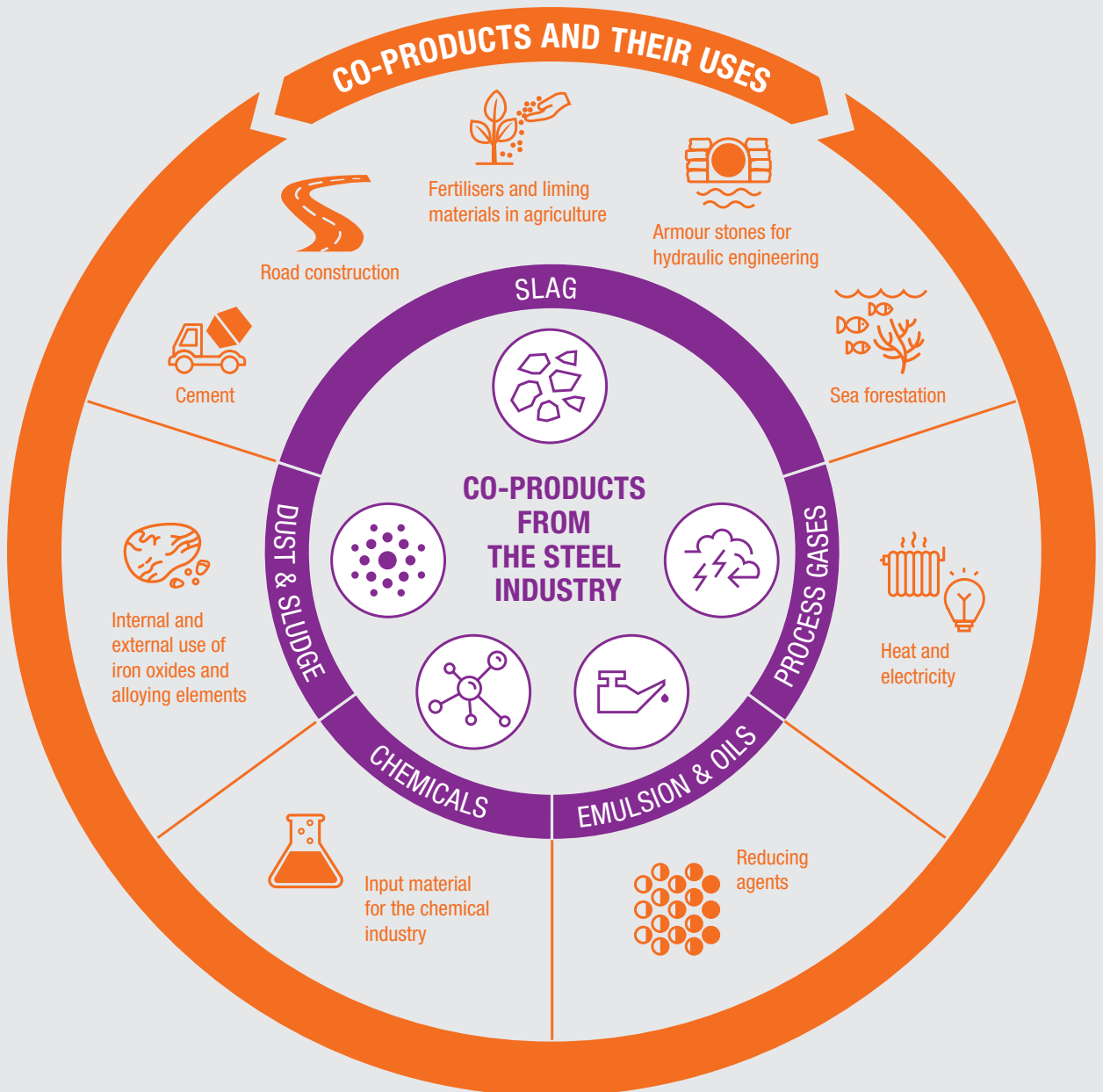


# STEEL INDUSTRY CO-PRODUCTS

worldsteel position paper



**Over the past 20 years, the use of the steel industry's co-products has increased significantly.**

Innovative technology developments and synergies with other industries have brought the steel industry ever closer to its goal of zero waste to landfill.

