

## 2.C.1 - Iron & Steel Production

### Short description

Source category *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 <sub>2</sub> | NO <sub>x</sub> | NH <sub>3</sub> | NM VOC | CO  | BC | Pb  | Hg  | Cd  | Diox | PAH | HCb | TSP | PM <sub>10</sub> | PM <sub>2.5</sub> |
| 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

|           |                                 |
|-----------|---------------------------------|
| <b>D</b>  | Default                         |
| <b>RA</b> | Reference Approach              |
| <b>T1</b> | Tier 1 / Simple Methodology *   |
| <b>T2</b> | Tier 2*                         |
| <b>T3</b> | Tier 3 / Detailed Methodology * |
| <b>C</b>  | CORINAIR                        |
| <b>CS</b> | Country Specific                |
| <b>M</b>  | Model                           |

\* as described in the EMEP/CORINAIR Emission Inventory Guidebook - 2007, in the group specific chapters.

|   |                                      |
|---|--------------------------------------|
| <b>AD - Data Source for Activity Data</b> |                                      |
| <b>NS</b>                                 | National Statistics                  |
| <b>RS</b>                                 | Regional Statistics                  |
| <b>IS</b>                                 | International Statistics             |
| <b>PS</b>                                 | Plant Specific data                  |
| <b>AS</b>                                 | Associations, business organisations |
| <b>Q</b>                                  | specific questionnaires, surveys     |
| <b>EF - Emission Factors</b>              |                                      |
| <b>D</b>                                  | Default (EMEP Guidebook)             |
| <b>C</b>                                  | Confidential                         |
| <b>CS</b>                                 | Country Specific                     |
| <b>PS</b>                                 | Plant Specific data                  |

The last Siemens-Martin steel works (Stahlwerk Brandenburg) was shut down shortly after 1990; the last Thomas steel works (Maxhütte Sulzbach-Rosenberg) discontinued the production in 2002. Due to their minor relevance and the phasing out, the emissions from Siemens-Martin and Thomas steel production are jointly calculated with the emissions from oxygen steel production.

The other structural elements are sinter production, hot iron production, hot rolling, iron and steel foundries (including malleable casting). Energy-related emissions from steel production for the years 1990 - 1994 (for individual pollutants until 1999) are reported under [1.A.2.a](#).

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



## Method

### Activity data

Activity data are surveyed plant specific and submitted by national statistics. After discontinuation of the special 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. 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, instead of coke. To date, these materials have not yet been included in the national statistics and in the Energy Balance. For this reason, the data used was provided by the steel trade association (Wirtschaftsvereinigung Stahl).

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

### Emission factors

The emission factors used for emissions calculation are based on emission data from individual plants, either determined by the Umweltbundesamt (UBA) itself (emission factors for 1995 - 2001) or by a research project (emission factors for 2008). As the EF for the years 1995 - 2001 as well as for 2008 are based on real stack emission data, it is not possible to distinguish between combustion and process emissions (they are emitted via the same stacks). Hence wherever plant-based EF were

available, i.e. for most pollutants for the years 1995 and later, all emissions are reported under 2.C.1.

Please note that the reported emissions now also cover diffuse emissions from sources that were not covered in previous reporting periods, nor 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 hardly significant for the diffuse emissions from other plants. The emission factors given below were calculated as the weighted average of pollution loads reported for individual diffuse sources by the plant operators, in relation to their corresponding production amounts.

