Greenhouse gas emissions

Content

This document presents additional figures that were elaborated during the data analysis for the monitoring of greenhouse gas emissions by the raw materials industries (indicator 20) in the 2018 Raw Materials Scoreboard. The final version of the Scoreboard indicator elaborates on figures 2 and 3, while Figures 1 was not included.

This document also provides more details about the methodological changes in the indicator as compared to the 2016 version of the Scoreboard.

Novelties from the 2016 version of the Scoreboard

- A stand-alone analysis for greenhouse gas (GHG) emissions from the raw materials industries, as compared to the 2016 version of the Scoreboard, which presented the analysis of GHG together with that of air pollutant emissions. This allows for a more specific analysis of the sector's impact on climate change, which is becoming more and more present in the EU policy agenda.
- Change of the data source to the Emissions Database for Global Atmospheric Research (EDGAR), which has longer time series than the alternative possible data sources and is regularly updated. Expansion of the time and sectoral scope of the analysis, covering the period 1970-2012 and a sector scope more in line with the EIP on Raw Materials.
- Contrary to the data source used in the 2016 Scoreboard, whose emissions data could be only referred to the monetary value of the industries' production, EDGAR emissions data can be related to production in physical units. EDGAR data includes GHG emissions from direct onsite activities, i.e. only those emissions directly generated at the industrial facility and not those associated to e.g. offsite production of electricity or the extraction of inputs materials.

Key points

- Since 1970 GHG emissions from the EU-28 raw materials sector have steadily decreased, while at the global level emissions increased sharply.
- This reduction in EU-28 mirrors a general shift of industrial production to other world regions and improvements in production efficiency.

Facts and figures

- Figure 1 puts the emissions from the raw materials sector into perspective. It compares, for year 2012, GHG emissions from the raw materials sectors with other economic activities that

significantly contribute to total GHG emissions in the EU-28[1]. Data accounts for direct emissions, i.e. GHG released onsite by the EU industrial facilities. Data does not account for other emissions embodied in the raw materials production chain, such as emissions associated to the offsite production of electricity, fuels, chemicals, equipment, etc. that are used at the raw materials production facilities; or those GHG emitted during transportation of materials.

- The figure shows that the raw materials industries account for 8 % of total direct GHG emissions, while other major contributing sectors such as energy and fuel production, road transport, and households and other sources (residential), are responsible for, 30.3 %, 18.4 % and 14.3 %, respectively. The production of non-metallic minerals accounts for half of the GHG emissions from the raw materials sectors (around 4 % of total GHG emissions), followed by iron and steel production (around 2 %). It needs to be taken into account, that e.g. energy and fuel producers yield materials that are used by raw materials production.

