

Carbon Dioxide Capture and Storage in the Iron and Steel Sector

Tim Dixon and Stanley Santos

IEA Greenhouse Gas R&D Programme

Cheltenham, UK

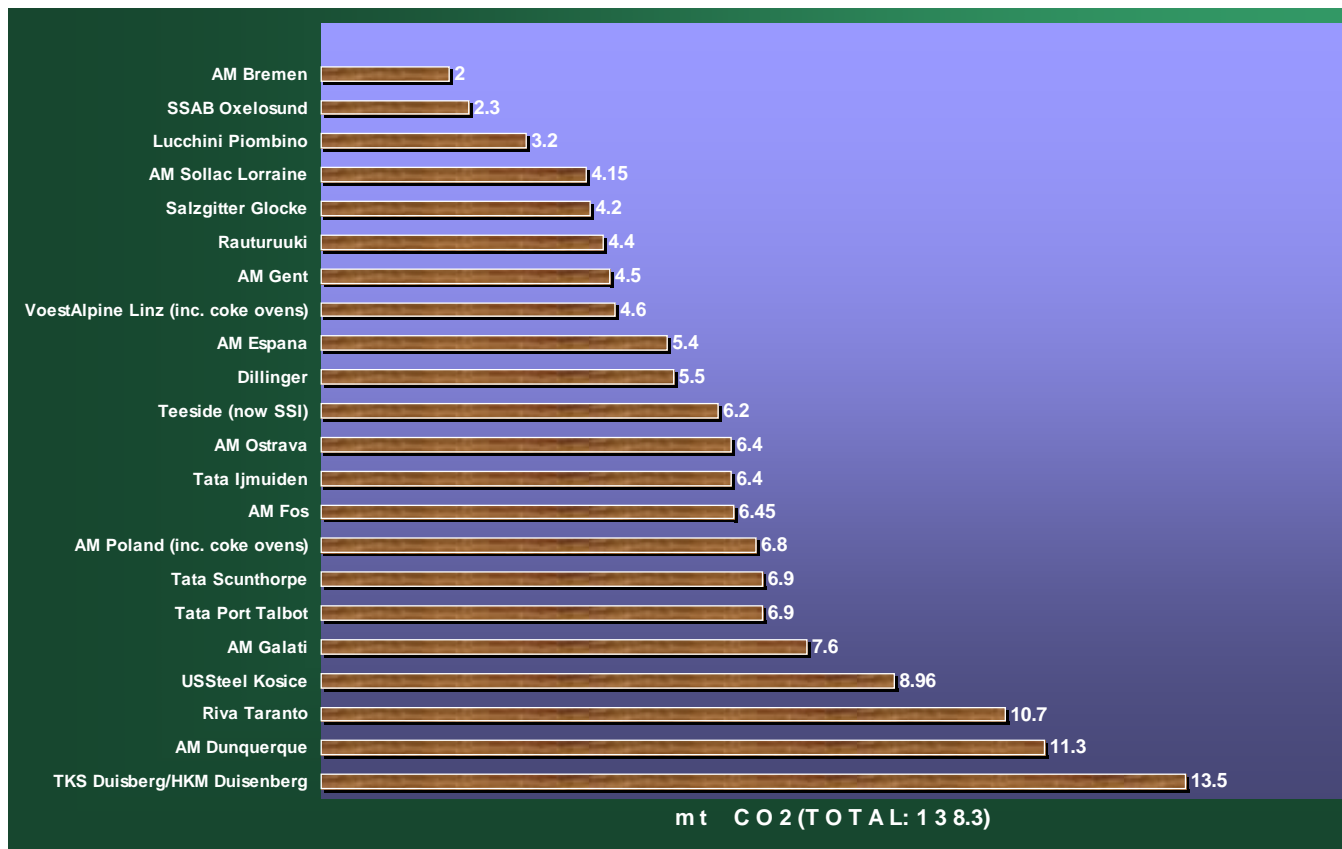
The Necessity of CCS: Looking Beyond Fossil Power

COP-18

Doha

3 December 2012

Iron and Steel in Europe – 22 Sites with > 2 Mt/y CO₂ Emissions (2008)



Data from C. Beauman – EBRD

Amount of CO₂ capture per site could be greater than what we get from coal fired power plant.