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

| <b>pollutant</b> | <b>Type of source</b> | <b>EF 1990</b> | <b>EF 1995</b> | <b>EF 2000</b> | <b>EF 2005</b> | <b>EF 2010</b> | <b>EF 2016</b> | <b>unit</b> | <b>Trend</b> |
|------------------|-----------------------|----------------|----------------|----------------|----------------|----------------|----------------|-------------|--------------|
| Cd               |                       |                | 0.098          |                | 0.052          |                | 0.017          | g/t         | falling      |
| CO               |                       | 19.152         |                | 17.325         | 15.497         |                | 14.4           | kg/t        | falling      |
| Cr               |                       |                | 0.077          |                | 0.044          |                | 0.02           | g/t         | falling      |
| HCb              |                       |                |                | 0.03           |                |                |                | mg/t        | constant     |
| Hg               |                       |                | 0.059          |                | 0.028          |                | 0.005          | g/t         | falling      |
| Ni               |                       |                | 0.139          |                | 0.068          |                | 0.015          | g/t         | falling      |
| NMvOC            |                       |                |                | 0.12           |                |                |                | kg/t        | constant     |
| NOx              |                       |                | IE             | 0.558          | 0.46           |                | 0.401          | kg/t        | falling      |
| PAH              |                       | 320.00         | 248.571        | 177.143        |                | 120            |                | mg/t        | falling      |
| Pb               |                       |                | 5.299          |                | 3.242          |                | 1.7            | g/t         | falling      |
| PCB              |                       | 3.0            | 2.285714       | 1.571429       |                | 1              |                | mg/t        | falling      |
| PCDD/F           |                       | 6.0            | 4.575          | 3.149          | 1.724          | 0.796          | 0.578          | µg/t        | falling      |
| SO2              |                       |                | IE             | 1.08           | 0.837          |                | 0.691          | kg/t        | falling      |
| TSP              | channelled            |                | 0.65           | 0.465          | 0.234          |                | 0.096          | kg/t        | falling      |
| TSP              | diffuse               |                |                | 0.046          |                |                |                | kg/t        | new EF       |
| PM10             | channelled            |                | 0.445          | 0.336          | 0.177          |                | 0.07           | kg/t        | falling      |
| PM10             | diffuse               |                |                | 0.016          |                |                |                | kg/t        | new EF       |
| PM2.5            | channelled            |                | 0.214          | 0.206          | 0.13           |                | 0.056          | kg/t        | falling      |

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

| <b>pollutant</b> | <b>Type of source</b> | <b>EF 1995</b> | <b>EF 2000</b> | <b>EF 2005</b> | <b>EF 2010</b> | <b>EF 2016</b> | <b>unit</b> | <b>Trend</b> |
|------------------|-----------------------|----------------|----------------|----------------|----------------|----------------|-------------|--------------|
| B(a)P            |                       |                |                | 0.05           |                |                | mg/t        | constant     |
| Cd               | channelled            |                |                | 0.004          |                |                | g/t         | constant     |
| Cd               | diffuse               |                |                | 0.000203       |                |                | g/t         | constant     |
| CO               | channelled            | 1.18           | 0.915          | 0.65           | 0.491          | 0.491          | kg/t        | falling      |
| CO               | diffuse               |                |                | 0.398          |                |                | kg/t        | constant     |
| Cr               | channelled            | 0.019          | 0.006          | 0.002          | 0.001          | 0.001          | g/t         | falling      |
| Cr               | diffuse               |                |                | 0.008          |                |                | g/t         | constant     |
| Hg               | channelled            | 0.002436       | 0.000192       | 0.000015       | 0.000003       | 0.000003       | g/t         | falling      |
| Hg               | diffuse               |                |                | 0.005          |                |                | mg/t        | constant     |
| Ni               | channelled            | 0.021          | 0.006          | 0.002          | 0.001          | 0.001          | g/t         | falling      |
| Ni               | diffuse               |                |                | 0.008          |                |                | g/t         | constant     |
| NMvOC            |                       |                |                | 0.018525       |                |                | kg/t        | constant     |
| NOx              | channelled            | 0.051938       | 0.051938       | 0.051938       | 0.0517         | 0.0517         | kg/t        | falling      |
| NOx              | diffuse               |                |                | 0.001          |                |                | g/t         | constant     |
| Pb               | channelled            |                |                | 0.022          |                |                | kg/t        | constant     |
| Pb               | diffuse               |                |                | 0.011          |                |                | g/t         | constant     |
| PCDD/F           |                       | 0.026          | 0.009          | 0.004          | 0.004          | 0.004          | µg/t        | falling      |
| SO2              | channelled            |                |                |                |                | 0.242          | g/t         | constant     |
| SO2              | diffuse               |                |                | 0.04           |                |                | kg/t        | constant     |
| TSP              | channelled            | 0.022          | 0.015          | 0.01           | 0.008          | 0.008          | kg/t        | falling      |
| TSP              | diffuse               |                |                | 0.016          |                |                | g/t         | constant     |
| PM10             | channelled            | 0.013          | 0.009          | 0.006          | 0.006          | 0.006          | kg/t        | falling      |

| <b>pollutant</b> | <b>Type of source</b> | <b>EF 1995</b> | <b>EF 2000</b> | <b>EF 2005</b> | <b>EF 2010</b> | <b>EF 2016</b> | <b>unit</b> | <b>Trend</b> |
|------------------|-----------------------|----------------|----------------|----------------|----------------|----------------|-------------|--------------|
| PM10             | diffuse               | 0.007          |                |                |                |                | kg/t        | constant     |
| PM2.5            | channelled            | 0.009          | 0.007          | 0.005          | 0.004          | 0.004          | kg/t        | falling      |

