

# ***E.S.C.H.***

Engineering Service Center und Handel GmbH



**INNOVATIVE SOLUTIONS FOR  
SUSTAINABLE STEEL PRODUCTION**



## **WASTE PLASTIC INJECTION**

**into the tuyeres  
of the blast furnace**



**OUR TECHNOLOGY AS A KEY TO  
RESOURCE EFFICIENCY AND  
CO<sub>2</sub> REDUCTION**

**[www.esch-online.de](http://www.esch-online.de)**

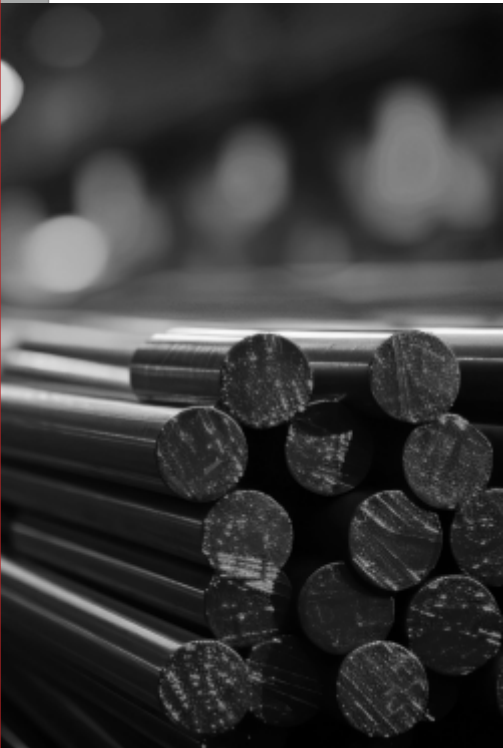
# SteelPRODUCTION

is among the most resource- and energy-intensive industries globally.

As demand for more sustainable and environmentally responsible production methods rises, the need for innovative solutions becomes increasingly critical.

We provide cutting-edge technologies for incorporating plastic waste and other by-products as alternative fuels in the blast furnace process.

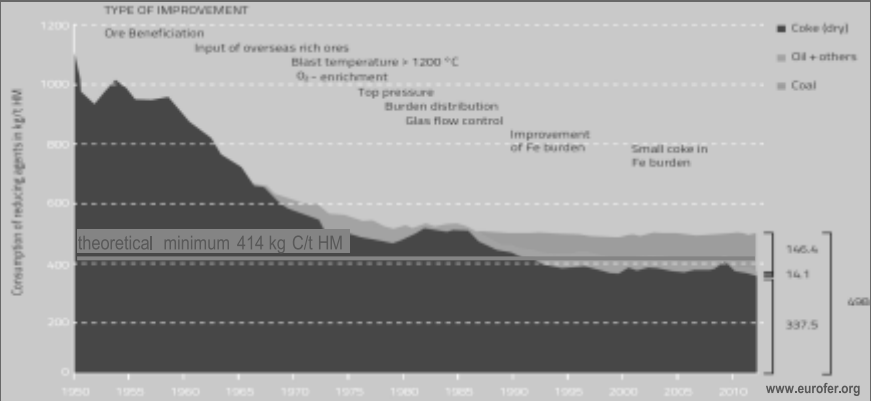
These solutions offer a transformative approach to reducing CO<sub>2</sub> emissions, optimising production efficiency, and lowering operational costs, positioning you at the forefront of sustainable steelmaking.



## The Role of Steel in the Global Economy

Steel is an essential material in countless industries, from automotive to construction. However, its production carries a heavy environmental footprint and high energy demands.

Over the years, the steel industry has adopted various technologies and fuels to replace traditional coke. These advancements aim to enhance production efficiency while simultaneously reducing the environmental footprint. By utilising alternative energy sources such as oil, coal dust, and plastic waste, the industry has been able to lower CO<sub>2</sub> emissions and improve the cost-effectiveness of steel production.



Historical development of the steel industry: Optimization of reducing agents and the gradual replacement of coke with alternative fuels to minimize coke a in production processes.

Coke Replacement Calculations for Injection Fuels									
Injection Fuel (dry basis, wt%)	Coal JSAW	SKS	BKS R	LVC	HVC	Plastics	Heavy Oil	Natural G.	COG
Carbon	72,00	76,00	63,31	91,22	77,86	72,66	87,87	75,00	42,00
Hydrogen	9,00	6,00	4,66	1,11	4,73	9,32	10,79	25,00	21,83
Nitrogen	2,00	3,00	0,61	0,49	1,71	0,29	0,49	0,00	15,67
Oxygen	5,50	5,00	24,94	0,00	4,71	11,98	0,00	0,00	18,30
Sulfur	0,50	0,50	0,71	0,74	1,03	0,10	0,85	0,00	2,20
Ash	11,00	9,50	5,77	6,14	9,95	4,90	0,00	0,00	0,00
Total	100,00	100,00	100,00	99,70	99,99	99,25	100,00	100,00	100,00
Moisture of fuel at injection	1,00	1,00	10,00	1,00	1,00	0,00	0,20	0,00	1,00
Heating Value (low), dry base									
Kilo Joule per kg (kJ/kg)		30000,00	24058,67	28000,00	28000,00	30000,00	40917,12		38680,26
Gas Utilization (%)	Replacement Ratio (kg of coke to be replaced by ONE kg of injection fuel)								
50	0,807	0,842	0,576	0,823	0,771	0,750	1,165	1,201	0,908

## The Need for Sustainable Transformation

Tighter CO<sub>2</sub> regulations and rising demand for greener products necessitate a rapid shift to more sustainable manufacturing methods. The steel industry must adapt by optimising processes that are both economically and ecologically viable.