Challenges to CCS deployment in the Iron and Steel sector



Synthesis Report:

Assessing the Potential of Implementing CO₂ Capture in an Integrated Steel Mill

Volume I: Estimating the Cost of Steel Production from an Integrated Steel Mill (Base Case)

Project Partners:



swerea | MEFOS



SSAB

LKAB

Project Management, Implementation and Delivery:

swerea | MEFOS

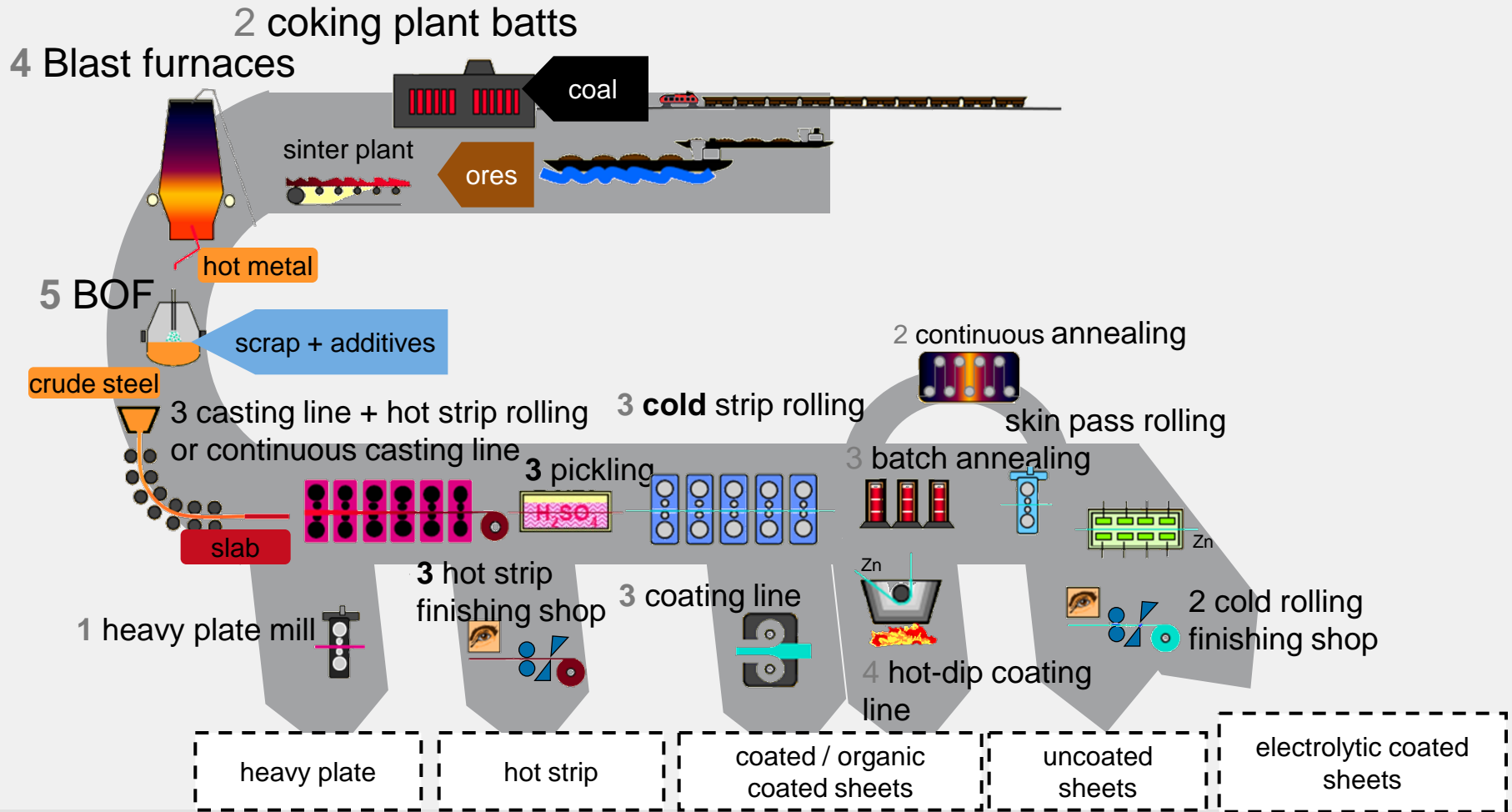
TATA STEEL

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An integrated steel mill is composed by numerous facilities - from iron ore to steel products

