

FACT SHEET

Steel and raw materials



Today, it is estimated that the global steel industry uses about 2 billion tonnes of iron ore, 1 billion tonnes of metallurgical coal and 575 million tonnes of recycled steel to produce 1.7 billion tonnes of crude steel annually. Efficient use of natural resources is critical to sustainability. The industry uses advanced technologies to increase production yield rates and to facilitate the use of co-products. Steel's advantage is that it is 100% recyclable and can be reused infinitely. As a result of the intrinsic recyclability of steel, the value of the raw materials invested in steel production lasts far beyond the end of a steel product's life.

Steel is indispensable to our modern way of life and critical to economic growth. The intrinsic benefits of steel make it a sustainable choice in a growing number of applications.

Almost everything that we use is either made from, or manufactured with, steel. It is a uniquely versatile material and is widely regarded as a high performance, contemporary engineering material continuously being improved to meet new market demands. World crude steel production reached just over 1.8 billion tonnes in 2018.¹

Raw materials in steelmaking

Key raw materials needed in steelmaking include iron ore, coal, limestone and recycled steel. The two main steel production routes and their related inputs are:

- **Route 1:** The integrated steelmaking route, based on the blast furnace (BF) and basic oxygen furnace (BOF), which uses raw materials including iron ore, coal, limestone and recycled steel. On average, this route uses 1,370 kg of iron ore, 780 kg of metallurgical coal, 270 kg of limestone, and 125 kg of recycled steel to produce 1,000 kg of crude steel.²
- **Route 2:** The electric arc furnace (EAF) route uses primarily recycled steels and direct reduced iron (DRI) or hot metal, and electricity. On average, the recycled steel-EAF route uses 710 kg of recycled steel 586 kg of iron ore, 150 kg of coal and 88 kg of limestone and 2.3 GJ of electricity, to produce 1,000 kg of crude steel.³
- Around 70% of total global steel production relies directly on inputs of coal via the BF/BOF route. In 2017, about 1.2 Gt of crude steel were produced in BOFs, which required the output of about 1.1 Gt of BF (hot metal/pig iron) and about 200 Mt of scrap.
- In 2017, global EAF output accounted for about 30% of global steel production (around 480 Mt), which required the output of about 60 Mt BF, 90 Mt of direct reduced iron (DRI) and 380 Mt of scrap.

worldsteel, with the help of its members, has developed a comprehensive and process-specific energy intensity benchmarking system, which includes the impact of raw material quality on the process for both iron ores and coal. This tool is stored on a secure data system. Member companies can submit data and compare their performance with the top performers.

worldsteel has also developed a global and regional life cycle inventory (LCI) database including "cradle-to-gate" environmental inputs and outputs tracking resource use (raw materials, energy and water) and emissions to land, air and water for 17 steel products. The LCI data is available upon request through the worldsteel website.

Steelmaking materials markets

Steelmaking materials are some of the biggest commodities in the world in terms of volume of production, consumption and transportation. For example, iron ore, with a production volume of around 2 billion tonnes and an export volume of about 1.5 billion tonnes, is the third largest commodity in terms of production volume - after crude oil and coal - and the second most traded commodity - after crude oil - globally. Ferrous scrap, with a global recycling volume of more than 600 Mt, is the largest commodity recycling activity in the world.

World iron ore exports, 2001 – 2017, in million tonnes (Mt)⁴

| | 2001 | 2005 | 2010 | 2017 |
|-----------------------------|------|------|-------|-------|
| World iron ore exports (Mt) | 476 | 755 | 1 130 | 1 547 |

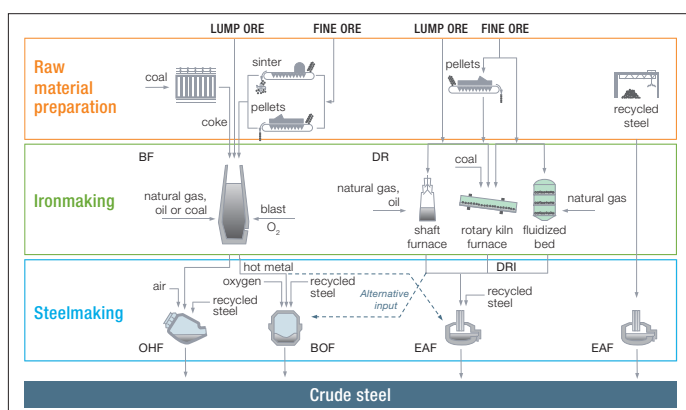
World exports of iron ore, coal and crude oil in 2015, in million tonnes (Mt)⁵

| World exports, 2015 (Mt) | Iron ore | Coal | Crude oil |
|--------------------------|----------|-------|-----------|
| | 1 447 | 1 308 | 2 216 |

Iron ore

Steel is an alloy consisting mostly of iron and less than 2% carbon. Iron ore is, therefore, essential for the production of steel, which in turn is essential in maintaining a strong industrial base. 98% of mined iron ore is used to make steel. Iron is one of the most abundant metallic elements. Its oxides, or ores, make up about 5% of the earth's crust. Average iron content for high-grade ores is 60% to 65%, after taking into account other naturally-occurring impurities.⁶

- Iron ore is mined in about 50 countries. The majority of iron ore is mined in Brazil, Australia, China, India, the US and Russia. Australia and Brazil together dominate the world's iron ore exports, each having about one-third of total exports.
- Worldwide iron ore resources are estimated to exceed 800 billion tonnes of crude ore, containing more than 230 billion tonnes of iron.^{6,7}
- The unprecedented growth of China's steel production in the 2000s resulted in very strong growth in global demand for steelmaking materials. Global iron ore exports grew from half a billion tonnes in 2000 to 1.5 billion tonnes in 2016. Australia consolidated its position as the main supplier of steelmaking materials with iron ore exports growing from about 150 Mt to 800 Mt.



