

AUSTRIA'S INFORMATIVE INVENTORY REPORT (IIR) 2017

Submission under the UNECE Convention on
Long-range Transboundary Air Pollution and
Directive (EU) 2016/2284 on the reduction of
national emissions of certain atmospheric
pollutants

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The information covered refers to the following accreditation scope of the IBE: EMEP/CORINAIR Emission Inventory Guidebook 2009, EMEP 2013, EMEP 2016.



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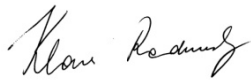
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This report is compiled and published as an inspection report in accordance with the Accreditation Law and the international standard ISO/IEC 17020, in fulfilment of and in compliance with the EMEP/EEA air pollutant emission inventory guidebook (scope of accreditation regarding air pollutants) as well as the CLRTAP Reporting Guidelines.

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PREFACE

The report “Austria’s Informative Inventory Report (IIR) 2017” provides a complete and comprehensive description of the methodologies used for the compilation of the Austrian Air Emission Inventory (“Österreichische Luftschadstoff-Inventur – OLI”) as presented in Austria’s 2017 submission under the Convention on Long-range Transboundary Air Pollution of the United Nations Economic Commission for Europe (UNECE/LRTAP) and under the Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants (NEC Directive).

Austria is required to annually report data on emissions of air pollutants covered under the UNECE/LRTAP Convention and its Protocols as well as under the NEC Directive for the main pollutants NO_x, SO₂, NMVOC, NH₃ and CO, Particulate Matter (PM), Persistent Organic Pollutants (POPs) and Heavy Metals (HM).

To be able to meet these reporting requirements, Austria compiles an Air Emission Inventory („Österreichische Luftschadstoff-Inventur – OLI”) which is updated annually.

This report follows the regulations under the UNECE/LRTAP Convention and its Protocols that define standards for national emission inventories. In 2008 the Executive Body adopted the Guidelines for Reporting Emission Data under the Convention on Long-Range Transboundary Air Pollution (LRTAP) (ECE/EB.AIR/97)^{1/2} for estimating and reporting of emission data. They are necessary to ensure transparency, accuracy, consistency, comparability and completeness (TACCC) of the reported emissions. In 2014 the Reporting Guidelines were revised (ECE/EB.AIR.125)³ and were adopted for application in 2015 and subsequent years.

The emission data presented in this report were compiled according to these guidelines for estimating and reporting emission data, which also define the new format of reporting emission data (**Nomenclature for Reporting – NFR** (latest version of the templates ‘NFR14’⁴ dated 17.4.2014)) as well as standards for providing supporting documentation which should ensure the transparency of the inventory.

The complete set of tables in the new NFR format, including sectoral reports, sectoral background tables and footnotes to the NFR tables, are submitted separately in digital form only. A summary of emission data is presented in the Appendix of this report.

The IIR 2017 at hand complements the reported emission data by providing background information. It follows the template⁵ of the “Informative Inventory Report – IIR” as elaborated by the LRTAP Convention’s “Task Force on Emission Inventories and Projections – TFEIP”. The structure of this report follows closely the structure of Austria’s National Inventory Report (NIR) submitted annually under the United Nations Framework Convention on Climate Change (UNFCCC) which includes a complete and comprehensive description of methodologies used for compilation of Austria’s greenhouse gas inventory (UMWELTBUNDESAMT 2017a).

¹ http://www.ceip.at/fileadmin/inhalte/emep/reporting_2009/Rep_Guidelines_ECE_EB_AIR_97_e.pdf

² At its twenty-sixth session (15–18 December 2008), the Executive Body approved the revised Guidelines (ECE/EB.AIR/2008/4) as amended at the session and requested the secretariat to circulate a final amended version.

³ http://www.ceip.at/fileadmin/inhalte/emep/2014_Guidelines/ece.eb.air.125_ADVANCE_VERSION_reporting_guidelines_2013.pdf

⁴ NFR14 – http://www.ceip.at/ms/ceip_home1/ceip_home/reporting_instructions/

⁵ http://www.ceip.at/fileadmin/inhalte/emep/doc/AnnexVI_IIR_300909.doc

The aim of this report is to document the methodology in order to facilitate understanding of the calculation of the Austrian air emission data. The more interested reader is kindly referred to the background literature cited in this document.

Elisabeth Rigler in her function as head of the Department *Climate Change Mitigation & Emission Inventories* of the *Umweltbundesamt* is responsible for the preparation and review of Austria's Air Emission Inventory as well as for the preparation of the IIR.

Klaus Radunsky in his function as head of the *Inspection Body for Emission Inventories* and Michael Anderl in his function as deputy are responsible for the content of this report and for the quality management system of the Austrian Air Emission Inventory.

The preparation and review of Austria's National Air Emission Inventory are the responsibility of the Department "Climate Change Mitigation & Emission Inventories" of the Umweltbundesamt.

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- Chapter 7 Recalculations & Improvements Simone Haider
- Chapter 8 Projections Andreas Zechmeister
- Chapter 9 Reporting of gridded emissions and LPS Simone Haider, Günther Schmidt
- Appendix Simone Haider.

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EXECUTIVE SUMMARY

ES.1 Reporting obligations under UNECE/LRTAP and Directive (EU) 2016/2284 (NEC Directive)

Austria's Informative Inventory Report (IIR) and the complete set of NFR tables (the latter are submitted in digital format only) represent Austria's official submission under the United Nations Economic Commission for Europe (UNECE) Convention on Long-range Transboundary Air Pollution (LRTAP) and under Directive (EU) 2016/2284 (NEC Directive). The Umweltbundesamt in its role as single national entity regarding emission inventories compiles Austria's annual delivery, and the Austrian Ministry of Agriculture, Forestry, Environment and Water Management submits it officially to the Executive Secretary of UNECE as well as to the European Commission.

As a party to the UNECE/LRTAP Convention and under the NEC Directive, Austria is required to annually report data on emissions of air pollutants covered in the Convention and its Protocols:

- main pollutants: nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOC), sulphur oxides (SO_x), ammonia (NH₃) and carbon monoxide (CO);
- particulate matter (PM): primary PM (fine particulate matter (PM_{2.5}) and coarse particulate matter (PM₁₀));
- priority heavy metals (HMs): lead (Pb), cadmium (Cd) and mercury (Hg);
- persistent organic pollutants (POPs): polychlorinated dibenzodioxins/dibenzofurans (PCDD/Fs), polycyclic aromatic hydrocarbons (PAHs), hexachlorobenzene (HCB) and polychlorinated biphenyls (PCBs).

In order to fulfil these reporting requirements, Austria compiles an Air Emission Inventory ("Österreichische Luftschadstoff-Inventur – OLI"), which is updated annually. The IIR contains information on Austria's inventories of air pollutants for all years from 1990 to 2015 for the main pollutants, for POPs and HMs and for the years 1990, 1995 and from 2000 onwards for PM.

From submission 2015 onwards, Austria reports all pollutants in the NFR14 reporting format from 1990 to the latest inventory year. Emissions of the years before 1990 were last updated and published in submission 2014.⁷

In addition, the report includes both detailed descriptions of methods, data sources and uncertainties and information on quality assurance and quality control (QA/QC) activities as well as analyses of emission trends.

The emission data presented in this report were compiled according to the revised 2014 Reporting Guidelines (ECE/EB.AIR.125) that were approved by the Executive Body for the UNECE/LRTAP Convention at its 36th session.

The Austrian inventory is complete with regard to reported gases, reported years and reported emissions from all sources, and also complete in terms of geographic coverage.

⁶ According to the CLRTAP Reporting GL the reporting of Total suspended particulates (TSPs) is not mandatory, but reported by Austria.

⁷ Austria's submission 2014 under the Convention on Long-range Transboundary Air Pollution covering the years 1980–2012: http://www.ceip.at/ms/ceip_home1/ceip_home/status_reporting/2014_submissions/

ES.2 Differences with other reporting obligations

NEC Directive (EU) 2016/2284 sets out national emission reduction commitments for the pollutants SO₂, NO_x, VOC, NH₃ and PM_{2.5}. Austria uses the national emission totals calculated on the basis of *fuel used* (thus excluding emissions from fuel exports in the vehicle tank) for compliance assessment under the NEC Directive.

The annual greenhouse gas reporting under the UNFCCC and the Kyoto Protocol also requires the reporting of indirect GHGs (NO_x, CO, NMVOC) and SO₂ emissions based on *fuel sold*. In contrast to UNFCCC requirements, emissions from aviation under the NEC Directive and the LRTAP Convention include domestic LTO and cruise. Furthermore, international navigation of inland waterways is covered under NEC and CLRTAP.

ES.3 Overview of emission trends

Main Pollutants

In 1990, national total SO₂ emissions amounted to 75 kt. Since then emissions have decreased quite steadily. In the year 2015, emissions were reduced by 80% compared to 1990 and amounted to 15 kt, which was mainly due to lower emissions from residential heating, combustion in industries and in energy industries. The sharp decrease from 2008 onwards is due to a further reduction of the sulfur content of gasoil to 10ppm. From 2014 to 2015 emissions slightly increased by 0.8% mainly due to higher emissions from NFR sectors *1.A.2 Manufacturing Industries* and *1.A.4 Other Sectors*. Emissions from manufacturing industries rose due to an increased coal and residual fuel use. Emissions from the residential sector increased due to the increased heating demand (more coal and biomass used) as a result of the colder winter.

In 1990, national total NO_x emissions amounted to 221 kt. After an all-time high of emissions between 2003 and 2005 emissions are decreasing continuously, which is mainly due to lower emissions from heavy duty vehicles influenced by declined fuel sales, fleet renewal and well-functioning NO_x exhaust after treatment systems. In 2015, NO_x emissions amounted to 149 kt and were about 32% lower than in 1990. From 2014 to 2015 emissions decreased by 2.6%, again mainly due to decreasing emissions of road transportation, in particular from heavy duty vehicles. In 2015 49% of the total nitrogen oxides emissions originate from road transport (including fuel exports). Austria is a landlocked country and fuel prices vary significantly between neighbouring countries. So Austria has experienced a considerable amount of 'fuel export' in the last few years and the share of NO_x emissions caused by fuel sold in Austria but used abroad is notable. Emissions for 2015 based on fuel used amount to 132 kt and are about 17 kt lower than based on fuel sold; the decrease between 1990 and 2015 is also slightly stronger.

In 1990, national total NMVOC emissions amounted to 281 kt. Emissions have decreased steadily since then and in the year 2015 emissions had been reduced by 60% to 113 kt compared to 1990. From 2014 to 2015 emissions increased by 2.4%. This was mainly due to higher fuel demand for residential heating as a consequence of the low winter temperatures in 2015 (higher biomass consumption).

In 1990, national total NH₃ emissions amounted to 66.1 kt; emissions have been quite stable over the period from 1990 to 2015. In 2015, emissions were 1.1% above 1990 levels and amounted to 66.9 kt. Compared to the previous year, emissions in 2015 remained nearly at the same level (+0.4%). NH₃ in Austria is almost exclusively emitted in the agricultural sector; emissions from agricultural soils, mainly resulting from organic and inorganic fertilization, have the highest contribution to national total NH₃ emissions.

In 1990, national total CO emissions amounted to 1 287 kt. Emissions considerably decreased from 1990 to 2015. In 2015, emissions were 56% below 1990 levels and amounted to 567 kt. This reduction was mainly due to decreasing emissions from road transport (catalytic converters). The emissions increased between 2014 and 2015 by 5.3%, mainly due to higher emissions from iron and steel plants and an increased use of biomass in residential heatings.

Particulate Matter

Particulate matter emissions in Austria mainly arise from industrial processes, road transport, agriculture and small heating installations.

Particulate matter (PM) emissions show a decreasing trend over the period 1990 to 2015: TSP emissions decreased by 11%, PM₁₀ emissions were about 22% below the level of 1990, and PM_{2.5} emissions dropped by about 34%. Between 2014 and 2015 PM emissions increased by 1.0% (TSP), 1.3% (PM₁₀) and 2.1% (PM_{2.5}) mainly because of higher biomass consumption of the residential sector due to lower winter temperatures in 2015, which has been partly compensated by decreasing emissions from road transport. Apart from industry and road transport, private households and the agricultural sector (soil cultivation and harvesting) are the main contributors to PM emissions. Where for TSP the most important sources are transport and industrial processes, small heating installations have the highest share in PM_{2.5} emissions.

Heavy Metals

Emissions of all three priority heavy metals (Cd, Pb and Hg) have decreased since 1990.

The overall Cd emissions reduction of 25% from 1990 to 2015 is mainly due to a decline in the industrial processes and energy sector, which is due to lower use of heavy fuel oil and lower emissions from iron and steel production. The increase of 2.0% between 2014 and 2015 mainly results from higher biomass consumption of households.

The overall reduction of Hg of about 55% for the period 1990 to 2015 was due to decreasing emissions from cement industries and the industrial processes sector as well as due to reduced use of coal for residential heating. Several bans in different industrial sub-sectors and in the agriculture sector are behind these developments in Austria.

The overall reduction trend of Pb emissions was minus 93% for the period 1990 to 2015, which is mainly a result of the ban of lead in gasoline. However, abatement techniques and product substitutions also contributed to the emission reduction.

Persistent Organic Pollutants (POPs)

Emissions of all POPs decreased remarkably from 1990 to 2015 (HCB, PAH and PCDD/F by about 60 to 80%), where the highest achievement was made until 1995. The significant increase of HCB emissions in the years 2012, 2013 and 2014 was due to unintentional releases of HCB by an Austrian cement plant.

In 2015 the emissions from HCB and PCB decreased compared to the previous year. The short term trend of HCB is influenced by the accidental release, as already mentioned, which is the reason for the decrease of 74% between 2014 and 2015. The slight decrease (-1.8%) of PCB between 2014 and 2015 is dependent on production activities in secondary lead production.

PAH and PCDD/F increased by 11% and by 7.4% respectively between 2014 and 2015.

The most important source for PAH, PCDD/F and HCB emissions in Austria is residential heating. In the 80s industry and waste incineration were still important sources regarding POP emissions. Due to legal regulations concerning air quality emissions from industry and waste incineration decreased remarkably from 1990 to 1993. PCB emissions are almost exclusively emitted in NFR sector 2 *Industrial Processes and Product Use* (Metal Production).

ES.4 Key categories

To determine key categories, a trend and a level assessment have been carried out, which resulted in 43 identified key categories. It shows that the residential sector has been identified as the most important key category: all air pollutants except NH₃ are found key in either the trend or the level assessment. In the following table the top 5 ranked key categories are listed.

Table 1: Most relevant key categories in Austria for air emissions 2015.

Name of key category	No of occurrences as key category
1.A.4.b.1 – Residential: stationary	23 times (SO ₂ , NO _x , NMVOC, CO, Cd, Pb, Hg, PAH, DIOX, HCB, PCB, TSP, PM ₁₀ , PM _{2.5})
2.C.1 – Iron and Steel Production	15 times (Cd, Pb, Hg, PAH, DIOX, HCB, PCB, TSP, PM ₁₀ , PM _{2.5})
1.A.3.b.1 R.T., Passenger cars	12 times (NO _x , NMVOC, CO, Pb, TSP, PM ₁₀ , PM _{2.5})
1.A.2.g.8 Other Stationary Combustion in Manufacturing Industries and Construction	14 times (SO ₂ , NO _x , Cd, Pb, DIOX, TSP, PM ₁₀ , PM _{2.5})
1.A.2.a Iron and Steel	4 times (SO ₂ , CO)

ES.5 Main differences in the inventory since the last submission

As a result of the continuous improvement process of Austria's Annual Air Emission Inventory, emissions for some sources have been recalculated, e.g. on the basis of updated activity data or revised methodologies. Thus emission data for the whole time series submitted this year differ from the data reported previously.

In NFR sector 1 *Energy*, changes are mainly due to revisions of the energy balance following a revision of the gross natural gas consumption affecting the 'own use' of the energy sector as well as the 'final energy consumption'. Minor revisions have been made for liquid fuels. For other fuels the major revision took place for the year 2014 where a shift of 'industrial waste' to municipal solid waste has been reported by energy statistics. Furthermore, emissions declarations 2007–2014 from large combustion plants have been updated and corrected.

In NFR sector 1.A.3 *Transport*, emissions have been slightly revised due to the usage of the most recent version of the emission calculation model "NEMO". Domestic consumption on the road has been slightly revised upwards for 2012–2014. In the model this results in a reduction in energy consumption of fuel export. Further recalculations are due to revisions of the energy balance (LPG and biogas fuel quantities, use of diesel).

In NFR sector 2 *Industrial Processes and Product Use*, recalculations have been carried out mainly due to updated activity data of NFR source categories 2.A *Mineral Products* (Mining, construction/demolition and handling of products), 2.B *Chemical Industry* (Handling of products and other chemical industry) and 2.C *Metal Production* (Aluminium and Lead production).

For NFR sector 3 *Agriculture*, revisions were on the one hand due to methodological improvements like the update of NH_3 and NO_x emission factors according to the EMEP/EEA Emission Inventory Guidebook 2016 in the sectors manure management and agricultural soils. On the other hand, recalculations have been carried out due to updated activity data (livestock data for horses, compost and land use data).

In NFR sector 5 *Waste*, recalculations have been carried out because Austria has adapted its DOC of residual waste for the historical years 1950–1989. This has affected the amount of land-fill gas generated and thus also the emission values for NMVOC and NH_3 . Further, amounts of deposited construction waste and tar paper for the year 2010 have been corrected slightly. NMVOC emissions from 5.D *Wastewater Treatment and Discharge* were estimated and reported for the first time in this years' submission.

For more detailed information see Chapter 7 – Recalculations and Improvements.

ES.6 Improvement Process

The Austrian Air Emission Inventory is subject to a continuous improvement programme resulting in annual recalculations (see Chapter ES.5 above). Furthermore, the regularly conducted CLRTAP stage 3 reviews trigger improvements. The last in-depth review of the Austrian Inventory took place in 2010 (UNITED NATIONS 2010). The findings were commented in Table 280. The next stage 3 review will take place in 2017. In addition to the CLRTAP review, from 2017 onwards the national emission inventory data will be also checked by the European Commission as set out in Article 10 of Directive 2016/2284. The inventories will be checked to verify the transparency, accuracy, consistency, comparability and completeness of information submitted and to identify possible inconsistencies with the requirements set out under international law, in particular under the LRTAP Convention.

Recalculations and improvements are summarized in Chapter 7 – Recalculations and Improvements and described in detail in the sector-specific chapters of this report.

1 INTRODUCTION

1.1 National inventory background

The Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW)⁸ administrates Austria's reporting obligations to the

- Convention on Long-range Transboundary Air Pollution (LRTAP)⁹ of the United Nations Economic Commission for Europe (UNECE),¹⁰
- United Nations Framework Convention on Climate Change (UNFCCC),¹¹
- European Commission (EC),¹² and the
- European Environment Agency (EEA).¹³

The Environmental Control Act (“Umweltkontrollgesetz”; Federal Law Gazette 152/1998)¹⁴ that entered into force on the 1st of January 1999 regulates responsibilities of environmental control in Austria and lists the tasks of the Umweltbundesamt. The Umweltbundesamt is designated as single national entity with overall responsibility for inventory preparation.

Furthermore, the Environmental Control Act incorporates the Umweltbundesamt as a private limited company. To ensure that the Umweltbundesamt has the resources required to fulfil all listed tasks, the financing is set up as a fixed amount of money annually allocated to the Umweltbundesamt. The Umweltbundesamt is free to manage this so called “basic funding”, provided that the tasks are fulfilled. Projects beyond the scope of the Environmental Control Act are financed on project basis by the contracting entity, which may be national or EC authorities as well as private entities.

One task is the preparation of technical expertise and the data basis for fulfilment of the obligations under the UNFCCC, UNECE and EC. Thus the Umweltbundesamt prepares and annually updates the Austrian Air Emissions Inventory (“Österreichische Luftschadstoff-Inventur OLI”), which covers greenhouse gases and emissions of other air pollutants as stipulated in the reporting obligations further explained in Chapter 1.2.2.

For the Umweltbundesamt, a national air emission inventory that identifies and quantifies the sources of pollutants in a consistent manner is of a high priority. Such an inventory provides a common means for comparing the relative contribution of different emission sources and hence can serve as an important basis for policies to reduce emissions.

1.2 Institutional, legal and procedural arrangements

The Umweltbundesamt established an Inspection Body for Emission Inventories (IBE, hereinafter also referred to as inspection body) which is entrusted with the preparation of emission inventories as assigned to the Umweltbundesamt as described above (refer to Chapter 1.1). So, since 23 December 2005, the Umweltbundesamt is accredited as *Inspection Body for Emission*

⁸ <http://www.bmlfuw.gv.at/>

⁹ <https://www.unece.org/env/lrtap/welcome.html>

¹⁰ <http://www.unece.org>

¹¹ <http://unfccc.int/2860.php>

¹² http://ec.europa.eu/index_en.htm

¹³ <http://www.eea.europa.eu/>

¹⁴ <http://www.umweltbundesamt.at/fileadmin/site/umweltkontrolle/gesetze/ukg.pdf>

Inventories, Type A (Id.No. 241), in accordance with EN ISO/IEC 17020 and the Austrian Accreditation Law (AkkG),¹⁵ by decree of Accreditation Austria/Federal Ministry of Economics, Family and Youth (No. BMWA-92.715/0036-I/12/2005), issued on 19 January 2006.

The accreditation comprises the emission inventory for all GHGs and air pollutants as reported under the UNFCCC and the Kyoto Protocol, the EC Monitoring Mechanism as well as the UNECE and NEC (see Chapter 1.6).

The personnel of the IBE are made up of staff from various organisational units of the Umweltbundesamt, who in the course of their inspection activity are assigned to the IBE and therefore responsible to the head of the inspection body. They are free from any commercial, financial and other pressures that might influence their technical judgement, and no technical instructions from outside the IBE is given for the preparation of emission inventories (see Figure 1).

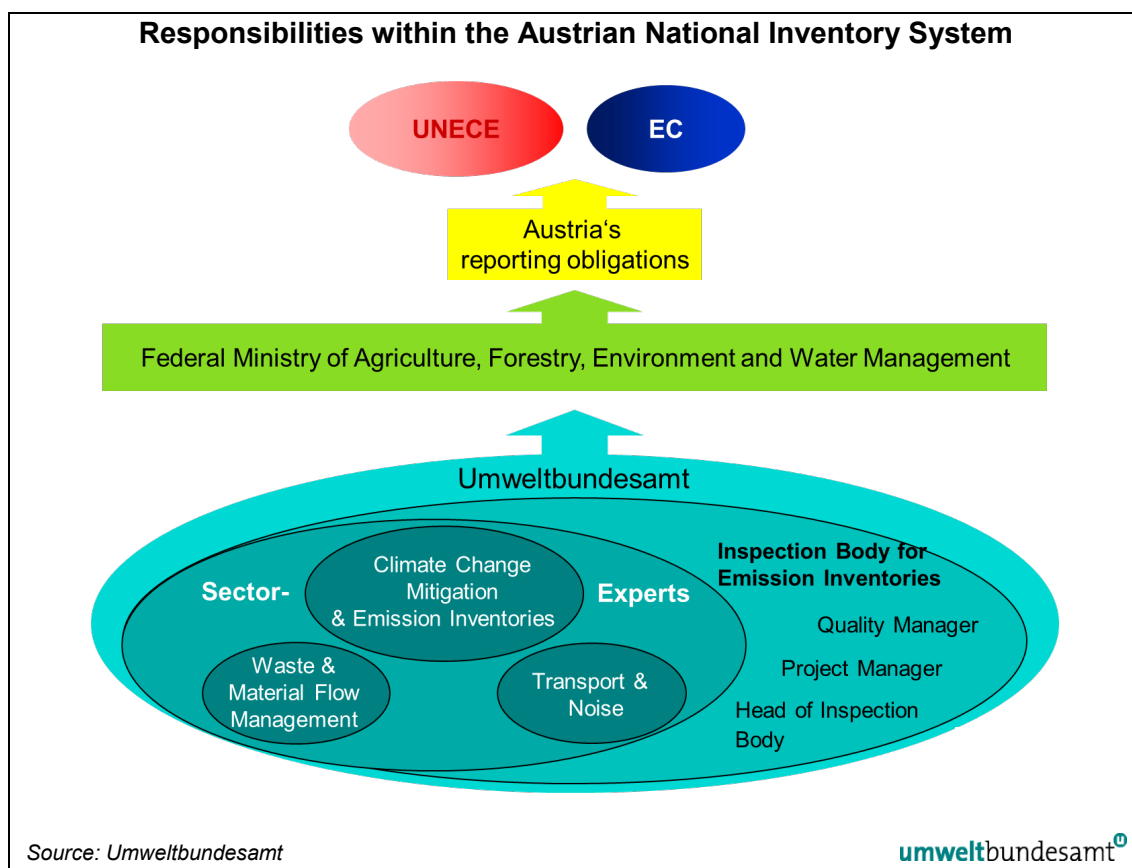


Figure 1: Responsibilities within the Austrian National Inventory System (Air Pollutants).

The quality system is maintained and updated under the responsibility of a quality representative; the inventory work is coordinated by a project manager. For these functions as well as for the head of inspection body deputies are appointed. Regarding the inventory work, specific responsibilities for the different emission source/sink categories ('Sector Experts') are defined. There are 8 sectors defined (Energy, Transport, Fugitive Emissions, IP, Product Use, Agriculture, LULUCF¹⁶ and Waste). Two experts form a sector team, whereas one team member is nominated as team leader ('Sector Lead'). For more information on the QMS please refer to Chapter 1.6.

¹⁵ Federal Law Gazette I No 28/2012 (Akkreditierungsgesetz 2012)

¹⁶ Only relevant for GHG emissions

In addition, the Austrian emissions trading registry is managed by the Umweltbundesamt on behalf of the Federal Ministry of Agriculture, Forestry, Environment and Water Management. This mandate was given to the Umweltbundesamt in the Registry Ordinance (Registerstellenverordnung) Federal Law Gazette II no. 208/2012. Umweltbundesamt is responsible for the operational management of the registry and serves as a contact point for national and international authorities.

The Austrian emissions trading registry has been operational since 2005 and serves both as registry for the EU Emissions Trading scheme and as the national registry for Austria as a party of the Kyoto Protocol.

Besides the Environmental Control Act there are some other legal and institutional arrangements in place as the main basis for the national system:

- Ordinance regarding Monitoring and Reporting of Greenhouse Gas Emissions¹⁷
- This ordinance pertains to the Austrian Emissions Certificate Trading Act¹⁸ that regulates monitoring and reporting in the context of the EU Emissions Trading scheme (ETS) in Austria.
- Paragraph 15 of this ordinance is designed to ensure consistency of emission trading data with the national inventory. It states that the Umweltbundesamt has to incorporate, as far as necessary, the emission reports of the emissions trading scheme into the national greenhouse gas inventory in order to comply with requirements of the EU Monitoring Mechanism and the UNFCCC. This is not only important for emissions from combustion of fuels, where more detailed information than provided in the national energy balance is available, but also for emissions from industrial processes, where the ordinance ensures data availability for most key categories (see Chapter 4 for details). First data from the EU ETS were available for the year 2005; since then ETS data were considered in the submissions.
- The Austrian statistical office (Statistik Austria) is required by contract with the Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW) and with the Federal Ministry of Science, Research and Economy (BMWF) to annually prepare the national energy balance (the contracts also cover some quality aspects). The energy balance is prepared in line with the methodology of the Organisation for Economic Co-operation and Development (OECD) and is submitted annually to the International Energy Agency (IEA) (IEA/EUROSTAT Joint Questionnaire (JQ) Submission). The national energy balance is the most important data basis for the Austrian Air Emissions Inventory.
- According to national legislation (Bundesstatistikgesetz¹⁹), the Austrian statistical office has to prepare annual import/export statistics, production statistics and statistics on agricultural issues (livestock counts etc.), providing an important data basis for calculating emissions from the sectors *Industrial Processes and Product Use* and *Agriculture*.
- In order to comply with the reporting obligations, the Umweltbundesamt has the possibility to obtain confidential data from the national statistical institute (of course these data have to be treated confidentially). The legal basis for this data exchange is the „Bundesstatistikgesetz“¹⁹ (federal statistics law), which allows the national statistical office to provide confidential data to authorities that have a legal obligation for the processing of these data.
- According to para 17 (1) of the (EG-K)²⁰ each licensee of an operating boiler with a thermal capacity of 2 megawatts (MW) or more is obligated to report the emissions to the competent authority. The Umweltbundesamt can request copies of these emission declarations. These data are used to verify the data from the national energy balance for the Energy sector.

¹⁷ „Verordnung des Bundesministers für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft über die Überwachung und Berichterstattung betreffend Emissionen von Treibhausgasen“, Federal Law Gazette II No. 458/2004

¹⁸ „Emissionszertifikate-Gesetz“, Federal Law Gazette I No. 46/2004

¹⁹ „Bundesstatistikgesetz“, Federal Law Gazette I No. 163/1999

²⁰ „Emissionsschutzgesetz für Kesselanlagen“, Federal Law Gazette I No. 150/2004

- According to the Landfill Ordinance (Deponieverordnung)²¹ the operators of landfill sites have to report type and amount of waste deposited annually. These reports (collected in a central database) provide the main basis for calculating emissions from the sector *Waste*.
- Until 2008 the Umweltbundesamt has run a landfill database for solid waste disposals (Depo-niedatenbank), where the data (reports) provided by the landfill operators were incorporated.
- However, since 2009 – starting with the deposited waste of the year 2008 – landfill operators are obliged to register their data electronically at the portal of <http://edm.gv.at> (Electronic Data Management).²² Responsible for data collection and analysis is the BMLFUW. The necessary data is requested by the Umweltbundesamt for the purpose of inventory preparation.
- Since 2004 there is a reporting obligation to the BMLFUW under the Austrian Fluorinated Compounds (FC) Ordinance²³ for users of FCs for the following applications: refrigeration and air-conditioning, foam blowing, semiconductor manufacture, electrical equipment, fire extinguishers and aerosols. These data are notified via EDM and used for estimating emissions from the consumption of fluorinated compounds (IPCC sector 2.F).

More information on the National Inventory System in Austria (NISA) is provided in the following Chapter 1.2.1.

²¹ „Deponieverordnung“; Federal Law Gazette No 164/1996, last amended by by Federal Law Gazette II No 49/2004

²² „Deponieverordnung 2008“; Federal Law Gazette II No 39/2008

²³ „Industriegas-Verordnung (HFKW-FKW-SF6-VO)“; Federal Law Gazette II No. 447/2002

1.2.1 National Inventory System Austria (NISA)

History of the National Inventory System Austria – NISA

Austria's National Inventory System (NISA) has to be adapted to different obligations which are subject to continuous development. A brief history of the development and the activities of NISA is provided below:

- Austria established estimates for SO₂ under EMEP in 1978 (Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe).²⁴
- As an EFTA²⁵ country, Austria participated in CORINAIR 90,^{26/27} an air emission inventory for Europe. It was part of the CORINE (Coordination d'Information Environnementale) work plan set up by the European Council of Ministers in 1985. The aim of CORINAIR 90 was to produce a complete, consistent and transparent emission inventory for the following pollutants: SO_x as SO₂, NO_x as NO₂, NMVOC, CH₄, CO, CO₂, N₂O and NH₃.
- Austria signed the UNFCCC on June 8, 1992 and subsequently submitted its instrument of ratification on February 28, 1994.²⁸ The Convention i.a. includes the commitment to prepare an emission inventory for GHG on a regular basis.
- In 1994, the first so-called Austrian Air Emission Inventory (Österreichische Luftschadstoff-Inventur, OLI) was prepared.
- In 1997, a consistent time series for the emission data from 1980 to 1995 was reported for the first time.
- In 1998, also emissions of heavy metals (HM), persistent organic pollutants (POP) and fluorinated compounds (FC) such as SF₆, PFCs and HFCs were included in the inventory.
- Austria signed the KYOTO PROTOCOL on April 4, 1998 and subsequently submitted its instrument of ratification on May 31, 2002.
- Inventory data for particulate matter (PM) were included in the inventory in 2001.
- The accreditation as *Inspection Body for Emission Inventories* according to ISO/IEC 17020 was awarded in 2005 and has been renewed in 2011 and 2015.

For more details on NISA, see the report "NISA – NATIONAL INVENTORY SYSTEM AUSTRIA – Implementation Report"²⁹ which presents an overview of NISA and evaluates its compliance with the guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol as specified under the Marrakesh Accord (decision 20/CP.7).³⁰

Organisation of the National Inventory System Austria – NISA

Regulations under the UNECE/LRTAP Convention and its Protocols define and continuously improve standards for the preparation of and reporting on national emission inventories. In 2002, the Executive Body³¹ adopted new guidelines for estimating and reporting emission data to en-

²⁴ <http://www.emep.int/>

²⁵ EFTA: European Free Trade Association; <http://www.efta.int/>

²⁶ The CORINAIR system has been integrated into the work programme of the European Environment Agency (EEA) and the work is continuing through the Agency's European Topic Centre on Air Emissions (ETC/ACC) (<http://air-climate.eionet.europa.eu/>).

²⁷ http://www.eea.europa.eu/publications/topic_report_1996_21

²⁸ http://unfccc.int/essential_background/convention/status_of_ratification/items/2631.php

²⁹ <http://www.umweltbundesamt.at/fileadmin/site/publikationen/REP0004.pdf>

³⁰ <http://unfccc.int/resource/docs/cop7/13a03.pdf#page=2>

³¹ <http://www.unece.org/environmental-policy/conventions/envlrtapwelcome/convention-bodies/executive-body.html>

sure that the transparency, consistency, comparability, completeness and accuracy of reported emissions are adequate for current LRTAP Conventions needs (EB.AIR/GE.1/2002/7³² and its supporting addendum).

The submission is in accordance with the revised Guidelines for Reporting Emission Data under the Convention on Long-range Transboundary Air Pollution (ECE/EB.AIR/125).

As illustrated in Figure 2, the Austrian Air Emission Inventory (OLI), comprising all air pollutants stipulated by various national and international obligations, represents the core of NISA. The national system as required under the Kyoto Protocol and the Quality Management System (ISO/IEC 17020) are incorporated into NISA as complementary sections.

The Austrian Air Emission Inventory (OLI) covers all pollutants, i.e. air pollutants reported to UNECE/EC and greenhouse gases (GHG) as reported to the UNFCCC. This is to streamline efforts and benefit from a common approach to inventory preparation in one single National Inventory System for Austria (NISA).

It is designed to comply with the – generally more stringent – standards for national emission inventories under the UNFCCC and the Kyoto Protocol and also meets all the requirements of the LRTAP Convention and other reporting obligations as presented above (Chapter 1.2.2.1).

The “National Inventory System Austria” (NISA) includes all institutional, legal and procedural arrangements made for the preparation of emission inventories and for reporting and archiving inventory information. It should ensure the quality of the inventory: timeliness, transparency, accuracy, consistency, comparability, and completeness (TACCC).

As there are many different obligations which are subject to continuous development, Austria's National Inventory System (NISA) has to be adapted continually to these changes. The present structure is illustrated in Figure 2.

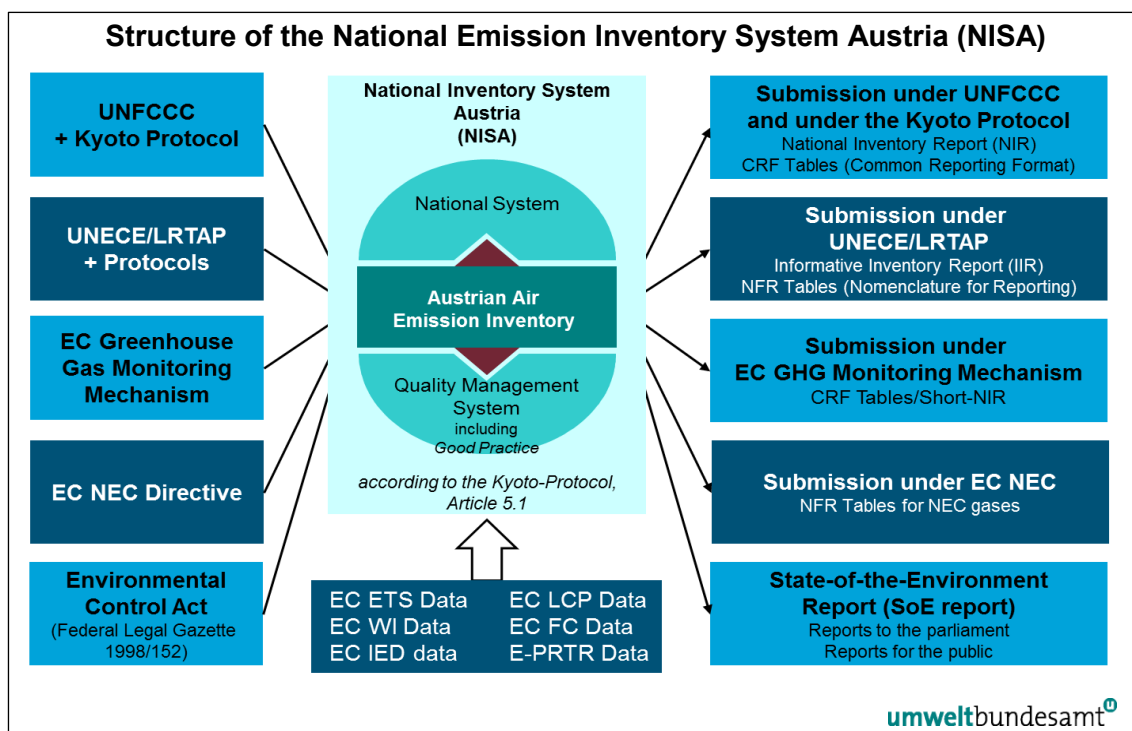


Figure 2: Structure of the National Emission Inventory System Austria (NISA).

³² <http://www.unece.org/fileadmin/DAM/env/documents/2002/eb/ge1/eb.air.ge.1.2002.7.e.pdf>

1.2.2 Austria's Obligations

Austria has to comply with the following air emission related obligations:

- UNECE Convention on Long-range Transboundary Air Pollution (LRTAP) and its Protocols comprising the annual reporting of national emission data on SO₂, NO_x, NMVOCs, NH₃, CO, TSP, PM₁₀, and PM_{2.5} as well as on the heavy metals Pb, Cd and Hg and persistent organic hydrocarbons (PAHs), dioxins and furans (PCDD/F), hexachlorobenzene (HCB) and Polychlorinated biphenyls (PCBs). Austria signed the convention in 1979; since its entry into force in 1983, the Convention has been extended by eight protocols which identify specific obligations or measures to be taken by Parties. These obligations as well as information regarding the status of ratification are listed in Table 2.
- Directive (EU) 2016/2284³³ on the reduction of national emissions of certain atmospheric pollutants (NEC-Directive) of the European Parliament and of the Council of 14.12.2016, amending Directive 2003/35/EC and repealing Directive 2001/81/EC³⁴. The national air emission ceilings law³⁵ transposes the NEC Directive into Austrian national legislation.
- „United Nations Framework Convention on Climate Change” (UNFCCC) (1992)³⁶ and the Kyoto Protocol (1997).³⁷
 - European Council Decision 525/2013/EC³⁸ “Monitoring Mechanism Regulation” on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change.
- Austrian “ambient air quality act”³⁹ comprising the reporting of national emission data on SO₂, NO_x, NMVOC, CO, heavy metals (Pb, Cd, Hg), benzene and particulate matter (PM).
- Industrial Emissions Directive 2010/75/EU⁴⁰ which requires the reporting of air emissions from various industrial activities.
- E-PRTR Regulation (EC) No 166/2006⁴¹ concerning the establishment of a European Pollutant Release and Transfer Register. E-PRTR is associated with Article 6 of the Aarhus Convention (United Nations: Aarhus, 1998) which refers to the right of the public to access environmental information and to participate in the decision-making process on environmental issues.

³³ <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016L2284&from=EN>

³⁴ http://www.umweltbundesamt.at/fileadmin/site/umweltthemen/luft/Richtlinie_2001.81.EG.pdf

³⁵ Emissionshöchstmengengesetz-Luft EG-L (*air emissions ceilings law*)

<https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20002763>

³⁶ http://unfccc.int/essential_background/convention/status_of_ratification/items/2631.php

³⁷ http://unfccc.int/files/essential_background/kyoto_protocol/application/pdf/kpstats.pdf

³⁸ <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:165:0013:0040:EN:PDF>
(repealing Decision 280/2004/EC)

³⁹ Immissionsschutzgesetz-Luft IG-L (*ambient air quality law*)

<https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=10011027>

⁴⁰ <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:334:0017:0119:en:PDF>

⁴¹ <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:033:0001:0017:EN:PDF>

Table 2: *Protocols of UNECE Convention on Long-range Transboundary Air Pollution (LRTAP).*

	Tools of UNECE Convention on Long-range Transboundary Air Pollution (LRTAP)	Parties	entered into force	signed/ratified by Austria
1979	Convention on Long-range Transboundary Air Pollution (in Geneva)	51	16.03.1983	13.11.1979 (s) 16.12.1982 (r)
1984	Geneva Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP)	47	28.01.1988	04.06.1987 (ac)
1985	Helsinki Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 per cent	25	02.09.1987	09.07.1985 (s) 04.06.1987 (r)
1988	Sofia Protocol concerning the Control of Nitrogen Oxides or their Transboundary Fluxes	35	14.02.1991	01.11.1988 (s) 15.01.1990 (r)
1991	Geneva Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes	24	29.09.1997	19.11.1991 (s) 23.08.1994 (r)
1994	Oslo Protocol on Further Reduction of Sulphur Emissions	29	05.08.1998	14.06.1994 (s) 27.08.1998 (r)
1998	Aarhus Protocol on Heavy Metals	33	29.12.2003	24.06.1998 (s) 17.12.2003 (r)
1998	Aarhus Protocol on Persistent Organic Pollutants (POPs)	33	23.10.2003	24.06.1998 (s) 27.08.2002 (r) ⁽¹⁾
1999	The 1999 Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone	26	17.05.2005	01.12.1999 (s)

Abbreviation: signed (s) ratified (r) accession (ac) Footnote: ⁽¹⁾ with declaration upon ratification

Source: http://www.unece.org/env/lrtap/status/lrtap_s.html

1.2.2.1 Reporting obligation under the UNECE/LRTAP Convention and its Protocols

As a minimum requirement, each Party shall report on emissions of the substances relevant to the Protocol to which they are a Party, as required by that Protocol. Since Austria has ratified all protocols to the UNECE/LRTAP Convention (with the exception of the Gothenburg Protocol), the annual reporting obligation enfoldes emission data of four groups: main pollutants, particulate matter (PM), heavy metals, and POPs. Table 3, taken from the Reporting Guidelines, gives the present set of components which have to be reported (minimum) and which should be reported voluntarily (additionally).

This report follows the regulations under the UNECE/LRTAP Convention and its Protocols that define standards for national emission inventories. In 2008, the Executive Body adopted the Guidelines for Reporting Emission Data under the Convention on Long-Range Transboundary Air Pollution (LRTAP) (ECE/EB.AIR/97)^{42/43} for estimating and reporting of emission data. They are necessary to ensure transparency, accuracy, consistency, comparability and completeness (TACCC) of the reported emissions. In 2014 the Reporting Guidelines were revised (ECE/EB.AIR.125)⁴⁴ and were adopted for application in 2015 and subsequent years.

The data presented in this report were compiled according to the Reporting Guidelines for estimating and reporting emission data, which also define the new reporting format (**Nomenclature for Reporting – NFR** (latest version of the templates 'NFR14'⁴⁵ dated 17.4.2014)) as well as standards for providing supporting documentation which should ensure the transparency of the inventory.

⁴² http://www.ceip.at/fileadmin/inhalte/emep/reporting_2009/Rep_Guidelines_ECE_EB_AIR_97_e.pdf

⁴³ At its twenty-sixth session (15–18 December 2008), the Executive Body approved the revised Guidelines (ECE/EB.AIR/2008/4) as amended at the session and requested the secretariat to circulate a final amended version.

⁴⁴ http://www.ceip.at/fileadmin/inhalte/emep/2014_Guidelines/ece.eb.air.125_ADVANCE_VERSION_reporting_guidelines_2013.pdf

⁴⁵ NFR14 – http://www.ceip.at/ms/ceip_home1/ceip_home/reporting_instructions/

Table 3: Emission Reporting Programme.

Element(s)	Pollutant(s)	Years ⁽¹⁾
A. National total emissions		
1. Main pollutants	SO _x , NO _x , NH ₃ , NMVOC, CO	from 1990 to 2015
2. Particulate matter	PM _{2.5} , PM ₁₀ , (TSP, BC)	for 1990, 1995, and for 2000 to 2015
3. Heavy metals	Pb, Cd, Hg, (<u>As, Cr, Cu, Ni, Se, Zn</u>)	from 1990 to 2015
4. POPs	PCDD/PCDF, PAHs ⁽²⁾ , HCB, PCBs	from 1990 to 2015
B. Emissions by NFR source category		
1. Main pollutants	SO _x , NO _x , NH ₃ , NMVOC, CO	from 1990 to 2015
2. Particulate matter	PM _{2.5} , PM ₁₀ , (TSP, BC)	for 1990, 1995, and for 2000 to 2015
3. Heavy metals	Pb, Cd, Hg, <u>As, Cr, Cu, Ni, Se, Zn</u>	from 1990 to 2015
4. POPs	PCDD/PCDF, PAHs ⁽²⁾ , HCB, PCBs	from 1990 to 2015
C. Activity data by source category		from 1990 to 2015
D. Gridded data in the EMEP 0.1x0.1 long/lat grid		
1. Sector emissions	SO _x , NO _x , NH ₃ , NMVOC, CO, PM ₁₀ , PM _{2.5} , Pb, Cd, Hg, PCDD/F, PAHs, HCB, PCBs	2000 (optional) , 2005, 2010, 2015 and every 4 years
2. National totals		
E. Emissions from large point sources		
	SO _x , NO _x , NH ₃ , NMVOC, CO, PM ₁₀ , PM _{2.5} , Pb, Cd, Hg, PCDD/F, PAHs, HCB, PCBs	2000 (optional) , 2005, 2010, 2015 and every 4 years
ADDITIONAL REPORTING/FOR REVIEW AND ASSESSMENT PURPOSES		
VOC speciation/Height distribution/Temporal distribution		
Land-use data/Mercury breakdown		
% of toxic congeners of PCDD/F emissions		
Pre-1990 emissions of PAHs, HCB, PCDD/F and PCB		
Information on natural emissions		
Projected emissions and projected activity data		
1. National total emission projections	SO _x , NO _x , NH ₃ , NMVOC, PM _{2.5} and BC	2020, 2025, 2030, 2040 and 2050
2. Emission projections by NFR14	SO _x , NO _x , NH ₃ , NMVOC, PM _{2.5} and BC	2020, 2025, 2030, 2040 and 2050
3. Projected activity data by NFR14		2020, 2025, 2030, 2040 and 2050

⁽¹⁾ As a minimum, data for the base year of the relevant protocol and from the year of entry into force of that protocol to the latest year should be reported

⁽²⁾ polycyclic aromatic hydrocarbons (PAHs) {benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, Total 1-4}

1.2.2.2 Reporting obligation under Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants (NEC-Directive)

According to Article 8 of NEC Directive 2016/2284 and Annex I, Table A, Member States shall prepare and annually update national emission inventories for the pollutants SO_x, NO_x, NH₃, NMVOC, CO, heavy metals (Cd, Hg, Pb), POPs (total PAHs, PCBs, HCB), PM_{2.5}, PM₁₀ and, if available, BC. Austria reports the national emission totals calculated on the basis of *fuel used* (thus excluding emissions from fuel exports in the vehicle tank) for compliance assessment under the NEC Directive.

Additionally, Member States shall prepare and update every four years spatially disaggregated national emission inventories and large point source inventories and, every two years, national emission projections for part of these pollutants as set out in the NEC Directive 2016/2284, Annex I, Table C.

Member States' submissions of national emission inventories and projections shall be accompanied by an informative inventory report (this report). The report follows the regulations under the UNECE/LRTAP Convention and its Protocols that define standards for national emission inventories (see chapter 1.2.2.1).

1.3 Inventory Preparation Process

The present Austrian Air Emission Inventory (OLI) for the period 1990 to 2015 was compiled according to the recommendations for inventories as set out by the UNECE Executive Body⁴⁶ and in the guidelines mentioned above.

The preparation of the inventory includes the following three stages as illustrated below.

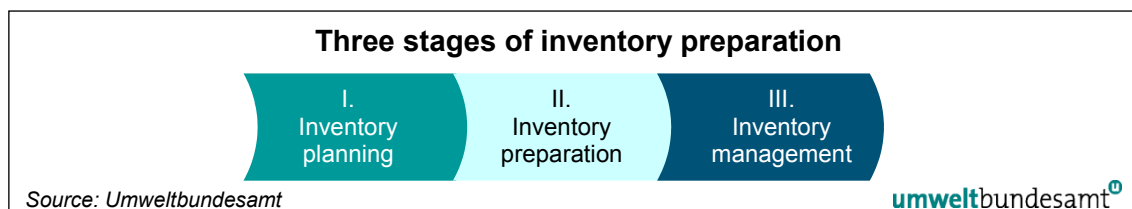


Figure 3: Three stages of inventory preparation.

I Inventory planning

In the first stage, specific responsibilities are defined and allocated: as mentioned before, the Umweltbundesamt has the overall responsibility for the national inventory, comprising greenhouse gases as well as other air pollutants.

Inventory planning also includes planning of how to distribute available resources, and thus, as resources are limited, also includes a prioritization of planned improvements, whereby the key category analysis is an important tool.

Within the inventory system, specific responsibilities for the different emission source categories are defined ("sector experts") as well as for all activities related to the preparation of the inventory, including QA/QC, data management and reporting.

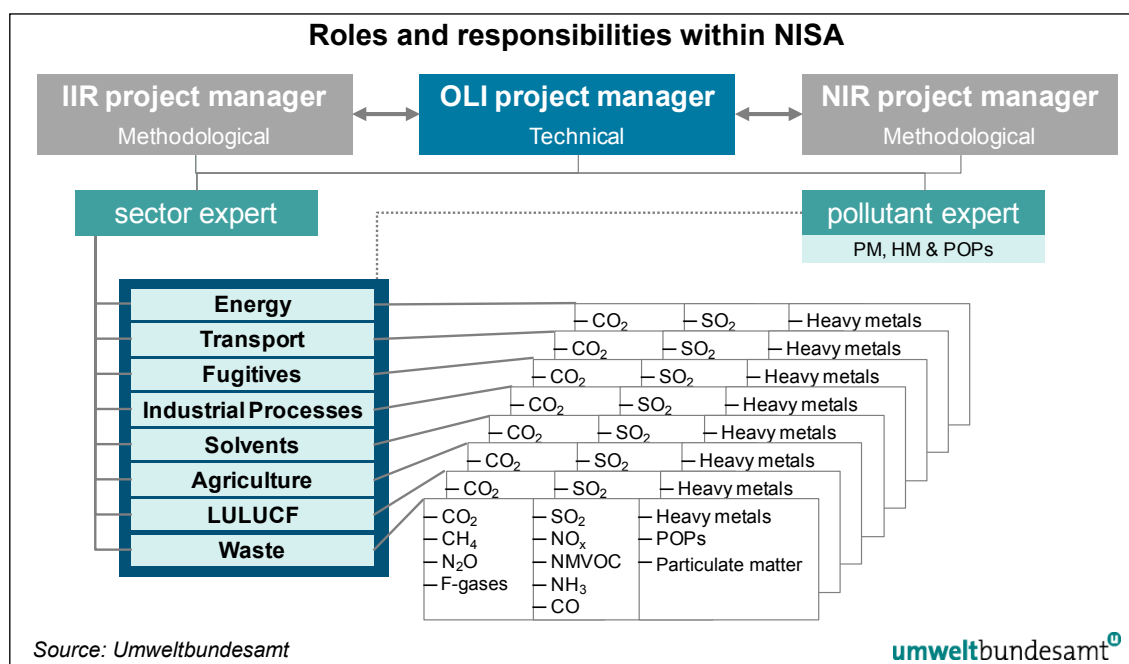


Figure 4: Roles and responsibilities within the National Emission Inventory System Austria (NISA).

⁴⁶ http://www.ceip.at/ms/ceip_home1/ceip_home/reporting_instructions/

Emissions of air pollutants are estimated together with greenhouse gases in a single data base based on the CORINAIR⁴⁷ scheme, which was formerly also used as reporting format under the UNECE. This nomenclature was designed by the ETC/ACC⁴⁸ to estimate emissions of all kind of air pollutants as well as greenhouse gases.

The CORINAIR system's nomenclature is called SNAP,⁴⁹ which may be expanded to adapt to national circumstances by so-called SPLIT codes, and additionally each SNAP/SPLIT category can be extended using a fuel code.

II Inventory preparation

In the second stage, the inventory preparation process, sector experts collect activity data, emission factors and all relevant information needed for finally estimating emissions. The sector experts are also responsible for methodological choices and for contracting studies, if needed.

As the source of emission factors and/or the methodology of emission estimation for HM, POPs and PM is different compared to the “main” pollutants for a lot of source categories, emission inventories for these pollutants were prepared in studies that were contracted out; however, the incorporation into the inventory system and the update of emission calculations for subsequent years is the responsibility of the sector experts.

All data collected together with emission estimates are fed into a database (see below), where data sources are documented for future reconstruction of the inventory.

As mentioned above, the Austrian Inventory is based on the SNAP systematic, and has to be transformed into the current reporting format under the LRTAP Convention and the NEC Directive – the NFR⁵⁰ format.

In addition to actual emission data, background tables of the NFR are filled in by the sector experts, and finally QA/QC procedures as defined in the inventory planning process are carried out before the data is submitted under the UNECE/EC.

The following table gives an overview on the tasks of inventory preparation together with a typical timeline.

Table 4: Overview Inventory related tasks.

Task	Description	Deadline
Management Review	Preparation of a report including evaluation of the fulfilment of the previous improvement plan and a plan for QMS and inventory improvement, i.a. based on audit and review findings.	Summer
Kick-Off	Meeting of inventory team (sector experts, deputies, project-/quality- and data managers of the inventory); definition of a working plan	End of Summer
Activity data collection	Collection of activity data, including contracting out studies.	November 15
Inventory preparation	Estimation of emissions for all sources, including collection of background data.	December 15

⁴⁷ CORINAIR: CORINE – CO-ordination d'INformation Environnementale and include a project to gather and organise information on emissions into the air relevant to acid deposition; Council Decision 85/338/EEC (OJ, 1985)

⁴⁸ European Topic Centre on Air Emissions <http://air-climate.eionet.europa.eu/>

⁴⁹ SNAP (Selected Nomenclature for sources of Air Pollution) 90 or 97 respectively means the stage of development

⁵⁰ NFR – Nomenclature For Reporting – is a classification system developed by the UN/ECE TFEIP for the Reporting Guidelines described in eb.air.ge.1.2001.6.e.doc

Task	Description	Deadline
Compilation of national inventory	Updating the data base and generating NFR data files	December 23
Quality checks	Tier 1 and Tier 2 QA/QC activities	December
Submission NFR tables	Finalization NFR tables and submission to UNECE/EC	February 15
Preparation of IIR	Compilation of the Informative Inventory Report	January–March
Submission IIR	Submission of the Informative Inventory Report to the EC (NEC Directive) and UNECE	March 15

III Inventory management

For the inventory management, a reliable data management scheme is needed to fulfil the data collecting and reporting requirements.

Data management is carried out using MS Excel™ spreadsheets in combination with Visual Basic™ macros, which is a very flexible system that can easily be adjusted to new requirements. The data is stored on a central network server which is backed up continuously for the needs of data security. The inventory management also includes quality management (see Chapter 1.6) as well as documentation on QA/QC activities.

1.4 Methodologies and Data Sources Used

- The main data supplier for the Austrian Emission Inventories is Statistik Austria, providing the underlying energy source data. The Austrian energy balances are based on several databases mainly prepared by the Federal Ministry of Economy, Family and Youth, „Bundeslastverteiler“ and Statistik Austria. Their methodology follows the IEA and Eurostat conventions. The aggregated balances, for example transformation input and output or final energy use, are harmonised with the IEA tables as well as their sectoral breakdown which follows the NACE classification.
- Information about activity data and emissions of the industry sector is mostly obtained directly from individual plants, or in other cases, from Associations of the Austrian Industries. Activity data for some sources are obtained from Statistik Austria which provides statistics on production data⁵¹.
- Operators of steam boilers with more than 50 MW report their emissions and their activity data directly to the Umweltbundesamt. Data from national and sometimes international studies are also used.
- Until 2008, operators of landfill sites reported their activity data directly to the Austrian Ministry of Environment or the Umweltbundesamt, where they were – after a check – in turn incorporated into a database on landfills. Emissions for the years 1998–2007 are calculated on basis of these data. Since 2009 landfill operators have to register and report their waste input directly to a database operated by the Federal Ministry of Agriculture, Forestry, Environment and Water Management (EDM, “Electronic Data Management”). These data are evaluated by the responsible body at federal level (BMLFUW) and are made available for emission calculation.
- Activity data needed for the calculation of non-energetic emissions are based on several statistics collected by Statistik Austria and national and international studies.

⁵¹ „Industrie und Gewerbestatistik“ published by STATISTIK AUSTRIA for the years until 1995; „Konjunkturstatistik im produzierenden Bereich“ published by STATISTIK AUSTRIA for the years since 1997.

The following table presents the main data sources used for activity data:

Table 5: Main data sources for activity data.

Sector	Data Sources for Activity Data
Energy	<ul style="list-style-type: none"> ● Energy Balance from Statistik Austria; ● EU-ETS; ● Steam boiler database; ● direct information from industry or associations of industry
Transport	<ul style="list-style-type: none"> ● Energy Balance from Statistik Austria ● Yearly growth rates of transport performance on Austrian roads from Austrian Ministry for Transport, Technology and Innovation
IPPU	<ul style="list-style-type: none"> ● National production statistics, ● import/export statistics; ● EU-ETS; ● direct information from industry or associations of industry ● Short term statistics for trade and services ● Austrian foreign trade statistics ● Structural business statistics ● Surveys at companies and associations
Agriculture	<ul style="list-style-type: none"> ● national Studies ● national agricultural statistics obtained from Statistik Austria
LULUCF	<ul style="list-style-type: none"> ● National forest inventory obtained from the Austrian Federal Office and Research Centre for Forests ● Soil inventories by the Federal States and by the Austrian Federal Office and Research Centre for Forests ● National agricultural statistics and land use statistics obtained from Statistik Austria
Waste	<ul style="list-style-type: none"> ● Federal Waste Management Plan (Data sources: Database on landfills (1998–2007), Electronic Data Management (EDM) in environment and waste management) ● EMREG-OW (Electronic Emission Register of Surface Water Bodies)

Emission calculation and related inventory work (reporting, QA/QC, documentation and archiving etc.) is carried out by the IBE sector experts.

In cases where the IBE's capabilities or resources are exceeded, some of its inventory activities are subcontracted, in some cases routinely (e.g. the emission inventory for road transport), in other cases as required (e.g. revision of methodologies for a complex emission source). Such subcontracts have so far been concluded with:

- Technical University Graz (road and off-road transport)
- Technical University of Natural Resources and Applied Life Sciences, Austrian Institute of Technology (agriculture)

However, the final assessment of fulfillment of the requirements is made by the IBE.

Detailed information on data sources for activity and emission data or emission factors used by sector can be found in Chapters 3–6.

For large point sources the Umweltbundesamt preferably uses – after careful assessment of plausibility of this data – emission data that are reported by the ‘operator’ of the source because these data usually reflect the actual emissions better than data calculated using general emission factors, as the operator has the best information about the actual circumstances. If such data is not available, and for area sources, national emission factors are used or, if there are no national emission factors, international emission factors are used to estimate emissions. Where no applicable data is found, standard emission factors e.g. from the EMEP/EEA 2016 Guidebook are applied.

The main sources for emission factors are:

- National studies for country specific emission factors as well as information on emissions from large point sources (plant specific data)
- IPCC 2006 Guidelines for National Greenhouse Gas Inventories⁵²
- EMEP/EEA air pollutant emission inventory guidebook – 2009. Technical report No 9/2009⁵³
- EMEP/EEA air pollutant emission inventory guidebook – 2013. Technical report No. 12/2013⁵⁴
- EMEP/EEA air pollutant emission inventory guidebook – 2016. Technical report No. 21/2016⁵⁵

Table 6 presents the methods applied and the origin of emission factors used for the categories in the NFR format for the present Austrian inventory.

For key source categories (see chapter 1.5) the most accurate methods for the preparation of the air emission inventory should be used. Required methodological changes and planned improvements are described in the corresponding sector analysis chapters (Chapters 3–6).

1.4.1 EU Emissions Trading System (EU ETS)

The European Union Emissions Trading Scheme has been established by Directive 2003/87/EC of the European Parliament and of the Council⁵⁶ and amended by Directive 2009/29/EC⁵⁷. From 2013 onwards, it is known as the European Union Emissions Trading System (EU ETS). It includes heavy energy-consuming installations in power generation and manufacturing. The activities covered are energy activities, the production and processing of ferrous metals, the mineral industry and some other production activities. From 2012 onwards, CO₂ emissions from aviation have also been included. For the trading period 2013–2020 the scope of the EU ETS has been further extended to include additional installations from the metal and chemical industry and compressor stations. For more detailed information on the included activities please refer to Annex I of the above mentioned directive.

⁵² <http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.htm>

⁵³ <http://www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook-2009>

⁵⁴ <http://www.eea.europa.eu/publications/emep-eea-guidebook-2013>

⁵⁵ <http://www.eea.europa.eu/publications/emep-eea-guidebook-2016>

⁵⁶ Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC, OJ L 275/32

⁵⁷ Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2003/87/EC so as to improve and extend the emission allowance trading scheme of the Community, OJ L 140/63

Greenhouse gases covered under the EU ETS are CO₂ (since 2005), N₂O (since 2010) and PFC (since 2013)⁵⁸. About one third of total Austrian GHG emissions currently result from installations under the EU-ETS (~28 Mt CO₂ in 2015).

Plant operators have to report their activity data and emissions annually for the GHG as mentioned above; for the first time they reported their emissions of 2005 in March 2006. The first trading period of the EU ETS ran from 2005–2007. The second trading period, which coincided with the 1st Kyoto commitment period, ran from 2008–2012. The third trading period, which coincides with the 2nd Kyoto commitment period, runs from 2013 to 2020. Since 2012 aircraft operators have also been included into the scheme. They have to report their emissions concerning internal flights in the European Economic Area.

General rules for reporting and verification of emissions in the EU ETS are defined in EU Directive 2003/87/EC and specific rules can be found in Commission Regulation (EU) No 601/2012⁵⁹. In Austria, Member State specific regulations are defined in the Austrian Emissions Allowance Trading Act⁶⁰ and the Austrian Monitoring, Reporting and Verification Ordinance⁶¹. This ordinance also specifies that the Umweltbundesamt has to incorporate, as far as necessary, the verified emissions of the emissions trading scheme into the national greenhouse gas inventory. For a detailed description of the sectors covered and the incorporation of these emissions into the national inventory please refer to the chapters 3 Energy (CRF Sector 1) and 4 Industrial Processes and Product Use (CRF Sector 2).

An important feature of the emissions reported under the EU-ETS is that these emissions have to pass independent verification by an accredited verifier. The Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management is in charge of granting the licence to independent verifiers. In addition, the Ministry has to fulfil a quality control function, which is implemented by spot checks of emissions and verification reports that the Umweltbundesamt performs on behalf of the Ministry.

1.4.2 Electronic Data Management (EDM)

The electronic data management (EDM of the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW) is an electronic recording and notification system (information network), implemented as an integrated e-government application. It allows enterprises and authorities to handle registration and notification obligations online in the areas of waste and environment (e.g. on Austrian Emissions Allowances, HFC or EMREG – Emission Register Surface Water). It provides main data for reporting in the sector *Waste* (e.g. landfilled and biologically treated amounts).

There are around 40 000 users registered, covering national and international waste owners (collectors, operators of treatment plants, waste producers) doing their reporting obligations according to national legislation, e.g. on landfilled amounts.

⁵⁸ Austria unilaterally opted-in N₂O as of 2010. Since 2013 N₂O and PFCs have been included in the EU ETS at EU level.

⁵⁹ Commission Regulation (EU) No 601/2012 of 21 June 2012 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council.

⁶⁰ Emissionszertifikatgesetz 2011, Federal Law Gazette I No. 118/2011, as amended

⁶¹ Überwachungs-, Berichterstattungs- und Prüfungs-Verordnung, Federal Law Gazette II No. 339/2007, as amended

1.4.3 Other data (E-PRTR)

The European Pollutant Release and Transfer Register (E-PRTR) which was established by the E-PRTR Regulation (EC) No 166/2006.

It covers 91 pollutants from nine activity groups, including all pollutants reported already under EPER. However, emissions only have to be reported if they exceed certain thresholds. In contrast to EPER, E-PRTR also included data on releases into soil, accidental releases, waste transfers and diffuse emissions⁶². E-PRTR was preceded by the European Pollutant Emission Register (EPER), with reporting years 2001 or 2002 and 2004.