# Facts

The steel sector  
accounts for  
**7-9%**  
of global  
**CO<sub>2</sub>**  
emissions

**400** million tonnes  
of plastic waste are produced globally  
each year

**9%** of plastics  
is mechanically recycled  
most ends up in landfills  
or incineration

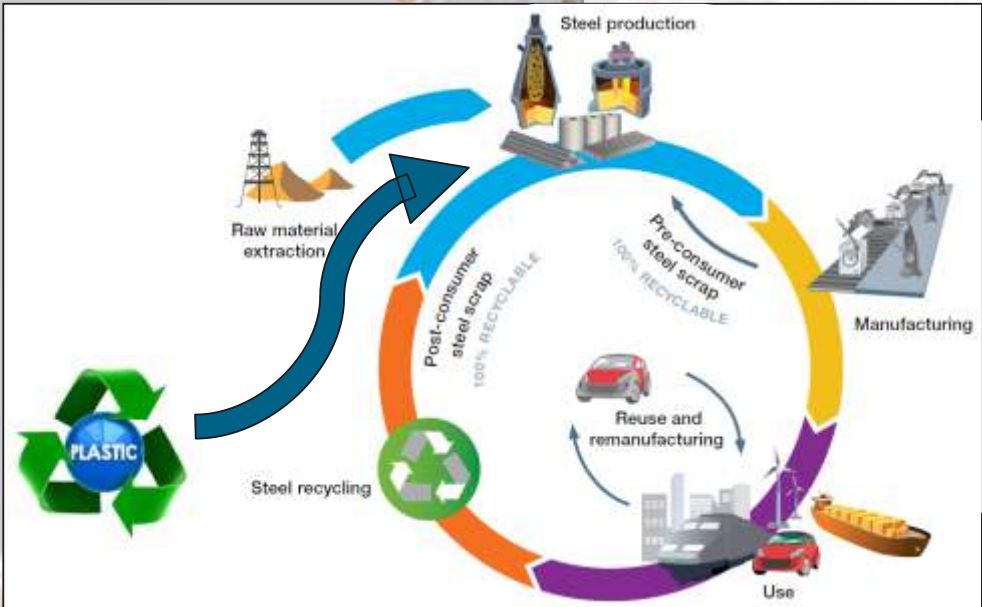
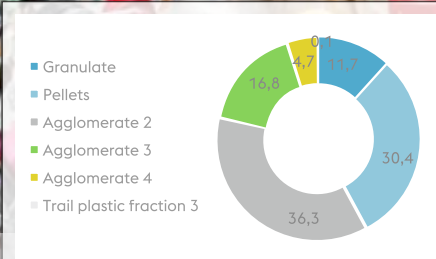


Image: “Using the steel life cycle for waste plastic recycling (reuse)”  
Illustration showing how plastic recycling fits into the steel production life cycle.

# Two GLOBAL CHALLENGES One INTEGRATED SOLUTION

## Linking Both Challenges

By transforming plastic waste into blast furnace fuel, we address two global problems: plastic pollution and industrial emissions. Our technology provides an immediate, scalable solution that fits seamlessly into existing infrastructures.

# WASTE PLASTIC INJECTION

into the tuyeres of the blast furnace  
using advanced **E.S.C.H.** Technology

- Calorific value to ensure stable BF operationm 30-35 MJ/kg
- Grain size distribution:
  - Oversize 8-10mm: < 1-2%
  - Fines/Dust 0-1mm: < 3-5%
  - Mixtures of different kinds are possible
- Chemical composition: Chlorine < 1%
- Moisture content: < 1,5%



Solidified and formed material, 4–8 mm in size, with a maximum single oversize particle < 10 mm



Loose and irregular particles, 2–6 mm in size, with a maximum single oversize particle < 8 mm



Hard and firm material, derived from the shredder residue treatment process, with a particle size of 1–4 mm

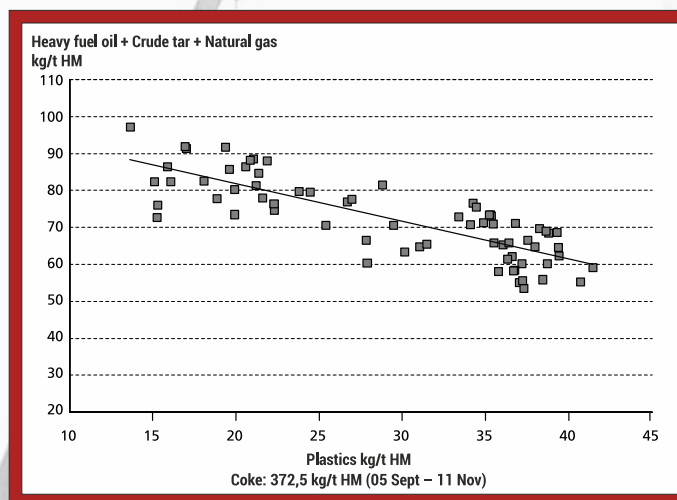


# Industry Benefits

## Sustainability Meets Profitability A New Approach to Steelmaking

### Process Efficiency and Optimisation

Efficient fuel use enhances production rates and overall energy performance.