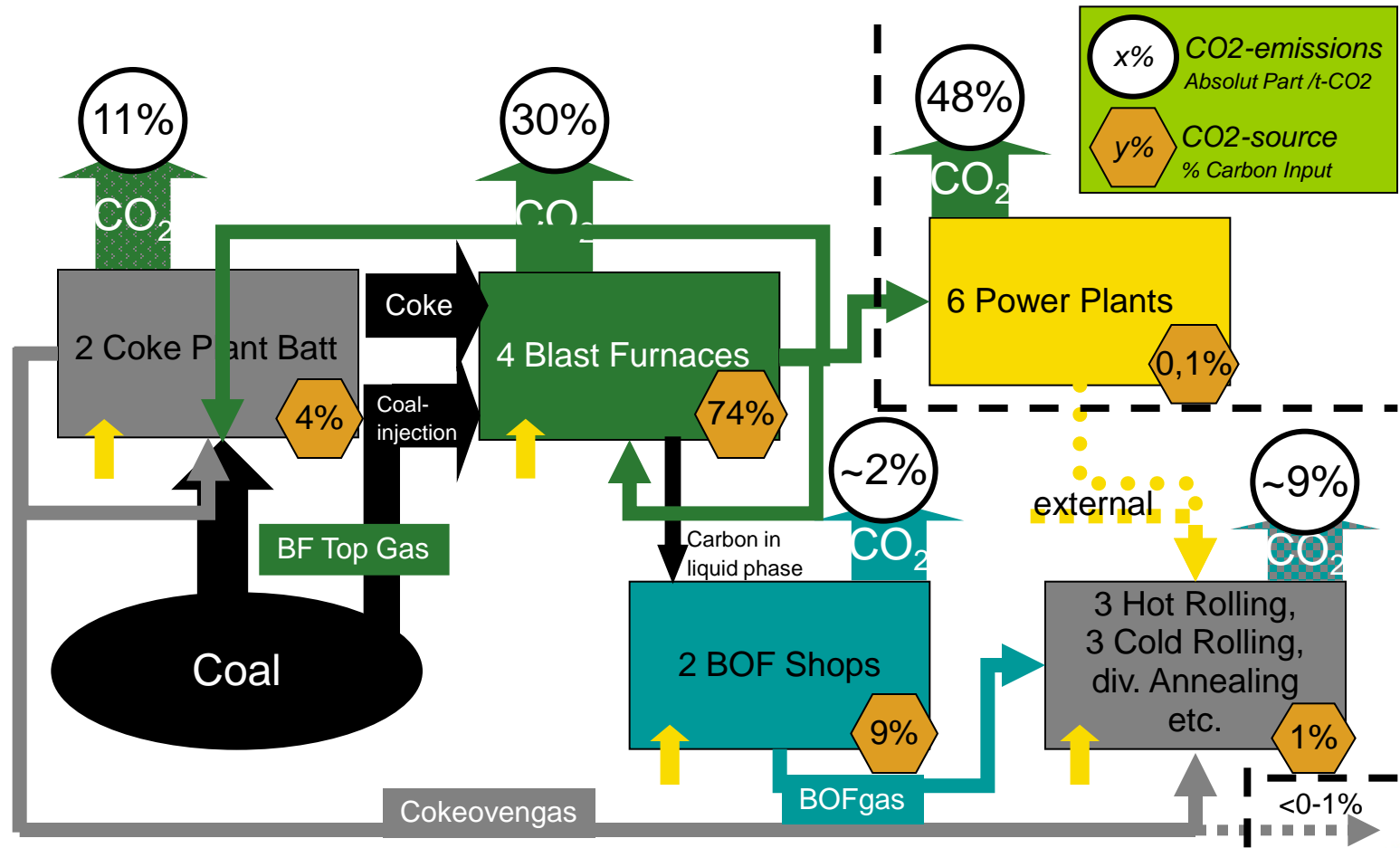


First Challenge...