Steelmaking routes

Coal and coke

Coking coal is a key raw material in steel production. As iron occurs only as iron oxides in the earth's crust, the ores must be converted, or 'reduced', using carbon. The primary source of this carbon is coking coal. Coke, made by carburising coking coal (i.e. heating in the absence of oxygen at high temperatures), is the primary reducing agent of iron ore. Coke reduces iron ore to molten iron saturated with carbon, called hot metal.

- Around 1 billion tonnes of metallurgical coal are used in global steel production, which accounts for around 15% of total coal consumption worldwide.⁸

- Coal reserves are available in almost every country worldwide, with recoverable reserves in around 80 countries. Although the biggest reserves are in the US, China, Russia, Australia and India, coal is actively mined in more than 70 countries.⁹
- China is by far the biggest producer of coking coal in the world. Australia dominates metallurgical coal exports, accounting for about 200 million tonnes of a total of 310 million tonnes of metallurgical coal exports globally.
- About 30% of coal can be saved by injecting fine coal particles into the blast furnace, a technology called Pulverised Coal Injection (PCI).¹⁰ One tonne of PCI coal used for steel production displaces about 1.4 tonnes of coking coal. Coals used for pulverised coal injection into blast furnaces have more narrowly defined qualities than steam coal used in electricity generation.

Sustainability of the supply chain

Iron is a common mineral on the earth's surface. Most iron ore is extracted in opencast mines in Australia and Brazil, carried to dedicated ports by rail, and then shipped to steel plants in Asia and Europe. Steelmakers worldwide look to ensure the sustainability of their supply chains. Many companies have policies and requirements for the safety, environmental and ethical performance of their raw material suppliers. Whenever possible, they work with suppliers to make improvements or corrections in cases of non-compliance.

Recycled steel

Steel products naturally contribute to resource conservation through their lightweight potential, durability and recyclability. At the end of a product's life, steel's 100% recyclability ensures that the resources invested in its production are not lost and can be infinitely reused. Due to its magnetic properties, steel is easy to separate from waste streams, enabling high recovery rates and avoiding landfills. Some steel products contain up to 100 percent recycled content.

- Steel is the most recycled material in the world, with about 670 Mt recycled in 2017, including pre- and post-consumer scrap.¹¹
- Steel is one of the few magnetic metals. It is easy to separate from waste streams.
- By sector, global steel recovery rates are estimated at at least 85% for construction, 90% for automotive (reaching close to 100% in the US), 90% for machinery, and 50% for electrical and domestic appliances.¹²
- Recycled steel (scrap) can be collected from excess material in steel facilities and foundries (home scrap) or downstream production processes (industrial scrap) and from discarded products (obsolete scrap).
- The availability of home and industrial scrap is closely related to current domestic steel production levels while the availability of obsolete scrap is closely related to levels of past steel production, average product lives and efficient recycling programmes.
- Recycled steel is a key input needed for all steelmaking process routes. EAFs can be charged with up to 100% of recycled steel and basic oxygen furnaces with approximately 30%.¹³
- Recycling this steel accounts for significant energy and raw material savings: over 1,400 kg of iron ore, 740 kg of coal, and 120 kg of limestone are saved for every 1,000 kg of steel scrap made into new steel.¹⁴

Responsible management of natural resources

- The strong growth seen in demand for steelmaking raw materials over the 1990s and 2000s resulted in a decline in the quality of the materials and led to a, still continuing, tightness in the market segments for higher quality materials. This has put pressure on the efficiency and the environmental performance of the global steel industry's raw materials processing operations.
- However, the development of new technology and techniques has enabled the global steel industry to meet ever more stringent environmental standards. The key contributing factors include high material efficiency rates, co-product recycling and steel recycling.
- Steelmaking is nearing zero-waste, with current material efficiency rates at 96.3%. This means that over 96% of raw materials used on-site are converted to products and by-products that are used or recycled.¹⁵
- Slag is the main steelmaking by-product; it is mostly used in cement production, reducing CO₂ emissions by around 50%.¹⁶ It can also be used in roads (substituting aggregates), as fertiliser (slag rich in phosphate, silicate, magnesium, lime, manganese and iron), and in coastal marine blocks to facilitate coral growth thereby improving the ocean environment.
- Gases from iron- and steelmaking (for example, from the coke oven, BF or BOF) once cleaned, are used internally to produce steam and electricity reducing the demand for externally-produced electricity. Gases can be fully reused within the steel production site, and can provide more than 60% of the site's power.¹⁷ Alternatively, gases can also be sold for power generation. They are flared only if no other option is available.

Footnotes

1. Annual crude steel production press release, January 2019, worldsteel
2. worldsteel calculation, 2018
3. worldsteel calculation, 2018
4. UN COMTRADE
5. UN COMTRADE (iron ore); IEA (coal) and IEA (crude oil, including Natural Gas Liquids)
6. Raw materials improvement report, worldsteel, 2014
7. Mineral Commodity Summaries, US Geological Survey, 2018
8. Coal and Steel Statistics 2014, World Coal Association, worldcoal.org
9. Official Journal of the World Coal Industry, Summer 2013, p. 15
10. Coal and Steel Statistics 2014, World Coal Association, worldcoal.org
11. worldsteel estimate, 2019
12. worldsteel data
13. World Steel Figures, p. 10, 2018
14. worldsteel data
15. worldsteel data.Sustainable indicators, worldsteel, 2018
16. Legal Status of slags, Position Paper, January 2006, pp 2, 10, The European Slag Association.
17. worldsteel data

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