## With 220.000 tonnes

of specified mixed plastic waste used as a reducing agent in BF's, we unlock powerful savings:

More than  
**400.000 tonnes**  
of CO<sub>2</sub> emissions avoided  
annually, plus significant  
reductions in SO<sub>2</sub>  
and dust

Over **10 million GJ** of  
energy saved – enough to  
supply **410.000** people in  
Germany with heat and  
hot water for a year

**880.000 m<sup>3</sup>** of landfill  
avoided – that's **11.000**  
fewer truckloads

## Cost Savings

Use of local plastic waste significantly  
reduces energy costs by cutting  
dependence on expensive fossil fuels.

# CO<sub>2</sub>

## Emission Comparison

**Up to 1,5 tonnes savings**  
per tonne of plastic used.

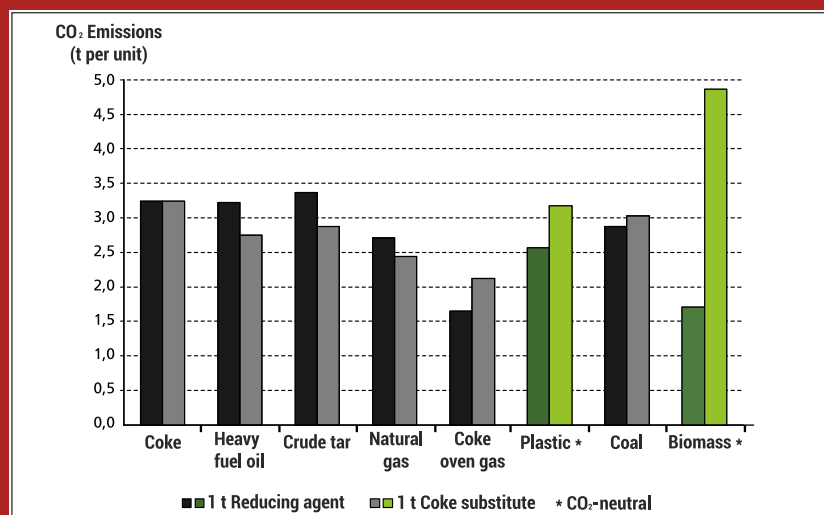


Image: "Substitution Ratio and CO<sub>2</sub> Emissions of Various Reducing Agents"  
Comparison of different reducing agents and their impact on CO<sub>2</sub> output.



# FROM WASTE TO Valuable Fuel

## Advanced Feedstock Recycling in the Blast Furnace

Plastic waste is processed and fed into the furnace through specialised systems. Once inside, it gasifies at high temperatures, forming a syngas of CO and H<sub>2</sub> that reduces iron ore.

- » Transformation of waste plastics to CO and H<sub>2</sub> in the high temperature zone:  
 $2C + 2H + O_2 = 2CO + H_2$
- » Smelting reduction process of iron oxides:  
 $Fe_2O_3 + 2CO + H_2 = 2Fe + 2CO_2 + H_2O$

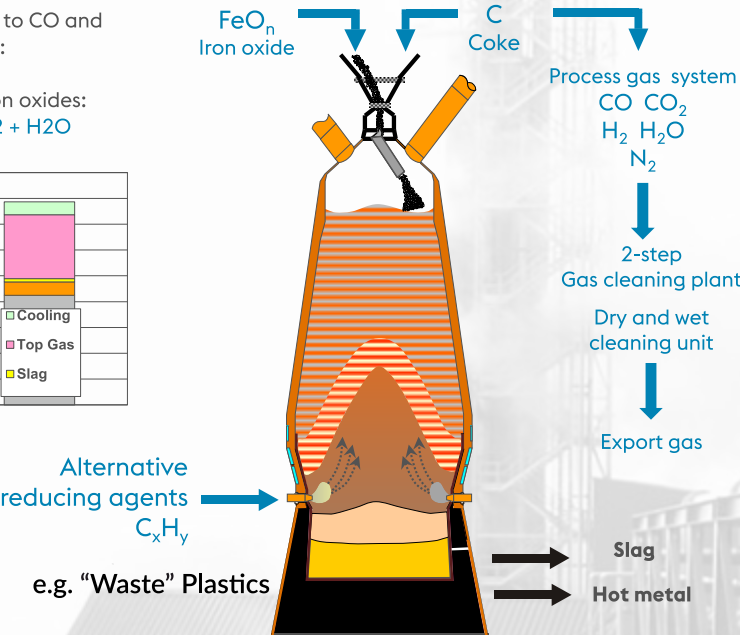
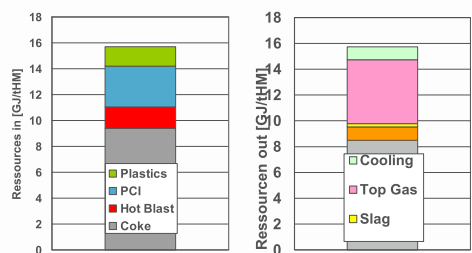


Image: "Blast Furnace Process Technology"  
Diagram of the blast furnace process incorporating alternative fuels, e.g. "Waste" Plastics.