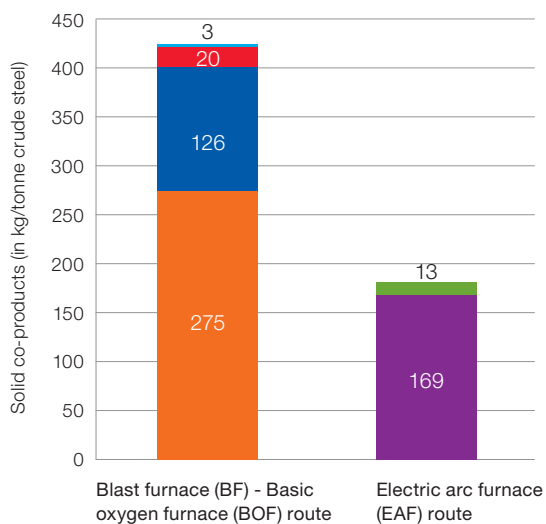
In this paper, co-products refer to materials that are produced in parallel to or, as a consequence of, the production of a primary product and which also have a potential value.

The main solid co-products produced during iron and crude steel production are slags (90% by mass), dust and sludge.

On average, the production of one tonne of steel results in around 200 kg of co-products for the electric arc furnace (EAF) route and 400 kg for the blast furnace - basic oxygen furnace (BF-BOF) route.

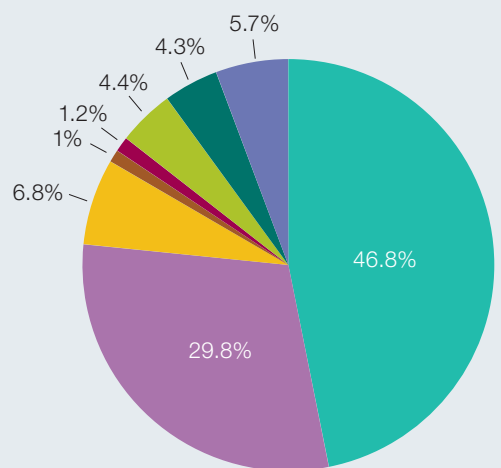
Alongside solid co-products, process gases from coke ovens, BFs or BOFs are also important steelmaking co-products.

**Main solid co-products per steelmaking route<sup>1</sup>  
(average outputs in kg/tonne crude steel)**



- Ironmaking slag (BF)
- Steelmaking slag (BOF)
- Ironmaking dust and sludge (BF)
- Steelmaking dust and sludge (BOF)
- Steelmaking slag (EAF)
- Steelmaking dust and sludge (EAF)

**Use of iron and steelmaking slags in Europe\*<sup>2</sup>  
in 2016 - total 41 Mt**



- Cement, concrete additive, etc.
- Road construction
- Metallurgical use
- Hydraulic engineering
- Fertiliser
- Other
- Interim storage
- Landfill

\*At a global level, percentages vary from region to region

<sup>1</sup> Steel Industry By-products report, worldsteel 2010

<sup>2</sup> EUROSLAG – The European Slag Association, 2017

## The use of steel industry co-products

Co-products from the steel industry have many uses within the industry itself, in other industries and in wider society. In some cases, it is the physical properties that determine the use, such as steelmaking slag used as aggregates in road construction; and sometimes it is the chemical composition e.g. process gases used as fuel to produce heat and/or electricity. Valuable non-ferrous metals can also be recovered from slags, dust and sludge when the concentrations are sufficient.

### Some examples of common uses of steel industry co-products:

- Blast furnace slag – substitute for clinker in cement-making
- Steelmaking slag – aggregates in road construction, soil improvement
- Process gases – heat and electricity production
- Dust and sludge – internal and external use of iron oxides and alloying elements
- Petrochemicals from cokemaking – tar, ammonia, phenol, sulphuric acid and naphthalene for the chemical industry
- Emulsions from mills and used oil – reducing agent in blast furnaces or used in coke plants.

In all cases, using a steel industry co-product as a substitute for an equivalent product will improve resource efficiency and contribute to the circular economy.

## Ongoing technological development

Technological development in the production and processing phases, with the aim of producing co-products with uniform and improved properties, is a continuous effort that will further increase co-product usage rates and, more importantly, expand their use by improving the quality of the materials recovered.

Recent developments include demand management and refocusing the production process to better control the properties of the co-products.

## Public and political perception

Today, there is no uniform legal definition of co-products; it varies from country to country and sometimes even between different pieces of legislation. When co-products are not clearly differentiated from waste, it creates unnecessary hurdles for the use and transport of co-products as well as issues around public and political perception.

