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CALCULATION OF EMISSIONS FROM IRON AND STEEL PRODUCTION:
EVALUATION OF METHODOLOGIES AND CALCULATION ON DIFFERENT SCALES

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Introduction

The iron and steel sector is a significant source of emissions of air pollutants, greenhouse gases, heavy metals and POP's. There is a large variety in technologies and abatement measures applied in the various world regions. Especially in developing countries and economies in transition the iron and steel sector is often outdated and inefficient.

In this MSc project the different techniques for iron and steel production, emission control measures and different methodologies to calculate global emissions from this sector have been analysed. Figure 1 presents a flowchart of an integrated iron and steel plant. Table 1 provides an overview of "best available techniques" BAT that can be applied to reduce emissions through either process integrated techniques (PI) or end of pipe techniques (EP).

Table 1: Overview of the Best Available Techniques

	Techniques	Sinter	Coke	BF	BOF	EAF
EP/PI	Process optimisation and plant maintenance	ALL [1] , Energy savings [2]	ALL [1,4]	CO,VOC,PAH	ALL [1]	Energy savings [2]
EP/PI	Low-NO_X techniques [3]	NO_X	NO_X			
EP/PI	Low-SO_X techniques [3]	SO_2	SO_2			
PI	Heat/energy recovery [3]	ALL [1] , Energy savings [2]	Energy savings [2]	Energy savings [2]	Energy savings [2]	Energy savings [2]
PI	Fuel and feed control	SO_2, VOC, NMVOC, POPs	SO_2	SO_2		POPs
EP	PM control technology	PM	PM	PM	PM	PM
EP	Wet scrubbers [5]	PM, SO_2	PM	PM	PM	
EP	De-dusting system [6]		PM	PM	PM	PM

[1] All relevant emissions e.g. CO, NO_X, SO_2, VOC, NMVOC, PM, and others (HM, HF, HCl, PCDD/F, etc.)
[2] Leading to reduction of energy needs therefore less coke is consumed, reducing all relevant emissions
[3] Includes all techniques and technologies currently in use
[4] Non-recovery coking leads to increase in PM and SO_2 compared to conventional coking
[5] Wet desulphurisation is usually performed in wet scrubbers
[6] Includes all primary and secondary off-gas collection systems currently in use

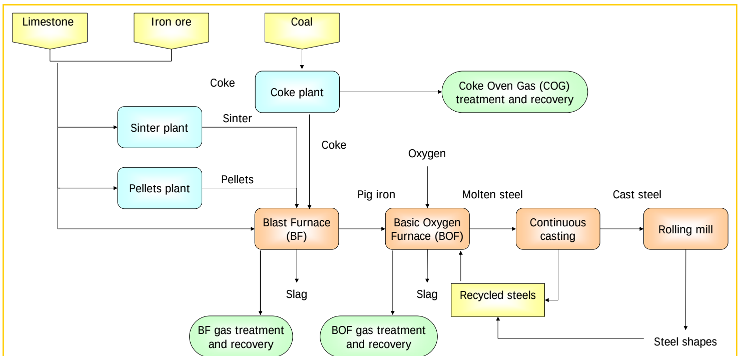

Figure 1: Simplified flowchart of integrated iron and steel plant

Analysis

Emissions are calculated using an emission factor approach in which activity data have been analysed for both fuel combustion and the industrial processes in the different stages of iron and steel production.

Emissions = Activity Data (AD) * Emission Factor (EF)

Different methodologies and different input parameters have been analysed to highlight differences amongst various emission inventories and to provide an insight in the uncertainty in global emission inventories of iron and steel production.
Emissions for the year 2000 have been calculated using
AD: EDGAR v3.2, RAINS (CLE)
EF: EDGAR v3.2, RAINS (CLE) and EPA (Fire 6.25)
Resulting emissions have been compared with UNFCCC national communications of the EU25 countries for NOx (Figure 2) and SO_2 (Figure 3) while for CO in China and India result have been compared with results from REAS and a study by Zhaobin (Figure 4). EPA controlled EF have been selected for EU25 and uncontrolled EF for Asia.