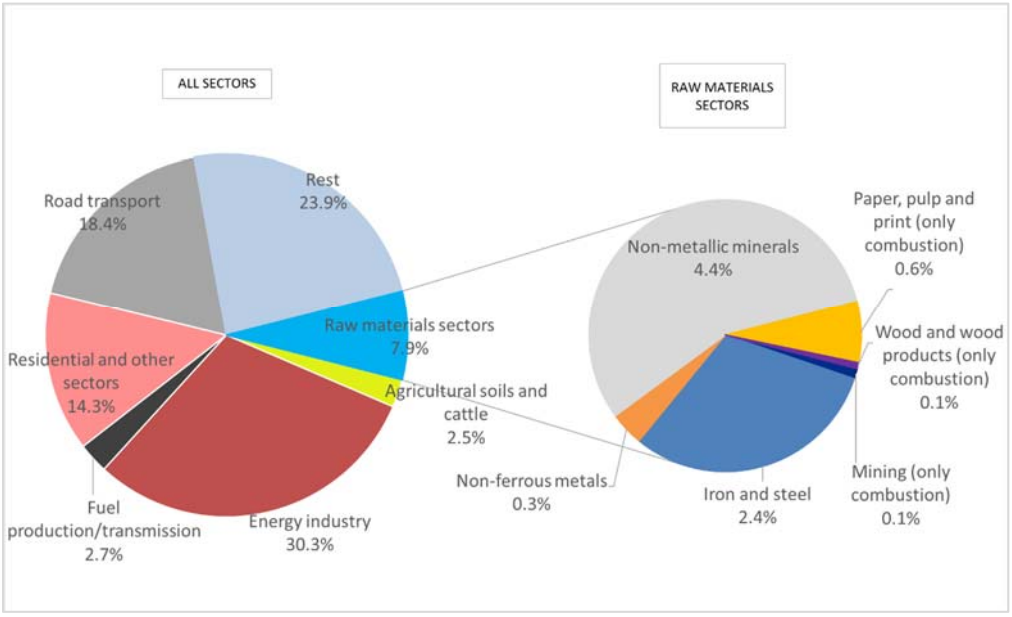

Figure 1: Share of GHG emissions by economic sector (left) and detailed for the individual raw materials sectors (right) (EU-28, 2012)[2].

- Figure 2 presents the trend of GHG by the EU-28 raw materials sector as compared to the world total. Data are displayed as an index relative to the values of 1970, and refer to the sum

[1] See methodological notes for details on sector coverage.

[2] Source: JRC elaboration based on data from the Emissions Database for Global Atmospheric Research (EDGAR) version 4. Janssens-Maenhout, G, Crippa, M, Guizzardi, D, Muntean, M, Schaaf, E, 2017, 'Emissions Database for Global Atmospheric Research, version v4.3.2 part I Greenhouse gases (time-series)'. European Commission, Joint Research Centre (JRC), PID: http://data.europa.eu/89h/jrc-edgar-edgar_v432_ghg_timeseries.

of GHG emissions[3] from the following sectors[4]: mining, production of iron and steel, production of non-ferrous metals, non-metallic minerals, pulp and paper, and wood and wood products.

- The figure shows a decreasing trend of GHG emissions from the EU-28 raw materials sectors. This can be attributed to a combination of improvements in emissions efficiency and to the decline of EU industrial production.
- Figure 2 also shows that at the global level, in contrast to the EU-28, GHG emissions from raw materials production have increased significantly, especially after the early 2000s, when GHG emissions started to grow steeply. This accelerated increase was mostly driven by countries like China and India, but also by Russia after their economic recovery. Therefore, the figure hints at the shift of industrial production to other world regions, over the whole period and especially from the 1990s onwards. GHG emissions rose sharply despite the fact that newly built facilities are overall more energy-efficient[5]. Consumption in both developed and developing countries has been a key driver of the expansion of the sector, and the consequential increase of emissions in developing economies[6].

[3] CO_2, which is the main contributor to total GHG emissions, CH_4 and N_2O. See methodological notes for further details on GHG coverage.

[4] This covers emissions from the combustion of fuel and for the remaining industrial processes (e.g. calcination process in cement production) except for mining, pulp and paper production, and wood production, for which only combustion-related emissions are covered. See methodological notes for further details.

[5] New developments allow for the installation of highly efficient plants (IPCC, 2014).

[6] IPCC 2014, Working Group III report: 'Climate change 2014: mitigation of climate change'. The report, enhancing the analysis of industrial emissions in the previous IPCC assessment, analyses industrial emissions along the supply chains, from extraction, through manufacturing to recycling, etc.