- ***There is no steel mill in this world which is alike...***
 - Steel is produced with different processes
 - Steel is produced with different types of finished or semi-finished products
 - Steel is produced with different grades

ThyssenKrupp Steel Europe – main CO₂ emitters (schematically) up to 20 Mt CO₂ p.a.



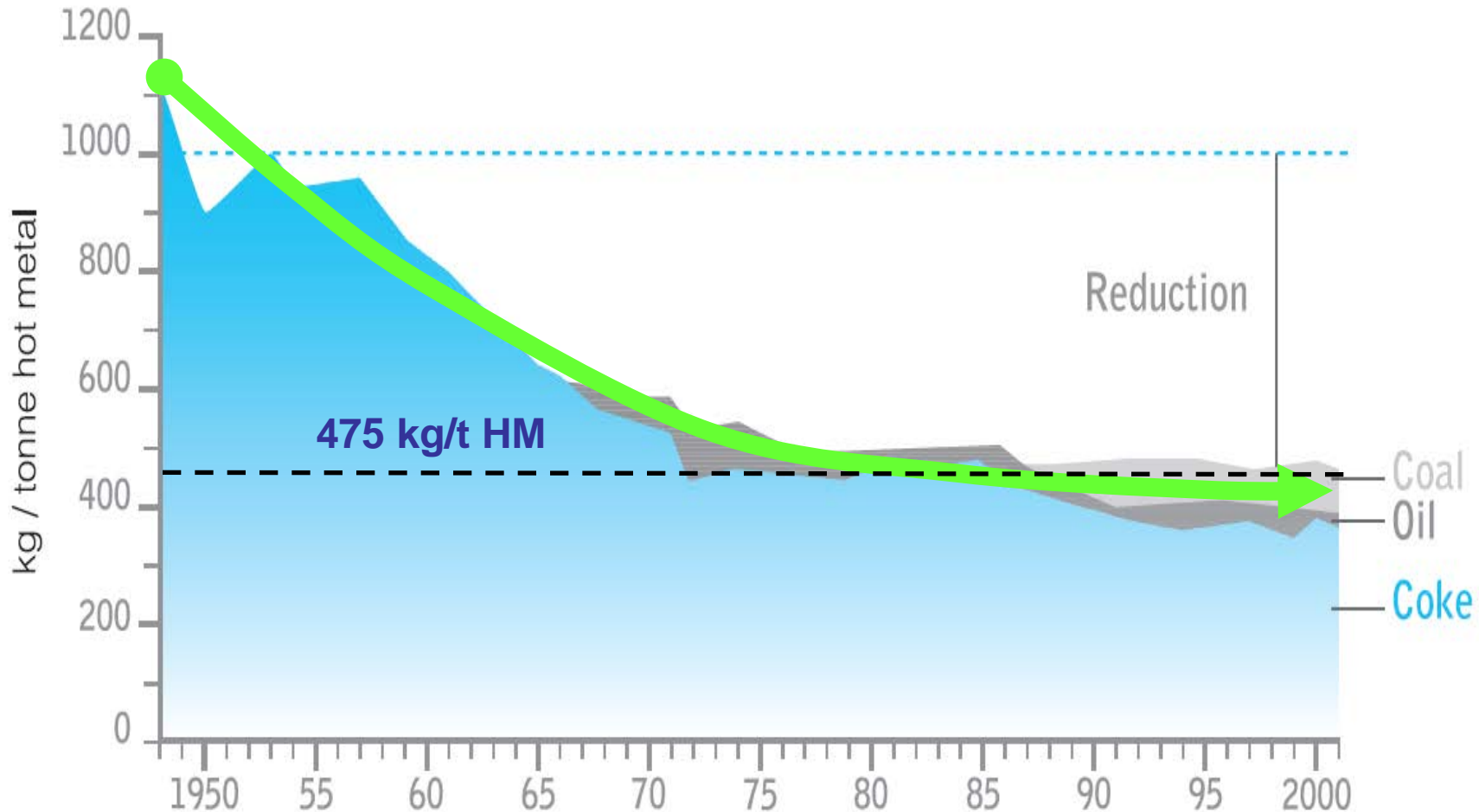
2nd and 3rd Challenges...



