ROLE OF IRONMAKING IN THE EU STEEL INDUSTRY – CHALLENGES AND FUTURE OPPORTUNITIES

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Outline of presentation

• Current situation of steel production and ironmaking capacities in EU
• Challenges of the EU steel production and their consequences for ironmaking
• Measures under implementation in ironmaking sector to secure competitiveness
• Potentials of direct and smelting reduction technologies to enhance energy efficiency and reduce CO₂ emissions
• New initiatives to meet long term target of EU policy
• EU 28 is the 2nd largest steel producer in the world
• EU 28 represents 10 % of the global steel production in 2016
• Total steel production in EU 28 decreases by 16 % from 1990 to 2016

Source: Wirtschaftsvereinigung Stahl and World Steel Association
Production of Crude Steel, Hot Metal and DRI/HBI in EU 28 (1990 – 2015)

- Drop of steel production after the 2008/09 did not recover to level of the years before
- The share of hot metal for crude steel production declines continuously since 1990

Source: World Steel Association, Steel Statistical Yearbook 2016 and earlier
Comparison of Crude Steel Production by Technologies – 2006/2015

• 60 % of crude steel in EU is produced by BF-BOF route
• Production decrease between 2006 and 2015 affects both integrated and mini mill sites

Source: World Steel Association, Steel Statistical Yearbook 2016
Decrease of crude steel production affects differently the individual countries in EU

Source: World Steel Association, Steel Statistical Yearbook 2016
Crude Steel Production by EU 28 and Main Steel Producing Countries – 2006/2015/Share of BF-BOF

• 5 biggest EU steel producing countries represent 64 % of EU steel production

Source: World Steel Association, Steel Statistical Yearbook 2016
Importance of Steel for EU

- EU 28 = 2\textsuperscript{nd} largest steel producer in the world
- 500 production sites in 23 Member States
- Steel-making is closely linked to many downstream industries such as
  - Automotive,
  - Construction,
  - Electronics, and
  - Mechanical and electrical engineering.
- Steel application crucial for EU’s
  - Transportation, urbanisation, and infrastructure
  - Low carbon energy transition
    wind-turbines and modern nuclear power stations
  - Energy union ambitions, pipelines and cabling for interconnections
  - Circular economy

Source: “Stahl Zentrum”, VDEh
Challenges and Opportunities for EU Steel Industry

- Uneven level playing field at international level
  - EU is open market, trade barriers for steel producers on international market
  - Competition from non-EU country producers – EU applies new regulations of Trade Defense Instruments (TDI) (June 2016)

- Cost and availability of raw materials and energy
  - EU industry is faced with higher energy prices than most of its international competitors
  - A trend which has been amplified by price development in recent years.

Source: BBC
Challenges and Opportunities for EU Steel Industry

- Environmental and climate change regulation
  - The EU Commissions Low Carbon Roadmap suggested a reduction of CO$_2$ emissions of 80% by 2050 compared to 2005 levels.
  - The transition towards a competitive low carbon Europe requires the transfer of the energy system, new technologies and large investments in new infrastructure.

Source: “Stahl Zentrum”, VDEh

Steel applications allow CO$_2$ savings
Challenges and Opportunities for EU Steel Industry

- EU’s support to steel
  - Steel industry is vital sector for EU’s goal to increase industry’s share of GDP to 20% by 2020
  - Commission adopted an Action Plan on the competitiveness of the steel sector in 2013
  - Clear commitment of EU commission to steel industry at EU Industry Day (Feb, 2017)

- Roadmap for steel in EU
  - Modernisation of EU steel sector
    - Increase of productivity
    - Less energy intensive
    - Lower CO₂ emissions
  - Best Available Techniques
    - Incremental improvements
  - Innovative Breakthrough Technologies
    - Significant reduction of fossil energy and CO₂ emissions

![Graph showing 50% CO₂ Reduction in EU between 1970 and 2015](Source: World Steel Association)
Challenges and Opportunities for EU Steel Industry

- **Roadmap for steel in EU**
  - Steel is not the problem, steel is part of the solution!

### CASE STUDIES FOR EU27 RESULT IN CO2 SAVINGS

**Source:** BCG/VDEh

<table>
<thead>
<tr>
<th>Case study</th>
<th>Net CO2 reduction potential(^2) per anno from 2030 onwards</th>
<th>Emissions from steel production(^3)</th>
<th>Ratio between CO2 reduction / emission</th>
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<tbody>
<tr>
<td><strong>ENERGY INDUSTRY</strong></td>
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<td>1 Efficient fossil-fuel PP</td>
<td><img src="https://example.com/efficient_fossil_fuel_graph.png" alt="Graph" /></td>
<td><img src="https://example.com/efficient_fossil_fuel_production_graph.png" alt="Graph" /></td>
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<td>2 Offshore wind power</td>
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<td>3 Other renewables(^1)</td>
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<td>6 Weight reduction - cars</td>
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**Note:** PP = power plant

\(^1\) Bioenergy; \(^2\) Net reduction refers to reduction attributable to steel; \(^3\) Refers to the emissions related to the amount of steel needed for the specific application.
Measures under implementation

✓ Sustainable use of by-products and exhaust energy
  ▪ Dry granulation of BF slag and production of superheated steam
  ▪ Recovery of iron and zinc from BOF dust
Measures under implementation