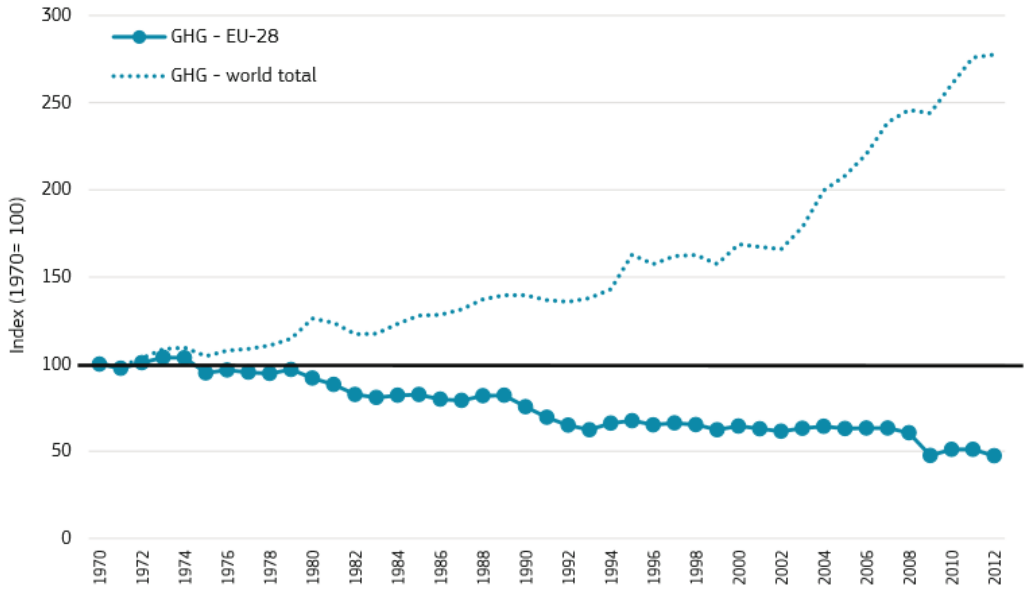

Figure 2: GHG emissions trends from the raw materials industry over time (EU-28 and world total, 1970-2012)[7].

- Figure 3 presents GHG emissions in the EU-28 broken down by raw materials sectors over the period 1970-2012. Emissions are presented both in absolute values and related to production volume. While absolute emissions give insight into the potential impact of emissions on the climate, production-corrected emissions serve to monitor changes in emissions efficiency (lower production-corrected emissions indicate greater efficiency)[8].
- The figures reflect the decrease in absolute GHG emissions for the selected raw materials sectors. In most sub-sectors, emissions rose between 2009 and 2011 due to the recovery of production after the financial crisis, but fell again in 2012.
- The figure shows that among the raw materials sectors the iron and steel manufacturing sector used to be the main contributor to GHG emissions during the 1970s, while non-metallic minerals industry took this first position in the 1990s, due to the faster decrease in GHG emissions in iron and steel production.
- Iron and steel production showed the largest absolute decrease between 1970 and 2012 (268 million t), followed by the production of non-metallic minerals (89 million t), paper production (22 million t), mining (14 million t), non-ferrous metals production (12 million t) and wood products (4 million t). For most sectors these reductions are in part a consequence of decreasing production volumes, except for the production of non-ferrous metals, and paper, and wood products, which increased over the period.

[7] Source: JRC elaboration based on EDGAR version 4 data (see methodological notes for more details).
[8] See methodological notes.

- The GHG emissions decreases were also due to improvements in emissions efficiency for all raw materials sectors, as reflected in the decreasing trends of production-corrected emissions. Particularly big improvements in efficiency were observed for wood products (around 80 %) and paper production (around 60 %). Efficiency improvements were due to technological enhancements of production processes[9] and to changes in the energy source mix used onsite by the sectors (e.g. from coal to gas or renewable sources).
- The figure also shows that GHG emissions experienced more significant decrease rates in certain periods, linked to changes in production volumes in a few raw materials' sectors. Examples of such periods are the reunification of Germany in 1990, and the financial crisis starting in 2008. The figure also allows identifying periods where the decreasing trend of absolute GHG emissions was temporarily reversed by increases in production. This is the case for the production of pulp and paper, wood and non-metallic minerals, which increased from 1990 onwards.

[9] e.g. the introduction of direct reduction in iron and steel making. JRC and PBL Netherlands Environmental Agency, 2016, 'Trends on global CO2 emissions — 2016 report'.

