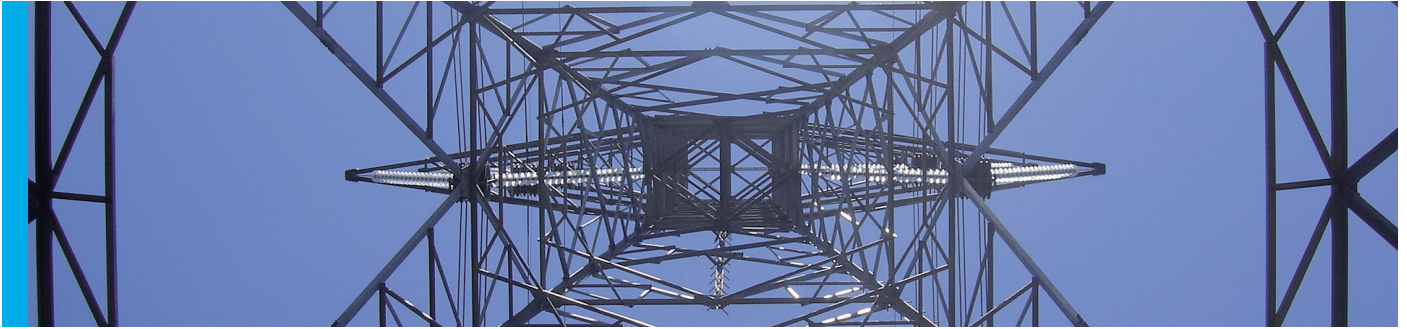


Energy use in the steel industry



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 1,860 million tonnes in 2020. Steel use is projected to increase steadily in the coming years to meet the needs of our growing population.

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 use within the steelworks boundary or exported from the site. 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 1.¹

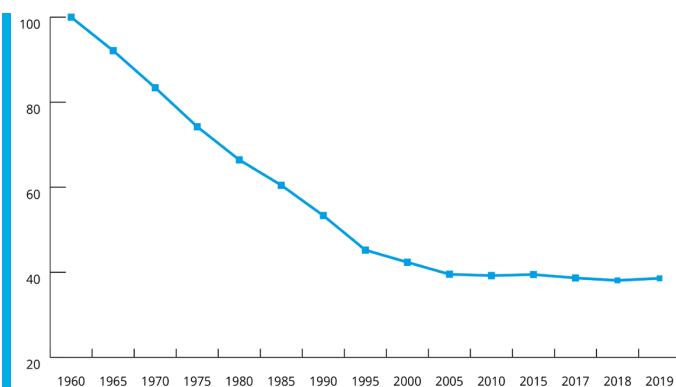


Figure 1: Indexed global energy consumption/tonne of crude steel production

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.

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

Energy inputs and associated costs

- Energy constitutes a significant portion of the cost of steel production, from 20% to 40%.^{2,3} 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 and quality 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. In the blast furnace-basic oxygen furnace (BF-BOF) route, this accounts for about 9% of the total energy required to produce the steel, including raw material extraction and steel production processes. In the electric arc furnace (EAF) route, this accounts for about 6% of total energy requirements⁴ (for details regarding the steelmaking routes, see Figure 2).
- About 89% of a BF-BOF's energy input comes from coal, 7% from electricity, 3% from natural gas and 1% from other gases and sources. In the case of the EAF route, the energy input from coal accounts for 11%, from electricity 50%, from natural gas 38% and 1% from other sources.⁴

Energy inputs as reducing agents

- The production of primary steel is more energy intensive than the production of secondary steel using scrap (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 supply energy for the heat needed.

- 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.
- 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 remaining 25% provides heat at the sinter and coking plants and, in the form of co-product gas, serves as an energy source (displacing other fuels) to various downstream process stages.⁵

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

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

Table 1: Applications of energy inputs in steel production

Co-product gases

- Co-product gases from the coke oven, blast furnace (BF) and basic oxygen furnace (BOF) are used, saving on additional fossil fuel and energy resources. They typically contribute to more than 60% of a steel plant's energy requirements and are used either as a direct fuel substitute or for the generation of electricity.⁵ Alternatively, gases can be used for power generation or exported off-site. They are flared only if no other use option is available.
- Technology now exists that allows CO₂ to be captured and sold, such as a steelmaking plant that is supplying a nearby gas facility with 50,000 tonnes of CO₂ per year.

Future improvements in energy efficiency

- Today's best-available steelmaking processes have the ability to optimise 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 when these new technologies reach commercial size and readiness levels.

Steel production basics

Steel is produced via [two main routes](#): the blast furnace-basic oxygen furnace (BF-BOF) route and electric arc furnace (EAF) route. Variations and combinations of production routes also exist.

The BF-BOF route produces steel using raw materials such as iron ore, coal, limestone and steel scrap. 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 and/or coating, the steel is delivered as strip, plate, sections or bars.

Steel made in an EAF uses electricity to melt steel scrap. Depending on the plant configuration and availability of steel scrap, other sources of metallic iron such as direct-reduced iron (DRI) or hot metal can also be used. Alloying materials 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 or even centuries before their function is no longer needed and they can then be reused, remanufactured or 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 routes. Both these production routes use recovered steel scrap as an input. Consequently, all new steel contains some 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 the production and maintenance of the material used.⁶

Steel in the circular economy

Steel can also reduce product life cycle energy use and emissions in other ways, by maximising the value of resources through improved product design, recovery and reuse, remanufacturing and recycling. Refer to the circular economy section under worldsteel.org for more information on this topic.

April 2021 | HR/CB/IM

Footnotes

1. worldsteel calculation
2. Saving One Barrel of Oil per Ton (SOBOT). American Iron and Steel Institute, 2005.
3. The State-of-the-Art Clean Technologies (SOACT) for Steelmaking Handbook, 2nd Edition, Asia Pacific Partnership for Clean Development and Climate, 2010, asiapacificpartnership.org.
4. Calculated from worldsteel LCI database, 2018
5. Energy use in the steel industry report, worldsteel, 2014
6. Danish Wind Industry Association, windpower.org