2.C.1 - Iron & Steel Production

Short description

The source subcategory *NFR 2.C.1 - Iron & Steel Production* comprises process-related emissions from oxygen steel and electric steel production.

Category Code	Method					AD					EF				
2.C.1	T2					NS					CS				
	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	Diox	PAH	HCB
Key Category:	-/-	-/-	L/-	-/-	L/T	L/T	L/T	-	L/-	L/T	L/T	L/T	L/T	L/T	L/-

T = key source by Trend **L** = key source by Level

Methods	
D	Default
T1	Tier 1 / Simple Methodology *
T2	Tier 2*
T3	Tier 3 / Detailed Methodology *
C	CORINAIR
CS	Country Specific
M	Model

* as described in the EMEP/EEA Emission Inventory Guidebook - 2019, in the group specific chapters.

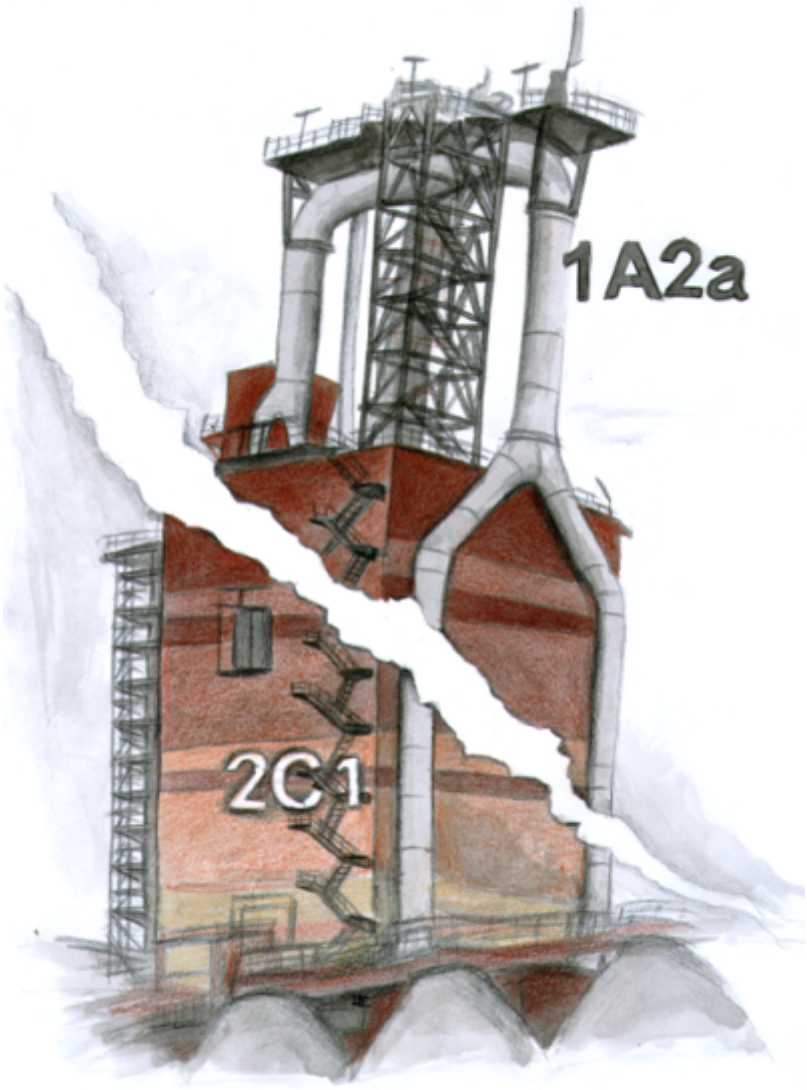
AD - Data Source for Activity Data	
NS	National Statistics
RS	Regional Statistics
IS	International Statistics
PS	Plant Specific data
As	Associations, business organisations
Q	specific Questionnaires (or surveys)
M	Model / Modelled
C	Confidential

EF - Emission Factors	
D	Default (EMEP Guidebook)
C	Confidential
CS	Country Specific
PS	Plant Specific data
M	Model / Modelled

In 2021 a total of 28.2 million tonnes of raw steel were produced in six integrated steelworks. Electrical steel production amounted to another 12.1 million tonnes.