## Injection Technology IN DETAIL

### Media Flexibility

Multi-lance configurations enable parallel or selective injection of different reducing agents (e.g. heavy fuel oil, coke oven gas, natural gas, plastic granulate).

### Adaptability

Modular system design allows for gradual integration of additional injection media and adjustment to changing process requirements.

### Operational Reliability through Redundancy

Redundant lances ensure uninterrupted injection during maintenance or failure of individual lances.

### Compatibility with CO<sub>2</sub> Reduction Strategies

Enables the use of alternative or secondary carbon carriers within existing blast furnace infrastructure.

### Process Stability via Improved Distribution

Enhanced flow and thermal distribution in the raceway zone due to optimised positioning and control of injection points.



High-precision lances enable controlled injection of alternative fuels directly into the raceway of the blast furnace.

- Up to 100 kg plastic waste per tonne of hot metal
- Up to 75% substitution of conventional fuels

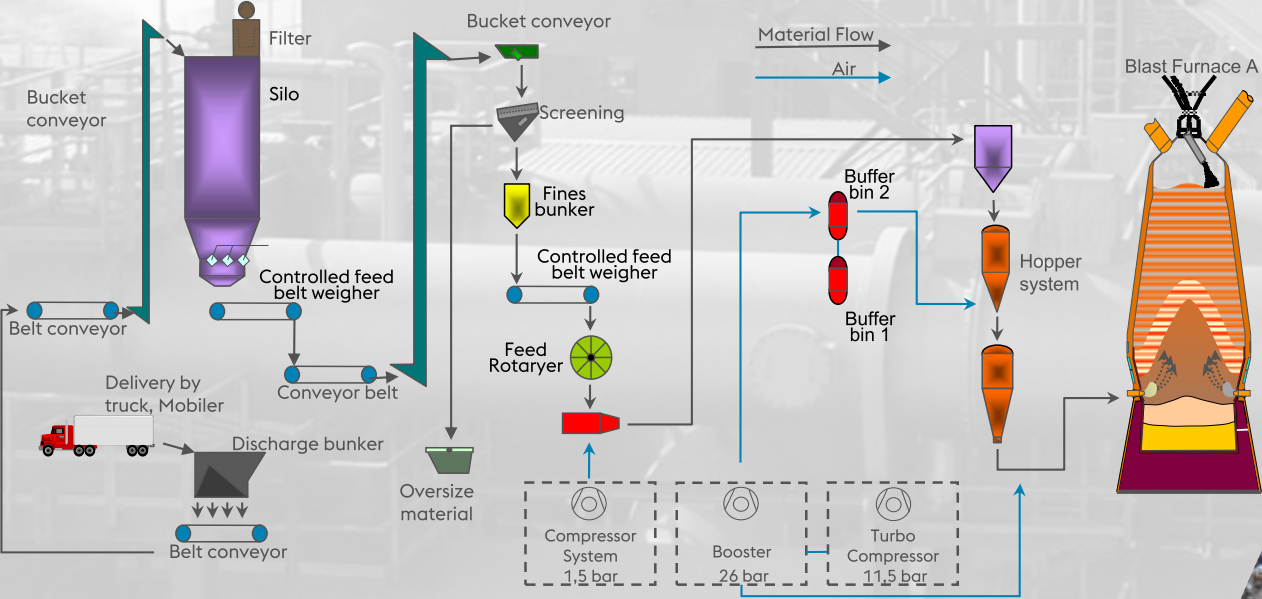
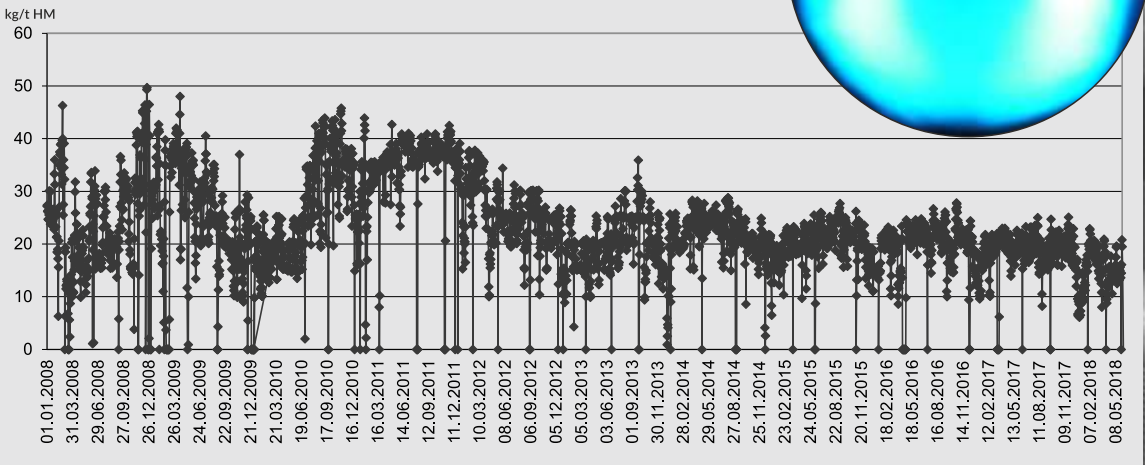


