worldsteel
ASSOCIATION

FACT SHEET

Steel and raw materials

Efficient use of natural resources is critical to sustainability. Steel's great advantage is that it is 100% recyclable and can be reused infinitely. The industry uses advanced technologies and techniques to increase production yield rates and to facilitate the use of by-products. 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 1,628 million tonnes (Mt) in 2016.[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:

- 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 1,400 kg of iron ore, 800 kg of coal, 300 kg of limestone, and 120 kg of recycled steel to produce 1,000 kg of crude steel.[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 880 kg of recycled steel combined with varying amounts of other sources (DRI, hot metal, and granulated iron), 16 kg of coal and 64 kg of limestone, to produce 1,000 kg of crude steel.[3]

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 a top 25% reference level for each process and determine what component in the process is deviating from the reference.

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 16 steel products. The LCI data is available upon request through the worldsteel website.

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.[4]

- 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.[4;5]

Coal and coke

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. Coal is a key raw material in steel production. Coal is primarily used as a solid fuel to produce electricity and heat through combustion. Coke, made by carburising 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.

- About 30% of coal can be saved by injecting fine coal particles into the blast furnace, a technology called Pulverised Coal Injection (PCI).[6] 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.
- Around 70% of total global steel production relies directly on inputs of coal. Around 1.2 billion tonnes of coal are used in global steel production, which is around 15% of total coal consumption worldwide.[6]
- Coal reserves are available in almost every country worldwide, with recoverable reserves in around 80 countries. Although the biggest reserves are in the US, Russia, China, and India, coal is actively mined in more than 70 countries.[7] At current production levels, proven coal reserves are estimated to last at least 120 years.[4]

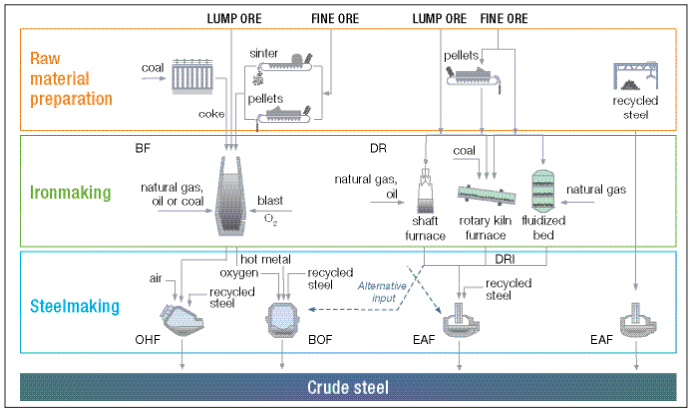

Figure 1: Steelmaking routes

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 630 Mt recycled in 2017, including pre- and post-consumer scrap.[8]
- Steel is one of the few magnetic metals. It is easy to separate from waste streams. About 83% of post-consumer steel is recovered for recycling.[9]
- By sector, global steel recovery rates are estimated at 85% for construction, 85% for automotive (reaching close to 100% in the US), 90% for machinery, and 50% for electrical and domestic appliances.[10]
- 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% (see Figure 1).[10]
- 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.[11]

Responsible management of natural resources

- The steel industry is highly efficient in its use of raw materials with technology available today. Key contributing factors include high material efficiency rates, by-product recycling and steel recycling.
- Steelmaking is nearing zero-waste, with current material efficiency rates at 97.6%. This means that over 97% of raw materials used on-site are converted to products and by-products that are used or recycled.[11]
- Slag is the main steelmaking by-product; it is mostly used in cement production, reducing CO_2 emissions by around 50%.[12] 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.[10]
- 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 up to 60% of the site's power.[13] Alternatively, gases can also be sold for power generation. They are flared only if no other option is available.

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Footnotes

1. Steel Statistical Yearbook 2017, worldsteel.org
2. Sustainable Steel: At the core of the green economy, p.13, worldsteel, 2012.
3. Sustainable Steel: At the core of the green economy, p.18, worldsteel, 2012.
4. Raw materials improvement report, worldsteel, 2014.
5. Mineral Commodity Summaries, US Geological Survey, p. 85, 2014.
6. Coal and Steel Statistics 2014, World Coal Association, worldcoal.org.
7. Official Journal of the World Coal Industry, Summer 2013, p. 15
8. worldsteel estimate, 2018.
9. Sustainable Steel: At the core of the green economy, p14, worldsteel, 2012.
10. worldsteel data.
11. Sustainable steel: Indicators 2017 and the future, worldsteel.org
12. Legal Status of slags, Position Paper, January 2006, pp 2, 10, The European Slag Association.
13. Energy use in the steel industry report, worldsteel, 2014.