ulcos

ArcelorMittal

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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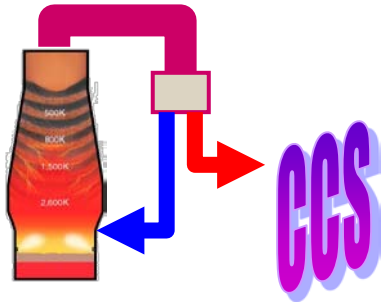
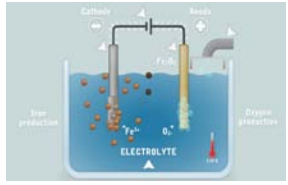
Steel & CO_2

- Steel produces about 5% of the world anthropogenic CO_2 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 CO_2, 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

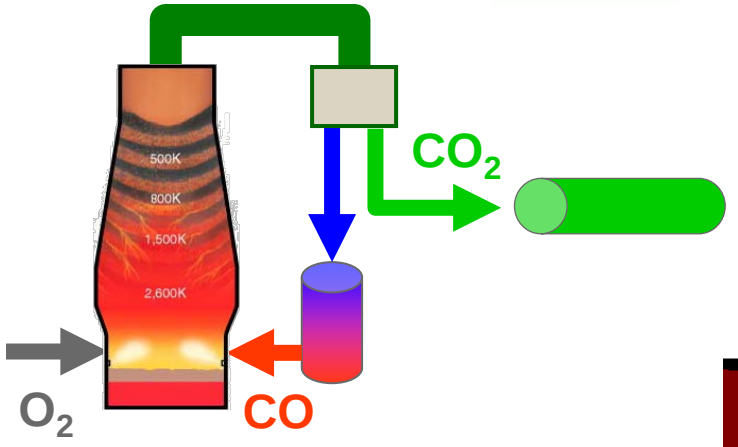
Coal & sustainable biomass		Natural gas	Electricity
Revamped BF	Greenfield	Revamped DR	Greenfield
ULCOS-BF 	HIsarna 	ULCORED 	ULCOWIN ULCOLYSIS 
Pilot tests (1.5 t/h) Demonstration under way	Pilot plant (8 t/h) start-up 2010	Pilot plant (1 t/h) to be erected in 2013?	Laboratory

ULCOS-BF (TGR + CCS)