The Umweltbundesamt implemented E-PRTR in Austria using an electronic system enabling the facilities and the authorities to fulfil the requirements of the E-PRTR Regulation electronically via the internet. In 2008, installations reported for the first time releases and transfers of pollutants and waste transfers from 2007 under the E-PRTR, which is an annual reporting obligation. The plausibility of the reports is checked by the competent authorities and the Umweltbundesamt. The Umweltbundesamt also checks the data for consistency with the national inventory.

Data from E-PRTR or its predecessor has so far not been used as a data source for the national inventory, as the E-PRTR/EPER reports contain only very little information other than emission data. Concerning methodology the only information included is whether emissions are estimated, measured or calculated. For activity data facilities report one value that is often not useful in the context of emissions and may be different between producers of the same product.

In addition, E-PRTR/EPER data is not complete for IPCC sectors and it is difficult to include this point source information because no background information (such as fuel consumption data) is available. Furthermore the reporting thresholds are relatively high, so that many of the relevant installations do not have to report.

Thus greenhouse gas emission data from the EU Emissions Trading System, combined with the top-down approach of the national inventory has been considered to be more reliable and data of EPER/E-PRTR has not been used as point source data for the national inventory, but for verification purposes only where possible.

1.4.4 Literature

National and sometimes international studies are also used as data suppliers (references are given in the sector analysis chapters).

Studies on HM, POPs and PM emissions

Emissions of HM and some POPs have already been estimated in the course of CORINAIR 1990 and 1994, respectively.⁶³ With these data and other Austrian publications as a basis, comprehensive emission inventories of HM, POPs and PM for different years were prepared by contractors of the Umweltbundesamt and incorporated into the inventory system afterwards.

- WINDSPERGER, A. et. al. (1999): Entwicklung der Schwermetallemissionen – Abschätzung der Emissionen von Blei, Cadmium und Quecksilber für die Jahre 1985, 1990 und 1995 gemäß der CORINAIR-Systematik. Institut für Industrielle Ökologie und Österreichisches Forschungszentrum Seibersdorf. Wien. (Nicht veröffentlicht).

⁶² Data can be downloaded from: <http://www.umweltbundesamt.at/prtr/>

⁶³ ORTHOFER, R. (1996); HÜBNER, C. (1996); HÜBNER, C. & WURST, F. (1997); HÜBNER, C. (2000)

Development of Heavy Metal Emissions – Estimation of emissions of Lead, Cadmium and Mercury for the years 1985, 1990 and 1995 according to the CORINAIR-systematics. Department for industrial ecology and Austrian Research Centers Seibersdorf. Vienna. (Not published).

- Österreichische Emissionsinventur für Cadmium, Quecksilber und Blei.
Austrian emission inventory for Cd, Hg and Pb 1995–2000 prepared by FTU – Forschungsgesellschaft Technischer Umweltschutz GmbH. Vienna November 2001 (not published).
- HÜBNER, C. (2001): Österreichische Emissionsinventur für POPs 1985–1999. FTU – Forschungsgesellschaft Technischer Umweltschutz GmbH. Werkvertrag des Umweltbundesamt, IB-650. Wien. (Nicht veröffentlicht).
Austrian emission inventory for POPs 1985–1999. Prepared by FTU – Research Center Technical environment protection (Ltd.). Study commissioned by Umweltbundesamt IB-650. Vienna. (Not published).
- WINIWARTER, W.; TRENKER, C.; HÖFLINGER, W. (2001): Österreichische Emissionsinventur für Staub. Österreichisches Forschungszentrum Seibersdorf. Wien.
Austrian emission inventory for PM. Austrian Research Centers Seibersdorf. Vienna.
- WINIWARTER, W.; SCHMID-STEJSKAL, H. & WINDSPERGER, A. (2007): Aktualisierung und Verbesserung der österreichischen Luftschadstoffinventur für Schwebstaub. Systems research – Austrian Research Centers & Institut für Industrielle Ökologie. Wien.
Updating and Improvement of the Austrian Air Emission Inventory (OLI) for PM. Systems research – Austrian Research Centers & Department for industrial ecology. Vienna.

1.4.5 Summary of methodologies applied for estimating emissions

In Table 6 a summary of methodologies applied for estimating emissions is given.

The following abbreviations are used:

- D DEFAULT
- L Literature
- CS COUNTRY SPECIFIC
- PS PLANT SPECIFIC

Dark shaded cells indicate that no such emissions arise from this source; light shaded cells (blue) indicate key sources.

Table 6: Summary of methodologies applied for estimating emissions.

NFR	Description	SO ₂	NO _x	NMVOC	NH ₃	CO	Cd	Hg	Pb	PAH	DIOX	HCB	PCB	TSP	PM ₁₀	PM _{2.5}
1.A.1.a	Public Electricity and Heat Production	PS, CS	PS, CS	CS	CS	PS, CS	D/CS	D/CS	D/CS	L/CS	L/CS	L/CS	D/CS	PS, CS	PS, CS	PS, CS
1.A.1.b	Petroleum refining	PS	PS		CS	PS	CS	CS	CS	L/CS	L/CS	CS	CS	PS	PS	PS
1.A.1.c	Manufac.of Solid fuels a. Oth. Energy Ind.		CS	CS	CS	CS					L/CS	CS		CS	CS	CS
1.A.2 mobile	Other mobile in industry	CS	CS	CS	CS	CS	CS	CS	CS	L/CS	L/CS	CS	L/CS	CS	CS	CS
1.A.2 stat	Manuf. Ind. & Constr. - stationary	PS, CS	PS, CS	PS, CS	CS	PS, CS	D/CS	D/CS	D/CS	L/CS	L/CS	CS	D/CS	PS, CS	PS, CS	PS, CS
1.A.3.a	Civil Aviation	CS	CS	CS	CS	CS	CS	CS	CS					CS	CS	CS
1.A.3.b.1	R.T., Passenger cars	CS	CS	CS	CS	CS	CS	CS	CS	L/CS	L/CS	CS	D	CS	CS	CS
1.A.3.b.2	R.T., Light duty vehicles	CS	CS	CS	CS	CS	CS	CS	CS	L/CS	L/CS	CS	D	CS	CS	CS
1.A.3.b.3	R.T., Heavy duty vehicles	CS	CS	CS	CS	CS	CS	CS	CS	L/CS	L/CS	CS	D	CS	CS	CS
1.A.3.b.4	R.T., Mopeds & Motorcycles	CS	CS	CS	CS	CS	CS	CS	CS	L/CS	L/CS	CS	D			
1.A.3.b.5	R.T., Gasoline evaporation			CS												
1.A.3.b.7	R.T., Automobile road abrasion						L							CS	CS	CS
1.A.3.c	Railways	CS	CS	CS	CS	CS	D/CS	D/CS	D/CS	L/CS	L/CS	CS	D/CS	CS	CS	CS
1.A.3.d	Navigation	CS	CS	CS	CS	CS	CS	CS	CS	L/CS	L/CS	CS	D/CS	CS	CS	CS
1.A.3.e	Other transportation		CS	CS	CS	CS					CS	CS		CS	CS	CS
1.A.4 mob	Other Sectors – mobile	CS	CS	CS	CS	CS	CS	CS	CS	L/CS	L/CS	CS		CS	CS	CS
1.A.4 stat	Other Sectors - stationary	CS	CS	CS	CS	CS	D/CS	D/CS	D/CS	L/CS	L/CS	CS	D/CS	CS	CS	CS
1.A.5	Other	CS	CS	CS	CS	CS	CS	CS	CS	L/CS	L/CS	CS	L/CS	CS	CS	CS
1.B	FUGITIVE EMISSIONS	PS		D, PS										CS	CS	CS
2.A	MINERAL PRODUCTS													CS	CS	CS

NFR	Description	SO ₂	NO _x	NM VOC	NH ₃	CO	Cd	Hg	Pb	PAH	DIOX	HCB	PCB	TSP	PM ₁₀	PM _{2.5}
2.B	CHEMICAL INDUSTRY	CS	CS	CS	PS	CS	CS	CS	CS					CS	CS	CS
2.C	METAL PRODUCTION	CS	CS	CS		CS	CS	CS	CS	CS	CS	CS	D	CS	CS	CS
2.D	NON ENERGY PRODUCTS FROM FUELS AND SOLVENT USE			CS		CS	PS		CS							
2.G	Other product manufacture and use													CS	CS	CS
2.H	Other Processes		CS	L		CS				CS	CS	CS		CS	CS	CS
2.I	Wood processing													CS	CS	CS
3.B.1	Cattle		D		CS									D	D	D
3.B.2	Sheep		D		D									D	D	D
3.B.3	Swine		D		CS									D	D	D
3.B.4.d	Goats		D		D									D	D	D
3.B.4.e	Horses		D		D									D	D	D
3.B.4.g	Poultry		D		D									D	D	D
3.B.4.h	Other animals		D		D									D	D	D
3.D	AGRICULTURAL SOILS		D	D	CS/D									L	L	L
3.F	Field burning of agricultural residues	CS/D	CS/D	CS/D	CS/D	CS/D	CS/D	CS/D	CS/D	CS/D	CS/D	CS/D		CS/D	CS/D	CS/D
3.I	Agriculture – Other															
5	WASTE	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS		CS	CS	CS

1.5 Key Category Analysis

The identification of key categories is described in the “EMEP/EEA air pollutant emission inventory guidebook 2016” (EEA 2016). It stipulates that a key category is one that is prioritised within the national inventory system because it is significantly important for one or a number of air pollutants in a country's national inventory of air pollutants in terms of the absolute level, the trend, or the uncertainty in emissions (EEA 2016).

Furthermore, it is good practice

- to identify the national key categories in a systematic and objective manner. This can be achieved by a quantitative analysis of the relationship between the magnitude of emission in any year (level) and the change in emission year to year (trend) of each category's emissions compared to the total national emissions;
- to focus the available resources for improvement in data and methods on categories identified as key. The identification of key categories in national inventories enables the limited resources available for preparing inventories to be prioritised; more detailed, higher tier methods can be selected for key categories. Inventory compilers should use the category specific methods presented in sectoral decision trees in the sectoral volumes;
- that the analysis should be performed at the level of NFR categories or subcategories at which the guidebook methods and decision trees are provided in the sectoral volumes. Where possible, some categories should be disaggregated by main fuel types;
- that each air pollutant emitted from each category should be considered separately;
- that for each key category, the inventory compiler should determine if certain subcategories are particularly significant usually, for this purpose, the subcategories should be ranked according to their contribution to the aggregate key categories. Those subcategories that contribute together more than 60% to the key category should be treated as particularly significant. It may be appropriate to focus efforts towards methodological improvements of these most significant subcategories.

All notations, descriptions of identification and results for key categories included in this chapter are based on the latest Inventory Guidebook (EEA 2016).

The identification includes all NFR categories and all reported gases

- SO₂, NO_x, NMVOC, NH₃, CO
- PM: TSP, PM₁₀, PM_{2.5}
- HM: Cd, Hg, Pb
- POP: PAH, PCDD/F, HCB, PCB

Used methodology for identification of key categories: Approach 1

The methodology follows the IPCC approach to produce pollutant-specific key categories and covers for both level and trend assessment. In Approach 1, key categories are identified using a predetermined cumulative emissions threshold. Key categories are those which, when summed together in descending order of magnitude, cumulatively add up to 80% of the total level.

The suggested aggregation level of analysis for Approach 1 provided in Table 2-1 of Chapter 2 of the EMEP/EEA emission inventory guidebook 2016 was used. No special considerations like disaggregation to main fuel types have been made. For reasons of transparency, the same level of aggregation for all pollutants was used.

The presented key category analysis was performed by the Umweltbundesamt with data for air emissions of the submission 2017 to the UNECE/LRTAP and the European Commission. For all gases a level assessment for all years 1990 (base year) and 2015 (last year), as well as a trend assessment for 1990 to 2015 was prepared.

1.A Combustion Activities

1.A Combustion Activities is the most important sector for emissions reported to UNECE and EC. To account for this fact and help prioritising efforts this sector was analysed in greater detail.

Furthermore, for mobile sources the different means of transport were considered separately, and additionally the sub category road transport was further disaggregated as it is an important source for many pollutants.

For stationary sources a split following the forth level of the NFR was used (1.A.2.g, 1.A.4.a, b, c).

NFR	Description	NFR	Description
1.A.1.a	Public Electricity and Heat Production	1.A.3.a	Civil Aviation – LTO (international and domestic)
1.A.1.b	Petroleum refining	1.A.3.b.1	R.T., Passenger cars
1.A.1.c	Manufacture of Solid fuels and Other Energy Industries	1.A.3.b.2	R.T., Light duty vehicles
1.A.2.a	Iron and Steel	1.A.3.b.3	R.T., Heavy duty vehicles
1.A.2.b	Non-ferrous Metals	1.A.3.b.4	R.T., Mopeds & Motorcycles
1.A.2.c	Chemicals	1.A.3.b.5	R.T., Gasoline evaporation
1.A.2.d	Pulp, Paper and Print	1.A.3.b.6	R.T., Automobile tyre and break wear
1.A.2.e	Food Processing, Beverages and Tobacco		
1.A.2.g.7	Mobile Combustion in Manufacturing Industries and Construction	1.A.3.b.7	R.T., Automobile road abrasion
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	1.A.3.c	Railways
1.A.4.a.1	Commercial/Institutional: Stationary	1.A.3.d	Navigation (national navigation and international inland waterway)
1.A.4.a.2	Commercial/Institutional: Mobile	1.A.3.e.1	Pipeline compressors
1.A.4.b.1	Residential: stationary	1.A.5.a	Other, Stationary (including Military)
1.A.4.b.2	Residential: Household and gardening (mobile)	1.A.5.b	Other, Mobile (including Military)
1.A.4.c.1	Agriculture/Forestry/Fishing: Stationary		
1.A.4.c.2	Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery		
1.A.4.c.3	Agriculture/Forestry/Fishing: National Fishing		

1.B Fugitive Emission

For fugitive emissions a split following the third level of the NFR was used.

NFR	Description	NFR	Description
1.B.1.a	Coal Mining and Handling	1.B.2.a	Oil
1.B.1.b	Solid fuel transformation	1.B.2.b	Natural gas
1.B.1.c	Other fugitive emissions from solid fuels	1.B.2.c	Venting and flaring (Oil and natural gas)
		1.B.2.d	Other fugitive emissions

2 Industrial Processes and Product Use

For source categories from Industrial processes a general split following the third level of the NFR was used. As 2.D.3 (Solvents) is an important source for NMVOC emissions, it was broken down into level 4. For the source categories NFR 2.I – NFR 2.L level two of the NFR was used.

NFR	Description	NFR	Description
2.A.1	Cement Production	2.D.3.a	Domestic Solvent Use including Fungicides
2.A.2	Lime Production	2.D.3.b	Road Paving with Asphalt
2.A.3	Glass Production	2.D.3.c	Asphalt Roofing
2.A.5	Mining, construction/demolition and handling of Product	2.D.3.d	Coating applications
2.A.6	Other Mineral Products	2.D.3.e	Degreasing
2.B.1	Ammonia Production	2.D.3.f	Dry cleaning
2.B.2	Nitric Acid Production	2.D.3.g	Chemical products
2.B.3	Adipic Acid Production	2.D.3.h	Printing
2.B.4	Carbide Production	2.D.3.i	Other Solvent Use
2.B.5	Other	2.H	Other Processes
2.B.6	Titanium Dioxide Production	2.I	Wood processing
2.B.7	Soda ash Production	2.J	Production of POPs
2.B.10	Other (Handling of products and other chemical industry)	2.K	Consumption of POPs and Heavy Metals (e.g. electrical and scientific equipment)
2.C.1	Iron and Steel Production	2.L	Other production, consumption, storage, transp. or handling of bulk products
2.C.2	Ferroalloys Production		
2.C.3	Aluminium Production		
2.C.4	Magnesium Production		
2.C.5	Lead Production		
2.C.6	Zinc Production		
2.C.7	Other Metal Production		

3 Agriculture

Level three of the NFR was used; only the sub category 3.B.4 und 3.D.a were further disaggregated, as these are important sources for NH₃. For 3.B.4 also the methodology is different for the animal categories.

NFR	Description	NFR	Description
3.B.1	Cattle	3.D.a.1	Inorganic N-fertilizers
3.B.2	Sheep	3.D.a.2	Organic fertilizers
3.B.3	Swine	3.D.a.3	Urine and dung deposited by grazing animals
3.B.4.a	Buffalo	3.D.d	Off-farm storage, handling and transport of agricultural products
3.B.4.d	Goats	3.D.e	Cultivated crops
3.B.4.e	Horses	3.F	Field Burning of agricultural Residues
3.B.4.f	Mules and Asses	3.I	Agriculture Other
3.B.4.g	Poultry		
3.B.4.h	Other animals		

5 Waste

Level two of the NFR was used.

NFR	Description	NFR	Description
5.A	Solid Waste Disposal on Land	5.D	Wastewater Treatment
5.B.1	Composting	5.E	Other Waste Handling
5.C.1	Waste Incineration		

Results of the Level and Trend Assessment (Approach 1)

As the analysis was made for all pollutants reported to the UNECE and as these pollutants differ in their way of formation, most of the identified categories are key for more than one pollutant: in total 43 key sources were identified.

Table 7: Summary of Key Categories for the year 2015 – Contributions per pollutant for Level Assessment (LA) and Trend Assessment (TA) in %.

NFR Code	NFR Category	% Contributions to pollutant totals for key categories (cumulative 80%)																												Sum of KC % contri- butions	Rank			
		SO ₂		NO _x		NMVOC		NH ₃		CO		Cd		Pb		Hg		PAH		DIOX		HCB		PCB		TSP		PM ₁₀				PM _{2.5}		
		LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA					
1.A.1.a	Public Electricity and Heat Production	8	7	6	4							11	8	13	8	16				5						2		3		5	6	104	6	
1.A.1.b	Petroleum refining				5							17	21																		43	17		
1.A.2.a	Iron and Steel	36	27							26	15																				104	5		
1.A.2.b	Non-ferrous Metals																			26		36									62	14		
1.A.2.d	Pulp, Paper and Print	6										8		5			6											3		4	33	21		
1.A.2.f	Non-metallic Minerals	8	5	4									8			17	23														65	13		
1.A.2.g.7	Mobile Combustion in Manufacturing Industries and Construction				4	12												4								4	5	3	3	3		38	19	
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	15	12	4	8								7	5						7	6						3	5	5	8	8	14	106	4
1.A.3.a	Civil Aviation - LTO				3																										3	42		
1.A.3.b.1	R.T., Passenger cars			21	32	4	32			8	42				43												3	2	3	5	5	199	3	
1.A.3.b.2	R.T., Light duty vehicles			4	5						5				3																	17	25	
1.A.3.b.3	R.T., Heavy duty vehicles			23														6									4		6	3	9	52	15	
1.A.3.b.4	R.T., Mopeds & Motorcycles									3	4																					7	33	
1.A.3.b.5	R.T., Gasoline evaporation						3																									3	40	

NFR Code	NFR Category	% Contributions to pollutant totals for key categories (cumulative 80%)																										Sum of KC % contri- butions	Rank				
		SO ₂		NO _x		NMVOC		NH ₃		CO		Cd		Pb		Hg		PAH		DIOX		HCB		PCB		TSP				PM ₁₀		PM _{2.5}	
		LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA				
1.A.3.b.7	R.T., Automobile road abrasion											8	8													18	17	10	11	6	8	86	7
1.A.3.c	Railways																									3						3	43
1.A.4.a.1	Commer- cial/Institutional: Stationary		5																													5	34
1.A.4.b.1	Residential: sta- tionary	9	25	6		21	5			40	12	18		11	6	14		69	47	51	22	69	31		12	12	9	20	6	34		552	1
1.A.4.b.2	Residential: Household and gardening (mobile)									3																						3	41
1.A.4.c.1	Agricul- ture/Forestry/ Fish- ing: Stationary									3	3							10	18	7	6		17							3	66	12	
1.A.4.c.2	Agriculture/ Forestry/ Fishing: Off- road Vehicles and Other Machinery			4																							4	3	5	5	8	29	23
1.B.2.a	Oil					4																										4	36
2.A.5	Mining, construc- tion/demolition and handling of prod- ucts																									23	14	19	14	4	4	78	8
2.B-10	Handling of prod- ucts and other chemical industry				7		3									19																29	22
2.C.1	Iron and Steel Production											20	16	47	21	33	32	4		9	13	11		19	50		19		19		15	326	2
2.C.3	Aluminium produc- tion																		4													4	38
2.C.5	Lead Production												7											44	24							75	9
2.C.7	Other metal pro- duction																							36								36	20

NFR Code	NFR Category	% Contributions to pollutant totals for key categories (cumulative 80%)																												Sum of KC % contributions	Rank		
		SO ₂		NO _x		NMVOC		NH ₃		CO		Cd		Pb		Hg		PAH		DIOX		HCB		PCB		TSP		PM ₁₀				PM _{2.5}	
		LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA	LA	TA				
2.D.3.a	Domestic solvent use including fungicides					21	27																								48	16	
2.D.3.d	Coating applications					15																									15	27	
2.D.3.e	Degreasing					7	3																								10	29	
2.D.3.g	Chemical products					4																									4	37	
2.D.3.h	Printing					4																									4	39	
2.D.3.i	Other solvent use					7																									7	32	
2.G	Other product manufacture and use																												3	2	5	35	
2.H	Other Processes					4												6													10	28	
3.B.1	Cattle							25	18																						43	18	
3.B.3	Swine							9	19																						29	24	
3.B.4.e	Horses								8																						8	30	
3.D.a.1	Inorganic N-fertilizers				3			7	10																17		14	5	6	4	67	11	
3.D.a.2	Organic fertilizers			4	5			42	25																						75	10	
5.B.1	Composting							7																							7	31	
5.C.1	Waste incineration											6							10												16	26	

Table 8: Key Categories for SO₂ emissions for the year 2015.

Level Assessment						
NFR Code	NFR Category	Latest Year (2015) Estimate [kt] E _{x,t}		Level Assessment L _{x,t}	Cumulative Total of L _{x,t}	
1.A.2.a	Iron and Steel	5.43		36.5%	36.5%	
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	2.17		14.6%	51.0%	
1.A.4.b.1	Residential: stationary	1.32		8.8%	59.9%	
1.A.1.a	Public Electricity and Heat Production	1.21		8.1%	68.0%	
1.A.2.f	Non-metallic Minerals	1.18		7.9%	75.9%	
1.A.2.d	Pulp, Paper and Print	0.95		6.3%	82.2%	
National Total		14.90				
Trend Assessment						
NFR Code	NFR Category	'Base Year' (1990) Estimate [kt] E _{x,0}	Latest Year (2015) Es- timate [kt] E _{x,t}	Trend Assessment L _{x,t}	Contribution to the trend	Cumulative Total of L _{x,t}
1.A.2.a	Iron and Steel	6.73	5.43	1.373	26.7%	26.7%
1.A.4.b.1	Residential: stationary	25.86	1.32	1.293	25.1%	51.8%
1.A.2.g.8	Other Stationary Combustion in Manuf- acturing Industries and Construction	1.95	2.17	0.598	11.6%	63.4%
1.A.1.a	Public Electricity and Heat Production	11.79	1.21	0.384	7.5%	70.9%
1.A.4.a.1	Commercial/Institutional: Stationary	5.24	0.23	0.274	5.3%	76.2%
1.A.2.f	Non-metallic Minerals	2.23	1.18	0.246	4.8%	81.0%
National Total		74.57	14.90			

Table 9: Key Categories for NO_x emissions for the year 2015.

Level Assessment				
NFR Code	NFR Category	Latest Year (2015) Estimate [kt] E_{x,t}	Level Assessment L_{x,t}	Cumulative Total of L_{x,t}
1.A.3.b.3	R.T., Heavy duty vehicles	34.33	23.0%	23.0%
1.A.3.b.1	R.T., Passenger cars	31.82	21.3%	44.4%
1.A.1.a	Public Electricity and Heat Production	9.66	6.5%	50.8%
1.A.4.b.1	Residential: stationary	9.62	6.5%	57.3%
1.A.3.b.2	R.T., Light duty vehicles	6.52	4.4%	61.7%
1.A.2.g.7	Mobile Combustion in Manufacturing Industries and Construction	6.35	4.3%	65.9%
1.A.4.c.2	Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	6.27	4.2%	70.1%
1.A.2.f	Non-metallic Minerals	5.99	4.0%	74.1%
3.D.a.2	Organic fertilizers	5.70	3.8%	78.0%
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	5.46	3.7%	81.6%
National Total		149.12		

Trend Assessment						
NFR Code	NFR Category	'Base Year' (1990) Es- timate [kt] E _{x,0}	Latest Year (2015) Es- timate [kt] E _{x,t}	Trend Assessment L _{x,t}	Contribution to the trend	Cumulative Total of L _{x,t}
1.A.3.b.1	R.T., Passenger cars	64.38	31.82	0.116	31.6%	31.6%
1.A.2.g.7	Mobile Combustion in Manufacturing Industries and Construction	3.03	6.35	0.043	11.7%	43.3%
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	3.85	5.46	0.028	7.8%	51.0%
2.B-10	Handling of products and other chemical industry	4.07	0.12	0.026	7.1%	58.2%
1.A.1.b	Petroleum refining	4.32	1.06	0.018	5.0%	63.2%
1.A.3.b.2	R.T., Light duty vehicles	7.01	6.52	0.018	4.8%	68.1%
3.D.a.2	Organic fertilizers	5.91	5.70	0.017	4.6%	72.7%
1.A.1.a	Public Electricity and Heat Production	12.04	9.66	0.015	4.2%	76.8%
3.D.a.1	Inorganic N-fertilizers	5.47	4.84	0.011	3.1%	79.9%
1.A.3.a	Civil Aviation - LTO	0.41	1.37	0.011	3.0%	82.9%
National Total		220.89	149.12			

Table 10: Key Categories for NMVOC emissions for the year 2015.

Level Assessment			
NFR Code	NFR Category	Latest Year (2015) Estimate [kt] E _{x,t}	Cumulative Total of L _{x,t}
1.A.4.b.1	Residential: stationary	23.79	21.1%
2.D.3.a	Domestic solvent use including fungicides	23.30	20.6%
2.D.3.d	Coating applications	17.49	15.5%
2.D.3.i	Other solvent use	7.82	6.9%
2.D.3.e	Degreasing	7.41	6.6%
2.D.3.g	Chemical products	4.32	3.8%
2.D.3.h	Printing	4.15	3.7%
1.A.3.b.1	R.T., Passenger cars	4.03	3.6%
National Total		112.89	

Trend Assessment						
NFR Code	NFR Category	'Base Year' (1990) Estimate [kt] E _{x,0}	Latest Year (2015) Estimate [kt] E _{x,t}	Trend Assessment L _{x,t}	Contribution to the trend	Cumulative Total of L _{x,t}
1.A.3.b.1	R.T., Passenger cars	58.44	4.03	0.429	31.5%	31.5%
2.D.3.a	Domestic solvent use including fungicides	16.30	23.30	0.369	27.1%	58.7%
1.A.4.b.1	Residential: stationary	51.44	23.79	0.068	5.0%	63.7%
1.B.2.a	Oil	11.44	1.88	0.060	4.4%	68.1%
2.H	Other Processes	2.29	3.50	0.057	4.2%	72.2%
1.A.3.b.5	R.T., Gasoline evaporation	5.88	0.24	0.047	3.4%	75.7%
2.D.3.e	Degreasing	13.26	7.41	0.046	3.4%	79.0%
2.B-10	Handling of products and other chemical industry	8.29	1.32	0.044	3.3%	82.3%
National Total		280.63	112.89			

Table 11: Key Categories for NH₃ emissions for the year 2015.

Level Assessment			
NFR Code	NFR Category	Latest Year (2015) Estimate [kt] E _{x,t}	Cumulative Total of L _{x,t}
3.D.a.2	Organic fertilizers	28.22	42.2%
3.B.1	Cattle	16.77	25.1%
3.B.3	Swine	6.26	9.4%
3.D.a.1	Inorganic N-fertilizers	4.95	7.4%
National Total		66.87	

Trend Assessment						
NFR Code	NFR Category	'Base Year' (1990) Estimate [kt] $E_{x,0}$	Latest Year (2015) Estimate [kt] $E_{x,t}$	Trend Assessment $L_{x,t}$	Contribution to the trend	Cumulative Total of $L_{x,t}$
3.D.a.2	Organic fertilizers	30.81	28.22	0.043	24.5%	24.5%
3.B.3	Swine	8.46	6.26	0.034	19.3%	43.8%
3.B.1	Cattle	14.48	16.77	0.032	17.9%	61.7%
3.D.a.1	Inorganic N-fertilizers	3.70	4.95	0.018	10.1%	71.8%
3.B.4.e	Horses	0.67	1.65	0.014	8.1%	79.9%
5.B.1	Composting	0.35	1.21	0.013	7.2%	87.1%
National Total		66.15	66.87			

Table 12: Key Categories for CO emissions for the year 2015.

Level Assessment						
NFR Code	NFR Category	Latest Year (2015) Estimate [kt] E _{x,t}		Level Assessment L _{x,t}	Cumulative Total of L _{x,t}	
1.A.4.b.1	Residential: stationary	226.10		39.9%	39.9%	
1.A.2.a	Iron and Steel	145.68		25.7%	65.6%	
1.A.3.b.1	R.T., Passenger cars	47.01		8.3%	73.8%	
1.A.3.b.4	R.T., Mopeds & Motorcycles	17.38		3.1%	76.9%	
1.A.4.b.2	Residential: Household and gardening (mobile)	17.32		3.1%	80.0%	
1.A.4.c.1	Agriculture/Forestry/Fishing: Stationary	14.97		2.6%	82.6%	
National Total		567.13				
Trend Assessment						
NFR Code	NFR Category	'Base Year' (1990) Estimate [kt] E _{x,0}	Latest Year (2015) Es- timate [kt] E _{x,t}	Trend Assessment L _{x,t}	Contribution to the trend	Cumulative Total of L _{x,t}
1.A.3.b.1	R.T., Passenger cars	437.91	47.01	0.584	41.8%	41.8%
1.A.2.a	Iron and Steel	210.72	145.68	0.211	15.1%	57.0%
1.A.4.b.1	Residential: stationary	417.16	226.10	0.169	12.1%	69.1%
1.A.3.b.2	R.T., Light duty vehicles	44.89	2.67	0.068	4.9%	74.0%
1.A.3.b.4	R.T., Mopeds & Motorcycles	9.86	17.38	0.052	3.7%	77.7%
1.A.4.c.1	Agriculture/Forestry/Fishing: Stationary	12.30	14.97	0.038	2.7%	80.5%
National Total		1 287.20	567.13			

Table 13: Key Categories for Cd emissions for the year 2015.

Level Assessment						
NFR Code	NFR Category	Latest Year (2015) Estimate [t] $E_{x,t}$		Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$	
2.C.1	Iron and Steel Production	0.23		19.5%	19.5%	
1.A.4.b.1	Residential: stationary	0.21		18.0%	37.5%	
1.A.1.b	Petroleum refining	0.21		17.4%	54.9%	
1.A.1.a	Public Electricity and Heat Production	0.13		11.2%	66.0%	
1.A.3.b.7	R.T., Automobile road abrasion	0.10		8.2%	74.2%	
1.A.2.d	Pulp, Paper and Print	0.09		7.7%	82.0%	
National Total		1.19				
Trend Assessment						
NFR Code	NFR Category	'Base Year' (1990) Es- timate [t] $E_{x,0}$	Latest Year (2015) Es- timate [t] $E_{x,t}$	Trend Assessment $L_{x,t}$	Contribution to the trend	Cumulative Total of $L_{x,t}$
1.A.1.b	Petroleum refining	0.09	0.21	0.158	20.7%	20.7%
2.C.1	Iron and Steel Production	0.46	0.23	0.123	16.1%	36.8%
1.A.3.b.7	R.T., Automobile road abrasion	0.06	0.10	0.062	8.2%	45.0%
1.A.1.a	Public Electricity and Heat Production	0.10	0.13	0.062	8.1%	53.1%
1.A.2.f	Non-metallic Minerals	0.10	0.02	0.057	7.5%	60.6%
1.A.2.g.8	Other Stationary Combustion in Manufac- turing Industries and Construction	0.03	0.07	0.056	7.4%	68.0%
2.C.5	Lead Production	0.07	0.00	0.054	7.1%	75.1%
5.C.1	Waste incineration	0.06	0.00	0.049	6.4%	81.4%
National Total		1.59	1.19			

Table 14: Key Categories for Pb emissions for the year 2015.

Level Assessment						
NFR Code	NFR Category	Latest Year (2015) Estimate [t] E _{x,t}		Level Assessment L _{x,t}	Cumulative Total of L _{x,t}	
2.C.1	Iron and Steel Production	6.94		47.1%	47.1%	
1.A.1.a	Public Electricity and Heat Production	1.88		12.8%	59.9%	
1.A.4.b.1	Residential: stationary	1.68		11.4%	71.4%	
1.A.2.d	Pulp, Paper and Print	0.79		5.4%	76.7%	
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	0.78		5.3%	82.0%	
National Total		14.73				
Trend Assessment						
NFR Code	NFR Category	‘Base Year‘ (1990) Estimate [t] E _{x,0}	Latest Year (2015) Estimate [t] E _{x,t}	Trend Assessment L _{x,t}	Contribution to the trend	Cumulative Total of L _{x,t}
1.A.3.b.1	R.T., Passenger cars	144.55	0.01	9.808	43.1%	43.1%
2.C.1	Iron and Steel Production	32.09	6.94	4.705	20.7%	63.7%
1.A.1.a	Public Electricity and Heat Production	0.90	1.88	1.806	7.9%	71.7%
1.A.4.b.1	Residential: stationary	3.82	1.68	1.411	6.2%	77.8%
1.A.3.b.2	R.T., Light duty vehicles	11.38	0.00	0.772	3.4%	81.2%
National Total		215.07	14.73			

Table 15: Key Categories for Hg emissions for the year 2015.

Level Assessment						
NFR Code	NFR Category	Latest Year (2015) Estimate [t] E _{x,t}	Level Assessment L _{x,t}		Cumulative Total of L _{x,t}	
2.C.1	Iron and Steel Production	0.32	33.2%		33.2%	
1.A.2.f	Non-metallic Minerals	0.17	17.3%		50.5%	
1.A.1.a	Public Electricity and Heat Production	0.16	16.3%		66.8%	
1.A.4.b.1	Residential: stationary	0.14	14.1%		80.9%	
National Total		0.97				
Trend Assessment						
NFR Code	NFR Category	'Base Year' (1990) Estimate [t] E _{x,0}	Latest Year (2015) Estimate [t] E _{x,t}	Trend Assessment L _{x,t}	Contribution to the trend	Cumulative Total of L _{x,t}
2.C.1	Iron and Steel Production	0.26	0.32	0.467	32.2%	32.2%
1.A.2.f	Non-metallic Minerals	0.70	0.17	0.338	23.3%	55.4%
2.B-10	Handling of products and other chemical industry	0.27	0.00	0.277	19.1%	74.5%
1.A.2.d	Pulp, Paper and Print	0.07	0.07	0.091	6.3%	80.8%
National Total		2.14	0.97			

Table 16: Key Categories for PAH emissions for the year 2015.

Level Assessment						
NFR Code	NFR Category	Latest Year (2015) Estimate [t] $E_{x,t}$		Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$	
1.A.4.b.1	Residential: stationary	3.69		69.4%	69.4%	
1.A.4.c.1	Agriculture/Forestry/Fishing: Stationary	0.53		9.9%	79.3%	
2.C.1	Iron and Steel Production	0.19		3.6%	82.9%	
National Total		5.31				
Trend Assessment						
NFR Code	NFR Category	'Base Year' (1990) Estimate [t] $E_{x,0}$	Latest Year (2015) Estimate [t] $E_{x,t}$	Trend Assessment $L_{x,t}$	Contribution to the trend	Cumulative Total of $L_{x,t}$
1.A.4.b.1	Residential: stationary	7.94	3.69	0.633	47.3%	47.3%
1.A.4.c.1	Agriculture/Forestry/Fishing: Stationary	0.34	0.53	0.240	17.9%	65.2%
1.A.3.b.3	R.T., Heavy duty vehicles	0.05	0.16	0.085	6.3%	71.5%
2.H	Other Processes	0.55	0.04	0.081	6.1%	77.6%
1.A.2.g.7	Mobile Combustion in Manufacturing Industries and Construction	0.02	0.10	0.053	4.0%	81.5%
National Total		16.28	5.31			

Table 17: Key Categories for PCDD/F/Furan emissions for the year 2015.

Level Assessment						
NFR Code	NFR Category	Latest Year (2015) Estimate [g] E _{x,t}		Level Assessment L _{x,t}	Cumulative Total of L _{x,t}	
1.A.4.b.1	Residential: stationary	16.76		50.6%	50.6%	
2.C.1	Iron and Steel Production	2.93		8.9%	59.4%	
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	2.44		7.4%	66.8%	
1.A.4.c.1	Agriculture/Forestry/Fishing: Stationary	2.36		7.1%	73.9%	
1.A.1.a	Public Electricity and Heat Production	1.52		4.6%	78.5%	
2.C.3	Aluminium production	1.26		3.8%	82.3%	
National Total		33.15				
Trend Assessment						
NFR Code	NFR Category	'Base Year' (1990) Estimate [g] E _{x,0}	Latest Year (2015) Estimate [g] E _{x,t}	Trend Assessment L _{x,t}	Contribution to the trend	Cumulative Total of L _{x,t}
1.A.2.b	Non-ferrous Metals	47.87	0.35	1.392	26.2%	26.2%
1.A.4.b.1	Residential: stationary	41.82	16.76	1.190	22.4%	48.5%
2.C.1	Iron and Steel Production	37.21	2.93	0.693	13.0%	61.5%
5.C.1	Waste incineration	18.19	0.16	0.525	9.9%	71.4%
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	0.46	2.44	0.343	6.5%	77.9%
1.A.4.c.1	Agriculture/Forestry/Fishing: Stationary	1.61	2.36	0.296	5.6%	83.4%
National Total		160.74	33.15			

Table 18: Key Categories for HCB emissions for the year 2015.

Level Assessment						
NFR Code	NFR Category	Latest Year (2015) Estimate [kg] E _{x,t}		Level Assessment L _{x,t}	Cumulative Total of L _{x,t}	
1.A.4.b.1	Residential: stationary	24.85		69.5%	69.5%	
2.C.1	Iron and Steel Production	3.90		10.9%	80.4%	
National Total		35.78				
Trend Assessment						
NFR Code	NFR Category	'Base Year' (1990) Estimate [kg] E _{x,0}	Latest Year (2015) Estimate [kg] E _{x,t}	Trend Assessment L _{x,t}	Contribution to the trend	Cumulative Total of L _{x,t}
1.A.2.b	Non-ferrous Metals	15.95	0.09	0.439	36.2%	36.2%
1.A.4.b.1	Residential: stationary	50.35	24.85	0.377	31.1%	67.2%
1.A.4.c.1	Agriculture/Forestry/Fishing: Stationary	2.44	3.87	0.210	17.3%	84.5%
National Total		91.94	35.78			

Table 19: Key Categories for PCB emissions for the year 2015.

Level Assessment						
NFR Code	NFR Category	Latest Year (2015) Estimate [kg] E _{x,t}		Level Assessment L _{x,t}	Cumulative Total of L _{x,t}	
2.C.5	Lead Production	78.08		44.2%	44.2%	
2.C.7	Other metal production	62.85		35.6%	79.7%	
2.C.1	Iron and Steel Production	33.70		19.1%	98.8%	
National Total		176.73				
Trend Assessment						
NFR Code	NFR Category	'Base Year' (1990) Estimate [kg] E _{x,0}	Latest Year (2015) Estimate [kg] E _{x,t}	Trend Assessment L _{x,t}	Contribution to the trend	Cumulative Total of L _{x,t}
2.C.1	Iron and Steel Production	19.34	33.70	0.100	49.7%	49.7%
2.C.5	Lead Production	94.40	78.08	0.049	24.1%	73.8%
1.A.4.b.1	Residential: stationary	4.53	0.18	0.024	12.1%	86.0%
National Total		194.23	176.73			

Table 20: Key Categories for TSP emissions for the year 2015.

Level Assessment						
NFR Code	NFR Category	Latest Year (2015) Estimate [kt] E _{x,t}	Level Assessment L _{x,t}	Cumulative Total of L _{x,t}		
2.A.5	Mining, construction/demolition and handling of products	12.60	22.8%	22.8%		
1.A.3.b.7	R.T., Automobile road abrasion	9.74	17.6%	40.4%		
3.D.a.1	Inorganic N-fertilizers	9.66	17.5%	57.9%		
1.A.4.b.1	Residential: stationary	6.82	12.3%	70.3%		
1.A.2.g.7	Mobile Combustion in Manufacturing Industries and Construction	2.01	3.6%	73.9%		
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	1.68	3.0%	77.0%		
1.A.3.c	Railways	1.63	3.0%	79.9%		
1.A.1.a	Public Electricity and Heat Production	1.17	2.1%	82.0%		
National Total		55.24				
Trend Assessment						
NFR Code	NFR Category	'Base Year' (1990) Estimate [kt] E _{x,0}	Latest Year (2015) Estimate [kt] E _{x,t}	Trend Assessment L _{x,t}	Contribution to the trend	Cumulative Total of L _{x,t}
2.C.1	Iron and Steel Production	6.43	0.74	0.102	19.0%	19.0%
1.A.3.b.7	R.T., Automobile road abrasion	5.86	9.74	0.091	17.1%	36.2%
2.A.5	Mining, construction/demolition and handling of products	9.97	12.60	0.075	14.0%	50.2%
1.A.4.b.1	Residential: stationary	10.29	6.82	0.048	9.0%	59.2%
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	0.36	1.68	0.028	5.2%	64.4%
1.A.2.g.7	Mobile Combustion in Manufacturing Industries and Construction	0.89	2.01	0.025	4.6%	69.0%
1.A.3.b.3	R.T., Heavy duty vehicles	1.93	0.58	0.023	4.3%	73.4%
1.A.4.c.2	Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	2.46	1.17	0.021	3.9%	77.2%
1.A.3.b.1	R.T., Passenger cars	1.72	0.77	0.015	2.9%	80.1%
National Total		61.86	55.24			

Table 21: Key Categories for PM₁₀ emissions for the year 2015.

Level Assessment						
NFR Code	NFR Category	Latest Year (2015) Estimate [kt] E _{x,t}	Level Assessment L _{x,t}	Cumulative Total of L _{x,t}		
1.A.4.b.1	Residential: stationary	6.21	19.8%	19.8%		
2.A.5	Mining, construction/demolition and handling of products	5.98	19.1%	38.9%		
3.D.a.1	Inorganic N-fertilizers	4.35	13.9%	52.8%		
1.A.3.b.7	R.T., Automobile road abrasion	3.25	10.4%	63.2%		
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	1.51	4.8%	68.0%		
1.A.1.a	Public Electricity and Heat Production	1.06	3.4%	71.4%		
1.A.2.g.7	Mobile Combustion in Manufacturing Industries and Construction	1.05	3.4%	74.7%		
1.A.4.c.2	Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	0.92	2.9%	77.7%		
1.A.3.b.1	R.T., Passenger cars	0.77	2.5%	80.2%		
National Total		31.32				
Trend Assessment						
NFR Code	NFR Category	'Base Year' (1990) Estimate [kt] E _{x,0}	Latest Year (2015) Estimate [kt] E _{x,t}	Trend Assessment L _{x,t}	Contribution to the trend	Cumulative Total of L _{x,t}
2.C.1	Iron and Steel Production	4.56	0.52	0.124	18.5%	18.5%
2.A.5	Mining, construction/demolition and handling of products	4.73	5.98	0.095	14.1%	32.7%
1.A.3.b.7	R.T., Automobile road abrasion	1.95	3.25	0.071	10.6%	43.3%
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	0.33	1.51	0.052	7.7%	51.0%
1.A.4.b.1	Residential: stationary	9.34	6.21	0.043	6.4%	57.4%
1.A.3.b.3	R.T., Heavy duty vehicles	1.93	0.58	0.038	5.6%	63.0%
1.A.4.c.2	Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	2.24	0.92	0.034	5.0%	68.0%
3.D.a.1	Inorganic N-fertilizers	4.56	4.35	0.033	4.9%	72.9%
1.A.3.b.1	R.T., Passenger cars	1.72	0.77	0.023	3.4%	76.4%
1.A.2.g.7	Mobile Combustion in Manufacturing Industries and Construction	0.69	1.05	0.021	3.1%	79.5%
1.A.2.d	Pulp, Paper and Print	0.95	0.25	0.020	3.0%	82.5%
National Total		40.29	31.32			

Table 22: Key Categories for PM_{2.5} emissions for the year 2015.

Level Assessment						
NFR Code	NFR Category	Latest Year (2015) Estimate [kt] E _{x,t}		Level Assessment L _{x,t}	Cumulative Total of L _{x,t}	
1.A.4.b.1	Residential: stationary	5.61		33.7%	33.7%	
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	1.26		7.6%	41.3%	
1.A.3.b.7	R.T., Automobile road abrasion	0.97		5.9%	47.2%	
3.D.a.1	Inorganic N-fertilizers	0.97		5.8%	53.0%	
1.A.1.a	Public Electricity and Heat Production	0.89		5.3%	58.3%	
1.A.3.b.1	R.T., Passenger cars	0.77		4.7%	63.0%	
1.A.4.c.2	Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	0.77		4.6%	67.6%	
2.A.5	Mining, construction/demolition and handling of products	0.67		4.0%	71.7%	
1.A.3.b.3	R.T., Heavy duty vehicles	0.58		3.5%	75.1%	
1.A.2.g.7	Mobile Combustion in Manufacturing Industries and Construction	0.48		2.9%	78.0%	
2.G	Other product manufacture and use	0.46		2.7%	80.8%	
National Total		16.62				
Trend Assessment						
NFR Code	NFR Category	‘Base Year‘ (1990) Estimate [kt] E _{x,0}	Latest Year (2015) Estimate [kt] E _{x,t}	Trend Assess- ment L _{x,t}	Contribution to the trend	Cumulative Total of L _{x,t}
2.C.1	Iron and Steel Production	2.07	0.23	0.103	14.5%	14.5%
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	0.27	1.26	0.099	14.0%	28.5%
1.A.3.b.3	R.T., Heavy duty vehicles	1.93	0.58	0.063	8.9%	37.4%
1.A.4.c.2	Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	2.11	0.77	0.056	7.9%	45.4%
1.A.3.b.7	R.T., Automobile road abrasion	0.59	0.97	0.054	7.6%	53.0%
1.A.1.a	Public Electricity and Heat Production	0.64	0.89	0.043	6.0%	59.0%
1.A.3.b.1	R.T., Passenger cars	1.72	0.77	0.033	4.6%	63.6%
2.A.5	Mining, construction/demolition and handling of products	0.53	0.67	0.029	4.2%	67.7%
1.A.2.d	Pulp, Paper and Print	0.78	0.21	0.028	4.0%	71.7%
3.D.a.1	Inorganic N-fertilizers	1.01	0.97	0.027	3.8%	75.6%
1.A.4.c.1	Agriculture/Forestry/Fishing: Stationary	0.34	0.43	0.019	2.7%	78.2%
2.G	Other product manufacture and use	0.41	0.46	0.017	2.4%	80.7%
National Total		25.25	16.62			

1.6 Quality Assurance, Quality Control and verification

For fulfillment of the reporting obligations the department *Climate Change Mitigation & Emission Inventories* at the Umweltbundesamt, in particular the *Inspection Body for Emission Inventories*, operates a QMS based on the International Standard EN ISO/IEC 17020 *General Criteria for the operation of various types of bodies performing inspections*. Since 23 December 2005, the IBE is accredited⁶⁴ as a Type A inspection body (Id.No. 241), in accordance with EN ISO/IEC 17020 and the Austrian Accreditation Law (AkkG)⁶⁵, by decree of Accreditation Austria/Federal Ministry of Economics, Family and Youth (No. BMWA-92.715/0036-I/12/2005, issued on 19 January 2006).

In addition to the elements of a QMS as described in the ISO 9000 series, the EN ISO/IEC 17020 focusses on the competence of the personnel, and ensures strict independence, impartiality and integrity. The implementation is audited by the Austrian Accreditation Body regularly every 15 months; every five years the accreditation has to be renewed in a more comprehensive audit. The accreditation of the IBE has been awarded for the first time in 2005 and has been renewed in 2011 and 2016 so far. In 2017 the IBE again has undergone and successfully passed an external audit by a quality expert appointed by Accreditation Austria.

Major element of the QMS is the Quality Manual of the IBE and its quality and technical procedures ("Austrian QA/QC Plan").

1.6.1 Requirements of the ISO compared to the IPCC 2006 GL as well as the EMEP/EEA air pollutant emission inventory guidebook 2016

The implementation of QA/QC procedures as required by the IPCC 2006 GL and the EMEP/EEA air pollutant emission inventory guidebook 2016 support the development of national air emissions inventories that can be readily assessed in terms of quality and completeness. The QMS as implemented in the Austrian inventory includes all elements of the QA/QC system outlined in the 2006 IPCC GL Chapter 6 „Quality Assurance and Quality Control” and the EMEP/EEA air pollutant emission inventory guidebook 2016 Chapter 6 “Inventory management, improvement and QA/QC” (see Table below), and goes beyond. It also comprises supporting and management processes in addition to the QA/QC procedures in inventory compilation and thus ensures agreed standards not only within (i) the inventory compilation process and (ii) supporting processes (e.g. archiving), but also for (iii) management processes (e.g. annual management reviews, internal audits, regular training of personnel, definition of procedures for external communication).

⁶⁴ For more information on the accreditation please refer to Annex 6.

⁶⁵ Federal Law Gazette I No 28/2012 (Akkreditierungsgesetz 2012)

Table 23: Overview of obligatory QA/QC elements in different technical and quality standards.

EMEP/EEA GB 2016 ⁶⁶	IPCC 2006 GL	ISO 9001 ⁶⁷	ISO/IEC 17020 ⁶⁸
Roles and Responsibilities	Roles and Responsibilities	Responsibilities and authorities	Organisation and Management
QA/QC plan	QA/QC plan	Quality manual and quality procedures	Quality manual and quality procedures
QC procedures	QC procedures	Corrective actions	Corrective actions
QA procedures	QA procedures	Preventive actions	Preventive actions
QA/QC system interaction with uncertainty analysis	QA/QC system interaction with uncertainty analysis	-	-
Verification activities	Verification activities	-	-
Reporting, documenting and archiving procedures	Reporting, documenting and archiving procedures	Records on product realisation	Inspection reports, inspection records
Inventory management report ⁶⁹	-	Management review (report)	Management review (report)
-	-	Control of documents and records	Control of documents and records
-	-	Internal audits	Internal audits
-	-	-	Competence
-	-	-	Independence, impartiality and integrity

1.6.2 Quality policy and objectives

As stated in the Quality Manual of the IBE, the overall objective of the work of the IBE is to promote, under the Kyoto Protocol, climate change mitigation measures and air quality control. To achieve this, the IBE is committed to strict impartiality and quality management. In this context, the term quality means:

1. Fulfilment of requirements for emission inventories.
2. For the fulfilment of these requirements, the IBE undertakes to keep its staff updated on the latest technical expertise, scientific findings and the latest developments. The IBE will therefore encourage the participation of its staff in international technical and political processes and ensure the transfer of knowledge within the IBE.

⁶⁶ Requirements largely based on the 'Quality Assurance/Quality Control and Verification' chapter of the 2006 IPCC Guidelines (IPCC 2006).

⁶⁷ Basic international standard for quality management and quality assurance

⁶⁸ contains additional requirements compared to ISO 9001

⁶⁹ According to the EMEP Guidebook 2016, it also is good practice to summarize lessons learned from previous inventory preparation cycles in an inventory management report.

3. Compliance with the EN ISO/IEC 17020 standard by ensuring the implementation and continuous improvement of a QMS as described in this manual by the IBE and its personnel. The QMS procedures are designed to facilitate the preparation of the emission inventories in a professional and timely manner, particularly to enhance the transparency to allow full reproduction, and the correctness via quality checks and validation activities. One of the key managerial functions is raising the personnel's quality awareness.

Aim of the IBE is to provide a very good example by setting a high quality standard – even higher than specified in the requirements – so as to improve the quality of air emission reporting in the long term, and to encourage other countries to set up similar systems.

The quality objectives for emission inventories are above all to fulfil all relevant requirements in terms of content and format: 'TACCC': transparency, accuracy, completeness, comparability, consistency (as defined in the IPCC 2006 GL), and timeliness.

The QMS was primarily developed to meet the requirement of reporting greenhouse gas emissions under the Kyoto Protocol. For this reason the emphasis was originally placed on greenhouse gases, but by now all main air pollutants are covered by the QMS.

1.6.3 Design of the Austrian QMS

The design of the QMS of the *Inspection Body for Emission Inventories* (IBE) at the Umweltbundesamt follows a *process based approach* (see Figure 5).

The Quality Manual of the Inspection Body for Emission Inventories is published on:

http://www.umweltbundesamt.at/umweltsituation/luft/emissionsinventur/emi_ueberwachung/

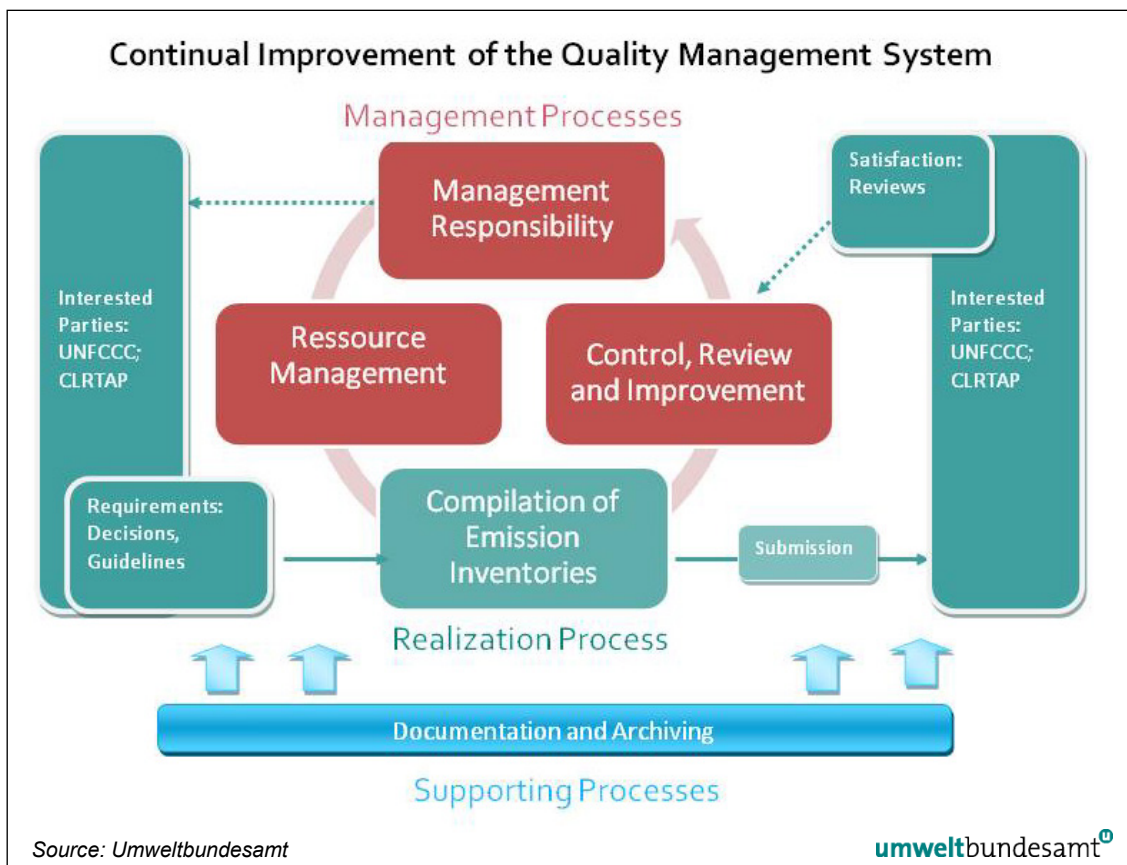


Figure 5: Process-based QMS of the IBE.

Roles and Responsibilities

The Umweltbundesamt is designated as the single national entity responsible for Austria's Air Emission Inventory by law, and is thus responsible for QA/QC activities. Within the Umweltbundesamt, the *Inspection Body for Emission Inventories* IBE has been established and entrusted with the preparation of emission inventories. Within the IBE, roles and responsibilities of the different functions – quality representative, sector expert, sector lead, project manager, head of inspection body, inventory support – are defined in the QMS.

1.6.4 QA/QC Plan

Activities to be conducted by the personnel of the inspection body are written down in quality and technical procedures, respectively that complement the Quality Manual. Such activities are:

- QC activities
- procedures for country specific methodologies
- internal audits (QM specific)
- procedures for sub-contracting
- inventory improvement plan
- documentation and archiving
- treatment of confidential data
- annual Management Review

Quality Manual

The Quality System is divided into three levels, whereas the documents listed above – quality and technical procedures – form Level 2:

- Level 1: General (the actual 'Quality Manual': general information, description of QMS, general responsibilities, etc.):
http://www.umweltbundesamt.at/umweltsituation/luft/emissionsinventur/emi_ueberwachung/
- Level 2: Detailed description of activities to be conducted and checklists and forms to be filled out ('quality procedures' and 'technical documents').
- Level 3: Documentation of QC activities (filled out checklists, documentation of methodologies,...)

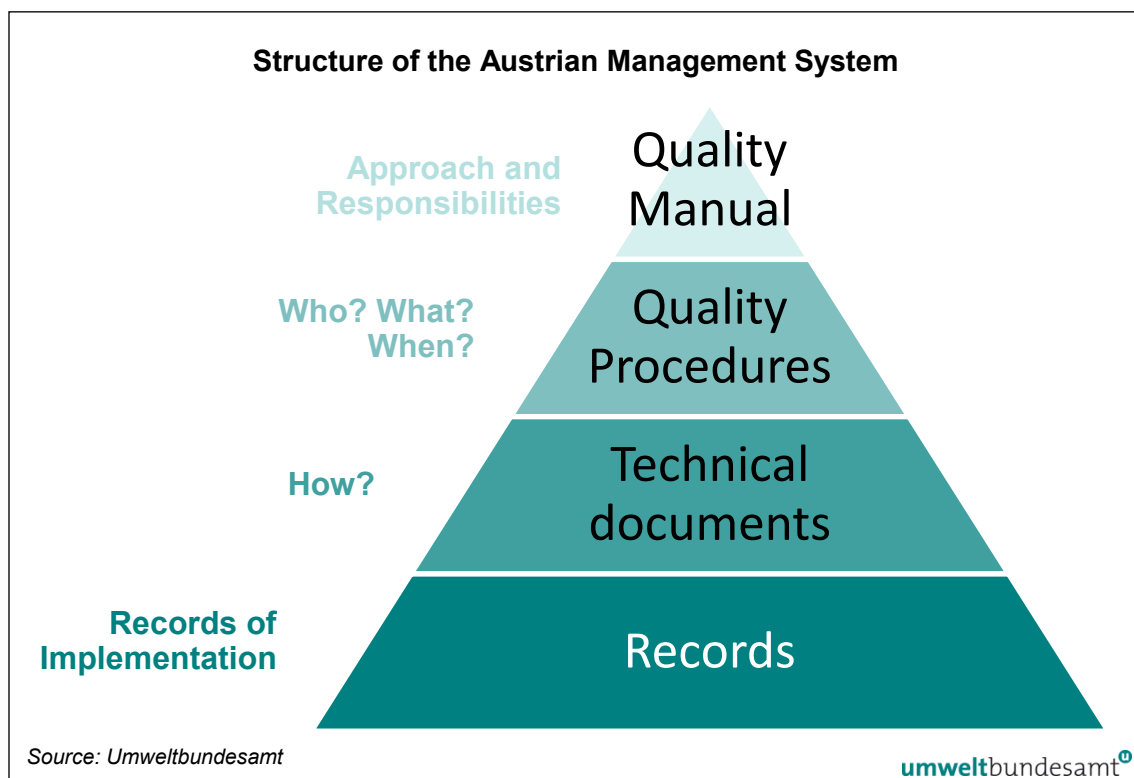


Figure 6: Structure of the Austrian Quality Management System (QMS).

1.6.5 QC Activities

The following four quality-check-steps are performed before finalization of the data submission:

1. Tier 2/category specific: by the sector expert in the course of the inventory preparation
2. Tier 1/general Step 1: QC by the sector expert after emissions have been estimated
3. Tier 1/general Step 2: QC by the data manager in the course of the preparation of the overall inventory (electronic checks e.g. check for completeness and comparison with last years' inventory)
4. Tier 1/general Step 3: QC of final submission by the sector expert

Where possible the above checks are conducted by the sector expert that has not predominantly prepared the sectoral inventory in the particular year.

QC activities are conducted following QC checklists, covering issues like:

- | | |
|---------------------------------------|--|
| ✓ documentation of assumptions | ✓ completeness |
| ✓ documentation of expert judgements | ✓ correct transformation/transcription into CFR |
| ✓ clear explanation of recalculations | ✓ information on background tables |
| ✓ including of references | ✓ consistency of data and information with information in inspection reports |
| ✓ plausibility of data | ✓ treatment of confidential data |
| ✓ consistency of data | |

Additionally, in the course of preparation of the IIR, the following four QC steps are performed:

5. Tier 2/category specific Step 1: check of methodologies, assumptions and explanations by sector expert in the course of report preparation
6. Tier 2/category specific Step 2: check of methodologies, assumptions and explanations by the head of inspection body
7. Tier 1/ general Step 1: final report check by sector experts
8. Tier 1/ general Step 2: final check of consistency of figures in reporting format and report by a member of the IBE team

1.6.6 QA Activities

The following QA activities are performed:

Validation of methodologies and calculation

Before methodologies are applied the methodology is defined as a SOP (standard operating procedure) together with a template for calculating emissions, where needed. The SOP is checked for applicability and completeness of information needed and finally approved by the head of the inspection body. New and changed calculation files are validated before use.

Annual second party audits for every sector

Once a year the documentation of one emission source per sector is checked throughout the whole emission estimation and reporting process (from archiving of underlying information, emission calculation, input into the data management system, documentation, information in the

IIR etc.) for transparency, reproducibility, clearness and completeness. This tool proved to be very helpful in order to further improve the documentation and the implementation of (new) QA/QC routines.

Second party audits for work performed by sub-contractors

The sector experts at the Umweltbundesamt are responsible for incorporation of results in the inventory database and additional QA/QC (works as second party audit).

Accreditation audits (third party audits)

In the course of the accreditation process, conformity of the QMS with ISO/IEC 17020 is regularly monitored: audits are performed every 15 months by the accreditation body (one day audit), and every fifth year the accreditation has to be renewed (two day audit). The audits aim to assess the QM system with regard to compliance with the underlying standard ISO/IEC 17020, to check its implementation in practice and to assure that measures and recommendations as set out in previous audits have been implemented accordingly.

- In 2005: accreditation according to EN ISO/IEC 17020 as *Inspection Body for Emission Inventories*.
- Periodic external audits by “Accreditation Austria” in 2006, 2008 and 2009
- In 2011: first re-accreditation according to EN ISO/IEC 17020
- Periodic external audits by “Accreditation Austria” in 2012, 2013 and 2014
- In 2015: second re-accreditation according to EN ISO/IEC 17020
- Periodic external audit by “Accreditation Austria “ in 2017

Audits of data suppliers

Suppliers of annual activity data, that do not have in place a (certified) QMS or whose data are not independently verified, are audited in a so called ‘input data audit’. The aim of the audits is to assess:

- (1) whether the requirements regarding independence and integrity are fulfilled
- (2) the long term availability of the data
- (3) the data collection and management process
- (4) whether the QC requirements of the data processing are fulfilled

When indicated, recommendations for improvements are made and implementation of these measures is assessed. These input data audits have proven a good basis for the cooperation with the data supplier.

Since 2007 all main data suppliers have been audited:

- Statistik Austria regarding
 - energy balance in 2007
 - agricultural statistical data in 2009
 - import/export and production statistics in 2016
- the administrator of the landfill database in 2009
- the administrator of the electronic data management for landfills (EDM) in 2014
- the Institute for Industrial Ecology in 2016
- the national forest inventory at the Austrian Federal Office and Research Centre for Forests (BFW) in 2016

It is planned to conduct a follow-up audit at these institutions only when substantial changes become apparent.

