TECHNOLOGICAL SOLUTION PATHS FOR REDUCING CO2 EMISSIONS IN THE STEEL SECTOR

7-8 November 2006

Presentation by Mr. Jean-Pierre Birat, IISI.

Wolfgang Hübner, Head of Structural Policy Division
Tel: +33 1 45 24 91 32  Fax: +33 1 44 30 62 63  E-mail: wolfgang.hubner@oecd.org

JT03217671
Technological solution paths for reducing CO₂ emissions in the Steel sector
Jean-Pierre Birat

Overview

- energy intensity and CO₂ emissions of the European Steel Industry
- the ULCOS example
- the CO₂ breakthrough program
- conclusions
Energy and CO$_2$ status
European Steel Industry

Carbon consumption

Reducing agent - 55%
Steel contributes to the CO₂-leanness of other sectors

- steel is either a key component of most artifacts or has been a key component of the tools used to make them (⇒ very large materials and energy savings!)
- steel is the major material that cuts automobile weight and thus helps reduce the emissions of the transportation sector
- blast furnace slag can substitute clinker 1/1 and thus cut steel emissions by 15%
- etc…
the EU example is that of an economic sector that has made steady and sustained efforts over the last 60 years to adapt its process technologies to meet demand in terms of volume, quality and price.

- Economic competition has been the driver to adjust energy consumption and CO₂ emissions.
- The process routes used today in the EU are very close to various equilibria in terms of:
  - Energy
  - Scrap
  - Prereduction (natural gas)

The process routes used today in the EU are very closed to various equilibria:
- Minimum energy consumption especially in the integrated route, within the energy price structure of the EU. Slight differences between EU & Japan, but VERY close to physical limits.
- Balance between virgin and recycled iron units, driven by the amount of available scrap, itself high because of strong recycling culture fostered by EU regulations.
- Very limited use of natural gas for ore prereduction, because of the high local price of gas.
Today's status - World

- *mutatis mutandis*, what is true in Europe is also true in the whole world.
- the Integrated Mill is as close as feasible to physical limits (thermodynamics). Room for improved energy performance is very limited, when state-of-art technologies are used.
- worldwide, the utilization of scrap is very high and scrap generation & trade very active and efficient. There is very limited room for improvement related to using more scrap.
- worldwide, natural gas is used more than in Europe, where NG price is low. Today's level of production reflect is "optimal" under these economic conditions.

What about CO₂?

- how can the Steel Sector reduce its emissions, if it cannot PHYSICALLY reduce its energy consumption? (state of the art)
- the only way out of this conundrum is to uncouple energy and CO₂. This means venturing into breakthrough technologies...
- this means deep paradigm changes in the way steel is made, which requires time for development – a generation, money – >1 G€?, and high risk.
The ULCOS example

How is steel made?

- Coke
- Coal
- Natural Gas
- Syngas
- H₂
- Electric Arc Furnace
- Blast Furnace
- Decarbonation
- CO₂ capture & storage
- Use of C from sustainable biomass
- Natural gas prereduction
- H₂ prereduction
- H₂ by electrolysis of H₂O
- Electrolysis
- Electrons
- Existing technology
- New Technology
- Use of C from sustainable biomass
- CO₂ capture & storage
- Use of C from sustainable biomass

21-Sep-06
A consortium to share skills & risks...

Explore a broad range of solutions...

- C-based steel production + CO₂ Capture & Storage
- Biomass-based steel production
- Natural Gas-based steel production
- Electrolysis steel production
- Hydrogen-based steel production
Phase II route selection...

CO₂ emissions...

Energy consumption GJ/t coil

CO₂ emissions kg CO₂/t HRC

Scope 2
A new Blast Furnace concept...

SP1 TGR-BF V1 – Coal

- 598 MJ
- 86 kWh
- 1.2 Nm³
- 0.5 Nm³
- 190 kg
- 25 kWh
- 185 kg
- 185 kg
- 165 kg
- 165 kg
- 885 kg
- 30 kWh
- 1 000 kg
- Natural Gas
- CONTINUOUS CASTING
- Electricity

A new Smelting Reduction concept...

SP2 ISARNA – Haematite MV coal (coal only)

- 750 MJ
- 86 kWh
- 12.5 kWh
- 24 MJ
- 1 000 kg
- 1.2 Nm³
- 0.5 Nm³
- 165 kg
- 165 kg
- 879 kg
- 85 MJ
- 25 kWh
- 30 kWh
- Limestone
- ISARNA
- Fine iron ore
- DRI & SR coal
- Limestone
- 85 kg
A new Prereduction concept...

**SP3 New DR (0.2%C hot) + EAF + CCS**

- HOT ROLLING: 1 023 kg
- продолжение
- CONTINUOUS CASTING: 1 024 kg
- Electricity: 340 kWh
- Coils: 1 000 kg
- O₂: 142 Nm³
- HOT DR: 944 kg
- 3 Nm³
- Scraps: 165 kg
- Coal: 11 kg
- Natural Gas: 7 244 MJ
- Electricity: 12.5 kWh
- Natural Gas: 24 MJ
- Electricity: 86 kWh
- Natural Gas: 1.2 Nm³
- O₂: 0.5 Nm³
- HOT ROLLING: 86 kWh
- CONTINUOUS CASTING: 12.5 kWh

An Electrolysis concept...

**SP5 Alkaline Electrolysis**

- HOT ROLLING: 1 022 kg
- продолжение
- CONTINUOUS CASTING: 1 024 kg
- Electricity: 3 260 kWh
- Coils: 1 000 kg
- O₂: 142 Nm³
- HOT DR: 944 kg
- 3 Nm³
- Scraps: 165 kg
- Coal: 11 kg
- Natural Gas: 7 244 MJ
- Electricity: 12.5 kWh
- Natural Gas: 24 MJ
- Electricity: 86 kWh
- Natural Gas: 1.2 Nm³
- O₂: 0.5 Nm³
- HOT ROLLING: 86 kWh
- CONTINUOUS CASTING: 12.5 kWh

DSTI/SU/SC(2006)68
Conclusions..

- The Steel Sector has applied a very severe program of energy optimization over the last 60 years, driven by market demand and competition.
- State-of-the-art technologies are close to physical limits – in terms of energy and iron sources.
- Further decrease in CO\(_2\) emissions requires developing breakthrough technologies - and no regret solutions are no longer available.
- This will take time and money and involves a substantial amount of risk!