→ It is necessary to clearly differentiate co-products from waste in legislation to improve the perception of co-products and to encourage their use.

### VALUE FOR THE COMMUNITY › Use of process gases

Process gases from iron and steelmaking (from the coke oven, BF and BOF) once cleaned, are used internally as reducing agents in the BF, to produce steam and to fuel reheating furnaces. They are also used as fuel in power plants to produce electricity either on or off site. Typically, part of this electricity is then used by the steel plant while part is used by local communities or neighbouring industries.

When gases are fully reused within the steel production site they can provide between 60 to 100% of the plant's electricity requirements<sup>1</sup> depending on the configuration of the plant. The gases are flared only if no other option is available.

<sup>1</sup>Energy use in the steel industry, worldsteel, 2014

## Regulatory framework

Beneficial use of steelmaking co-products will reduce the energy and emissions required to make equivalent products. Their use should therefore be given preferential treatment, or at least be encouraged.

worldsteel believes it should be possible to substitute equivalent products for co-products within the same legal framework. This should include the application of identical quality and environmental testing requirements and limits for primary and secondary materials. For example, leachate levels for slags used in road construction should also be applicable to natural aggregates of diverse geological origin.

Furthermore, the development of international/regional quality standards for applications of co-products may improve public and political perception of co-products.

- **The use of co-products should be encouraged, thereby saving natural resources and energy.**
- **Legislation should in the best case give precedence to the use of co-products or should at least avoid stricter requirements for their use.**
- **Legislative frameworks that promote the use of process gases would save fossil fuels and reduce CO<sub>2</sub> emissions from gases that are still flared.**

## Circular economy, resource efficiency and zero waste

The use of co-products has contributed to a material efficiency rate in the steel industry of 96.3% worldwide<sup>1</sup> (average of all steel industry efficiency rates). Our goal is the 100% efficient use of raw materials and zero waste.

Co-products can be used during the steelmaking process or sold for use by other industries. This increases resource efficiency, prevents landfill waste and reduces CO<sub>2</sub> emissions. The sale of these co-products is also economically sustainable. It generates revenues for steel producers and forms the base of a viable industry worldwide.

Minimising waste and ensuring resources remain in use for as long as possible are key to achieving a sustainable circular economy.

For example, replacing Portland cement with slag cement in concrete can save up to 59% of the embodied CO<sub>2</sub> emissions and 42% of the embodied energy required to manufacture concrete and its constituent materials<sup>2</sup>.

- **There is a need for a holistic approach in the use of co-products where all environmental, energy and resource aspects are considered.**
- **There should be strong support for the use of co-products in legislation and the development of new applications should be promoted.**
- **Partnerships with local communities should be encouraged as the steel industry can be a reliable partner by providing process gases, steam or excess heat to the local community.**

<sup>1</sup> Sustainable steel – Indicators 2018 and industry initiatives, worldsteel 2018

<sup>2</sup> Slag Cement Association

## Research

In order to use more of the steel industry's co-products and achieve the maximum benefit from this use, research into processes, processing and applications is continuously being conducted.

For example, research is ongoing in the field of Carbon Capture and Use (CCU), which in the future could allow the capture of the CO<sub>2</sub> in the process gases, and its subsequent use, for example in the chemical industry.

To make further progress, however, the steel industry would benefit greatly from partnerships with other industry sectors as well as government support. This would also increase knowledge among policy makers and hopefully initiate discussions on the necessary legal frameworks.

→ Research into new applications of co-products would greatly benefit from increased government support.



### Circular economy

Ensuring the maximum value of resources through product design, recovery and reuse, remanufacturing and recycling.



### Zero waste

Ensuring that raw materials and co-products are fully utilised and no material is going to landfill.

## INDUSTRY APPLICATION ›

### Recycling of iron bearing materials

A number of co-products with a high iron content are generated throughout the steelmaking process. These include dust and sludge from the wet and dry abatement equipment, mill scale from the hot rolling mill and iron ore and sinter fines. The valuable iron content from these co-products is recovered and returned to the steelmaking process, replacing virgin material and contributing to a more efficient use of resources.