1.6.7 Error correction and continuous improvement

All issues regarding transparency, accuracy, completeness, consistency or comparability identified by experts from different backgrounds are incorporated in the inventory improvement plan. Sources of these findings are:

- UNECE/LRTAP Review: The last In-depth review (stage 3) took place in 2010; the findings are summarized in Chapter 7.4, Table 280. The stage 1 review (initial check of submissions for timeliness, completeness and formats) and stage 2 review (check of consistency, comparability, KCA, trends and IEFs) are carried out annually.
- NEC Review: From 2017 onwards the national emission inventory data will be also checked by the European Commission as set out in Article 10 of Directive 2016/2284 (NEC Directive).
- external experts (e.g. experts from federal provinces: some of them who prepare a partly independent emission inventory for their federal province compare their results with the disaggregated national inventory),
- stakeholders (e.g. industrial facilities or association of industries: the NIR is communicated to every data supplier and Austrian experts involved in emission inventorying after submission),
- personnel of the inspection body (head of inspection body, sector experts etc.).

These findings are documented including a plan to improve the inventory, a timeline and responsibilities. The improvement plan and fulfilment of planned improvements is monitored by the head of inspection body. Improvements that are relevant in terms of resources are presented in the annual Management Review to the managing director, and if additional resources are needed are notified to the Federal Ministry of Agriculture, Forestry, Environment and Water Management.

1.6.8 Archiving and documentation

For each sector the documentation includes:

Documentation of the methodology:

- description (source/sink category, emissions, key source, completeness, uncertainty),
- methodology,
- template for emission estimation,
- documentation of validation.

Documentation of actual emission calculation:

- methodology,
- „logbook” (who did what and when),
- calculation file,
- references for activity data, emission factors and/or emissions, respectively,
- documentation of assumptions, sources of data and information, expert judgments etc. to allow full reproduction and understanding of choices,
- recalculations,
- planned improvements,
- QC activities.

Documentation of expert judgements in line with the IPCC 2006 GL and the EMEP/EEA GB 2016:

- name of the expert and institution/department,
- date,
- basis of judgement (references to relevant studies etc.),
- underlying assumptions.

Relevant literature has to be archived and references to be stated in the internal documentation as well as in the IIR.

1.6.9 Treatment of confidentiality issues

The IBE ensures confidential treatment of sensitive information obtained in the course of its inspection activities. Information or data is declared as confidential when it could directly or indirectly identify an individual person, business or organisation. For this reason some emissions are reported at a higher, aggregated level so that confidentiality is no longer an issue, e.g. for f-gases. Compliance with confidentiality provisions is organized and documented in the QM manual, which contains specific quality system procedures. Staff of the inspection body is obliged to issue a written commitment stating their full compliance with all provisions.

- Confidentiality of statistics

The strict confidentiality provisions concerning handling of sensitive data relating to individuals and organisations are regulated by the Austrian Federal Statistics Act 2000⁷⁰.

- Security of data

Confidentiality of sensitive data used to calculate the emissions is a legal obligation: Ensuring confidentiality through technical and organisational measures (e.g. final QC whether confidential information is not visible in the CRF tables) is obligatory for the Umweltbundesamt and consequently also for the Inspection Body.

- Trust of respondents

Individuals, associations and organizations providing information to the Inspection Body can be sure that the provided data are used exclusively for purposes of inspection activities. Data – either of official, private or of another nature – are treated confidentially and will not be passed on to third parties.

Also in case of voluntary reviews an absolute confidential treatment of data exchanged is ensured by strictly adhering to the rules of the QM System of the Inspection Body.

⁷⁰ Federal Act on Federal Statistics (Federal Statistics Act 2000) no. 163/1999, as amended by BGBl. I, no. 136/2001, by BGBl. I, no. 71/2003, by BGBl. I, no. 92/2007 and by BGBl. I, no. 125/2009.

1.6.10 QMS activities and improvements 2016

Several changes of the Quality Manual and its quality and technical procedures were made in 2016, e.g. regarding treatment of confidential data, access (rights) to the internal OLI folders, judgement of reliability of input data (emission factors), risk analysis, scope of internal audits or planned participation of sector experts in the international review process. Moreover, the IBE-team was slightly re-arranged, overall increasing the number of experts involved in inventory work. To strengthen the technical competence of the IBE 11 IBE sector experts participated in the basic training course for reviewers, established by the UNFCCC secretariat and passed the exam in December 2016.

Moreover, the following QA/QC activities were done in 2016:

- An input data audit was conducted at the Austrian Federal Research and Training Centre for Forests, Natural Hazards and Landscape (BFW) to gain background information on quality and procedural arrangements of the main data supplier of LULUCF data
- An input data audit was performed by IBE experts on national production statistics and import/export statistics – sources for solvent emissions – to get insight into the process of data collection and compilation.
- An emergency exercise on data management, i.e. compilation of emission data tables and preparing the submission, was successfully conducted by the deputy of the data manager of the IBE, with the aim of training the expert and testing the quality of the internal documentation on this issue. It is planned to conduct such a dummy inventory compilation as a training every two years to keep the deputy up-to-date and fit for a submission in case of an unplanned absence of the data manager.
- The cooperation (mutual review) with New Zealand (started 2014) was continued in 2016, with focus on QA/QC processes and tools, experiences with the review 2016 and basic exchange on benefits of ISO standards and preparation/certification process.
- Two further experts join the IBE as “inventory support” for the sector LULUCF.

Moreover, in 2017 a periodic review took place, conducted as a one-day QM audit by a competent external auditors appointed by Accreditation Austria. Improvement measures set during the Re-Accreditation 2015 were checked and further questions on the Quality Management System of the IBE and its implementation in practice raised. The audit proved continuous improvement of the system and compliance with the underlying standard ISO/IEC 17020.

1.7 Uncertainty Assessment

In submission 2017 a qualitative uncertainty assessment and additionally a quantitative uncertainty analysis for the main pollutants (SO₂, NO_x, NMVOC, NH₃ and PM_{2.5}) has been carried out. Information on methodology and data sources used is provided in the following sections.

1.7.1 Method used

The method used for the assessment of uncertainty is described in the “EMEP/EEA air pollutant emission inventory guidebook 2016” (EEA 2016).¹

In the Austrian uncertainty analysis the Tier 1 method was applied for the following pollutants: SO₂, NO_x, NMVOC, NH₃ and PM_{2.5}. By using the error propagation method, the uncertainties for a specific source category can be estimated and by combining these uncertainties an overall uncertainty can be calculated. For the remaining other pollutants a qualitative indication of the uncertainty is presented.

The Tier 2 method (Monte Carlo Simulation) was not included in this assessment as the less comprehensive Tier 1 method already gives a clear reference point of the general uncertainty per pollutant.

1.7.2 Data source

In order to estimate the overall uncertainty, the uncertainty of activity data and emission factor, respectively, has to be quantified. The uncertainties of activity data on sectoral level are based on the GHG uncertainty analysis (for more information see UMWELTBUNDESAMT 2017a).

Uncertainties of emission factors of the relevant pollutants are based on the qualitative ratings published in the Austrian IIR 2016 (UMWELTBUNDESAMT 2016b) following the EMEP/EEA air pollutant emission inventory guidebook 2016 (EEA 2016). Therefore the arithmetic mean value of the proposed upper and lower emission factor uncertainty was calculated and used for the calculation of the overall combined uncertainty.

The quality of estimates for all relevant pollutants has been rated using qualitative indicators as suggested in Chapter 5 of the EMEP/EEA air pollutant emission inventory guidebook 2016 (EEA 2016). The definition of the ratings is given in Table 24, the ratings for the emission estimates are presented in Table 25.

Table 24: Rating definitions.

Rating	Definition	Typical Error Range
A	An estimate based on a large number of measurements made at a large number of facilities that fully represent the sector	10 to 30%
B	An estimate based on a large number of measurements made at a large number of facilities that represent a large part of the sector	20 to 60%
C	An estimate based on a number of measurements made at a small number of representative facilities, or an engineering judgement based on a number of relevant facts	50 to 200%
D	An estimate based on single measurements, or an engineering calculation derived from a number of relevant facts	100 to 300%
E	An estimate based on an engineering calculation derived from assumptions only	order of magnitude

Source: Table 3-2 Rating definitions, Chapter 5 of the EMEP/EEA emission inventory guidebook 2016.

1.7.3 Results of uncertainty estimation

1.7.3.1 Qualitative assessment for all pollutants

A qualitative assessment was performed on sectoral level for all pollutants. The relevant sectors of each pollutant were classified in different quality groups from A to E (see Table 25) following the EMEP/EEA air pollutant emission inventory guidebook 2016 (EEA 2016). Table 24 presents a definition and default error ranges for each quality group.

Table 25: Quality of emission estimates.

NFR	Description	SO ₂	NO _x	NMVOC	NH ₃	CO	Cd	Hg	Pb	PAH	Diox	HCB	PCB	TSP	PM ₁₀	PM _{2.5}
1.A.1.a	Public Electricity and Heat Production	A	A	D	E	A	C	C	C	C	C	C	C	B	C	C
1.A.1.b	Petroleum refining	A	A		E	A	C	C	C	D	D	D	D	A	B	B
1.A.1.c	Manufacture of Solid fuels & Other Energy Ind.		B	D	E	D					D	D		B	B	B
1.A.2 mobile	Other mobile in industry	A	B	B	C	B	C	C	C	D	D	D	D	B	B	B
1.A.2 stat (I)	Manuf. Ind. and Constr. stationary LIQUID	A	B	D	E	C	C	B	C	C	E	D	D	C	C	C
1.A.3.a	Civil Aviation	A	B	B	C	B	B	B	B					B	B	B
1.A.3.b.1	R.T., Passenger cars	A	B	B	C	B	B	B	C	C	D	D	D	B	B	B
1.A.3.b.2	R.T., Light duty vehicles	A	B	B	C	B	B	B	C	C	D	D	D	B	B	B
1.A.3.b.3	R.T., Heavy duty vehicles	A	B	B	C	B	B	B	C	C	D	D	D	B	B	B
1.A.3.b.4	R.T., Mopeds & Motorcycles		B	B	C	B	B	B	C	D	D	D	D			
1.A.3.b.5	R.T., Gasoline evaporation			B												
1.A.3.b.7	R.T., Automobile road abrasion						C	C	C					C	C	C
1.A.3.c	Railways	A	B	B	C	B	B	B	C	D	D	D	D	B	B	B
1.A.3.d	Navigation	A	B	B	C	B	B	B	C	D	D	D	D	B	B	B
1.A.3.e	Other transportation		A	D	E	C						D		C	C	C
1.A.4.a	Commercial/ Institut.	A	B	C*	C	C	C	C	C	D	D	D	E	C	C	C*
1.A.4.b	Residential	A	B	C*	C	C	C	C	C	D	D	D	E	C	C	C*
1.A.4.c	Agriculture/Forestry/ Fisheries	A	C*	C*	C	C	C	C	C	D	D	D	E	C	C	C*
1.A.5	Other	B	C	C	D	C	C	C	C	D	D	D	D	C	C	C

NFR	Description	SO ₂	NO _x	NM VOC	NH ₃	CO	Cd	Hg	Pb	PAH	Diox	HCB	PCB	TSP	PM ₁₀	PM _{2.5}
1.B	FUGITIVE EMISSIONS	A		A										D	D	D
2.A	MINERAL PRODUCTS													D	D	D
2.B	CHEMICAL INDUSTRY	B	B	D	A	D	A	A	B					A	A	A
2.C	METAL PRODUCTION	C	B	C		B	B	B	C	C	C	C		B	B	B
2.D.	NON ENERGY PRODUCTS FROM FUELS /SOLVENT USE			A		B	B		B							
2.H	Other Processes		B	B		B				E	E	E		D	D	D
2.L	Other production				E											
3.B.1	Cattle		C		A									D	D	D
3.B.2	Sheep		C		B									D	D	D
3.B.3	Swine		C		A									D	D	D
3.B.4.d	Goats		C		B									D	D	D
3.B.4.e	Horses		C		B									D	D	D
3.B.4.g	Poultry		C		B									D	D	D
3.B.4.h	Other animals		C		B									D	D	D
3.D	Agricultural Soils		C	E	B									D	D	D
3.F	Field burning of agricultural residues	B	B	B	B	B	C	C	C	C	C	C		C	C	C
5.A	Solid waste disposal on land			B*	B*	C	B	B	B					D	D	D
5.B	Biological treatment of waste				C											
5.C	Incineration and open burning of waste	D	D	C	C	C	B	B	B	C	C	C		D	D	D
5.D	Wastewater treatment			C												

Abbreviations: see Table 24

(dark shaded cells indicate that no such emissions arise from this source, light shaded cells (blue) indicate that source is a key source for this pollutant)

*value for calculation lies within quality rating, but is based on expert judgement and therefore no arithmetic mean value has been applied.

1.7.3.2 Quantitative uncertainty assessment

The quantitative uncertainty assessment was performed with the Tier 1 methods according to (EEA 2016) for the air pollutants SO₂, NO_x, NMVOC, NH₃ and PM_{2.5} in the year 2015 and the respective level and trend uncertainties. Basis for this assessment is the qualitative rating as presented in Table 25.

The results of the uncertainty analysis are indicated in the following tables.

Table 26: Result of overall uncertainty estimation for the main pollutants SO₂, NO_x, NMVOC, NH₃ and PM_{2.5}.

Pollutant	Emissions 2015 [kt]	Level uncertainty 2015 [%]	Trend uncertainty 2015 [%]
SO ₂	14.9	7.3	1.7
NO _x	149.1	21.0	2.8
NMVOC	112.9	22.9	10.6
NH ₃	66.9	24.1	5.5
PM _{2.5}	16.6	33.5	7.7

A more detailed presentation of the uncertainties on sectoral level per pollutant is given in the following tables below.

Table 27: Uncertainty estimation of SO₂ emissions 1990 and 2015.

Reporting year:	2015											
NRF sector	Pollutant	Base year emissions	Year t emissions	Activity data uncertainty (1)	Emission factor uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty (2)	Uncertainty in trend in national emissions introduced by activity data uncertainty (3)	Uncertainty introduced into the trend in total national emissions
		kt	kt	%	%	%	%	%	%	%	%	%
	SO ₂	Input data	Input data	input data Note A	input data Note A	$\sqrt{(E^2 + F^2)}$	$\frac{(G \cdot D)^2}{\sum(D^2)}$	Note B	$\frac{D}{\sum C}$	I-F Note C	J · E · $\sqrt{2}$ Note D	K ² + L ²
1 A 1 a	SO ₂	11.8	1.2	8.0	20.0	21.54	3.07	-0.02	0.02	-0.31	0.18	0.13
1 A 1 b	SO ₂	2.3	0.2	1.0	10.0	10.05	0.03	0.00	0.00	-0.03	0.00	0.00
1 A 2 a	SO ₂	6.7	5.4	5.0	10.0	11.18	16.61	0.05	0.07	0.55	0.52	0.57
1 A 2 b	SO ₂	0.1	0.2	5.0	20.0	20.62	0.06	0.00	0.00	0.04	0.02	0.00
1 A 2 c	SO ₂	0.8	0.5	5.0	20.0	20.62	0.44	0.00	0.01	0.09	0.05	0.01
1 A 2 d	SO ₂	4.3	0.9	10.0	20.0	22.36	2.01	0.00	0.01	0.02	0.18	0.03
1 A 2 e	SO ₂	1.6	0.2	5.0	20.0	20.62	0.09	0.00	0.00	-0.03	0.02	0.00
1 A 2 f	SO ₂	2.2	1.2	5.0	20.0	20.62	2.66	0.01	0.02	0.20	0.11	0.05
1 A 2 g 7	SO ₂	0.2	0.0	1.0	20.0	20.02	0.00	0.00	0.00	-0.01	0.00	0.00
1 A 2 g 8	SO ₂	1.9	2.2	10.0	20.0	22.36	10.61	0.02	0.03	0.48	0.41	0.40
1 A 3 a	SO ₂	0.0	0.1	3.0	20.0	20.22	0.02	0.00	0.00	0.03	0.01	0.00
1 A 3 b	SO ₂	4.9	0.1	3.0	20.0	20.22	0.03	-0.01	0.00	-0.23	0.01	0.05
1 A 3 c	SO ₂	0.4	0.1	3.0	20.0	20.22	0.01	0.00	0.00	-0.01	0.00	0.00
1 A 3 d	SO ₂	0.0	0.0	3.0	20.0	20.22	0.00	0.00	0.00	0.00	0.00	0.00
1 A 4 a	SO ₂	5.2	0.2	5.0	20.0	20.62	0.10	-0.01	0.00	-0.22	0.02	0.05
1 A 4 b	SO ₂	25.9	1.3	15.0	20.0	25.00	4.90	-0.05	0.02	-1.03	0.38	1.21
1 A 4 c	SO ₂	1.8	0.1	5.0	20.0	20.62	0.02	0.00	0.00	-0.07	0.01	0.00
1 A 5 b	SO ₂	0.0	0.0	1.0	40.0	40.01	0.00	0.00	0.00	0.01	0.00	0.00
1 B 2 b	SO ₂	2.0	0.0	5.0	20.0	20.62	0.00	0.00	0.00	-0.10	0.00	0.01
2 B-10	SO ₂	1.6	0.4	2.0	40.0	40.05	0.96	0.00	0.00	0.03	0.01	0.00
2 C 1	SO ₂	0.3	0.0	0.5	125.0	125.00	0.16	0.00	0.00	0.00	0.00	0.00
2 C 7	SO ₂	0.4	0.4	5.0	125.0	125.10	11.36	0.00	0.01	0.54	0.04	0.29
3 F	SO ₂	0.0	0.0	100.0	40.0	107.70	0.00	0.00	0.00	0.00	0.00	0.00
5 C	SO ₂	0.1	0.0	7.0	200.0	200.12	0.02	0.00	0.00	-0.01	0.00	0.00
Total		74.6	14.9				53.16					2.80
Total Uncertainties						Uncertainty in total inventory %:	7.29	Trend uncertainty %				1.67

Table 28: Uncertainty estimation of NO_x emissions 1990 and 2015.

Reporting year:	2015											
NRF sector	Pollutant	Base year emissions kt	Year t emissions kt	Activity data uncertainty (1) %	Emission factor uncertainty (1) %	Combined uncertainty %	Contribution to variance by category in year x %	Type A sensitivity %	Type B sensitivity %	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty (2) %	Uncertainty in trend in national emissions introduced by activity data uncertainty (3) %	Uncertainty introduced into the trend in total national emissions %
		Input data	Input data	input data Note A	input data Note A	$\sqrt{(E^2 + F^2)}$	$\frac{(G \cdot D)^2}{\sum(D^2)}$	Note B	$\frac{D}{\sum C}$	I-F Note C	$I \cdot E \cdot \sqrt{2}$ Note D	$K^2 + L^2$
1 A 1 a	NOX	12.0	9.7	8.0	20.0	21.54	1.95	0.01	0.04	0.14	0.49	0.26
1 A 1 b	NOX	4.3	1.1	1.0	10.0	10.05	0.01	-0.01	0.00	-0.08	0.01	0.01
1 A 1 c	NOX	1.4	1.1	2.0	40.0	40.05	0.09	0.00	0.01	0.04	0.01	0.00
1 A 2 a	NOX	5.4	4.1	5.0	10.0	11.18	0.09	0.00	0.02	0.02	0.13	0.02
1 A 2 b	NOX	0.3	0.3	5.0	40.0	40.31	0.01	0.00	0.00	0.02	0.01	0.00
1 A 2 c	NOX	1.7	1.5	5.0	40.0	40.31	0.16	0.00	0.01	0.06	0.05	0.01
1 A 2 d	NOX	7.0	4.8	10.0	40.0	41.23	1.75	0.00	0.02	0.01	0.31	0.09
1 A 2 e	NOX	1.7	0.9	5.0	40.0	40.31	0.06	0.00	0.00	-0.05	0.03	0.00
1 A 2 f	NOX	10.0	6.0	5.0	40.0	40.31	2.62	0.00	0.03	-0.14	0.19	0.06
1 A 2 g 7	NOX	3.0	6.4	1.0	40.0	40.01	2.91	0.02	0.03	0.78	0.04	0.61
1 A 2 g 8	NOX	3.9	5.5	10.0	40.0	41.23	2.28	0.01	0.02	0.52	0.35	0.39
1 A 3 a	NOX	0.4	1.4	3.0	40.0	40.11	0.14	0.00	0.01	0.20	0.03	0.04
1 A 3 b	NOX	122.2	73.2	3.0	40.0	40.11	387.28	-0.04	0.33	-1.68	1.41	4.78
1 A 3 c	NOX	1.9	1.0	3.0	40.0	40.11	0.08	0.00	0.00	-0.04	0.02	0.00
1 A 3 d	NOX	0.6	0.6	3.0	40.0	40.11	0.02	0.00	0.00	0.03	0.01	0.00
1 A 3 e	NOX	0.6	0.5	2.0	10.0	10.20	0.00	0.00	0.00	0.00	0.01	0.00
1 A 4 a	NOX	3.4	1.3	5.0	40.0	40.31	0.13	0.00	0.01	-0.17	0.04	0.03
1 A 4 b	NOX	13.9	10.1	15.0	40.0	42.72	8.39	0.00	0.05	0.13	0.97	0.96
1 A 4 c	NOX	10.5	7.1	5.0	100.0	100.12	23.03	0.00	0.03	0.04	0.23	0.05
1 A 5 b	NOX	0.1	0.1	1.0	125.0	125.00	0.00	0.00	0.00	0.02	0.00	0.00
2 B 1	NOX	IE	0.2	2.0	40.0	40.05	0.00		0.00		0.00	
2 B 2	NOX	IE	0.1	2.0	40.0	40.05	0.00		0.00		0.00	
2 B-10	NOX	4.1	0.1	2.0	40.0	40.05	0.00	-0.01	0.00	-0.48	0.00	0.23
2 C 1	NOX	0.2	0.1	0.5	40.0	40.00	0.00	0.00	0.00	0.00	0.00	0.00
2 C 7	NOX	0.0	0.0	5.0	40.0	40.31	0.00	0.00	0.00	0.00	0.00	0.00
2 H	NOX	0.6	1.2	10.0	40.0	41.23	0.11	0.00	0.01	0.15	0.08	0.03
3 B 1	NOX	0.3	0.2	1.0	125.0	125.00	0.04	0.00	0.00	0.01	0.00	0.00
3 B 2	NOX	0.0	0.0	10.0	125.0	125.40	0.00	0.00	0.00	0.00	0.00	0.00
3 B 3	NOX	0.1	0.0	4.0	125.0	125.06	0.00	0.00	0.00	-0.01	0.00	0.00
3 B 4	NOX	0.1	0.1	10.0	125.0	125.40	0.01	0.00	0.00	0.02	0.01	0.00
3 D a	NOX	11.4	10.5	5.0	125.0	125.10	78.07	0.01	0.05	1.61	0.34	2.71
3 F	NOX	0.0	0.0	100.0	40.0	107.70	0.00	0.00	0.00	0.00	0.00	0.00
5 C	NOX	0.1	0.0	7.0	200.0	200.12	0.00	0.00	0.00	-0.05	0.00	0.00
Total		220.9	149.1				509.24					10.29
Total Uncertainties						Uncertainty in total inventory %:	22.57	Trend uncertainty %				3.21

Table 29: Uncertainty estimation of NMVOC emissions 1990 and 2015.

Reporting year:	2015											
NRF sector	Pollutant	Base year emissions kt	Year t emissions kt	Activity data uncertainty (1) %	Emission factor uncertainty (1) %	Combined uncertainty %	Contribution to variance by category in year x %	Type A sensitivity %	Type B sensitivity %	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty (2) %	Uncertainty in trend in national emissions introduced by activity data uncertainty (3) %	Uncertainty introduced into the trend in total national emissions %
	NMVOC	Input data	Input data	input data Note A	input data Note A	$\sqrt{(E^2 + F^2)}$	$\frac{(G \cdot D)^2}{\sum(D^2)}$	Note B	$\frac{D}{\sum E}$	I-F Note C	J · E · $\sqrt{2}$ Note D	$K^2 + L^2$
1 A 1 a	NMVOC	0.3	0.4	8.0	200.0	200.16	0.48	0.00	0.00	0.18	0.02	0.03
1 A 1 c	NMVOC	0.0	0.0	2.0	200.0	200.01	0.00	0.00	0.00	0.00	0.00	0.00
1 A 2 a	NMVOC	0.1	0.2	5.0	200.0	200.06	0.11	0.00	0.00	0.11	0.00	0.01
1 A 2 b	NMVOC	0.0	0.0	5.0	200.0	200.06	0.00	0.00	0.00	0.00	0.00	0.00
1 A 2 c	NMVOC	0.0	0.0	5.0	200.0	200.06	0.01	0.00	0.00	0.02	0.00	0.00
1 A 2 d	NMVOC	0.7	0.2	10.0	200.0	200.25	0.17	0.00	0.00	-0.04	0.01	0.00
1 A 2 e	NMVOC	0.0	0.0	5.0	200.0	200.06	0.00	0.00	0.00	0.00	0.00	0.00
1 A 2 f	NMVOC	0.2	0.3	5.0	200.0	200.06	0.26	0.00	0.00	0.13	0.01	0.02
1 A 2 g 7	NMVOC	0.5	0.7	1.0	40.0	40.01	0.05	0.00	0.00	0.06	0.00	0.00
1 A 2 g 8	NMVOC	0.0	0.2	10.0	40.0	41.23	0.00	0.00	0.00	0.02	0.01	0.00
1 A 3 a	NMVOC	0.2	0.5	3.0	40.0	40.11	0.03	0.00	0.00	0.06	0.01	0.00
1 A 3 b	NMVOC	73.6	7.2	3.0	125.0	125.04	64.10	-0.08	0.03	-9.94	0.11	98.81
1 A 3 c	NMVOC	0.4	0.1	3.0	40.0	40.11	0.00	0.00	0.00	-0.01	0.00	0.00
1 A 3 d	NMVOC	0.6	0.3	3.0	40.0	40.11	0.01	0.00	0.00	0.01	0.00	0.00
1 A 3 e	NMVOC	0.0	0.0	2.0	200.0	200.01	0.00	0.00	0.00	0.00	0.00	0.00
1 A 4 a	NMVOC	0.7	0.8	5.0	70.0	70.18	0.25	0.00	0.00	0.13	0.02	0.02
1 A 4 b	NMVOC	56.2	25.1	15.0	70.0	71.59	253.88	0.01	0.09	0.62	1.90	4.00
1 A 4 c	NMVOC	4.4	3.5	5.0	100.0	100.12	9.80	0.01	0.01	0.63	0.09	0.40
1 A 5 b	NMVOC	0.0	0.0	1.0	125.0	125.00	0.00	0.00	0.00	0.00	0.00	0.00
1 B 1 a	NMVOC	2.9	NA	5.0	20.0	20.62						
1 B 2 a	NMVOC	11.4	1.9	0.5	20.0	20.01	0.11	-0.01	0.01	-0.19	0.00	0.04
1 B 2 b	NMVOC	1.1	0.5	5.0	20.0	20.62	0.01	0.00	0.00	0.00	0.01	0.00
2 B-10	NMVOC	8.3	1.3	2.0	200.0	200.01	5.51	-0.01	0.00	-1.43	0.01	2.05
2 C 1	NMVOC	0.3	0.2	0.5	125.0	125.00	0.07	0.00	0.00	0.05	0.00	0.00
2 C 7	NMVOC	0.2	0.2	5.0	125.0	125.10	0.05	0.00	0.00	0.05	0.01	0.00
2 D	NMVOC	114.4	64.5	5.0	20.0	20.62	138.76	0.07	0.23	1.31	1.63	4.36
2 H	NMVOC	2.3	3.5	10.0	40.0	41.23	1.63	0.01	0.01	0.37	0.18	0.17
3 D e	NMVOC	1.2	1.0	5.0	750.0	750.02	46.89	0.00	0.00	1.52	0.03	2.30
3 F	NMVOC	0.1	0.1	100.0	40.0	107.70	0.00	0.00	0.00	0.00	0.03	0.00
5 A	NMVOC	0.1	0.0	12.0	25.0	27.73	0.00	0.00	0.00	0.00	0.00	0.00
5 C	NMVOC	0.0	0.0	7.0	125.0	125.20	0.00	0.00	0.00	0.00	0.00	0.00
5 D	NMVOC	0.0	0.0	20.0	125.0	126.59	0.00	0.00	0.00	0.00	0.00	0.00
Total		280.6	112.9				522.20					112.22
Total						Uncertainty in total inventory %:	22.85	Trend uncertainty %				10.59

Table 30: Uncertainty estimation of NH₃ emissions 1990 and 2015.

Reporting year:	2015											
NRF sector	Pollutant	Base year emissions	Year t emissions	Activity data uncertainty (1)	Emission factor uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty (2)	Uncertainty in trend in national emissions introduced by activity data uncertainty (3)	Uncertainty introduced into the trend in total national emissions
		kt	kt	%	%	%	%	%	%	%	%	%
	NH3	Input data	Input data	input data Note A	input data Note A	$\sqrt{(E^2 + F^2)}$	$\frac{(G \cdot D)^2}{\sum (D^2)}$	Note B	$\frac{D}{\sum C}$	I-F Note C	J-E · $\sqrt{2}$ Note D	$K^2 + L^2$
1 A 1 a	NH3	0.1	0.3	8.0	750.0	750.04	13.32	0.00	0.00	2.44	0.06	5.97
1 A 1 b	NH3	0.1	0.1	1.0	750.0	750.00	0.90	0.00	0.00	0.09	0.00	0.01
1 A 1 c	NH3	0.0	0.0	2.0	750.0	750.00	0.01	0.00	0.00	-0.02	0.00	0.00
1 A 2 a	NH3	0.0	0.0	5.0	750.0	750.02	0.05	0.00	0.00	0.07	0.00	0.00
1 A 2 b	NH3	0.0	0.0	5.0	750.0	750.02	0.00	0.00	0.00	0.03	0.00	0.00
1 A 2 c	NH3	0.0	0.0	5.0	750.0	750.02	0.16	0.00	0.00	0.09	0.00	0.01
1 A 2 d	NH3	0.1	0.1	10.0	750.0	750.07	0.45	0.00	0.00	-0.08	0.01	0.01
1 A 2 e	NH3	0.0	0.0	5.0	750.0	750.02	0.05	0.00	0.00	-0.01	0.00	0.00
1 A 2 f	NH3	0.1	0.1	5.0	750.0	750.02	2.11	0.00	0.00	-0.14	0.01	0.02
1 A 2 g 7	NH3	0.0	0.0	1.0	125.0	125.00	0.00	0.00	0.00	0.00	0.00	0.00
1 A 2 g 8	NH3	0.1	0.2	10.0	125.0	125.40	0.09	0.00	0.00	0.19	0.04	0.04
1 A 3 a	NH3	0.0	0.0	3.0	125.0	125.04	0.00	0.00	0.00	0.00	0.00	0.00
1 A 3 b	NH3	1.1	1.3	3.0	200.0	200.02	15.92	0.00	0.02	0.58	0.09	0.34
1 A 3 c	NH3	0.0	0.0	3.0	125.0	125.04	0.00	0.00	0.00	0.00	0.00	0.00
1 A 3 d	NH3	0.0	0.0	3.0	125.0	125.04	0.00	0.00	0.00	0.00	0.00	0.00
1 A 3 e	NH3	0.0	0.0	2.0	750.0	750.00	0.01	0.00	0.00	0.07	0.00	0.01
1 A 4 a	NH3	0.1	0.1	5.0	125.0	125.10	0.01	0.00	0.00	-0.02	0.01	0.00
1 A 4 b	NH3	0.5	0.5	15.0	125.0	125.90	0.83	0.00	0.01	-0.08	0.15	0.03
1 A 4 c	NH3	0.0	0.0	5.0	125.0	125.10	0.01	0.00	0.00	0.01	0.00	0.00
1 A 5 b	NH3	0.0	0.0	1.0	200.0	200.00	0.00	0.00	0.00	0.00	0.00	0.00
2 B 1	NH3	0.0	0.0	2.0	20.0	20.10	0.00	0.00	0.00	0.00	0.00	0.00
2 B 2	NH3	0.0	0.0	2.0	20.0	20.10	0.00	0.00	0.00	0.00	0.00	0.00
2 B-10	NH3	0.3	0.1	2.0	20.0	20.10	0.00	0.00	0.00	-0.06	0.00	0.00
2 G	NH3	0.0	0.0	20.0	40.0	44.72	0.00	0.00	0.00	0.00	0.00	0.00
3 B 1	NH3	14.5	16.8	1.0	20.0	20.02	25.21	0.03	0.25	0.64	0.36	0.54
3 B 2	NH3	0.5	0.6	10.0	40.0	41.23	0.14	0.00	0.01	0.04	0.13	0.02
3 B 3	NH3	8.5	6.3	4.0	20.0	20.40	3.65	-0.03	0.09	-0.69	0.54	0.77
3 B 4	NH3	4.1	5.2	10.0	40.0	41.23	10.44	0.02	0.08	0.68	1.12	1.72
3 D a	NH3	35.6	33.9	5.0	40.0	40.31	417.42	-0.03	0.51	-1.29	3.62	14.78
3 F	NH3	0.0	0.0	100.0	40.0	107.70	0.00	0.00	0.00	-0.02	0.02	0.00
5 A	NH3	0.0	0.0	12.0	25.0	27.73	0.00	0.00	0.00	0.00	0.00	0.00
5 B	NH3	0.4	1.2	20.0	125.0	126.59	5.29	0.01	0.02	1.62	0.52	2.90
5 C	NH3	0.0	0.0	7.0	125.0	125.20	0.00	0.00	0.00	0.00	0.00	0.00
Total		66.1	66.9				496.06					27.16
Total Uncertainties						Uncertainty in total inventory %:	22.27	Trend uncertainty %				5.21

Table 31: Uncertainty estimation of PM_{2.5} emissions 1990 and 2015.

Reporting year:	2015											
NRF sector	Pollutant	Base year emissions kt	Year t emissions kt	Activity data uncertainty (1) %	Emission factor uncertainty (1) %	Combined uncertainty %	Contribution to variance by category in year x %	Type A sensitivity %	Type B sensitivity %	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty (2) %	Uncertainty in trend in national emissions introduced by activity data uncertainty (3) %	Uncertainty introduced into the trend in total national emissions %
	PM2.5	Input data	Input data	input data Note A	input data Note A	$\sqrt{(E^2 + F^2)}$	$\frac{(G \cdot D)^2}{\sum(D^2)}$	Note B	$\frac{D}{\sum C}$	I-F Note C	I · E · $\sqrt{2}$ Note D	K ² + L ²
1 A 1 a	PM2.5	0.6	0.9	8.0	60.0	60.53	10.41	0.02	0.04	1.11	0.40	1.38
1 A 1 b	PM2.5	0.1	0.0	1.0	40.0	40.01	0.01	0.00	0.00	-0.05	0.00	0.00
1 A 1 c	PM2.5	0.1	0.1	2.0	40.0	40.05	0.06	0.00	0.00	0.08	0.01	0.01
1 A 2 a	PM2.5	0.0	0.0	5.0	40.0	40.31	0.00	0.00	0.00	-0.03	0.00	0.00
1 A 2 b	PM2.5	0.0	0.0	5.0	40.0	40.31	0.00	0.00	0.00	0.01	0.00	0.00
1 A 2 c	PM2.5	0.2	0.3	5.0	40.0	40.31	0.47	0.00	0.01	0.20	0.08	0.04
1 A 2 d	PM2.5	0.8	0.2	10.0	40.0	41.23	0.26	-0.01	0.01	-0.49	0.12	0.25
1 A 2 e	PM2.5	0.1	0.0	5.0	40.0	40.31	0.00	0.00	0.00	-0.06	0.01	0.00
1 A 2 f	PM2.5	0.1	0.1	5.0	40.0	40.31	0.03	0.00	0.00	0.06	0.02	0.00
1 A 2 g 7	PM2.5	0.6	0.5	1.0	125.0	125.00	12.83	0.00	0.02	0.50	0.03	0.25
1 A 2 g 8	PM2.5	0.3	1.3	10.0	60.0	60.83	21.27	0.04	0.05	2.57	0.71	7.10
1 A 3 a	PM2.5	0.0	0.1	3.0	40.0	40.11	0.07	0.00	0.00	0.14	0.02	0.02
1 A 3 b	PM2.5	4.8	2.6	3.0	125.0	125.04	380.47	-0.02	0.10	-2.89	0.44	8.55
1 A 3 c	PM2.5	0.6	0.2	3.0	40.0	40.11	0.32	-0.01	0.01	-0.28	0.04	0.08
1 A 3 d	PM2.5	0.1	0.0	3.0	40.0	40.11	0.01	0.00	0.00	-0.07	0.01	0.00
1 A 3 e	PM2.5	0.0	0.0	2.0	125.0	125.02	0.00	0.00	0.00	0.01	0.00	0.00
1 A 4 a	PM2.5	0.7	0.3	5.0	60.0	60.21	1.32	-0.01	0.01	-0.32	0.09	0.11
1 A 4 b	PM2.5	8.5	5.6	15.0	60.0	61.85	438.67	0.00	0.22	0.05	4.73	22.37
1 A 4 c	PM2.5	2.4	1.2	5.0	100.0	100.12	52.54	-0.02	0.05	-1.62	0.34	2.73
1 A 5 b	PM2.5	0.0	0.0	1.0	125.0	125.00	0.02	0.00	0.00	0.03	0.00	0.00
1 B 1 a	PM2.5	0.1	0.1	5.0	200.0	200.06	0.64	0.00	0.00	-0.04	0.02	0.00
2 A 1	PM2.5	0.1	0.0	1.1	200.0	200.00	0.29	0.00	0.00	-0.37	0.00	0.14
2 A 2	PM2.5	0.0	0.1	1.6	200.0	200.01	0.55	0.00	0.00	0.27	0.01	0.08
2 A 5	PM2.5	0.5	0.7	5.0	200.0	200.06	65.30	0.01	0.03	2.55	0.19	6.53
2 B-10	PM2.5	0.3	0.1	2.0	20.0	20.10	0.03	0.00	0.01	-0.05	0.02	0.00
2 C 1	PM2.5	2.1	0.2	0.5	40.0	40.00	0.32	-0.04	0.01	-1.78	0.01	3.18
2 C 2	PM2.5	0.0	0.0	5.0	40.0	40.31	0.00	0.00	0.00	0.01	0.00	0.00
2 G	PM2.5	0.4	0.5	20.0	40.0	44.72	1.51	0.01	0.02	0.30	0.51	0.35
2 H	PM2.5	0.0	0.0	10.0	200.0	200.25	0.00	0.00	0.00	0.00	0.00	0.00
2 I	PM2.5	0.1	0.2	1.0	40.0	40.01	0.20	0.00	0.01	0.14	0.01	0.02
3 B 1	PM2.5	0.1	0.0	1.0	200.0	200.00	0.31	0.00	0.00	0.05	0.00	0.00
3 B 2	PM2.5	0.0	0.0	10.0	200.0	200.25	0.01	0.00	0.00	0.03	0.00	0.00
3 B 3	PM2.5	0.0	0.0	4.0	200.0	200.04	0.08	0.00	0.00	0.03	0.01	0.00
3 B 4	PM2.5	0.0	0.0	10.0	200.0	200.25	0.12	0.00	0.00	0.10	0.02	0.01
3 D a	PM2.5	1.0	1.0	5.0	200.0	200.06	135.09	0.01	0.04	2.36	0.27	5.64
3 D d	PM2.5	0.0	0.0	5.0	200.0	200.06	0.01	0.00	0.00	0.05	0.00	0.00
3 F	PM2.5	0.1	0.1	100.0	125.0	160.08	0.38	0.00	0.00	-0.14	0.36	0.15
5 A	PM2.5	0.0	0.1	12.0	200.0	200.36	0.66	0.00	0.00	0.42	0.05	0.18
5 C	PM2.5	0.0	0.0	7.0	200.0	200.12	0.00	0.00	0.00	-0.01	0.00	0.00
Total		25.2	16.6				1,124.27					59.20
Total Uncertainties						Uncertainty in total inventory %:	33.53	Trend uncertainty %				7.69

1.8 Completeness

The emission data presented in this report were compiled according to the revised 2014 Reporting Guidelines (ECE/EB.AIR.125) approved by the Executive Body for the UNECE/LRTAP Convention at its 36th session.

The inventory is complete with regard to reported gases, reported years and reported emissions from all sources, and also complete in terms of geographic coverage.

Geographic Coverage

The geographic coverage is complete. There is no territory in Austria not covered by the inventory.

However, if fuel prices vary considerably in neighbouring countries, fuel sold within the territory of a Party is used outside its territory (so-called 'fuel export'). Austria has experienced a considerable amount of 'fuel export' in the last few years (see also Chapter 2.5).

According to the revised 2014 Reporting Guidelines (ECE/EB.AIR.125), Parties within the EMEP region should calculate and report emissions, consistent with national energy balances reported to Eurostat or the International Energy Agency (IEA). Emissions from road vehicle transport should therefore be calculated and reported on the basis of the fuel sold. In addition, Parties may voluntarily report emissions from road vehicles based on fuel used in the geographic area of the Party.

Emissions of the Austrian road transport sector are therefore generally reported on the basis of fuel sold. With respect to compliance under Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants, emissions are accounted on the basis of 'fuel used'. The Austrian NEC Totals therefore differ from the LRTAP Totals presented in this report (see Appendix, Chapter 12.2).

Gases, Reporting Years

In accordance with the Austrian obligation, all relevant pollutants mentioned in Table 3 (minimum reporting programme), are covered by the Austrian inventory and are reported for the years 1990–2015 for the main pollutants, from 1990 onwards for POPs and HMs and for the years 1990, 1995 and from 2000 onwards for PM.

From submission 2015 onwards Austria reports all pollutants in the NFR14 reporting format from 1990 to the latest inventory year. Emissions of the years before 1990 were last updated and published in submission 2014⁷¹.

Notation Keys

Notation keys are used according to the revised 2014 Reporting Guidelines (ECE/EB.AIR.125) (see Table 32) to indicate where emissions are not occurring in Austria, where emissions have not been estimated or have been included elsewhere as suggested by EMEP/EEA Emission Inventory Guidebook 2016.

⁷¹ Austria's submission 2014 under the Convention on Long-range Transboundary Air Pollution covering the years 1980–2012: http://www.ceip.at/ms/ceip_home1/ceip_home/status_reporting/2014_submissions/

Table 32: Notation keys used in the NFR.

Abbreviation	Meaning	Objective
NA	not applicable	is used for activities in a given source category which are believed not to result in significant emissions of a specific compound;
NE	not estimated	for activity data and/or emissions by sources of pollutants which have not been estimated but for which a corresponding activity may occur within a Party. Where NE is used in an inventory to report emissions of pollutants, the Party should indicate in the IIR why such emissions have not been estimated. Furthermore, a Party may consider that a disproportionate amount of effort would be required to collect data for a pollutant from a specific category that would be insignificant in terms of the overall level and trend in national emissions and in such cases use the notation key NE. The Party should in the IIR provide justifications for their use of NE notation keys, e.g., lack of robust data, lack of methodology, etc. Once emissions from a specific category have been reported in a previous submission, emissions from this specific category should be reported in subsequent inventory submissions;
IE	included elsewhere	for emissions by sources of pollutants estimated but included elsewhere in the inventory instead of under the expected source category. Where IE is used in an inventory, the Party should indicate, in the IIR, where in the inventory the emissions for the displaced source category have been included, and the Party should explain such a deviation from the inclusion under the expected category, especially if it is due to confidentiality;
C	confidential	(confidential information), for emissions by sources of pollutants of which the reporting could lead to the disclosure of confidential information. The source category where these emissions are included should be indicated;
NO	not occurring	for categories or processes within a particular source category that do not occur within a Party;
NR	not relevant	according to paragraph 37 in the Guidelines, emission inventory reporting for the main pollutants should cover all years from 1990 onwards if data are available. However, NR is introduced to ease the reporting where reporting of emissions is not strictly required by the different protocols, e.g., emissions for some Parties prior to agreed base years.

Assessment of transparency and completeness

In the Austrian QMS a transparency and completeness index is used to quantify the quality of the inventory, calculated as follows:

$$\text{Transparency [\%]} = [1 - (\text{number of IE}/\text{number of estimates})] * 100$$

$$\text{Completeness [\%]} = [1 - (\text{number of NE}/\text{number of estimates})] * 100$$

The total number of data records (emission data) are counted as well as the numbers reported as 'not estimated' and 'included elsewhere'. Then the share of 'NE' and 'IE' to total data records are determined.

The result of this years' analysis is shown in Table 33. As can be seen the completeness parameter is very high. For PAHs the lowest completeness was investigated, which is due to not estimated PAH emissions from sectors *Transport* (international and domestic aviation) and *Industrial Processes and Product Use* (Soda Ash Production, Chemical Industry: other⁷², Ferroalloys Production, Aluminium Production, Other Product Use).

The transparency analysis for the reporting year 2015 shows also a high transparency of the Austrian inventory. For NMVOC the largest number of 'IE' has been identified, which was applied for eight sub-categories. Explanations are provided in the respective sector chapters on 'Completeness'.

Table 33: Transparency and completeness in submission 2017.

Pollutants	Submission 2017			
	IE	NE	Transparency	Completeness
NO _x (as NO ₂)	6	0	95%	100%
NMVOC	8	0	94%	100%
SO _x (as SO ₂)	6	0	95%	100%
NH ₃	5	0	96%	100%
PM _{2.5}	4	2	97%	98%
PM ₁₀	4	2	97%	98%
TSP	4	2	97%	98%
CO	4	0	97%	100%
Pb	4	1	97%	99%
Cd	4	1	97%	99%
Hg	4	2	97%	98%
PCDD/PCDF	4	4	97%	97%
PAHs (total)	4	6	97%	95%
HCB	4	4	97%	97%
PCBs	3	2	98%	98%

⁷² PAH emissions from graphite production (production of graphite electrodes only) are not estimated, as no emission factor is available.

2 EXPLANATIONS OF KEY TRENDS

This chapter describes the trends and the drivers of air pollutant emissions which Austria is obliged to report based on the following listed protocols. Additionally the trends of SO₂, NO_x, NH₃, NMVOC and PM_{2.5} emissions not including fuel exports (fuel used) as reported under Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants are described in chapter 2.5.

From submission 2015 onwards Austria reports all mandatory pollutants in the NFR14 reporting format from 1990 to the latest inventory year. Emissions of the years before 1990 were last updated and published in submission 2014⁷³.

1985 Helsinki Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes: This protocol requires parties to reduce their sulphur emissions by at least 30%. All parties achieved this reduction target by the target year 1993. In 2015, Austria's SO₂ emissions were 80% lower than in 1990.

1988 Sofia Protocol concerning the Control of Emissions of Nitrogen Oxides or their Transboundary Fluxes: This Protocol requires as a first step, to freeze emissions of nitrogen oxides or their transboundary fluxes. The general reference year is 1987. The second step to the NO_x Protocol requires the application of an effects-based approach to further reduce emissions of nitrogen compounds. Nineteen of the 25 Parties to the 1988 NO_x Protocol have reached the target and stabilized emissions at 1987⁷⁴ levels or reduced emissions below that level according to the latest emission data reported. Austria was successful in fulfilling the stabilisation target set out in the Protocol. Since 2003–2005, when emissions reached an all-time high due to a considerable increase of fuel export and the failure of European provisions for the reduction of vehicle emissions, NO_x emissions are decreasing.

1991 Geneva Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes. This Protocol specifies three options for emission reduction targets that have to be chosen upon signature or upon ratification. Austria chose the option which requires a 30 % reduction of VOCs by 1999 using a base year between 1984 and 1990 and chose 1988 as base year. Austria met the reduction target.

1998 Aarhus Protocol on Heavy Metals: It targets three particularly harmful metals: cadmium, lead and mercury. According to one of the basic obligations, Parties have to reduce their emissions for these three metals below their levels in the reference year. Austria has chosen 1985 as the reference year and current emissions are well below the level of the reference year.

1998 Aarhus Protocol on Persistent Organic Pollutants (POPs): The protocol focuses on a list of 16 substances that were singled out according to agreed risk criteria. These substances comprise eleven pesticides, two industrial chemicals and three by-products/contaminants. The ultimate objective is to eliminate any discharges, emissions and losses of POPs. Parties have to reduce their emissions for PAHs, Dioxins/Furans and HCB below their levels in the reference year. Austria has chosen 1985 as the reference year and current emissions are well below the level of the reference year.

1999 Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone “Multi-Effect Protocol”. The Protocol sets emission ceilings for 2010 for four pollutants: sulphur, NO_x, VOCs and ammonia. In May 2012 the protocol was amended to include national emission reduction commitments to be achieved in 2020 and beyond. Austria has not ratified the Protocol and is not Party to the Protocol, but reports the concerned emissions.

⁷³ Austria's submission 2014 under the Convention on Long-range Transboundary Air Pollution covering the years 1980-2012: http://www.ceip.at/ms/ceip_home1/ceip_home/status_reporting/2014_submissions/

⁷⁴ or in the case of the United States 1978

2.1 Emission Trends for Air Pollutants covered by the Multi-Effect Protocol as well as CO

National total emissions and trends (1990–2015) for air pollutants covered by the Multi-Effect Protocol are shown in Table 34. Please note that emissions from mobile sources are calculated based on fuel sold in Austria, thus national total emissions include 'fuel export'. Austria's emissions based on fuel used – thus excluding 'fuel export' – are presented in Chapter 2.5.

Table 34: National total emissions and trends 1990–2015 for air pollutants covered by the Multi-Effect Protocol and CO.

Year	Emission [kt]				
	SO ₂	NO _x	NM VOC	NH ₃	CO
1990	74.57	220.89	280.63	66.15	1 287.20
1991	71.59	229.34	276.60	67.62	1 286.65
1992	55.20	215.92	255.13	65.93	1 216.87
1993	53.58	206.19	240.82	66.75	1 151.04
1994	47.93	200.49	217.92	68.15	1 085.65
1995	47.53	200.00	204.29	69.45	987.99
1996	44.81	217.43	197.98	68.05	993.63
1997	40.13	205.89	176.94	68.44	924.17
1998	35.49	218.11	169.03	68.97	886.00
1999	33.59	209.64	161.32	67.50	784.15
2000	31.56	215.09	153.24	66.10	785.94
2001	32.43	224.93	149.91	66.30	763.54
2002	31.62	230.76	146.24	65.68	731.04
2003	31.67	239.01	144.11	65.59	735.48
2004	27.08	236.29	139.62	65.21	716.68
2005	25.95	238.06	136.62	65.30	687.97
2006	26.63	223.65	131.18	65.53	666.80
2007	23.17	213.05	126.30	66.81	628.35
2008	20.58	197.13	123.32	66.39	604.49
2009	15.12	180.78	118.11	67.46	570.02
2010	16.70	181.08	118.73	66.80	582.91
2011	15.57	171.37	114.70	66.22	564.85
2012	15.06	164.47	113.93	66.31	565.14
2013	14.94	164.31	115.78	66.18	585.74
2014	14.78	153.07	110.24	66.60	538.34
2015	14.90	149.12	112.89	66.87	567.13
Trend 1990–2015	-80.0%	-32.5%	-59.8%	1.1%	-55.9%

2.1.1 SO₂ Emissions

In 1990, national total SO₂ emissions amounted to 75 kt. Since then emissions have decreased quite steadily. In the year 2015, emissions were reduced by 80% compared to 1990 and amounted to 15 kt, which was mainly due to lower emissions from residential heating, combustion in industries and in energy industries. The sharp decrease from 2008 onwards is due to a further reduction of the sulfur content of gasoil to 10ppm. From 2014 to 2015 emissions slightly increased by 0.8% mainly due to higher emissions from NFR sectors *1.A.2 Manufacturing Industries* and *1.A.4 Other Sectors*. Emissions from manufacturing industries rose due to an increased coal and residual fuel use. Emissions from the residential sector increased due to the increased heating demand (more coal and biomass used) as a result of the colder winter.

Main sources and emission trends in Austria

As shown in Figure 7 the main source of SO₂ emissions in Austria in 2015 is NFR sector *1.A Fuel Combustion Activities* with 94% in national total SO₂ emissions. Sector *2 Industrial Processes and Product Use* contributes with 5.5%.

NFR sectors *1.B Fugitive Emissions*, *3 Agriculture* and *5 Waste* are only minor contributors to national total SO₂ emissions in 2015 with 0.3%, 0.01% and 0.1%, respectively.

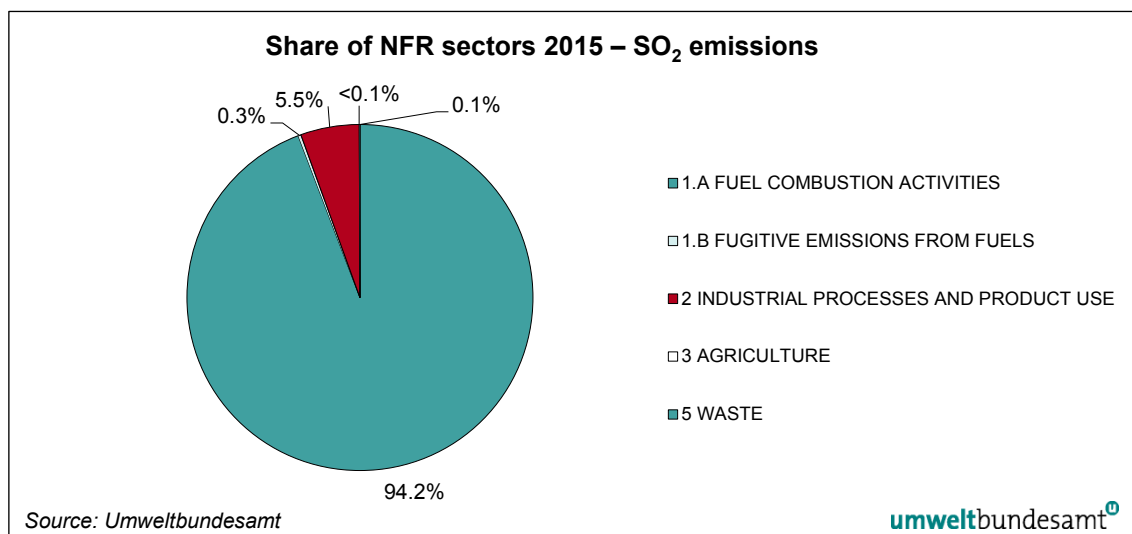


Figure 7: Share of NFR sectors 2015 in SO₂ emissions.

1.A Fuel Combustion Activities

As shown in Table 35 the main source for SO₂ emissions in Austria, with a share of 94% in 1990 and in 2015, is category *1.A Fuel Combustion Activities*. Within this source, the main contributors to total SO₂ emissions are *1.A.2 Manufacturing Industries* with 71% (about half of the emissions stem from iron and steel industry), *1.A.4 Other Sectors* (residential heating) with 11% and *1.A.1 Energy Industries* with 10% of the total share, respectively.

The constant decrease of emissions since 1990 from 1.A.1 *Energy Industries*, 1.A.2 *Manufacturing Industries and Construction*, 1.A.3 *Transport* and 1.A.4 *Other Sectors* (mainly residential heating) is mainly due to:

- a lowering of the sulphur content in mineral oil products and fuels (due to e.g. Fuel Ordinance⁷⁵),
- a switch-over from high sulfur fuels to low-sulphur fuels or to even sulphur free fuel (e.g. natural gas) – sulphur-free fuels, such as those offered nationwide in Austria since 2006, are a precondition for the use of advanced exhaust gas after treatment technologies.
- implementation of desulphurisation units in power plants (due to e.g. LCP directive⁷⁶ and preceding national legislation),
- abatement techniques like combined flue gas treatment.

2 Industrial Processes and Product Use

The share in national total SO₂ emissions from NFR sector 2 *Industrial Processes and Product Use* in 2015 is 5.5%. Within this source, SO₂ emissions result from 2.B *Chemical Industry* (45%) and 2.C *Metal Production* (55%). In both subcategories emissions have decreased since 1990 mainly caused by a decline in production and, on the other hand, abatement techniques such as systems for purification of waste gases and desulfurization facilities.

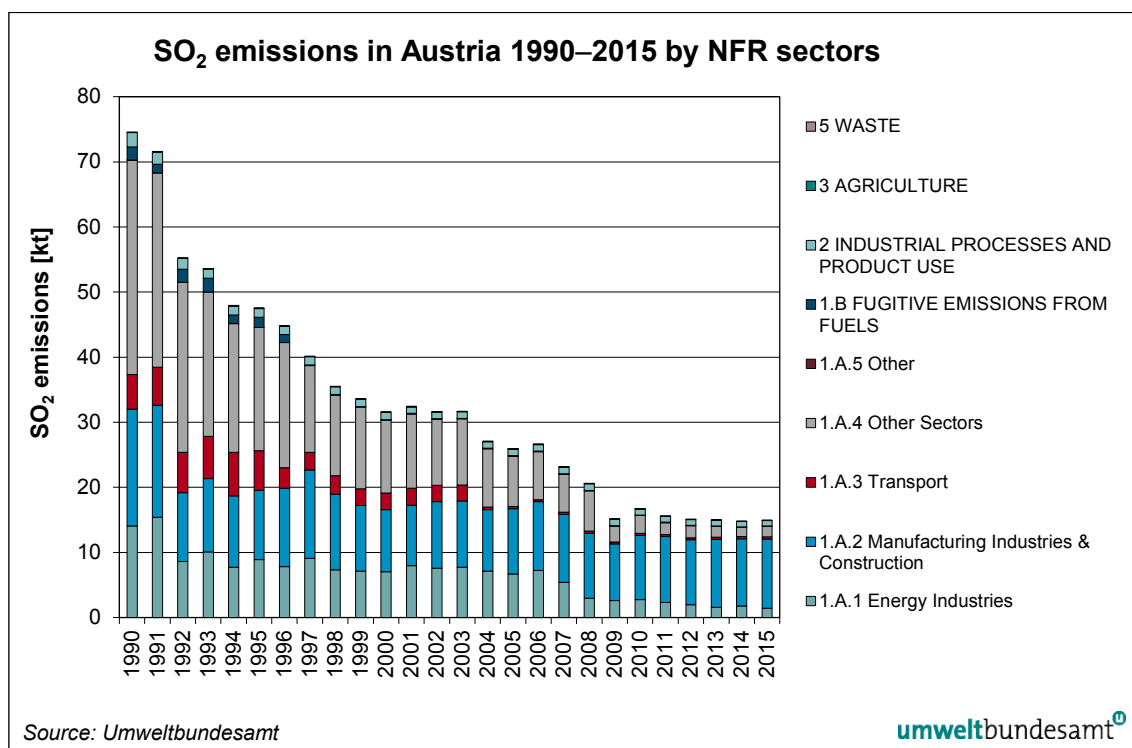


Figure 8: SO₂ emissions in Austria 1990–2015 by sectors in absolute terms.

⁷⁵ BGBl. II_417-04_Kraftstoffverordnung; idF. BGBl. II Nr. 398/2012

⁷⁶ Luftreinhaltegesetzes für Kesselanlagen (LRG-K) BGBl. I Nr. 127/2013 (older version: BGBl. Nr. 380/1988 idF. BGBl. Nr. 185/1993, BGBl. I Nr. 150/2004; Umsetzung der Richtlinie 96/61/EG; Richtlinie 96/82/EG, Richtlinie 88/609/EWG, Richtlinie 2001/80/EG, Richtlinie 2002/49/EG)

Table 35: SO₂ emissions per NFR Category 1990 and 2015, their trend 1990–2015 and their share in total emissions.

NFR Category		SO ₂ Emission in [kt]		Trend		Share in National Total	
		1990	2015	1990–2015	2014–2015	1990	2015
1	ENERGY	72.27	14.08	-81%	1%	97%	94%
1.A	FUEL COMBUSTION ACTIVITIES	70.27	14.04	-80%	1%	94%	94%
1.A.1	Energy Industries	14.04	1.45	-90%	-18%	19%	10%
1.A.1.a	Public Electricity and Heat Production	11.79	1.21	-90%	-3%	16%	8%
1.A.1.b	Petroleum refining	2.25	0.24	-90%	-55%	3%	2%
1.A.1.c	Manufacture of Solid fuels & Other Energy Ind.	0.00	NA	NA	NA	<1%	NA
1.A.2	Manufacturing Industries and Construction	17.96	10.61	-41%	3%	24%	71%
1.A.2.a	Iron and Steel	6.73	5.43	-19%	2%	9%	36%
1.A.2.b	Non-ferrous Metals	0.15	0.18	21%	96%	<1%	1%
1.A.2.c	Chemicals	0.76	0.48	-36%	6%	1%	3%
1.A.2.d	Pulp, Paper and Print	4.30	0.95	-78%	-14%	6%	6%
1.A.2.e	Food Processing, Beverages and Tobacco	1.65	0.22	-87%	4%	2%	1%
1.A.2.f	Non-metallic Minerals	2.23	1.18	-47%	-1%	3%	8%
1.A.2.g	Manufacturing Industries and Constr. - other	2.15	2.18	1%	10%	3%	15%
1.A.3	Transport	5.32	0.31	-94%	1%	7%	2%
1.A.3.a	Civil Aviation	0.03	0.11	220%	5%	<1%	1%
1.A.3.b	Road Transportation	4.85	0.13	-97%	2%	7%	1%
1.A.3.c	Railways	0.39	0.06	-85%	-1%	1%	<1%
1.A.3.d	Navigation	0.05	0.02	-61%	-17%	<1%	<1%
1.A.3.e	Other transportation	NA	NA	NA	NA	NA	NA
1.A.4	Other Sectors	32.94	1.66	-95%	14%	44%	11%
1.A.4.a	Commercial/Institutional	5.24	0.23	-96%	37%	7%	2%
1.A.4.b	Residential	25.92	1.32	-95%	11%	35%	9%
1.A.4.c	Agriculture/Forestry/Fisheries	1.78	0.11	-94%	9%	2%	1%
1.A.5	Other	0.01	0.02	23%	1%	<1%	<1%
1.B	FUGITIVE EMISSIONS FROM FUELS	2.00	0.04	-98%	8%	3%	<1%
2	INDUSTRIAL PROCESSES AND PRODUCT USE	2.22	0.81	-63%	-3%	3%	5%
2.A	MINERAL PRODUCTS	NA	NA	NA	NA	NA	NA
2.B	CHEMICAL INDUSTRY	1.56	0.37	-77%	-7%	2%	2%
2.C	METAL PRODUCTION	0.66	0.45	-32%	<1%	1%	3%
2.D	NON ENERGY PRODUCTS/ SOLVENTS	NA	NA	NA	NA	NA	NA
2.G	Other product manufacture and use	NA	NA	NA	NA	NA	NA
2.H	Other Processes	NA	NA	NA	NA	NA	NA
2.I	Wood processing	NA	NA	NA	NA	NA	NA
2.J	Production of POPs	NO	NO	NO	NO	NO	NO
2.K	"Consumption of POPs and heavy metals	NO	NO	NO	NO	NO	NO
2.L	Other production, consumption, storage, transportation or handling of bulk products	NO	NO	NO	NO	NO	NO
3	AGRICULTURE	0.00	0.00	-75%	-25%	<1%	<1%
5	WASTE	0.07	0.01	-87%	<1%	<1%	<1%
Total without sinks		74.57	14.90	-87%	<1%		

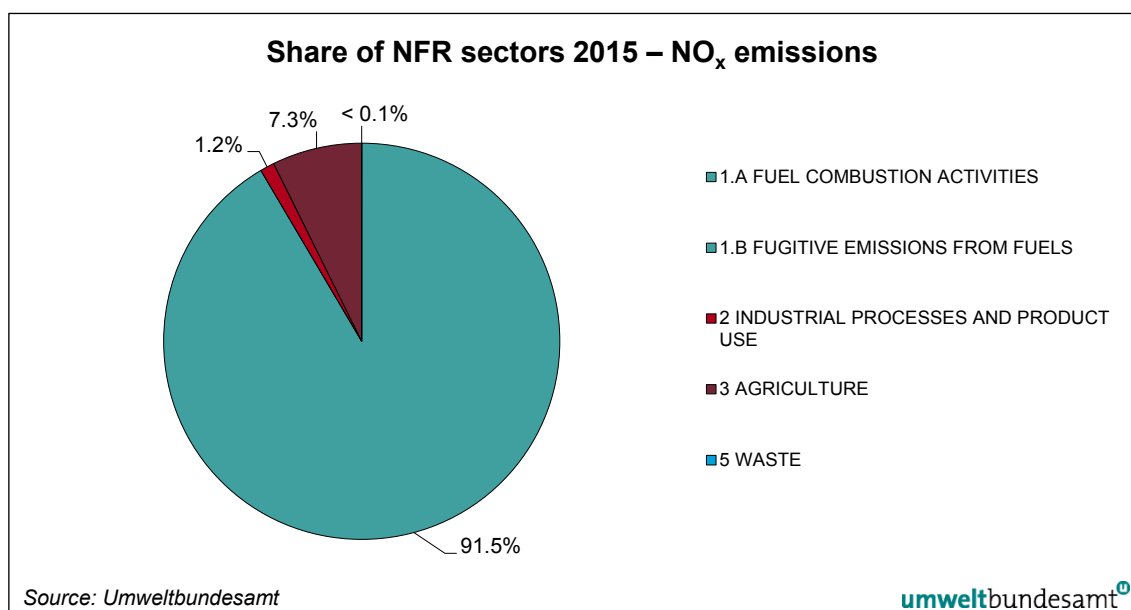
2.1.2 NO_x Emissions

In 1990, national total NO_x emissions amounted to 221 kt. After an all-time high of emissions between 2003 and 2005 emissions are decreasing continuously, which is mainly due to lower emissions from heavy duty vehicles influenced by declined fuel sales, fleet renewal and well-functioning NO_x exhaust after treatment systems. In 2015, NO_x emissions amounted to 149 kt and were about 32.5% lower than in 1990. From 2014 to 2015 emissions decreased by 2.6%, again mainly due to decreasing emissions of road transportation, in particular from heavy duty vehicles. In 2015 49% of the total nitrogen oxides emissions originate from road transport (including fuel exports).