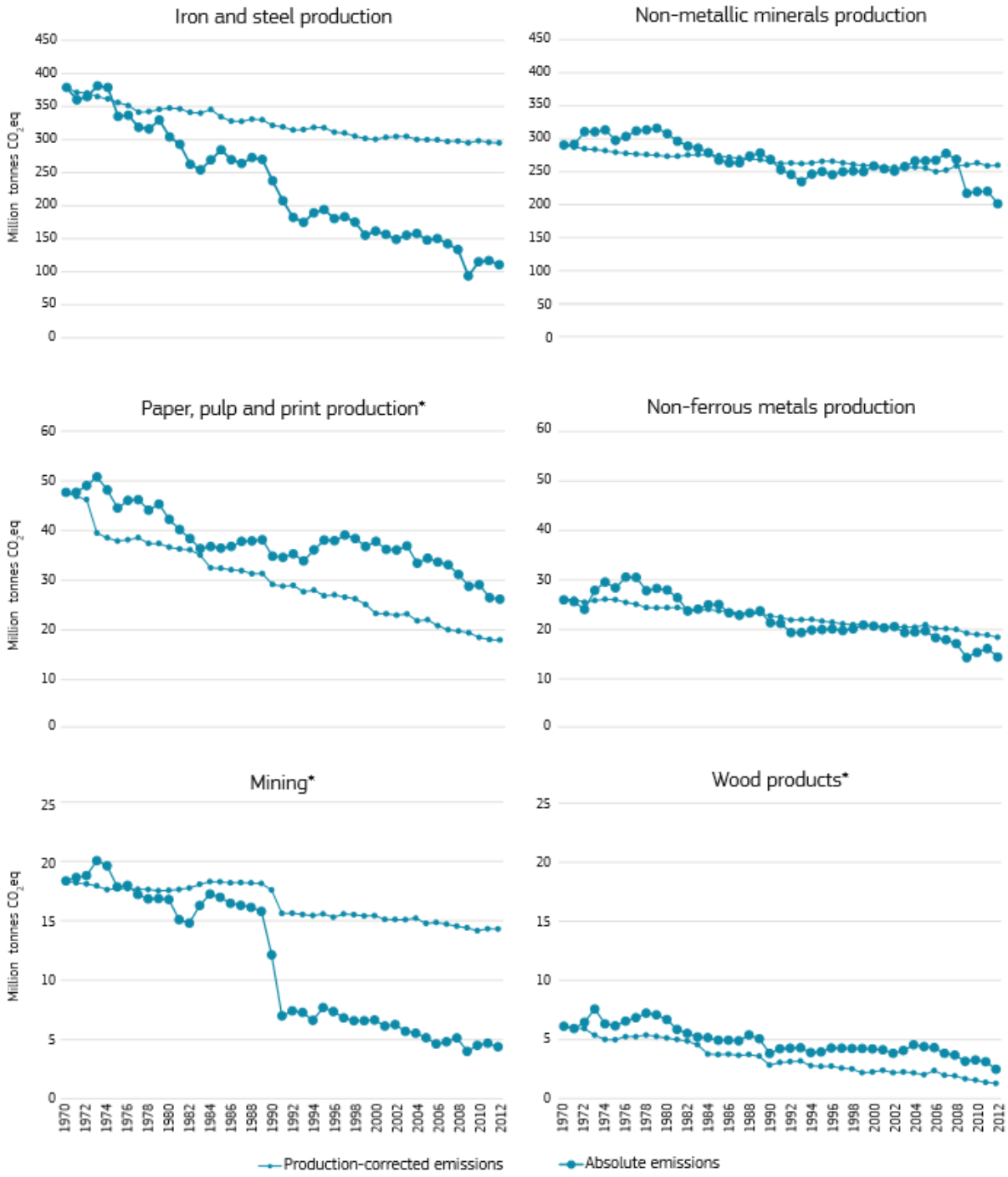

Figure 3: GHG emissions trend by raw materials sector (EU-28, 1970-2012)[10]. The graphs display absolute GHG emissions and emissions related to production.

[10] Source: JRC elaboration based on EDGAR data. Note that GHG emissions from the industrial processes of pulp and paper manufacturing are disregarded in EDGAR (see methodological notes). Only iron and steel and non-metallic minerals manufacturing refer to the left axis.

Box 1: Iron and steel – GHG emission intensity trends

Technology improvements, together with the shift of EU production to other world regions, have led to a significant decrease in GHG emissions from the EU iron and steel sector. GHG emissions efficiency has improved in what concerns the combustion of the fuel and for industrial processes such as the smelting of steel in furnaces.

Figure Box.1a presents a global comparison of GHG process-emission intensities in iron and steel manufacturing, i.e. GHG emission per unit of production for industrial processes other than fuel combustion. The graph shows that the EU is among the world leaders in GHG emission efficiency in the iron and steel sector. It also shows that emission intensities have decreased sharply from 1970 to 1984 in all world regions. This can be attributed to the increased use of electric arc furnaces and direct reduction[11]. It can be also attributed to the adoption of end-of-pipe solutions.

