Global Perspectives and Best Practice in the Steel Industry
Steel Industry Improvements

The steel industry has pushed hard to reduce cost and secure sustainability

- Specific energy consumption:
  Metric ton coal equivalent per t crude steel
  -41% decrease from 1960 to 2007

- Specific CO₂ emission (Average BF/BOF and EAF):
  Metric ton CO₂ per t crude steel
  -45% decrease from 1960 to 2007

- Specific dust emission:
  Kg dust per t crude steel
  -96% decrease from 1960 to 2007

- Accident rate:
  Number of accidents per million working hours
  -88% decrease from 1970 to 2007

SOURCE: Wirtschaftsvereinigung Stahl

McKinsey & Company | 4

02 August 2013
- worldsteel CO₂ Data Collection
- Energy Use in the Steel Industry
- Breakthrough technologies
worldsteel CO$_2$ Data Collection
**CO₂ data Collection Methodology**

\[ CO₂ \text{ emissions} = \text{Direct} + \text{Indirect} - \text{Credit} \]

\[ CO₂ \text{ intensity} = \frac{CO₂ \text{ emissions (tonne)}}{\text{crude steel (tonne)}} \]
## 2011 CO₂ Data Collection – in progress

<table>
<thead>
<tr>
<th>Region</th>
<th>Number of companies</th>
<th>Number of sites</th>
<th></th>
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Trend of Averages 4 Survey Years of CO₂ data

- CO₂ emissions intensity of each route [tCO₂/tCS]
4 year trend of CO₂ intensity for BF-BOF route

- CO₂ Intensity [tCO₂/tCS] weighted by production volume
  - Every year the data collection includes different participations
  - Averaged only for those who submitted data 4 years in a row.
- CO₂ methodology model reflects the economic trend
  - Production drop under BF capacity decrease its efficiency

<table>
<thead>
<tr>
<th>Year</th>
<th>CO₂ Intensity</th>
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<tr>
<td>2007</td>
<td>0.93</td>
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<td>2008</td>
<td>0.89</td>
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<td>2009</td>
<td>0.86</td>
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<td>2010</td>
<td>0.99</td>
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- Maximum ~1.5% variation
- Collection of all submitted sites (over 80 sites)
- Collection of 4 years fully submitted sites (57 sites)
- World steel production volume by BOF [Bt]
4 year trend of CO₂ intensity for EAF route

- CO₂ Intensity [tCO₂/tCS] weighted by production volume
  - Every year the data collection includes different participations
  - Averaged only for those who submitted data 4 years in a row.

- The data collection model reflects the economic trend
  - Economic recession likely reduce external scrap level → CI ↑

CO₂ Intensity 2007-2010

- 2007: 0.42
- 2008: 0.41
- 2009: 0.34
- 2010: 0.41

World steel production volume by EAF [Bt]

Collection of all submitted sites (67~80 sites)
Collection of 4 years fully submitted sites (35 sites)

Maximum ~7% fluctuation
Energy Use in the Steel Industry
Objectives of the Energy Project:

- Provide opportunities to decrease the energy intensity / ton of crude steel.
- Provide best or good practices to utilize energy sources more effectively.
- Provide best or good practices to recover energy (heat, gas) where practical.
- Enabling companies to develop plans for plant energy intensity reduction.
- Practice benchmarking allows prioritization of investments to improve energy efficiency with the biggest impact.
Energy project coverage members steel production in 2010

1,413.6 mmt of crude steel was total world steel production in 2010

Energy use project members produced 373.3 mmt of crude steel in 2010

346 mmt of steel represent approximately **26.4%** of the total world steel production in 2010
Energy Benchmarking Process

1. Energy Questionnaire → Site Performance Against Reference → Plant Performance Against Reference

2. Technology Questionnaire → Impact on Energy Efficiency → Technological Solutions to close gap
   Investment appraisal

3. Raw Material Questionnaire → Impact on Energy Efficiency relative to reference plant → Raw material effect
   “Rules of thumb”
   Operational Gap per plant
   Benchmark
Breakthrough Technologies
Programme Status / Update reports.

- **ULCOS**: TGR – BF, HIsarna, ULCORED, ULCOWIN / ULCOLYSIS
- **AISI**: Hydrogen Flash Melting
- **Australian Program**: Heat Recovery of Molten Slag, Extend Biomass Use
- **China Steel Corporation**: CO$_2$ capturing technologies (including adsorption, absorption, etc.)
- **JISF Course 50**: Development of technologies to reduce CO$_2$ emissions from Blast Furnaces
  Development of technologies to capture CO$_2$ from Blast Furnace Gas.
- **POSCO CO$_2$**: Carbon-lean Steelmaking
  Carbon Capture & Storage of Steelmaking
  Hydrogen Steelmaking
Projects potential impact

Key activities high impact
-30% - 50% CO2
- TGRBF
- HISARNA
- ULCOS
- > 80% CO2 with CCS

Key activities with lesser impact
- CC&S
- CSC, Course 50
- POSCO, ULCOS

Longer term projects
- Suspension H2-Technology
  - AISI
- Electrolysis
  - AISI, ULCOS
- CO2 Utilization
  - (Algaes)
  - CSC

L Level of impact H

L Likely hood of early success H

- Charcoal
- Biowaste
- Paired Straight
- Hearth with smelter

- H2-Enrichment
  - (Reforming)
  - Course 50
  - Posco

- Waste Heat Usage
  - Australia
  - Course 50
  - Posco

- CH4, H2
  - Australia, Posco

- 10% to-20% CO2
  - Posco
### ULCOS Projects

<table>
<thead>
<tr>
<th>Coal &amp; sustainable biomass</th>
<th>Natural gas</th>
<th>Electricity</th>
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<tbody>
<tr>
<td>Revamping BF</td>
<td>Brownfield</td>
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<tr>
<td>TGR-BF</td>
<td>Hilsarna</td>
<td>ULCORED</td>
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<tr>
<td>Pilot tests (1.5 t/h)</td>
<td>Pilot plant (8 t/h) start-up 2010</td>
<td>Pilot plant (1 t/h) to be erected in 2011?</td>
</tr>
</tbody>
</table>
Potential Development Timeline

2010  |  2015  |  2020  |  2025  |  2030  |  2040  |  2050

- Ulcos phase II
- TGR-BF -2015
- Hisarna 2013

- ULCOS
  - Hisarna commercial size
  - Ongoing development
  - And up-scaling

- CCS
- Policy and test sites

- Infrastructure
- Sites established

- Charcoal
- Bio-Mass development

- Ongoing development
- Farm cropping trial

- H2-Enrichment

- Waste heat recovery

- CH4, H2 & Ethanol

- Suspension H2 Technology

- Electrolysis
- Clean electricity required

- CO2 utilisation
- Grow Algae

19