Main sources and emission trends in Austria

As can be seen in Figure 9 and Table 36, the main source for NO_x emissions in Austria with a share of 92% in 2015 are *1.A Fuel Combustion Activities*. Sector *3 Agriculture* contributes with 7.3%.

NFR sectors *2 Industrial Processes and Product Use* and *5 Waste* are minor sources regarding NO_x emissions. These sectors contribute with 1.2% and 0.01% to national total NO_x emissions in 2015.



Note: NO_x emissions from NFR sector 1.B Fugitive Emissions from fuels are reported as IE.

Figure 9: Share of NFR sectors 2015 in NO_x emissions

1.A Fuel Combustion Activities

Within source category *1.A Fuel Combustion Activities*, *1.A.3.b Road Transportation*, with about 49% of national total emissions in 2015, is the main contributor to total NO_x emissions.

Please note that emissions from mobile sources are calculated based on fuel sold, which for the last few years is considerably higher than fuel used because of the high extent of fuel export in *1.A.3 Transport* since the 1990ies: Emissions for 2015 based on fuel used amount to 132 kt and are about 17 kt lower than based on fuel sold (see also chapter 2.5).

The most important NO_x sources within NFR 1.A *Fuel Combustion Activities* are:

- **NFR 1.A.3 Transport** – in particular diesel-powered passenger cars and heavy duty traffic. In passenger transport the number of diesel vehicles has rapidly increased since the 1990ies. Also mileage has increased in passenger and freight transport. While NMVOC and CO emissions from road transport have been reduced significantly since 1990 due to well-functioning after-treatment devices, NO_x emissions increased up to 2003. Since then NO_x emissions have shown a decreasing trend, which is due to a combination of several facts. First of all, NO_x emissions from gasoline passenger cars are declining and are negligible now; second, NO_x emissions from heavy duty vehicles have decreased significantly due to the above mentioned well-functioning after-treatment devices (SCR, EGR). Additionally, NO_x emissions from fuel export show a decreasing trend because of the rapid renewal rate of the transit fleet.
Specific NO_x emissions (NO_x/km) from newly registered diesel passenger cars do not show the desired reduction rates though. A substantial reduction will only be realised with the introduction of specific nitrogen oxide catalysts for diesel vehicles.
- **NFR 1.A.2 Manufacturing Industries and Construction:** NO_x emissions have decreased compared to 1990 (-11.0%) mainly caused by increased efficiency, implementation/installation of denitrification installations (DENOX plant) and/or low-NO_x burners, introduction of modern fuel technology, gas-fired equipments and furnaces. This is counterbalanced by a significant increase in energy consumption (also the use of biomass).
- **NFR 1.A.4 Other Sectors** (mainly residential heating): NO_x emissions decreased steadily between 1990 and 2015 (-33%) mainly due to increased efficiency and modern fuel technology. From 2014 to 2015 NO_x emissions from residential heating increased by 0.46 kt (+2.5%) due to an increased use of biomass.

3 Agriculture

Besides the main NO_x emitter NFR sector 1.A *Fuel Combustion Activities*, sector 3 *Agriculture* is also a source of NO_x emissions in Austria, although to a much lesser extent. It is responsible for 7.3% of national total NO_x emissions in Austria in 2015. Within the Agriculture sector, source category 3.D *Agricultural Soils* is the biggest contributor with 97% in 2015. Emissions mainly result from the application of N-fertilizers and organic waste (largely animal manure) on agricultural soils.

Since 1990 the agricultural NO_x emissions decreased by 8.3%, mainly influenced by livestock numbers and N-fertilizer consumption. Compared to the previous year 2014 emissions slightly increased by 3.6%, which was due to higher mineral fertilizer consumption.

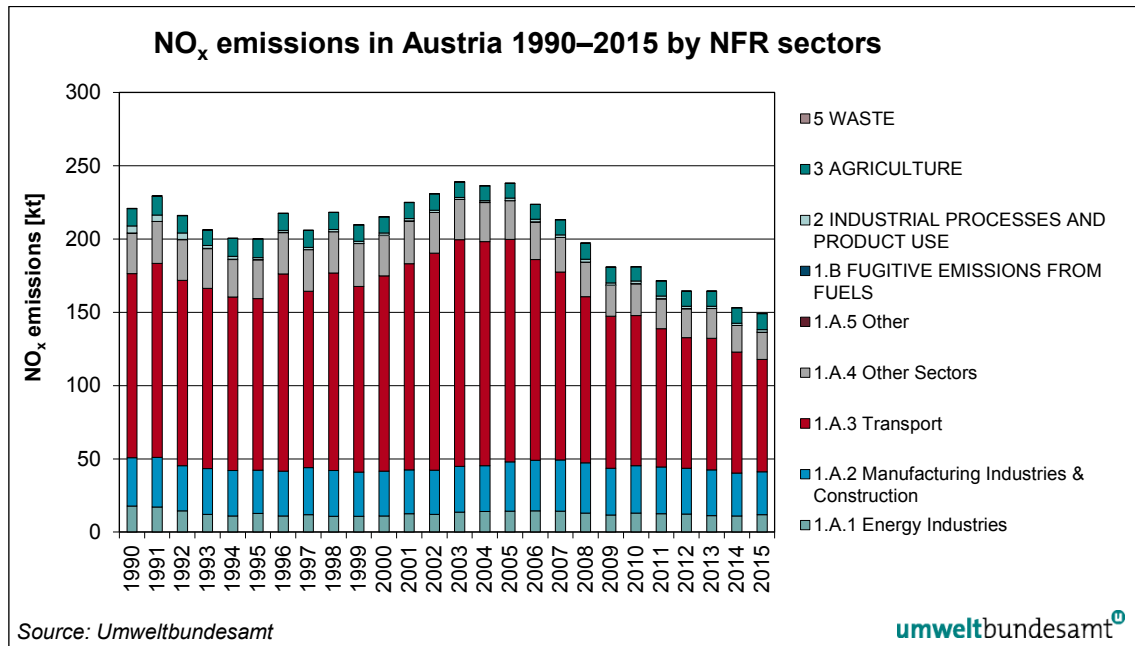


Figure 10: NO_x emissions in Austria 1990–2015 by sectors in absolute terms.

Table 36: NO_x emissions per NFR Category 1990 and 2015 their trend 1990–2015 and their share in total emissions.

NFR Category		NO _x Emission in [kt]		Trend		Share in National Total	
		1990	2015	1990–2015	2014–2015	1990	2015
1	ENERGY	204.10	136.48	-33%	-3%	92%	92%
1.A	FUEL COMBUSTION ACTIVITIES	204.10	136.48	-33%	-3%	92%	92%
1.A.1	Energy Industries	17.73	11.85	-33%	8%	8%	8%
1.A.1.a	Public Electricity and Heat Production	12.04	9.66	-20%	4%	5%	6%
1.A.1.b	Petroleum refining	4.32	1.06	-76%	3%	2%	1%
1.A.1.c	Manufacture of Solid fuels & Other Energy Ind.	1.37	1.13	-18%	68%	1%	1%
1.A.2	Manufacturing Industries and Construction	32.97	29.33	-11%	<1%	15%	20%
1.A.2.a	Iron and Steel	5.41	4.07	-25%	10%	2%	3%
1.A.2.b	Non-ferrous Metals	0.26	0.28	9%	20%	<1%	<1%
1.A.2.c	Chemicals	1.69	1.48	-12%	2%	1%	1%
1.A.2.d	Pulp, Paper and Print	7.00	4.78	-32%	-1%	3%	3%
1.A.2.e	Food Processing, Beverages & Tobacco	1.74	0.91	-48%	9%	1%	1%
1.A.2.f	Non-metallic Minerals	9.99	5.99	-40%	-4%	5%	4%
1.A.2.g	Manufacturing Industries and Constr. - other	6.88	11.81	72%	-2%	3%	8%
1.A.3	Transport	125.61	76.64	-39%	-7%	57%	51%
1.A.3.a	Civil Aviation	0.41	1.37	235%	7%	<1%	1%
1.A.3.b	Road Transportation	122.15	73.16	-40%	-7%	55%	49%
1.A.3.c	Railways	1.86	1.04	-44%	-4%	1%	1%
1.A.3.d	Navigation	0.58	0.57	-3%	-18%	<1%	<1%
1.A.3.e	Other transportation	0.61	0.51	-17%	7%	<1%	<1%
1.A.4	Other Sectors	27.72	18.59	-33%	3%	13%	12%
1.A.4.a	Commercial/Institutional	3.38	1.33	-61%	-4%	2%	1%
1.A.4.b	Residential	13.88	10.11	-27%	8%	6%	7%
1.A.4.c	Agriculture/Forestry/Fisheries	10.46	7.15	-32%	-3%	5%	5%
1.A.5	Other	0.07	0.08	11%	<1%	<1%	<1%
1.B	FUGITIVE EMISSIONS FROM FUELS	IE	IE	IE	IE	IE	IE
2	INDUSTRIAL PROCESSES /PRODUCT USE	4.80	1.72	-64%	15%	2%	1%
2.A	MINERAL PRODUCTS	NA	NA	NA	NA	NA	NA
2.B	CHEMICAL INDUSTRY	4.07	0.39	-90%	17%	2%	<1%
2.C	METAL PRODUCTION	0.17	0.11	-39%	-2%	<1%	<1%
2.D	NON ENERGY PRODUCTS/ SOLVENTS	NA	NA	NA	NA	NA	NA
2.G	Other product manufacture and use	NA	NA	NA	NA	NA	NA
2.H	Other Processes	0.55	1.22	122%	15%	<1%	1%
2.I	Wood processing	NA	NA	NA	NA	NA	NA
2.J	Production of POPs	NO	NO	NO	NO	NO	NO
2.K	"Consumption of POPs and heavy metals	NO	NO	NO	NO	NO	NO
2.L	Other production, consumption, storage ...	NO	NO	NO	NO	NO	NO
3	AGRICULTURE	11.89	10.91	-8%	4%	5%	7%
3.B	MANURE MANAGEMENT	0.48	0.37	-23%	<1%	<1%	<1%
3.D	AGRICULTURAL SOILS	11.38	10.53	-7%	4%	5%	7%
3.F	FIELD BURNING OF AGRICULTURAL RESIDUE	0.03	0.01	-80%	-26%	<1%	<1%
3.I	Agriculture OTHER	NO	NO	NO	NO	NO	NO
5	WASTE	0.10	0.01	-87%	<1%	<1%	<1%
Total without sinks		220.89	149.12	-32%	-3%		

2.1.3 NMVOC Emissions

In 1990, national total NMVOC emissions amounted to 281 kt. Emissions have decreased steadily since then and in the year 2015 emissions were reduced by 60% to 113 kt compared to 1990. From 2014 to 2015 emissions increased by 2.4%. This was mainly due to higher fuel demand for residential heating as a consequence of the low winter temperatures in 2015 (higher biomass consumption).

Main sources and emission trends in Austria

As can be seen in Figure 11 and Table 37, the main source of NMVOC emissions in 2015 in Austria is NFR sector 2 *Industrial Processes and Product Use* with a share of 62% in national total emissions, followed by 1.A *Fuel Combustion Activities* with a contribution of 35%.

NMVOC emissions resulting from NFR sectors 1.B *Fugitive Emissions*, 3 *Agriculture* and 5 *Waste* are minor sources contributing to national total NMVOC emissions with 2.1%, 1.0% and 0.1%, respectively.

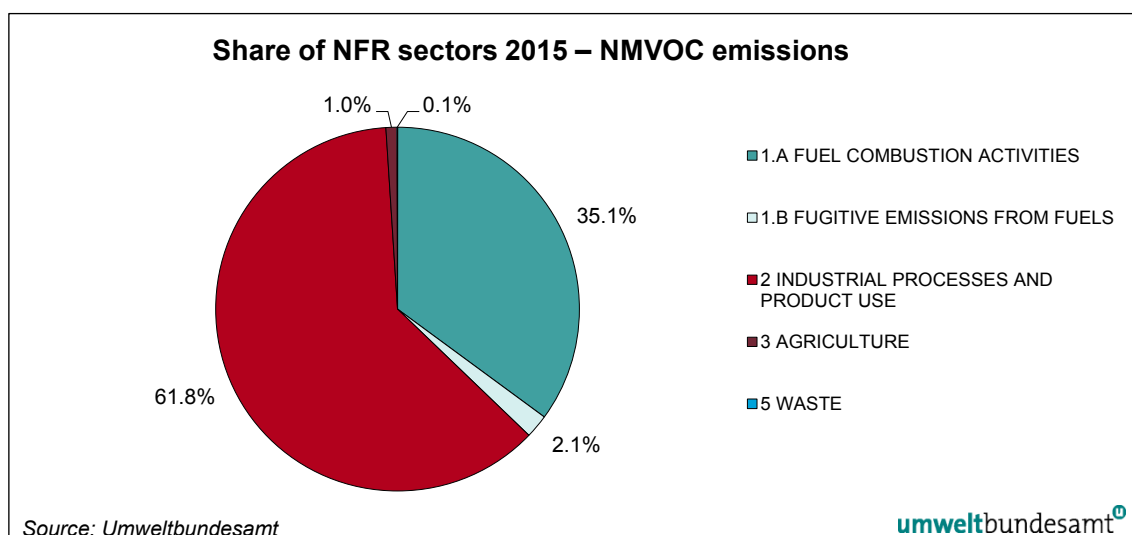


Figure 11: Share of NFR sectors 2015 in NMVOC emissions.

2 Industrial Processes and Product Use

The main source of NMVOC emissions in Austria within sector 2 *Industrial Processes and Product Use* is NFR 2.D.3 *Solvent Use* (57% of the national total).

The overall reduction in sector *Solvent Use* is due to abatement measures such as substitution, using products with lower solvent content as well as exhaust gas cleaning systems and after-treatment as a result of legal requirements.

- **NFR 2.D.3.a Domestic Solvent use including fungicides:** The increase of the NMVOC emissions until 2000 in this category is due to an increased use of solvent containing products in households; from 2000 onwards emissions are linked to populations' data.
- **NFR 2.D.3.d Coating Application:** This category contributed mainly to the overall decrease in the emissions of the concerned sector, which was primarily achieved from 1990 to 2000 due to various legal and regulatory enforcements (especially for coil and wood coating until 1999) and due to a reduction of solvents in paint as well as due to the substitution of solvent-based paint for paint with less or without solvents (see Chapter 4.6).

- **NFR 2.D.3.e and 2.D.3.f Degreasing and Dry Cleaning:** The emission reduction in this sub sectors was achieved due to technical abatement measures such as closed loop processes, waste gas purification and recycling.
- **NFR 2.D.3.g Chemical Products:** An emission reduction of 66% between 1990 and 2015 could be achieved due to technical abatement measures such as closed loop processes, waste gas purification and recycling but also due to product substitution. The NFR 2.D.3.g covers manufacturing activities mainly of pharmaceutical products, paints, wood preservatives and glues.
- **NFR 2.D.3.h Printing:** The decrease of NMVOC emissions (-67% between 1990 and 2015) is a result of legal/abatement measures.
- **NFR 2.D.3.i Other solvent use:** The long term emission reduction of 41% could be achieved due to technical abatement measures such as closed loop processes, waste gas purification and recycling.

1.A Fuel Combustion Activities

NMVOC emissions from *1.A Fuel Combustion Activities* contribute with 35% to the national total. Within sector *1.A Fuel Combustion Activities* the main emitters are *1.A.4 Other Sectors* (26% of the national total, mainly residential heating) and *1.A.3 Transport* (7.2% of the national total).

In source category *1.A Fuel Combustion Activities*, NMVOC emissions decreased notably in both main categories:

- **NFR 1.A.4 Other Sectors:** Emissions from residential heating decreased by 52% since 1990 due to improved biomass heatings in households and due to lower fuel wood consumption of stoves. Compared to the previous year 2014 emissions from this source category increased by 9.3% due to higher biomass use of households as a consequence of lower winter temperatures in 2015 (heating degree days increased by 11.6%).
- **NFR 1.A.3 Transport:** The introduction of more stringent emission standards for passenger cars according to the state-of-art (regulated catalytic converter) and the increased use of diesel vehicles in the passenger car sector are drivers for the decreasing trend since 1990 of NMVOC emissions (-89%).

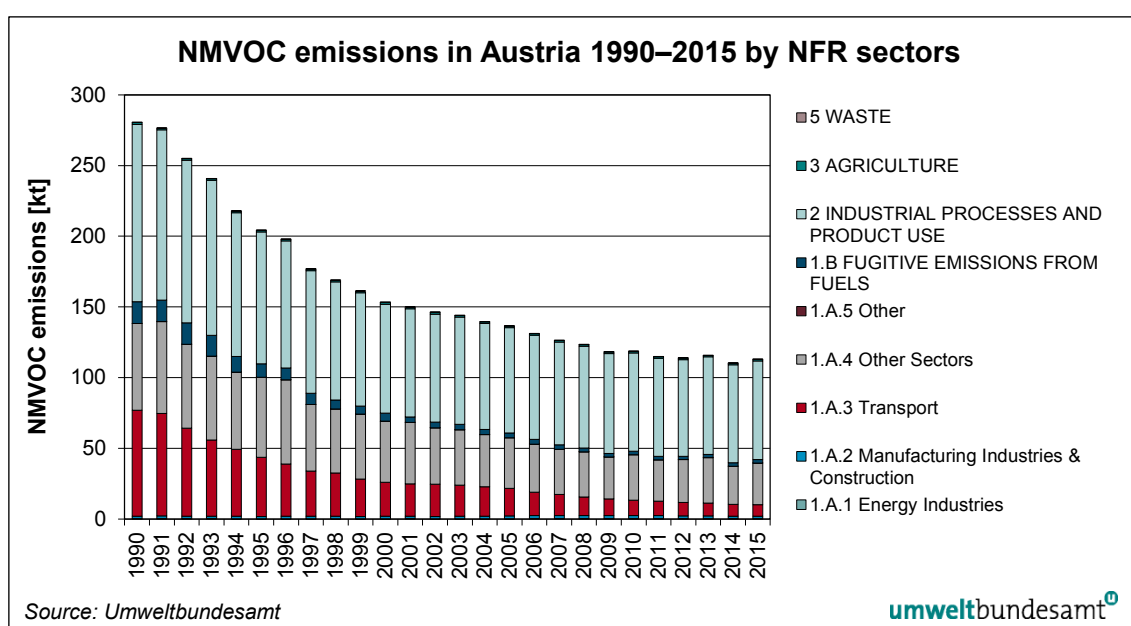


Figure 12: NMVOC emissions in Austria 1990–2015 by sectors in absolute terms.

Table 37: NMVOC emissions per NFR Category 1990 and 2015, their trend 1990–2015 and their share in total emissions.

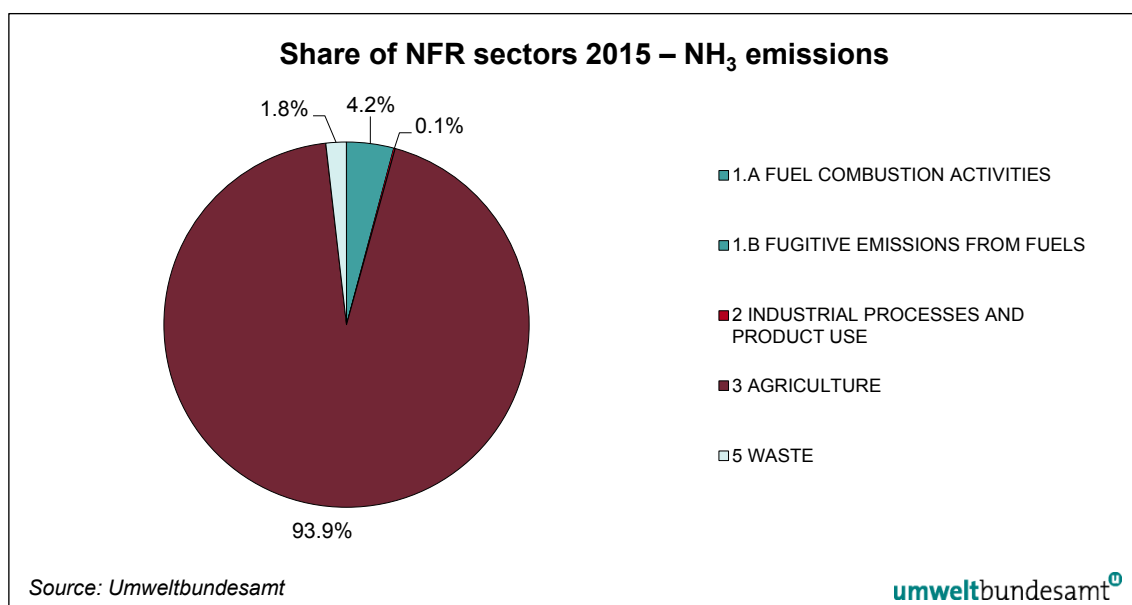
NFR Category		NMVOC Emission in [kt]		Trend		Share in National Total	
		1990	2015	1990– 2015	2014– 2015	1990	2015
1	ENERGY	153.67	41.96	-73%	6%	55%	37%
1.A	FUEL COMBUSTION ACTIVITIES	138.18	39.61	-71%	6%	49%	35%
1.A.1	Energy Industries	0.33	0.39	19%	7%	<1%	<1%
1.A.2	Manufacturing Industries and Construction	1.69	1.59	-6%	-2%	1%	1%
1.A.3	Transport	74.80	8.15	-89%	-3%	27%	7%
1.A.3.a	Civil Aviation	0.20	0.52	156%	6%	<1%	<1%
1.A.3.b	Road Transportation	73.59	7.23	-90%	-3%	26%	6%
1.A.3.c	Railways	0.38	0.11	-73%	-6%	<1%	<1%
1.A.3.d	Navigation	0.62	0.29	-54%	-10%	<1%	<1%
1.A.3.e	Other transportation	0.00	0.01	160%	16%	<1%	<1%
1.A.4	Other Sectors	61.36	29.47	-52%	9%	22%	26%
1.A.4.a	Commercial/Institutional	0.73	0.81	11%	17%	<1%	1%
1.A.4.b	Residential	56.23	25.13	-55%	10%	20%	22%
1.A.4.c	Agriculture/Forestry/Fisheries	4.39	3.53	-20%	3%	2%	3%
1.A.5	Other	0.01	0.02	10%	<1%	<1%	<1%
1.B	FUGITIVE EMISSIONS FROM FUELS	15.49	2.35	-85%	-3%	6%	2%
2	INDUSTRIAL PROCESSES AND PRODUCT USE	125.53	69.78	-44%	1%	45%	62%
2.A	MINERAL PRODUCTS	NA	NA	NA	NA	NA	NA
2.B	CHEMICAL INDUSTRY	8.29	1.32	-84%	<1%	3%	1%
2.C	METAL PRODUCTION	0.52	0.45	-14%	-1%	<1%	<1%
2.D	NON ENERGY PRODUCTS/ SOLVENTS	114.43	64.50	-44%	<1%	41%	57%
2.D.3	Solvent use	114.43	64.50	-44%	<1%	41%	57%
2.D.3.a	Domestic solvent use including fungicides	16.30	23.30	43%	<1%	6%	21%
2.D.3.b	Road paving with asphalt	IE	IE	IE	IE	IE	IE
2.D.3.c	Asphalt roofing	IE	IE	IE	IE	IE	IE
2.D.3.d	Coating applications	45.79	17.49	-62%	2%	16%	15%
2.D.3.e	Degreasing	13.26	7.41	-44%	<1%	5%	7%
2.D.3.f	Dry cleaning	0.44	0.02	-96%	<1%	<1%	<1%
2.D.3.g	Chemical products	12.79	4.32	-66%	<1%	5%	4%
2.D.3.h	Printing	12.65	4.15	-67%	<1%	5%	4%
2.D.3.i	Other solvent use	13.20	7.82	-41%	<1%	5%	7%
2.G	Other product manufacture and use	NA	NA	NA	NA	NA	NA
2.H	Other Processes	2.29	3.50	53%	5%	1%	3%
2.I	Wood processing	NA	NA	NA	NA	NA	NA
2.J	Production of POPs	NO	NO	NO	NO	NO	NO
2.K	"Consumption of POPs and heavy metals	NO	NO	NO	NO	NO	NO
2.L	Other production, consumption, storage, ...	NO	NO	NO	NO	NO	NO
3	AGRICULTURE	1.27	1.09	-15%	<1%	<1%	1%
5	WASTE	0.16	0.07	-59%	-6%	<1%	<1%
Total without sinks		280.63	112.89	-60%	2%		

2.1.4 NH₃ Emissions

In 1990, national total NH₃ emissions amounted to 66.1 kt; emissions have been quite stable over the period from 1990 to 2015. In 2015, emissions were 1.1% above 1990 levels and amounted to 66.9 kt. Compared to the previous year, emissions in 2015 remained nearly at the same level (+0.4%).

Main sources and emission trends in Austria

As it is illustrated in Figure 13 and in Table 38, NH₃ emissions in Austria are almost exclusively emitted by the agricultural sector. The share in national total NH₃ emissions is about 94% for 2015. Sector *1.A Fuel Combustion Activities* contributes with 4.2% in national total emissions. NH₃ emissions resulting from NFR sectors *2 Industrial Processes and Product Use* and *5 Waste* are minor sources. These sectors contribute to national total NH₃ emissions in 2015 with 0.1% and 1.8%, respectively.



Note: NH₃ emissions from NFR sector 1.B Fugitive Emissions from fuels are reported as IE.

Figure 13: Share of NFR sectors 2015 in NH₃ emissions.

3 Agriculture

In 1990 national NH₃ emissions from the sector *Agriculture* amounted to 63 kt; emissions have been relatively stable since then and by the year 2015 emissions were reduced by 0.7% to 63 kt mainly due to decreasing animal numbers. Compared to the previous year, emissions slightly increased in 2015 (+0.3%) due to higher consumption of mineral fertilizer on agricultural soils.

- *NFR 3.B Manure Management* has a share of 43.2% in national total NH₃ emissions in 2015. The emissions result from animal husbandry and the storage of manure. Within this source category manure management of cattle has the highest contribution with 58%. Emissions are linked to livestock numbers but also to housing systems and manure treatment (e.g. NH₃ emissions from loose housing systems are considerably higher than those applied for tied systems). Since 1990 emissions from this sub sector are increasing by 4.8%, mainly due to higher emissions from cattle.

- **NFR 3.D Agricultural Soils** with a share of 50.7% has the highest contribution to national total NH_3 emissions in 2015. These emissions result from fertilization with mineral N-fertilizers as well as organic fertilizers (including the application of animal manure, sewage sludge, energy crops and compost). Another source of NH_3 emissions is urine and dung deposited on pastures by grazing animals.

1.A Fuel Combustion Activities

NH_3 emissions from **1.A Fuel Combustion Activities** are the second largest source category but it is only a small source of NH_3 emissions with a contribution to national total NH_3 emissions of 4.2% in 2015. NH_3 emissions from NFR sector 1.A are increasing: in 1990, emissions amounted to about 2.3 kt. In the year 2015, they were about 22% higher than 1990 levels and amounted to about 2.8 kt. The increase is mainly due to an increase of biomass use for **1.A.1.a Public Electricity and Heat Production** and **1.A.2.g Other Stationary Combustion in Manufacturing Industries and Construction** (wood processing industries) as well as a slight increase from **1.A.3.b.i Passenger Cars - 4 stroke engines**.

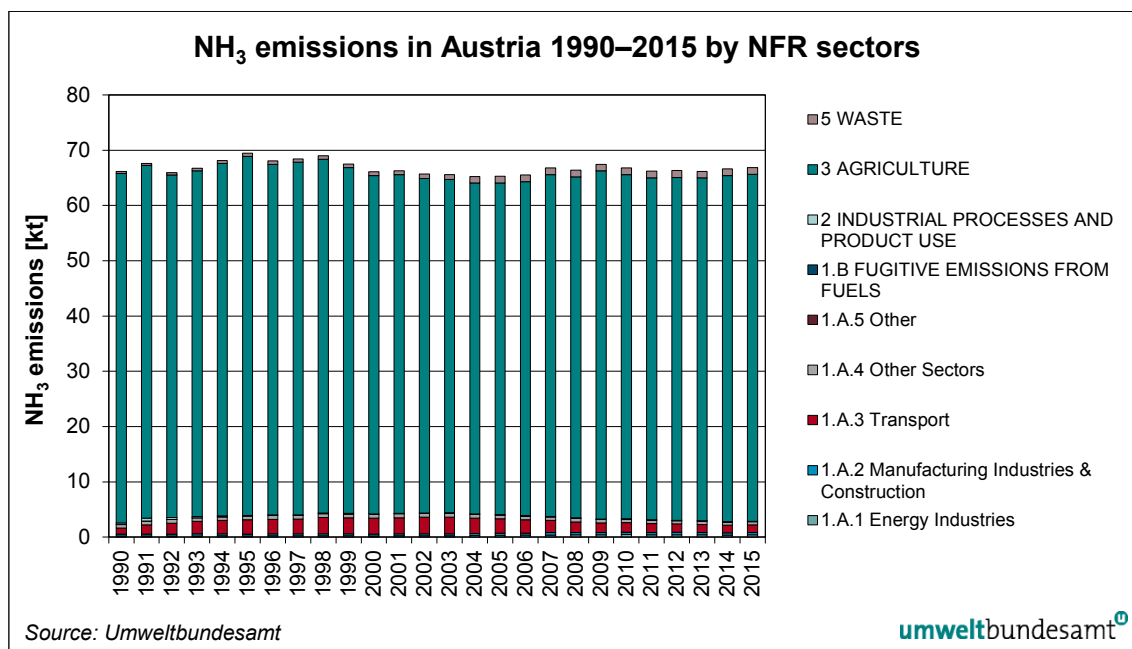


Figure 14: NH_3 emissions in Austria 1990–2015 by sectors in absolute terms.

Table 38: *NH₃ emissions per NFR Category 1990 and 2015, their trend 1990 – 2015 and their share in total emissions.*

NFR Category		NH ₃ Emission in [kt]		Trend		Share in National Total	
		1990	2015	1990–2015	2014–2015	1990	2015
1	ENERGY	2.29	2.79	22%	4%	3%	4%
1.A	FUEL COMBUSTION ACTIVITIES	2.29	2.79	22%	4%	3%	4%
1.A.1	Energy Industries	0.19	0.42	115%	10%	<1%	1%
1.A.2	Manufacturing Industries and Construction	0.33	0.44	31%	7%	1%	1%
1.A.3	Transport	1.14	1.35	18%	-1%	2%	2%
1.A.4	Other Sectors	0.63	0.59	-7%	8%	1%	1%
1.A.5	Other	0.00	0.00	34%	1%	<1%	<1%
1.B	FUGITIVE EMISSIONS FROM FUELS	IE	IE	IE	IE	IE	IE
2	INDUSTRIAL PROCESSES AND PRODUCT USE	0.27	0.08	-70%	-8%	<1%	<1%
2.A	MINERAL PRODUCTS	NA	NA	NA	NA	NA	NA
2.B	CHEMICAL INDUSTRY	0.27	0.08	-70%	-8%	<1%	<1%
2.C	METAL PRODUCTION	IE	IE	IE	IE	IE	IE
2.D	NON ENERGY PRODUCTS/ SOLVENTS	NA	NA	NA	NA	NA	NA
2.G	Other product manufacture and use	0.00	0.00	<1%	<1%	<1%	<1%
2.H	Other Processes	NA	NA	NA	NA	NA	NA
2.I	Wood processing	NA	NA	NA	NA	NA	NA
2.J	Production of POPs	NO	NO	NO	NO	NO	NO
2.K	"Consumption of POPs and heavy metals	NO	NO	NO	NO	NO	NO
2.L	Other production, consumption, storage, ...	NO	NO	NO	NO	NO	NO
3	AGRICULTURE	63.23	62.78	-1%	<1%	96%	94%
3.B	MANURE MANAGEMENT	27.55	28.88	5%	<1%	42%	43%
3.B.1	Cattle	14.48	16.77	16%	<1%	22%	25%
3.B.2	Sheep	0.54	0.61	14%	1%	1%	1%
3.B.3	Swine	8.46	6.26	-26%	<1%	13%	9%
3.B.4	Other livestock	4.07	5.24	29%	1%	6%	8%
3.B.4.a	Buffalo	NO	NO	NO	NO	NO	NO
3.B.4.d	Goats	0.06	0.13	105%	8%	<1%	<1%
3.B.4.e	Horses	0.67	1.65	144%	2%	1%	2%
3.B.4.f	Mules and asses	IE	IE	IE	IE	IE	IE
3.B.4.g	Poultry	3.31	3.44	4%	<1%	5%	5%
3.B.4.h	Other animals	0.03	0.03	13%	<1%	<1%	<1%
3.D	AGRICULTURAL SOILS	35.64	33.89	-5%	<1%	54%	51%
3.D.a	Direct Soil Emissions	35.64	33.89	-5%	<1%	54%	51%
3.D.b	Indirect emissions from managed soils	NO	NO	NO	NO	NO	NO
3.D.c	On-farm storage	NO	NO	NO	NO	NO	NO
3.D.d	Off-farm storage	NA	NA	NA	NA	NA	NA
3.D.e	Cultivated crops	NA	NA	NA	NA	NA	NA
3.D.f	Use of pesticides	NO	NO	NO	NO	NO	NO
3.F	FIELD BURNING OF AGRICULTURAL RES.	0.04	0.01	-69%	-16%	<1%	<1%
3.I	Agriculture OTHER	NO	NO	NO	NO	NO	NO
5	WASTE	0.36	1.22	240%	1%	1%	2%
Total without sinks		66.15	66.87	1%	<1%		

2.1.5 Carbon monoxide (CO) Emissions

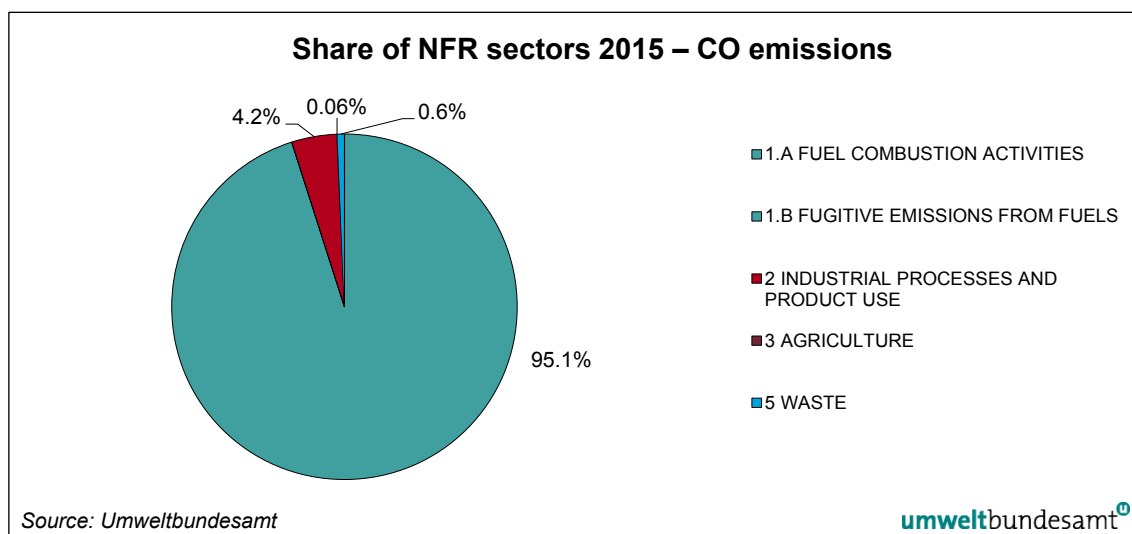
CO is a colourless and odourless gas, formed when carbon in fuel is not burned completely. It is a component of motor vehicle exhaust; other sources of CO emissions include industrial processes, non-transportation fuel combustion, and natural sources such as wildfires.

In 1990, national total CO emissions amounted to 1 287 kt. Emissions considerably decreased from 1990 to 2015. In 2015, emissions were 55.9% below 1990 levels and amounted to 567 kt. This reduction was mainly due to decreasing emissions from road transport (catalytic converters). The emissions increased between 2014 and 2015 by 5.3% (29 kt), mainly due to higher emissions from iron and steel plants (+11 kt) and an increased use of biomass in residential heatings (+21 kt).

Main sources and emission trends in Austria

As can be seen in Figure 15 and Table 39, CO emissions in Austria are almost exclusively emitted by the Energy sector, and more specifically, *1.A Fuel Combustion Activities*. The share in national total CO emissions is about 96% for 1990 and 95% for 2015.

CO emissions resulting from NFR sectors *2 Industrial Processes and Product Use*, *3 Agriculture* and *5 Waste* are minor sources. These sectors contribute to national total CO emissions with 4.2%, 0.1% and 0.6%, respectively.



Note: CO emissions from NFR sector 1.B Fugitive Emissions from fuels are reported as IE.

Figure 15: Share of NFR sectors 2015 in CO emissions.

1.A Fuel Combustion Activities

As described above, in the period 1990–2015, the share of CO emissions from *1.A Fuel Combustion Activities* in national total emissions has been stable in spite of growing activities because of considerable efforts regarding abatement techniques and improved combustion efficiency in all sub-sectors.

The main contributors of CO emissions within sector *1.A Fuel Combustion Activities* are:

- **NFR 1.A.4 Other Sectors:** CO emissions decreased since 1990 by 43% due the switch-over to improved technologies and decreased use of coke. Between 2014 and 2015 emissions increased by 9.2% because of the cold winter 2015 and thus increased use of biomass.
- **NFR 1.A.2 Manufacturing Industries and Construction:** Compared to 1990 emissions decreased by 26%. The trend is dominated by fuel combustion from iron and steel industry. The emissions increase of 5.0% compared to the previous year 2014 is mainly due to higher emissions from iron and steel plants.
- **NFR 1.A.3 Transport:** The significant emission reduction of 83% from *1.A.3 Transport* compared to 1990 was mainly possible due to optimized combustion processes in the engine and the introduction of the catalytic converters.

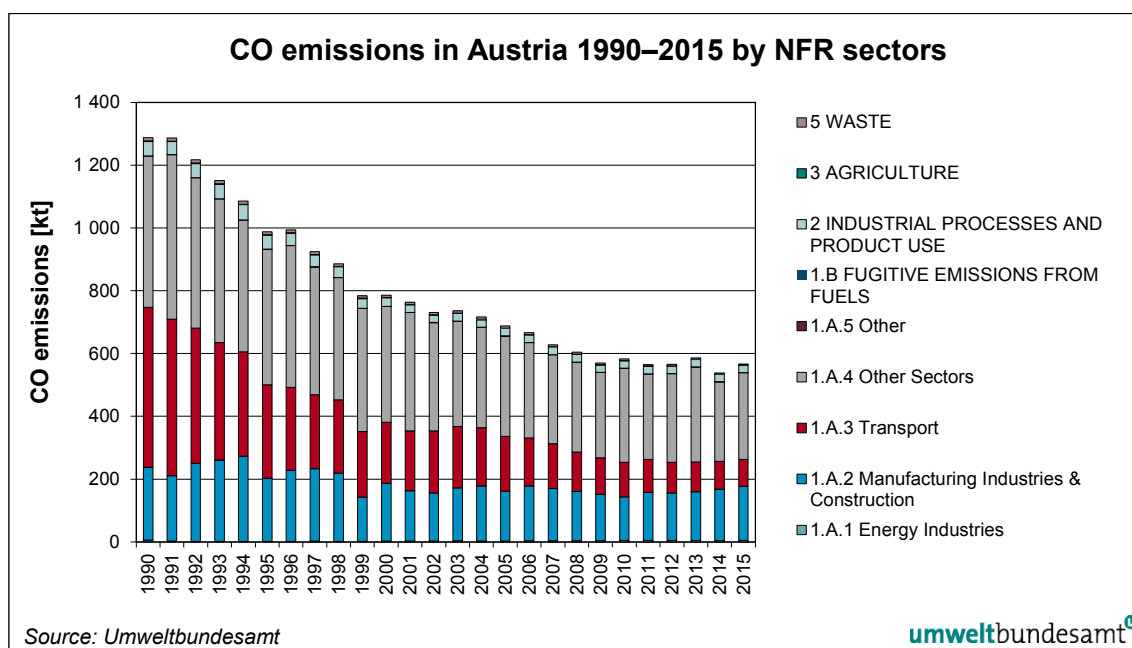


Figure 16: CO emissions in Austria 1990–2015 by sectors in absolute terms.

Table 39: CO emissions per NFR Category 1990 and 2015, their trend 1990–2015 and their share in total emissions.

NFR Category		CO Emission in [kt]		Trend		Share in National Total	
		1990	2015	1990–2015	2014–2015	1990	2015
1	ENERGY	1 229.31	539.12	-56%	6%	96%	95%
1.A	FUEL COMBUSTION ACTIVITIES	1 229.31	539.12	-56%	6%	96%	95%
1.A.1	Energy Industries	6.07	4.42	-27%	4%	<1%	1%
1.A.2	Manufacturing Industries and Construction	231.58	172.48	-26%	5%	18%	30%
1.A.2.a	Iron and Steel	210.72	145.68	-31%	8%	16%	26%
1.A.2.b	Non-ferrous Metals	0.05	0.08	64%	59%	<1%	<1%
1.A.2.c	Chemicals	0.80	1.05	32%	9%	<1%	<1%
1.A.2.d	Pulp, Paper and Print	4.09	1.89	-54%	-1%	<1%	<1%
1.A.2.e	Food Processing, Beverages and Tobacco	0.20	0.15	-24%	13%	<1%	<1%
1.A.2.f	Non-metallic Minerals	11.03	14.19	29%	-16%	1%	3%
1.A.2.g	Manufacturing Industries and Constr. - other	4.70	9.45	101%	-2%	<1%	2%
1.A.3	Transport	509.44	86.07	-83%	-3%	40%	15%
1.A.3.a	Civil Aviation	2.47	4.04	63%	10%	<1%	1%
1.A.3.b	Road Transportation	501.61	79.11	-84%	-3%	39%	14%
1.A.3.c	Railways	2.14	0.70	-67%	-4%	<1%	<1%
1.A.3.d	Navigation	3.19	2.12	-34%	-4%	<1%	<1%
1.A.3.e	Other transportation	0.04	0.11	160%	16%	<1%	<1%
1.A.4	Other Sectors	482.00	275.85	-43%	9%	37%	49%
1.A.4.a	Commercial/Institutional	11.94	6.93	-42%	9%	1%	1%
1.A.4.b	Residential	438.87	243.42	-45%	10%	34%	43%
1.A.4.c	Agriculture/Forestry/Fisheries	31.19	25.50	-18%	4%	2%	4%
1.A.5	Other	0.22	0.29	32%	1%	<1%	<1%
1.B	FUGITIVE EMISSIONS FROM FUELS	IE	IE	IE	IE	IE	IE
2	INDUSTRIAL PROCESSES AND PRODUCT USE	46.37	24.00	-48%	1%	4%	4%
2.A	MINERAL PRODUCTS	NA	NA	NA	NA	NA	NA
2.B	CHEMICAL INDUSTRY	12.67	11.13	-12%	<1%	1%	2%
2.C	METAL PRODUCTION	23.52	2.20	-91%	-2%	2%	<1%
2.D	NON ENERGY PRODUCTS/ SOLVENTS	9.78	9.78	<1%	<1%	1%	2%
2.G	Other product manufacture and use	NA	NA	NA	NA	NA	NA
2.H	Other Processes	0.40	0.89	122%	15%	<1%	<1%
2.I	Wood processing	NA	NA	NA	NA	NA	NA
2.J	Production of POPs	NO	NO	NO	NO	NO	NO
2.K	"Consumption of POPs and heavy metals	NO	NO	NO	NO	NO	NO
2.L	Other production, consumption, storage, ...	NO	NO	NO	NO	NO	NO
3	AGRICULTURE	1.20	0.36	-70%	-16%	<1%	<1%
3.B	MANURE MANAGEMENT	NA	NA	NA	NA	NA	NA
3.D	AGRICULTURAL SOILS	NA	NA	NA	NA	NA	NA
3.F	FIELD BURNING OF AGRICULT. RESIDUES	1.20	0.36	-70%	-16%	<1%	<1%
3.I	AGRICULTURE OTHER	NO	NO	NO	NO	NO	NO
5	WASTE	10.31	3.65	-65%	-6%	1%	1%
5.A	SOLID WASTE DISPOSAL ON LAND	10.26	3.64	-64%	-6%	1%	1%
5.B	BIOLOGICAL TREATMENT OF WASTE	NA	NA	NA	NA	NA	NA
5.C	INCINERATION/BURNING OF WASTE	0.05	0.01	-82%	<1%	<1%	<1%
5.D	WASTEWATER TREATMENT	NA	NA	NA	NA	NA	NA
5.E	OTHER WASTE HANDLING	NO	NO	NO	NO	NO	NO
Total without sinks		1 287.20	567.13	-56%	5%		

2.2 Emission Trends for Particulate matter (PM)

Particulate matter (PM) is a complex mixture consisting of both directly emitted and secondarily formed components of both natural and anthropogenic origin (e.g. geological material, combustion by-products and biological material). It has an inhomogeneous composition of sulphate, nitrate, ammonium, organic carbon, heavy metals, PAH and dioxins/furans (PCDD/F). Anthropogenic PM is formed during industrial production and combustion processes as well as during mechanical processes such as abrasion of surface materials. In addition, PM originates from secondary formation from SO_2 , NO_x , NMVOC or NH_3 .

PM does not only have effects on the chemical composition and reactivity of the atmosphere but also affects human and animal health and welfare. When breathed in, a particle-loaded atmosphere impacts on the respiratory tract. The observable effects are dependent on the particle size, therefore for legislative issues particulate matter is classified according to its size (see Figure 17).

PM₁₀ is the fraction of suspended particulate matter in the air with an aerodynamic diameter of less than 10 μm . These particles are small enough to be breathable and could be deposited in lungs, which may cause deteriorated lung functions.

The size fraction **PM_{2.5}** refers to particles with an aerodynamic diameter of less than 2.5 μm . Studies link long-term exposure to PM_{2.5} with cardiovascular and respiratory deaths, as well as increased sickness, such as childhood respiratory diseases. PM_{2.5} also causes reductions in visibility and solar radiation due to enhanced scattering of light. Aerosol precursors such as ammonia (the source of which is mainly agriculture) form PM_{2.5} as secondary particles through chemical reactions in the atmosphere.

Total suspended particulate matter (TSP) refers to the entire range of ambient air matter that can be collected, from the sub-micron level up to 100 μm in aerodynamic diameter (d_{ae}). Particles with a d_{ae} larger than 100 μm will not remain suspended in the atmosphere for a significant length of time. Compared to PM₁₀ and PM_{2.5}, TSP remains in the air for shorter periods of time and is therefore generally not carried over long distances. As a result, TSP pollution tends to be a local rather than a regional problem, occurring close to industrial sources, such as metal processing plants and mining operations, along roads because of the re-suspension, and close to stables and agricultural crop land.

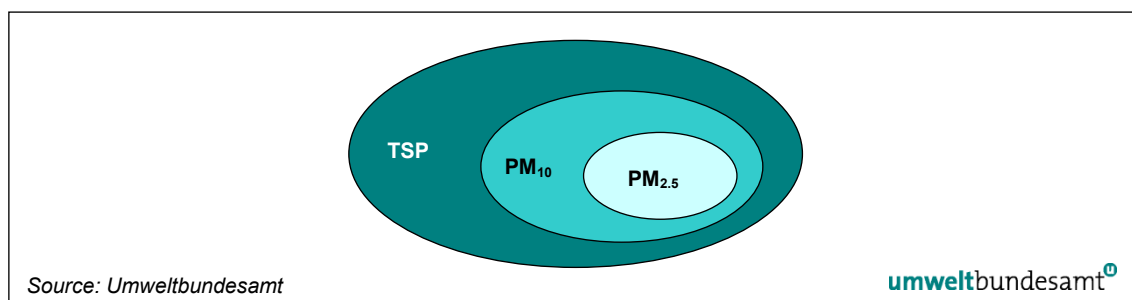


Figure 17: Distribution of TSP, PM₁₀ and PM_{2.5} (schematic).

Main sources and emission trends in Austria

Particulate matter emissions in Austria mainly arise from 1.A *Fuel Combustion Activities* (1.A.3 *Road transport*, 1.A.4 *Other sectors – residential heating*), 2 *Industrial Processes and Product Use* and 3 *Agriculture*. Where for TSP the most important source is industrial processes, small heating installations are the highest contributor for PM_{2.5} emissions.

NFR sectors 1.B *Fugitive Emissions* and 5 *Waste* are minor sources regarding PM emissions (less than 1%).

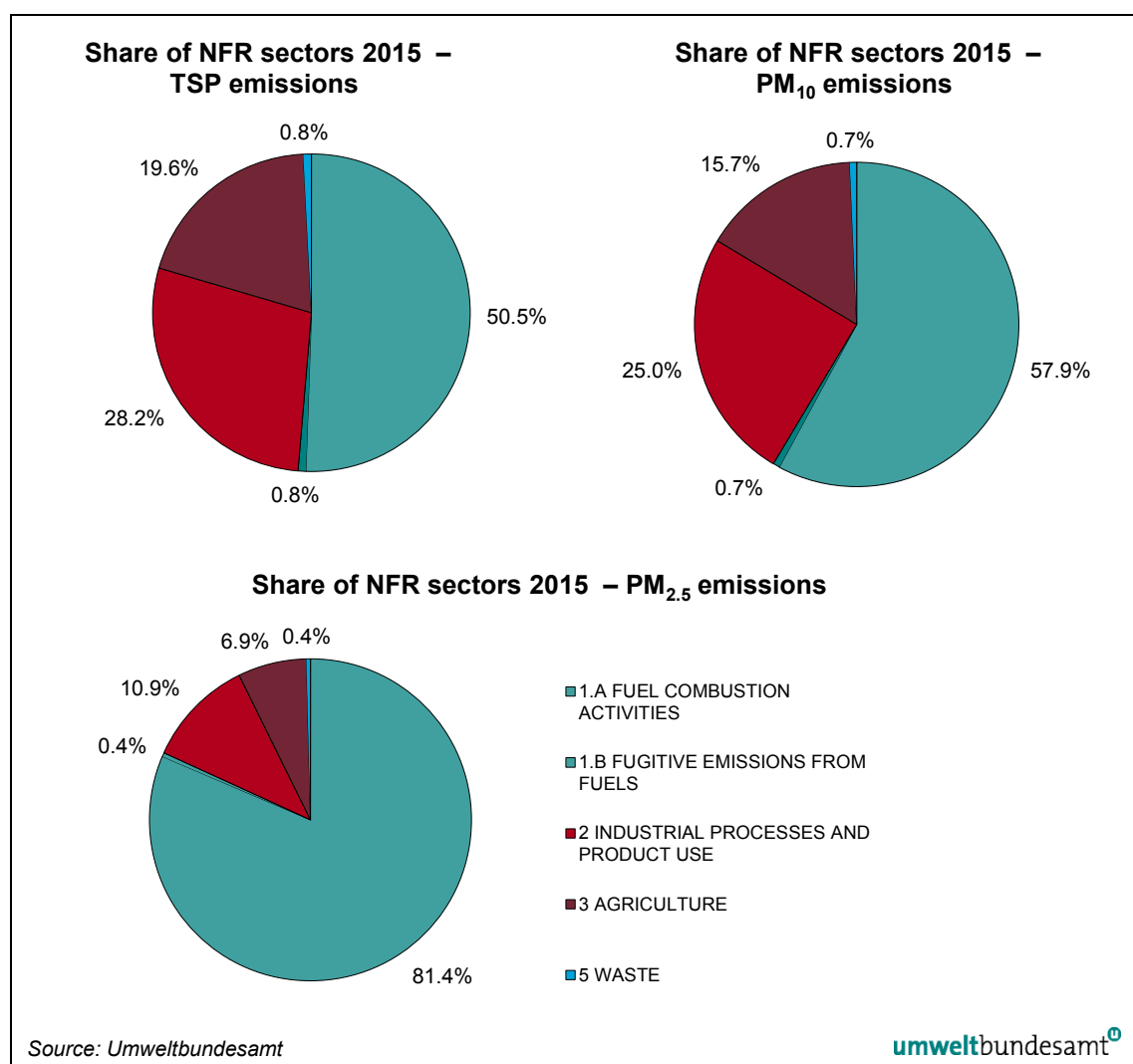


Figure 18: Share of NFR sectors 2015 in PM emissions (TSP, PM₁₀ and PM_{2.5}).

Table 40: National total emissions and emission trends for particulate matter (PM) 1990–2015.

Year	Emissions [kt]		
	TSP	PM ₁₀	PM _{2.5}
1990	61.856	40.294	25.248
:	NR	NR	NR
1995	62.434	39.647	24.387
:	NR	NR	NR
2000	62.602	39.135	23.631
2001	62.258	39.049	23.777
2002	61.223	37.963	22.964
2003	61.111	37.817	22.839

Year	Emissions [kt]		
	TSP	PM ₁₀	PM _{2.5}
2004	61.529	37.720	22.426
2005	61.096	37.266	22.106
2006	59.530	35.990	21.243
2007	58.636	35.066	20.432
2008	59.272	35.087	19.945
2009	56.601	33.252	18.710
2010	57.019	33.591	19.022
2011	56.643	32.932	18.182
2012	56.003	32.445	17.823
2013	56.413	32.753	18.059
2014	54.693	30.921	16.277
2015	55.236	31.318	16.622
Trend 1990–2015	-10.7%	-22.3%	-34.2%

Particulate matter (PM) emissions show a decreasing trend over the period 1990 to 2015: TSP emissions decreased by 10.7%, PM₁₀ emissions were about 22.3% below the level of 1990, and PM_{2.5} emissions dropped by about 34.2%. Between 2014 and 2015 PM emissions increased by 1.0% (TSP), 1.3% (PM₁₀) and 2.1% (PM_{2.5}) mainly because of higher biomass consumption of the residential sector due to colder winter temperatures in 2015, which has been partly compensated by decreasing emissions from road transport. Apart from industry and road transport, private households and the agricultural sector are the main contributors to PM emissions. The explanations for these trends are given below.

1.A Fuel Combustion Activities

One of the main sources of PM emissions is NFR sector *1.A Fuel Combustion Activities*. Within this source the largest contributors are *NFR 1.A.3 Transport*, *NFR 1.A.4 Other Sectors* and *NFR 1.A.2 Manufacturing Industries and Construction*. Further important sources of PM emissions are the sectors *2 Industrial Processes and Product Use (2.A Mineral Products)* as well as *3 Agriculture (3.D Agricultural Soils)*.

- *NFR 1.A.3 Transport* includes transportation activities, mechanical abrasion from road surfaces, and re-suspended dust from roads and has a contribution of 24% TSP, 18% PM₁₀ and 18% PM_{2.5} emissions of the respective national totals. The reduction of PM emissions since 2005 is due to improvements in the drive and exhaust gas after treatment technologies and the integration of particulate filter systems in the fuel consumption based taxation for passenger cars in Austria (NOVA). PM emissions from automobile tyre and break wear (reported together with automobile road abrasion under *1.A.3.b.7*) are increasing as a function of travelled vehicles kilometres which have shown an increasing trend since 1990.
- *NFR 1.A.4 Other Sectors*: small combustion plants, residential heating, household ovens and stoves (*NFR 1.A.4.b*) are large sources of TSP, PM₁₀ and PM_{2.5}, as well as Off Road Vehicles and Other Machinery (*NFR 1.A.4.c*) which are important sources of PM_{2.5}. Emission reduction could be achieved through:
 - substitution of old installations with modern technology,
 - reduction of biomass consumption in household ovens and stoves due to less use as a main heating system,

- installation of energy-saving boilers,
- connection to the district-heating networks or other public energy- and heating networks,
- substitution from high-emission fuels to low-emission (low-ash) fuels (wood pellets),
- raising awareness for energy saving.

This downward trend counteracted the application of CO₂-neutral fuels such as biomass (wood, pellets etc.).

- **NFR 1.A.1 Energy Industries and NFR 1.A.2 Manufacturing Industries and Construction:** NFR 1.A.2 *Manufacturing Industries and Construction* is responsible for 8.2% of the national total TSP emissions, 11% of PM₁₀ emissions and 14% of PM_{2.5} emissions. 1.A.1 *Energy Industries* contributes in 2015 with 2.4% of TSP, 3.9% of PM₁₀ and 6.2% of PM_{2.5} to the respective national totals. Achievements for reducing emissions in both subcategories were made by several appropriate measures in this category:

- application of abatement techniques such as flue gas collection and flue gas cleaning systems (already in the 1980),
- installation of energy- and resource-saving production processes (already in the 1980),
- substitution from high-emission fuels to low-emission (low-ash) fuels (already in the 1980),
- raising awareness for environmental production.

However, the measures are more than counterbalanced in the last decade by the enormous increase in energy consumption. Another reason for rising PM emissions in these source categories is the increasing use of CO₂-neutral fuels such as biomass (wood, pellets etc.) in district-heating plants. Even with modern combustion technology solid biomass causes considerable higher emissions than liquid or gaseous fuels.

2 Industrial Processes and Product Use

- **NFR 2.A Mineral Products:** The handling of bulk materials like mineral products and the activities in the field of civil engineering represent the majority of PM sources within sector 2 *Industrial Processes and Product Use*. The increase of PM emissions since 1990 of subcategory NFR 2.A *Mineral products* is a result of increased activities due to manifold construction activities, whereas from 2008 to 2010 a significant decrease because of the economic crisis can be noted. Since 2011 the emission trend shows ups and downs. Between 2014 and 2015 a decrease can be observed.
- **NFR 2.C Metal Production,** a decreasing trend of about 88% of all PM fractions can be noted for the period 1990 to 2015 because considerable efforts were made by introducing low-PM technologies, abatement techniques, flue gas collection and flue gas cleaning systems etc. In 2015 this sub category represents a minor source of PM emissions.

3 Agriculture

- **NFR 3.D Agricultural Soils,** which consider tillage operations and harvesting activities, is the main source of PM emissions within sector Agriculture. The decrease in agricultural production (soil cultivation, harvesting etc.) is responsible for the decrease of about 11% of the total agricultural PM_{2.5} emissions. Total TSP and PM₁₀ emissions from sector 3 *Agriculture* decreased by 6.0% and 6.7% over the period 1990 to 2015.

PM₁₀ emissions and emission trends in Austria

National total PM₁₀ emissions amounted to 40 kt in 1990 and have decreased steadily so that by the year 2015 emissions were reduced by 22% (to 31 kt) – see Table 41.

As shown in Figure 18 and Table 41, the main sources for PM₁₀ emissions in 2015 in Austria are combustion processes in the NFR category 1.A *Fuel Combustion Activities* (58% in national total emissions) as well as handling of bulk materials like mineral products and the activities in the field of civil engineering of category 2 *Industrial Processes and Product Use* (25% in national total emissions).

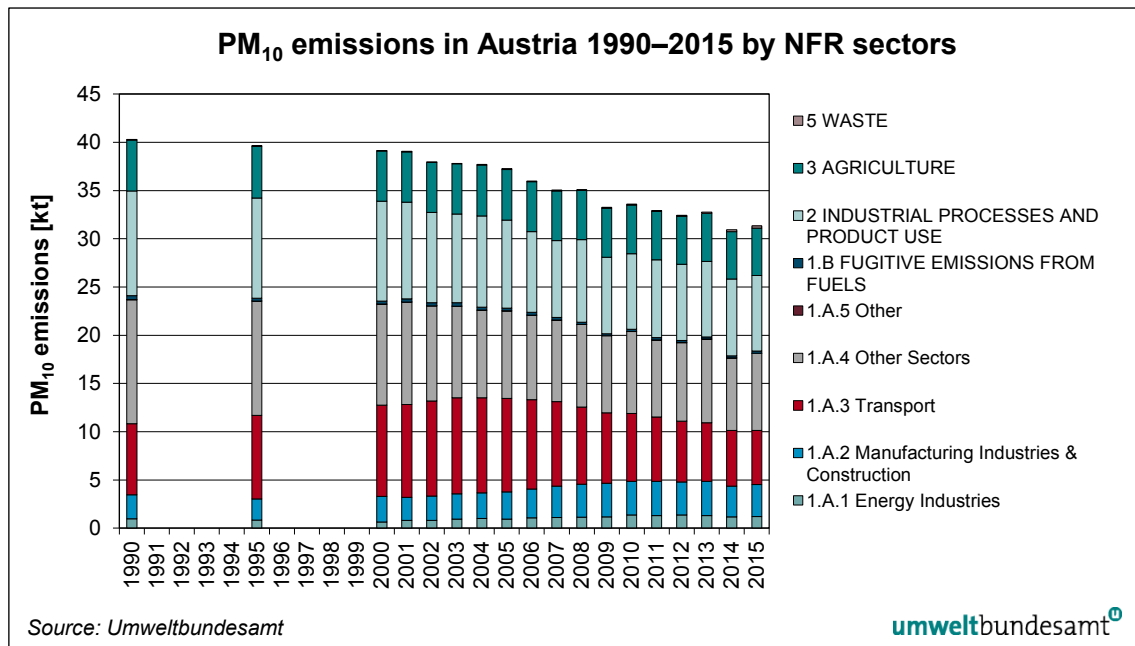


Figure 19: PM₁₀ emissions in Austria 1990–2015 by sectors in absolute terms.

Table 41: PM₁₀ emissions per NFR Category 1990 and 2015, their trend 1990–2015 and their share in total emissions.

NFR Category		PM ₁₀ Emission in [kt]		Trend		Share in National Total	
		1990	2015	1990–2015	2014–2015	1990	2015
1	ENERGY	24.10	18.35	-24%	3%	60%	59%
1.A	FUEL COMBUSTION ACTIVITIES	23.70	18.13	-23%	3%	59%	58%
1.A.1	Energy Industries	0.98	1.22	25%	5%	2%	4%
1.A.2	Manufacturing Industries and Construction	2.50	3.30	32%	3%	6%	11%
1.A.2.a	Iron and Steel	0.05	0.01	-78%	4%	<1%	<1%
1.A.2.b	Non-ferrous Metals	0.01	0.02	59%	69%	<1%	<1%
1.A.2.c	Chemicals	0.29	0.34	17%	5%	1%	1%
1.A.2.d	Pulp, Paper and Print	0.95	0.25	-74%	18%	2%	1%
1.A.2.e	Food Processing, Beverages and Tobacco	0.11	0.03	-77%	11%	<1%	<1%
1.A.2.f	Non-metallic Minerals	0.07	0.09	31%	38%	<1%	<1%
1.A.2.g	Manufacturing Ind. and Constr. - other	1.02	2.56	152%	1%	3%	8%
1.A.3	Transport	7.35	5.62	-24%	-3%	18%	18%
1.A.3.a	Civil Aviation	0.03	0.11	225%	5%	<1%	<1%
1.A.3.b	Road Transportation	6.19	4.87	-21%	-3%	15%	16%
1.A.3.c	Railways	0.99	0.60	-40%	-1%	2%	2%
1.A.3.d	Navigation	0.13	0.04	-67%	-21%	<1%	<1%
1.A.3.e	Other transportation	0.00	0.00	160%	16%	<1%	<1%
1.A.4	Other Sectors	12.85	7.98	-38%	6%	32%	25%
1.A.4.a	Commercial/Institutional	0.75	0.34	-55%	4%	2%	1%
1.A.4.b	Residential	9.47	6.23	-34%	8%	24%	20%
1.A.4.c	Agriculture/Forestry/Fisheries	2.62	1.41	-46%	-2%	7%	4%
1.A.5	Other	0.02	0.02	7%	1%	<1%	<1%
1.B	FUGITIVE EMISSIONS FROM FUELS	0.40	0.21	-48%	8%	1%	1%
2	INDUSTRIAL PROCESSES AND PRODUCT USE	10.86	7.84	-28%	-2%	27%	25%
2.A	MINERAL PRODUCTS	4.94	6.12	24%	-2%	12%	20%
2.A.1	Cement Production	0.16	0.05	-68%	2%	<1%	<1%
2.A.2	Lime Production	0.06	0.09	51%	-2%	<1%	<1%
2.A.3	Glass production	IE	IE	IE	IE	IE	IE
2.A.5	Mining, construction, handling of products	4.73	5.98	27%	-2%	12%	19%
2.A.6	Other Mineral products	NO	NO	NO	NO	NO	NO
2.B	CHEMICAL INDUSTRY	0.57	0.27	-53%	<1%	1%	1%
2.C	METAL PRODUCTION	4.58	0.54	-88%	-7%	11%	2%
2.D	NON ENERGY PRODUCTS/ SOLVENTS	NA	NA	NA	NA	NA	NA
2.G	Other product manufacture and use	0.41	0.46	12%	1%	1%	1%
2.H	Other Processes	0.00	0.00	-18%	-1%	<1%	<1%
2.I	Wood processing	0.37	0.46	26%	2%	1%	1%
2.J	Production of POPs	NO	NO	NO	NO	NO	NO
2.K	"Consumption of POPs and heavy metals	NO	NO	NO	NO	NO	NO
2.L	Other production, consumption, storage,...	NO	NO	NO	NO	NO	NO
3	AGRICULTURE	5.27	4.92	-7%	<1%	13%	16%
3.B	MANURE MANAGEMENT	0.54	0.48	-12%	<1%	1%	2%
3.D	AGRICULTURAL SOILS	4.58	4.38	-4%	<1%	11%	14%
3.F	FIELD BURNING OF AGRICUL. RESIDUES	0.14	0.06	-55%	-8%	<1%	<1%
3.I	Agriculture OTHER	NO	NO	NO	NO	NO	NO
5	WASTE	0.07	0.21	207%	25%	<1%	1%
Total without sinks		40.29	31.32	-22%	1%		

PM_{2.5} emissions and emission trends in Austria

National total PM_{2.5} emissions amounted to 25 kt in 1990 and have decreased steadily so that by the year 2015 emissions were reduced by 34% (to 17 kt) – see Table 42.