- ***Emissions from integrated steel mills come from multiple sources.***
- ***The source of CO₂ may not be the emitter of the CO₂.***
 - Strongly dependent on how you define boundary limit
 - In addition to the direct use of fossil fuels, the emissions is also strongly dependent on the use of by-product gases

4th Challenge...

BF technology is already near the theoretical limit of efficiency



source : VDEh, Germany.

Essentials for CCS deployment



- Accounting of CO₂ Emissions is an essential activity for Deployment of CO₂ Capture Technology in the Iron and Steel Sector.
- Accounting of CO₂ Emissions should be based on a globally consistent methodology that will allow production normalised CO₂ emission comparable between regions.
- These would result in better benchmarking – therefore providing a meaningful number for the CO₂ avoidance cost.



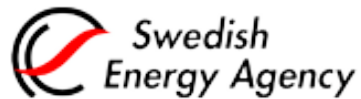
IEA Greenhouse Gas Study – Brief Overview and Key Results

UNDERSTANDING THE COST OF INCORPORATING CO₂ CAPTURE IN AN INTEGRATED STEEL MILL

Acknowledgement



- **PROJECT PARTNERS**



swerea|MEFOS

SSAB

LKAB



- **PROJECT DELIVERY**

swerea|MEFOS

TATA STEEL



Total value of the Project:
IEA GHG Contribution:

