The industrial steel blueprint represents a typical production layout in the steel sector. It covers the major steps and the related energy as well as material requirements of the steel classical production route (Blast Furnace-Basic Oxygen Furnace route). Therefore, the steel blueprint allows the other industrial sectors or other potential industrial symbiosis (IS) partners to check the different material and energy streams available in the neighbouring steel plant.

**INTRODUCTION**

The industrial steel blueprint represents a typical production layout in the steel sector. It covers the major steps and the related energy as well as material requirements of the steel classical production route (Blast Furnace-Basic Oxygen Furnace route). Therefore, the steel blueprint allows the other industrial sectors or other potential industrial symbiosis (IS) partners to check the different material and energy streams available in the neighbouring steel plant.

**THE STEEL BLUEPRINT**

In the process of finding industrial symbiosis potential between two IS partners, the first and most complicated part is the understanding of the partner’s processes and knowing the types of material and energy involved in the processes. In the EPOS project, the sectors’ blueprints were created to address this. The steel blueprint is one of the sector blueprints in EPOS.

Steel is produced globally by two major routes: the classical blast furnace/basic oxygen furnace route for producing steel from iron ore, recycled steel, coal, and minerals; and the electric arc furnace route which recycles steel scraps. From a heating, cooling and materials perspective, the former is inherently more interesting for industrial symbiosis as the process operates at a variety of temperatures and includes additional steps (coke plant, sinter plant, BF, etc.). Additionally, this process represents approximately 60% of the steel production in EU27 countries and thus is the main contributor to the sector’s energy and material consumption. A simplified representation of the BF/BOF steelmaking process is represented by the flowsheet in Figure 1.

![Figure 1: Flowsheet showing the major steel production processes](image-url)
Steel production begins with the sinter plant where iron ore is mixed with other materials and undergoes a combustion process to yield the blast furnace iron source, referred to as sinter in the industry. The other initial process is the reduction of coal to coke to provide a reducing agent for the iron ore in the blast furnace. Coal feedstock undergoes a pyrolysis reaction at high temperature to remove non-carbon elements, principally oxygen and hydrogen. This reaction encourages the evolution of a mixed gas stream (coke oven gas). Prepared sinter and coke enter the blast furnace where iron oxides are reduced by coke. The resulting product, pig iron, is produced in its liquid form at approximately 1,500 °C at the bottom of the blast furnace. Another mixed gas stream, blast furnace gas, is also produced in this unit and is commonly treated and reused elsewhere, as with the coke oven gas. Hot metal is fed to the basic oxygen furnace where the final adjustments of the steel are performed. Various trace materials, in addition to recycled steel scrap, can be added at this stage to adjust the steel composition and properties. Injection of oxygen to adjust carbon content produces additional heat from the oxidation reaction, thus also requiring careful temperature control. Yet another gaseous stream is produced, basic oxygen furnace gas, and undergoes processing/reuse. The finished steel is cast from its liquid state into solid slabs at approximately 900 °C and is stored in slab yards where they are cooled down. Hot rolling is a typical final step in the integrated iron and steel plant where steel slabs are heated for malleability and then rolled into steel coils which are the final products.

**MATERIAL PROFILE**

The process described above includes raw materials use, by-products generation and waste generation. Some of the by-products are reused in the process (sludges, scraps, scales, etc.) The Sankey diagram presented in Figure 2 represents the material flows in the steel production processes. The loops represent the recycling of some by-products internally.

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![Sankey diagram](image-url)
ENERGY (GAS AND ELECTRICITY) PROFILES

The Sankey diagram representing energy (gas) and electricity flows in the steel production process are shown in Figure 3. The steel blueprint includes the distribution of energy flows between the different processes as well as the residual waste heat from these processes that could be recovered internally or through industrial symbiosis.

Figure 3: Energy flows in the steel production process

FLEXIBLE AND SIZABLE BLUEPRINT

The information needed to build the blueprint was collected from many steel plants in Europe in order to make the blueprint the most representative of the sector. It has been validated with the values in the BAT (Best Available Techniques (BAT) Reference Document for Iron and Steel Production). Default parameters were calculated to correlate the values of these flows with the steel production. The user is then able to change the production of the plant (which is usually public information) and all the values of material and energy flows will change automatically. Moreover, the blueprint is flexible in that each parameter can be changed (the correlations, the quantities of flows etc.) in case the plant parameters are known exactly.

CONCLUSION

The steel blueprint is presented in this insight. It gives a general representation of the steel production plant (BF route), the different material and energy flows involved. The steel blueprint is flexible and sizable for use in order to check industrial symbiosis potential, especially when using the EPOS toolbox.