Image: "System Schematic of Plastic Injection into the Blast Furnace"  
Visual representation of how plastics are integrated into the furnace system.





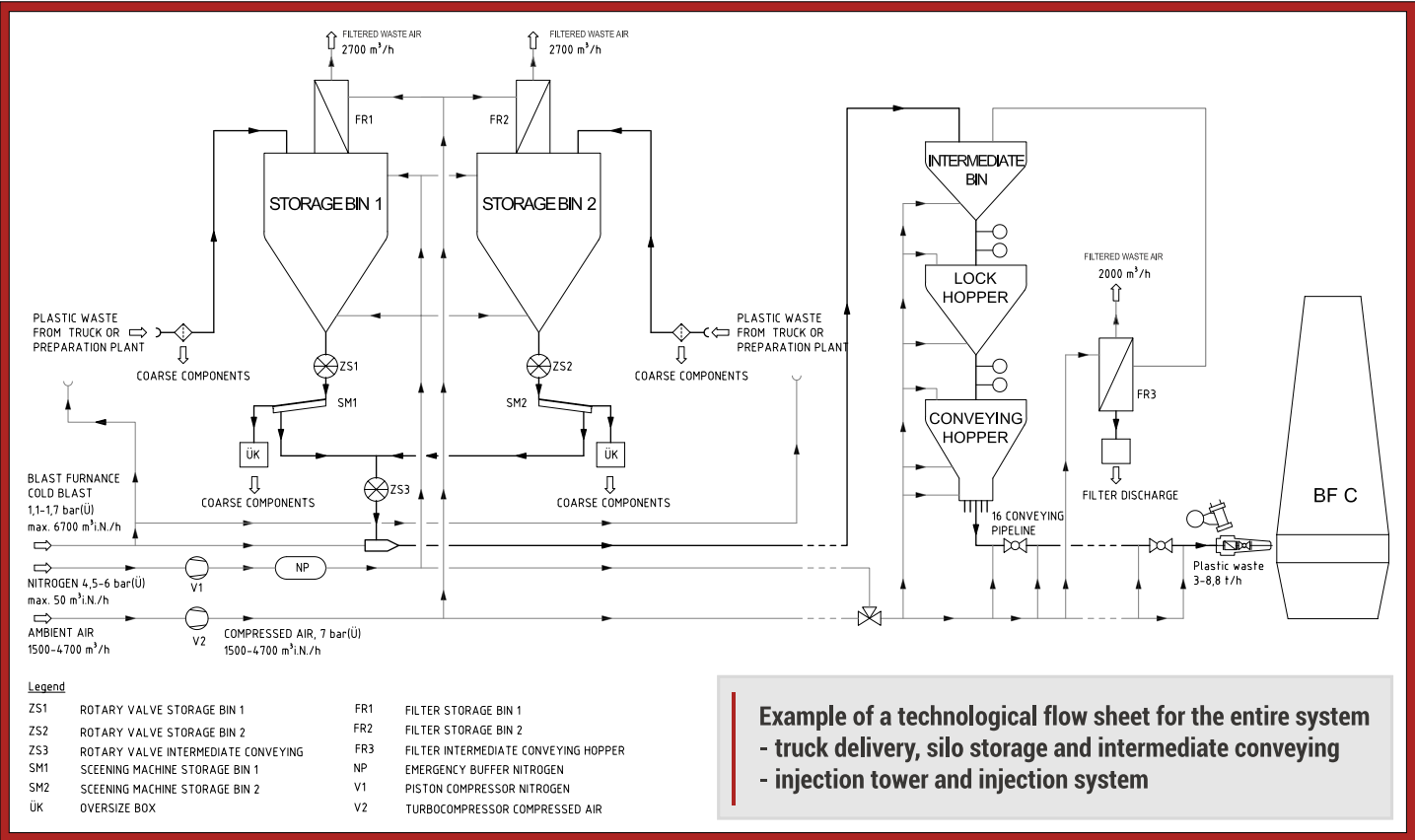
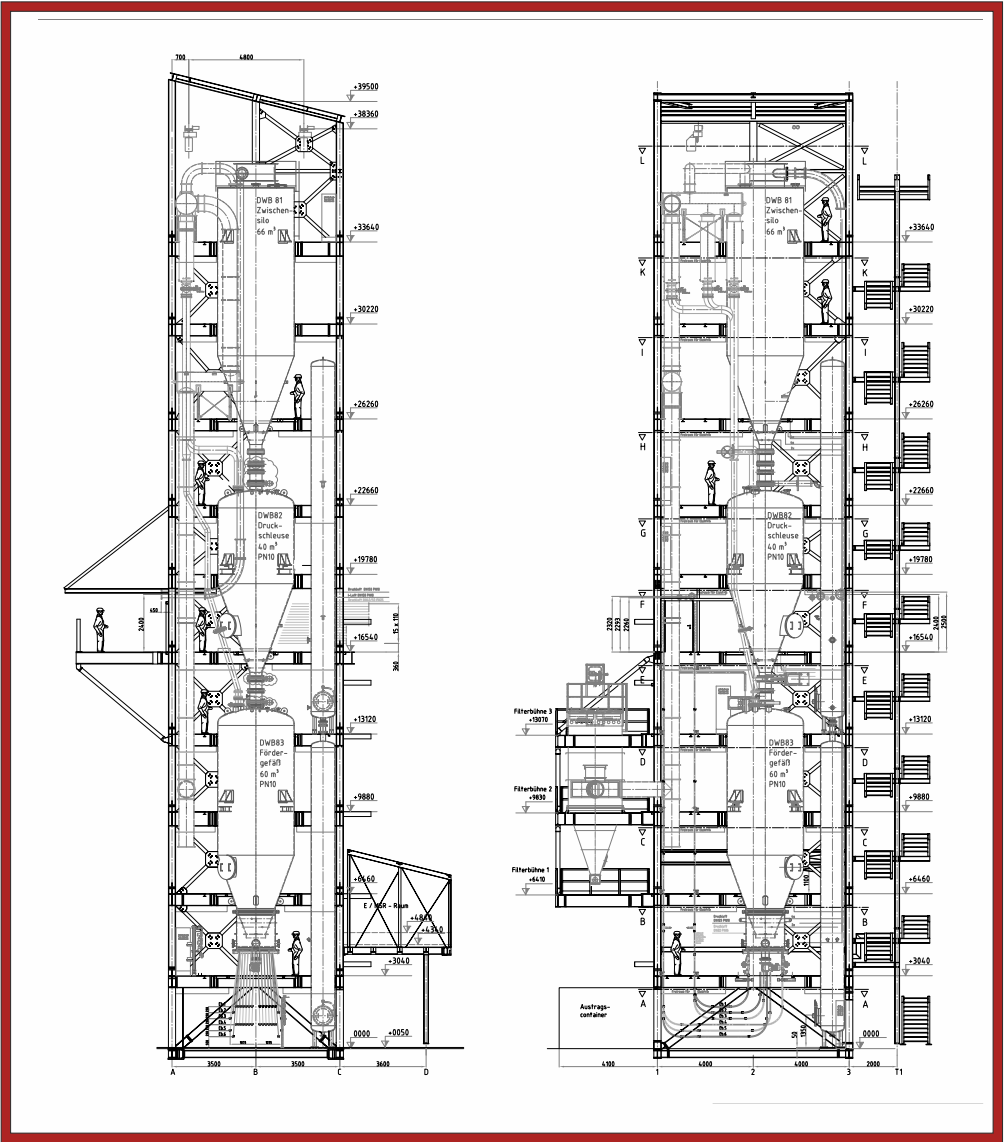
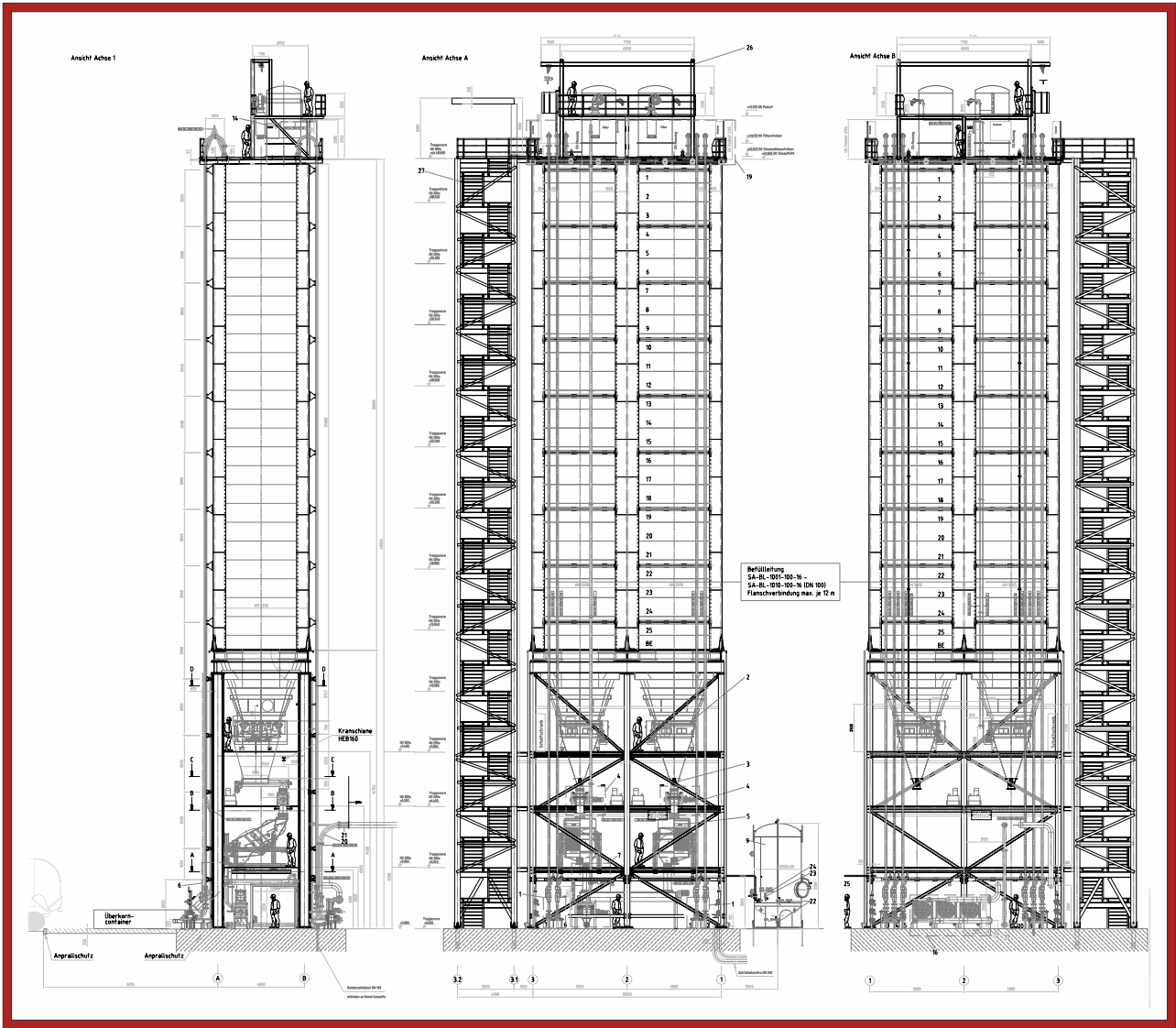
# Project Engineering

