity-Weighted Results

AIR RELEASES (99%)	WATER RELEASES (<1%)
Manganese	Lead
Chromium	Copper
Lead	Chromium

Source: U.S. EPA

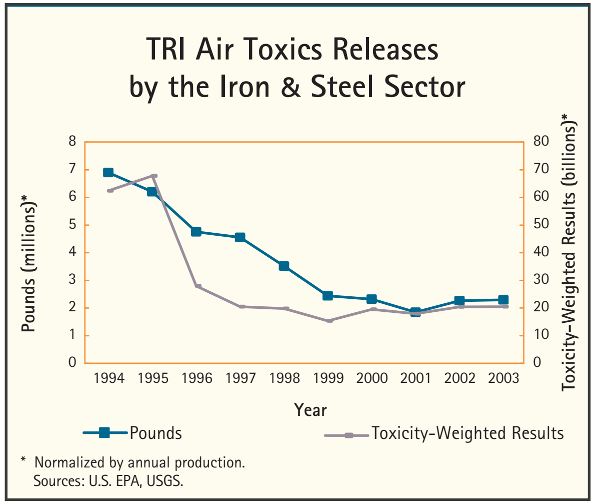
Manganese, chromium, and lead releases to air, the primary contributors to the sector's toxicity-weighted results, have remained steady in recent years. Manganese is inherent in the iron and steel production process and is one of the chemicals that drives the toxicity-weighted results.

EPA's RSEI model conservatively assumes that chemicals are released in the form associated with the highest toxicity weight. With respect to chromium releases to air and water, therefore, the model assumes that 100% of these emissions are hexavalent chromium (the most toxic form, with significantly higher oral and inhalation toxicity weights than trivalent chromium).[29] Research indicates that the hexavalent form of chromium does not constitute a majority of total chromium releases from this sector.[30] Thus, RSEI analyses overestimate the relative harmfulness of chromium in the sector.

REDUCING AIR EMISSIONS Steelmaking generates a variety of air emissions, including air toxics and GHG. While emissions of air toxics during the manufacturing process are largely captured in the TRI air releases discussed above, this section takes a closer look at both of these chemical categories.

Air Toxics Air toxics, also called hazardous air pollutants, are a subset of the TRI chemicals presented above. The Clean Air Act designates 188 chemicals (182 of which are included in TRI) that can cause serious health and environmental effects as air toxics.

In 2003, 75 facilities in the sector reported air toxics releases of 2.1 million pounds. As shown in the *TRI Air Toxics Releases* line graph, normalized air toxics releases decreased by 70% from 1994 to 2003. Since 2000, normalized air toxics releases have remained fairly steady.[31] Toxicity-weighted results for air toxics releases declined by 69% over the 10-year period.[32]



Greenhouse Gases Steelmaking generates GHG emissions both directly and indirectly. For example, integrated mills produce CO_2 when transforming coke and iron ore into iron. Additionally, both minimills and integrated mills consume significant amounts of electricity, the generation of which often results in GHG emissions. Between 1994 and 2003, the sector's aggregate GHG emissions fell by more than 25%.[33]

In 2003, AISI joined Climate VISION, a voluntary program administered by DOE to reduce GHG intensity.[34] Between 2002 and 2003, the industry reduced its energy intensity per ton of steel shipped by approximately 7%. Because of the close relationship between energy use and GHG emissions, the industry's aggregate CO_2 emissions per ton of steel shipped were reduced by a comparable percentage during this period.[35]

In addition, one steel manufacturer (U.S. Steel Corporation) has joined EPA's Climate Leaders program, which helps partners to develop long-term comprehensive climate change strategies, set corporate-level GHG reduction goals, and inventory emissions to measure progress.[36] Internationally, the industry has established the CO_2 Breakthrough Program to fund the development of new steelmaking technologies that do not emit CO_2. The program also includes research and development into technologies that capture and sequester CO_2.[37]