# 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 | | | | |
| **Key Category** | **$SO_2$** | **$NO_x$** | **$NH_3$** | **NMVOC** | **CO** | **BC** | **Pb** | **Hg** | **Cd** | **Diox** | **PAH** | **HCB** | **TSP** | **$PM_{10}$** | **$PM_{2.5}$** |
| 2.C.1 | L/- | - | - | - | L/- | - | L/T | L/T | L/T | L/T | - | - | L/T | L/T | L/T |

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

| Methods | |
|---|---|
| **D** | Default |
| **RA** | Reference Approach |
| **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/CORINAIR Emission Inventory Guidebook - 2007, in the group specific chapters.

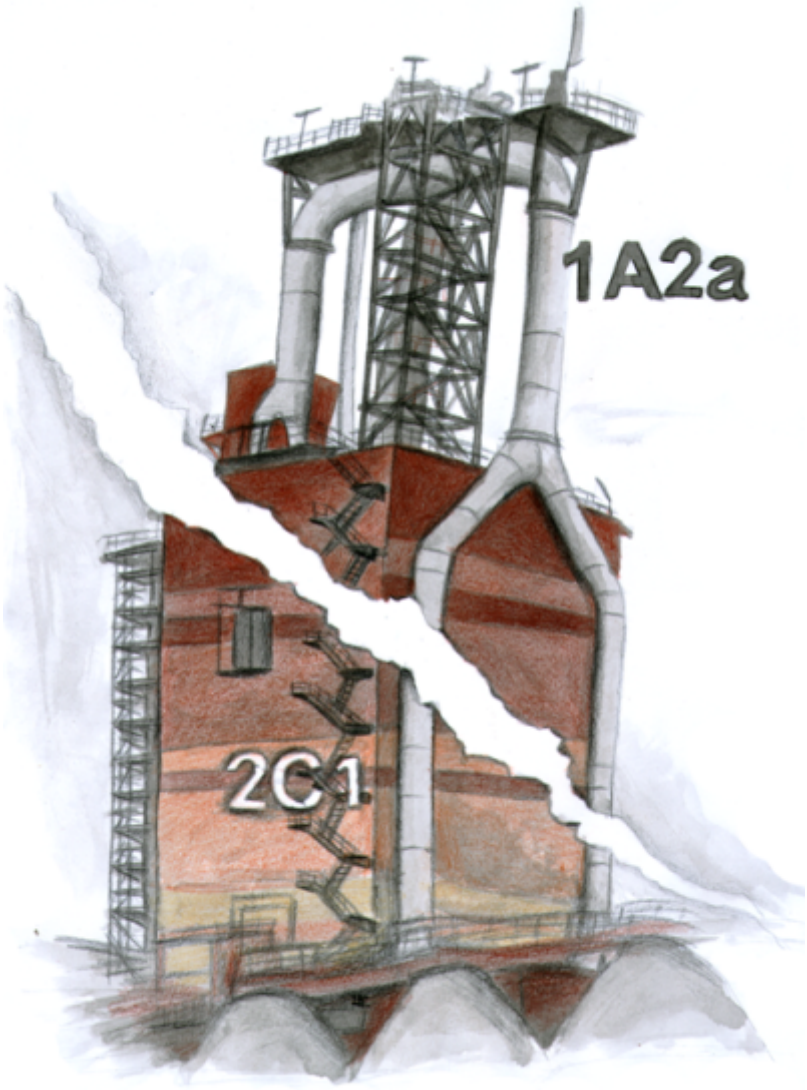
| AD - Data Source for Activity Data | |
|---|---|
| **NS** | National Statistics |
| **RS** | Regional Statistics |
| **IS** | International Statistics |
| **PS** | Plant Specific data |
| **AS** | Associations, business organisations |
| **Q** | specific questionnaires, surveys |

| EF - Emission Factors | |
|---|---|
| **D** | Default (EMEP Guidebook) |
| **C** | Confidential |
| **CS** | Country Specific |
| **PS** | Plant Specific data |

In 2019 a total of 27.7 million tonnes of raw steel were produced in six integrated steelworks. Electrical steel production amounted to another 11.9 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.




## 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

| Pollutant | 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 | | 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

| Pollutant | Type of source | EF 1995 | EF 2000 | EF 2005 | EF 2010 | Unit |
|---|---|---|---|---|---|---|
| B(a)P | | 0.05 | | | | 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 |

| Pollutant | 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

| Pollutant | 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 | | 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

| Pollutant | Type of source | EF 1995 | EF 2000 | EF 2005 | EF 2010 | Unit |
|---|---|---|---|---|---|---|
| B(a)P | | 2.531 | 1.661 | 0.792 | 0.271 | mg/t |
| 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 | 3.793 | 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

| Pollutant | 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

| Pollutant | EF 2010 | Unit | Trend |
|---|---|---|---|
| B(a)P | 10 | mg/t | constant |
| $NH_3$ | 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 |

## Discussion of emission trends

The trends in emissions correspond to the trends of emission factors given in the table above. In many cases the trend is due to regulatory measures. Since 2010, the main driver of the emission trends in most cases is the activity data.

## Recalculations

Replacing data of the preliminary energy balance with data of the final energy balance lead to restatements for the years 2017 and 2018.

For more information on recalculated emission estimates for the Base Year and 2018, please see the pollutant specific recalculation tables in the following chapter 8.1 - Recalculations.

## Planned improvements

HCB emissions from **iron and steel production** have not been included so far due to a lack of emission data (notation key NE). In the past, the standard emission factor was not considered as appropriate, because it was unclear from what kind of data the factor was derived from and to which process/activity rate it actually referred to. In order to overcome this data gap, information will be collected within the scope of a reserach project for updating and completing the emission factors for the sector. The project will start in 2021 and is designed to run for three years.

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.

[1)] , [2)]

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