As shown in Figure 18 and Table 42, PM_{2.5} emissions in Austria mainly arose from combustion processes in the energy sector with a share of 81% in the total emissions in 2015. Besides the sources already mentioned in the context of TSP and PM₁₀, PM_{2.5} emissions resulted on a big scale from power plants with flue gas cleaning systems, which filter larger particles. Further emission sources are NFR sectors 2 *Industrial Processes and Product Use* and 3 *Agriculture*, which had a share of 11% and 6.9%, respectively, in national total emissions.

In general, the reduction of PM_{2.5} emission is due to the installation of flue gas collection and modern flue gas cleaning technologies in several branches.

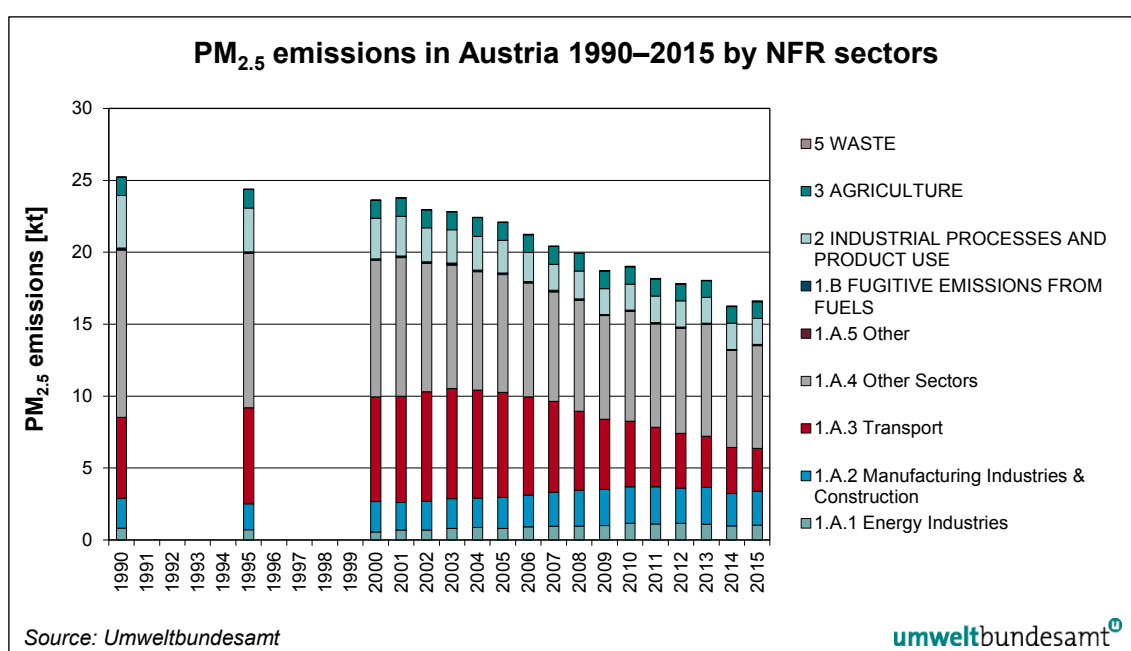


Figure 20: PM_{2.5} emissions in Austria 1990–2015 by sectors in absolute terms.

Table 42: *PM_{2.5} emissions per NFR Category 1990 and 2015, their trend 1990–2015 and their share in total emissions.*

NFR Category		PM _{2.5} Emission in [kt]		Trend		Share in National Total	
		1990	2015	1990–2015	2014–2015	1990	2015
1	ENERGY	20.30	13.60	-33%	3%	80%	82%
1.A	FUEL COMBUSTION ACTIVITIES	20.19	13.53	-33%	3%	80%	81%
1.A.1	Energy Industries	0.83	1.03	24%	5%	3%	6%
1.A.2	Manufacturing Industries and Construction	2.06	2.35	14%	4%	8%	14%
1.A.2.a	Iron and Steel	0.04	0.01	-78%	4%	<1%	<1%
1.A.2.b	Non-ferrous Metals	0.01	0.01	59%	69%	<1%	<1%
1.A.2.c	Chemicals	0.24	0.28	17%	5%	1%	2%
1.A.2.d	Pulp, Paper and Print	0.78	0.21	-74%	18%	3%	1%
1.A.2.e	Food Processing, Beverages and Tobacco	0.09	0.02	-77%	11%	<1%	<1%
1.A.2.f	Non-metallic Minerals	0.06	0.08	31%	38%	<1%	<1%
1.A.2.g	Manufacturing Industries and Constr. - other	0.84	1.74	107%	1%	3%	10%
1.A.3	Transport	5.62	2.99	-47%	-7%	22%	18%
1.A.3.a	Civil Aviation	0.03	0.11	225%	5%	<1%	1%
1.A.3.b	Road Transportation	4.83	2.59	-46%	-7%	19%	16%
1.A.3.c	Railways	0.63	0.23	-63%	-3%	2%	1%
1.A.3.d	Navigation	0.13	0.04	-67%	-21%	1%	<1%
1.A.3.e	Other transportation	0.00	0.00	160%	16%	<1%	<1%
1.A.4	Other Sectors	11.65	7.15	-39%	6%	46%	43%
1.A.4.a	Commercial/Institutional	0.68	0.32	-54%	4%	3%	2%
1.A.4.b	Residential	8.52	5.63	-34%	8%	34%	34%
1.A.4.c	Agriculture/Forestry/Fisheries	2.45	1.20	-51%	-2%	10%	7%
1.A.5	Other	0.02	0.02	7%	1%	<1%	<1%
1.B	FUGITIVE EMISSIONS FROM FUELS	0.11	0.07	-39%	8%	<1%	<1%
2	INDUSTRIAL PROCESSES AND PRODUCT USE	3.65	1.81	-50%	-1%	14%	11%
2.A	MINERAL PRODUCTS	0.71	0.78	9%	<1%	3%	5%
2.A.1	Cement Production	0.14	0.04	-68%	2%	1%	<1%
2.A.2	Lime Production	0.04	0.06	51%	-2%	<1%	<1%
2.A.3	Glass production	IE	IE	IE	IE	IE	IE
2.A.5	Mining, construction, handling of products	0.53	0.67	26%	<1%	2%	4%
2.A.6	Other Mineral products	NO	NO	NO	NO	NO	NO
2.B	CHEMICAL INDUSTRY	0.30	0.14	-53%	<1%	1%	1%
2.C	METAL PRODUCTION	2.08	0.25	-88%	-7%	8%	1%
2.D	NON ENERGY PRODUCTS/ SOLVENTS	NA	NA	NA	NA	NA	NA
2.G	Other product manufacture and use	0.41	0.46	12%	1%	2%	3%
2.H	Other Processes	0.00	0.00	-40%	-1%	<1%	<1%
2.I	Wood processing	0.15	0.18	26%	2%	1%	1%
2.J	Production of POPs	NO	NO	NO	NO	NO	NO
2.K	"Consumption of POPs and heavy metals	NO	NO	NO	NO	NO	NO
2.L	Other production, consumption, storage, ...	NO	NO	NO	NO	NO	NO
3	AGRICULTURE	1.28	1.15	-11%	-1%	5%	7%
3.B	MANURE MANAGEMENT	0.12	0.11	-12%	<1%	<1%	1%
3.D	AGRICULTURAL SOILS	1.02	0.98	-4%	<1%	4%	6%
3.F	FIELD BURNING OF AGRICULT. RES.	0.14	0.06	-54%	-7%	1%	<1%
3.I	Agriculture OTHER	NO	NO	NO	NO	NO	NO
5	WASTE	0.02	0.07	194%	24%	<1%	<1%
Total without sinks		25.25	16.62	-34%	2%		

Total suspended particulate matter (TSP) emissions and emission trends in Austria

National total TSP emissions amounted to 62 kt in 1990, decreased over the period 1990 to 2015 by 11% and amounted to 55 kt in 2015, as can be seen in Figure 18 and Table 43. TSP emissions in Austria mainly derive from *2 Industrial Processes and Product Use* with a share of 28% in national total emissions in 2015 as well as *1.A.3 Road Transport* with a share of 21%. Further important sources are *3.D Agricultural Soils* contributing with 18% and *1.A.4 Other Sectors* (mainly small heating installations) with 16% in national total emissions.

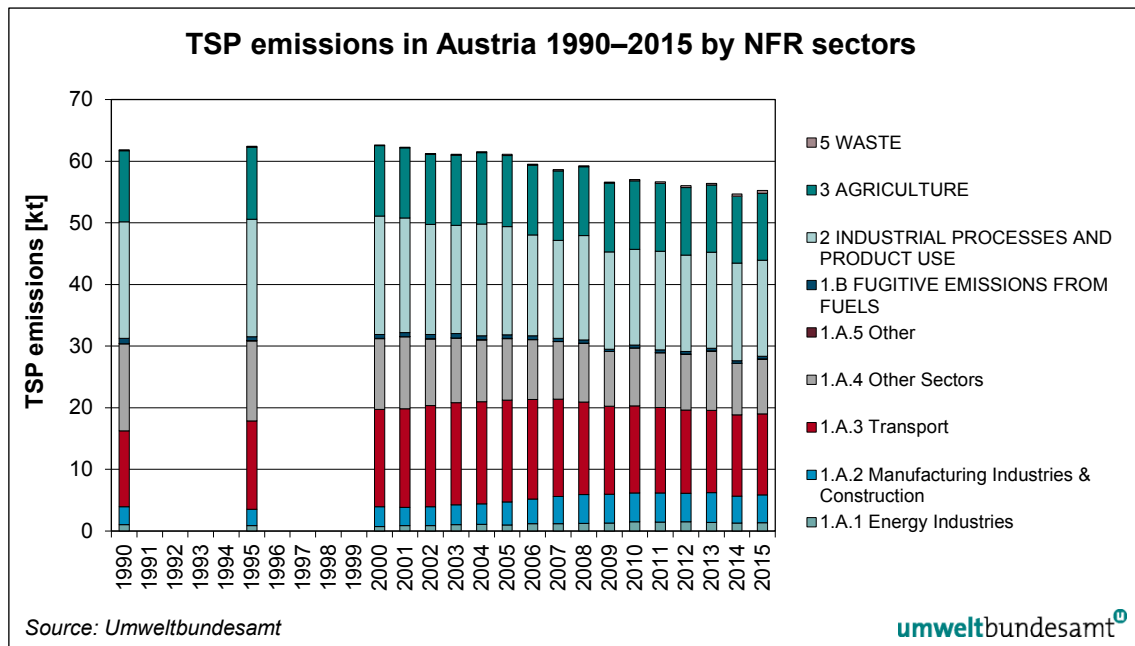


Figure 21: TSP emissions in Austria 1990–2015 by sectors in absolute terms.

Table 43: TSP emissions per NFR Category 1990 and 2015, their trend 1990–2015 and their share in total emissions.

NFR Category		TSP Emission in [kt]		Trend		Share in National Total	
		1990	2015	1990–2015	2014–2015	1990	2015
1	ENERGY	31.23	28.36	-9%	3%	50%	51%
1.A	FUEL COMBUSTION ACTIVITIES	30.38	27.92	-8%	3%	49%	51%
1.A.1	Energy Industries	1.03	1.33	29%	5%	2%	2%
1.A.2	Manufacturing Industries and Construction	2.90	4.50	55%	2%	5%	8%
1.A.2.a	Iron and Steel	0.06	0.01	-78%	4%	<1%	<1%
1.A.2.b	Non-ferrous Metals	0.01	0.02	59%	69%	<1%	<1%
1.A.2.c	Chemicals	0.32	0.38	17%	5%	1%	1%
1.A.2.d	Pulp, Paper and Print	1.06	0.28	-74%	18%	2%	1%
1.A.2.e	Food Processing, Beverages and Tobacco	0.12	0.03	-77%	11%	<1%	<1%
1.A.2.f	Non-metallic Minerals	0.08	0.10	31%	38%	<1%	<1%
1.A.2.g	Manufacturing Industries and Constr. - other	1.25	3.69	194%	<1%	2%	7%
1.A.3	Transport	12.30	13.16	7%	<1%	20%	24%
1.A.3.a	Civil Aviation	0.03	0.11	225%	5%	<1%	<1%
1.A.3.b	Road Transportation	10.10	11.36	12%	<1%	16%	21%
1.A.3.c	Railways	2.03	1.63	-19%	<1%	3%	3%
1.A.3.d	Navigation	0.13	0.04	-67%	-21%	<1%	<1%
1.A.3.e	Other transportation	0.00	0.01	160%	16%	<1%	<1%
1.A.4	Other Sectors	14.13	8.90	-37%	6%	23%	16%
1.A.4.a	Commercial/Institutional	0.82	0.36	-57%	5%	1%	1%
1.A.4.b	Residential	10.43	6.84	-34%	9%	17%	12%
1.A.4.c	Agriculture/Forestry/Fisheries	2.89	1.71	-41%	-1%	5%	3%
1.A.5	Other	0.02	0.02	6%	1%	<1%	<1%
1.B	FUGITIVE EMISSIONS FROM FUELS	0.85	0.45	-48%	8%	1%	1%
2	INDUSTRIAL PROCESSES AND PRODUCT USE	18.94	15.57	-18%	-2%	31%	28%
2.A	MINERAL PRODUCTS	10.21	12.75	25%	-2%	17%	23%
2.A.1	Cement Production	0.17	0.06	-68%	2%	<1%	<1%
2.A.2	Lime Production	0.06	0.09	51%	-2%	<1%	<1%
2.A.3	Glass production	IE	IE	IE	IE	IE	IE
2.A.5	Mining, construction, handling of products	9.97	12.60	26%	-2%	16%	23%
2.A.6	Other Mineral products	NO	NO	NO	NO	NO	NO
2.B	CHEMICAL INDUSTRY	0.96	0.46	-52%	<1%	2%	1%
2.C	METAL PRODUCTION	6.45	0.75	-88%	-8%	10%	1%
2.D	NON ENERGY PRODUCTS/ SOLVENTS	NA	NA	NA	NA	NA	NA
2.G	Other product manufacture and use	0.41	0.46	12%	1%	1%	1%
2.H	Other Processes	0.00	0.00	-13%	-1%	<1%	<1%
2.I	Wood processing	0.92	1.16	26%	2%	1%	2%
2.J	Production of POPs	NO	NO	NO	NO	NO	NO
2.K	"Consumption of POPs and heavy metals	NO	NO	NO	NO	NO	NO
2.L	Other production, consumption, storage, ...	NO	NO	NO	NO	NO	NO
3	AGRICULTURE	11.53	10.85	-6%	<1%	19%	20%
3.B	MANURE MANAGEMENT	1.21	1.06	-12%	<1%	2%	2%
3.D	AGRICULTURAL SOILS	10.18	9.72	-4%	<1%	16%	18%
3.F	FIELD BURNING OF AGRICULTURAL RES.	0.14	0.06	-55%	-8%	<1%	<1%
3.I	Agriculture OTHER	NO	NO	NO	NO	NO	NO
5	WASTE	0.15	0.45	211%	25%	<1%	1%
Total without sinks		61.86	55.24	-11%	1%		

2.3 Emission Trends for Heavy Metals

In general emissions of heavy metals decreased remarkably from 1990 to 2015. Emission trends for heavy metals from 1990 to 2015 are presented in Table 44. Emissions for all three priority heavy metals (Cd, Pb, Hg) are well below their 1985 level, which is the obligation for Austria as a Party to the Heavy Metals Protocol. From submission 2015 onwards Austria reported all mandatory pollutants in the NFR14 reporting format from 1990 to the latest inventory year. Emissions of the years before 1990 were last updated and published in submission 2014⁷⁷.

Table 44: National total emissions and emission trends for heavy metals 1990–2015.

Year	Emissions [t]		
	Cd	Hg	Pb
1990	1.59	2.14	215.07
1991	1.54	2.04	176.32
1992	1.26	1.64	121.54
1993	1.17	1.39	84.84
1994	1.08	1.18	58.81
1995	0.98	1.20	16.07
1996	1.00	1.16	15.52
1997	0.97	1.13	14.46
1998	0.90	0.95	12.97
1999	0.95	0.94	12.41
2000	0.93	0.89	11.88
2001	0.95	0.96	11.99
2002	0.98	0.92	12.17
2003	1.03	0.97	12.50
2004	1.04	0.94	12.83
2005	1.11	0.98	13.22
2006	1.12	1.00	13.53
2007	1.17	1.00	14.29
2008	1.19	1.01	14.64
2009	1.08	0.89	12.72
2010	1.20	0.99	14.90
2011	1.18	0.98	14.82
2012	1.19	0.98	14.77
2013	1.24	1.05	15.50
2014	1.16	0.99	14.60
2015	1.19	0.97	14.73
Trend 1990–2015	-25%	-55%	-93%

⁷⁷ Austria's submission 2014 under the Convention on Long-range Transboundary Air Pollution covering the years 1980-2012: http://www.ceip.at/ms/ceip_home1/ceip_home/status_reporting/2014_submissions/

2.3.1 Cadmium (Cd) Emissions

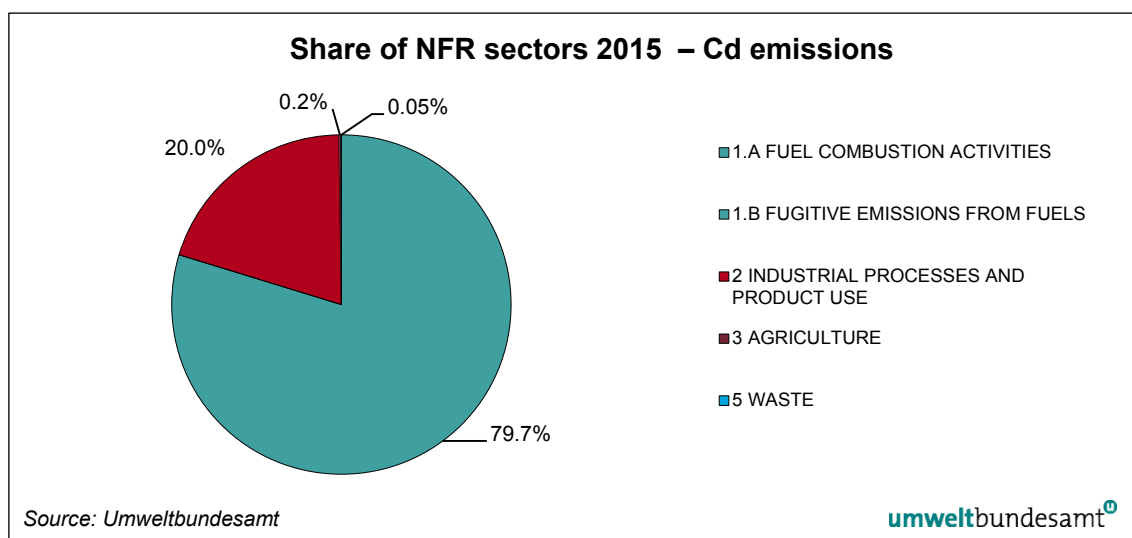
Cadmium (Cd) has been ubiquitously distributed in the natural environment for millions of years. It occurs in the earth's crust with a content estimated to be between 0.08 and 0.5 ppm. Unlike some other heavy metals, such as lead or mercury, which have been used since ancient times, Cd has been refined and utilized only since 100 years, but it was already discovered in 1817. The production and consumption of Cd has risen distinctly only since the 1940's. The primary uses are electroplated cadmium coatings, nickel-cadmium storage batteries, pigments, and stabilizers for plastics. Publicity about the toxicity of cadmium has affected the consumption significantly.

For human beings Cd does not have a biological function unlike many other elements. The smoking (of tobacco) stands for an important exposure to Cd: smokers generally have about twice as high cadmium concentrations in the renal cortex compared to non-smokers. For the non-smoking population food is an important source of exposure because Cd is accumulated in the human and animal bodies due to its long half-life. Cd compounds and complexes are classified as an unambiguous carcinogenic working material.

Main sources and emission trends in Austria

The most important source for Cd emissions is the combustion of solid fuels (fossil and biomass), *1.A. Fuel Combustion Activities*, contributing with a share of 80% to national total Cd emissions in 2015. The second important source is *2 Industrial Processes and Product Use* with 20% in national total (see Figure 22 and Table 45).

Cd emissions resulting from NFR sectors *3 Agriculture* and *5 Waste* are minor sources. These sectors contribute to national total Cd emissions with 0.2% and 0.05%, respectively.



Note: Cd emissions from NFR sector 1.B Fugitive Emissions from fuels are reported as NA.

Figure 22: Share of NFR sectors 2015 in Cd emissions.

National total Cd emissions amounted to 1.59 t in 1990; emissions have decreased steadily and by the year 2015 emissions were reduced by 25% to 1.19 t in the period 1990–2015. However the most significant reduction of national total Cd emissions could be achieved in the period 1985-1990. For further information see Austria's Informative Inventory Report 2014 (UMWELTBUNDESAMT 2014d).

Between 1990 and 1998 emissions were still decreasing, mainly due a decrease in the use of heavy fuel oil and lower process emissions from iron and steel production. From 2000 to 2010 Cd emissions were increasing again, which was due to the growing activities in the industrial processes sector and energy sector. Since then emissions remain quite stable. The increase of 2.0% between 2014 and 2015 mainly results from higher biomass consumption of households.

1.A Fuel Combustion Activities

In the period from 1990 to 2015 Cd emissions of *1.A Fuel Combustion Activities* decreased by 4.7% to 0.95 t. The main sources of Cd emission within NFR sector *1.A. Fuel Combustion Activities* are *1.A.1 Energy Industries*, *1.A.4 Other Sectors*, *1.A.2 Manufacturing Industries and Construction* and *1.A.3 Transport*:

- *NFR 1.A.1 Energy Industries*: The increasing Cd emissions in the last thirteen years were due to increasing use of wood and wooden litter in small combustion plants, the combustion of heavy fuel oil and residues from the petroleum processing in the refinery as well as the thermal utilisation of industrial residues and residential waste.
- *NFR 1.A.4 Other Sectors*: Cd emissions decreased by 31% since 1990 to 0.29 t, representing a share of 24% in national total emissions in 2015. The reduction is mainly due to a decreased use of coal.
- *NFR 1.A.2 Manufacturing Industries and Construction*: Between 1990 and 2015 Cd emissions decreased by 33%, however since 2002 emissions show an increasing trend due to increased use of biomass in *wood processing industries (1.A.2.g.8)*.
- *NFR 1.A.3 Transport*: The increase of Cd emission is due to the enormous increasing activity of the transport sector in passenger and freight transport. Cd emissions arise for the most part from tyre and brake abrasion. Emissions from tyre and brake wear are increasing as a function of travelled vehicles kilometres which have shown an increasing trend since 1990.

In all mentioned subcategories, except for NFR sectors *1.A.1* and *1.A.3*, Cd emissions have decreased steadily with regard to the long-term trend, mainly due to an increase in efficiency, the implementation and installation of flue gas treatment system as well as due to dust removal systems.

2 Industrial Processes and Product Use

Within sector *2 Industrial Processes and Product Use* the main source for Cd emission is subcategory *2.C Metal Production*.

- *NFR 2.C Metal Production*: As shown in Table 45 in the period from 1990 to 2015 the Cd emissions decreased by 55% to 0.24 t, which is a share of 20% to the total Cd emission. Emissions from *NFR 2.C.1 Iron and steel* decreased significantly due to extensive abatement measures but also by production and product substitution.

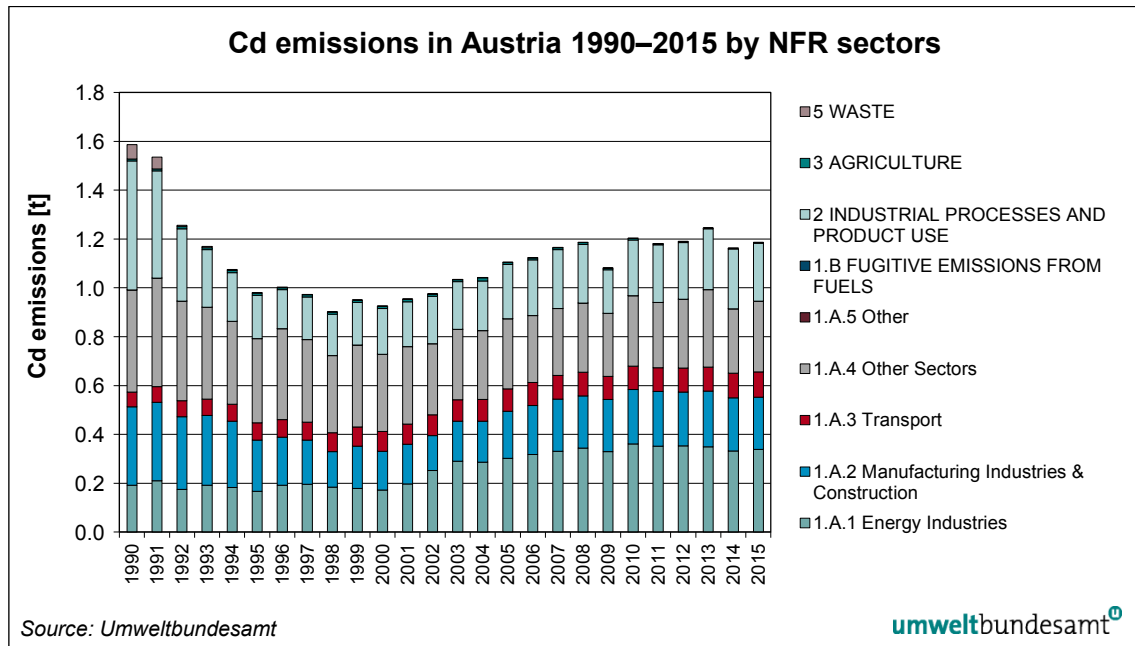


Figure 23: Cd emissions in Austria 1990–2015 by sectors in absolute terms.

Table 45: Cd emissions per NFR Category 1990 and 2015, their trend 1990–2015 and their share in total emissions.

NFR Category		Cd Emission in [t]		Trend		Share in National Total	
		1990	2015	1990–2015	2014–2015	1990	2015
1	ENERGY	0.99	0.95	-5%	3%	63%	80%
1.A	FUEL COMBUSTION ACTIVITIES	0.99	0.95	-5%	3%	63%	80%
1.A.1	Energy Industries	0.19	0.34	76%	2%	12%	29%
1.A.1.a	Public Electricity and Heat Production	0.10	0.13	27%	6%	7%	11%
1.A.1.b	Petroleum refining	0.09	0.21	133%	-1%	6%	17%
1.A.1.c	Manufacture of Solid fuels & Other Energy Ind.	NA	NA	NA	NA	NA	NA
1.A.2	Manufacturing Industries and Construction	0.32	0.21	-33%	-2%	20%	18%
1.A.2.a	Iron and Steel	0.01	0.00	-49%	-6%	<1%	<1%
1.A.2.b	Non-ferrous Metals	0.01	0.01	-12%	<1%	1%	1%
1.A.2.c	Chemicals	0.03	0.01	-53%	10%	2%	1%
1.A.2.d	Pulp, Paper and Print	0.14	0.09	-36%	-6%	9%	8%
1.A.2.e	Food Processing, Beverages and Tobacco	0.00	0.00	-89%	5%	<1%	<1%
1.A.2.f	Non-metallic Minerals	0.10	0.02	-78%	-17%	6%	2%
1.A.2.g	Manufacturing Industries and Constr. - other	0.03	0.07	141%	8%	2%	6%
1.A.3	Transport	0.06	0.10	71%	2%	4%	9%
1.A.3.a	Civil Aviation	0.00	0.00	212%	5%	<1%	<1%
1.A.3.b	Road Transportation	0.06	0.10	72%	2%	4%	9%
1.A.3.c	Railways	0.00	0.00	-86%	-1%	<1%	<1%
1.A.3.d	Navigation	0.00	0.00	-1%	-15%	<1%	<1%
1.A.3.e	Other transportation	NA	NA	NA	NA	NA	NA
1.A.4	Other Sectors	0.42	0.29	-31%	10%	26%	24%
1.A.4.a	Commercial/Institutional	0.07	0.02	-73%	13%	5%	2%
1.A.4.b	Residential	0.31	0.21	-32%	10%	20%	18%
1.A.4.c	Agriculture/Forestry/Fisheries	0.03	0.06	80%	9%	2%	5%
1.A.5	Other	0.00	0.00	40%	1%	<1%	<1%
1.B	FUGITIVE EMISSIONS FROM FUELS	NA	NA	NA	NA	NA	NA
2	INDUSTRIAL PROCESSES AND PRODUCT USE	0.53	0.24	-55%	-3%	33%	20%
2.A	MINERAL PRODUCTS	NA	NA	NA	NA	NA	NA
2.B	CHEMICAL INDUSTRY	0.00	0.00	-30%	<1%	<1%	<1%
2.C	METAL PRODUCTION	0.53	0.24	-55%	-3%	33%	20%
2.D	NON ENERGY PRODUCTS/ SOLVENTS	0.00	0.00	<1%	<1%	<1%	<1%
2.G	Other product manufacture and use	NA	NA	NA	NA	NA	NA
2.H	Other Processes	NA	NA	NA	NA	NA	NA
2.I	Wood processing	NA	NA	NA	NA	NA	NA
2.J	Production of POPs	NO	NO	NO	NO	NO	NO
2.K	"Consumption of POPs and heavy metals	NO	NO	NO	NO	NO	NO
2.L	Other production, consumption, storage, ...	NO	NO	NO	NO	NO	NO
3	AGRICULTURE	0.01	0.00	-73%	-22%	1%	<1%
5	WASTE	0.06	0.00	-99%	-5%	4%	<1%
Total without sinks		1.59	1.19	-25%	2%		

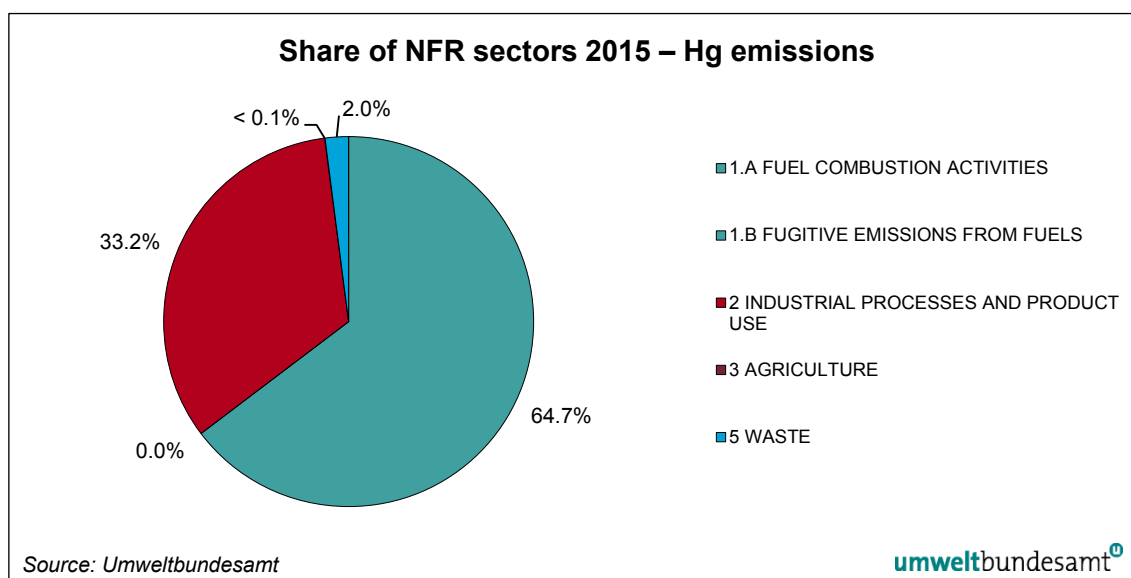
2.3.2 Mercury (Hg) Emissions

Mercury (Hg) has been ubiquitously distributed in the natural environment for millions of years. It occurs in the earth's crust with a content estimated to be about $4 \cdot 10^{-5}\%$. Because of its special properties, mercury has had a number of uses for a long time: the conventional application is the thermometer, barometer, and hydrometer; other important areas of use are the lighting industry and for electrical components. Mercury forms alloys with a large number of metals, these alloys also have a wide range of applications.

Main sources and emission trends in Austria

As can be seen in Figure 24 and Table 45 the two most important Hg emission sources are NFR sectors *1.A Fuel Combustion Activities* and *2 Industrial Processes and Product Use* with shares in national totals in 2015 of 65% and 33%, respectively.

NFR sectors *3 Agriculture* and *5 Waste* are only minor Hg sources. These sectors contribute to national total Hg emissions with 0.04% and 2.0%, respectively.



Note: Hg emissions from NFR sector 1.B Fugitive Emissions from fuels are reported as NA.

Figure 24: Share of NFR sectors 2015 in Hg emissions.

In 1990 national total Hg emissions amounted to 2.1 t; emissions have decreased steadily. In the year 2015 national total Hg emissions were 55% below the level of 1990 (see Table 44). Between 2014 and 2015 emissions decreased by 1.7% mainly due to decreasing emissions from cement production (*1.A.2.f Non-metallic Minerals*).

The overall reduction of about 55% for the period 1990 to 2015 was due to decreasing emissions from cement industries and the industrial processes sector as well as due to reduced use of coal for residential heating. Several bans in different industrial sub-sectors and in the agriculture sector led to the sharp fall of total Hg emission in Austria, where the reduction was already achieved before 2000.

The main sources of Hg emissions are described in the following.

1.A Fuel Combustion Activities

- **NFR 1.A Fuel Combustion (mainly 1.A.1 Energy Industries, 1.A.2 Manufacturing Industries and Construction, 1.A.4 Other Sectors):** Hg emissions are a result of combustion of coal, heavy fuel oil and waste in manufacturing industries and construction, the combustion of wood, wood waste and coal in residential plants and combustion of coal and heavy fuel oil in public electricity and heat production. Overall Hg emissions could be reduced significantly by different abatement techniques such as filter installation and wet flue gas treatment in industry and due to decreasing coal consumption in the residential sector.

2 Industrial Processes and Product Use

- **NFR 2.C Metal Production:** Emissions from iron and steel production are the main source within this source category and increased by about 26% since 1990 due to increased activities, which were partly compensated by implemented extensive abatement measures.
- **NFR 2.B Chemical Industry:** Hg emissions from this source were remarkable in 1990 but decreased steadily to a share of less than 0.01% in 2015. It covers processes in inorganic chemical industries reported under NFR 2.B.5 *Other*. The decrease is a result of abatement measures but also by production process substitution and product substitution. Furthermore, in 1999, the process of chlorine production was changed from mercury cell to membrane cell.

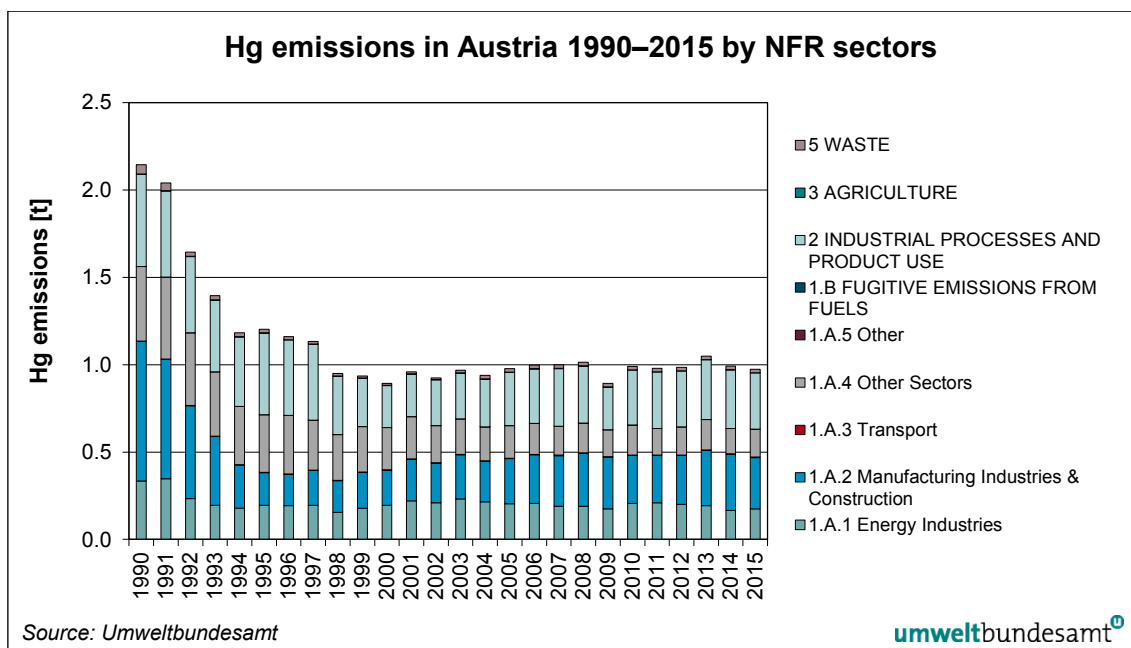


Figure 25: Hg emissions in Austria 1990–2015 by sectors in absolute terms.

Table 46: Hg emissions per NFR Category 1990 and 2015, their trend 1990–2015 and their share in total emissions.

NFR Category		Hg Emission in [t]		Trend		Share in National Total	
		1990	2015	1990–2015	2014–2015	1990	2015
1	ENERGY	1.56	0.63	-60%	-1%	73%	65%
1.A	FUEL COMBUSTION ACTIVITIES	1.56	0.63	-60%	-1%	73%	65%
1.A.1	Energy Industries	0.33	0.17	-48%	5%	16%	18%
1.A.1.a	Public Electricity and Heat Production	0.33	0.16	-52%	4%	15%	16%
1.A.1.b	Petroleum refining	0.01	0.02	139%	17%	<1%	2%
1.A.1.c	Manufacture of Solid fuels & Other Energy Ind.	NA	NA	NA	NA	NA	NA
1.A.2	Manufacturing Industries and Construction	0.80	0.29	-63%	-8%	37%	30%
1.A.2.a	Iron and Steel	0.00	0.00	-40%	2%	<1%	<1%
1.A.2.b	Non-ferrous Metals	0.01	0.01	16%	4%	<1%	1%
1.A.2.c	Chemicals	0.01	0.01	-24%	3%	1%	1%
1.A.2.d	Pulp, Paper and Print	0.07	0.07	6%	-5%	3%	7%
1.A.2.e	Food Processing, Beverages and Tobacco	0.00	0.00	-55%	22%	<1%	<1%
1.A.2.f	Non-metallic Minerals	0.70	0.17	-76%	-14%	33%	17%
1.A.2.g	Manufacturing Industries and Constr. - other	0.01	0.04	225%	7%	1%	4%
1.A.3	Transport	0.00	0.00	5%	1%	<1%	<1%
1.A.3.a	Civil Aviation	0.00	0.00	212%	5%	<1%	<1%
1.A.3.b	Road Transportation	0.00	0.00	64%	2%	<1%	<1%
1.A.3.c	Railways	0.00	0.00	-92%	-1%	<1%	<1%
1.A.3.d	Navigation	0.00	0.00	-1%	-15%	<1%	<1%
1.A.3.e	Other transportation	NA	NA	NA	NA	NA	NA
1.A.4	Other Sectors	0.43	0.16	-63%	10%	20%	16%
1.A.4.a	Commercial/Institutional	0.03	0.01	-75%	12%	1%	1%
1.A.4.b	Residential	0.39	0.14	-65%	10%	18%	14%
1.A.4.c	Agriculture/Forestry/Fisheries	0.01	0.02	16%	9%	1%	2%
1.A.5	Other	0.00	0.00	40%	1%	<1%	<1%
1.B	FUGITIVE EMISSIONS FROM FUELS	NA	NA	NA	NA	NA	NA
2	INDUSTRIAL PROCESSES AND PRODUCT USE	0.53	0.32	-39%	-4%	25%	33%
2.A	MINERAL PRODUCTS	NA	NA	NA	NA	NA	NA
2.B	CHEMICAL INDUSTRY	0.27	0.00	-100%	<1%	13%	<1%
2.C	METAL PRODUCTION	0.26	0.32	26%	-4%	12%	33%
2.D	NON ENERGY PRODUCTS/ SOLVENTS	NA	NA	NA	NA	NA	NA
2.G	Other product manufacture and use	NA	NA	NA	NA	NA	NA
2.H	Other Processes	NA	NA	NA	NA	NA	NA
2.I	Wood processing	NA	NA	NA	NA	NA	NA
2.J	Production of POPs	NO	NO	NO	NO	NO	NO
2.K	"Consumption of POPs and heavy metals	NO	NO	NO	NO	NO	NO
2.L	Other production, consumption, storage, ...	NO	NO	NO	NO	NO	NO
3	AGRICULTURE	0.00	0.00	-76%	-24%	<1%	<1%
5	WASTE	0.05	0.02	-63%	<1%	2%	2%
Total without sinks		2.14	0.97	-55%	-2%		

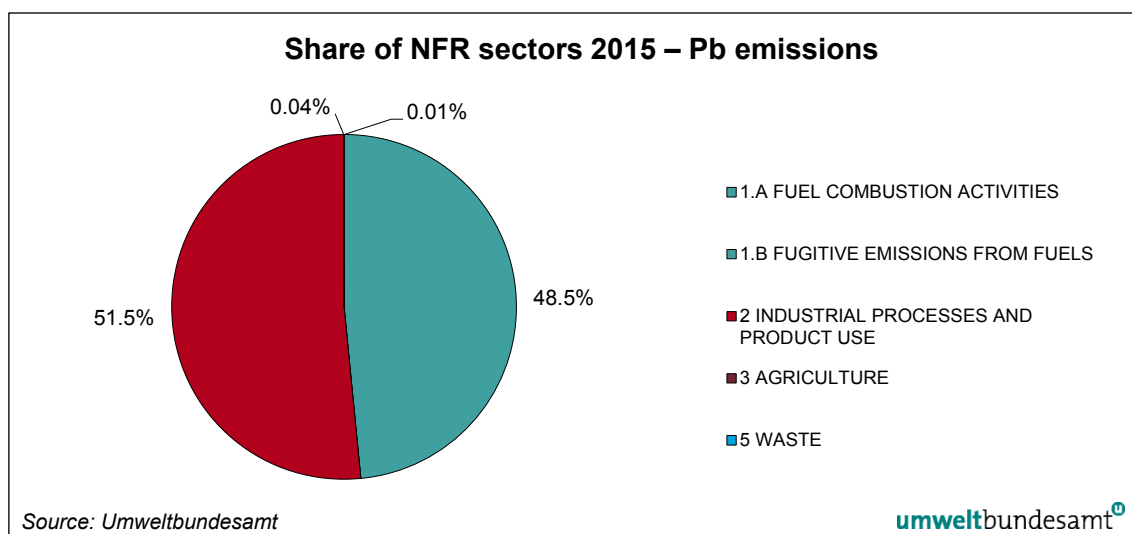
2.3.3 Lead (Pb) Emissions

In the past, automotive sources were the major contributor of lead emissions to the atmosphere. Due to Austrian regulatory efforts to reduce the content of lead in gasoline the contribution of air emissions of lead from the transportation sector has drastically declined over the past two decades. Today, industrial processes, primarily metals processing, are the major sources of lead emissions. The highest air concentrations of lead are usually found in the vicinity of smelters and battery manufacturers. Exposure to lead occurs mainly through inhalation of air and ingestion of lead in food, water, soil, or dust. It accumulates in the blood, bones, and soft tissues and can adversely affect the kidneys, liver, nervous system, and other organs. Lead can also be deposited on the leaves of plants, which pose a hazard to grazing animals and humans through ingestion via food chain.

Main sources and emission trends in Austria

As it is shown in Figure 26 and Table 47, today's Pb emissions mainly arise from the NFR 1.A *Fuel Combustion Activities* and 2 *Industrial Processes and Product Use* with shares in national total emissions of 48% and 51%, respectively.

Pb emissions resulting from NFR sectors 3 *Agriculture* and 5 *Waste* are minor sources. These sectors contribute to national total Pb emissions with 0.04% and 0.01%, respectively.



Note: Pb emissions from NFR sector 1.B Fugitive Emissions from fuels are reported as NA.

Figure 26: Share of NFR sectors 2015 in Pb emissions.

In 1990 national total Pb emissions amounted to 215 t; emissions have decreased sharply until 1995 mainly due to enforced laws, while since the mid 90ies emissions remained quite stable. In the year 2015 emissions were 93% lower than in 1990 and amounted to 15 t. Compared to the previous year Pb emissions remained nearly at the same level (+0.9%).

1.A Fuel Combustion Activities

- **NFR 1.A.2 Manufacturing Industries and Construction and NFR 1.A.4 Other Sectors:** Pb emissions have decreased steadily mainly due to an increase in efficiency, implementation and installation of flue gas treatment system as well as due to dust removal systems.

- **NFR 1.A.1 Energy Industries:** Increasing Pb emissions could be noted in the last decade due to increasing activities.
- **NFR 1.A.4 Other Sectors:** Between 1990 and 2015 emissions decreased steadily due to a decreased use of coal and a reduced content of Pb in the heating oil.
- **NFR 1.A.3 Transport:** By the conditions laid down in European directives, emission limits for cars and trucks as well as more stringent quality requirements for fuels lead to almost completely reduced lead emissions from the transport sector. From 1990 to 1995 Pb emissions from this sub-sector decreased by nearly 100%.

2 Industrial Processes and Product Use

- **NFR 2.C Metal Production:** Emissions from this sub sector decreased significantly due to extensive abatement measures but also due to production process substitution and product substitution.

In addition to emission reduction in the energy sector the sector industrial processes reduced its emissions remarkably due to improved dust abatement technologies.

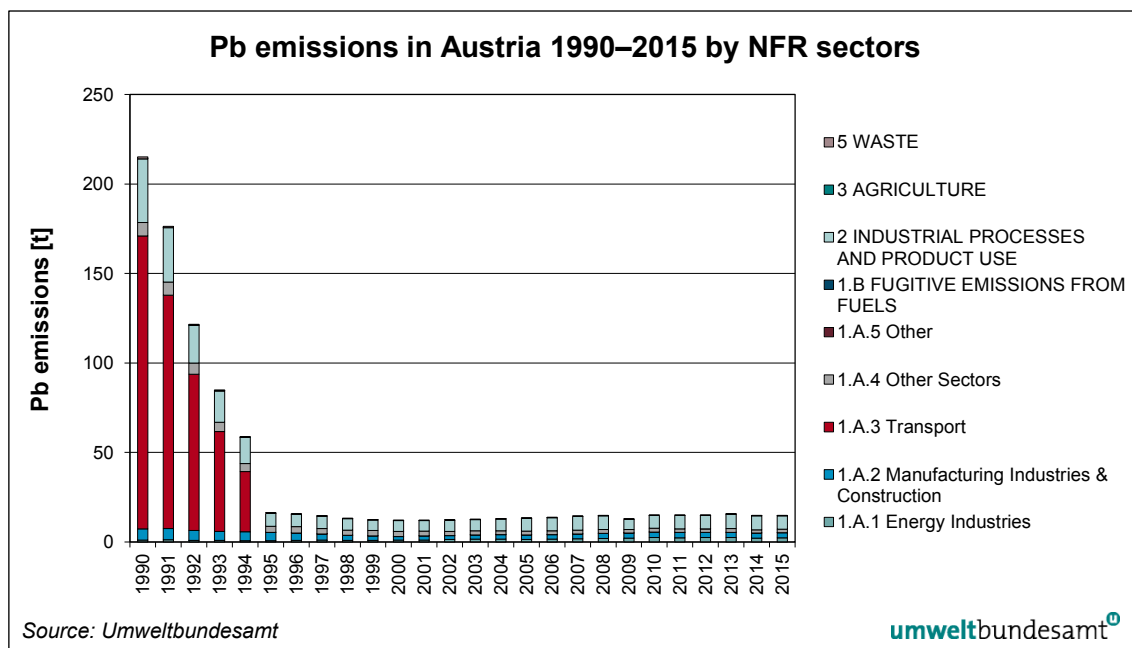


Figure 27: Pb emissions in Austria 1990–2015 by sectors in absolute terms.

Table 47: Pb emissions per NFR Category 1990 and 2015, their trend 1990–2015 and their share in total emissions.

NFR Category		Pb Emission in [t]		Trend		Share in National Total	
		1990	2015	1990–2015	2014–2015	1990	2015
1	ENERGY	178.39	7.13	-96%	5%	83%	48%
1.A	FUEL COMBUSTION ACTIVITIES	178.39	7.13	-96%	5%	83%	48%
1.A.1	Energy Industries	1.08	2.30	113%	7%	1%	16%
1.A.1.a	Public Electricity and Heat Production	0.90	1.88	108%	5%	<1%	13%
1.A.1.b	Petroleum refining	0.18	0.42	139%	17%	<1%	3%
1.A.1.c	Manufacture of Solid fuels & Other Energy Ind.	NA	NA	NA	NA	NA	NA
1.A.2	Manufacturing Industries and Construction	6.14	2.80	-54%	1%	3%	19%
1.A.2.a	Iron and Steel	0.26	0.15	-45%	-6%	<1%	1%
1.A.2.b	Non-ferrous Metals	0.54	0.48	-12%	<1%	<1%	3%
1.A.2.c	Chemicals	0.21	0.28	34%	17%	<1%	2%
1.A.2.d	Pulp, Paper and Print	0.62	0.79	28%	-5%	<1%	5%
1.A.2.e	Food Processing, Beverages and Tobacco	0.01	0.00	-57%	19%	<1%	<1%
1.A.2.f	Non-metallic Minerals	4.27	0.33	-92%	7%	2%	2%
1.A.2.g	Manufacturing Industries and Constr. - other	0.23	0.78	232%	2%	<1%	5%
1.A.3	Transport	163.69	0.01	-100%	1%	76%	<1%
1.A.3.a	Civil Aviation	1.64	0.00	-100%	6%	1%	<1%
1.A.3.b	Road Transportation	161.80	0.01	-100%	1%	75%	<1%
1.A.3.c	Railways	0.01	0.00	-93%	-1%	<1%	<1%
1.A.3.d	Navigation	0.25	0.00	-100%	-12%	<1%	<1%
1.A.3.e	Other transportation	NA	NA	NA	NA	NA	NA
1.A.4	Other Sectors	7.48	2.02	-73%	10%	3%	14%
1.A.4.a	Commercial/Institutional	0.45	0.15	-68%	13%	<1%	1%
1.A.4.b	Residential	6.01	1.68	-72%	10%	3%	11%
1.A.4.c	Agriculture/Forestry/Fisheries	1.01	0.19	-82%	9%	<1%	1%
1.A.5	Other	0.00	0.00	40%	1%	<1%	<1%
1.B	FUGITIVE EMISSIONS FROM FUELS	NA	NA	NA	NA	NA	NA
2	INDUSTRIAL PROCESSES AND PRODUCT USE	35.65	7.58	-79%	-3%	17%	51%
2.A	MINERAL PRODUCTS	NA	NA	NA	NA	NA	NA
2.B	CHEMICAL INDUSTRY	0.00	0.00	-30%	<1%	<1%	<1%
2.C	METAL PRODUCTION	35.63	7.56	-79%	-3%	17%	51%
2.D	NON ENERGY PRODUCTS/ SOLVENTS	0.02	0.02	<1%	<1%	<1%	<1%
2.G	Other product manufacture and use	NA	NA	NA	NA	NA	NA
2.H	Other Processes	NA	NA	NA	NA	NA	NA
2.I	Wood processing	NA	NA	NA	NA	NA	NA
2.J	Production of POPs	NO	NO	NO	NO	NO	NO
2.K	"Consumption of POPs and heavy metals	NO	NO	NO	NO	NO	NO
2.L	Other production, consumption, storage, ...	NO	NO	NO	NO	NO	NO
3	AGRICULTURE	0.01	0.01	-28%	-1%	<1%	<1%
5	WASTE	1.02	0.00	-100%	-2%	<1%	<1%
Total without sinks		215.07	14.73	-93%	1%		

2.4 Emission Trends for POPs

From submission 2015 onwards Austria reports all mandatory pollutants in the NFR14 reporting format from 1990 to the latest inventory year. Emissions of the years before 1990 were last updated and published in submission 2014⁷⁸. PCB emissions are reported from submission 2016 onwards.

Emissions of all POPs decreased remarkably from 1990 to 2015 (HCB, PAH and PCDD/F by about 60 to 80%), where the highest achievement was made until 1995. The significant increase of HCB emissions in the years 2012, 2013 and 2014 was due to unintentional releases of HCB by an Austrian cement plant.

In 2015 the emissions from HCB and PCB decreased compared to the previous year. The short term trend of HCB is influenced by the accidental release, as already mentioned, which is the reason for the significant decrease of 74% between 2014 and 2015. The slight decrease of 1.8% of PCB between 2014 and 2015 is dependent on production activities in secondary lead production.

PAH and PCDD/F increased by 11% and by 7.4% respectively between 2014 and 2015.

The most important source for PAH, PCDD/F and HCB emissions in Austria is residential heating. In the 80s industry and waste incineration were still important sources regarding POP emissions. Due to legal regulations concerning air quality emissions from industry and waste incineration decreased remarkably from 1990 to 1993.

For PCB emissions the most important source category is *2.C Metal Production*.

PAH emissions from NFR subcategory *2.D.3 Solvent Use* stopped in 1997, emissions of dioxin/furan (PCDD/F) stopped in 1993 and emissions of HCB stopped in 2001.

Table 48: Emissions and emission trends for POPs 1990–2015.

Year	Emission			
	PAH [t]	PCDD/F [g]	HCB [kg]	PCB [kg]
1990	16.28	160.74	91.94	194.23
1991	16.92	135.46	84.63	175.76
1992	12.17	76.87	69.67	147.97
1993	9.51	67.09	64.02	142.96
1994	8.52	56.32	51.98	159.73
1995	8.87	58.51	53.06	161.98
1996	9.42	59.84	55.76	159.26
1997	8.45	59.35	51.86	162.91
1998	8.03	56.24	49.09	163.23
1999	8.05	53.63	47.57	161.86
2000	7.43	52.09	44.30	163.35
2001	7.56	51.82	45.86	163.88
2002	6.81	37.85	42.02	164.77
2003	6.55	36.66	41.02	165.08

⁷⁸ Austria's submission 2014 under the Convention on Long-range Transboundary Air Pollution covering the years 1980-2012: http://www.ceip.at/ms/ceip_home1/ceip_home/status_reporting/2014_submissions/

Year	Emission			
	PAH [t]	PCDD/F [g]	HCB [kg]	PCB [kg]
2004	6.46	36.51	41.03	171.63
2005	6.71	38.00	42.97	175.73
2006	6.29	37.18	40.37	188.10
2007	5.97	35.85	38.28	190.73
2008	5.94	35.84	38.18	185.31
2009	5.37	32.64	34.29	161.40
2010	5.92	36.32	39.17	178.99
2011	5.28	33.04	35.33	182.00
2012	5.42	33.79	60.60	176.13
2013	6.17	37.59	143.81	179.89
2014	4.80	30.86	140.28	179.89
2015	5.31	33.15	35.78	176.73
Trend 1990–2015	-67%	-79%	-61%	-9.0%

2.4.1 Polycyclic Aromatic Hydrocarbons (PAH) Emissions

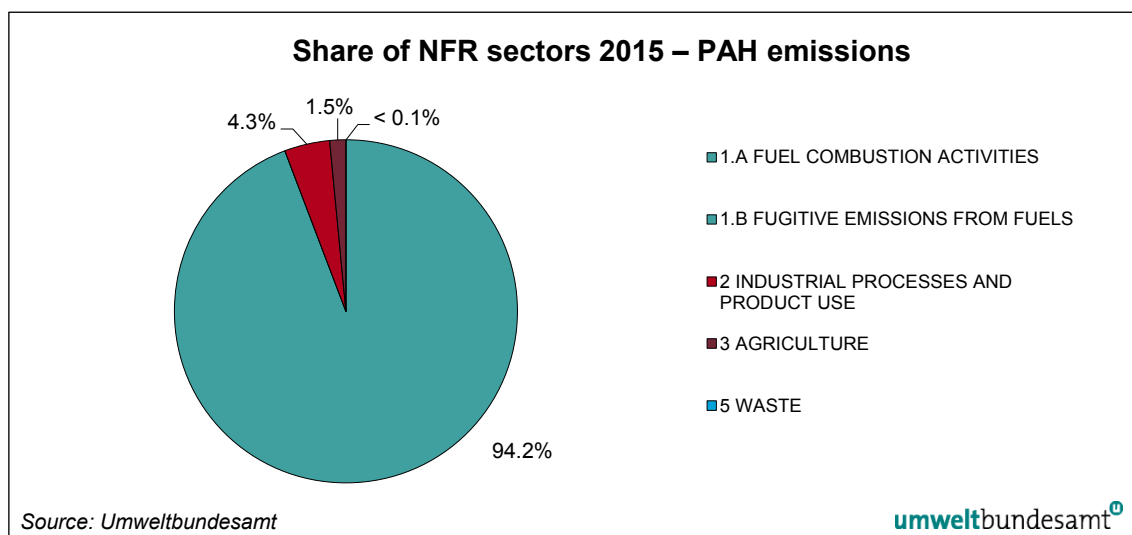
The polycyclic aromatic hydrocarbons (PAH) are molecules built up of benzene rings which resemble fragments of single layers of graphite. PAHs are a group of approximately 100 compounds. Most PAHs in the environment arise from incomplete burning of carbon-containing materials like oil, wood, garbage or coal. Fires are able to produce fine PAH particles, they bind to ash particles and sometimes move long distances through the air. Thus PAHs have been ubiquitously distributed in the natural environment since thousands of years.

Out of all different compounds of the pollutant group of PAHs, the four compounds benz(a)pyren, benzo(b)fluoranthene, benzo(k)fluoranthene and indeno(1,2,3-cd)pyren are used as indicators for the purposes of emission inventories, which has been specified in the UNECE POPs Protocol mentioned above.

Main sources and emission trends in Austria

In 1990 the main emission sources for PAH emissions were NFR 1.A *Fuel Combustion Activities* (55%) and *Industrial processes and Product Use* (44%). In 2015 emissions are almost exclusively emitted by source category 1.A *Fuel Combustion Activities* with 94% of national total PAH emissions as it is illustrated in Figure 28 and Table 49.

From 1990 to 2015 PAH emissions from Agriculture decreased remarkably by 68% due to prohibition of open field burning. In 2015 NFR sectors 3 *Agriculture* (1.5%) and 5 *Waste* (<0.1%) are minor sources.



Note: PAH emissions from NFR sector 1.B Fugitive Emissions from fuels are reported as NA.

Figure 28: Share of NFR sectors 2015 in PAH emissions.

In 1990 national total PAH emissions amounted to 16.3 t; emissions have decreased since then, where the main achievement was made until 1993, and by the year 2015 emissions were reduced by about 67% (to 5.3 t in 2015).

1.A Fuel Combustion Activities

In 2015 PAH emissions are largely emitted by *1.A Fuel Combustion Activities* with a share of 94%. Within this source, PAH emissions mainly result from sector *1.A.4.b Residential (stationary)*, and to a much smaller extent from NFR sector *1.A.3 Transport*.

- *1.A.4.b Residential (stationary)*: Emissions have decreased since 1990 by 53% because of a decreased use of coal and an increased share of efficient biomass boilers with lower specific emissions. Compared to the previous year emissions increased by 14% due to higher biomass consumption.
- *1.A.3 Transport*: Emissions have increased by 21% since 1990 due to increased activities (emissions here result from exhaust and non-exhaust (tyre- and brake-wear) activities). A reduction potential results in the future by reducing the soot emissions of diesel-powered vehicles because the PAHs are mostly attached to the microparticles.

2 Industrial Processes and Product Use

PAH emissions from the sector *Industrial processes and Product Use* decreased by 97% since 1990 due to the shutdown of primary aluminium production in Austria, which was a main source for PAH emissions.

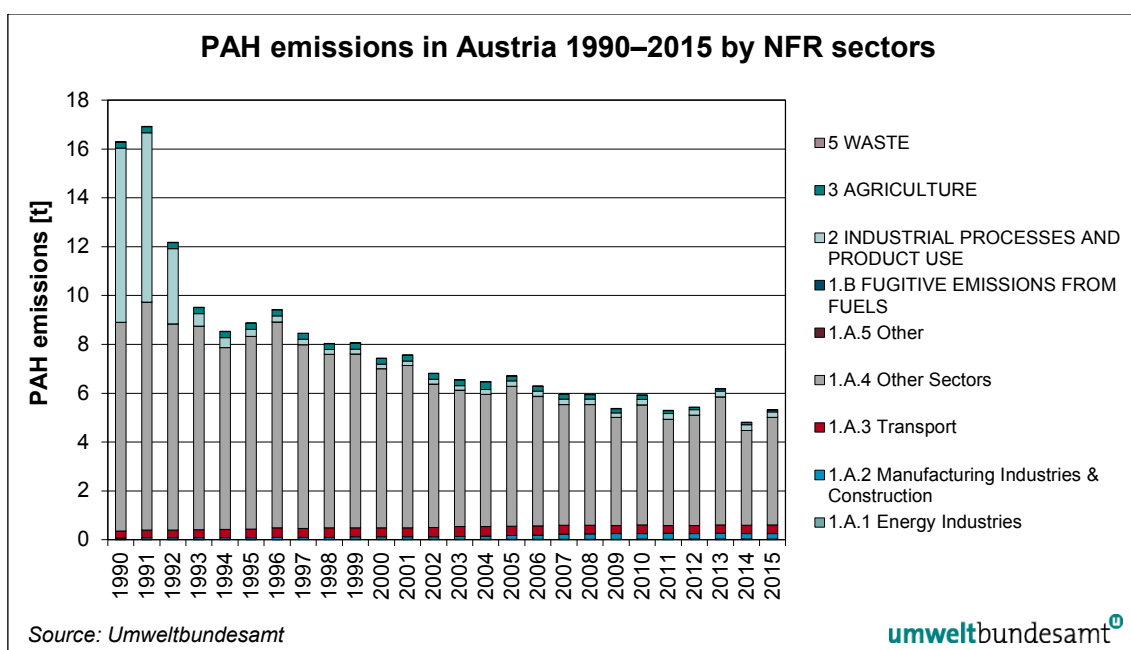


Figure 29: PAH emissions in Austria 1990–2015 by sectors in absolute terms.

Table 49: PAH emissions per NFR Category 1990 and 2015, their trend 1990–2015 and their share in total emissions.

