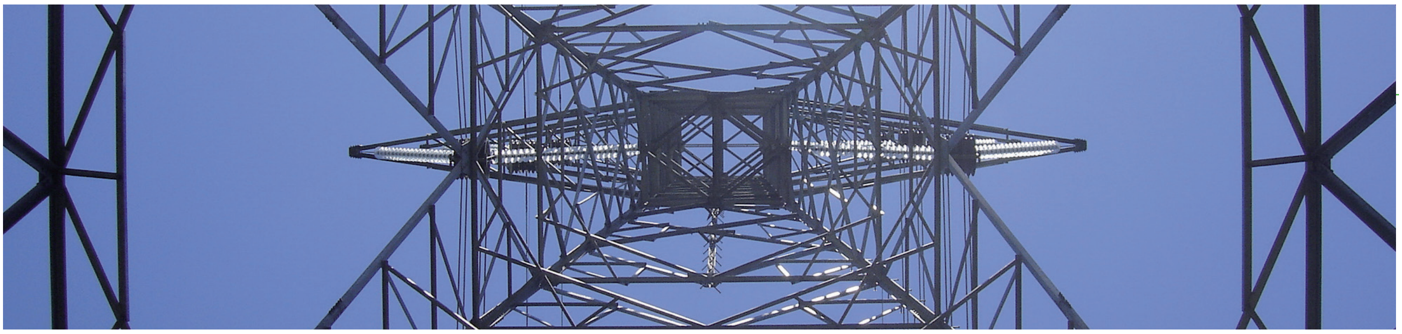
FACT SHEET

Energy use in the steel industry



The steel industry actively manages the use of energy. Energy conservation in steelmaking is crucial to ensure the competitiveness of the industry and to minimise environmental impacts, such as greenhouse gas emissions. Steel saves energy over its many life cycles through its 100% recyclability, durability and lightweight potential.

World crude steel production reached 1,691 million tonnes (Mt) in 2017. By 2050, steel use is projected to increase by 1.5 times that of present levels, to meet the needs of our growing population.[1]

Energy use in steelmaking

Steel production is energy intensive. However, sophisticated energy management systems ensure efficient use and recovery of energy throughout the steelmaking process for reuse, wherever possible. Improvements in energy efficiency have led to reductions of about 60% in energy required to produce a tonne of crude steel since 1960, as demonstrated in Figure 1.[2]

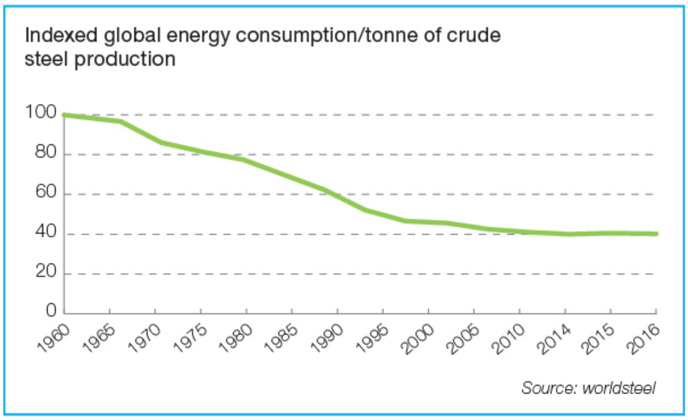


Figure 1: Indexed global energy consumption/tonne of crude steel production

worldsteel, with the help of its members, has developed a comprehensive and process specific energy benchmarking system that is available to its members only. It is stored on a secure data system and companies can submit data and compare their performance with a reference level for each process and determine what component in the process is deviating from the reference.

Energy inputs and associated costs

- Energy constitutes a significant portion of the cost of steel production, from 20% to 40%.[3, 4] Thus, improvements in energy efficiency result in reduced production costs and thereby improved competitiveness.
- The energy efficiency of steelmaking facilities varies depending on production route, type of iron ore and coal used, the steel product mix, operation control technology, and material efficiency.
- Energy is also consumed indirectly for the mining, preparation, and transportation of raw materials (about 8% of the total energy required to produce the steel - including raw material extraction and steel production processes).[5]
- About 50% of an integrated facility's energy input comes from coal, 35% from electricity, 5% from natural gas and 5% from other gasses.[6]

This includes the impact of raw materials on the process efficiency, including ore types, coal types and by-products generated per tonne of hot metal produced.

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.

Energy inputs as reducing agents

- The production of primary steel is more energy intensive than the production of secondary steel (see Figure 2) due to the chemical energy required to reduce iron ore to iron using carbon-based reducing agents. Because reduction does not take place at room temperature, reducing agents such as coal, coke and natural gas also provide the heat supply.
- Coke, made by carburising the coal (i.e. heating in the absence of oxygen at high temperatures), is the primary reducing agent of iron ore, and other fuels are used to substitute a portion of coke. If a plant doesn't produce its own coke and/or electricity on-site, these must be purchased externally.
- Up to 75% of the energy content of the coal at an integrated facility is consumed in the blast furnace, where in the form of coke it serves multiple roles including chemical reductant, furnace burden support, and acts as a fuel. The remainder provides heat at the sinter and coking plants and, in the form of by-product gas, serves as an energy source displacing other fuels to various downstream process stages.[7]

Table 1 shows the main energy inputs of steel production and their applications as energy and reducing agents.[3]

Energy input	Application as energy	Application as energy and reducing agent
Coal	-	Coke production, BF pulverised coal injection
Electricity	EAF, rolling mills and motors	-
Natural gas	Furnaces, power generators	BF injection, DRI production
Oil	Steam production	Blast furnace (BF) injection

Table 1: Applications of energy inputs in steel production[3]

By-product gases

- By-product gases from the coke oven, blast furnace and basic oxygen furnace (BOF) can be reused, saving additional fossil fuel and energy resources. They typically contribute 60% to total energy and are used either as a direct fuel substitute or for the internal generation of electricity.[7] Alternatively, gases can also be sold for power generation. They are flared only if no other option is available.
- Innovative technology now exists that allows CO_2 to be recaptured and remarketed, such as a steelmaking plant that is supplying a nearby gas facility with 50,000 tonnes of CO_2 per year. In turn, the gas is cleaned up and used to make carbonated drinks.

