Innovative developments concerning non or low CO2 energy and industries: steel case

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ESTEP: European Steel Technology Platform

- Among the first ETPs created in Europe
- Financially supported by the EU steel industry only
- Focused on topics linked with Societal Challenges for Europe. One of them is « reducing the CO2 emissions directly in steelmaking and indirectly by offering suitable steel solutions ».
- Living Strategic Research Agenda (SRA)
- Wide panel of stakeholders (Academia, Research and Technology centers, E. Commission, Member States representatives, suppliers, clients...)
- Strong involvement in People activities
Steel production process

**Primary steel production**

- **Raw material preparation**
  - coal
  - sinter
  - pellets
  - coke

- **Iron making**
  - BF
    - natural gas, oil or coal
    - blast
    - $O_2$
  - DR
    - natural gas, oil
    - coal
    - rotary kiln furnace
    - fluidized bed

- **Steel making**
  - OHF
    - air
    - oxygen
    - scrap
  - BOF
    - hot metal
    - scrap
  - EAF
    - scrap

**Secondary steel production**

- pellets
- scrap

**Crude steel**

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Steel production process(2)

- The EU27 crude steel production is around 200mt/year, with 60% produced through the BF/BOF route and 40% through scrap recycling and EAF.
- The production of primary steel, using iron ore (BF/BOF) is more energy intensive than the production using recycled scrap due to the chemical energy required to reduce iron ore.
- Taking into account the CO2 emissions linked to the electricity consumed from the grid, the CO2 emission factor is around 4 times higher for primary steel vs scrap.
Over the last forty years, the EU steel industry has reduced its emissions by 50% per ton of steel produced, driven by process improvements, material efficiency and scrap recycling. For primary steel production, the best plants are closed to the thermodynamic and physical limits, and residual margin for CO2 emissions savings is at the level <10%. 

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Our challenges for CO2 emissions

• Reduce CO2 emissions for each tonne of steel produced
  – Maximizing steel recycling, but mainly depending on the scraps availability (quantity, quality, cost)
  – Improving steelmaking technologies and share best practices
  – Implementing breakthrough technologies (ULCOS)

• Maximise the emission reduction benefits offered by steel products over their life cycle: positive CO2 balance
  – Energy sector, including renewables
  – Transports
  – Construction
ULCOS: breakthrough technologies for reduction of CO2 emissions

- ULCOS (Ultra Low CO2 Steelmaking) has been running in the EU since 2004 in order to investigate breakthroughs.
- 4 families of process routes have been selected for further investigations including pilots and demonstrators:
  - Blast Furnace with TGR (Top Gas Recycling) and CCS.
  - Hisarna, a smelting reduction process with combination of a hot cyclone and a bath smelter.
  - ULCORED, a direct reduction (DR) process, producing DR Iron in a shaft furnace, either from natural gas or from coal gasification.
  - 2 electrolysis variants Ulcowin and Ulcolys with laboratory pilots.
## ULCOS process solutions...

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ULCOWIN
ULCOLYSIS

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Timeline

- IISI working groups
- 1st papers from Steel
- Rio
- Kyoto
- ETS in EU
- ULCOS worldsteel CO₂ BP
- ULCOS II pilots
- ULCOS II demonstrators
- ULCOS II
- 2013
- 2020
- 2050

* Deployment will depend on the technical success of demonstrators, their operating costs and CCS acceptability

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CO₂ reduction ($t_{CO2}/t_{HRC}$)

Scope 1  Scope 2  CO₂ captured
ULCOS-BF reduces CO2 emissions by 60% and overall energy consumption by 10%

CO2 emissions of the steel plant: - 60%

-100 kg coke/t_{steel}

Underground storage of CO2
0.8 t/t_{steel}

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ULCOS-BF project: NER-300 submission in 2011

CO₂ storage

ULCOS I
3 projets RFCS + 1 FP

Florange

ArcelorMittal

Eisenhüttenstadt-EHS

ArcelorMittal

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Hlsarna

Iron ore
Oxygen
CCF cyclone (CORUS)
Oxygen

Coal
Smelter (HIsmelt)

iron

CCS

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Hisarna: pilot 8t/h. Start-up April 2011
Steel Products contribute to CO2 reduction in key sectors

• Steel products offer CO2 savings over the life cycle that are greater than the CO2 emitted during their production
  – Energy Sector
    • Efficient fossil fuel power plants (high T° resistant alloyed steels); ratio between CO2 reduction/emission \textbf{over 100:1}
    • Efficient transformers (electrical steel sheets); ratio 14:1
    • Wind power plants (tower, gearbox, offshore foundations..); ratio 30:1
  – Automotive
    • Advanced high-strength steels for lightweighting; ratio \textbf{1.3:1}
    • Efficient electrical motors; ratio \textbf{3:1}
  – Construction
    • Innovative steel solutions for envelope retrofitting
    • Holistic building approach for energy-efficient new steel constructions
• Total Life Cycle Assessment (LCA) for steel applications
  – Ongoing studies of GHG emissions resulting from all steel life phases.
Conclusions

- Steel industry offers a set of solutions to meet the long term needs of the EU low-carbon economy, both for steel production and for steel applications.

- For steel production huge progresses have been done during the last 40 years, and we are now close to the thermodynamic efficiency with existing technologies.

  - for the next 20 years, we have potential to increase scrap use depending on the availability and the market conditions

  - Still some margins of progress with conventional route but < 10%

- ULCOS investigates breakthroughs with pilots and demonstrators:

  - experiments, trials and long-period testing operations to be done in the next 10 years with ULCOS-BF, Hisarna and Ulcored.

  - Industrial deployment beyond 2020, depending on the technical results, the operating costs, and the acceptability of CCS.

- Steel products contribute to CO2 reduction in key sectors, within CO2 savings over the life cycle.

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