Figure Box.2b further shows a global comparison of GHG fuel combustion-emission intensities in iron and steel manufacturing. The figure shows the steady decrease of combustion-related GHG emission intensity in the EU. It also shows that combustion-related emission intensity has kept relatively more stable over time than for process-emissions. This is due to the fact that improvements in combustion-related emissions efficiency very much depend on the fuel mix.

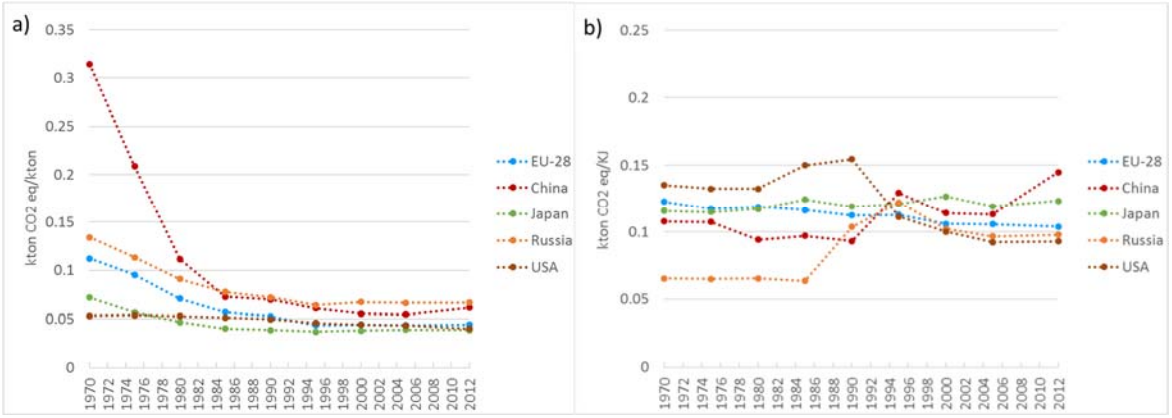

Figure Box.1: Iron and steel GHG emissions intensity for non-combustion processes (process-emissions) (a) and combustion processes (b) (EU-28 and a selection of major world players, 1970- 2012)[12].

Summary of other options that were considered

- **Option 1 – Air emissions by sector over time from official emission inventories**
  - This option provides an analysis of emission trends over time for the EU and a set of non-EU countries based on data from official emission inventories data, i.e. the UNFCCC (United Nations Framework Convention on Climate Change).

[11] JRC and PBL Netherlands Environmental Agency, 2016, 'Trends on global CO_2 emissions – 2016 report'.
[12] Source: JRC elaboration based on EDGAR data.

- This option was considered unfit for the Scoreboard since it does neither allow to present a long time series of emissions, nor emissions related to the production level in physical units.

- **Option 2 – Air emission by sector over time based on EE-IO tables**
  - Data from EXIOBASE version 3, an environmentally-extended input-output (EE-IO) database, provides air emission trends over time between 1995 and 2011 for certain raw materials sectors considering both direct onsite emissions and indirect emissions. The data presented in the 2016 Scoreboard also came from an EE-IO database.
  - This option was considered unfit for the Scoreboard since at the time this document was produced (September 2017) the final version of the database had not yet been officially released, and therefore it could not be assessed. Also, it is uncertain whether the database will be updated on a regular basis. Moreover, its time coverage is more limited than in the case of the option preferred (EDGAR).
- **Option 3 – Air emissions data from *ad-hoc* LCA case studies**
  - Based on a Life Cycle Assessment (LCA), this option would zoom into the GHG emissions generated along the production chain (extraction and processing, etc.) of a reference amount of specific raw materials (one metal, e.g. aluminium/steel; one industrial mineral, e.g. fluorspar; and one biotic material, e.g. pulpwood).
  - This option was considered unfit for the Scoreboard since it would not allow for a time trend analysis neither it will have a comprehensive sector coverage.