Other structural elements are sinter production, hot iron production, hot rolling, iron and steel foundries (including malleable casting). The last Siemens-Martin steelworks (Stahlwerk Brandenburg) was shut down shortly after 1990. The last Thomas steelworks (Maxhütte Sulzbach-Rosenberg) discontinued its production in 2002. Due to their minor relevance and their phase-out, the emissions from Siemens-Martin and Thomas steel production are jointly calculated with the emissions from oxygen steel production.

Energy-related emissions from steel production for the years 1990 to 1994 (for individual pollutants until 1999) are reported under 1.A Fuel combustions in the respective subcategory 1.A.2.a. A detailed explanation for the individual pollutants is also found there.



Method

Activity data

Activity data is collected from plant operators by national institutions. Since the discontinuation of the special public statistics for iron and steel production (FS. 4, R. 8.1), the information is collected by the German steel trade association Wirtschaftsvereinigung Stahl (WV Stahl) based on a formal agreement.

As the activity rates for 2017 could not be provided by WV Stahl as a result of compliance issues, aggregated figures from emissions trading were used instead. The consistency of emissions trading data was verified against comparative figures for previous years. The deviations were less than 1%; only in sinter production were they noticeably higher (maximum + 8%).

In the iron and steel industry, only minor amounts of secondary fuels are used for pig iron production in individual blast furnaces. They are used as substitute reducing agents of coke and coal. To date, these materials have not yet been included in the national statistics nor in the Energy Balance. For this reason, the data used is also provided by WV Stahl.

Emission factors

The emission factors used to calculate emissions are based on emission data from individual plants. The emission factors for 1995 to 2001 were determined by the German Environment Agency (UBA for its initials in German) itself and those for 2008 and later through a research project.

As the EF for the years 1995 to 2001 as well as for 2008 are based on real stack emission data. Since both combustion and process-related emissions are released through the same stacks, emission factors could not be calculated individually for combustion or process-related emissions. Hence, wherever plant-based EF were availaible, as it the case for most pollutants for the years 1995 and later, all emissions are reported under 2.C.1.

Please note that the reported emissions also cover diffuse emissions from sources that are not covered in the EMEP/EEA Guidebook. For many pollutants and sources, individual EFs for channelled as well as diffuse emissions have been determined. While there is sufficient knowledge and measurement data of channelled emissions, the emission data concerning diffuse sources is usually based on estimations using parameters adapted to the local conditions of the individual emission source. Therefore, emission data for one source of diffuse emissions is not significant for the diffuse emissions from other plants. The emission factors given below were calculated as the weighted average of the pollution loads reported by the plant operators for individual diffuse sources, in relation to their corresponding production amounts.

Table 1: Overview of the emission factors applied for sinter production

	Type of source	EF 1990	EF 1995	EF 2000	EF 2005	EF 2010	Unit
Cd		0.098			0.052	0.017	g/t
CO		19.152		17.325	15.497	14.4	kg/t
Cr		0.077			0.044	0.02	g/t
HCB		0.03					mg/t
Hg		0.059			0.028	0.005	g/t
Ni		0.139			0.068	0.015	g/t
NMVOC		0.12					kg/t
NO_x		IE[1)]		0.558	0.46	0.401	kg/t
PAH	channelled	320.00	248.571	177.143	120		mg/t
Pb		5.299			3.242	1.7	g/t
PCB		3.0	2.285714	1.571429	1		mg/t
PCDD/F		6.0	4.575	3.149	1.724	0.796	µg/t
SO_2		IE[2)]		1.08	0.837	0.691	kg/t
TSP	channelled		0.65	0.465	0.234	0.096	kg/t
TSP	diffuse					0.046	kg/t
PM_{10}	channelled		0.445	0.336	0.177	0.07	kg/t
PM_{10}	diffuse					0.016	kg/t
$PM_{2.5}$	channelled		0.214	0.206	0.13	0.056	kg/t