NFR Category		PAH Emission in [t]		Trend		Share in National Total	
		1990	2015	1990–2015	2014–2015	1990	2015
1	ENERGY	8.90	5.01	-44%	12%	55%	94%
1.A	FUEL COMBUSTION ACTIVITIES	8.90	5.01	-44%	12%	55%	94%
1.A.1	Energy Industries	0.00	0.02	397%	8%	<1%	<1%
1.A.2	Manufacturing Industries and Construction	0.07	0.23	240%	2%	<1%	4%
1.A.2.a	Iron and Steel	0.00	0.00	-39%	2%	<1%	<1%
1.A.2.b	Non-ferrous Metals	0.00	0.00	79%	77%	<1%	<1%
1.A.2.c	Chemicals	0.02	0.02	17%	6%	<1%	<1%
1.A.2.d	Pulp, Paper and Print	0.00	0.00	22%	-1%	<1%	<1%
1.A.2.e	Food Processing, Beverages and Tobacco	0.00	0.00	-46%	10%	<1%	<1%
1.A.2.f	Non-metallic Minerals	0.00	0.01	168%	21%	<1%	<1%
1.A.2.g	Manufacturing Industries and Constr. - other	0.04	0.20	374%	1%	<1%	4%
1.A.3	Transport	0.28	0.34	21%	2%	2%	6%
1.A.3.a	Civil Aviation	NE	NE	NE	NE	NE	NE
1.A.3.b	Road Transportation	0.26	0.33	27%	2%	2%	6%
1.A.3.c	Railways	0.02	0.01	-46%	<1%	<1%	<1%
1.A.3.d	Navigation	0.01	0.01	1%	-15%	<1%	<1%
1.A.3.e	Other transportation	NA	NA	NA	NA	NA	NA
1.A.4	Other Sectors	8.54	4.41	-48%	13%	52%	83%
1.A.4.a	Commercial/Institutional	0.17	0.10	-44%	16%	1%	2%
1.A.4.b	Residential	7.96	3.71	-53%	14%	49%	70%
1.A.4.c	Agriculture/Forestry/Fisheries	0.41	0.60	47%	9%	2%	11%
1.A.5	Other	0.00	0.00	-7%	<1%	<1%	<1%
1.B	FUGITIVE EMISSIONS FROM FUELS	NA	NA	NA	NA	NA	NA
2	INDUSTRIAL PROCESSES AND PRODUCT USE	7.13	0.23	-97%	-3%	44%	4%
2.A	MINERAL PRODUCTS	NA	NA	NA	NA	NA	NA
2.B	CHEMICAL INDUSTRY	NE	NE	NE	NE	NE	NE
2.C	METAL PRODUCTION	6.44	0.19	-97%	-4%	40%	4%
2.C.1	Iron and Steel Production	0.35	0.19	-45%	-4%	2%	4%
2.C.2	Ferroalloys Production	NE	NE	NE	NE	NE	NE
2.C.3	Aluminium production	6.09	NE	NE	NE	37%	NE
2.C.4	Magnesium production	NO	NO	NO	NO	NO	NO
2.C.5	Lead Production	NA	NA	NA	NA	NA	NA
2.C.6	Zinc production	NO	NO	NO	NO	NO	NO
2.C.7	Other metal production	IE	IE	IE	IE	IE	IE
2.D	NON ENERGY PRODUCTS/ SOLVENTS	0.15	NA	NA	NA	1%	NA
2.G	Other product manufacture and use	NE	NE	NE	NE	NE	NE
2.H	Other Processes	0.55	0.04	-93%	<1%	3%	1%
2.I	Wood processing	NA	NA	NA	NA	NA	NA
2.J	Production of POPs	NO	NO	NO	NO	NO	NO
2.K	"Consumption of POPs and heavy metals	NO	NO	NO	NO	NO	NO
2.L	Other production, consumption, storage, ...	NO	NO	NO	NO	NO	NO
3	AGRICULTURE	0.25	0.08	-68%	-11%	2%	2%
5	WASTE	0.00	0.00	-95%	<1%	<1%	<1%
Total without sinks		16.28	5.31	-67%	11%		

2.4.2 Dioxins and Furan (PCDD/F)

Dioxins form a family of toxic chlorinated organic compounds that share certain chemical structures and biological characteristics. Several hundred of these compounds exist and are members of three closely related families: the chlorinated dibenzo(p)dioxins (CDDs), chlorinated dibenzofurans (CDFs) and certain polychlorinated biphenyls (PCBs). Dioxins bio-accumulate in humans and wildlife due to their fat solubility and 17 of these compounds are especially toxic.

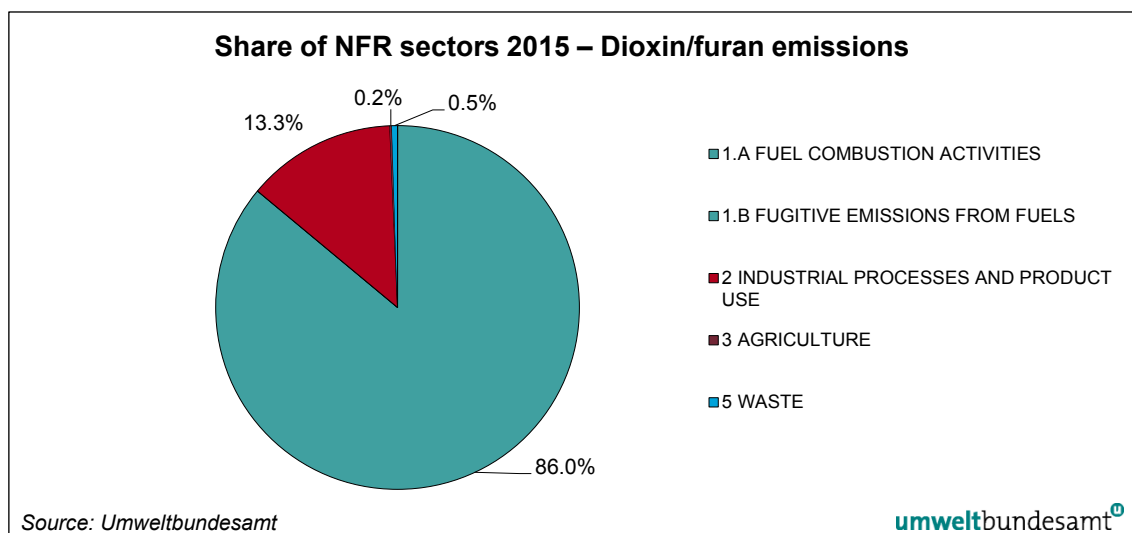
Dioxins are formed as a result of combustion processes such as commercial or municipal waste incineration and from burning fuels like wood, coal or oil as a main source of dioxins. Dioxins can also be formed when household trash is burned and as a result of natural processes such as forest fires. Dioxins enter the environment also through the production and use of organo-chlorinated compounds: chlorine bleaching of pulp and paper, certain types of chemical manufacturing and processing, and other industrial processes are able to create small quantities of dioxins. Cigarette smoke also contains small amounts of dioxins.

Due to stringent legislation and modern technology, dioxin emissions from combustion and incineration as well as from chemical manufacturing and processes have been reduced dramatically. Nowadays domestic combustion as well as thermal processes in metals extraction and processing have become more significant.

Main sources and emission trend in Austria

The main source for dioxin and furan emissions in Austria, with a share of 86% in 2015, is category *1.A Fuel Combustion Activities* (see Figure 30 and Table 50). Sector *2 Industrial Processes and Product Use* contributes with 13% in national total emissions.

In 2015 PCDD/F emissions from sectors *3 Agriculture* and *5 Waste* are minor sources. Agriculture has a share of 0.2% in national total emissions (*3.F Field burning of agricultural residues* is the only source). NFR sector *5 Waste* contributes with 0.5% in national total emissions.



Note: Dioxin/furan emissions from NFR sector 1.B Fugitive Emissions from fuels are reported as NA.

Figure 30: Share of NFR sectors 2015 in Dioxin/furan emissions.

In 1990 national total dioxin/furan (PCDD/F) emissions amounted to about 161 g; emissions have decreased since then, where the main achievement was made until 1993, and by the year 2015 emissions were reduced by about 79% (to 33 g in 2015).

1.A Fuel Combustion Activities

In more detail within sector *1.A Fuel Combustion Activities*, the main sources of dioxin and furan emissions are:

- *NFR 1.A.4 Other Sectors*: This sector has the highest contribution (62%) to national total dioxin/furan (PCDD/F) emissions in 2015 within source *1.A Fuel Combustion Activities* due to biomass heating.
- *NFR 1.A.2 Manufacturing Industries and Construction*: Emissions decreased significantly since 1990 and contribute with 14% to national dioxin/furan (PCDD/F) emissions in 2015.

2 Industrial Processes and Product Use

The second largest source is sector *2 Industrial Processes and Product Use* (13% in national total emissions).

- *NFR 2.C Metal Production*: Dioxin/furan (PCDD/F) emissions decreased remarkably due to extensive abatement measures since 1990 (-89%). Within sector *Industrial Processes* emissions are emitted by subcategory *2.C.1 Iron and Steel Production*, *2.C.3 Aluminium Production* and *2.C.5 Lead Production*.

5 Waste

- *5 Waste*: From 1990 to 2015 dioxin/furan (PCDD/F) emissions from sector *Waste* decreased by 99% due to stringent legislation and modern technology. As shown in Table 50 in the period from 1990 to 2015 dioxin/furan emissions decreased to 0.16 g, which is a share of 0.5% in total dioxin/furan emissions, whereas in 1990 dioxin/furan (PCDD/F) emissions contributed 11% to the total dioxin/furan emissions. Emissions of dioxin/furan (PCDD/F) from NFR sub-sector *5.C Incineration and open burning of waste* are not rated as key source of the Austrian Inventory.

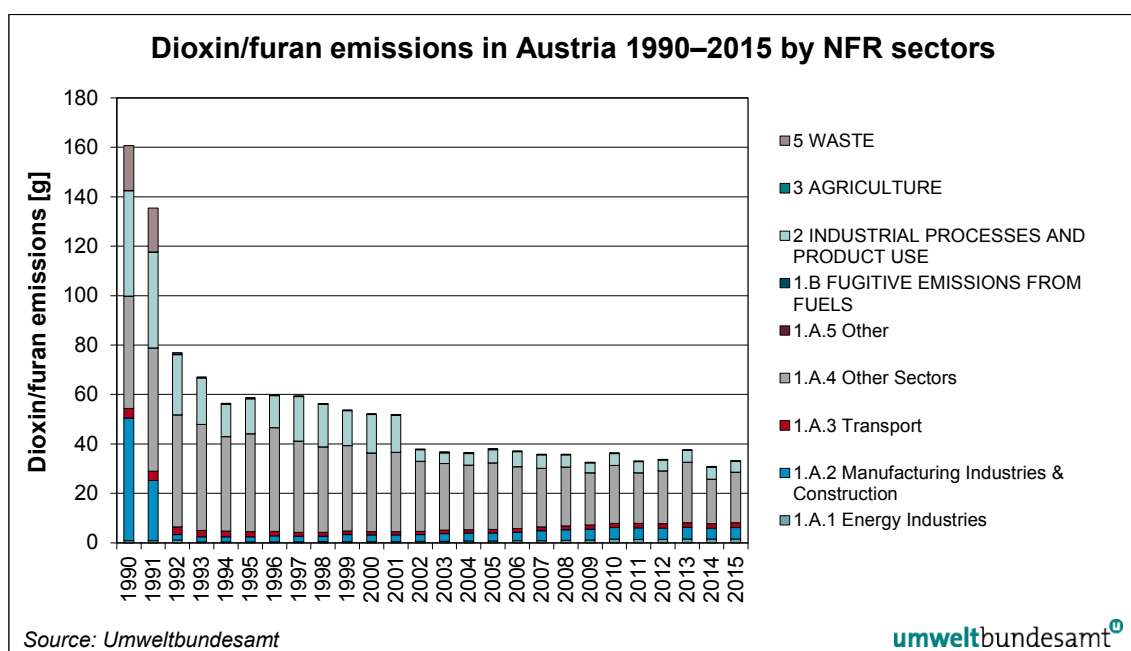


Figure 31: Dioxin/Furan emissions in Austria 1990–2015 by sectors in absolute terms.

Table 50: Dioxin/Furan (PCDD/F) emissions per NFR Category 1990 and 2015, their trend 1990 – 2015 and their share in total emissions.

NFR Category		Dioxin Emission in [g]		Trend		Share in National Total	
		1990	2015	1990–2015	2014–2015	1990	2015
1	ENERGY	99.84	28.53	-71%	11%	62%	86%
1.A	FUEL COMBUSTION ACTIVITIES	99.84	28.53	-71%	11%	62%	86%
1.A.1	Energy Industries	0.82	1.53	88%	5%	1%	5%
1.A.2	Manufacturing Industries and Construction	49.62	4.58	-91%	5%	31%	14%
1.A.2.a	Iron and Steel	0.03	0.02	-29%	-2%	<1%	<1%
1.A.2.b	Non-ferrous Metals	47.87	0.35	-99%	3%	30%	1%
1.A.2.c	Chemicals	0.44	0.51	18%	7%	<1%	2%
1.A.2.d	Pulp, Paper and Print	0.49	0.59	22%	-1%	<1%	2%
1.A.2.e	Food Processing, Beverages and Tobacco	0.03	0.03	-13%	17%	<1%	<1%
1.A.2.f	Non-metallic Minerals	0.29	0.49	66%	9%	<1%	1%
1.A.2.g	Manufacturing Industries and Constr. - other	0.48	2.58	437%	5%	<1%	8%
1.A.3	Transport	3.88	1.97	-49%	6%	2%	6%
1.A.3.a	Civil Aviation	NE	NE	NE	NE	NE	NE
1.A.3.b	Road Transportation	3.83	1.94	-49%	6%	2%	6%
1.A.3.c	Railways	0.04	0.02	-58%	2%	<1%	<1%
1.A.3.d	Navigation	0.01	0.01	-10%	-9%	<1%	<1%
1.A.3.e	Other transportation	0.00	0.00	160%	16%	<1%	<1%
1.A.4	Other Sectors	45.51	20.44	-55%	13%	28%	62%
1.A.4.a	Commercial/Institutional	1.95	1.17	-40%	13%	1%	4%
1.A.4.b	Residential	41.87	16.81	-60%	14%	26%	51%
1.A.4.c	Agriculture/Forestry/Fisheries	1.69	2.46	46%	11%	1%	7%
1.A.5	Other	0.00	0.00	46%	3%	<1%	<1%
1.B	FUGITIVE EMISSIONS FROM FUELS	NA	NA	NA	NA	NA	NA
2	INDUSTRIAL PROCESSES AND PRODUCT USE	42.53	4.40	-90%	-10%	26%	13%
2.A	MINERAL PRODUCTS	NA	NA	NA	NA	NA	NA
2.B	CHEMICAL INDUSTRY	NA	NA	NA	NA	NA	NA
2.C	METAL PRODUCTION	39.68	4.27	-89%	-10%	25%	13%
2.C.1	Iron and Steel Production	37.21	2.93	-92%	-14%	23%	9%
2.C.2	Ferroalloys Production	NE	NE	NE	NE	NE	NE
2.C.3	Aluminium production	2.40	1.26	-48%	<1%	1%	4%
2.C.4	Magnesium production	NO	NO	NO	NO	NO	NO
2.C.5	Lead Production	0.07	0.07	4%	-3%	<1%	<1%
2.C.6	Zinc production	NO	NO	NO	NO	NO	NO
2.C.7	Other metal production	IE	IE	IE	IE	IE	IE
2.D	NON ENERGY PRODUCTS/ SOLVENTS	1.06	NA	NA	NA	1%	NA
2.G	Other product manufacture and use	NE	NE	NE	NE	NE	NE
2.H	Other Processes	1.79	0.13	-93%	<1%	1%	<1%
2.I	Wood processing	NA	NA	NA	NA	NA	NA
2.J	Production of POPs	NO	NO	NO	NO	NO	NO
2.K	"Consumption of POPs and heavy metals	NO	NO	NO	NO	NO	NO
2.L	Other production, consumption, storage, ...	NO	NO	NO	NO	NO	NO
3	AGRICULTURE	0.18	0.06	-66%	-11%	<1%	<1%
5	WASTE	18.19	0.16	-99%	<1%	11%	<1%
Total without sinks		160.74	33.15	-79%	7%		

2.4.3 Hexachlorobenzene (HCB) Emissions

Hexachlorobenzene (HCB) has been widely employed as a fungicide on seeds, especially against the fungal disease 'bunt' that affects some cereal crops. The marketing and use of hexachlorobenzene as a plant protection product was banned in the European Union in 1988.

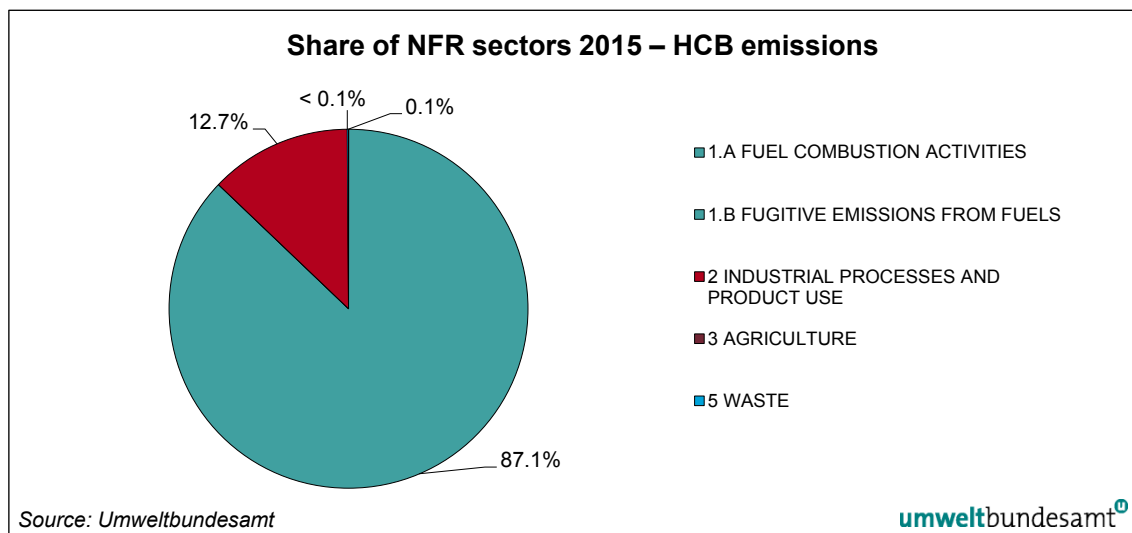
As there is no more hexachlorobenzene production in the EU, the only man-made releases of hexachlorobenzene are as unintentional by-product; it is emitted from the same chemical and thermal processes as Dioxins/Furans (PCDD/F) and formed via a similar mechanism.

It is released to the environment as an unintentional by-product in chemical industry (production of several chlorinated hydrocarbons such as drugs, pesticides or solvents) and in metal industries and is formed in combustion processes in the presence of chlorine.

Main sources and emission trends in Austria

As can be seen in Figure 32 and Table 51 the main HCB emission source in 2015 is NFR sector *1.A Fuel Combustion Activities* with 87% in national total emissions. Sector *2 Industrial Processes and Product Use* has a share of 13% in national total emissions.

From 1990 to 2015 HCB emissions from the sectors NFR 3 *Agriculture* as well as NFR 5 *Waste* decreased remarkably by 66% and 92%, respectively, more due to stringent legislation and modern technology. Both sectors are minor sources of HCB emissions in 2015 with shares of 0.03% and 0.1% in national total emissions.



Note: HCB emissions from NFR sector 1.B Fugitive Emissions from fuels are reported as NA.

Figure 32: Share of NFR sectors 2015 in HCB emissions.

Total emissions of HCB are generally decreasing over the period 1990-2015 by 61%. The highest reduction was achieved in NFR category *1.A.2.b non-ferrous metals* from 1990 to 1992. However, due to unintentional HCB releases in 2012, 2013 and 2014 emissions rose to a very high level: HCB contaminated material (lime) was co-incinerated in a cement plant at too low temperatures, that's why the HCB was not destroyed as planned. The sharp decrease of total emissions between 2014 and 2015 by 74% can therefore be explained as emissions in 2015 were at the usual level again.

1.A Fuel Combustion Activities

Within this source category the small combustion sector (i.e. residential heating) is the most important sector. HCB emissions of sector 1.A decreased by 56% since 1990.

- **1.A.4 Other Sectors:** This subcategory had a share of 59% in 1990 and 82% in 2015 and is the highest contributor within sector 1.A *Fuel Combustion Activities* due to the high amounts of biomass used in the residential sector. Since 1990 emissions decreased by 46%. Compared to the previous year an increase of 13% can be observed, due to the higher biomass use as a consequence of the colder winter and the corresponding higher demand for space heating.

2 Industrial Processes and Product Use

The second largest source for HCB emissions in 2015 was sector 2 *Industrial Processes and Product Use* (Iron and Steel Production) with a share of 13% in national total emissions. HCB emissions of this sector decreased by 77% from 1990 to 2015. This reduction could be mainly achieved with abatement measures in iron and steel industry as well as in secondary lead production. HCB was also a by-product of chlorinated pesticides, which production was banned step-by-step in the beginning of the 1990s.

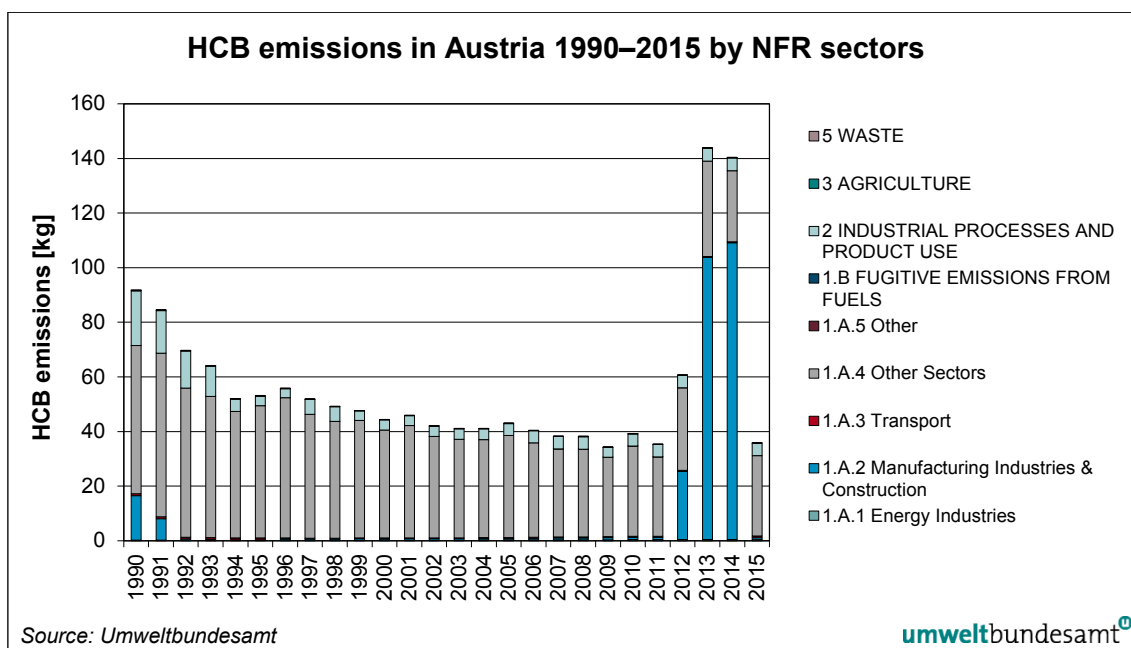


Figure 33: HCB emissions in Austria 1990–2015 by sectors in absolute terms.

Table 51: Hexachlorbenzene (HCB) emissions per NFR Category 1990 and 2015, their trend 1990–2015 and their share in total emissions.

NFR Category		HCB Emission in [kg]		Trend		Share in National Total	
		1990	2015	1990–2015	2014–2015	1990	2015
1	ENERGY	71.54	31.18	-56%	-77%	78%	87%
1.A	FUEL COMBUSTION ACTIVITIES	71.54	31.18	-56%	-77%	78%	87%
1.A.1	Energy Industries	0.21	0.51	148%	4%	<1%	1%
1.A.2	Manufacturing Industries and Construction	16.25	0.79	-95%	-99%	18%	2%
1.A.2.a	Iron and Steel	0.01	0.00	-35%	-3%	<1%	<1%
1.A.2.b	Non-ferrous Metals	15.95	0.09	-99%	1%	17%	<1%
1.A.2.c	Chemicals	0.07	0.08	19%	8%	<1%	<1%
1.A.2.d	Pulp, Paper and Print	0.10	0.12	22%	-1%	<1%	<1%
1.A.2.e	Food Processing, Beverages and Tobacco	0.00	0.00	-20%	16%	<1%	<1%
1.A.2.f	Non-metallic Minerals	0.06	0.08	44%	-100%	<1%	<1%
1.A.2.g	Manufacturing Industries and Constr. - other	0.07	0.41	458%	5%	<1%	1%
1.A.3	Transport	0.78	0.39	-49%	6%	1%	1%
1.A.3.a	Civil Aviation	NE	NE	NE	NE	NE	NE
1.A.3.b	Road Transportation	0.77	0.39	-49%	6%	1%	1%
1.A.3.c	Railways	0.01	0.00	-58%	2%	<1%	<1%
1.A.3.d	Navigation	0.00	0.00	-10%	-9%	<1%	<1%
1.A.3.e	Other transportation	0.00	0.00	160%	16%	<1%	<1%
1.A.4	Other Sectors	54.31	29.49	-46%	13%	59%	82%
1.A.4.a	Commercial/Institutional	1.49	0.73	-51%	14%	2%	2%
1.A.4.b	Residential	50.36	24.86	-51%	13%	55%	69%
1.A.4.c	Agriculture/Forestry/Fisheries	2.45	3.89	59%	11%	3%	11%
1.A.5	Other	0.00	0.00	46%	3%	<1%	<1%
1.B	FUGITIVE EMISSIONS FROM FUELS	NA	NA	NA	NA	NA	NA
2	INDUSTRIAL PROCESSES AND PRODUCT USE	19.96	4.56	-77%	-3%	22%	13%
2.A	MINERAL PRODUCTS	NA	NA	NA	NA	NA	NA
2.B	CHEMICAL INDUSTRY	1.26	NA	NA	NA	1%	NA
2.C	METAL PRODUCTION	9.29	4.53	-51%	-3%	10%	13%
2.C.1	Iron and Steel Production	8.09	3.90	-52%	-4%	9%	11%
2.C.2	Ferroalloys Production	NE	NE	NE	NE	NE	NE
2.C.3	Aluminium production	1.20	0.63	-47%	<1%	1%	2%
2.C.4	Magnesium production	NO	NO	NO	NO	NO	NO
2.C.5	Lead Production	NA	NA	NA	NA	NA	NA
2.C.6	Zinc production	NO	NO	NO	NO	NO	NO
2.C.7	Other metal production	IE	IE	IE	IE	IE	IE
2.D	NON ENERGY PRODUCTS/ SOLVENTS	9.05	NA	NA	NA	10%	NA
2.G	Other product manufacture and use	NE	NE	NE	NE	NE	NE
2.H	Other Processes	0.36	0.03	-93%	<1%	<1%	<1%
2.I	Wood processing	NA	NA	NA	NA	NA	NA
2.J	Production of POPs	NO	NO	NO	NO	NO	NO
2.K	"Consumption of POPs and heavy metals	NO	NO	NO	NO	NO	NO
2.L	Other production, consumption, storage, ...	NO	NO	NO	NO	NO	NO
3	AGRICULTURE	0.04	0.01	-66%	-11%	<1%	<1%
5	WASTE	0.39	0.03	-92%	<1%	<1%	<1%
Total without sinks		91.94	35.78	-61%	-74%		

2.4.4 Polychlorinated biphenyl (PCB) Emissions

Polychlorinated Biphenyls are a class of synthetic organic chemicals and there are 209 configurations. Since 1930 until the beginning of the 1980's PCBs were used for a variety of industrial uses (mainly as dielectric fluids in capacitors and transformers but also as flame retardants, ink solvents, plasticizers, etc.) because of their chemical stability (fire resistance, low electrical conductivity, high resistance to thermal breakdown and a high resistance to oxidants and other chemicals)⁷⁹.

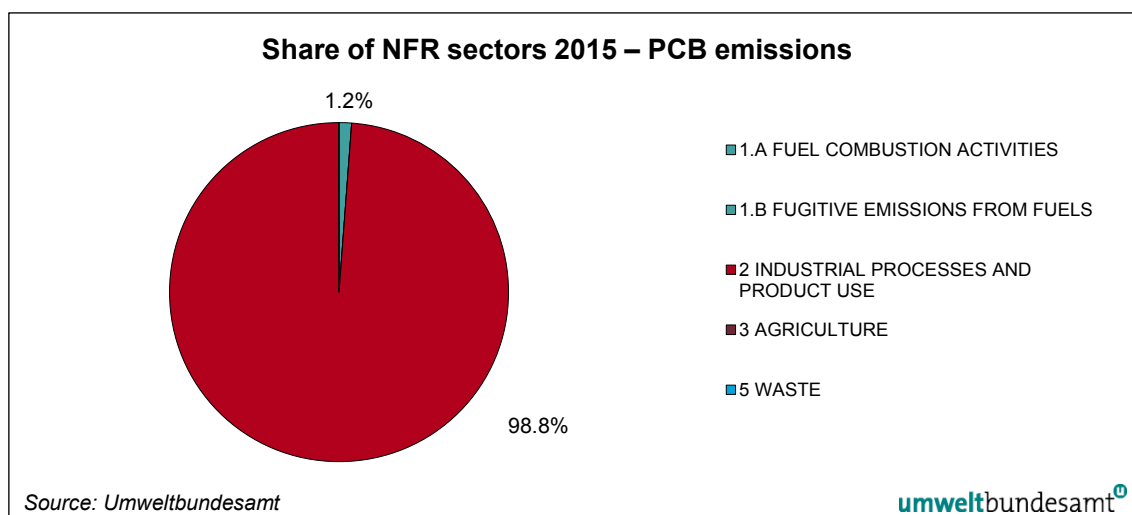
PCBs have entered the environment through both use and disposal. PCBs can be easily carried along from the place of contamination and are distributed in all global ecosystems (UMWELTBUNDESAMT 1996a). Because of its substantial characteristics PCB is persistent. As it is also liposoluble it is easily accumulated in the food chain (BAYERISCHES LANDESAMT FÜR UMWELT 2008).

PCB production was banned by the United States Congress in 1979 and by the Stockholm Convention on Persistent Organic Pollutants⁸⁰ in 2001 because of its environmental toxicity and classification as a persistent organic pollutant. As PCB is no longer produced in the EU, the only man-made release of PCB is as unintentionally produced pollutant (Umweltbundesamt 2012).

Main sources and emission trends in Austria

Austrian PCB emissions are almost exclusively emitted in NFR sector 2 *Industrial Processes and Product Use* with a share of 99% in national total PCB emissions in 2015 (see Figure 34 and Table 52).

NFR 1.A Fuel Combustion Activities, both from stationary and mobile sources (*NFR 1.A.3 Transport*), is a minor source of PCB emissions with a share of 1.2% in total emissions in 2015. PCB emissions from stationary combustion are decreasing since 1990, mainly due to a reduced consumption of coal and bunker oil. Emissions from subcategory *Transport* are a minor source and do not influence the emission trend.



Note: PCB emissions from NFR sector 1.B Fugitive Emissions from fuels are reported as NA.

Figure 34: Share of NFR sectors 2015 in PCB emissions.

⁷⁹ <http://chm.pops.int/Implementation/PCBs/Overview/tabid/273/Default.aspx>

⁸⁰ <http://chm.pops.int/default.aspx>

In 1990 national total PCB emissions amounted to about 194 kg; emissions have decreased by 9.0% and in 2015 emissions were at the level of 177 kg. The emission trend is largely influenced by metal production.

2 Industrial Processes and Product Use

Within the IPPU sector, all of the PCB is arising from subcategory NFR 2.C *Metal Production*: NFR 2.C.5 *Lead Production* is the largest source with 44% of national total PCB emissions in 2015, followed by NFR 2.C.7 *Other Metal Production* with 36% and NFR 2.C.1 *Iron and Steel Production* with 19%. Since 1990 emissions from subcategory 2.C decreased by 5.9%; the emissions generally follow the production activities.

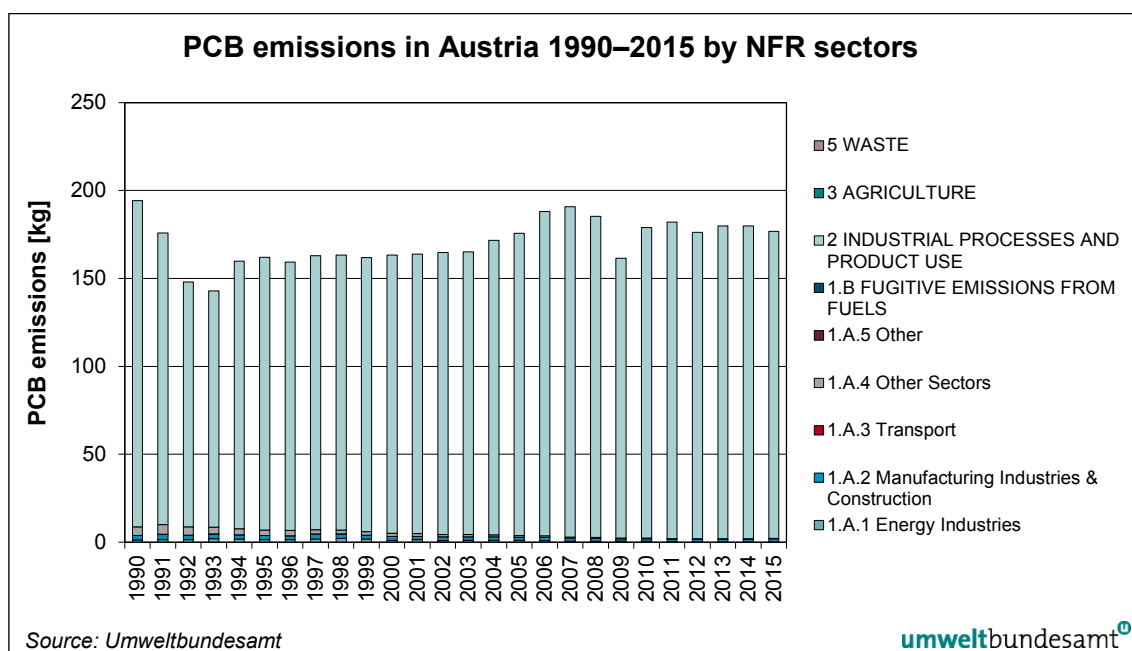


Figure 35: PCB emissions in Austria 1990–2015 by sectors in absolute terms.

Table 52: Polychlorinated biphenyl (PCB) emissions per NFR Category 1990 and 2015, their trend 1990–2015 and their share in total emissions.

NFR Category		PCB Emission in [kg]		Trend		Share in National Total	
		1990	2015	1990–2015	2014–2015	1990	2015
1	ENERGY	8.73	2.10	-76%	11%	4%	1%
1.A	FUEL COMBUSTION ACTIVITIES	8.73	2.10	-76%	11%	4%	1%
1.A.1	Energy Industries	1.16	0.21	-82%	126%	1%	<1%
1.A.2	Manufacturing Industries and Construction	2.64	1.67	-37%	4%	1%	1%
1.A.2.a	Iron and Steel	0.08	0.02	-73%	<1%	<1%	<1%
1.A.2.b	Non-ferrous Metals	0.04	0.06	46%	126%	<1%	<1%
1.A.2.c	Chemicals	0.21	0.20	-1%	-15%	<1%	<1%
1.A.2.d	Pulp, Paper and Print	1.49	0.76	-49%	4%	1%	<1%
1.A.2.e	Food Processing, Beverages and Tobacco	0.15	0.04	-73%	21%	<1%	<1%
1.A.2.f	Non-metallic Minerals	0.48	0.49	2%	<1%	<1%	<1%
1.A.2.g	Manufacturing Industries and Constr. - other	0.19	0.10	-48%	64%	<1%	<1%
1.A.3	Transport	0.00	0.00	<1%	-9%	<1%	<1%
1.A.4	Other Sectors	4.92	0.21	-96%	12%	3%	<1%
1.A.4.a	Commercial/Institutional	0.30	0.02	-93%	11%	<1%	<1%
1.A.4.b	Residential	4.53	0.18	-96%	12%	2%	<1%
1.A.4.c	Agriculture/Forestry/Fisheries	0.09	0.00	-96%	10%	<1%	<1%
1.A.5	Other	0.00	0.00	-35%	-17%	<1%	<1%
1.B	FUGITIVE EMISSIONS FROM FUELS	NA	NA	NA	NA	NA	NA
2	INDUSTRIAL PROCESSES AND PRODUCT USE	185.50	174.63	-6%	-2%	96%	99%
2.A	MINERAL PRODUCTS	NA	NA	NA	NA	NA	NA
2.B	CHEMICAL INDUSTRY	NA	NA	NA	NA	NA	NA
2.C	METAL PRODUCTION	185.50	174.63	-6%	-2%	96%	99%
2.C.1	Iron and Steel Production	19.34	33.70	74%	-3%	10%	19%
2.C.2	Ferroalloys Production	NA	NA	NA	NA	NA	NA
2.C.3	Aluminium production	NA	NA	NA	NA	NA	NA
2.C.4	Magnesium production	NO	NO	NO	NO	NO	NO
2.C.5	Lead Production	94.40	78.08	-17%	-3%	49%	44%
2.C.6	Zinc production	NO	NO	NO	NO	NO	NO
2.C.7	Other metal production	71.77	62.85	-12%	<1%	37%	36%
2.C.7.a	Copper production	NO	NO	NO	NO	NO	NO
2.C.7.b	Nickel production	NO	NO	NO	NO	NO	NO
2.C.7.c	Other metals	71.77	62.85	-12%	<1%	37%	36%
2.C.7.d	Storage, handling and transport of metal products	NO	NO	NO	NO	NO	NO
2.D	NON ENERGY PRODUCTS/ SOLVENTS	NA	NA	NA	NA	NA	NA
2.G	Other product manufacture and use	NA	NA	NA	NA	NA	NA
2.H	Other Processes	NA	NA	NA	NA	NA	NA
2.I	Wood processing	NA	NA	NA	NA	NA	NA
2.J	Production of POPs	NO	NO	NO	NO	NO	NO
2.K	"Consumption of POPs and heavy metals	NO	NO	NO	NO	NO	NO
2.L	Other production, consumption, storage, ...	NO	NO	NO	NO	NO	NO
3	AGRICULTURE	NA	NA	NA	NA	NA	NA
5	WASTE	NA	NA	NA	NA	NA	NA
Total without sinks		194.23	176.73	-9%	-2%		

2.5 National emission total calculated on the basis of fuels used

According to Article 2 of NEC Directive 2016/2284, the Directive covers emissions from all sources occurring in the territory of the Member States, their exclusive economic zones and pollution control zones. Austria is a landlocked country and fuel prices significantly vary between neighbouring countries. Fuels tend to be sold in the territories where fuel prices are lower and they are exported to (and used in) other countries. Austria has experienced a considerable amount of 'fuel export' in the last few years; this needs to be taken into account when reporting emissions occurring in the Austrian territory.

For this reason Austria has chosen the usage of the national emission totals on the basis of fuels used (not including 'fuel exports') as a basis for compliance under the NEC Directive. Further details regarding 'fuel exports' are provided below in this chapter.

Table 53 presents the national emission totals of the SO₂, NO_x, NH₃, NMVOC and PM_{2.5} calculated on the basis of fuels used.

Table 53: Austria's emissions 1990–2015 calculated on the basis of fuels used.

	Austria's Air Emissions not including 'fuel exports' [kt]				
	SO ₂	NO _x	NMVOC	NH ₃	PM _{2.5}
1990	73.7	203.1	277.3	66.1	24.7
1991	70.4	204.2	268.8	67.4	NR
1992	54.0	193.6	251.0	65.8	NR
1993	52.3	183.6	238.5	66.7	NR
1994	46.7	181.3	217.2	68.2	NR
1995	46.4	180.0	203.8	69.5	23.6
1996	44.0	178.8	197.9	68.2	NR
1997	39.6	181.1	177.8	68.7	NR
1998	34.8	178.9	167.8	69.0	NR
1999	33.0	178.5	161.3	67.7	NR
2000	31.0	177.5	152.8	66.3	22.7
2001	31.7	179.4	148.4	66.3	22.7
2002	30.9	177.1	142.9	65.3	21.5
2003	30.9	178.9	139.8	65.0	21.2
2004	27.0	177.3	135.3	64.6	20.8
2005	25.9	178.9	132.4	64.7	20.5
2006	26.6	177.5	127.9	65.0	19.9
2007	23.1	171.8	123.4	66.3	19.3
2008	20.6	165.2	121.4	66.0	19.1
2009	15.1	150.8	116.3	67.1	18.0
2010	16.7	149.4	117.2	66.5	18.3
2011	15.5	146.2	113.6	66.0	17.7
2012	15.0	141.2	113.0	66.2	17.4

Austria's Air Emissions not including 'fuel exports' [kt]					
	SO ₂	NO _x	NM VOC	NH ₃	PM _{2.5}
2013	14.9	138.4	114.9	66.1	17.6
2014	14.7	132.6	109.6	66.5	15.9
2015	14.9	131.7	112.4	66.8	16.3
Trend 90–15	-79.8%	-35.1%	-59.5%	1.1%	-33.8%

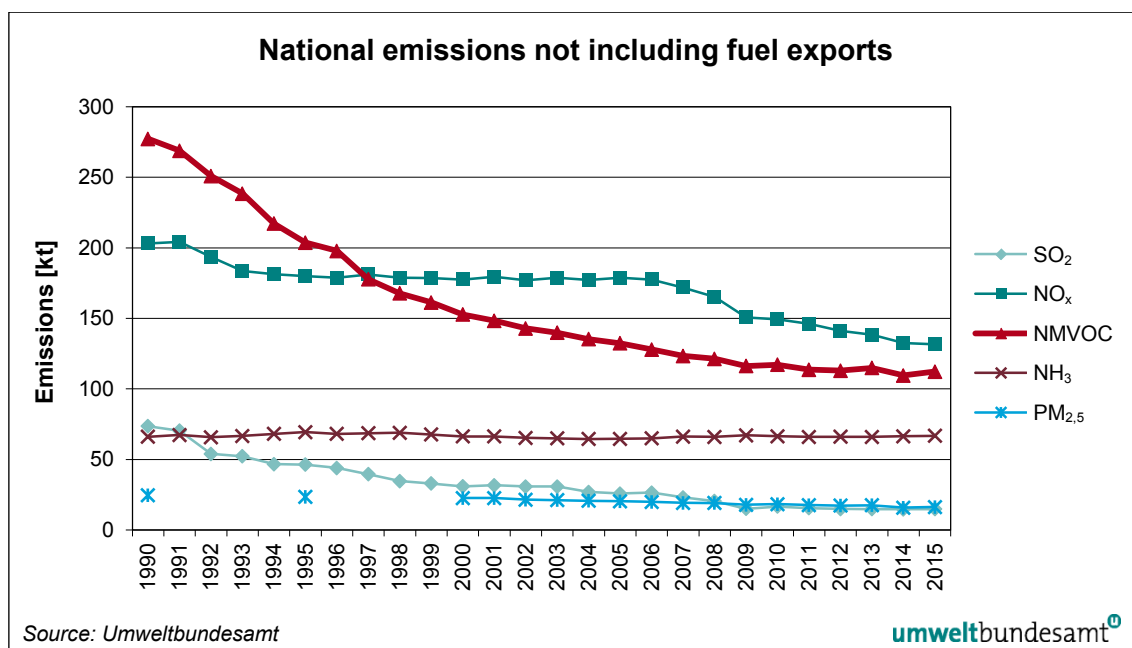


Figure 36: SO₂, NO_x, NMVOC, NH₃ and PM_{2.5} emissions totals based on 'fuels used'.

SO₂ emissions

In 1990, SO₂ emissions calculated on the basis of fuels used amounted to 73.7 kt; emissions have decreased steadily since then and in 2015 emissions amounted to 14.9 kt (- 80%).

From 2014 to 2015 emissions slightly increased by 0.8% mainly due to higher emissions from manufacturing industries and residential heating. Emissions from manufacturing industries rose due to an increased coal and residual fuel use, emissions from the residential sector increased due to higher coal and biomass use.

NO_x emissions

In 1990, NO_x emissions calculated on the basis of fuels used amounted to 203.1 kt; in 2015 emissions were 35% below 1990 levels with 131.7 kt. In the beginning of the 1990ies until the year 2005 NO_x emissions remained quite stable. From 2005 onwards emissions decreased steadily; compared to the previous year 2014 emissions decreased slightly by 0.7%.

Reasons for the downwards emission trend since 2005 are mainly declining NO_x emissions from gasoline passenger cars and from heavy duty vehicles. Between 2005 and 2015 about 10 kt NO_x were reduced in inland passenger car transport, whereas 90% of this reduction results from gasoline passenger cars. The specific NO_x emission factor per kilometre for an average gaso-

line passenger car declined in this period by 74%, whereas this indicator only declined by 17% for diesel passenger cars. In the same period 21 kt NO_x were reduced in inland transport with heavy duty vehicles which showed a reduction of 58% in the average specific NO_x emission factor per kilometre due to the well-functioning after-treatment devices (SCR, EGR) in order to meet the air pollution limit values of EURO IV – VI.

NMVOC emissions

In 1990 NMVOC emissions calculated on the basis of fuels used amounted to 277.3 kt. By 2015 emissions had fallen to 112.4 kt (-59.5%). From 2014 to 2015 emissions increased by 2.5%, mainly due to higher biomass consumption for residential heating as a consequence of the cold winter temperatures in 2015.

NH₃ emissions

In 1990 NH₃ emissions calculated on the basis of fuels used amounted to 66.1 kt; in 2015 emissions were 1.1% above 1990 levels (66.8 kt).

Compared to the previous year, emissions in 2015 remained nearly at the same level (+0.4%).

PM_{2.5} emissions

National total PM_{2.5} emissions calculated on the basis of fuels used amounted to 25 kt in 1990 and have decreased steadily so that by the year 2015 emissions were reduced by 34% to 16 kt. The largest emission reductions since 1990 could be observed in the NFR sectors *1.A.4 Other Sectors* and *1.A.3 Transport*.

Emissions from 'fuel export'

In the year 2004, a study was commissioned to analyse the effects of fuel price differences between Austria and its neighbouring countries. One of these effects was found to be the so-called 'fuel export' effect, which means that fuel is sold in Austria and used abroad. Relevant calculations were based on extensive questionnaires (addressed to truckers at the border, truckage companies), results from the Austrian transport model, and traffic counts. The importance of 'fuel exports' was confirmed by an update of the study in 2008 (unpublished).

The following Table 54 provides information on the quantities of emissions that can be attributed to the fuel export in vehicle tanks.

Table 54: Emissions from 'fuel exports'.

	Emissions [Kilotonnes]				
	SO ₂	NO _x	NMVOC	NH ₃	PM _{2.5}
1990	0.91	17.77	3.36	0.06	0.58
1991	1.17	25.15	7.80	0.21	NR
1992	1.18	22.34	4.15	0.14	NR
1993	1.32	22.55	2.36	0.09	NR
1994	1.23	19.21	0.70	0.00	NR
1995	1.13	20.02	0.54	-0.03	0.75
1996	0.82	38.61	0.11	-0.17	NR
1997	0.50	24.75	-0.83	-0.24	NR
1998	0.73	39.23	1.22	-0.05	NR

	Emissions [Kilotonnes]				
	SO ₂	NO _x	NM VOC	NH ₃	PM _{2.5}
1999	0.54	31.10	0.00	-0.22	NR
2000	0.60	37.61	0.43	-0.21	0.90
2001	0.71	45.51	1.53	-0.03	1.12
2002	0.76	53.66	3.30	0.36	1.45
2003	0.82	60.10	4.28	0.57	1.68
2004	0.06	59.03	4.32	0.61	1.66
2005	0.05	59.11	4.19	0.59	1.63
2006	0.04	46.11	3.25	0.55	1.31
2007	0.04	41.24	2.87	0.52	1.15
2008	0.03	31.92	1.97	0.35	0.81
2009	0.03	29.99	1.78	0.33	0.73
2010	0.04	31.66	1.54	0.26	0.70
2011	0.03	25.22	1.08	0.17	0.52
2012	0.03	23.31	0.94	0.15	0.46
2013	0.04	25.87	0.85	0.12	0.48
2014	0.03	20.43	0.62	0.08	0.36
2015	0.03	17.39	0.53	0.06	0.30
Trend 90–15	-96.4%	-2.2%	-84.3	15.8%	-48.9

In 2015 about 12% of the reported national total NO_x emissions were caused by 'fuel export'. Emissions from fuel export increased between 1990 and 2005. From then emissions show a decreasing trend which is in line with decreased activities (amount of fuel consumption) from 2005 onwards. Truck traffic holds the main share in fuel export (energy related) with 93%. This reduction can be explained due to the fact that NO_x after treatment systems of trucks are working very well. In 2015, NO_x emissions of total fuel export were slightly below the level of 1990.

In passenger transport the phenomenon of fuel export plays a minor role with an average share of only about 1% in NO_x emissions of sector road transport in 2015. In contrast, fuel export in road freight transport with heavy duty vehicles plays a major role in Austria with an average share of 22% in NO_x emissions of sector road transport in 2015. For more details, please also refer to chapter 3.2.6.

3 ENERGY (NFR SECTOR 1)

Sector 1 *Energy* considers emissions originating from fuel combustion activities (NFR 1.A)

- 1.A.1 Energy Industries
- 1.A.2 Manufacturing Industries and Construction
- 1.A.3 Transport
- 1.A.4 Other Sectors (commercial and residential)
- 1.A.5 Other (Military)

as well as fugitive emissions from fuels (NFR 1.B)

- 1.B.1 Solid fuels
- 1.B.2 Oil and natural gas.

3.1 NFR 1.A Stationary Fuel Combustion Activities

3.1.1 General description

This chapter gives an overview of category *1.A Stationary Fuel Combustion Activities*. It includes information on completeness, QA/QC and planned improvements as well as on emissions, emission trends and methodologies applied (including emission factors).

Information is also provided in the Austrian National Inventory Report 2016 (UMWELTBUNDESAMT 2017a) which is part of the submission under the UNFCCC.

- Additionally to information provided in this document, Annex 2 of (UMWELTBUNDESAMT 2017a) includes further information on the underlying activity data used for emissions estimation. It describes the national energy balance (fuels and fuel categories, net calorific values) and the methodology of how activity data are extracted from the energy balance (correspondence of energy balance to SNAP and IPCC categories).
- National energy balance data is presented in Annex 4 of (UMWELTBUNDESAMT 2017a).

3.1.1.1 Completeness

Table 55 provides information on the status of emission estimates of all sub categories. A “✓” indicates that emissions from this sub category have been estimated.

Table 55: Completeness of “1.A Stationary Fuel Combustion Activities”.

NFR Category	NO _x	CO	NM VOC	SO _x	NH ₃	TSP	PM ₁₀	PM _{2.5}	Pb	Cd	Hg	DIOX	PAH	HCB	PCB
1.A.1.a Public Electricity and Heat Production	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	NE ⁽³⁾														
1.A.1.b Petroleum refining	✓	✓	IE ⁽¹⁾	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1.A.1.c Manufacture of Solid fuels and Other Energy Industries	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	IE ⁽⁴⁾	IE ⁽⁴⁾	IE ⁽⁴⁾	IE ⁽⁴⁾	IE ⁽⁴⁾	IE ⁽⁴⁾	IE ⁽⁴⁾	IE ⁽⁴⁾	IE ⁽⁴⁾	IE ⁽⁴⁾	IE ⁽⁴⁾	IE ⁽⁴⁾	IE ⁽⁴⁾	IE ⁽⁴⁾	IE ⁽⁴⁾
1.A.2.a Iron and Steel	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	IE ⁽⁵⁾														
1.A.2.b Non-ferrous Metals	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1.A.2.c Chemicals	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1.A.2.d Pulp, Paper and Print	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1.A.2.e Food Processing, Beverages and Tobacco	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1.A.2.f Non-metallic Minerals	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(8)														
1.A.2.g Other Stationary combustion	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1.A.3.e.1 Pipeline compressors	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	NE ⁽⁶⁾	NA ⁽⁷⁾	✓	NA ⁽⁷⁾
1.A.4.a.1 Commercial/Institutional: stationary	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1.A.4.b.1 Residential: stationary	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1.A.4.c.1 Agriculture/Forestry/Fishing, Stationary	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1.A.5.a Other, Stationary (including Military)	IE ⁽²⁾	IE ⁽²⁾	IE ⁽²⁾	IE ⁽²⁾	IE ⁽²⁾	IE ⁽²⁾	IE ⁽²⁾	IE ⁽²⁾	IE ⁽²⁾	IE ⁽²⁾	IE ⁽²⁾	IE ⁽²⁾	IE ⁽²⁾	IE ⁽²⁾	NO

⁽¹⁾ NMVOC emissions from Petroleum Refining are included in 1.B.

⁽²⁾ Emissions from military facilities are included in 1.A.4.a.

⁽³⁾ NH₃ slip emissions from NO_x control are not estimated.

⁽⁴⁾ Emissions from coke ovens are included in 1.A.2.a or 2.C.1. Emissions from final energy use of coal mines are included in 1.A.2.f.

⁽⁵⁾ Heavy metals, POPs and PM emissions from integrated iron and steel plants are included in 2.C.1.

⁽⁶⁾ Dioxin emissions (PCDD/F) from natural gas compressors are not estimated but assumed to be negligible (at level of detection limit).

⁽⁷⁾ PAH and PCB emissions from natural gas compressors are assumed to be negligible (below detection limit).

⁽⁸⁾ PM emissions from cement and lime kilns are included in 2.A.1 and 2.A.3.

Table 56 shows the correspondence of NFR and SNAP categories.

Table 56: NFR and SNAP categories of “1.A Stationary Fuel Combustion Activities”.

NFR Category		SNAP
1.A.1.a Public Electricity and Heat Production	0101	Public power
	0102	District heating plants
1.A.1.b Petroleum refining	0103	Petroleum refining plants
1.A.1.c Manufacture of Solid fuels and Other Energy Industries	0104	Solid fuel transformation plants
	010503	Oil/Gas Extraction plants
	010504	Gas Turbines
1.A.2.a Iron and Steel	0301	Comb. In boilers, gas turbines and stationary engines (Iron and Steel Industry)
	030302	Reheating furnaces steel and iron
	030326	Processes with Contact-Other(Iron and Steel Industry)
1.A.2.b Non-ferrous Metals	0301	Comb. In boilers, gas turbines and stationary engines (Non-ferrous Metals Industry)
	030307	Secondary lead production
	030309	Secondary copper production
	030310	Secondary aluminium production
	030324	Nickel production (thermal process)
1.A.2.c Chemicals	0301	Comb. in boilers, gas turbines and stationary engines (Chemicals Industry)
1.A.2.d Pulp, Paper and Print	0301	Comb. in boilers, gas turbines and stationary engines (Pulp, Paper and Print Industry)
1.A.2.e Food Processing, Beverages and Tobacco	0301	Comb. in boilers, gas turbines and stationary engines (Food Processing, Beverages and Tobacco Industry)
1.A.2.f Non-metallic Minerals	030311	Cement
	030317	Glass
	030312	Lime
	030319	Bricks and Tiles
	030323	Magnesium production (dolomite treatment)
1.A.2.g Other Stationary Combustion	0301	Comb. in boilers, gas turbines and stationary engines (Industry not included in 1.A.2.a to 1.A.2.f)
1.A.3.e Other transportation	010506	Pipeline Compressors
1.A.4.a.1 Commercial/Institutional: stationary	0201	Commercial and institutional plants Open Firepits and Bonfires
1.A.4.b.1 Residential: stationary	0202	Residential plants Barbecue
1.A.4.c.1 Agriculture/ Forestry/Fishing, Stationary	0203	Plants in agriculture, forestry and aquaculture

3.1.1.2 Key Categories

Key category analysis is presented in Chapter 1.5. This chapter includes information on the Energy (stationary) sector. Key sources within this category are presented in Table 57.

Table 57: Key sources of sector Energy (stationary).

IPCC Category	Category Name	Pollutant	KS-Assessment
1.A.1.a	Public Electricity and Heat Production	SO ₂ , NO _x , Cd, Pb, Hg ²⁾ , DIOX ²⁾ , TSP ²⁾ , PM ₁₀ ²⁾ , PM _{2.5}	LA, TA
1.A.1.b	Petroleum refining	NO _x ¹⁾ , Cd	LA, TA
1.A.2.a	Iron and Steel	SO ₂ , CO	LA, TA
1.A.2.b	Non-ferrous Metals	DIOX, HCB	TA
1.A.2.d	Pulp, Paper and Print	SO ₂ ²⁾ , Cd ²⁾ , Pb ²⁾ , Hg ¹⁾ , PM ₁₀ ¹⁾ , PM _{2.5} ¹⁾	LA, TA
1.A.2.f	Non-metallic Minerals	SO ₂ , NO _x ²⁾ , Cd ¹⁾ , Hg	LA, TA
1.A.2.g.7	Mobile Combustion in Manufacturing Industries and Construction	NO _x , PAH ¹⁾ , TSP ²⁾ , PM ₁₀ , PM _{2.5} ²⁾	LA, TA
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	SO ₂ , NO _x , Cd ¹⁾ , Pb ²⁾ , DIOX, TSP, PM ₁₀ , PM _{2.5}	LA, TA
1.A.4.a.1	Commercial/Institutional: Stationary	SO ₂	TA
1.A.4.b.1	Residential: stationary	SO ₂ , NO _x ²⁾ , NMVOC, CO, Cd ²⁾ , Pb, Hg ²⁾ , PAH, DIOX, HCB, PCB ¹⁾ , TSP ²⁾ , PM ₁₀ ²⁾ , PM _{2.5} ²⁾	LA, TA
1.A.4.b.2	Residential: Household and gardening (mobile)	CO	LA
1.A.4.c.1	Agriculture/Forestry/Fishing: Stationary	CO, PAH, DIOX, HCB ¹⁾ , PM _{2.5} ¹⁾	LA, TA
1.A.4.c.2	Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	NO _x ²⁾ , TSP ¹⁾ , PM ₁₀ , PM _{2.5}	LA, TA
1.B.2.a	Oil	NMVOC	LA

LA = Level Assessment (if not further specified – for the years 1990 and 2015)

TA = Trend Assessment 2015

Note: ¹⁾only TA, ²⁾only LA

3.1.1.3 Uncertainty Assessment

The table below gives an overview of uncertainties for Sector Energy (stationary). The method used for the assessment of uncertainty is according to the EMEP/EEA air pollutant emission inventory guidebook 2016 (EEA 2016). Further information on the uncertainty assessment of activity data can be found in Austria's National Inventory Report (UMWELTBUNDESAMT 2017a). Where no specific information on uncertainties of emission factors was available, an average of the default values, based on the definitions of the qualitative ratings given in the EMEP/EEA Emission Inventory Guidebook 2016 is used (see chapter 1.7).

Table 58: Combined uncertainties for NO_x, SO₂, NMVOC, NH₃ and PM_{2.5} for Energy (stationary).

NFR Categories		NO _x Emissions [%]	NH ₃ Emissions [%]	NMVOC Emissions [%]	SO ₂ Emissions [%]	PM _{2.5} Emissions [%]
1.A.1.a	Public Electricity and Heat Production	21.54	750.04	200.16	21.54	60.53
1.A.1.b	Petroleum refining	10.05	750.00	200.01	10.05	40.01
1.A.2.a	Iron and Steel	40.05	750.00	200.06	11.18	40.05
1.A.2.b	Non-ferrous Metals	11.18	750.02	200.06	20.62	40.31
1.A.2.c	Chemicals	40.31	750.02	200.06	20.62	40.31
1.A.2.d	Pulp, Paper and Print	40.31	750.02	200.25	22.36	40.31
1.A.2.e	Food Processing, Beverages and Tobacco	41.23	750.07	200.06	20.62	41.23
1.A.2.f	Non-metallic Minerals	40.31	750.02	200.06	20.62	40.31
1.A.2.g.7	Mobile Combustion in Manufacturing Industries and Construction	40.31	750.02	40.01	20.02	40.31
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	40.01	125.00	41.23	22.36	125.00
1.A.4.a	Commercial/Institutional	40.31	125.10	70.18	20.62	60.21
1.A.4.b	Residential	42.72	125.90	71.59	25.00	61.85
1.A.4.c	Agriculture/Forestry/ Fisheries	100.12	125.10	100.12	20.62	100.12
1.A.5	Other	125.00	200.00	125.00	40.01	125.00

3.1.2 Methodological issues

General Methodology for stationary sources of NFR categories 1.A.1 to 1.A.5

For large point sources in categories 1.A.1.a, 1.A.1.b, 1.A.2.a, 1.A.2.d and 1.A.2.f (cement industry) emission measurements of NO_x, SO₂, NMVOC, CO and TSP are the basis for the reported emissions.

The remaining sources (area sources), where measured (plant-specific) emission data and plant specific activity data is not available, were estimated using the simple CORINAIR methodology by multiplying the fuel consumption of each sub category taken from the national energy balance with a fuel and technology dependent emission factor. Fuel specific emission factors are mainly country specific and taken from national studies.

Emission factors

Emission factors are expressed as: kg released pollutant per TJ of burned fuel [kg/TJ].

Emission factors may vary over time for the following reasons:

- The chemical characteristics of a fuel category varies, e.g. sulphur content in residual oil.
- The mix of fuels of a fuel category changes over time. If the different fuels of a fuel category have different calorific values and their share in the fuel category changes, the calorific value of the fuel category might change over time. If emission factors are in the unit kg/t the transformation to kg/TJ induces a different emission factor due to varying net calorific values.
- The (abatement-) technology of a facility – or of facilities – changes over time.

Sources of NO_x, SO₂, VOC, CO, and TSP emission factors have been periodically published reports (BMWA 1990), (BMWA 1996), (UMWELTBUNDESAMT 2001a), (UMWELTBUNDESAMT 2004b). In these studies emission factors are provided for the years 1987, 1995 and 1996. Emission factors are mainly based on country specific measurements. NH₃ emission factors are taken from a national study (UMWELTBUNDESAMT 1993) and (EMEP/CORINAIR 2005, chapter B112). Details are included in the relevant chapters.

PCB emission factors

PCB emission factors for coal and gasoil are selected from the EMEP 2013 Guidebook. The PCB emission factor of 3600 µg/t for residual fuel oil has been selected from (KAKAREKA et al 2004) and converted to 85 µg/GJ.

The PCB emission factors for biofuels and waste have been derived from the ratio of Dioxin and PCB emission factors according to the measurements undertaken by (HEDMAN et al 2006). A ratio of 0.09 g PCB per g Dioxin has been selected. The same ratio has also been selected for refinery fuels.

NH₃

Emission factors are constant for the whole time series.

SO₂, NO_x, NMVOC, CO

For the years 1990 to 1994 emission factors are linearly interpolated by using the emission factors from 1987 and 1995 taken from the studies mentioned above. From 1997 onwards mainly the emission factors of 1996 are used.

In several national studies only emission factors for VOC are cited. NMVOC emissions are calculated by subtracting a certain share of CH₄ emissions from VOC emissions.

Characteristic of oil products

According to a national standard, residual fuel oil is classified into 3 groups with different sulphur content (heavy, medium, light). Consumption of special residual fuel oil with a sulphur content higher than 1% is limited to special power plants ≥ 50 MW and the oil refinery. Heating fuel oil is mainly used for space heating in small combustion plants. The following Table shows the sulphur contents of oil products which decreased strongly since 1980 due to legal measures. The years presented in the table are the years where legal measures came into force.

Table 59: Limited sulphur content of oil product classes according to the Austrian standard „ÖNORM“.

Year	Residual fuel oil “Heavy”	Residual fuel oil “Medium”	Residual fuel oil “Light”	Heating fuel oil
1980	3.5%	2.5%	1.50%	0.8%
1981				0.5%
1982		1.5%	0.75%	
1983	3.0%			0.3%
1984	2.5%; 2.0%	1.0%	0.50%	
1985				
1987		0.6%		
1989			0.30%	0.2%
1990			0.20%	0.1%
1992	1.0%			
1994		0.4%		

Since the year 2008 a new gasoil product was introduced in Austria with a maximum sulphur content of 10 ppm (0.001%) which has the same quality as transport diesel. In the inventory it is assumed that the new product has a 100% market share since 2009 because of its lower taxes.

Activity data

A description of methodology and activity data will be provided in (UMWELTBUNDESAMT 2017a). If the energy balance reports fuel quantities by mass or volume units the fuel quantities must be converted into energy units [TJ] by means of net calorific values (NCV) which are provided by *Statistik Austria* along with the energy balance.

Not all categories of the gross inland fuel consumption are combusted or relevant for the inventory:

- Emissions from international bunker fuels are not included in the National Total but reported separately as *Memo Item*.
- Avoiding of activity data double counting: transformation and distribution losses and transformations of fuels to other fuels (like hard coal to coke oven coke or internal refinery processes which have been added to the transformation sector of the energy balance) is not considered as activity data.
- Non-energy use is also not considered for calculation of emissions in Sector 1.A *Energy*. However, from these fuels fugitive emissions might occur which are considered in Sector 2.D.3 *Solvents*. Emissions from fuel used as a feedstock are considered in Sector 2 *Industrial Processes*.

Measured emissions

In case that measured emissions are used for inventory preparation it is essential that the correspondent activity data is additionally reported to avoid double counting of emissions within the inventory. Plant or industrial branch specific emissions are mostly broken down to fuel specific emissions per NFR source category. In case that complete time series of measured emission data are not available implied emission factors are used for emission calculation. Implied emission factors may also be used for validation of measured emissions.

3.1.3 NFR 1.A.1 Energy Industries

NFR Category 1.A.1 comprises emissions from fuel combustion for *public electricity and heat production* (NFR 1.A.1.a), in *petroleum refining* (NFR 1.A.1.b), and in manufacture of solid fuels and other energy industries (NFR 1.A.1.c).

General Methodology

The following Table 60 gives an overview of methodologies and data sources of sub category 1.A.1 *Energy Industries*.

