Steel, CO$_2$ mitigation, CCS and ULCOS

Ultra-Low CO$_2$ Steelmaking

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Challenges & Opportunities of CCS in the Iron & Steel Industry

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Steel & CO₂

• Steel produces about 5% of the world anthropogenic CO₂ emissions (3-8%)
• 70% of steel is produced, today, in integrated steel mills, 30% in EAF mills (recycled steel=scrap, circular economy)
• integrated mills use coal (coke) as a reducing agent and transform it into CO₂, when it scavenges metallic iron from iron ore in a Blast Furnace. "Ironmaking" accounts for roughly 80% of emissions and is thus the process that needs to be made carbon-lean.
• Steel simply cannot use technologies developed by other sectors: it had to develop its own solutions.
• Thus, to investigate, select and eventually develop them from scratch, the steel sector in Europe has launched a common initiative called ULCOS.
The ULCOS approach

- the ULCOS approach was developed in the early 2000s and implemented in a major EU program in 2004:
  - from a broad panel of potential production routes (80), select those which can deliver a credible cut in emissions of 50% or more
  - carry out this selection process inside the ULCOS consortium
  - choose the most realistic solutions and scale them up within the same consortium
  - the scale up process is now called ULCOS II

- ULCOS has been the largest and most comprehensive effort in the Steel sector all over the world to identify and practically develop carbon-lean production routes. The 80 routes have been studied in great detail, to the level of other publications in the field.
## The 4 ulcos process routes

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- **Pilot tests (1.5 t/h)**
  - Demonstration under way

- **Pilot plant (8 t/h)** start-up 2010

- **Pilot plant (1 t/h)** to be erected in 2013?

- **Laboratory**
ULCOS-BF (TGR + CCS)

\[ \text{CO}_2 \text{ emissions of the steel plant: } -60\% \]

Full CCS demonstrator, filed as an NER-300 proposal

-100 kg coke/\(t_{\text{steel}}\)

Underground storage of \(\text{CO}_2\)

0.8 t/\(t_{\text{steel}}\)
Hlsarna, smelting reduction

Iron ore
Oxygen
Oxygen

CCF cyclone (CORUS)
Coal
Smelter (HIsmelt)
Iron

Ijmuiden pilot Strated up in 5/2011
Hlsarna, smelting reduction
CCS in ULCOS is an original process...

- CCS applied to Steel production cuts CO$_2$ emissions (> 50%) but also energy input (-25% coke consumption for ULCOS-BF)
- CSC also improves productivity (20-30% for ULCOS-BF)
- ... and cuts CO$_2$ abatement cost by half compared to an end-of-pipe solution
- in the steel case, the CAPTURE part of CCS is an original concept (in-process capture), which does not have much in common with power-plant solutions; the STORAGE part might also be substantially different
- in the Steel sector, CCS will not be a bridging technology, at least for the next 50/100 years
The future...

- pilot & demonstrator to be built and started up within 5 years
- the demonstrator is to operate for at least 10 years
- Industrial deployment, based on "technological realism" (feasibility), might start in the 2020s
- ... but, beyond these technological issues, there remains many political and economic issues, which will have to be tackled at the appropriate geopolitical scale
- parallel to ULCOS-BF, we have been developing a line of ULCOS solutions, targeted at the world more than at Europe, which ought to reach maturity with a delay (5 to 20 years)
- it seems to us premature and rather meaningless to publish cost data for CCS in the Steel sector, before a demonstrator is in place.