Table 2: Overview of the emission factors applied for pig iron production

	Type of source	EF 1995	EF 2000	EF 2005	EF 2010	Unit
PAH	channelled	0.5				mg/t
Cd	channelled	4.0				mg/t
Cd	diffuse	0.203				mg/t
CO	channelled	1.18	0.915	0.65	0.491	kg/t
CO	diffuse	0.398				kg/t
Cr	channelled	0.019	0.006	0.002	0.001	g/t
Cr	diffuse	0.008				g/t
Hg	channelled	2.436	0.192	0.015	0.003	mg/t
Hg	diffuse	0.005				mg/t
Ni	channelled	21.0	6.0	2.0	1.0	mg/t
Ni	diffuse	8.0				mg/t
NMVOC		18.525				g/t
NO_x	channelled	0.051938	0.051938	0.051938	0.0517	kg/t
NO_x	diffuse	0.001				g/t
Pb	channelled	0.022				g/t
Pb	diffuse	0.011				g/t
PCDD/F		0.026	0.009	0.004	0.004	µg/t
SO_2	channelled	0.242				kg/t
SO_2	diffuse	0.04				kg/t
TSP	channelled	0.022	0.015	0.01	0.008	kg/t

	Type of source	EF 1995	EF 2000	EF 2005	EF 2010	Unit
TSP	diffuse	0.016				kg/t
PM_{10}	channelled	0.013	0.009	0.006	0.006	kg/t
PM_{10}	diffuse	0.007				kg/t
$PM_{2.5}$	channelled	0.009	0.007	0.005	0.004	kg/t

Table 3: Overview of the emission factors applied for oxygen steel production

	Type of source	EF 1995	EF 2000	EF 2005	EF 2010	Unit
Cd		0.053	0.038	0.024	0.016	g/t
CO		11.500	11.077	10.654	10.400	kg/t
Cr	channelled	0.715	0.306	0.125	0.028	g/t
Cr	diffuse	0.069				g/t
Ni	channelled	0.090	0.060	0.030	0.006	g/t
Ni	diffuse	0.004				g/t
NO_x	channelled	0.006	0.005	0.005	0.004	kg/t
NO_x	diffuse	0.0037				kg/t
PAH	channelled	0.100				mg/t
Pb	channelled	2.941	1.883	0.824	0.189	g/t
Pb	diffuse	0.278				g/t
PCB		2.670	1.740	1	1	mg/t
PCDD/F		0.070	0.070	0.070	0.069	µg/t
SO_2	diffuse	0.001				kg/t
TSP	channelled	0.155	0.145	0.145	0.024	kg/t
TSP	diffuse	0.049				kg/t
PM_{10}	channelled	0.099	0.093	0.093	0.020	kg/t
PM_{10}	diffuse	0.019				kg/t
$PM_{2.5}$	channelled	0.025	0.023	0.023	0.017	kg/t

