

## 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 reuse of by-products. As a result of the intrinsic recyclability of steel and the industry's sustainability efforts, 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.

In 2010, world crude steel production was 1,414 million metric tons (mmt). This was an increase of 15% compared to 2009, a new record for global crude steel production.<sup>1</sup>

### 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), uses raw materials including iron ore, coal, limestone and recycled steel. On average, this route uses 1,400 kg of iron ore, 770 kg of coal, 150 kg of limestone, and 120 kg of recycled steel to produce a tonne of crude steel.<sup>1</sup>
- The electric arc furnace (EAF) route, based on the EAF, uses primarily recycled steels and/or direct reduced iron (DRI) and electricity. On average, the recycled steel-EAF route uses 880 kg of recycled steel, 150 kg of coal and 43 kg of limestone to produce a tonne of crude steel.<sup>1</sup>

### 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, compose about 5% of the earth's crust. Average iron content for ores is 60% to 65%, after taking into account other naturally-occurring impurities.<sup>2</sup>

- 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.<sup>3</sup>

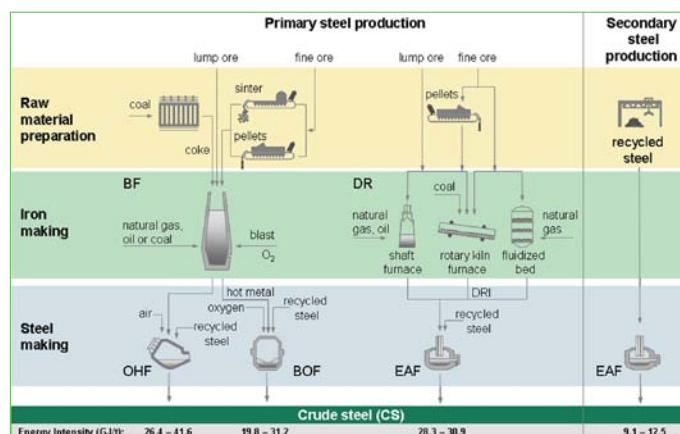
- Current reserves (extractable using available technology) of iron ore are estimated at 180 billion tonnes. If potential reserves are included, this increases to 370 billion tonnes.<sup>3</sup>

### 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 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).<sup>4</sup> 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.
- Global steel production is dependent on coal – around 68% of total production relies directly on the input of coal. 761Mt of coking coal and Pulverised Coal Injection (PCI) coals are used in global steel production, which is around 12% of total hard coal consumption worldwide.<sup>5</sup>
- Coal reserves are available in almost every country worldwide, with recoverable reserves in around 70 countries. At current production levels, proven coal reserves are estimated to last 119 years.<sup>5</sup>

**FIGURE 1: STEEL PRODUCTION 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.

Steel producers are also working together to develop a method for ensuring and demonstrating to customers and other stakeholders that their steel products are responsibly sourced.<sup>1</sup>

Iron ore and coking coal are primarily shipped in capesize vessels, huge bulk carriers that can hold a cargo of 140,000 tonnes or more. Sea freight is an area of major concern for steelmakers, as the high demand for raw materials is causing backlogs at ports, with vessels delayed in queues.

## Recycled steel

Recycled steel is a key input needed for all steelmaking process routes. Some steel products contain up to 100 percent recycled content.

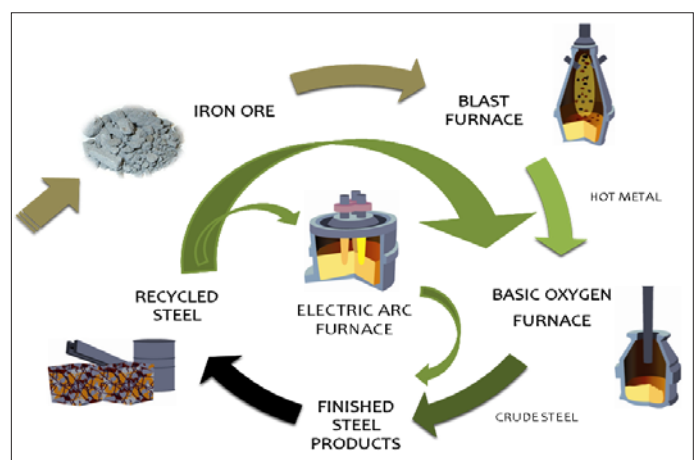
- Steel is one of the few magnetic metals. It is easy to separate from waste streams. About 80% of post-consumer steel is recycled.<sup>1</sup>
- By sector, steel recovery rates are estimated at 85% for construction, 85% for automotive, 90% for machinery, and 50% for electrical and domestic appliances.<sup>1</sup>
- 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.
- EAFs can be charged with up to 100% of recycled steel, basic oxygen furnaces with up to 30% (see Figure 2).<sup>1</sup>

## 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 around 98%. This means that 98% of raw materials used are converted to products or by-products that are used or recycled.<sup>1</sup>
- Slag is the main steelmaking by-product; it is mostly used in cement production, reducing CO<sub>2</sub> emissions by around 50%.<sup>6</sup> 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.<sup>1</sup>
- Gases produced during steelmaking are fully reused as an energy source either in the blast furnace and reheating furnaces or in power generation plants within the steelworks, saving fossil fuels. Coke oven gas contains about 55% hydrogen and may prove an important hydrogen source in the future.<sup>7</sup>

**FIGURE 2: RECYCLED STEEL USE IN STEELMAKING**



## Steel recycling

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.

More steel is recycled worldwide annually than all other materials put together, with about 500 mmt of scrap being melted each year.<sup>1</sup> Recycling this steel:

- avoids 700 mmt of CO<sub>2</sub> emissions
- saves 710 mmt of iron ore, and
- saves the energy equivalent of 220 mmt of anthracite coal.<sup>1</sup>

Last updated: May 2011

## Footnotes

1. From World Steel Association data or publications (worldsteel.org)
2. "Analysis of economic indicators of the EU metals industry: the impact of raw materials and energy supply on competitiveness." European Commission, 2006
3. Mineral Commodity Summaries, US Geological Survey, 2010
4. Coal & Steel Facts 2007, World Coal Institute, worldcoal.org
5. Coal and Steel Statistics, World Coal Institute, worldcoal.org
6. Legal Status of Slags, Position Paper, January 2006, pp 2, 10, The European Slag Association
7. "The State-of-the-Art Clean Technologies (SOACT) for Steelmaking Handbook", Asia-Pacific Partnership for Clean Development and Climate, 2007