✔ Use of imported DRI/HBI in blast furnace
Potentials of alternative ironmaking technologies

Comparison of steelmaking routes
Direct Emissions
- Conversion of fossil carbon and calcination in the process (no credits considered)

Indirect Emissions
- Production and transport of raw materials (pellets, sinter, coke, burnt lime)
- Production of electric energy and oxygen

Indirect CO₂ Emissions:
- 0 kg CO₂/kWh (BF + FINEX)
- 0 kg CO₂/Nm³ O₂ (BF + FINEX)
- 0,6 kg CO₂/kWh (DR+EAF)
- 0,3 kg CO₂/Nm³ O₂ (DR+EAF)
- 162 kg CO₂/t Pellet
- 1400 kg CO₂/t Burnt Lime

Substantial lower CO₂ emissions for DR- Shaft + EAF Route
Total: ~ 35 %
Direct: ~ 60 %
Potentials of alternative ironmaking technologies

Use of Coke Oven Gas for DRI Production in Integrated Route

Case Study:
100 % of Coke Oven Gas is utilized for Steelmaking with DR-Shaft – EAF Route
Overall Effect for Integrated Steel works by Utilization of COG for DR-Shaft+EAF

- 3 % lower total energy consumption and 11 % lower fossil energy consumption
- Production increase by 5 to 7 %
- 11 % lower direct CO$_2$ Emission and 10 % lower total CO$_2$ Emission

Upstream Substitution of COG by NG for hot rolling is considered in CO$_2$ Balance
Potentials of alternative ironmaking technologies

Use of Coke Oven Gas for DRI Production in Integrated Route

Case Study:
100 % of Coke Oven Gas is utilized for DRI Production for BF
Overall Effect for Integrated Steel Works by Utilization of COG to produce DRI for BF

- 3 % lower total energy consumption and 11 % lower fossil energy consumption
- Production increase by 5 to 7 %
- 6 % lower direct CO₂ Emission and 6 % lower total CO₂ Emission
Initiatives to meet long term target of EU climate policy

**Carbon Direct Avoidance**
- hydrogen, electricity -
  (CDA)
  - Hybrit
  - Salcos
  - SuSteel
  - SEDERWIN
  - H2Future
  - GrInHy

**Carbon Capture and Use**
- (CCU)
  - Steelanol
  - Carbon2Chem

**Carbon Capture and Storage**
- (CCS)
  - Hisarna
  - UICOS BF
  - IGAR (Injection de Gaz Réformé)
Initiatives to meet long term target of EU climate policy

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Hybrit

Steel production with sponge iron produced from carbon lean hydrogen

- **Aim**
  Reduce carbon dioxide emissions from ironmaking to zero by eliminating the need of using fossil fuel for iron ore reduction.
  Use hydrogen from “clean” energy
  Save 10 % of CO₂ emission of Sweden

- **Technology**
  Direct reduction shaft furnace operated with 100 % hydrogen. Conversion of DRI to steel in conventional EAF.

- **Consortium**
  3 partners from Sweden (SSAB, LKAP and Vattenfall).

- **Project realization**
  Feasibility study 2018 – 2024, Demo Plant 2025-235 phase
SuSteel

Direct steelmaking with hydrogen plasma smelting reduction

- **Aim**
  Direct steel production from iron ore with the use of hydrogen plasma as energy source and reductant

- **Technology**
  Smelting vessel with hydrogen plasma torch, off gas is used to pre-heat and to pre-reduce the fine iron ore

- **Consortium**
  3 partners from Austria (Montanuniv. Leoben, voestalpine, K1-Met).

- **Project realization**
  1\textsuperscript{st} phase 2016 – 2019, 2\textsuperscript{nd} phase 2019++
H2Future

H2 generation by PEM (polymer electrolyte membrane) electrolyser

- **Aim**
  Full scale demonstration of hydrogen production and electricity grid balancing
  Integration of this concept in an integrated steel mill site

- **Technology**
  Full scale operation of world largest PEM electrolysis

- **Consortium**
  5 partners from AT, GE and NL. Plant will be implemented at voestalpine Linz works, PEM supplier Siemens, Funded by EU

- **Project realization**
  Demonstration plant 2017++

Source: By Davidlfritz - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=26251918 and Siemens
Carbon2Chem
Production of bio-ethanol via gas fermentation and steel waste gases

- **Aim**
  Conversion of process gases from steel production including the containing CO₂ to base chemicals

- **Technology**
  CO₂ from steel exhaust gases will be converted with hydrogen produced from renewable energies to ammonia or fuel

- **Consortium**
  17 partners from Germany. Funded by German government

- **Project realization**
  1<sup>st</sup> Demonstration plant: 2016 – 2020, 2<sup>nd</sup> phase 2020++
Summary and Conclusions

Main challenges for ironmaking in EU 28:

• Current international market environment for steel
• Cost and availability of raw materials and energy
• Environmental and climate change regulation

Future opportunities for ironmaking in EU 28

• Support of steel industry within EU administration is increasing
• Roadmap for EU steel industry under development

Activities to enhance sustainability of ironmaking in EU

• Bridge technologies for reduction of CO₂ emission of existing ironmaking technologies are under implementation and application
• Breakthrough technologies for drastic reduction of CO₂ emission are under development
THANK YOU FOR YOUR ATTENTION

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