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

| <b>pollutant</b> | <b>Type of source</b> | <b>EF 1995</b> | <b>EF 2000</b> | <b>EF 2005</b> | <b>EF 2010</b> | <b>EF 2016</b> | <b>unit</b> | <b>Trend</b>     |
|------------------|-----------------------|----------------|----------------|----------------|----------------|----------------|-------------|------------------|
| Cd               |                       | 0.053          | 0.038          | 0.024          | 0.016          | 0.016          | g/t         | falling          |
| CO               |                       | 11.500         | 11.077         | 10.654         | 10.400         | 10.400         | kg/t        | falling          |
| Cr               | channelled            | 0.715          | 0.306          | 0.125          | 0.028          | 0.028          | g/t         | falling          |
| Cr               | diffuse               | 0.069          |                |                |                |                | g/t         | new EF, constant |
| Ni               | channelled            | 0.090          | 0.060          | 0.030          | 0.006          | 0.006          | g/t         | falling          |
| Ni               | diffuse               | 0.004          |                |                |                |                | g/t         | new EF, constant |
| NOx              | channelled            | 0.006          | 0.005          | 0.005          | 0.004          | 0.004          | kg/t        | falling          |
| NOx              | diffuse               | 0.0037         |                |                |                |                | kg/t        | constant         |
| PAH              |                       | 0.100          |                |                |                |                | mg/t        | constant         |
| Pb               | channelled            | 2.941          | 1.883          | 0.824          | 0.189          | 0.189          | g/t         | falling          |
| Pb               | diffuse               | 0.278          |                |                |                |                | g/t         | new EF, constant |
| PCB              |                       | 2.670          | 1.740          | 1              | 1              | 1              | mg/t        | falling          |
| PCDD/F           |                       | 0.070          | 0.070          | 0.070          | 0.069          | 0.069          | µg/t        | falling          |
| SO2              | diffuse               | 0.001          |                |                |                |                | kg/t        | constant         |
| TSP              | channelled            | 0.155          | 0.145          | 0.145          | 0.024          | 0.024          | kg/t        | falling          |
| TSP              | diffuse               | 0.049          |                |                |                |                | kg/t        | new EF, constant |
| PM10             | channelled            | 0.099          | 0.093          | 0.093          | 0.020          | 0.020          | kg/t        | falling          |
| PM10             | diffuse               | 0.019          |                |                |                |                | kg/t        | new EF, constant |
| PM2.5            | channelled            | 0.025          | 0.023          | 0.023          | 0.017          | 0.017          | kg/t        | falling          |