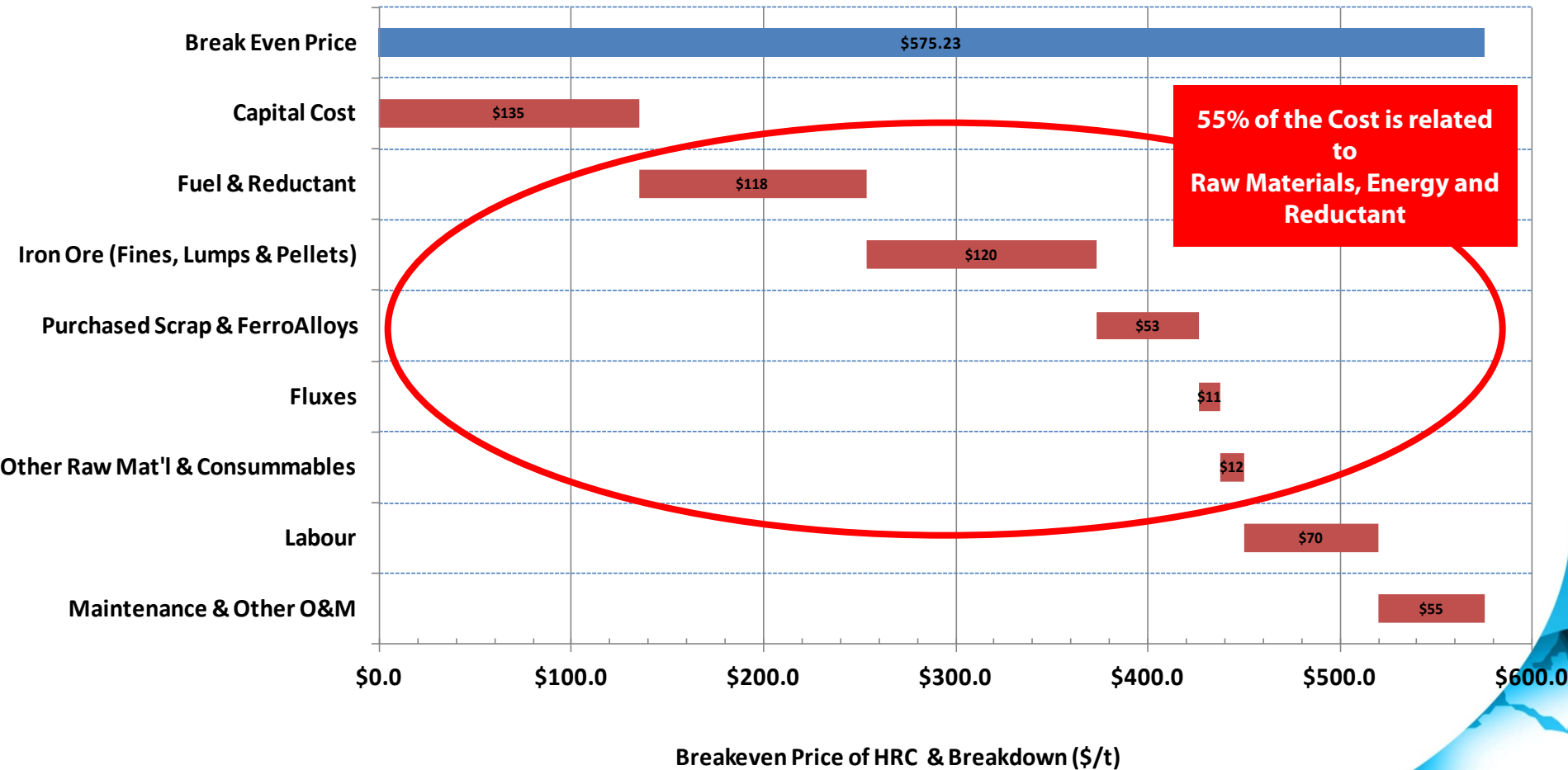
~4.4 million SKr
~1.2 million SKr

Objectives of the Study



- ***To specify a “REFERENCE” steel mill typical to Western European configuration and evaluate the techno-economic performance of the integrated steel mill with and without CO₂ capture.***
- ***To determine the techno-economic performance, CO₂ emissions and avoidance cost of the following cases:***