Table 60: Overview of 1.A.1 methodologies for main pollutants.

	Activity data	Reported/measured emissions	Emission factors
1.A.1.a boilers ≥ 50 MW _{th}	Reporting Obligation: fuel consumption (monthly). 2005–2015: ETS data	Reporting Obligation: NO _x , SO ₂ , TSP, CO (monthly) (56.Boilers)	NMVOC, NH ₃ : national studies
1.A.1.a boilers < 50 MW _{th}	Energy balance 2005–2015: ETS data for plants ≥ 20 MW _{th}	Used for deriving emission factors	All pollutants: national studies
1.A.1.b (1 plant)	Reported by plant operator (yearly) 2005–2015: ETS data	Reported by plant operator: SO ₂ , NO _x , CO, NMVOC (yearly)	NH ₃ : national study
1.A.1.c	Energy balance 2005–2015: ETS data		All pollutants: national studies

For 2005–2015 activity data from the emission trading system (ETS) has been considered. ETS data fully covers category 1.A.1.b, covers about 65% of category 1.A.1.a and about 15% (from 2014 on about 50-70%) of category 1.A.1.c activity data.

3.1.3.1 NFR 1.A.1.a Public Electricity and Heat Production

In this category large point sources are considered. The Umweltbundesamt operates a database called „Dampfkesseldatenbank“ (DKDB) which stores plant specific monthly fuel consumption as well as measured CO, NO_x, SO_x and TSP emissions from boilers with a thermal capacity greater than 3 MW_{th} from 1990 to 2006. Since 2007 the reporting has been changed to an online system. To reach consistency with the GHG inventory all ETS plants and additionally 13 waste incineration boilers/kilns are considered as large point sources. These data are used to generate a split of the categories *Public Power* and *District Heating* into the two categories ≥ 300 MW_{th} and ≥ 50 MW_{th} to 300 MW_{th}. Currently about 75 boilers are considered in this approach. It turned out that this methodology is appropriate for most cases but overall fuel consumption has to be checked against the national energy balance or other available complete datasets/surveys (see section on QA/QC).

Fuel consumption in the public electricity sector varies strongly over time. The most important reason for this variation is the fact that in Austria up to 78% of yearly electricity production comes from hydropower. If production of electricity from hydropower is low, production from thermal power plants is high and vice versa.

The following table shows the gross electricity and heat production of public power and district heating plants. Increasing district heat production is mainly generated by new biomass (local) heat plants and by waste incineration. The share of combined heat and power plants (CHP generation) is increasing and leads to higher efficiency of energy generation. The year 2010 shows a historic maximum of about 19 TWh of electricity production and the year 2013 shows a maximum of 76 PJ district heat production from fuel combustion.

Table 61: Public gross electricity and heat production.

	Public gross electricity production [GWh]						Public Heat Production [TJ] by Combustible Fuels
	Total	Hydro ¹⁾	Combustible Fuels	Geothermal	Solar	Wind	
1990	43 403	30 111	13 292	0	0	0	24 427
1991	43 497	30 268	13 229	0	0	0	29 038
1992	42 848	33 530	9 318	0	0	0	27 601
1993	44 809	35 070	9 738	0	1	0	30 428
1994	44 804	34 078	10 725	0	1	0	30 729
1995	47 580	35 431	12 147	0	1	1	34 426
1996	45 953	32 892	13 055	0	1	5	44 483
1997	47 527	34 532	12 973	0	2	20	40 597
1998	47 789	35 596	12 146	0	2	45	43 415
1999	52 192	39 593	12 546	0	2	51	42 465
2000	52 810	41 131	11 609	0	3	67	42 197
2001	53 763	39 681	13 972	0	5	105	44 575
2002	54 385	40 597	13 636	3	9	140	45 056
2003	52 508	34 230	17 888	3	15	372	48 896
2004	56 051	37 700	17 397	2	18	934	51 786
2005	58 514	38 205	18 955	2	21	1 331	54 244
2006	56 263	36 907	17 578	3	22	1 753	55 120
2007	56 322	38 017	16 242	2	24	2 037	54 599
2008	57 942	39 458	16 441	2	30	2 011	61 627
2009	60 603	42 414	16 184	2	49	1 954	64 248
2010	61 648	40 500	18 994	1	89	2 064	75 506
2011	56 351	36 816	17 424	1	174	1 936	71 493
2012	64 030	47 158	14 072	1	337	2 462	74 274
2013	60 215	45 253	11 227	0	582	3 153	77 163
2014	57 741	44 273	8 837	0	785	3 846	69 742
2015	57 466	40 113	11 576	0	937	4 840	72 212

¹⁾ including pumped storage; Source: STATISTIK AUSTRIA 2016C

As shown in Table 62 electricity supply increased by 10 397 GWh since 2000 of which approx. 80% has been supplied by additional imports until 2008. The year 2009 shows falling electricity consumption (supply) but an increase of production, mainly by hydro power. The year 2015 shows an historical maximum of net imports which contribute to 15% of total electricity supply.

Table 62: Electricity supply, gross production imports, exports and net imports [GWh].

	Electricity [GWh]				
	Supply ¹⁾	Gross production ²⁾	Imports	Exports	Net Imports
1990	46 489	50 294	6 839	7 298	-459
1991	48 793	51 483	8 503	7 738	765
1992	48 197	51 190	9 175	8 621	554
1993	49 073	52 421	8 072	8 804	-732
1994	49 596	53 132	8 219	9 043	-824
1995	50 979	56 225	7 287	9 757	-2 470
1996	52 515	54 880	9 428	8 476	952
1997	53 069	56 704	9 008	9 775	-767
1998	54 039	57 001	10 304	10 467	-163
1999	55 167	60 944	11 608	13 507	-1 899
2000	55 750	61 257	13 824	15 192	-1 368
2001	58 338	62 449	14 467	14 252	215
2002	58 074	62 499	15 375	14 676	699
2003	60 058	60 174	19 003	13 389	5 614
2004	61 320	64 152	16 629	13 548	3 081
2005	62 865	66 830	20 397	17 732	2 665
2006	65 595	64 686	21 257	14 407	6 850
2007	66 706	65 170	22 130	15 511	6 619
2008	66 144	66 866	19 796	14 933	4 863
2009	63 266	69 089	19 542	18 762	780
2010	65 906	71 129	19 898	17 567	2 331
2011	65 836	65 811	24 972	16 777	8 195
2012	66 788	72 601	23 264	20 455	2 809
2013	66 757	68 312	24 960	17 689	7 271
2014	66 328	65 442	26 712	17 437	9 275
2015	66 539	65 299	29 369	19 311	10 058

Source: Statistik Austria

¹⁾ Excluding own use and heat pumps, boilers and pumped storage use. Including losses²⁾ Public and autoproducer gross production

Total fuel consumption data is taken from the energy balance (IEA JQ 2016) prepared by *Statistik Austria*. The remaining fuel consumption (= total consumption minus reported boiler consumption) is the activity data of plants < 50 MW_{th} used for emission calculation with the simple CORINAIR methodology using national emission factors.

Table 63 shows activity data of category 1.A.1.a.

Table 63: Fuel consumption from NFR 1.A.1.a Public Electricity and Heat Production 1990–2015.

NFR	1.A.1.a	1.A.1.a	1.A.1.a	1.A.1.a	1.A.1.a	1.A.1.a
Fuel		liquid	solid	gaseous	biomass	other
[PJ]						
1990	140.52	15.62	61.40	59.46	1.63	2.41
1991	149.36	19.01	67.33	57.55	2.57	2.90
1992	114.73	18.78	39.97	49.50	3.00	3.49
1993	117.57	25.99	30.81	53.89	3.12	3.76
1994	122.55	24.02	32.97	58.34	3.39	3.82
1995	135.17	19.69	45.49	62.07	4.02	3.91
1996	157.79	19.63	47.52	79.74	6.12	4.77
1997	154.75	24.33	50.96	68.42	6.15	4.89
1998	148.83	27.91	35.81	73.53	6.81	4.78
1999	147.76	22.06	37.88	76.62	6.47	4.74
2000	139.22	14.86	49.16	62.51	8.05	4.64
2001	159.94	19.91	59.76	63.60	11.08	5.59
2002	155.42	10.33	56.12	69.12	13.07	6.77
2003	189.28	14.16	70.88	82.38	14.01	7.85
2004	188.66	14.74	69.06	78.93	15.84	10.09
2005	203.72	14.07	61.63	97.57	20.23	10.22
2006	198.03	12.50	60.19	82.07	30.35	12.91
2007	187.58	8.91	54.46	73.50	37.96	12.76
2008	198.14	8.80	47.87	83.32	45.23	12.92
2009	191.33	7.93	32.46	86.00	48.05	16.90
2010	220.78	8.61	41.47	94.55	57.97	18.18
2011	211.80	4.84	45.64	85.23	56.26	19.83
2012	195.84	2.91	37.18	75.00	60.00	20.75
2013	177.07	2.43	35.78	61.30	57.33	20.24
2014	156.99	1.99	24.74	51.03	57.02	22.21
2015	177.24	3.25	24.98	65.88	60.02	23.11
Trend						
1990–2015	26.1%	-79.2%	-59.3%	10.8%	3586.9%	857.1%
Trend						
2014–2015	12.9%	63.7%	1.0%	29.1%	5.3%	4.0%

Boilers and gas turbines $\geq 50 \text{ MW}_{\text{th}}$

This category considers steam boilers and gas turbines with heat recovery. Due to national regulations coal and residual fuel oil operated boilers are mostly equipped with NO_x controls, flue gas desulphurisation and dust control units. A high share (regarding fuel consumption) of natural gas operated boilers and gas turbines are also equipped with NO_x controls. Emission data of boilers $\geq 50 \text{ MW}_{\text{th}}$ is consistent with data used for the national report to the Large Combustion Plant Directive 2001/80/EG (UMWELTBUNDESAMT 2006a) except in the case where gap filling was performed. An overview about installed SO₂ and NO_x controls and emission trends are presented in (UMWELTBUNDESAMT 2006a).

Emissions by fuel type are essential for validation and review purposes. If boilers are operated with mixed fuels derivation of fuel specific emissions from measured emissions is not always appropriate. Fuel specific emissions were derived as following:

- i Add up fuel consumption and emissions of the boiler size classes $\geq 300 \text{ MW}_{th}$ and $\geq 50 \text{ MW}_{th}$ < 300 MW_{th} . Convert fuel consumption from mass or volume units to TJ by means of average heating values from the energy balance.
- ii Derive default emission factors for each fuel type of the “most representative” plants by means of actual flue gas concentration measurements and/or legal emission limits. This work is done by the Umweltbundesamt. The national “default” emission factors are periodically published in reports like (UMWELTBUNDESAMT 2004b).
- iii Calculate “default” emissions by fuel consumption and national “default” emission factors.
- iv Calculate emission ratio of calculated emissions and measured emissions by boiler size class.
- v Calculate emissions by fuel type and boiler size class by multiplying default emissions with emission ratio. Implied emission factors by fuel type may be calculated.

In the approach above different coal types and residual fuel classifications are considered. Table 64 shows some selected aggregated results for 2015. The ratios of measured to calculated emissions show that the application of a simple Tier 2 Approach would introduce a high uncertainty for CO.

Table 64: NFR 1.A.1.a $\geq 50 \text{ MW}_{th}$ emission factors fuel consumption and emissions ratios for the year 2015.

Fuel consumption [TJ]		NO _x [kg/TJ]	CO [kg/TJ]
NFR 1.A.1.a $\geq 50 \text{ MW}_{th}$		0.86 ⁽¹⁾	0.19 ⁽¹⁾
SNAP 010101		0.93 ⁽¹⁾	1.44 ⁽¹⁾
Hard Coal	24 981	50.0	1
Oil	98	26.0	3.0
Natural gas	45 533	30.0	4.0
Sewage sludge	20	100.0	200.0
Biomass	749	94.0	72.0
SNAP 010102		1.02 ⁽¹⁾	1.37 ⁽¹⁾
Natural gas	4 316	30.0	4.0
Waste	11 765	100.0	200.0
SNAP 010201		4.87 ⁽¹⁾	11.82 ⁽¹⁾
Oil	281	100.0	4.0
Natural gas	1 639	25.0	4.0
SNAP 010202		0.38 ⁽¹⁾	0.02 ⁽¹⁾
Oil	721	85.0	4.0
Natural gas	5 555	25.0	4.0
Waste	11 340	48.0	200.0
Sewage Sludge	2 135	100.0	200.0

⁽¹⁾ Emission ratio of measured emissions divided by calculated emissions.

Boilers and gas turbines < 50 MW_{th}

Table 65 shows main pollutant emission factors used for calculation of emissions from boilers < 50 MW_{th} for the year 2015. Increasing biomass consumption of smaller plants is a main source of NO_x emissions from this category in 2015.

Table 65: NFR 1.A.1.a < 50 MW_{th} main pollutant emission factors and fuel consumption for the year 2015.

Fuel	Activity [TJ]	NO _x [kg/TJ]	CO [kg/TJ]	NMVOC [kg/TJ]	SO ₂ [kg/TJ]	NH ₃ [kg/TJ]
Light Fuel Oil	120	159.4	10/45 ⁽¹⁾	0.8	92	2.7
Medium Fuel Oil	0	159.4	15	8.0	196	2.7
Heavy Fuel Oil	1 932	317.4	3/15 ⁽¹⁾	8.0	50/398 ⁽¹⁾	2.7
Gasoil	99	65	10	4.8	0.5	2.7
Diesel oil	0	700	15	0.8	18.8	2.7
Liquified Petroleum Gas	0	150	5	0.5	6	1
Natural Gas/power and CHP	6 824	30	4	0.5	NA	1
Natural Gas/district heating	2 014	41	5	0.5	NA	1
Solid Biomass	46 806	94	72	5.0	11	5
Biogas, Sewage Sludge Gas, Landfill Gas	10 150	150	4	0.5	NA	1

⁽¹⁾ Different values for: Electricity & CHP/District heating.

Sources of emission factors

Sources of NO_x, SO₂, VOC, CO, and TSP emission factors are periodically published reports (BMWA 1990), (BMWA 1996), (BMWA 2003), (UMWELTBUNDESAMT 2004b). These reports provide information about the methodology of emission factor derivation and are structured by SNAP nomenclature. Emission factors for electricity and heat plants are based on expert judgment by Umweltbundesamt and experts from industry.

The NO_x emission factor for biomass boilers ≤ 50 MW_{th} and municipal solid waste is taken from a national unpublished study (UMWELTBUNDESAMT 2006b). Biomass NO_x EFs are derived by means of measurements of 71 Boilers which have been selected as a representative sample from the approximately 1000 existing biomass boilers in 2005. Municipal waste NO_x EFs are derived from plant specific data taken from (BMLFUW 2002b).

NH₃ emission factors for coal, oil and gas are taken from (UMWELTBUNDESAMT 1993). For waste the emission factor of coal is selected. NH₃ emission factors for biomass are taken from (EMEP/CORINAIR 2005, chapter B112) and a value of 5 kg/TJ was selected.

VOC emission factors are divided into NMVOC and CH₄ emission factors as shown in Table 66. The split follows closely (STANZEL et al. 1995).

Table 66: Share of NMVOC emissions in VOC emissions for 1.A.1.a.

	Solid Fossile	Liquid Fossile	Natural Gas	Biomass
Electricity plants	90%	80%	25%	75%
District Heating plants	Hard coal 70% Brown Coal 80%	80%	30%	75%

3.1.3.2 NFR 1.A.1.b Petroleum Refining

In this category emissions from fuel combustion of a single petroleum refining plant are considered. The plant does not have any secondary DeNO_x equipment but a certain amount of primary NO_x control has been achieved since 1990 by switching to low NO_x burners (UMWELTBUNDESAMT 2006b). SO₂ reduction is achieved by a regenerative Wellman-Lord process facility (WINDSPERGER & HINTERMEIER 2003). Particulates control is achieved by two electrostatic precipitator (ESP) units. CO emissions were significantly reduced between 1990 and 1991 due to reconstruction of a FCC facility (UMWELTBUNDESAMT 2001a). Since 2007 the plant is equipped with a SNO_x facility which reduces SO₂ by about 65% and NO_x emissions by about 55%.

The Austrian association of mineral oil industry (*Fachverband der Mineralölindustrie*) communicates yearly fuel consumption, SO₂, NO_x, CO, VOC and TSP emissions to the Umweltbundesamt. NMVOC emissions from fuel combustion are reported together with fugitive emissions under category 1.B.2.a. NH₃, heavy metals and POPs emissions are calculated with the simple CORINAIR methodology. The following Table 67 shows the fuel consumption of the refinery.

Table 67: Fuel consumption from NFR 1.A.1.b Petroleum Refining 1990–2015.

NFR	1.A.1.b	1.A.1.b	1.A.1.b	1.A.1.b	1.A.1.b	1.A.1.b
Fuel		liquid	solid	gaseous	biomass	other
[PJ]						
1990	35.35	27.47	-	7.88	-	-
1991	35.64	26.27	-	9.37	-	-
1992	34.91	26.38	-	8.53	-	-
1993	37.78	27.90	-	9.88	-	-
1994	36.13	29.20	-	6.93	-	-
1995	34.22	26.61	-	7.61	-	-
1996	39.44	31.06	-	8.38	-	-
1997	39.78	31.05	-	8.74	-	-
1998	38.81	30.49	-	8.32	-	-
1999	31.43	26.37	-	5.06	-	-
2000	31.68	26.62	-	5.06	-	-
2001	31.75	27.24	-	4.51	-	-
2002	35.95	31.84	-	4.11	-	-
2003	37.65	33.38	-	4.27	-	-
2004	40.44	33.36	-	7.08	-	-
2005	41.61	32.29	-	9.32	-	-
2006	41.81	33.13	-	8.68	-	-
2007	42.43	34.26	-	8.18	-	-
2008	41.74	32.61	-	9.13	-	-
2009	39.22	35.06	-	4.16	-	-
2010	39.70	30.70	-	9.00	-	-
2011	40.17	31.18	-	9.00	-	-
2012	40.46	30.65	-	9.81	-	-

NFR	1.A.1.b	1.A.1.b	1.A.1.b	1.A.1.b	1.A.1.b	1.A.1.b
Fuel		liquid	solid	gaseous	biomass	other
[PJ]						
2013	40.93	29.09	-	11.84	-	-
2014	39.34	28.47	-	10.87		
2015	39.84	30.18	-	9.65	-	-
Trend 1990–2015	12.7%	9.9%		22.5%		
Trend 2014–2015	1.3%	6.0%		-11.2%		

Sources of emission factors

NH₃ emission factors for petroleum products (2.7 kg/TJ) and natural gas (1 g/TJ) are taken from (UMWELTBUNDESAMT 1993).

Facility specific 1990 to 1998 emissions are presented in (UMWELTBUNDESAMT 2000a) and (UMWELTBUNDESAMT 2001a).

3.1.3.3 NFR 1.A.1.c Manufacture of Solid fuels and Other Energy Industries

This category includes emissions from natural gas combustion in the oil and gas extraction sector, natural gas refining, natural gas compressors for natural gas storage systems as well as own energy use of gas works which closed in 1995.

Furthermore PM emissions of charcoal kilns are included in this category.

Emissions from final energy consumption of coal mines are included in category 1.A.2.g. Emissions from coke ovens are included in category 1.A.2.a.

Emissions from this category are presented in the following table.

Fuel consumption is taken from the national energy balance. Emissions are calculated with the simple CORINAIR methodology.

Table 68: Fuel consumption from NFR 1.A.1.c Manufacture of Solid fuels and Other Energy Industries 1990–2015.

NFR	1.A.1.c	1.A.1.c	1.A.1.c
Fuel		Liquid	Gaseous
[PJ]			
1990	9.23	0.062	9.13
1991	9.94	0.040	9.87
1992	9.45	0.000	9.42
1993	7.69	0.002	7.65
1994	8.20	0.001	8.17
1995	11.06	0.007	11.02
1996	4.74	0.00	4.71
1997	5.03	0.00	5.00
1998	6.39	0.00	6.36
1999	6.65	0.00	6.62

NFR	1.A.1.c	1.A.1.c	1.A.1.c
Fuel		Liquid	Gaseous
		[PJ]	
2000	6.63	0.00	6.60
2001	5.86	0.00	5.83
2002	5.07	0.00	5.04
2003	4.02	0.00	3.99
2004	5.92	0.00	5.89
2005	7.14	0.00	7.10
2006	4.76	0.00	4.73
2007	4.80	0.00	4.76
2008	4.31	0.00	4.28
2009	4.81	0.00	4.77
2010	4.34	0.00	4.30
2011	5.89	0.00	5.85
2012	4.94	0.00	4.90
2013	4.56	0.00	4.52
2014	4.50	0.00	4.47
2015	7.55	0.00	7.50
Trend 1990–2015	-18.2%	-100.0%	-17.9%
Trend 2014–2015	67.6%	-	68.0%

Emission factors and activity data 2015

Table 69 summarizes the selected emission factors for main pollutants and activity data for the year 2015. It is assumed that emissions are uncontrolled.

Table 69: NFR 1.A.1.c main pollutant emission factors and fuel consumption for the year 2015.

Fuel	Source of NO _x , CO, NMVOC, SO ₂ emission factors ⁽¹⁾	Activity [TJ]	NO _x [kg/TJ]	CO [kg/TJ]	NMVOC [kg/TJ]	SO ₂ [kg/TJ]	NH ₃ [kg/TJ]
Natural Gas/Oil gas extraction and Gasworks	(BMWA 1990)	7 503	150.0	10.0	0.5	NA	1.0
Residual fuel oil/ Gasworks	(BMWA 1996)	0 ⁽²⁾	235.0	15.0	8.0	398.0	2.7
Liquid petroleum gas/Gasworks	(BMWA 1990)	0 ⁽²⁾	40.0	10.0	0.5	6.0	1.0

⁽¹⁾ Default emission factors for industry are selected

⁽²⁾ Gasworks closed in 1995

NH₃ emission factors are taken from (UMWELTBUNDESAMT 1993).

PM emissions from charcoal production

It is assumed (WINIWARTER et al. 2007) that charcoal is produced in traditionally kilns by approximately 20 producers. Assuming 10 charges per producer and year each of 50 m³ wood input, assuming an output of 200 kg of charcoal from 1 000 kg of wood input and assuming a density of 350 kg/m³ wood leads to an estimated activity of 1 000 t charcoal per year which is 31 TJ (net

calorific value 31 MJ/kg charcoal). Applying an emission factor of 2.2 kg TSP/GJ charcoal which is similar to brown coal stoker fired furnaces this leads to an emission of approx. 70 t TSP per year. Furthermore it is assumed that 100% of particles are PM_{2.5}.

3.1.3.4 Emission factors for heavy metals

Coal

Values were taken from the CORINAIR Guidebook (1999), Page B111-58, Table 31:

For 1985, two thirds of the values for “DBB, Dust Control” were selected (from the ranges given in the guidebook the mean value was used). For 1995, the value for “DBB, Dust Control + FGD” was selected, as in these 10 years the existing dust controls were supplemented with flue gas desulphurisation. For the years in between the values were linearly interpolated.

The net calorific value used to convert values given in [g/Mg fuel] to [g/MJ fuel] was 28 MJ/kg for hard coal and 10.9 MJ/kg for brown coal.

Due to the legal framework most coal fired power plants were already equipped with dust control and flue gas desulphurisation in 1995, and no substantial further improvements were made since then. Thus the emission factor for 1995 was used for the years onwards.

The cadmium emission factor of brown coal is derived from a flue gas concentration of 6 µg/m³ (UMWELTBUNDESAMT 2003b).

Fuel oil

The emission factors base on the heavy metal content of oil products of the only Austrian refinery that were analysed in 2001 (see Table 70). It is assumed that imported oil products have a similar metal content.

Table 70: Heavy Metal Contents of Fuel Oils in Austria.

[mg/kg]	Cadmium	Mercury	Lead
Heating Oil	< 0.01	< 0.003	< 0.01
Light fuel oil	< 0.01	< 0.003	< 0.01
Heavy fuel oil (1%S)	0.04	< 0.003	< 0.01

Only for heavy fuel oil a value for the heavy metal content was quantifiable, for lighter oil products the heavy metal content was below the detection limit. As the heavy metal content depends on the share of residues in the oil product the emission factor of medium fuel oil was assumed to be half the value of heavy fuel oil. For light fuel oil and heating and other gas oil one fifth and one tenth respectively of the detection limit was used.

As legal measures ban the use of heavy fuel oil without dust abatement techniques and the emission limits were lower over the years it was assumed that the emission factor decreased from 1985–1995 by 50%, except for Mercury where dust abatement techniques do not effect emissions as efficiently as Mercury is mainly not dust-bound.

The emission factors for “other oil products” (which is only used in the refinery) are based on the following assumption: the share of Cd and Pb in crude oil is about 1% and 2%, respectively. The share of this HM - in particulate emissions of the refinery - was estimated to be a fifth of the share in crude oil, which results in a share of 0.2% and 0.4% of dust emissions from the refinery. Based on a TSP emission factor of about 5.7 g/GJ, the resulting emission factors for Cd and Pb are 10 mg/GJ and 20 mg/GJ.

For Mercury 10 times the EF for heavy fuel oil for category 1.A.1.a was used.

For 1985 twice the value as for 1990 was used.

Other Fuels

For fuel wood the value from (OBERNBERGER 1995) for plants > 4 MW was used for 1985 and 1990. For 1995 and for wood waste for the whole time series the value taken from personal information about emission factors for wood waste from the author was used.

For plants < 50 MW the emission factor for industrial waste is based on measurements of Austrian plants (FTU 2000).

The emission factors for the years 1985–1995 for municipal waste and sewage sludge base on regular measurements at Austrian facilities (MA22 1998). For industrial waste for plants > 50 MW emission factors were based on (EPA 1998, CORINAIR 1997, EPA 1997, EPA 1993, WINIWARTER 1993, ORTHOFER 1996); improvements in emission control have been considered.

The emission factors for waste (municipal and industrial waste and sewage sludge) for plants > 50 MW for 2004 were taken from (BMLFUW 2002b):

Table 71: Cd emission factors for Sector 1.A.1 Energy Industries.

Cadmium EF [mg/GJ]	1985	1990	1995	2010
Coal				
102A Hard coal	0.1548	0.1140	0.073	0.073
105A Brown coal	2.13 (all years)			
Oil				
204A Heating and other gas oil 2050 Diesel	0.02 (all years)			
203B Light fuel oil	0.05 (all years)			
203C Medium fuel oil	0.5 (all years)			
203D Heavy fuel oil	1.0	0.75	0.5	0.5
110A Petrol coke 224A Other oil products	20	10	10	10
Other Fuels				
111A Fuel wood 116A Wood waste	6.1	6.1	2.5	2.5
115A Industrial waste (< 50MW)	7 (all years)			

The following table presents Cd emission factors of several waste categories. Emission factors 2006 are derived from actual measurements (UMWELTBUNDESAMT 2007).

Table 72: Cd emission factors for waste for Sector 1.A.1 Energy Industries.

Cadmium EF [mg/t Waste]	1985	1990	1995	2010
114B Municipal waste	2 580	71	12	11
115A Industrial waste (> 50 MW)	720	510	30	4.5
118A Sewage sludge	–	235	19	5.2

Table 73: Hg emission factors for Sector 1.A.1 Energy Industries.

Mercury EF [mg/GJ]	1985	1990	1995	2010
Coal				
102A Hard coal	2.98	2.38	1.8	1.8
105A Brown coal	7.65	6.12	4.6	4.6
Oil				
204A Heating and other gas oil 2050 Diesel		0.007 (all years)		
203B Light fuel oil		0.015 (all years)		
203C Medium fuel oil		0.04 (all years)		
203D Heavy fuel oil		0.075 (all years)		
110A Petrol coke 224A Other oil products		0.75 (all years)		
Other Fuels				
111A Fuel wood		1.9 (all years)		
116A Wood waste (> 50 MW)		1.9 (all years)		
115A Industrial waste (< 50 MW)		2.0 (all years)		

The following table presents Hg emission factors of several waste categories. Emission factors 2006 are derived from actual measurements (UMWELTBUNDESAMT 2007).

Table 74: Hg emission factors for waste for Sector 1.A.1 Energy Industries.

Mercury EF [mg/t Waste]	1985	1990	1995	2010
114B Municipal waste	1 800	299	120	25.2
115A Industrial waste (> 50 MW)	100	112	49	15.5
118A Sewage sludge	–	55	9	9

Table 75: Pb emission factors for Sector 1.A.1 Energy Industries.

Lead EF [mg/GJ]	1985	1990	1995	2010
Coal				
102A Hard coal	13.33	11.19	9.1	9.1
105A Brown coal	1.93	1.44	0.96	0.96
Oil				
204A Heating and other gas oil 2050 Diesel		0.02 (all years)		
203B Light fuel oil		0.05 (all years)		
203C Medium fuel oil		0.12 (all years)		
203D Heavy fuel oil	0.25	0.19	0.13	0.13
110A Petrol coke 224A Other oil products		20 (all years)		
Other Fuels				
111A Fuel wood	26.3	26.3	21.15	21.15
116A Wood waste: Public Power [0101]		21 (all years)		
116A Wood waste: District Heating [0102]		50 (all years)		
115A Industrial waste (< 50 MW)		50 (all years)		

The following table presents Hg emission factors of several waste categories. Emission factors 2006 are derived from actual measurements (UMWELTBUNDESAMT 2007).

Table 76: Pb emission factors for waste for Sector 1.A.1 Energy Industries.

Lead EF [mg/t Waste]	1985	1990	1995	2010
114B Municipal waste	30 000	1 170	150	36
115A Industrial waste (> 50 MW)	8 300	2 400	10	10
118A Sewage sludge	–	730	6	6

3.1.3.5 Emission factors for POPs

Fossil fuels

The dioxin (PCDD/F) emission factor for coal and gas were taken from (WURST & HÜBNER 1997), for fuel oil the value given in the same study and new measurements were considered (FTU 2000).

The HCB emission factor for coal was taken from (BAILY 2001).

The PAK emission factors are based on results from (UBA BERLIN 1998), (BAAS et al. 1995), (ORTHOFFER & VESSELY 1990) and measurements by FTU.

PCB emission factors have been selected as outlined in chapter 3.1.3.

Other fuels

The dioxin (PCDD/F) emission factor for wood is based on measurements at Austrian plants > 1 MW (FTU 2000).

The PAK emission factors are based on results from (UBA BERLIN 1998) and (BAAS et al. 1995).

Gasworks

Default national emission factors of industrial boilers were selected. For 224A Other Oil Products the emission factors of 303A LPG were selected.

Table 77: POP emission factors for Sector 1.A.1 Energy Industries.

EF	PCDD/F μ g/GJ	HCB [μ g/GJ]	PAK4 [mg/GJ]	PCB [μ g/GJ]
Coal				
Coal (102A, 105A, 106A)	0.0015	0.46	0.0012	0.0033
Fuel Oil				
Fuel Oil (203B, 203C, 203D, 204A) exc. Gasworks, 110A Petrol coke	0.0004	0.08	0.16	0.00013
203D Heavy fuel oil in gasworks	0.009	0.12	0.24	85
224A Other oil products in gasworks	0.0017	0.14	0.011	85
308A Refinery gas	0.0006	0.04	NA	0.000054
Gas				
301A, 303A Natural gas and LPG exc. SNAP 010202, 010301	0.0002	0.04	NA	NA
301A, 303A Natural gas and LPG, SNAP 010202, 010301	0.0004	0.08	NA	0.000036
Other Fuels				

EF	PCDD/F μg /GJ]	HCB [μg /GJ]	PAK4 [mg/GJ]	PCB [μg /GJ]
114B Municipal Waste	0.024	14.5	0.17	0.0005
115A Industrial waste/unspecified				0.0008
Biomass				
111A Wood (> 1 MW)	0.01	2.0	0.2	0.0009
116A Wood waste (> 1 MW)				
111A Wood (< 1 MW)	0.14	28.0	2.4	0.0009
116A Wood waste (< 1 MW)				
116A Wood waste/Straw	0.12	24.0	3.7	0.0009
309A, 309B, 310A Gaseous biofuels	0.0006	0.072	0.032	NA

Waste emissions factors are expressed as per ton of dry substance and derived from plant specific measurements (UMWELTBUNDESAMT 2002, 2007). Comma separated values indicate plant specific emissions factors.

Table 78: POP emission factors for Sector 1.A.1 Energy Industries.

EF	PCDD/F [μg /t]	HCB [μg /t]	PAK4 [mg/t]
114B Municipal Waste	0.09	247.0	0.7; 0.13
115A Industrial waste	0.21	126.0	0.16
118A Sewage Sludge	0.09	20.0	0.09

3.1.3.6 Emission factors for PM

As already described in chapter 1.4 the emission inventories of PM for different years were prepared by contractors and incorporated into the inventory system afterwards.

Large point sources (LPS)

In a first step large point sources (LPS) are considered. For the reporting years up to 2006 the UMWELTBUNDESAMT was operating a database to store plant specific data, called „Dampfkessel-datenbank“ (DKDB) which includes data on fuel consumption, NO_x, SO_x, CO and PM emissions from boilers with a thermal capacity greater than 3 MW_{th} for all years from 1990 onwards. From the reporting year 2007 on this database has been replaced by a web based reporting system (EDM⁸¹) operated by the ministry of environment. These data are used to generate a split of the categories *Public Power* and *District Heating*, with further distinction between the two categories $\geq 300 \text{ MW}_{th}$ and $\geq 50 \text{ MW}_{th}$ to 300 MW_{th} of thermal capacity. Currently about 75 boilers are considered with this approach. From the year 2007 on fuel consumption of large point sources is taken from the emission trading system (ETS) which considers facilities which a total boiler thermal capacity $\geq 20 \text{ MW}_{th}$. The yearly emission declarations from the corresponding boilers are taken from the EDM.

The fuel consumption of all considered point sources is subtracted from the total consumption of this category which is taken from the energy balance. The other combustion plants are considered as area source.

For point sources $\geq 50 \text{ MW}$ plant specific emission and activity data from the DKDB were used. The ‘implied emission factors’, which are calculated by division of emissions by activity data, are given in Table 79.

⁸¹ www.edm.gv.at

Emission factors from 2000 onwards for the fuel type **wood waste** were taken from (UMWELTBUNDESAMT 2006a).

The shares of PM₁₀ and PM_{2.5} were taken from (WINIWARTER et al. 2001).

Table 79: PM implied emission factors (IEF) for LPS in NFR 1.A.1 Energy Industries.

	TSP IEF [g/GJ]				%PM ₁₀	%PM _{2.5}
	1990	1995	2000	2015	[%]	[%]
Public Power (0101) ⁽¹⁾	5.51	3.34	2.74	0.93	95	80
District Heating (0102) ⁽¹⁾	3.89	1.41	0.73	0.36	95	80
Petroleum Refining (010301) ⁽²⁾	4.3	2.8	3.4	1.5	95	80
Wood waste (116A)	55	55	22	22	90	75

⁽¹⁾ Used fuels: Hard coal(102A), Lignite(105A), Log wood(111A), Industrial waste(115A), Sewage sludge(118A), Residual fuel oil(203B, 203C, 203D and Natural gas(301)

⁽²⁾ Used fuels: Refinery gas (308A), FCC coke (110A), Residual fuel oil (203D), LPG (303A), Other oil products (224A) and Natural gas (301A)

Area sources

In a second step the emissions of the **area source** are calculated. Emissions of plants < 50 MW are calculated by multiplying emission factors with the corresponding activity.

Coal and gas

The emission factors for **coal** and **gas** were taken from (WINIWARTER et al. 2001) and are valid for the whole time series.

Oil

The emission factor for **high-sulphur fuel** (203D) **medium-sulphur fuel** (203C) and **low-sulphur fuel** (203B) base on an analysis of Austrian combustion plants regarding limit values (TSP: 70 mg/Nm³, 60 mg/Nm³ and 50 mg/Nm³) (UMWELTBUNDESAMT 2006a), these values were used for all years.

The emission factor for **heating and other gas oil** (204A) was taken from (WINIWARTER et al. 2001) and used for all years.⁸²

For diesel the emission factors for heavy duty vehicles and locomotives as described in chapter 3.2.6 were used.

Other Fuels

Emission factors for **wood** and **wood waste** (111A and 116A), **MSW renewable**, **MSW non-renewable** and **industrial waste** (114B and 115A) and **low-sulphur fuel** (203B) for the years 1990 and 1995 were taken from (WINIWARTER et al. 2001), for the years afterwards an updated value from (UMWELTBUNDESAMT 2006a) has been used.

The emission factor for **biogas**, **sewage sludge gas** and **landfill gas** (309B and 310A) were taken from (WINIWARTER et al. 2001) and used for all years.

The shares of PM₁₀ and PM_{2.5} were taken from (WINIWARTER et al. 2001).

⁸² as of central heating boilers in the residential sector (Hauszentralheizung – HZH)

Table 80: PM emission factors for combustion plants (< 50 MW) in NFR 1.A.1.

	TSP Emission Factors [g/GJ]				PM ₁₀	PM _{2.5}
	1990	1995	2000	2015	[%]	[%]
Gas						
301A and 303A		0.50			90	75
Coal						
102A		45.00			90	75
105A and 106.A		50.00			90	75
Oil						
203B		16.00			90	75
203D		22.00			90	80
204A		1.00			90	80
224A		0.50			90	75
2050		50.00			100	100
Other Fuels						
111A and 116A	55.00	55.00	22.00	22.00	90	75
114B and 115 A	9.00	9.00	1.00	1.00	95	80
309B and 310A		0.50			90	75

3.1.3.7 Category-specific Recalculations

Public Electricity and Heat Production (1.A.1.a)

Update and error correction of large combustion plants emissions declarations 2007-2014. For the year 2014 the update result in -0.06 kt SO₂, -0.8 kt NO_x and -0.01 kt PM₁₀ emissions.

Manufacture of Solid fuels and Other Energy Industries (1.A.1.c)

Recalculations 1999 to 2012 follow the revisions of the energy balance and result in lower NO_x emissions in the range from -0.2 kt to -1.2 kt.

Updates of activity data and of NCVs follow the updates of the IEA-compliant energy balance compiled by the federal statistics authority *Statistik Austria* (Chapter 3.1.10).

3.1.4 NFR 1.A.2 Manufacturing Industry and Combustion

NFR Category 1.A.2 *Manufacturing Industries and Construction* comprises emissions from fuel combustion in the sub categories

- Iron and steel (NFR 1.A.2.a),
- Non-ferrous metals (NFR 1.A.2.b),
- Chemicals (NFR 1.A.2.c),
- Pulp, paper and print (NFR 1.A.2.d),
- Food processing, beverages and tobacco (NFR 1.A.2.e),
- Non-metallic Minerals (NFR 1.A.2.f)
- Mobile Combustion in Manufacturing Industries and Construction (NFR 1.A.2.g.7)⁸³
- Other Stationary Combustion in Manufacturing Industries and Construction (NFR 1.A.2.g.8).

⁸³ methodologies for mobile sources are described in Chapter 3.2.7.1

3.1.4.1 General Methodology

Table 81 gives an overview of methodologies and data sources of sub category *1.A.2 Manufacturing Industry and Combustion*. Reported/Measured emission data is not always taken one-to-one in cases that reported fuel consumption is not in line with data from energy balance. However, in these cases data is used for emission factor derivation. For the reporting year 2005 on activity data from the emission trading system (ETS) has been considered for validation of the energy statistics and ETS activity data has been used for a breakdown by sectors of category 1.A.2.f.

Table 81: Overview of 1.A.2 methodologies for main pollutants.

	Activity data	Reported/Measured emissions	Emission factors
1.A.2.a Iron and Steel – Integrated Plants (2 units)	Reported by plant operator (yearly).	Reported by plant operator: SO ₂ , NO _x , CO, NMVOC, TSP, (yearly).	NH ₃ : National study
1.A.2.a Iron and Steel – other	Energy balance 2005–2015: ETS data.		All pollutants: National studies
1.A.2.b Non-ferrous Metals	Energy balance 2005–2015: ETS data.		All pollutants: National studies
1.A.2.c Chemicals	Energy balance 2005–2015: ETS data.		All pollutants: National studies
1.A.2.d Pulp, Paper and Print	Energy balance 2005–2015: ETS data.	Reported by Industry Association: SO ₂ , NO _x , CO, NMVOC, TSP (yearly).	NH ₃ : National study
1.A.2.e Food Processing, Beverages and Tobacco	Energy balance 2005–2015: ETS data.		All pollutants: National studies
1.A.2.f Cement Clinker Production	National Studies 2005–2015: ETS data.	Reported by Industry Association: SO ₂ , NO _x , CO, NMVOC, TSP, Heavy Metals (yearly).	NH ₃ : National study
1.A.2.f Glass Production	Association of Glass Industry 2005–2015: ETS data.	Direct information from industry association: NO _x , SO ₂ .	CO, NMVOC, NH ₃ : National studies
1.A.2.f Lime Production	Energy balance 2005–2015: ETS data.		All pollutants: National studies
1.A.2.f Bricks and Tiles Production	Association of Bricks and Tiles Industry 2005–2015: ETS data.		All pollutants: National studies
1.A.2.g Other	Energy balance 2005–2015: ETS data.		All pollutants: National studies

3.1.4.2 NFR 1.A.2.a Iron and Steel

In this category mainly two integrated iron and steel plants with a total capacity of about 6 Mt pig iron or 7.5 Mt of crude steel per year are considered. Facilities relevant for air emissions are blast furnaces, coke ovens, iron ore sinter plants, LD converters, rolling mills, scrap preheating, collieries and other metal processing. According to the SNAP and NFR nomenclatures this activities have to be reported to several sub categories. In case of the Austrian inventory emissions from above mentioned activities are reported in sub categories 1.A.2.a and 2.C. Heavy metals, POPs and PM emissions are included in category 2.C (SNAP 0402). Emissions from fuel combustion in other steel manufacturing industries are considered in category 1.A.2.a too.

Integrated steelworks (two units)

Two companies report their yearly NO_x, SO₂, NMVOC, CO and PM emissions to the Umweltbundesamt. Environmental reports are available on the web at www.emas.gv.at under EMAS register-Nr. 221 and 216 which partly include data on air emissions. During the last years parts of the plants were reconstructed and equipped with PM emission controls which has also led to lower heavy metal and POP emissions. Reduction of SO₂ and NO_x emissions of in-plant power stations was achieved by switching from coal and residual fuel oil to natural gas.

Table 82: PM emission controls of integrated iron & steel plants.

	Facility	Controlled emissions
Plant 1 1,5 Mt/a crude steel	Iron ore sinter plant:	PM: electro filter, fabric filter
	Cast house/pig iron recasting	PM
	LD converter	PM: electro filter
	Ladle furnace	PM: electro filter
Plant 2: 6 Mt/a crude steel	Iron ore sinter plant: 2 mio t/a sinter	PM: "AIRFINE" wet scrubber
	Coke oven: 1,9 mio t/a coke	Coke transport and quenching: PM
	Cast house	PM
	LD converter	PM
	Rolling mill	PM

The following table shows emissions of main pollutants from the two integrated iron and steel plants.

Table 83: NFR 1.A.2.a – integrated iron and steel plants – reported main pollutant emissions.

	NO _x (kt)	SO ₂ (kt)	NMVOC (kt)	CO (kt)
1990	4.97	6.05	0.07	210.68
1991	4.94	4.75	0.06	185.41
1992	4.14	3.25	0.05	226.91
1993	4.50	3.48	0.05	237.35
1994	4.18	3.79	0.06	250.57
1995	4.44	3.69	0.06	182.09
1996	4.20	4.20	0.06	206.61
1997	4.43	4.43	0.07	211.56
1998	4.45	4.46	0.07	197.77
1999	4.37	4.52	0.07	121.11
2000	4.18	4.06	0.09	164.47
2001	4.04	4.53	0.09	140.79
2002	4.30	4.71	0.09	134.37
2003	4.33	4.89	0.22	147.20
2004	4.10	4.50	0.26	153.14
2005	4.61	4.86	0.29	138.18
2006	4.69	5.31	0.31	147.90
2007	4.74	5.37	0.30	138.79
2008	4.56	4.76	0.27	124.65

	NO _x (kt)	SO ₂ (kt)	NM VOC (kt)	CO (kt)
2009	3.73	3.83	0.25	116.96
2010	4.15	4.72	0.24	107.79
2011	4.05	4.91	0.26	120.81
2012	4.06	5.03	0.26	120.62
2013	3.64	5.21	0.22	125.26
2014	3.45	5.27	0.17	134.60
2015	3.78	5.36	0.18	145.63

Other fuel combustion

Fuel combustion in other iron and steel manufacturing industry is calculated by the simple CORINAIR methodology. Activity data is taken from energy balance. The following tables summarize the selected emission factors for the main pollutants and activity data for the year 2015. It is assumed that emissions are uncontrolled.

Table 84: NFR 1.A.2.a - area source – main pollutant emission factors and fuel consumption for the year 2015.

Fuel	Source of NO _x , CO, NMVOC, SO ₂ emission factors	Activity [TJ]	NO _x [kg/TJ]	CO [kg/TJ]	NM VOC [kg/TJ]	SO ₂ [kg/TJ]	NH ₃ [kg/TJ]
Hard coal	(BMWA 1990) ⁽¹⁾	0	250.0	150.0	15.0	600.0	0.01
Coke oven coke	(BMWA 1990) ⁽¹⁾	86	220.0	150.0	8.0	500.0	0.01
Residual fuel oil < 1% S	(BMWA 1996) ⁽¹⁾	0	118.0	10.0	0.8	92.0	2.70
Residual fuel oil ≥ 1% S	(BMWA 1996) ⁽¹⁾	85	235.0	15.0	8.0	398.0	2.70
Heating oil	(BMWA 1996) ⁽²⁾	0	65.0	15.0	4.8	45.0	2.70
Kerosene	(BMWA 1996) ⁽³⁾	0	118.0	15.0	4.8	92.0	2.70
Natural gas	(BMWA 1996) ⁽¹⁾	6 131	41.0	5.0	0.5	NA	1.00
LPG	(BMWA 1996) ⁽⁴⁾	0	41.0	5.0	0.5	6.0 ⁽⁶⁾	1.00

⁽¹⁾ Default emission factors for industry

⁽²⁾ Default emission factors for district heating plants

⁽³⁾ Upper values from residual fuel oil < 1% S and heating oil

⁽⁴⁾ Values for natural gas are selected

⁽⁵⁾ Values for bark are selected

⁽⁶⁾ From (LEUTGÖB et al. 2003)

NH₃ emission factors are taken from (UMWELTBUNDESAMT 1993). PM, HM and POP emission factors are described in a separate section below.

3.1.4.3 NFR 1.A.2.b Non-ferrous Metals

This category enfold emissions from fuel combustion in non-ferrous metals industry including heavy metal and POPs emissions from melting of products. Fuel consumption activity data is taken from the energy balance. Emissions from this category are presented in the following tables.

Activity data

Fuel consumption is taken from (IEA JQ 2016).

Table 85: Fuel consumption from NFR 1.A.2.b Non-ferrous Metals 1990–2015.

NFR	1.A.2.b	1.A.2.b	1.A.2.b	1.A.2.b	1.A.2.b	1.A.2.b
Fuel	(PJ)	liquid	solid	gaseous	biomass	other
1990	2.08	0.52	0.21	1.35	-	-
1991	1.86	0.48	0.17	1.21	-	-
1992	2.09	0.43	0.08	1.58	-	-
1993	2.55	0.44	0.19	1.92	-	-
1994	4.43	0.56	0.14	3.73	-	-
1995	4.36	0.57	0.09	3.70	-	-
1996	2.86	0.69	0.15	2.02	-	-
1997	3.46	0.91	0.19	2.37	-	-
1998	3.28	0.82	0.16	2.30	-	-
1999	3.00	0.63	0.21	2.16	-	-
2000	3.11	0.63	0.17	2.31	-	-
2001	3.39	0.70	0.10	2.60	-	-
2002	3.43	0.61	0.16	2.67	-	-
2003	3.55	0.58	0.15	2.82	-	-
2004	3.68	0.51	0.16	3.02	-	-
2005	3.71	0.48	0.13	3.10	-	-
2006	3.77	0.46	0.12	3.19	-	-
2007	4.32	0.44	0.14	3.74	-	-
2008	4.33	0.30	0.13	3.89	-	-
2009	3.97	0.21	0.16	3.60	-	-
2010	4.09	0.25	0.07	3.77	-	-
2011	4.29	0.29	0.07	3.94	-	-
2012	4.23	0.29	0.06	3.88	0.00	0.00
2013	4.51	0.30	0.13	4.03	0.03	0.02
2014	4.59	0.25	0.14	4.15	0.03	0.01
2015	5.00	0.17	0.32	4.47	0.03	0.01
Trend						
1990–2015	140.1%	-67.3%	54.0%	230.2%	-	-
Trend						
2015–2015	9.1%	-33.1%	129.9%	7.6%	-3.3%	30.0%

The following Table 86 shows fuel consumption and main pollutant emission factors of category 1.A.2.b for the year 2015.

Table 86: NFR 1.A.2.b main pollutant emission factors and fuel consumption for the year 2015.

Fuel	Source of NO _x , CO, NMVOC, SO ₂ emission factors	Activity [TJ]	NO _x [kg/TJ]	CO [kg/TJ]	NMVOC [kg/TJ]	SO ₂ [kg/TJ]	NH ₃ [kg/TJ]
Coke oven coke	(BMWA 1990) ⁽¹⁾	324	220.0	150.0	8.0	500.0	0.01
Residual fuel oil < 1% S	(BMWA 1996) ⁽¹⁾	119	118.0	10.0	0.8	92.0	2.70
Residual fuel oil ≥ 1% S	(BMWA 1996) ⁽¹⁾	5	235.0	15.0	8.0	398.0	2.70
Heating oil	(BMWA 1996) ⁽²⁾	0	65.0	15.0	4.8	0.5 ⁽⁶⁾	2.70
Kerosene	(BMWA 1996) ⁽³⁾	0	118.0	15.0	4.8	92.0	2.70
Natural Gas	(BMWA 1996) ⁽¹⁾	4 467	41.0	5.0	0.5	NA	1.00
LPG	(BMWA 1996) ⁽⁴⁾	0	41.0	5.0	0.5	6.0 ⁽⁵⁾	1.00

⁽¹⁾ Default emission factors for industry⁽²⁾ Default emission factors for district heating plants⁽³⁾ Upper values from residual fuel oil < 1% S and heating oil⁽⁴⁾ Values for natural gas are selected⁽⁵⁾ From (LEUTGÖB et al. 2003)⁽⁶⁾ 10 ppm sulphur content

3.1.4.4 NFR 1.A.2.c Chemicals

Category 1.A.2.c includes emissions from fuel combustion in chemicals manufacturing industry. Because the inventory is linked with the NACE/ISIC consistent energy balance, plants which mainly produce pulp are considered in this category. Main polluters are pulp and basic anorganic chemicals manufacturers. Fuel consumption is taken from the energy balance (IEA JQ 2016). Main pollutant emission factors used for emission calculation are industrial boilers default values or derived from plant specific measurements.

Activity data

Fuel consumption is taken from (IEA JQ 2016).

Table 87: Fuel consumption from NFR 1.A.2.c Chemicals 1990–2015.

NFR	1.A.2.c	1.A.2.c	1.A.2.c	1.A.2.c	1.A.2.c	1.A.2.c
Fuel	(PJ)	liquid	solid	gaseous	biomass	other
1990	16.23	1.21	1.09	9.36	2.90	1.67
1991	16.03	1.26	1.41	8.33	2.90	2.12
1992	17.39	0.92	1.95	8.83	3.26	2.42
1993	17.75	1.11	1.96	10.89	2.18	1.60
1994	16.49	1.34	1.58	9.97	1.81	1.79
1995	17.05	1.27	1.58	10.33	1.72	2.15
1996	18.89	1.31	1.94	10.35	2.66	2.63
1997	20.33	1.83	2.66	10.87	2.91	2.05
1998	18.57	1.55	2.63	10.48	2.20	1.72
1999	25.45	1.07	3.24	14.65	4.98	1.51
2000	25.39	0.79	2.61	15.78	3.95	2.26

NFR	1.A.2.c	1.A.2.c	1.A.2.c	1.A.2.c	1.A.2.c	1.A.2.c
Fuel	(PJ)	liquid	solid	gaseous	biomass	other
2001	23.90	1.13	2.65	15.46	1.84	2.81
2002	24.22	0.92	2.64	14.95	1.58	4.13
2003	26.66	0.99	2.62	15.12	2.11	5.82
2004	27.50	0.96	2.48	15.13	1.68	7.26
2005	27.03	0.95	1.57	18.81	2.26	3.43
2006	24.71	0.84	1.12	16.95	2.33	3.48
2007	23.74	0.96	0.84	16.40	2.75	2.79
2008	27.77	1.13	0.75	17.31	2.52	6.05
2009	29.09	1.55	0.74	17.82	2.32	6.67
2010	30.41	1.87	0.81	18.29	2.97	6.46
2011	29.90	1.63	0.72	18.35	2.65	6.55
2012	28.22	1.67	0.73	18.67	2.86	4.30
2013	27.31	1.40	0.88	18.11	3.65	3.27
2014	26.40	0.95	1.29	18.59	3.21	2.36
2015	27.44	0.99	1.08	19.33	3.05	2.98
Trend						
1990–2015	114.4%	-10.6%	18.3%	179.1%	21.6%	65.9%
Trend						
2014–2015	0.2%	-32.5%	46.9%	3.2%	-2.2%	-16.4%

Table 88 summarizes activity data and emission factors for 2014. Underlined values indicate non default emission factors.

Table 88: NFR 1.A.2.c main pollutant emission factors and fuel consumption for the year 2015.

Fuel	Source of NO _x , CO, NMVOC, SO ₂ emission factors	Activity [TJ]	NO _x [kg/TJ]	CO [kg/TJ]	NMVOC [kg/TJ]	SO ₂ [kg/TJ]	NH ₃ [kg/TJ]
Hard coal	(BMWA 1990) ⁽¹⁾	1 081	80.3 ⁽⁵⁾	150.0	15.0	60.0 ⁽⁹⁾	0.01
Coke oven coke	(BMWA 1990) ⁽¹⁾	0	220.0	150.0	8.0	500.0	0.01
Residual fuel oil < 1% S	(BMWA 1996) ⁽¹⁾	554	118.0	10.0	0.8	92.0	2.70
Residual fuel oil ≥ 1% S	(BMWA 1996) ⁽¹⁾	237	235.0	15.0	8.0	398.0	2.70
Heating oil	(BMWA 1996) ⁽²⁾	43	65.0	15.0	4.8	0.5	2.70
Natural Gas	(BMWA 1996) ⁽¹⁾	19 331	41.0	5.0	0.5	NA	1.00
LPG	(BMWA 1996) ⁽³⁾	0	41.0	5.0	0.5	6.0 ⁽⁴⁾	1.00
Industrial waste	(BMWA 1990) ⁽¹⁾	2 983	47.0 ⁽⁶⁾	200.0	0.54	65.00 ⁽⁶⁾	0.02
Solid biomass	(BMWA 1996) ⁽¹⁾	2 511	100.0 ⁽⁷⁾	72.00	5.0	30.0	5.00
Biogas	(BMWA 1990) ⁽⁸⁾	541	150.0	5.0	0.5	NA	1.00

⁽¹⁾ Default emission factors for industry⁽²⁾ Default emission factors for district heating plants⁽³⁾ Values for natural gas are selected⁽⁴⁾ From (LEUTGÖB et al. 2003)⁽⁵⁾ 50% of hard coal are assigned to fluidized bed boilers in pulp industry with comparatively low EF. Emissions are taken from DKDB.⁽⁶⁾ About 50% of waste composition is known as MSW fractions and sludges. Remaining amount is assumed to be gaseous with low sulphur content. A comparison to DKDB is used for verification. The selected NO_x emission factor is taken from (WINDSPERGER et al. 2003). The SO₂ emission factor is derived from plant specific data of the DKDB.⁽⁷⁾ Assumed to be consumed by one plant. The selected NO_x emission factor is derived from plant specific data of the DKDB.⁽⁸⁾ Uncontrolled default emission factors for natural gas fired industrial boilers are selected.⁽⁹⁾ For hard coal an uncontrolled SO₂ emission factor of 600 kg/TJ with a control efficiency of 90% is assumed.⁽¹⁰⁾ 10 ppm sulphur content

3.1.4.5 NFR 1.A.2.d Pulp, Paper and Print

Category 1.A.2.d includes emissions from fuel combustion in pulp, paper and print industry. Plants which mainly produce pulp are considered in category 1.A.2.c *Chemicals* except black liquor recovery boilers. In 2008 all black liquor recovery boilers are equipped with flue gas desulphurization and electrostatic precipitators. Additionally all fluidized bed boilers are equipped with electrostatic precipitators and/or fabric filters. A detailed description of boilers, emissions and emission controls is provided in the unpublished study (UMWELTBUNDESAMT 2005b).

Fuel consumption activity data is taken from the energy balance. SO₂ emissions are taken from (AUSTROPAPIER 2002–2015). TSP emissions are taken from (UMWELTBUNDESAMT 2005a). Other main pollutant emission factors used for emission calculation are industrial boilers default values.

Activity data

Fuel consumption is taken from (IEA JQ 2016).

Table 89: Fuel consumption from NFR 1.A.2.d Pulp, Paper and Print 1990–2015.

NFR	1.A.2.d	1.A.2.d	1.A.2.d	1.A.2.d	1.A.2.d	1.A.2.d
Fuel		liquid	solid	gaseous	biomass	other
[PJ]						
1990	54.16	10.94	4.13	17.01	21.88	0.19
1991	60.40	14.24	5.53	18.35	22.10	0.19
1992	54.93	8.53	4.71	18.49	22.93	0.26
1993	56.52	8.81	4.45	16.02	27.02	0.23
1994	68.31	8.39	3.81	27.11	28.68	0.32
1995	65.73	6.72	3.97	24.57	29.99	0.48
1996	64.85	5.14	3.87	28.24	26.79	0.81
1997	75.39	6.61	4.69	33.48	30.54	0.07
1998	69.92	5.59	4.68	31.56	28.02	0.07
1999	69.69	2.98	3.79	31.28	31.50	0.14
2000	67.14	2.24	4.70	31.83	28.38	-
2001	71.29	2.30	4.02	30.33	34.53	0.11
2002	64.17	1.97	4.83	29.53	27.71	0.12
2003	68.52	2.12	4.42	33.04	28.74	0.20
2004	66.83	1.74	4.63	30.65	29.57	0.25
2005	74.59	1.81	5.02	30.85	36.81	0.11
2006	70.51	1.64	5.24	28.81	34.68	0.15
2007	72.06	1.22	4.01	30.98	35.68	0.17
2008	72.27	1.06	3.68	31.94	35.50	0.10
2009	72.43	1.31	3.80	31.84	35.39	0.10
2010	76.89	0.94	3.55	34.91	37.41	0.08
2011	76.11	0.72	3.94	33.88	37.48	0.09
2012	72.75	0.50	3.95	30.02	38.23	0.06
2013	70.21	0.61	4.23	27.20	38.01	0.17
2014	66.83	0.35	4.19	24.19	37.93	0.18
2015	66.19	0.52	4.29	25.32	35.87	0.18
Trend 1990–2015	22.2%	-95.2%	3.8%	48.8%	64.0%	-6.9%
Trend 2014–2015	-1.0%	50.2%	2.5%	4.7%	-5.4%	0.2%

Table 90 shows activity data and emission factors for 2015. SO₂ emission factors were derived from national default values for industrial boilers taken from (BMWA 1990) and not highly representative for single fuels. Black liquor recovery and fluidized bed boilers are fired with combined fuels and therefore NO_x emission factors are not always representative for single fuel types. Underlined values indicate non default emission factors.

Table 90: NFR 1.A.2.d main pollutant emission factors and fuel consumption for the year 2015.

Fuel	Source of NO _x , CO, NMVOC, SO ₂ emission factors	Activity [TJ]	NO _x [kg/TJ]	CO [kg/TJ]	NMVOC [kg/TJ]	SO ₂ [kg/TJ]	NH ₃ [kg/TJ]
Hard coal	(BMWA 1990) ⁽¹⁾	4 292	<u>120.0</u> ⁽⁹⁾	150.0	15.0	<u>111.2</u>	0.01
Brown coal	(BMWA 1990) ⁽¹⁾	0	170.0	150.0	23.0	<u>91.2</u>	0.02
Brown coal briquettes	(BMWA 1990) ⁽¹⁾	0	170.0	150.0	23.0	<u>91.2</u>	0.02
Coke oven coke	(BMWA 1990) ⁽¹⁾	0	220.0	150.0	8.0	<u>120.5</u>	0.01
Residual fuel oil < 1% S	(BMWA 1996) ⁽¹⁾	85	118.0	10.0	0.8	<u>15.8</u>	2.70
Residual fuel oil ≥ 1% S	(BMWA 1996) ⁽¹⁾	393	235.0	15.0	8.0	<u>68.5</u>	2.70
Heating oil	(BMWA 1996) ⁽²⁾	43	65.0	15.0	4.8	<u>0.1</u>	2.70
Kerosene	(BMWA 1996) ⁽⁶⁾	0	118.0	15.0	4.8	<u>15.8</u>	2.7
LPG	(BMWA 1996) ⁽³⁾	0	41.0	5.0	0.5	6.0 ⁽⁴⁾	1.00
Natural Gas	(BMWA 1996) ⁽¹⁾	25 324	41.0	5.0	0.5	NA	1.00
Industrial waste	(BMWA 1990) ⁽¹⁾	180	100.0	200.0	0.54	<u>19.8</u>	0.02
Black liquor	(BMWA 1990) ⁽¹⁾	28 396	<u>77.0</u> ⁽⁷⁾	20.0	4.0	<u>19.8</u>	0.02
Fuel wood	(BMWA 1996) ⁽⁸⁾	0	110.0	370.0	5.00	<u>9.1</u>	5.00
Solid biomass	(BMWA 1996) ⁽¹⁾	6 267	<u>120.0</u> ⁽⁹⁾	72.00	5.0	<u>9.1</u>	5.00
Biogas	(BMWA 1990) ⁽⁵⁾	956	150.0	5.0	0.5	NA	1.00

⁽¹⁾ Default emission factors for industry⁽²⁾ Default emission factors for district heating plants⁽³⁾ Values for natural gas are selected⁽⁴⁾ From (LEUTGÖB et al. 2003)⁽⁵⁾ Uncontrolled default emission factors for natural gas fired industrial boilers are selected.⁽⁶⁾ Upper values from residual fuel oil < 1% S and heating oil⁽⁷⁾ NO_x emission factor for black liquor is derived from partly continuous measurements according to (UMWELTBUNDESAMT 2005a).⁽⁸⁾ Emission factors of wood chips fired district heating boilers are selected.⁽⁹⁾ NO_x emission factor of combined hard coal, paper sludge and bark fired boilers is taken from (UMWELTBUNDESAMT 2003a).

3.1.4.6 NFR 1.A.2.e Food Processing, Beverages and Tobacco

Category 1.A.2.e includes emissions from fuel combustion in food processing, beverages and tobacco industry. Due to the low fuel consumption it is assumed that default emission factors of uncontrolled industrial boilers are appropriate although it is known that sugar factories operate some natural gas and coke oven coke fired lime kilns. It is assumed that any type of secondary emission control does not occur within this sector.

Activity data

Fuel consumption is taken from (IEA JQ 2016).

Table 91: Fuel consumption from NFR 1.A.2.e Food Processing, Beverages and Tobacco 1990–2015.

NFR	1.A.2.e	1.A.2.e	1.A.2.e	1.A.2.e	1.A.2.e	1.A.2.e
Fuel	(PJ)	liquid	solid	gaseous	biomass	other
1990	13.88	4.42	0.18	9.15	0.13	-
1991	14.76	5.11	0.20	9.33	0.12	-
1992	13.65	4.43	0.10	9.03	0.09	-
1993	14.01	5.03	0.20	8.62	0.15	-
1994	14.64	4.52	0.18	9.84	0.10	-
1995	15.14	4.45	0.06	10.53	0.10	-
1996	14.65	3.28	0.11	11.22	0.03	0.006
1997	17.09	4.02	0.13	12.91	0.02	0.006
1998	15.66	3.22	0.11	12.31	0.01	0.006
1999	14.28	2.16	0.08	11.83	0.22	-
2000	15.17	2.19	0.21	12.53	0.24	-
2001	15.77	3.15	0.12	12.22	0.27	-
2002	19.11	2.34	0.15	16.36	0.27	-
2003	16.03	2.94	0.15	12.71	0.23	-
2004	16.00	3.37	0.12	12.29	0.23	-
2005	16.55	3.21	0.13	12.71	0.50	-
2006	16.11	3.22	0.10	12.27	0.52	-
2007	15.43	2.76	0.11	12.02	0.55	-
2008	15.26	2.47	0.12	12.19	0.48	-
2009	15.70	2.70	0.14	12.44	0.42	0.000
2010	16.58	2.73	0.14	13.52	0.19	0.005
2011	16.52	2.66	0.15	13.47	0.25	0.002
2012	17.35	2.67	0.16	13.85	0.66	0.003
2013	16.23	2.49	0.15	13.23	0.36	0.001
2014	15.90	2.08	0.17	13.31	0.34	0.000
2015	17.78	2.08	0.22	15.13	0.35	0.000
Trend 1990–2015	28.1%	-52.9%	22.4%	65.4%	170.9%	-
Trend 2014–2015	11.8%	0.4%	25.5%	13.6%	4.2%	67.5%

Fuel consumption activity data is taken from the energy balance. Main pollutant emission factors used for emission calculation are industrial boilers default values taken from (BMWA 1990).