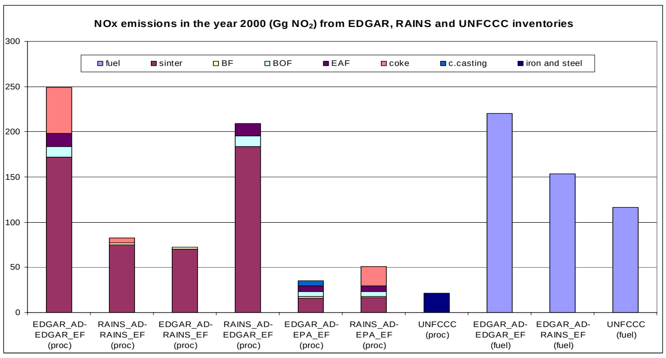

Figure 2: EU25 emissions of NO_x

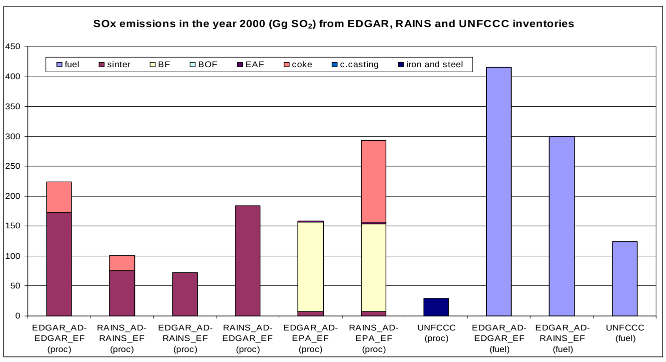

Figure 3: EU25 emissions of SO_2

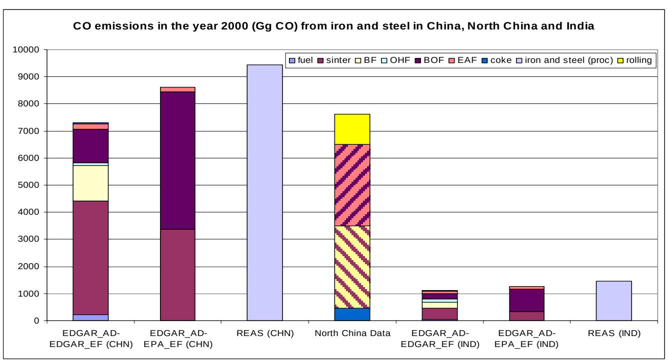

Figure 4: CO emissions in China and India

Major findings

RAINS
- Abatement techniques provided at country level
- Pig iron EF available only for Austria and United Kingdom
- In combustion in boilers no separation of COG, BF gas and natural gas

EDGAR
- EF provided for 1970 and 1995 are identical
- Abatement techniques not explicitly mentioned
- EF cover all processes and full range of fuel used in iron and steel

UNFCCC
- Not all countries report emissions from iron and steel sector

REAS
- For the iron and steel sector only CO and CO_2 emissions are considered.
- No distinction between emissions by process and fuel

EPA
- CO emissions from BF are not considered
- Large difference in NOx and SO2 emissions with other inventories

North China Data
- Emissions for the year 2003 in Beijing,Tianjin, Hebei, Shanxi and Inner Mongolia

Conclusions

a) Emissions calculated using different method provides an insight in the uncertainty in emission calculation for iron and steel production
b) For EU25 significant differences occur between RAINS and EDGAR emission estimates (most likely due to overestimation by EDGAR) and between EPA and UNFCCC studies. More detailed analysis needed to draw conclusions on the cause of these differences.
c) Although in China and India different methods result in comparable total emission estimates for CO, the importance of the different processes varies.
Further steps to finish MSc project
d) Compare results of detailed calculation for an individual facility (Lucchini S.p.a, Italy) with calculation on national scale (EDGAR, RAINS, UNFCCC)
e) Detailed examination to compare the installed abatement measures in Europe to facilities in Asia, USA and other parts of the world

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