

Steel and raw materials



On average, 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 steel¹.

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.

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.

Steelmaking materials markets

Steelmaking materials are some of the world's biggest commodities 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 recycling volume of more than 600 Mt, is the world's largest commodity recycling activity.

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

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

Iron ore

Steel is an alloy consisting primarily of iron and less than 2% carbon. Iron ore is, therefore, essential for steel production, which 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 Australia, Brazil, 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 a 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.

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, accounting 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.

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 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 97.5%. This means that over 97% of raw materials used on-site are converted to products and co-products that are used or recycled.¹⁵
- Slag is the main steelmaking co-product; it is primarily 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.

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