 - An integrated steel mill typical to Western Europe as the base case.
 - An end of pipe CO₂ capture using conventional MEA at two different levels of CO₂ capture rate
 - An Oxygen Blast Furnace (OBF) and using MDEA for CO₂ capture.

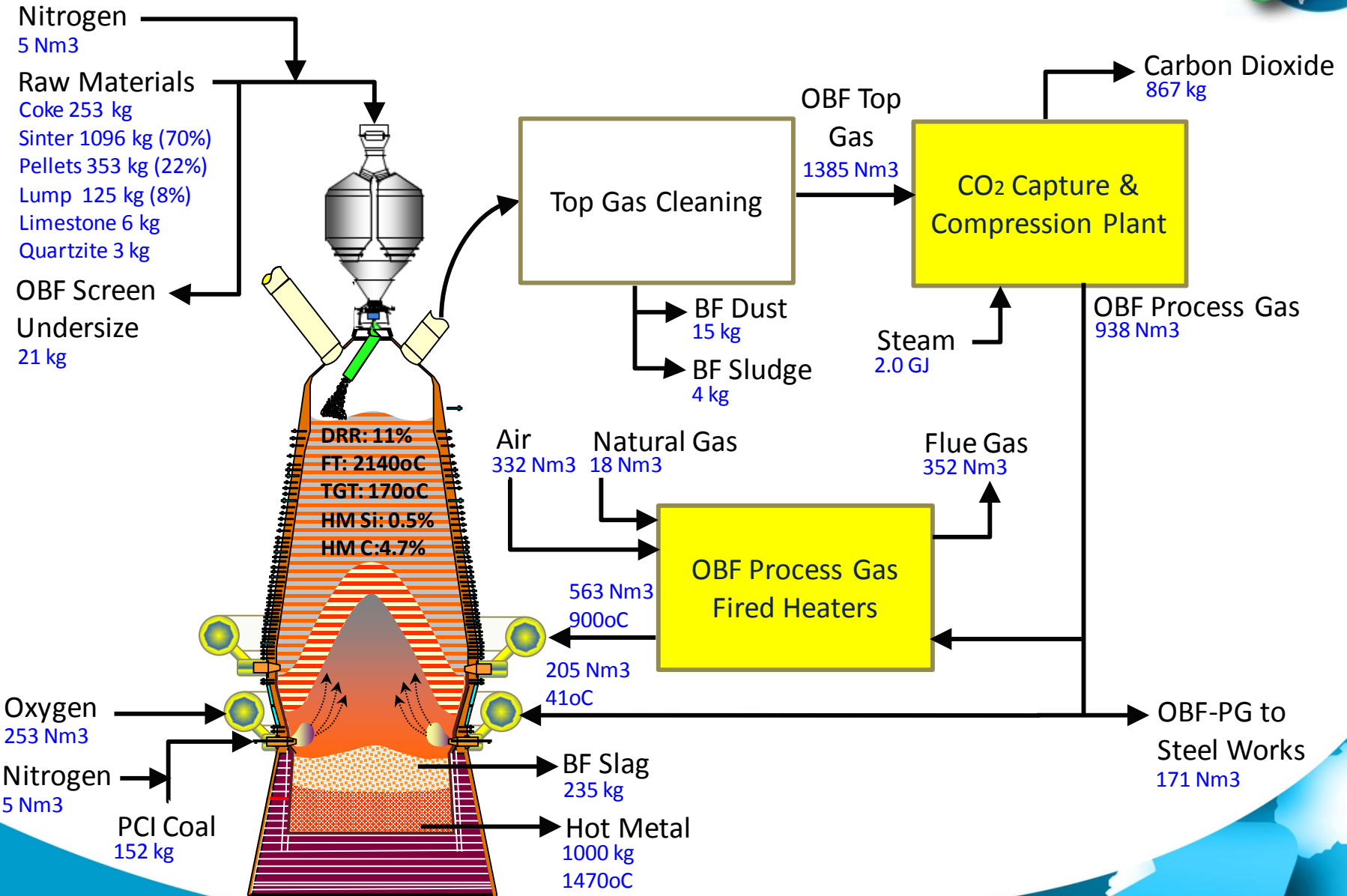
Cost of Steel Production – Breakdown without CO2 capture