From feasibility studies to full-scale operations, our engineering expertise ensures seamless integration and reliable performance.

Each solution is custom-engineered to match client-specific furnace and waste conditions.

At **E.S.C.H.**, we're more than just a provider – we're your **partner in innovation**. From **feasibility studies** to **full-scale operation**, we offer **tailored solutions** designed to meet the unique needs of your furnace and waste conditions. Our engineering expertise ensures that your system integrates seamlessly, delivering **reliable performance** from day one.

Every solution we offer is **custom-built** with your specific goals in mind, ensuring optimal efficiency and long-term sustainability. With us, you get everything you need under one roof: **design, engineering, implementation, and ongoing support**, all backed by our commitment to excellence.





# REALIZED PROJECTS

## & EXAMPLES OF CORE COMPONENTS

Compressed air station with dryers



Silo storage discharge equipment



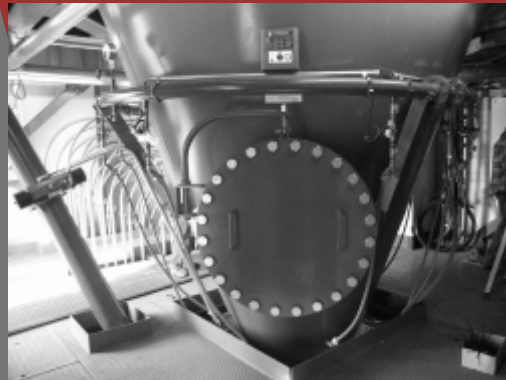
Screening and sieving for oversize grain



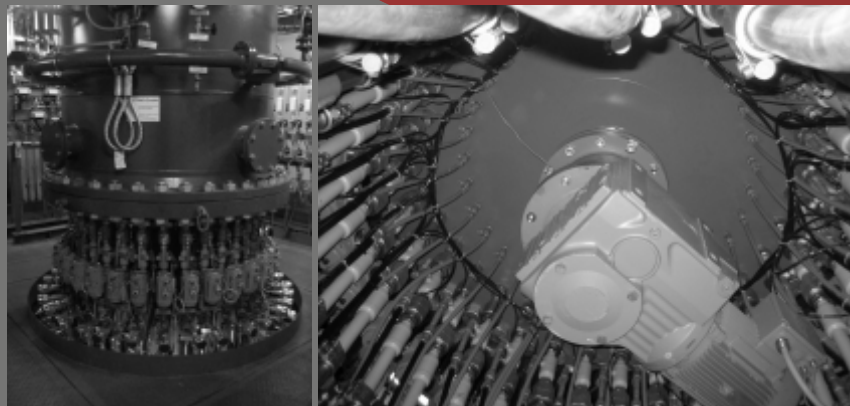
Single conveying pipelines



Special nozzle system for movement of plastic waste in the pressure vessels



Pressure vessel discharge for equal distribution to 32 single conveying pipelines



## Proven Success in Plastic Waste Utilisation for Blast Furnace Operations

Voestalpine has successfully implemented the use of **processed plastic waste** in blast furnace operations for years, achieving remarkable results. With a capacity of **up to 220.000 tonnes of plastic waste per year**, this innovative approach has enabled the significant reduction of heavy fuel oil consumption, optimizing both environmental performance and process efficiency.