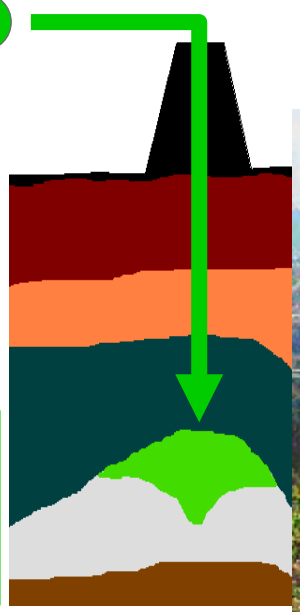
stored AND avoided

CO_2 emissions of the steel plant: **- 60%**

Full CCS demonstator, filed as an NER-300 proposal

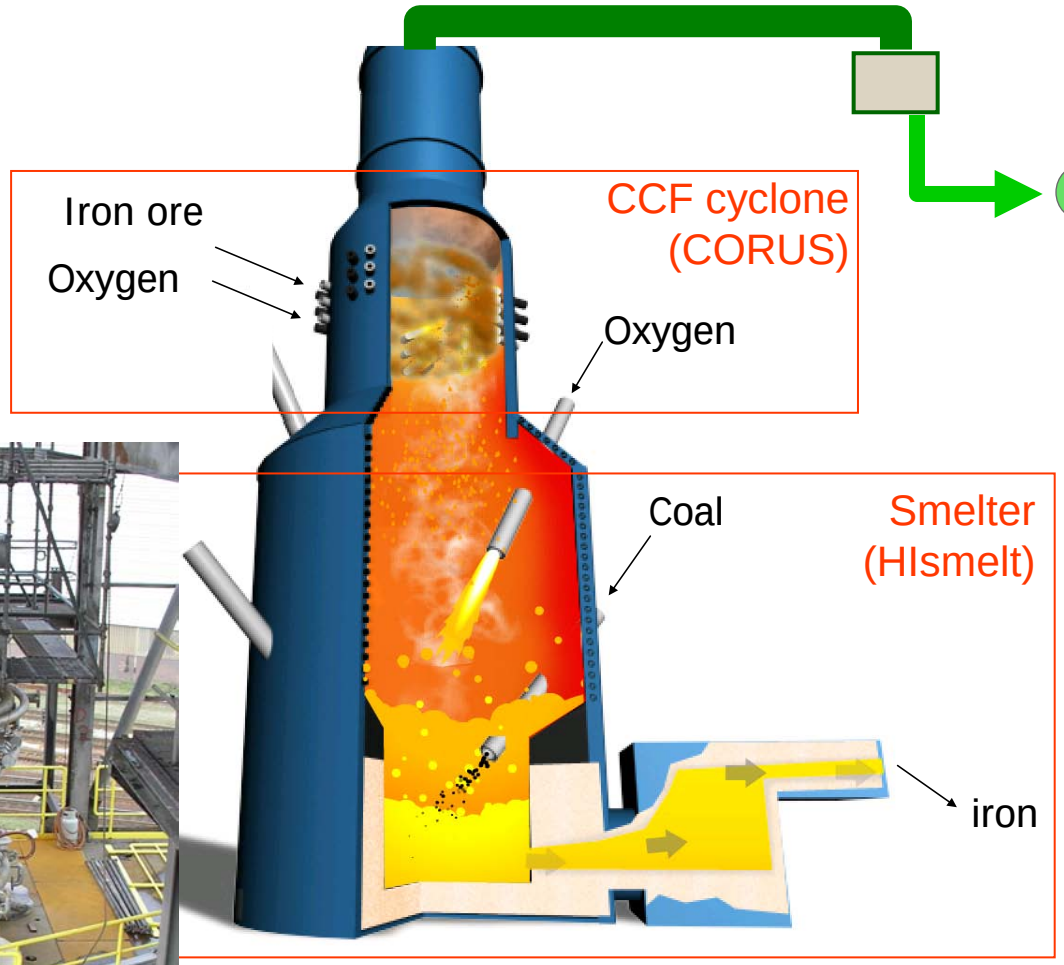


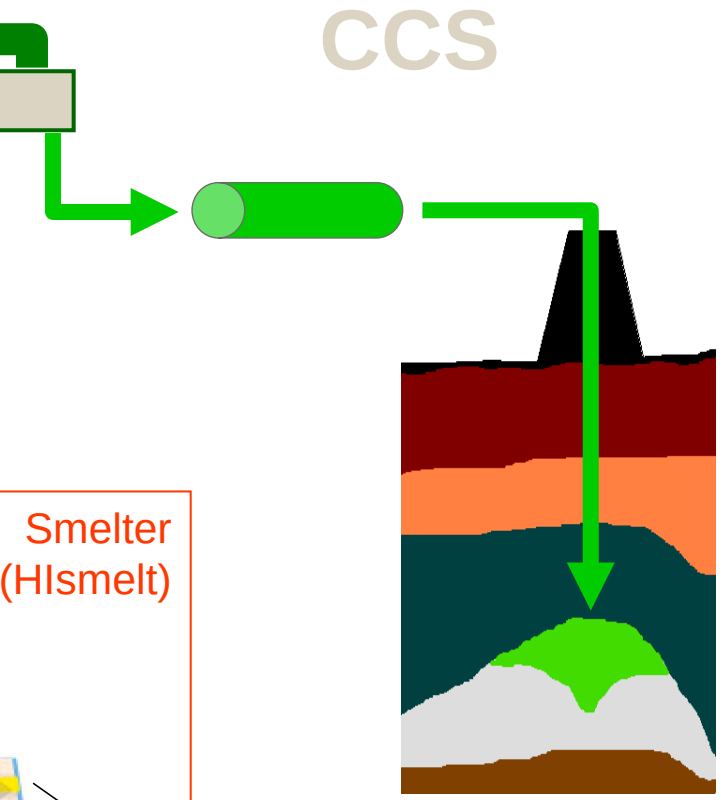
-100 kg coke/t_{steel}



Underground storage of CO_2 0.8 t/t_{steel}