Table 4: Overview of the emission factors applied for electric steel production

	Type of source	EF 1995	EF 2000	EF 2005	EF 2010	Unit
Cd		0.240	0.157	0.065	0.016	g/t
CO	channelled	1.700	1.187	0.674	0.366	kg/t
CO	diffuse	0.001				kg/t
Cr	channelled	0.481	0.206	0.258	0.323	g/t
Cr	diffuse	0.851				g/t
Hg	channelled	0.306	0.288	0.154	0.070	g/t
Ni	channelled	0.483	0.207	0.145	0.124	g/t
Ni	diffuse	0.284				g/t
NMVOC		0.035	0.024	0.012	0.006	kg/t
NO_x	channelled	0.122	0.12	0.106	0.098	kg/t
NO_x	diffuse	0.014				kg/t
PAH		45	22.1	3.798	3.793	mg/t
Pb	channelled	4.075	1.747	0.720	0.170	g/t
Pb	diffuse	0.056				g/t
PCB		5.68	3.360	1.500	1.500	mg/t
PCDD/F		0.466	0.295	0.158	0.158	µg/t
SO_2	channelled	0.113				kg/t
SO_2	diffuse	0.004				kg/t
TSP	channelled	0.28	0.12	0.074	0.018	kg/t
TSP	diffuse				0.043	kg/t
PM_{10}	channelled	0.179	0.08	0.051	0.013	kg/t
PM_{10}	diffuse				0.007	kg/t
$PM_{2.5}$	channelled	0.045	0.04	0.038	0.011	kg/t

Table 5: Overview of the emission factors applied for hot and cold rolling

	Type of source	EF 1995	EF 2000	EF 2005	EF 2010	unit	Trend
CO					5.0	g/t	constant
NH_3			0.700			g/t	constant
NMVOC			3.0			g/t	constant
NO_x			0.410	0.276	0.196	kg/t	falling
SO_2			0.059	0.050	0.044	kg/t	falling
TSP	channelled				0.020	kg/t	constant
TSP	diffuse				0.010	kg/t	constant
PM_{10}	channelled				0.304	g/t	constant
PM_{10}	diffuse				0.645	g/t	constant
$PM_{2.5}$	channelled				0.266	g/t	constant

Table 6: Overview of the emission factors applied for iron and steel casting

	EF 2010	Unit	Trend
NH_3	0.027	kg/t	falling
NMVOC	0.150	kg/t	constant
NO_x	0.242	kg/t	falling
PAH	0.100	g/t	constant
PCDD/F	0.190	µg/t	constant
SO_2	0.256	kg/t	falling
TSP	0.200	kg/t	constant
PM_{10}	0.137	kg/t	constant
$PM_{2.5}$	0.0836	kg/t	constant

HCB

For **sinter production**, as long as no country specific emission factor for HCB has been derived, the standard emission factor is used. By implementing the EMEP/EEA Guidebook standard emission factor, Germany is following recommendations provided by the Expert Review Team for the NECD-Review in 2020.

PAH

In the 2021 review the application of a consistent methodology in reporting of PAH emissions in 2C1-iron and steel production was claimed. As there is not enough data available to report individual PAHs Germany decided to only report total-PAHs for the whole time. But for pig iron production a national total-PAH emission factor was missing. For that source the national inventory solely included BaP emissions. Due to the limitation of data the total-PAH emission factor for pig iron production was derived from the BaP emission factor on the basis of the following conservative ansatz (not changing the overall PAH emission trend): Emissions of PAH depend on the coating material used. The emission factor in table 3.8 of the actual emission guidebook 2019 for pig iron production (2500 mg/t) is only valid for tar containing coating material and excluded abatement technics. Both assumptions are not appropriate for Germany. As tar-free materials are used for coating PAH emissions should not play any role. And the blast furnace gas is conducted and used. But as PAH emissions could not be surely ruled out and in order to avoid an underestimation of PAH emissions in pig iron production the emission factor for total-PAH is set to the 10-fold of the BaP emission factor.

Discussion of emission trends

The trends in emissions correspond to the trends of emission factors given in the tables above, which are often driven by regulatory measures.
However, since 2010, the main driver of the emission trends in most cases is the activity data.

Recalculations

For more **information on recalculated emission estimates for the**

Base Year and 2020, please see the pollutant specific recalculation tables in the following chapter 8.1 - Recalculations.

Planned improvements

no improvements planned.

[1)] , [2)]

Emissions were reported under NRF Code 1.A.2.a