Since the successful completion of initial trials in **2006**, where **30.000 tonnes of plastic-based materials** — including pellets, agglomerates, and granules — were utilized, the technology has proven its effectiveness in real-world applications. These early trials demonstrated the viability of substituting plastic waste for traditional carbon carriers in the blast furnace, setting the stage for full-scale

implementation.

In conventional blast furnace operations, the production of one tonne of hot metal typically requires **370 kg of coke and 90 kg of heavy fuel oil**. Through the application of **E.S.C.H. Technology**, up to **70 kg of plastic waste** has consistently replaced heavy oil, contributing to both cost savings and a reduction in carbon emissions.

To date, voestalpine has successfully replaced **150.000 tonnes of heavy oil annually with 220.000 tonnes of plastic waste**, demonstrating the technology's scalability and effectiveness. This long track record of successful implementation underscores our commitment to advancing sustainable practices in the steel industry.



## References

- EKO Stahl GmbH, Germany, Eisenhüttenstadt, BF 3, operation cycle 1996-2001
- POSCO, Pohang, Korea, BF 5, erected 1996
- EKO Stahl GmbH, Germany, Eisenhüttenstadt, BF 1, operation cycle 2001-2007
- Stahlwerke Bremen GmbH, Germany, BF 3, operation cycle 2003-2006
- Voestalpine Stahl Linz GmbH, Austria, BF A, in operation since March 2006
- DK Recycling und Roheisen GmbH, Germany, Duisburg, Test injection plant at BF, trials in 2006
- Salzgitter Flachstahl GmbH, Germany, Salzgitter, BF C, in operation since 2008



GERMAN ENGINEERING EXCELLENCE

MEETS INDIAN EXPERTISE

# German-Indian Collaboration

for advanced industrial solutions between



**SPET** DESIGN AND ENGINEERING SERVICES (P) LTD.

*Innovation towards Engineering Excellence*

India

&

**E.S.C.H.**

Engineering Service Center und Handel  
Germany

## Integrated Engineering and Delivery Solutions – Tailored for Industrial Projects in India

With extensive experience in delivering high-performance industrial systems, **E.S.C.H.** and **SPET** provide Indian clients with an exceptional blend of **German engineering reliability** and **cost-efficient, locally executed solutions**.

This partnership is more than a service agreement – it is a **deeply integrated collaboration**, where E.S.C.H. assumes full

system responsibility, while SPET contributes engineering capacity, project execution, and local sourcing expertise directly from India.

The result is a **cohesive, technically robust solution**, designed to meet the specific requirements of Indian industry – without compromising on quality or efficiency.

## What This Means for You

### Single-Source Accountability

E.S.C.H. offers a complete package – from basic and detailed engineering, equipment specification and delivery, to on-site commissioning and after-sales support. With SPET fully embedded in the process, clients benefit from a streamlined approach with no gaps between design, procurement, and execution.

### Local Presence, Immediate Support

SPET's presence in India enables direct project supervision, hands-on engineering input, and immediate technical response during all phases – including erection, commissioning, training, and aftercare. This significantly reduces reliance on overseas personnel and minimises delays.

### High-Quality Equipment, Sourced Locally

We collaborate with trusted Indian manufacturers, carefully selected and audited to meet international engineering and quality standards. Mechanical, electrical, instrumentation, and automation components – including software – are all sourced and configured under the technical lead of E.S.C.H.

### Faster Spare Parts and Service Availability

With key components manufactured and available locally, clients gain speed and flexibility in spare part logistics and service – especially in critical or time-sensitive situations.

### Your Project, Our Responsibility

- Performance Guarantee by E.S.C.H.
- Project Management by SPET
- After-Sales & Lifecycle Support – Local & Reliable

### Bringing Unique Technologies to India

Through this collaboration, Indian clients gain access to **proven, globally unique technologies** and specialised engineering solutions developed in Germany – implemented locally through SPET's infrastructure and expertise. This ensures that advanced systems, such as **Pulverised Coal Injection (PCI)** and other high-end industrial process solutions, can be deployed efficiently in Indian plants – with full consideration of site conditions, compliance standards, and operating requirements.





Engineering Service Center und Handel GmbH

## Industrial Innovation with Environmental Impact

### Responsibility

Our work is more than technical progress; it's a commitment to shaping a sustainable future. Through intelligent use of waste, we help industry reduce environmental impact while unlocking economic potential.

### Social Impact and Opportunities

The circular economy promotes job creation, regional value chains, and innovation in waste management and energy sectors.

**We provide cutting-edge, globally leading technologies for converting plastic waste into high-value fuels for steelmaking.**

**Our solutions support clients in making sustainability an economic advantage.**

### Your Benefits:

- Energy cost savings
- Substantial CO<sub>2</sub> reductions
- Enhanced efficiency
- Support of circular economy principles

**Let's build the green steel industry of tomorrow – together with E.S.C.H. GmbH.**

### Contact:

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