Oxy-Blast Furnace Operation



(Picture of OBF courtesy of Tata Steel)



Impact of the OBF/MDEA CO2 Capture Plant to the Breakeven Cost of HRC Production

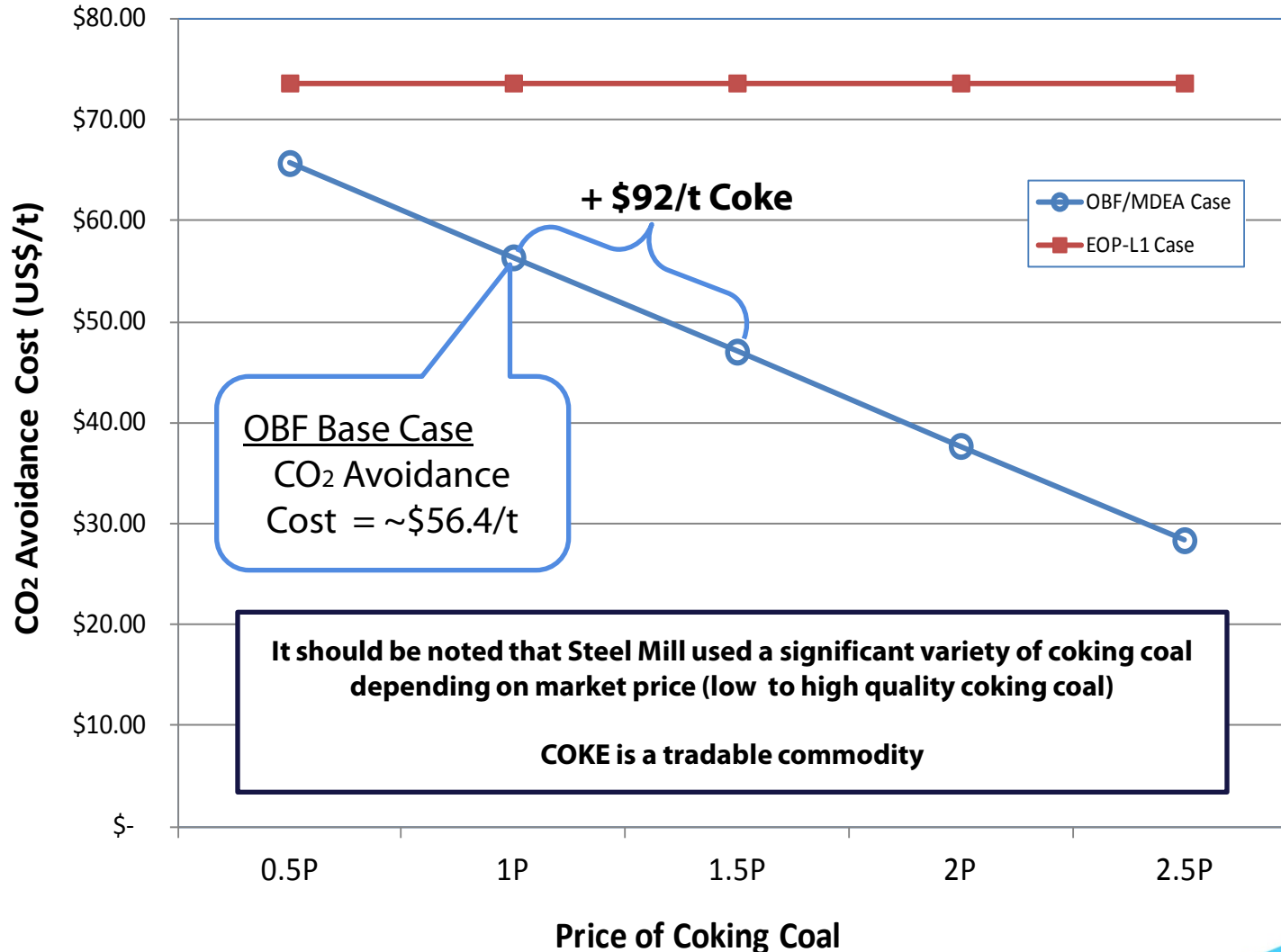


Break- even Cost of HRC Production for OBF @ \$630/t increase of \$55/t over reference plant without capture

- **Capital Cost** *increased by 18.8%*
- **Fuel and Reductant Cost** *increased by 17.3%*
 - Coking Coal Cost – decreased by ~24%
 - Natural Gas Cost – increased by ~495%
- **Iron Burden Cost** *increased by 1.0%*
 - Iron Ore (Fines, Lumps and Pellets), Purchased Scrap & Ferroalloys
- **Fluxes Cost** *decreased by 9.4%*
 - Significant reduction of limestone and quartzite consumption
- **Other Consumable Cost** *increased by 15.7%*
 - Increased in cost of raw water consumption
 - Additional cost due to Chemicals & Consumables used by SGP.
 - Additional cost due to MDEA/Pz Solvent Make Up
- **Labour Cost** *increased by 1.4%*
- **Maintenance and Other OPEX** *increased by 10.4%*

Summary of Results

(Sensitivity to Coke Price)



What We Have Learned from this Study



- ***Recognising the different limitations for this study allows us to identify where the gaps in information are and what we need to evaluate in future studies.***
- ***What are these limitations...***
 - Availability of a reliable cost data
 - Limited budget for this study didn't allow us to optimise certain aspects of the different processes evaluated.

What We Have Learned from this Study...



- ***Technical Aspects...***

- Helped us understand the dynamics of the integrated steel mill – especially interaction of various processes with respect to CO₂ emissions.
- Identified the uncertainties with respect to the operation of the oxy-blast furnace.
 - Need to verify and validate coke reduction potential of the oxy-blast furnace.
 - This study presented a reduction of 24% of coke requirements for the Blast Furnace

What We Have Learned from this Study...



- ***Stakeholders discussion***
 - 1st Workshop – November 2011
 - Review Meeting – April 2012
 - Planned 2nd Workshop – April/May 2013
- ***ULCOS Data Comparison***

Conclusions



- **CCS** has an **important** role to play in **emissions mitigation** in the 2°C policy scenario
- **Industrial sector** is expected to contribute **40% of the overall CCS emissions reduction by 2035**, with Iron and Steel having a big role to play in this sector
- The **strategy** for the Iron and Steel Sector has **to also look at efficiency improvements and fuel switching**
- **Much needs to be done** in terms of **benchmarking emissions and costs**, identifying the **best options** and in **optimising process performance**
- **Cost competitiveness** is a **significant challenge** to the Iron and Steel industry
- **Demonstration of integrated CCS** with large scale storage **~10 Mt/y** would be a **key milestone**



Thank You

stanley.santos@ieaghg.org