Future improvements in energy efficiency

- Today's best-available steelmaking processes have optimised energy use.
- Medium-term energy efficiency improvements in the steel industry are expected through technology transfer, or applying best-available technology to outdated steel plants worldwide.
- Breakthrough technologies are expected to lead to major changes in the way steel is made, with a time frame of 2020 and beyond.

Steel production basics

Steel is produced using primary or secondary methods, as shown in Figure 2.

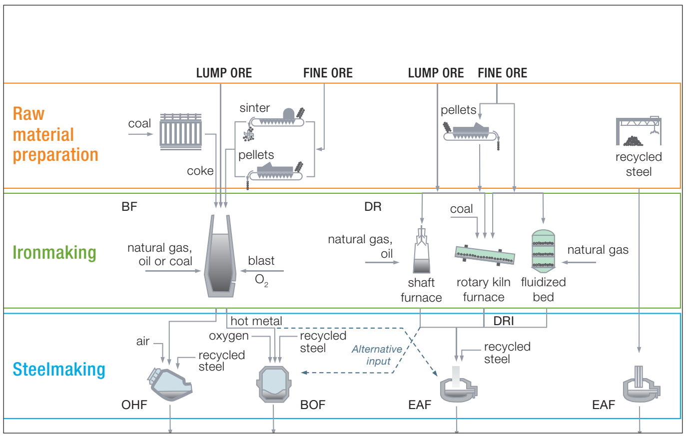


Figure 2: Steelmaking routes

Globally, steel is produced via two main routes: the blast furnace-basic oxygen furnace (BF-BOF) route and electric arc furnace (EAF) route, which are shown in Figure 2. Variations and combinations of production routes also exist.

The BF-BOF route produces steel predominantly using raw materials such as iron ore, coal, limestone and recycled steel. About 75% of steel is produced using the BF-BOF route. First, iron ores are reduced to iron, also called hot metal or pig iron. Then the iron is converted to steel in the BOF. After casting and rolling or/and coating, the steel is delivered as coil, plate, sections or bars.

Steel made in an EAF uses electricity to melt recycled steel. Depending on the plant configuration and availability of recycled steel, other sources of metallic iron such as direct-reduced iron (DRI) or hot metal can also be used. Additives, such as alloys, are used to adjust the steel to the desired chemical composition. Electrical energy can be supplemented with oxygen injected into the EAF. Downstream process stages, such as casting, reheating and rolling, are similar to those found in the BF-BOF route. About 25% of steel is produced via the EAF route.

Most steel products remain in use for decades before they need to be recycled. Therefore, there is not enough recycled steel to meet growing demand. Demand is met through a combined use of the BF-BOF and EAF production methods. Both these production methods use recycled steel scrap as an input. Consequently, all new steel contains recycled steel.

Steel saves energy over product life cycles

While steel products require energy to be produced, they can also offer savings over the life cycle of the product, sometimes greater than the energy used during their production.

For example, over 20 years, a three-megawatt wind turbine can deliver 80 times more energy than is used in its production and maintenance.[8]

Steel also reduces product life cycle energy use and emissions in other ways, including through:

- Lightweighting – New grades of Advanced High-Strength Steels (AHSS) enable carmakers to reduce vehicle weight by 25-39% compared to conventional steel. When applied to a typical five-passenger family car, the overall weight of the vehicle is reduced by 170 to 270 kg, which corresponds to a lifetime saving of 3 to 4.5 tonnes of greenhouse gases over the vehicle's total life cycle.[9]
- Long product life cycle – steel's strength and durability allow for long product life cycles. For example, buildings and bridges made with steel last 40 to 200 years, or longer with proper maintenance.
- Recycling – steel is easily recovered with magnets and is 100% recyclable. It can be infinitely recycled without loss of quality. Steel is the most recycled material in the world, with around 650 Mt recycled annually, including pre- and post-consumer scrap[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]

Last updated HR February 2018

Footnotes

1. Sustainable Steel: At the core of the green economy, p.11, worldsteel, 2012.
2. Steel's contribution to a low carbon future, worldsteel, 2014.
3. Saving One Barrel of Oil per Ton (SOBOT). American Iron and Steel Institute, 2005.
4. The State-of-the-Art Clean Technologies (SOACT) for Steelmaking Handbook, 2nd Edition, Asia Pacific Partnership for Clean Development and Climate, 2010, asiapacificpartnership.org.
5. LCA methodology report, worldsteel, 2011.
6. Energy intensity project report and energy intensity system, worldsteel, 2014.
7. Energy use in the steel industry report, worldsteel, 2014.
8. Danish Wind Industry Association, windpower.org
9. Sustainable Steel: At the core of the green economy, FutureSteelVehicle case study, p.31, worldsteel, 2012.
10. worldsteel estimates, 2018
11. Sustainable Steel – Policy and Indicators 2014, p.5, worldsteel.