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

| <b>pollutant</b> | <b>Type of source</b> | <b>EF 1995</b> | <b>EF 2000</b> | <b>EF 2005</b> | <b>EF 2010</b> | <b>EF 2016</b> | <b>unit</b> | <b>Trend</b>     |
|------------------|-----------------------|----------------|----------------|----------------|----------------|----------------|-------------|------------------|
| B(a)P            |                       | 2.531          | 1.661          | 0.792          | 0.271          | 0.271          | mg/t        | falling          |
| Cd               |                       | 0.240          | 0.157          | 0.065          | 0.016          | 0.016          | g/t         | falling          |
| CO               | channelled            | 1.700          | 1.187          | 0.674          | 0.366          | 0.366          | kg/t        | falling          |
| CO               | diffuse               | 0.001          |                |                |                |                | kg/t        | new EF, constant |
| Cr               | channelled            | 0.481          | 0.206          | 0.258          | 0.323          | 0.323          | g/t         | fluctuating      |
| Cr               | diffuse               | 0.851          |                |                |                |                | g/t         | constant         |
| Hg               | channelled            | 0.306          | 0.288          | 0.154          | 0.070          | 0.070          | g/t         | falling          |
| Ni               | channelled            | 0.483          | 0.207          | 0.145          | 0.124          | 0.124          | g/t         | falling          |
| Ni               | diffuse               | 0.284          |                |                |                |                | g/t         | constant         |
| NM VOC           |                       | 0.035          | 0.024          | 0.012          | 0.006          | 0.006          | kg/t        | falling          |
| NOx              | channelled            | 0.122          | 0.12           | 0.106          | 0.098          | 0.098          | kg/t        | falling          |
| NOx              | diffuse               | 0.014          |                |                |                |                | kg/t        | new EF, constant |
| PAH              |                       | 45             | 22             | 3.793          | 3.790          | 3.793          | mg/t        | falling          |
| Pb               | channelled            | 4.075          | 1.747          | 0.720          | 0.170          | 0.170          | g/t         | falling          |
| Pb               | diffuse               | 0.056          |                |                |                |                | g/t         | new EF, constant |
| PCB              |                       | 5.68           | 3.360          | 1.500          | 1.500          | 1.500          | mg/t        | falling          |
| PCDD/F           |                       | 0.466          | 0.295          | 0.158          | 0.158          | 0.158          | µg/t        | falling          |
| SO2              | channelled            | 0.113          |                |                |                |                | kg/t        | constant         |
| SO2              | diffuse               | 0.004          |                |                |                |                | kg/t        | new EF, constant |
| TSP              | channelled            | 0.28           | 0.12           | 0.074          | 0.018          | 0.018          | kg/t        | falling          |
| TSP              | diffuse               |                |                |                | 0.043          | 0.043          | kg/t        | new EF, constant |
| PM10             | channelled            | 0.179          | 0.08           | 0.051          | 0.013          | 0.013          | kg/t        | falling          |
| PM10             | diffuse               |                |                |                | 0.007          | 0.007          | kg/t        | new EF, constant |
| PM2.5            | channelled            | 0.045          | 0.04           | 0.038          | 0.011          | 0.011          | kg/t        | falling          |

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

| pollutant | Type of source | EF 1995 | EF 2000 | EF 2005 | EF 2010 | EF 2016 | unit | Trend            |
|-----------|----------------|---------|---------|---------|---------|---------|------|------------------|
| CO        |                |         |         |         | 0.005   | 0.005   | kg/t | constant         |
| NH3       |                |         |         |         | 0.700   |         | g/t  | constant         |
| NM VOC    |                |         |         |         | 0.003   |         | kg/t | constant         |
| NOx       |                |         | 0.410   | 0.276   | 0.196   | 0.196   | kg/t | falling          |
| SO2       |                |         | 0.059   | 0.050   | 0.044   | 0.044   | kg/t | falling          |
| TSP       | channelled     |         |         |         | 0.020   | 0.020   | kg/t | new EF, constant |
| TSP       | diffuse        |         |         |         | 0.010   | 0.010   | kg/t | new EF, constant |
| PM10      | channelled     |         |         |         | 0.304   | 0.304   | g/t  | new EF, constant |
| PM10      | diffuse        |         |         |         | 0.645   | 0.645   | g/t  | new EF, constant |
| PM2.5     | channelled     |         |         |         | 0.266   | 0.266   | g/t  | new EF, constant |

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

| pollutant | EF 2010 | unit | Trend    |
|-----------|---------|------|----------|
| B(a)P     | 10      | mg/t | constant |
| NH3       | 0.027   | kg/t | falling  |
| NM VOC    | 0.150   | kg/t | constant |
| NOx       | 0.242   | kg/t | falling  |
| PAH       | 0.100   | g/t  | constant |
| PCDD/F    | 0.190   | µg/t | constant |
| SO2       | 0.256   | kg/t | falling  |
| TSP       | 0.200   | kg/t | constant |
| PM10      | 0.137   | kg/t | constant |
| PM2.5     | 0.0836  | kg/t | constant |

### Uncertainties

[Text einfügen]

## Discussion of emission trends

Trends in emissions correspond to trends of emission factors in the table above, in many cases due to regulatory measures. Since 2010, the main driver for 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 leads to restatements for the year 2017.



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

## Planned improvements

HCB emissions have not been included in iron production till German Informative Inventory Report 2021 due to lack of emission data (notation key NE). And the standard emission factor is not seen as appropriate. In order to overcome this data gap, information search will be done within the scope of a Project for actualizing several emission factors. The project should start in 2021 and is designed to run three years. As long as there is no country specific emission factor for HCB the standard emission factor is used. In implementing the EMEP/EEA Guidebook standard emission factor Germany is following

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recommendations provided by the Expert Review Team for the NECD-Review in 2020.