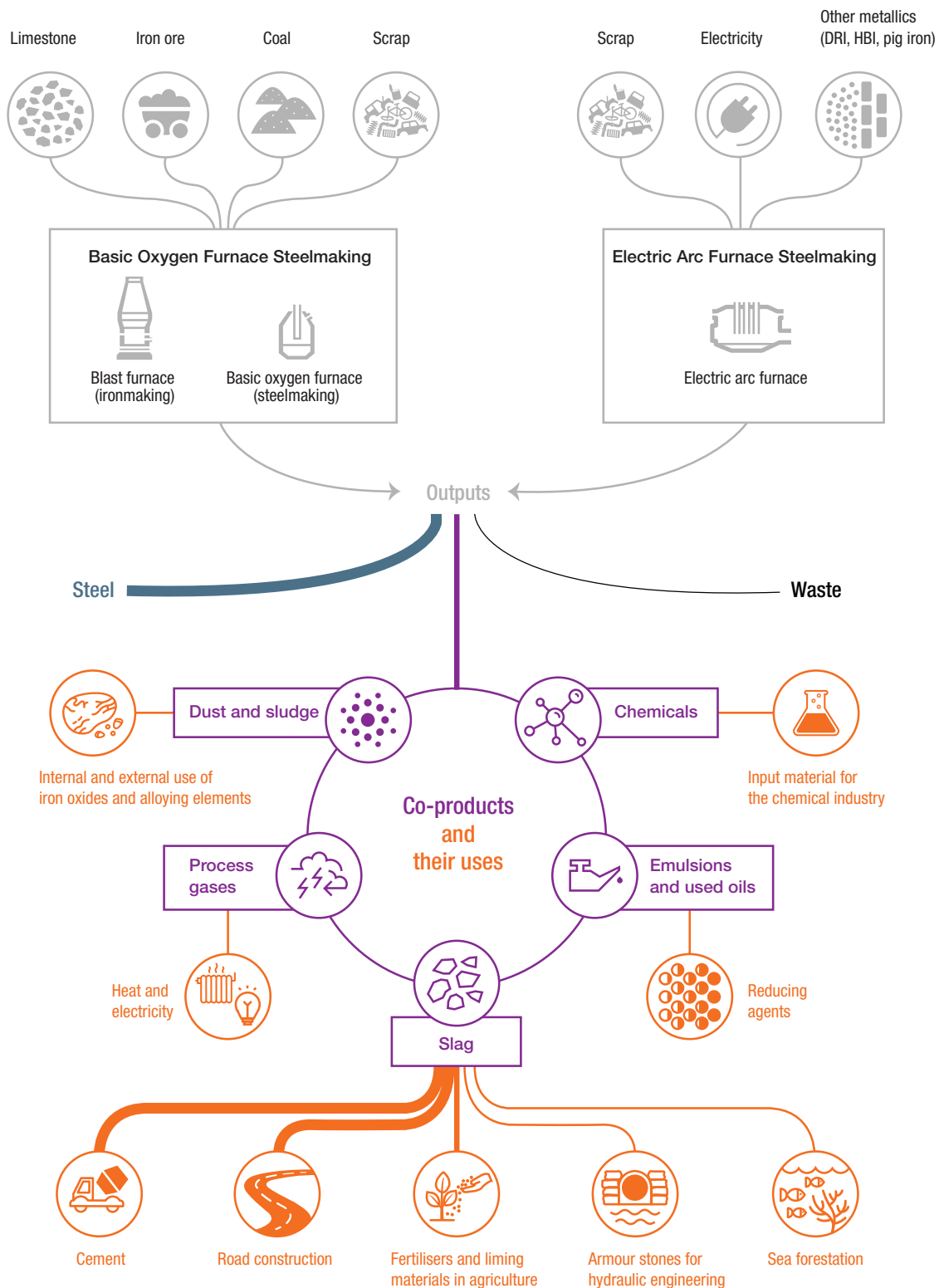
## VALUE FOR OTHER INDUSTRIES › From construction to healthcare to agriculture



Tar is a cokemaking co-product that is used as a seal coating material in the construction sector and to produce paints and synthetic dyes. As a medication, tar can be further processed and used in applications such as soap and shampoo to treat dandruff and skin conditions (psoriasis). Sulphur is used to vulcanise rubber and manufacture sulphuric acid but is also used in insecticides and fertilisers. These are just a few examples that demonstrate the value of co-products for many industries, presenting an environmental advantage by preserving virgin materials.

# STEEL INDUSTRY CO-PRODUCTS

## Steel production and co-products at a glance



The use of co-products should be encouraged to:

Reduce CO<sub>2</sub> emissions

Prevent landfill waste

Increase resource efficiency

Generate revenue