HIsarna, smelting reduction





Ijmuiden pilot
Strated up in 5/2011

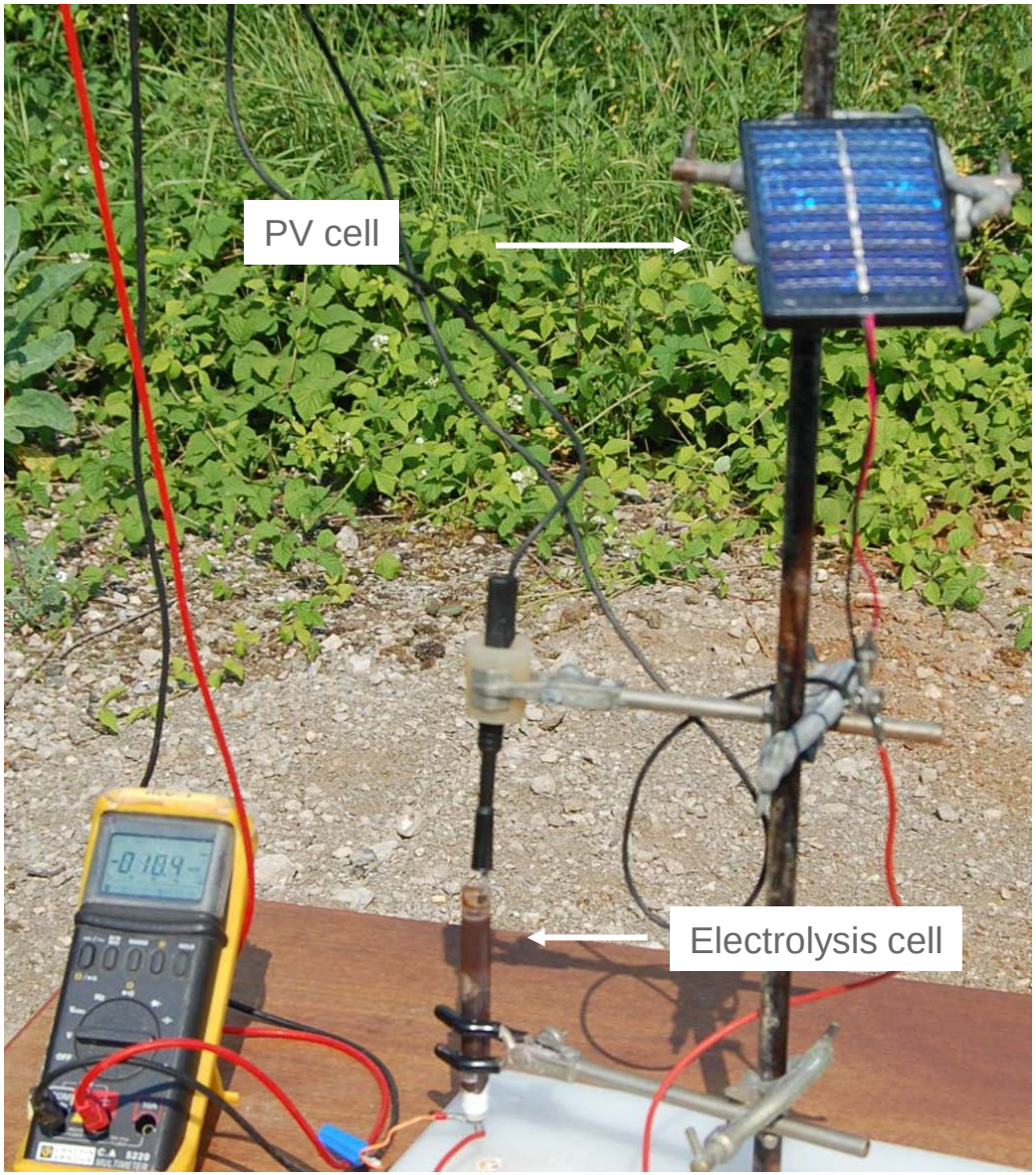
Hlsarna, smelting reduction

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 tan 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.*


PV cell
Electrolysis cell