Methodological notes

- **Name of indicator:** Greenhouse gas emissions (absolute values and production-corrected emissions).
- **Organization (data provider):** Emissions Database for Global Atmospheric Research (EDGAR) version 4. EDGAR is a research database that calculates the emissions generated by economic activities. It has a global coverage, it estimates emissions of a comprehensive set of substances and it covers the industrial sectors as given by the 2006 IPCC Guidelines. EDGAR data are used by many relevant authorities and institutions, such as DG CLIMA and DG ENV, the International Energy Agency, OECD, the IPCC and UNFCCC and many universities and research institutes (e.g. Max Planck Institute Jena, CEA-LSCE Paris, Uni Amsterdam, MIT, Stanford University, JPNIES (Japan)).
- **Website (URL):** http://data.jrc.ec.europa.eu/collection/EDGAR (GHG emissions data). Activity data for relating GHG to the production has been provided *ad-hoc* by the JRC EDGAR team and is not publicly available.
- **Definition, description of data:** Data on absolute emissions of major GHGs and activity data over time by economic sector. Similar to national emission inventories, EDGAR emission estimates are based on the level of activity of the industry (e.g. fuel use, output, etc.) and so-called emission factors, which gauge the emissions generated by each activity unit. Activity data comes mostly from major, trustworthy producer associations and USGS[13], while emission factors[14], mostly come from IEA[15] and the IPCC. These factors may use different tiers, i.e. degree of analytical complexity and the quantity of information required, depending on whether facility-, industry-, and country-specific emission factors are available. The accuracy of the emission estimates will partly depend on the specificity of the tier followed, where certain countries and sectors, respectively, allow for more accurate estimates than others. EDGAR emissions estimates account for direct (onsite) emissions.
- **Update frequency:** Updates of the database (annual data) is done every few years.
- **Data format:** Online, downloadable in csv format.
- **Geographic coverage:** EU-28 Member States, world total data, and data for a selection of non-EU countries. The database has a global coverage.
- **JRC processing methodology for the indicator:** It included the selection of the GHG coverage, the selection of the sector coverage, the transformation of emission data to CO_2 equivalent units, and the calculation of emissions corrected by the production level.
    - GHG coverage

      Major GHGs, which include CO_2 (the main component), CH_4 and N_2O. The emissions coverage is not comprehensive, since some raw materials sectors, such as the non-ferrous metals sector, emit significant amounts of other GHGs, e.g. perfluorocarbons (PFCs) and sulphur hexafluoride (SF6) in aluminium and magnesium production, respectively.

[13] United States Geological Survey.
[14] Emission factors are representative values to relate substance emissions to the atmosphere with an activity.
[15] International Energy Agency. They take into account several factors such as technology and fuel mixes used in production.

- Sector coverage

  EDGAR covers the industrial sectors cited in the 2006 Intergovernmental Panel on Climate Change (IPCC) guidelines[16]. Among these sectors, the following sectors were selected for analysis: mining, and production of iron and steel, non-ferrous metals, non-metallic minerals, pulp and paper and wood and wood products. The mining sector covers NACE divisions B07, B08 and B099, and excludes the mining of energy carriers.

  The EDGAR data presented here cover both „emissions from combustion" and „process-emissions", except for mining, wood production and pulp and paper production, for which only combustion-related emissions are available. For wood and paper production, process emissions are disregarded in EDGAR, since these emissions are accounted for in other sectors (forestry and land use), in which they are often compensated by vegetation planting/growth.

  In addition to the raw materials sectors, the following sectors (the most relevant contributors to total GHG emissions in the EU-28) were selected for the cross-sector comparison of GHG emissions in Figure 1:

  - Energy industry: emissions from fuel combustion from self-produced energy, public energy supply from different energy sources, and public district heating.
  - Road transport: emissions from the fuel combustion in road transport. (Emission from aviation, navigation, etc., are accounted by the non-road transport sector, whose emissions are below those from road transport.)
  - Residential and other sectors: residential emissions and emissions from fuel combustion in agriculture, forestry, fishing, and commercial and public services.
  - Fuel production and transmission: emissions from fuel combustion from fuel production (oil, natural gas, peat, etc.), transmission of crude oil, gas, and transport by oil trucks.
  - Agricultural soils and cattle: emissions from crops, use of fertilisers and cattle.

  The remaining sectors are summarised by category „Rest".

[16] IPCC, '2006 IPCC guidelines for national greenhouse gas inventories – volume 1: General guidance and reporting', Annex 8.A2 reporting tables, http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_8x_Ch8_An2_ReportingTables.pdf.