Table 92 summarizes activity data and emission factors for 2015.

Table 92: NFR 1.A.2.e main pollutant emission factors and fuel consumption for the year 2015.

Fuel	Source of NO _x , CO, NMVOC, SO ₂ emission factors	Activity [TJ]	NO _x [kg/TJ]	CO [kg/TJ]	NMVOC [kg/TJ]	SO ₂ [kg/TJ]	NH ₃ [kg/TJ]
Hard coal	(BMWA 1990) ⁽¹⁾	0	250.0	150.0	15.0	600.0	0.01
Brown coal	(BMWA 1990) ⁽¹⁾	0	170.0	150.0	23.0	630.0	0.02
Brown coal briquettes	(BMWA 1990) ⁽¹⁾	0	170.0	150.0	23.0	630.0	0.02
Coke oven coke	(BMWA 1990) ⁽¹⁾	216	220.0	150.0	8.0	500.0	0.01
Residual fuel oil < 1% S	(BMWA 1996) ⁽¹⁾	989	118.0	10.0	0.8	92.0	2.70
Residual fuel oil ≥ 1% S	(BMWA 1996) ⁽¹⁾	45	235.0	15.0	8.0	398.0	2.70
Heating oil	(BMWA 1996) ⁽²⁾	773	65.0	15.0	4.8	0.5	2.70
Kerosene	(BMWA 1996) ⁽⁶⁾	0	118.0	15.0	4.8	92.0	2.7
LPG	(BMWA 1996) ^(3, 8)	277	41.0	5.0	0.5	6.0 ⁽⁴⁾	1.00
Natural Gas	(BMWA 1996) ⁽¹⁾	15 127	41.0	5.0	0.5	NA	1.00
Industrial waste	(BMWA 1990) ⁽¹⁾	0	100.0	200.0	0.54	130.0	0.02
Fuel wood	(BMWA 1996) ⁽⁷⁾	43	110.0	370.0	5.00	11.0	5.00
Solid biomass	(BMWA 1996) ⁽¹⁾	0	134.0	72.00	5.0	60.0	5.00
Biogas	(BMWA 1990) ⁽⁵⁾	312	150.0	5.0	0.5	NA	1.00

⁽¹⁾ Default emission factors for industry

⁽²⁾ Default emission factors for district heating plants

⁽³⁾ Values for natural gas are selected

⁽⁴⁾ From (LEUTGÖB et al. 2003)

⁽⁵⁾ Uncontrolled default emission factors for natural gas fired industrial boilers are selected.

⁽⁶⁾ Upper values from residual fuel oil < 1% S and heating oil.

⁽⁷⁾ Emission factors of wood chips fired district heating boilers are selected.

⁽⁸⁾ According to a sample survey (WINDSPERGER et al. 2003) natural gas NO_x emissions factors are in the range of 41 (furnaces) to 59 (boilers) kg/TJ.

3.1.4.7 NFR 1.A.2.f Non-metallic Minerals

Category 1.A.2.f includes emissions from fuel combustion of furnaces and kilns of cement, lime, bricks/tiles and glass manufacturing industries and magnesit sinter plants.

Table 93: Fuel consumption from NFR 1.A.2.f Non-metallic Minerals 1990–2015.

NFR	1.A.2.f.i	1.A.2.f.i	1.A.2.f.i	1.A.2.f.i	1.A.2.f.i	1.A.2.f.i
Fuel	(PJ)	liquid	solid	gaseous	biomass	other
1990	23.34	6.26	5.69	10.09	0.00	1.31
1991	23.58	6.59	5.05	10.28	0.00	1.67
1992	23.29	5.76	6.28	9.37	0.00	1.88
1993	23.50	6.89	5.07	9.73	0.00	1.82

NFR	1.A.2.f.i	1.A.2.f.i	1.A.2.f.i	1.A.2.f.i	1.A.2.f.i	1.A.2.f.i
Fuel	(PJ)	liquid	solid	gaseous	biomass	other
1994	23.97	7.82	3.98	10.22	0.00	1.94
1995	22.07	4.37	4.63	11.10	0.00	1.98
1996	22.97	3.32	5.55	11.93	0.00	2.17
1997	24.60	3.40	5.85	13.25	0.00	2.10
1998	24.58	3.41	5.63	12.87	0.00	2.66
1999	21.45	3.81	3.80	10.97	0.00	2.88
2000	22.79	2.32	5.34	11.58	0.00	3.56
2001	23.33	1.93	4.89	11.97	0.00	4.55
2002	25.06	3.29	3.62	13.59	0.00	4.56
2003	24.80	3.37	3.26	14.01	0.00	4.16
2004	27.61	4.46	3.03	14.78	0.00	5.34
2005	25.77	3.39	3.92	11.90	1.74	4.82
2006	27.23	2.54	5.71	11.54	1.56	5.89
2007	28.84	2.66	6.50	11.94	1.59	6.16
2008	28.61	2.45	6.13	11.59	3.34	5.10
2009	24.43	1.97	4.61	9.67	3.11	5.08
2010	24.26	2.17	3.33	10.86	2.87	5.04
2011	24.60	2.33	2.94	11.14	3.00	5.19
2012	24.27	1.87	3.06	10.55	3.25	5.53
2013	23.17	1.83	2.71	11.35	1.41	5.87
2014	23.76	1.69	2.88	11.48	1.21	6.51
2015	23.75	1.64	2.77	11.28	0.83	7.23
Trend 1990–2015	1.7%	-73.8%	-51.4%	11.8%	#DIV/0!	451.6%
Trend 2014–2015	-0.1%	-2.8%	-3.9%	-1.7%	-31.2%	11.1%

Table 94 shows total fuel consumption and emissions of main pollutants for sub categories of *1.A.2.f Non-metallic Minerals* for the year 2015.

Table 94: NFR 1.A.2.f Non-metallic Minerals - Fuel consumption and emissions of main pollutants by sub category for the year 2015.

Category	Fuel Consumption [TJ]	NO _x [kt]	CO [kt]	NM VOC [kt]	SO ₂ [kt]	NH ₃ [kt]
SNAP 030311 Cement Clinker Production	9 746	2.23	13.70	0.23	0.27	0.115
SNAP 030312 Lime Production	2 891	0.74	0.19	0.02	0.51	0.002
SNAP 030317 Glass Production	3 485	1.03	0.02	0.00	0.15	0.004
SNAP 030319 Bricks and Tiles Production	2 829	0.73	0.07	0.01	0.12	0.005
SNAP 030323 Magnesite Production	4 793	1.25	0.21	0.03	0.12	0.004
Total	23 744	5.99	14.19	0.29	1.18	0.129

Cement clinker manufacturing industry (SNAP 030311)

Currently nine cement clinker manufacturing plants are operated in Austria. Some rotary kilns are operated with a high share of industrial waste. In 2006 all exhaust streams from kilns and product heat recovery units were controlled by electrostatic precipitators. All plants are equipped with continuous emission measurement devices for PM, NO_x and SO_x, four plants with CO, two plants with TOC and one plant with a continuous Hg measurement device (MAUSCHITZ 2004). Annual activity data for 1990 to 2013 and emissions of 25 pollutants of all plants are estimated in periodic surveys (HACKL & MAUSCHITZ 1995, 1997, 2001, 2003, 2007), (MAUSCHITZ 2004, 2008, 2010-2016) and (ZEMENTINDUSTRIE 2009). Table 95 shows detailed fuel consumption data for 2015.

Table 95: Cement clinker manufacturing industry. Fuel consumption for the year 2015.

Fuel	Activity [TJ]
Hard coal	901
Brown coal	874
Petrol coke	1 019
Residual fuel oil < 1% S	869
Residual fuel oil 0.5% S	11
Residual fuel oil ≥ 1% S	0
Heating oil	37
Natural Gas	13
Industrial waste	69
Pure biogenic residues	6 696
Total	160

HCB accidental release

Between the years 2012 and 2014 high amounts of HCB were released from a cement plant unintentionally⁸⁴. The reason for release was the co-incineration of HCB contaminated material (lime) at temperatures that were too low to destroy the HCB. Around 97 kt of lime was incinerated which contained about 586 kg of HCB of which 40% were released. It has to be noted that these assumptions are very uncertain due to the limited amount of data.

⁸⁴ http://www.ktn.gv.at/302524_DE-HCB-Messberichte

The releases are estimated to be the following:

Table 96: HCB accidental releases for the years 2012, 2013 and 2014.

Year	HCB (kg)
2012	24
2013	102
2014	108

Lime manufacturing industry (SNAP 030312)

This category includes emissions from natural gas fired lime kilns. From 1990 to 2004 it includes magnesit sinter plants because sector specific data is available from the year 2005 on only (ETS data). Natural gas consumption is calculated by subtracting natural gas consumption of glass manufacturing industry (SNAP 030317), bricks and tiles industry (SNAP 030319), magnesit sinter industry (SNAP 030323) and cement industry (SNAP 030311) from final consumption of energy balance category *Non-metallic Mineral Products*. Thus it is assumed that uncertainty of this “residual” activity data could be rather high especially for the last inventory year because the energy balance is based on preliminary data. Lime production data are shown in Table 97. Heavy metals emission factors are presented in the following subchapter. Fuel consumption and main pollutant emission factors are shown in Table 99.

Table 97: Lime production 1990 to 2015.

Year	Lime [t]
1990	512 610
1991	477 135
1992	462 392
1993	479 883
1994	518 544
1995	522 934
1996	505 189
1997	549 952
1998	594 695
1999	595 978
2000	654 437
2001	666 633
2002	718 662
2003	754 156
2004	785 931
2005	788 328
2006	780 565
2007	816 370
2008	846 298
2009	695 019
2010	764 845
2011	809 982
2012	761 040
2013	779 299
2014	786 565
2015	772 225

Glass manufacturing industry (SNAP 030317)

This category includes emissions from glass melting furnaces. Fuel consumption 1990 to 1994 is taken from (WIFO 1996). For the years 1997 and 2002 fuel consumption, SO₂ and NO_x emissions are reported from the Austrian association of glass manufacturing industry to the Umweltbundesamt by personal communication. Activity data for the years in between are interpolated. Natural gas consumption 2003 to 2004 is estimated by means of glass production data and an energy intensity rate of 7.1 GJ/t glass. Fuel consumption from 2005 onwards is taken from ETS. NO_x and SO₂ emissions for missing years of the time series are calculated by implied emission factors derived from years where complete data is available. SO₂ emissions include process emissions. Fuel consumption and main pollutant emission factors are shown in Table 99. Table 98 shows the sum of flat and packaging glass production data. The share of flat glass in total glass production is about 5%.

Table 98: Glass production 1990 to 2015.

Year	Glass [t]
1990	398 515
1991	458 666
1992	405 863
1993	406 222
1994	434 873
1995	435 094
1996	435 094
1997	405 760
1998	405 760
1999	445 069
2000	375 348
2001	440 865
2002	389 497
2003	476 901
2004	356 702
2005	417 685
2006	448 176
2007	496 709
2008	504 213
2009	442 515
2010	498 156
2011	474 222
2012	472 040
2013	487 359
2014	496 782
2015	497 368

Bricks and tiles manufacturing industry (SNAP 030319)

This category includes emissions from fuel combustion in bricks and tiles manufacturing industry. Bricks are baked with continuously operated natural gas or fuel oil fired tunnel kilns at temperatures around 1000°C. The chlorine content of porousing material is limited by a national regulation (HÜBNER 2001b). Activity data 1990 to 1995 is communicated by the Austrian association of non-metallic mineral industry. Activity data 1996 to 2004 are linearly extrapolated 1995 activity data. Activity data 2005 to 2015 is taken from ETS. For main pollutants default emissions factors of industry are selected except for natural gas combustion for which the NO_x emission factor (294 kg/TJ) is taken from (WINDSPERGER et al. 2003). Table 99 presents fuel consumption and main pollutant emission factors.

1.A.2.f Fuel consumption and main pollutant emission factors

Table 99 shows activity data and main pollutant emission factors of 1.A.2.f sub categories except for SNAP 030311 cement industry where emission factors are not available by type of fuel. Underlined cells indicate emission factors other than default values for industrial boilers.

Table 99: NFR 1.A.2.f main pollutant emission factors and fuel consumption for the year 2015 by sub category.

Fuel	Source of NO _x , CO, NMVOC, SO ₂ emission factors	Activity [TJ]	NO _x [kg/TJ]	CO [kg/TJ]	NMVOC [kg/TJ]	SO ₂ [kg/TJ]	NH ₃ [kg/TJ]
SNAP 030312 Lime manufacturing							
Brown coal	(BMWA 1990) ⁽¹⁾	792	170.0	150.0	23.0	630.0	0.02
Petrol coke	(BMWA 1990) ⁽¹⁾	37	220.0	150.0	8.0	<u>81.0⁽⁸⁾</u>	0.01
Residual fuel oil < 1% S	(BMWA 1996) ⁽¹⁾	1	235.0	15.0	8.0	398.0	2.70
Heating oil	(BMWA 1996) ⁽²⁾	2	65.0	15.0	4.8	0.5	2.70
Natural Gas	(BMWA 1996) ⁽¹⁾	2 001	<u>294.0⁽⁵⁾</u>	<u>30.0⁽⁶⁾</u>	0.5	NA	1.00
Industrial waste	(BMWA 1990) ⁽¹⁾	0	100.0	200.0	38.0	130.0	0.02
SNAP 030317 Glass manufacturing							
Residual fuel oil	(BMWA 1996) ⁽¹⁾	47	<u>299.1</u>	15.0	8.0	<u>432.1⁽⁷⁾</u>	2.70
LPG	(BMWA 1996) ⁽³⁾	0	<u>299.1</u>	5.0	0.5	<u>34.1⁽⁷⁾</u>	1.00
Natural Gas	(BMWA 1996) ⁽¹⁾	3 439	<u>299.1</u>	5.0	0.5	<u>34.1⁽⁷⁾</u>	1.00
SNAP 030319 Bricks and tiles manufacturing							
Brown coal	(BMWA 1990) ⁽¹⁾	80	170.0	150.0	23.0	630.0	0.02
Coke oven coke	(BMWA 1990) ⁽¹⁾	0	220.0	150.0	8.0	500.0	0.01
Petrol coke	(BMWA 1990) ⁽¹⁾	77	220.0	150.0	8.0	<u>81.0⁽⁸⁾</u>	0.01
Residual fuel oil < 1% S	(BMWA 1996) ⁽¹⁾	2	118.0	10.0	0.8	92.0	2.70
Residual fuel oil ≥ 1% S	(BMWA 1996) ⁽¹⁾	43	235.0	15.0	8.0	398.0	2.70
Heating oil, Diesel oil	(BMWA 1996) ⁽²⁾	5	65.0	15.0	4.8	0.5	2.70
LPG	(BMWA 1996) ⁽³⁾	0	41.0	5.0	0.5	6.0 ⁽⁴⁾	1.00
Natural Gas	(BMWA 1996) ⁽¹⁾	2 110	<u>294.0⁽⁵⁾</u>	5.0	0.5	NA	1.00
Industrial waste	(BMWA 1990) ⁽¹⁾	13	100.0	200.0	38.0	130.0	0.02
Solid biomass	(BMWA 1996) ⁽¹⁾	498	143.0	72.00	5.0	60.0	5.00

Fuel	Source of NO _x , CO, NMVOC, SO ₂ emission factors	Activity [TJ]	NO _x [kg/TJ]	CO [kg/TJ]	NMVOC [kg/TJ]	SO ₂ [kg/TJ]	NH ₃ [kg/TJ]
SNAP 030323 Magnesia Production							
Petrol coke	(BMWA 1990) ⁽¹⁾	496	220.0	150.0	8.0	81.0 ⁽⁹⁾	0.01
Natural Gas	(BMWA 1996) ⁽¹⁾	3 658	294.0 ⁽⁵⁾	5.0	0.5	NA	1.00
Industrial waste	(BMWA 1990) ⁽¹⁾	522	100.0	200.0	38.0	130.0	0.02
Solid biomass	(BMWA 1996) ⁽¹⁾	117	143.0	72.00	5.0	60.0	5.00

⁽¹⁾ Default emission factors for industry.

⁽²⁾ Default emission factors for district heating plants.

⁽³⁾ Values for natural gas are selected.

⁽⁴⁾ From (LEUTGÖB et al. 2003)

⁽⁵⁾ NO_x emission factor of natural gas fired lime kilns and bricks and tiles production is taken from (WINDSPERGER et al. 2003).

⁽⁶⁾ CO emission factor of natural gas fired lime kilns is assumed to be 5 times higher than for industrial boilers.

⁽⁷⁾ SO₂ emission factors of fuels used for glass manufacturing include emissions from product processing.

⁽⁸⁾ The same SO₂ emission factor as for SNAP 030323 Petrol coke is selected.

⁽⁹⁾ Sulphur content of 0.5% is assumed. 75% of sulphur remains in the product (carbide).

3.1.4.8 NFR 1.A.2.g.8 Other Stationary Combustion in Manufacturing Industries and Construction

Category 1.A.2.g.8 includes emissions of industrial boilers not considered in categories 1.A.2.a to 1.A.2.f.

Table 100: Fuel consumption from NFR 1.A.2.g.8 Other Stationary Combustion in Manufacturing Industries and Construction 1990–2015.

NFR	1.A.2.g.8	1.A.2.g.8	1.A.2.g.8	1.A.2.g.8	1.A.2.g.8	1.A.2.g.8
Fuel	(PJ)	liquid	solid	gaseous	biomass	other
1990	32.10	8.15	0.88	18.30	4.73	0.05
1991	34.64	8.98	0.84	19.16	5.07	0.58
1992	35.75	6.95	0.35	22.92	4.82	0.71
1993	36.12	10.59	0.64	19.59	4.78	0.52
1994	37.58	8.65	0.34	23.39	4.51	0.68
1995	41.13	10.52	0.17	25.68	4.08	0.67
1996	43.37	12.96	0.23	24.39	5.04	0.74
1997	38.13	18.42	0.49	16.91	0.84	1.46
1998	36.66	15.35	0.42	16.72	2.74	1.44
1999	35.26	8.25	1.17	15.87	9.10	0.87
2000	36.43	8.12	0.29	19.32	8.26	0.44
2001	35.84	9.14	0.07	17.29	8.53	0.80
2002	32.99	6.91	0.13	17.16	8.21	0.58
2003	37.46	8.68	0.12	18.19	9.75	0.72
2004	38.51	8.80	0.13	18.40	10.07	1.11
2005	47.10	9.36	0.35	23.65	12.22	1.52
2006	49.33	9.67	0.40	23.53	14.17	1.55
2007	53.18	7.81	0.41	23.04	19.62	2.32
2008	53.59	6.71	0.34	24.20	19.18	3.17

NFR	1.A.2.g.8	1.A.2.g.8	1.A.2.g.8	1.A.2.g.8	1.A.2.g.8	1.A.2.g.8
Fuel	(PJ)	liquid	solid	gaseous	biomass	other
2009	57.97	6.64	0.15	25.72	20.92	4.53
2010	61.47	6.82	0.16	27.93	23.46	3.10
2011	59.69	7.05	0.15	24.40	24.71	3.37
2012	59.77	7.02	0.00	24.96	25.31	2.48
2013	61.58	6.21	0.01	23.79	29.36	2.20
2014	53.54	5.14	0.01	20.24	25.16	3.00
2015	54.85	5.19	0.20	20.18	26.74	2.54
Trend						
1990–2015	70.9%	-36.3%	-77.4%	10.3%	465.6%	5419.4%
Trend						
2014–2015	2.5%	1.0%	3138.6%	-0.3%	6.3%	-15.3%

Other manufacturing industry – boilers (SNAP 0301)

This sub category includes emissions of industrial boilers not considered in categories 1.A.2.a to 1.A.2.f. No specific distinction of technologies is made but national default emission factors of industrial boilers (BMWA 1990) are taken for emission calculation. It is assumed that facilities are not equipped with secondary emission controls. Activity data is taken from the energy balance.

Activity data and main pollutant emission factors are shown in Table 99.

Table 101 shows activity data and main pollutant emission factors of category 1.A.2.g.8.

Table 101: NFR 1.A.2.g.8 main pollutant emission factors and fuel consumption for the year 2015.

Fuel	Source of NO _x , CO, NMVOC, SO ₂ emission factors	Activity [TJ]	NO _x [kg/TJ]	CO [kg/TJ]	NMVOC [kg/TJ]	SO ₂ [kg/TJ]	NH ₃ [kg/TJ]
SNAP 0301 Other boilers							
Coke oven coke	(BMWA 1990) ⁽¹⁾	198	220.0	150.0	8.0	500.0	0.01
Residual fuel oil < 1% S	(BMWA 1996) ⁽¹⁾	1 818	118.0	10.0	0.8	92.0	2.70
Residual fuel oil ≥ 1% S	(BMWA 1996) ⁽¹⁾	770	235.0	15.0	8.0	398.0	2.70
Heating oil, Diesel oil	(BMWA 1996) ⁽²⁾	1 269	65.0	15.0	4.8	0.5	2.70
LPG	(BMWA 1996) ⁽³⁾	1 337	41.0	5.0	0.5	6.0 ⁽⁴⁾	1.00
Natural gas	(BMWA 1996) ⁽¹⁾	20 183	41.0	5.0	0.5	NA	1.00
Industrial waste	(BMWA 1990) ⁽¹⁾	2 539	100.0	200.0	0.54	130.0	0.02
Fuel wood	(BMWA 1996) ⁽⁶⁾	460	110.0	370.0	5.00	11.0	5.00
Solid biomass	(BMWA 1996) ⁽¹⁾	25 937	143.0	72.00	5.0	60.0	5.00
Sewage sludge	(BMWA 1996) ⁽¹⁾	179	100.0	200.0	38.00	NA	0.02
Biogas	(BMWA 1990) ⁽⁵⁾	164	150.0	4.0	0.5	NA	1.00

⁽¹⁾ Default emission factors for industry.

⁽²⁾ Default emission factors for district heating plants.

⁽³⁾ Values for natural gas are selected.

⁽⁴⁾ From (LEUTGÖB et al. 2003)

⁽⁵⁾ Uncontrolled default emission factors for natural gas fired industrial boilers are selected.

⁽⁶⁾ Emission factors of wood chips fired district heating boilers are selected.

3.1.4.9 Emission factors for heavy metals

For cement industries (SNAP 030311) emission values were taken from (HACKL & MAUSCHITZ, 2001); in the Tables presented below implied emission factors (IEF) are given.

For the other sub categories emission factors were applied, references are provided below.

Coal

Emission factors for 1995 were taken from (Corinair 1995), Chapter B112, Table 12. For 1990 the emission factors were assumed to be 50% and for 1985 100% higher, respectively.

Fuel Oil

For fuel oil the same emission factors as for 1.A.1 were used.

Other Fuels

For fuel wood and wood wastes the value from (OBERNBERGER 1995) for plants > 4 MW was used for 1990. For fuel wood from 1995 onwards the value taken from personal information about emission factors for wood waste from the author was used.

For wood wastes from 1995 onwards the value for fuel wood of category 1.A.4.a (7 mg/GJ for Cd, 2 mg/GJ for Hg and 50 mg/GJ for Pb, valid for small plants) and a value of 0.8 mg/GJ for Cd, 13 mg/GJ for Hg and 1.0 mg/GJ for Pb, respectively, which are valid for plants with higher capacity (measurements at Austrian fluid bed combustion plants by FTU in 1999/2000) was weighted according to the share of overall installed capacity of the Austrian industry (25% high capacity and 75% low [< 5 MW] capacity).

Table 102: Cd emission factors for NFR 1.A.2 Manufacturing Industries and Construction.

Cadmium EF [mg/GJ]	1985	1990	1995	2014
Coal				
102A Hard coal	0.20	0.15	0.10	0.10
107A Coke oven coke				
105A Brown coal	0.80	0.60	0.40	0.40
106A brown coal briquettes				
Oil				
204A Heating and other gas oil		0.02 (all years)		
2050 Diesel				
203B light fuel oil		0.05 (all years)		
203C medium fuel oil		0.50 (all years)		
203D heavy fuel oil	1.00	0.75	0.50	0.50
Other Fuels				
111A Fuel wood	6.10	6.10	2.50	2.50
215A Black liquor				
116A Wood waste	6.10	6.10	2.35	2.35
115A Industrial waste				

Table 103: Hg emission factors for NFR 1.A.2 Manufacturing Industries and Construction.

Mercury EF [mg/GJ]	1985	1990	1995	2014
Coal				
102A Hard coal	3.40	2.55	1.70	1.70
107A Coke oven coke				

105A Brown coal	8.80	6.60	4.40	4.40
106A brown coal briquettes				
Oil				
204A Heating and other gas oil		0.007 (all years)		
2050 Diesel				
203B light fuel oil		0.015 (all years)		
203C medium fuel oil		0.04 (all years)		
203D heavy fuel oil		0.75 (all years)		
Other Fuels				
111A Fuel wood	1.90	1.90	1.25	1.25
215A Black liquor				
116A Wood waste				
115A Industrial waste				

Table 104: Pb emission factors for NFR 1.A.2 Manufacturing Industries and Construction.

LEAD EF [mg/GJ]	1985	1990	1995	2014
Coal				
102A Hard coal	12.00	9.00	6.00	6.00
107A Coke oven coke				
105A Brown coal	7.80	5.85	3.90	3.90
106A brown coal briquettes				
Oil				
204A Heating and other gas oil		0.02 (all years)		
2050 Diesel				
203B light fuel oil		0.05 (all years)		
203C medium fuel oil		1.20 (all years)		
203D heavy fuel oil	0.25	0.19	0.13	0.13
Other Fuels				
111A Fuel wood	26.3	26.3	21.15	21.15
215A Black liquor				
116A Wood waste				
115A Industrial waste		72.00 (all years)		

Emission factors not related to fuel input

The following Tables show production data of iron and steel, non-ferrous metals and other activity data for selected years used as activity data for calculating heavy metals and POPs emissions from products processing.

Table 105: Non-ferrous metals production [t].

Year	Secondary Lead (SNAP 030307)	Secondary Copper (SNAP 030309)	Secondary Aluminium (SNAP 030310)	Nickel Production (SNAP 030324)
[t]				
1990	23 511	79 742	60 000	638
1995	21 869	69 830	60 000	822
2000	21 869	69 830	190 000	4 000
2010	21 869	69 830	182 398	4 000
2015	21 869	69 830	180 118	4 000

Sources of activity data are:

- Secondary Lead: (ÖSTAT Industrie- und Gewerbestatistik)
- Secondary Copper: Plant specific
- Secondary Aluminium: (ÖSTAT Industrie- und Gewerbestatistik); (Umweltbundesamt 2000b)
- Nickel Production: (ÖSTAT Industrie- und Gewerbestatistik); (European Commission 2000)

Table 106: Activity data for calculation of HM and POP emissions with EF not related to fuel input.

Year	Cast Iron Production [t]	Cement clinker [t]
1990	110 000	3 693 539
1991	101 000	3 635 462
1992	83 000	3 820 397
1993	65 000	3 678 293
1994	68 000	3 791 131
1995	69 000	2 929 973
1996	64 997	2 915 956
1997	66 283	3 103 312
1998	74 118	2 869 035
1999	70 863	2 891 785
2000	74 654	3 052 974
2001	75 031	3 061 338
2002	70 680	3 118 227
2003	68 584	3 119 808
2004	75 704	3 222 802
2005	76 447	3 221 167
2006	80 782	3 653 477
2007	87 012	3 992 376
2008	86 639	3 996 243
2009	54 111	3 428 140
2010	65 463	3 097 043
2011	67 475	3 175 642
2012	62 979	3 206 055
2013	66 612	3 156 286
2014	64 756	3 143 495
2015	60 796	3 256 561

Table 107: Asphalt concrete production 1990 and 2015.

Year	Asphalt concrete [kt]
1990	403
2015	522

Emission factors for Iron and Steel: reheating furnaces were taken from (WINIWARTER & SCHNEIDER 1995).

Secondary lead is produced by two companies which use lead accumulators and plumbiferous metal ash as secondary raw materials. Lead recuperation is processed in rotary furnaces.

The emission factor for secondary lead for the years 1985 and 1990 were taken from (WINIWARTER & SCHNEIDER 1995), (VAN DER MOST et al. 1992) and (JOCKL & HARTJE 1991).

The emission factor for secondary lead production for 1995 was taken from (WINDSPERGER & TURI 1997). Measurements at Austrian facilities in 2000 showed that emissions decrease by about 80%, thus 20% of the value used for 1995 was used for the years from 2000 onwards.

The emission factors for secondary copper production base on measurements at an Austrian facility in 1994; as re-designs at the main Austrian facility do not influence emissions significantly, this values are also used for 2000.

The Pb emission factor for secondary aluminium production is based on the following regulations/assumptions: (i) TSP emissions from aluminium production is legally limited to 20 mg/m³ (BGBl. II 1/1998 for Al), (ii) as the facilities have to be equipped with PM filter to reach this limit, the emissions are usually well below the legal emission limit, (iii) thus PM emissions were estimated to be 5 mg/m³; (iv) using results from BAT documents (0.25% Pb content in PM; 126–527 mg PM/t Al; (BOIN et al. 2000) and (EUROPEAN COMMISSION, IPPC Bureau 2000) an emission factor of 200 mg/t Al was calculated.

For lime production the emission factors for cement production (taken from (HACKL & MAUSCHITZ 2001)) were used, as the two processes are technologically comparable.

Pb and Cd emission factors for glass production base on measurements at two Austrian facilities for the year 2000. As emission limits are legally restricted, and for 1995 the emission allowances were higher, for 1995 twice the value of 2000 was used. For 1990 and 1985 the Cd and Pb emission factors as well as the Hg emission factor were taken (WINIWARTER & SCHNEIDER 1995).

Heavy metals emissions from burning of fine ceramic materials arise if metal oxides are used as pigments for glaze. The emission factors for fine ceramic materials base on results from (BOOS 2001), assuming that HM concentrations in waste gas is 5% of raw gas concentrations.

Emission factors for nickel production base on measurements at the only relevant Austrian facility.

Table 108: HM emission factors not related to fuel input for NFR 1.A.2 Manufacturing Industries and Construction.

NFR	SNAP	Category Description	EF [mg/t Product]		
			Cd	Hg	Pb
1.A.2.a	030302	Iron and Steel: reheating furnaces	50	–	2 400
1.A.2.b	030307	Secondary lead	3 500–200 ⁸⁵	–	389 000–24 000 ⁸⁵
1.A.2.b	030309	Secondary copper	170	80	6 790
1.A.2.b	030310	Secondary aluminium	–	–	200
1.A.2.f	030311	Cement production (year 2013 value)	2.2	37.2	22.8
1.A.2.f	030312	Lime production	8.7	21	29
1.A.2.f	030317	Other glass	150–8 ⁸⁵	50–30 ⁸⁵	12 000–200 ⁸⁵
1.A.2.f	030320	Fine ceramic materials	150	–	5 000
1.A.2.b	030324	Nickel production	5	570	230

⁸⁵ upper value for 1985, lower value for 2000; years in between were linearly interpolated

3.1.4.10 Emission factors for POPs

For cement industries the dioxin (PCDD/F) emission factor of 0.01 µg/GJ is derived from measured 0.02 ng TE/Nm³ at 10% O₂ (WURST & HÜBNER 1997) assuming a flue gas volume of 1 600–1 700 Nm³/t cement clinker (HÜBNER 2001b) and an average energy demand of 3.55 GJ/t cement clinker. HCB emission factors are taken from (HÜBNER 2001b). The PAK4 emission factor of 0.28 mg/GJ fuel input is derived on actual measurements communicated to the Umweltbundesamt.

The dioxin (PCDD/F) emission factor for bricks and tiles and lime production is based on findings of the study (WURST & HÜBNER 1997). HCB emissions were calculated on the basis of dioxin emissions and assuming a factor of 200.

For pulp and paper industries the dioxin emission factor of 0.009 µgTE/GJ for all fuels bases on measurements of fluidized bed combustors in pulp and paper industries (FTU 1997) and data from literature with typical fuel mixes (LAI-report 1995), (NUSSBAUMER 1994). HCB emissions were calculated on the basis of dioxin emissions and assuming a factor of 200.

For the other sub categories emission factors for plants with different capacities were applied, together with assumptions on plant structure of the Austrian industry mean values for each fuel were calculated. The IEFs (average EF per fuel category) were used for all years; they are presented in Table 110.

Emission factors for dioxin were taken from (FTU 1997) and measurements at Austrian plants (FTU 2000).

References for PAK emission factors are provided in the following table.

Table 109: Source of PAH emission factor of different fuels.

PAH4 EF [mg/GJ]	Small plants ≤ 0.35 MW	Medium plants 0.35–1 MW	Large plants 1–50 MW	Source of EF
Natural gas	0.04	NA	NA	Same EF as for 1.A.4.b, central heating; for larger plants not relevant
Heating oil	0.24	0.16	0.16	For small plants same EF as for 1.A.4.b, central heating; for larger plants: (UBA BERLIN 1998) (four times the value of BaP).
Fuel oil	0.24	0.24	0.24	(UBA BERLIN 1998) (four times the value of BaP)
Wood	85	2.7	0.055	For small plants Same EF as for 1.A.4.b, central heating; for larger plants: measurements at Austrian plants by (FTU 2000).
Coal	85	2	0.04	For small plants Same EF as for 1.A.4.b, central heating; for large plants: (UBA BERLIN, 1998) (four times the value of BaP). For medium plants: expert judgement ⁸⁶ .

For other oil products the same emission factors as for category 1.A.1 were used.

For gaseous biofuels the same emission factors as for gas were used.

PCB emission factors have been selected as outlined in chapter 3.1.3.

⁸⁶ As the size structure for coal fired plants was not known, the EF for medium plants – which is the main size – was used for all activity data in this category.

Table 110: POP emission factors (average EF per fuel category) for 1.A.2 Manufacturing Industries and Construction.

	PCDD/F [µg/GJ]	HCB [µg/GJ]	PAK4 [mg/GJ]	PCB [µg/GJ]
All fuels in pulp and paper ind.	0.009	1.8	0.055	0.0008
Coal				
Hard coal	0.042	4.5	2.0	170
Brown coal	0.033	3.6	2.0	170
Brown coal briquettes	0.064	6.6	2.0	170
Coke oven coke	0.052	5.5	2.0	170
Fuel Oil				
Fuel Oil	0.0009	0.12	0.24	85
Heating and other gas oil	0.0006	0.095	0.18	NA
Other Oil Products	0.0017	0.14	0.011	NA
Gas				
Natural gas	0.0006	0.072	0.0032 (for iron and steel) NA (other sub categories)	NA
LPG	0.0006	0.079	0.004	NA
Other Fuels				
Fuel Wood	0.083	13.0	2.7	0.0075
Industrial waste Wood Waste	0.083	13.0	3.3	0.0075
Gaseous biofuels	0.0006	0.072	0.0032	NA

Emission factors not related to fuel input

Dioxin emission factors for reheating furnaces in iron and steel industries (foundries) were taken from (UBA BERLIN 1998) (average of hot air and cold air furnaces).

For calculation of PAK emissions from reheating furnaces in iron and steel industries the same emission factor as for coke in blast furnaces was used, as the coke fired reheating furnaces are technologically comparable to these.

HCB emissions for foundries were calculated on the basis of dioxin emissions and assuming a factor of 200.

The secondary lead dioxin emission factor of 3 µg/t product is derived from an assumed limit of 0.4 ng/Nm³ flue gas.

Secondary copper is mainly produced by one company which uses scrap as raw material. In a first step black copper is produced in a top loader kiln which is a relevant source of dioxin emissions. Black copper is further converted into blister copper which is further processed in a natural gas fired anode kiln and finally refined by electrolysis. In the 1980s secondary copper production was a main emitter of dioxin and furan emissions in Austria. Since then emission control could be achieved by changing raw materials, process optimization and a flue gas afterburner.

The dioxin emission factor from secondary copper production for the years after 1991 was taken from (WURST & HÜBNER 1997), in the years before no emission control (thermo reactor) was operating, furthermore input materials with more impurities were used. Thus emissions for these years were estimated to be about 200 times higher.

HCB emissions for secondary copper production were estimated on the basis of dioxin emissions and a factor of 330 which was calculated from different measurements at an Austrian facility (HÜBNER et al. 2000).

Secondary aluminium is mainly produced by two companies which uses scrap as raw materials. The raw material is mainly processed in rotary kilns and in some cases in hearth type furnaces. The main driver for dioxin and furan emissions is the composition of processed raw material (Chlorine content). While in the early 1990s emissions were widely uncontrolled the facilities have been recently equipped with particle filters and flue gas afterburners.

The dioxin emission factors for secondary aluminium production for the years 1985–1989 was taken from the Belgian emission inventory, as in these years in Austrian facilities hexachloroethane was used which results in higher emissions (and the Belgian emission factor reflect this). For 1990 the emission factor was taken from (HÜBNER 2000). For 1999 onwards a reduction by 95% was assumed, as dioxin emission reduction measures in the main Austrian plant started to operate.

HCB emissions for secondary aluminium production were estimated on the basis of dioxin emissions and a factor of 500, which was calculated taken from (AITTOLA et al. 1996).

POPs emissions are released in asphalt concrete plants when the bitumen/flint mixture is heated.

As dioxin EF the mean value of the emission factors given in (US-EPA 1998) was applied.

The PAK emission factor for asphalt concrete plants was taken from (SCHEIDL 1996).

Nickel is mainly produced by one company which uses catalysts and other potential recyclable as raw material. The raw material is processed in a rotary kiln and an electric arc furnace. Dioxin emissions 1993 are taken from an emissions declaration. Dioxin emissions of the remaining time series are calculated by multiplying production data with the implied emission factor of 1993.

The dioxin emission factor for nickel production bases on measurements in the only relevant Austrian facility.

Table 111: POP emission factors not related to fuel input for Sector 1.A.2 Manufacturing Industries and Construction.

	Dioxin [µg/t]	HCB [µg/t]	PAK4 [mg/t]
030302 Iron and Steel: reheating furnaces	0.25	50	1.1
030307 Secondary lead	3	NA	NA
030309 Secondary copper	600–4 ⁸⁷	200 000–1 300 ⁸⁷	–
030310 Secondary aluminium	130/40–7 ⁸⁷	65 000–3 500 ⁸⁷	–
030311 Cement production (2013 value)	0.037	5.6	1.04
030313 Asphalt concrete plants	0.01	2.8	0.15
030324 Nickel production	13	2 600–2.25 ⁸⁷	–

3.1.4.11 Emission factors for PM

As already described in Chapter 1.4 the emission inventories of PM for different years were prepared by contractors and incorporated into the inventory system afterwards.

The emission factors were taken from (WINIWARTER et al. 2001) and were used for the whole time series except for

- cement production (NFR 1.A.2.f): emissions taken from (HACKL & MAUSCHITZ 1995/1997/2001/2003/2007) are included in category 2.A.1.
- NFR 1.A.2.d pulp, paper and print: emission values were taken from (AUSTROPAPIER 2002–2015).

For these sources IEFs are presented in the following Table. The shares of PM₁₀ and PM_{2.5} were taken from (WINIWARTER et al. 2001).

Table 112: PM emission factors for NFR 1.A.2.

	TSP Emission Factors [g/GJ]				PM ₁₀	PM _{2.5}
	1990	1995	2000	2014	[%]	[%]
Gas						
Natural gas & LPG		0.5			90	75
Natural gas – Pulp & Paper (IEF)	0.20	0.10	0.11	0.07	90	75
Coal						
Hard coal & Coke oven coke		45			90	75
Brown coal & Brown coal briquettes		50			90	75
Coal – Pulp & Paper industries (IEF)	8.02	3.97	4.46	2.61	95	80
Oil						
Light fuel oil & Gasoil		3.0			90	75
Medium fuel oil		35			90	75
Heavy fuel oil		65			90	75
Other kerosene		3.0			95	80
Oil – Pulp & Paper industries (IEF)	20.05	9.93	11.16	6.51	90	75

⁸⁷ Higher value for 1995/1990, lower value for 2000

	TSP Emission Factors [g/GJ]				PM ₁₀	PM _{2.5}
	1990	1995	2000	2014	[%]	[%]
Other Fuels						
Fuel wood, Wood waste & Industrial waste		55			90	75
Fuel wood, Wood waste & Industrial waste – Pulp & Paper (IEF)	13.79	4.97	5.58	3.26	90	75
Black liquor – Pulp & Paper industries (IEF)	41.36	14.90	11.16	6.51	90	75
Gaseous biofuels		0.5			90	75
Gaseous biofuels – Pulp & Paper industries (IEF)	2.01	0.99	1.12	0.65	90	74

3.1.4.12 NFR 1.A.2.g.7 Mobile Combustion in Manufacturing Industries and Construction – soil abrasion

PM emissions from abrasion of off-road machinery are estimated by means of machinery stock, average operating hours and an PM emission factor of 30 [g TSP/machine operating hour]. The share in TSP emissions is 45% for PM₁₀ and 12% for PM_{2.5}. The following Table 113 presents the parameters used for emission calculation. Emission factors are taken from (WINIWARTER et al. 2007). Activity data is consistent with activity data used for calculation of exhaust emissions.

Table 113: Industry offroad machinery parameters for selected years.

	Stock	Total operating hours (1000s)	Avg. operating hours/year
1990	28 283	12 244	433
1995	39 794	17 359	436
2000	65 269	28 141	431
2005	84 760	41 624	491
2010	106 711	57 741	541
2015	107 410	57 974	540

3.1.4.13 Category-specific Recalculations

Updates of activity data and of NCVs follow the updates of the IEA-compliant energy balance compiled by the federal statistics authority Statistik Austria (Chapter 3.1.10).

The changes in this subsector mainly resulted from the revisions of the energy balance.

3.1.5 NFR 1.A.3.e.1 Pipeline compressors (SNAP 010506)

Category 1.A.3.e considers emissions from natural gas powered turbines used for natural gas pipelines transport. The simple CORINAIR methodology is used for emissions calculation.

Activity data is taken from the energy balance. The following Table 114 shows activity data and main pollutant emission factors. The NO_x emission factor of 150 kg/TJ is an expert guess by Umweltbundesamt. Since 2007 the NO_x emissions as reported in emissions declarations (<http://www.edm.gv.at>) have been used for the inventory.

Table 114: NFR 1.A.3 e main pollutant emission factors and fuel consumption for the year 2014.

Fuel	Source of NO _x , CO, NMVOC, SO ₂ emission factors	Activity [TJ]	NO _x [kg/TJ]	CO [kg/TJ]	NMVOC [kg/TJ]	SO ₂ [kg/TJ]	NH ₃ [kg/TJ]
Natural Gas	(BMWA 1996) ⁽¹⁾	10 870	150.0 ⁽²⁾ 48.1 ⁽³⁾	5.0	0.5	NA	1.00

⁽¹⁾ Default emission factors for industry.

⁽²⁾ Emission factor 1990 to 2006.

⁽³⁾ Implied emission factor 2015.

3.1.6 NFR 1.A.4 Other Sectors

Category 1.A.4 *Other sectors* enfolds emissions from stationary fuel combustion in the small combustion sector. It also includes emissions from mobile sources in households and gardening including snow cats and skidoos as well as from agriculture and forestry.

Source Description

Category 1.A.4 *Other Sectors* includes emissions from stationary fuel combustion in the small combustion sector as well as from some mobile machinery. Emissions of public district heating plants are included in category 1.A.1.a *Public Electricity and Heat*. Emissions of district heat generation delivered to third parties by industry are included in 1.A.2 *Manufacturing Industries and Construction*. Data of energy sources used for space and warm water heating in households and the commercial sector are collected by *Statistik Austria* using micro census questionnaires. According to *Statistik Austria* a clear distinction between “real” public district heating or micro heating networks which serve several buildings under same ownership cannot always be made by the interviewed person or interviewers.

Table 115 presents non-combustion PM emission sources.

Table 115: PM emissions from non-combustion sources in 2015.

Source	NFR	PM _{2.5} [t]
Bonfire	1.A.4.a.i	150
Open fire pits	1.A.4.a.i	16
Barbecue	1.A.4.b.i	763
Agriculture (off-site)	1.A.4.c.ii	31
Forestry	1.A.4.c.ii	23
Total		983

Table 116 shows NFR 1.A.4 category definitions partly taken from the IPCC 2006 Guidelines.

Table 116: NFR 1.A.4 category definitions.

Code Number and Name				Definitions
1.A.4	OTHER SECTORS			Combustion activities as described below, including combustion for the generation of electricity and heat for own use in these sectors.
1.A.4	a	Commercial/Institutional		Fuel combustion in commercial and institutional buildings; all activities included in ISIC Divisions 41, 50, 51, 52, 55, 63–67, 70–75, 80, 85, 90–93.And 99. <i>Bonfire and open fire pits.</i>
1.A.4	b	Residential		Fuel combustion in households.
1.A.4	b	1	Residential:stationary	Fuel combustion in buildings. <i>Barbecue.</i>
1.A.4	b	2	Residential: Household and gardening (mobile) ⁸³ (see page 160)	Fuel combusted in non-commercial mobile machinery such as for gardening and other off road vehicles.
1.A.4	c	Agriculture/Forestry/Fishing		Fuel combustion in agriculture, forestry, fishing and fishing industries such as fish farms. Activities included in ISIC Divisions 01, 02.And 05. Highway agricultural transportation is excluded.
1.A.4	c	1	Stationary	Fuels combusted in pumps, grain drying, horticultural greenhouses and other agriculture, forestry or stationary combustion in the fishing industry.
1.A.4	c	2	Off-road Vehicles and Other Machinery ⁸³ (see page 160)	Fuels combusted in traction vehicles and other mobile machinery on farm land and in forests.
1.A.4	c	3	National Fishing ⁸³ (see page 160)	Fuels combusted for inland, coastal and deep-sea fishing. Fishing should cover vessels of all flags that have refuelled in the country (include international fishing).

3.1.6.1 Methodology

The CORINAIR methodology is applied.

Three technology-dependent main sub categories (heating types) are considered in this category:

1. Central heating boilers (CH)
2. Apartment heating boilers (AH)
3. Stoves (ST)

Information about type of heating is collected by household micro census surveys carried out by STATISTIK AUSTRIA (formerly ÖSTAT) for the years 1988, 1990, 1992, 1999/2000, 2004, 2006, 2008, 2010, 2012 and 2014b. Number of interviews, type of questionnaires and interview modes were not consistent for all micro censuses. Up to the year 2000 householders were asked by face to face interviews whereas from 2004 on data were collected by telephone interviews. In 2006, a small sample of households was additionally interrogated on a voluntary basis for their daily natural gas usage over a two week period each in winter and summer. The collected data was used to supplement and confirm micro census data.

New boilers such as condensing oil and gas boilers with comparatively low NO_x emissions, controlled pellet boilers, wood gasification boilers and wood chip fired boilers with comparatively low VOC, CO, PM and POPs emissions are considered from 2000 onwards.

For each technology fuel dependent emission factors are applied.

Activity data

Total fuel consumption for each of the sub categories of 1.A.4 is taken from the national energy balance. From the view of energy statistics compilers this sector is sometimes the residual of gross inland fuel consumption because fuel consumption data of energy industries and manufacturing industry is collected each year in more detail and therefore of higher quality. However, in case of the Austrian energy balance fuel consumption of the small combustion sector is modelled over time series in consideration of heating degree days and micro census data. Activity data by type of heating is selected as the following:

1.A.4.a.1 Commercial/Institutional: stationary 1.A.4.b.1 Agriculture/Forestry/Fishing: stationary

There is no information about the structure of devices within these categories. It is assumed that the fuel consumption reported in (IEA JQ 2016) is combusted in devices similar to central heating boilers and therefore the respective emission factors are applied.

Table 117: Fuel consumption from NFR 1.A.4.a.1 Commercial/Institutional: Stationary 1990–2015.

NFR	1.A.4.a.1	1.A.4.a.1	1.A.4.a.1	1.A.4.a.1	1.A.4.a.1	1.A.4.a.1
Fuel	(PJ)	liquid	solid	gaseous	biomass	other
1990	37.84	18.70	0.96	12.75	2.06	3.36
1991	39.44	17.83	1.27	15.64	2.08	2.62
1992	48.59	18.27	0.92	24.22	1.93	3.25
1993	51.86	17.71	0.86	28.86	2.59	1.84
1994	43.27	15.67	0.80	22.32	2.50	1.98
1995	53.39	17.67	0.64	30.79	2.55	1.74
1996	54.52	23.75	0.67	24.80	2.40	2.90
1997	54.67	27.57	0.92	20.93	2.73	2.54
1998	51.21	24.79	0.74	21.37	2.71	1.61
1999	60.09	27.90	0.92	25.81	4.00	1.46
2000	49.85	17.87	1.10	25.24	4.26	1.38
2001	63.54	23.37	1.23	35.03	3.29	0.63
2002	60.65	24.36	0.86	31.67	3.13	0.62
2003	71.08	29.83	1.18	35.80	3.62	0.65
2004	71.77	23.36	0.83	42.79	4.27	0.52
2005	71.98	29.60	1.03	38.32	2.62	0.40
2006	71.97	27.49	0.82	40.67	2.72	0.27
2007	53.51	14.82	0.51	33.74	4.30	0.15
2008	63.51	21.35	0.43	36.81	4.90	0.02
2009	55.86	18.82	0.18	33.14	3.67	0.05
2010	52.00	14.60	0.21	32.87	4.27	0.06
2011	42.13	11.26	0.15	27.15	3.55	0.02
2012	36.56	5.59	0.15	26.91	3.88	0.02
2013	34.67	7.71	0.14	22.96	3.80	0.07
2014	37.03	10.81	0.11	22.84	3.19	0.08
2015	33.16	9.80	0.13	19.62	3.53	0.08
Trend						
1990–2015	-10.5%	-9.3%	10.5%	-14.1%	10.8%	0.4%
Trend						
2014–2015	-12.4%	-47.6%	-86.8%	53.8%	71.4%	-97.5%

Table 118: Fuel consumption from NFR 1.A.4.c.1 Agriculture/Forestry/Fishing: Stationary 1990–2015.

NFR	1.A.4.c 1	1.A.4.c 1	1.A.4.c 1	1.A.4.c 1	1.A.4.c 1	1.A.4.c 1
Fuel	(PJ)	liquid	solid	gaseous	biomass	other
1990	10.28	5.36	0.55	0.37	4.01	NO
1991	10.25	4.70	0.61	0.44	4.49	NO
1992	9.50	4.22	0.56	0.43	4.29	NO
1993	8.21	2.87	0.44	0.47	4.42	NO
1994	6.94	2.08	0.39	0.45	4.01	NO
1995	7.68	2.31	0.39	0.49	4.49	NO
1996	8.44	2.57	0.37	0.55	4.95	NO
1997	8.40	2.70	0.30	0.56	4.83	NO
1998	8.27	2.86	0.24	0.61	4.56	NO
1999	9.05	3.14	0.23	0.58	5.10	NO
2000	8.45	2.78	0.18	0.54	4.95	NO
2001	9.10	2.74	0.16	0.60	5.60	NO
2002	8.30	2.26	0.12	0.56	5.36	NO
2003	8.90	2.55	0.09	0.59	5.66	NO
2004	9.13	2.44	0.09	0.58	6.03	NO
2005	9.10	1.39	0.07	0.54	7.11	NO
2006	8.58	1.26	0.06	0.51	6.74	NO
2007	8.58	0.99	0.06	0.48	7.05	NO
2008	8.80	1.01	0.06	0.48	7.25	NO
2009	7.07	0.58	0.04	0.50	5.94	NO
2010	7.84	0.56	0.05	0.56	6.67	NO
2011	7.43	0.30	0.03	0.49	6.60	NO
2012	7.68	0.22	0.03	0.51	6.92	NO
2013	9.33	0.14	0.02	0.57	8.61	NO
2014	7.92	0.14	0.02	0.47	7.29	NO
2015	8.71	0.18	0.02	0.52	7.99	NO
Trend 1990–2015	9.9%	34.1%	10.1%	9.7%	9.5%	-
Trend 2014–2015	-15.3%	-96.6%	-96.1%	42.4%	99.3%	-

1.A.4.b.1 Residential: stationary

Energy consumption by type of fuel and by type of heating is taken from a statistical evaluation of micro census data 1990, 1992, 1999, 2004, 2006, 2008, 2010, 2012 and 2014 (STATISTIK AUSTRIA). The calculated shares are used to subdivide total final energy consumption to the several technologies. For the years in between the shares are interpolated.

The share of natural gas and heating oil condensing boilers in central and apartment heating boilers and new biomass boilers is estimated by means of projected boiler change rates from (LEUTGÖB et al. 2003). A later comparison with sales statistics from the Austrian Association of Boiler Suppliers implies a yearly fuel consumption of about 3 t heating oil by boiler in 2004. For the year 2015 it is assumed that 41% of oil central heating boilers and 19% of oil apartment heating boilers have about half NO_x emissions (20 kg NO_x/TJ) than conventional boilers (42 kg NO_x/TJ).

Pellet consumption 2004 (250 kt) is taken from a survey of the Provincial Chamber of Agriculture of Lower Austria. The increasing pellet consumption 2005 (539 kt) to 2015 (725 kt) is taken from the national energy balance. Wood chip consumption is calculated by subtracting pellet consumption from non-fuelwood biomass consumption taken from energy statistics. Pellet boilers are considered to have lower PM, POPs, NMVOC and CO emissions than wood chips fired boilers.

The share of wood gasification or other modern wood boilers in total fuel wood boilers is calculated by an annual substitution rate of 3 000 boilers from 1992 on assuming an average annual fuel consumption of 190 GJ/boiler which is approximately 12 t of fuel wood. Since 2001 fuel wood boiler sales are used for consumption estimates (about 13 000 new boilers yearly). The calculated average consumption rate of 172 GJ per boiler and year has been calculated by means of micro census data 2008 (33.3 PJ fuel wood used by 409 908 households, assuming that 2.12 households are sharing one boiler at avg.). Controlled wood gasification boilers are considered with lower POPs, NMVOC and CO emissions than manually operated boilers.

75 000 gasoil fired central heating boilers with blue flame burners are considered with lower PAH emissions than yellow flame burners. Activity data of blue flame burners are estimated by an average annual exchange rate of 4 200 boilers assuming an average annual consumption of 80 GJ/boiler (1.9 t heating oil equivalent) from 1991 on.

Table 119: Fuel consumption from NFR 1.A.4.b.1 Residential: stationary 1990–2015.

NFR	1.A.4.b.1	1.A.4.b.1	1.A.4.b.1	1.A.4.b.1	1.A.4.b.1	1.A.4.b.1
Fuel	(PJ)	liquid	solid	gaseous	biomass	other
1990	190.86	72.50	26.62	33.34	58.40	NO
1991	213.32	79.19	29.27	39.82	65.04	NO
1992	198.23	72.73	25.21	38.79	61.50	NO
1993	199.95	73.98	20.82	42.37	62.79	NO
1994	186.01	69.15	18.52	40.17	58.16	NO
1995	199.14	75.59	17.56	43.19	62.80	NO
1996	218.11	83.95	16.64	48.58	68.94	NO
1997	193.53	68.03	12.59	48.52	64.39	NO
1998	196.59	71.28	11.05	51.37	62.89	NO
1999	198.28	73.08	10.23	50.91	64.06	NO
2000	189.20	72.59	9.05	47.49	60.07	NO
2001	197.27	71.80	8.57	53.11	63.79	NO
2002	185.64	69.37	6.88	49.65	59.73	NO
2003	187.14	69.79	5.78	52.45	59.11	NO
2004	180.19	66.62	5.50	51.19	56.89	NO
2005	174.96	61.32	3.69	47.70	62.26	NO
2006	166.42	58.01	3.57	44.93	59.90	NO
2007	156.59	54.35	2.94	42.20	57.10	NO
2008	159.29	55.48	3.03	42.61	58.18	NO
2009	152.44	48.58	2.29	43.97	57.60	NO
2010	169.69	53.21	2.50	49.50	64.48	NO
2011	151.89	46.08	1.49	43.45	60.87	NO
2012	157.77	47.57	1.62	44.76	63.81	NO

NFR	1.A.4.b.1	1.A.4.b.1	1.A.4.b.1	1.A.4.b.1	1.A.4.b.1	1.A.4.b.1
Fuel	(PJ)	liquid	solid	gaseous	biomass	other
2013	167.72	44.38	1.19	50.31	71.84	NO
2014	140.11	37.02	0.97	41.90	60.23	NO
2015	153.81	40.63	1.08	45.97	66.12	NO
Trend 1990–2015	9.8%	9.8%	12.1%	9.7%	9.8%	-
Trend 2014–2015	-19.4%	-44.0%	-95.9%	37.9%	13.2%	-

Table 120 shows the selected share of each heating type for category *1.A.4.b.1.i*

Table 120: Share of 1.A.4.b.1 heating type on fuel category for the year 2015.

	Central Heating	Apartment Heating	Stove
Hard Coal			
Brown Coal			
Brown Coal Briquettes	88%	1%	11%
Coke			
Gas oil	84%	15%	2%
Residual Fuel Oil, Gas Works Gas, LPG, Petroleum	100%	–	–
Natural Gas	50%	43%	7%
Fuel Wood	85%	4%	10%
Wood Chips, Pellets, other solid biomass	85%	8%	7%

The following table shows biomass boiler sales from 2000 which are considered with lower CO, NMVOC and CH₄ emissions than equipment installed before 2000. The estimated accumulated consumption in 2015 is 63 PJ which is about 80% of total biomass consumption of *1.A.4.b residential*. The average yearly consumption is calculated by average consumption per household. In case of boilers it is assumed that a building contains 2.12 households which are heated by a single boiler. The selected factors are derived from the 2008 household census.

Table 121: Number of biomass boiler sales 2000–2015 and fuel consumption estimate.

Year	Pellet boilers	Pellet stoves	Wood chip boilers	Log wood boilers
2000	3 466	0	0	0
2001	4 932	0	2 645	5 364
2002	4 492	997	2 615	4 276
2003	5 193	1 827	2 890	4 144
2004	6 077	3 245	3 224	4 555
2005	8 874	3 780	4 509	6 078
2006	10 467	5 640	4 726	6 937
2007	3 915	1 750	3 578	4 835
2008	11 101	3 045	4 096	7 405
2009	8 446	2 600	4 328	8 530

Year	Pellet boilers	Pellet stoves	Wood chip boilers	Log wood boilers
2010	8 131	2 000	3 656	6 211
2011	10 400	2 700	3 744	6 328
2012	11 971	4 000	3 573	6 887
2013	10 281	3 500	2 891	5 754
2014	6 209	3 100	2 294	3 820
2015	5029	2400	2025	3453
Accumulated total number	118 984	40 584	50 794	84 577
Avg. estimated yearly consumption per boiler or stove [GJ]	203	48	331	236
Total estimated consumption of new boilers 2015 [TJ] ¹⁾	24 165	1 948	16 799	19 921

¹⁾ Assuming an average heating demand.

Figure 37 shows activity data of 1.A.4.b.1 Residential: stationary by type of fuel together with the correlating heating degree days for the years 1990 to 2015.

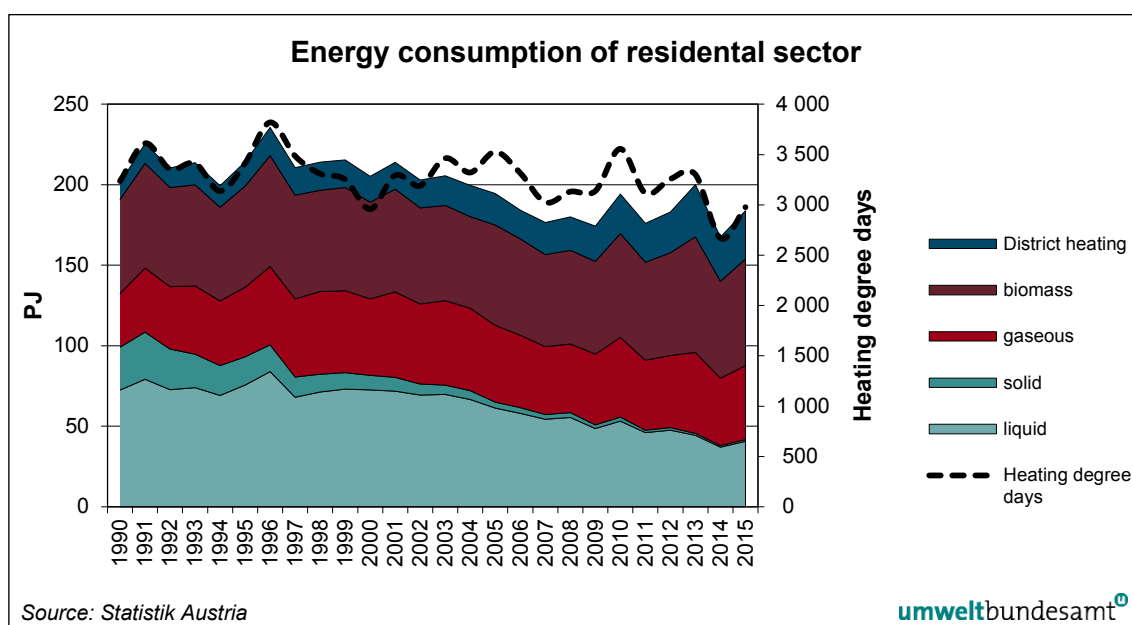


Figure 37: Energy consumption [PJ] of residential sector by type of fuel and number of heating degree days 1990–2015.

Table 122: NFR 1.A.4.b.1 percentual consumption by type of heating.

Year	Natural Gas			Fuel Oil, LPG		Gasoil		Coal (+ Briquettes)		
	CH	AH	ST	CH	CH	AH	ST	CH	AH	ST
	[%]			[%]		[%]		[%]		
1990	22.6	38.4	39.1	100	75.0	10.0	15.0	60.6	9.4	30.0
1991	26.0	36.4	37.6	100	75.0	10.0	15.0	62.3	8.8	29.0

Year	Natural Gas			Fuel Oil, LPG		Gasoil		Coal (+ Briquettes)		
1992	28.6	37.8	33.5	100	76.2	9.4	14.4	62.0	8.8	29.3
1993	31.3	39.2	29.5	100	77.3	8.9	13.8	61.6	8.7	29.6
1994	33.9	40.6	25.4	100	78.5	8.3	13.3	61.3	8.7	30.0
1995	36.6	42.1	21.4	100	79.6	7.7	12.7	61.0	8.7	30.3
1996	39.2	43.5	17.3	100	80.8	7.2	12.1	60.7	8.7	30.6
1997	41.9	44.9	13.2	100	81.9	6.6	11.5	60.4	8.7	30.9
1998	44.5	46.3	9.2	100	83.1	6.0	10.9	60.0	8.7	31.3
1999	47.1	47.7	5.1	100	84.2	5.4	10.4	59.7	8.7	31.6
2000	47.1	47.7	5.1	100	84.2	5.4	10.4	59.7	8.7	31.6
2001	47.2	45.4	7.5	100	81.8	9.1	9.1	61.7	10.7	27.5
2002	47.2	43.0	9.8	100	79.4	12.8	7.8	63.8	12.8	23.5
2003	47.3	40.6	12.2	100	77.1	16.4	6.5	65.8	14.8	19.4
2004	47.3	38.2	14.5	100	74.7	20.1	5.2	67.8	16.9	15.3
2005	47.3	38.2	14.5	100	76.1	19.0	4.9	67.8	16.9	15.3
2007	47.3	38.2	14.5	100	77.6	17.8	4.6	67.8	16.9	15.3
2007	47.1	38.6	14.3	100	79.2	17.2	3.6	75.0	11.8	13.2
2008	47.0	39.0	14.1	100	80.9	16.5	2.7	82.2	6.7	11.1
2009	46.1	40.3	13.6	100	81.3	16.3	2.4	80.7	10.6	8.7
2010	45.1	41.7	13.1	100	81.8	16.0	2.2	79.1	14.5	6.3
2011	45.6	41.2	13.2	100	82.9	15.2	1.9	74.9	8.9	16.3
2012	46.1	40.6	13.3	100	83.9	14.4	1.6	70.6	3.2	26.2
2013	48.1	41.6	10.3	100	83.8	14.6	1.6	79.3	2.2	18.5
2014	50.2	42.5	7.3	100	83.7	14.8	1.5	88.1	1.1	10.8
2015	50.2	42.5	7.3	100	83.7	14.8	1.5	88.1	1.1	10.8

Table 123: NFR 1.A.4.b.1 Type of heatings split.

Year	Fuel Wood (log wood)			Wood chips, pellets and other biomass		
	CH	AH	ST	CH	AH	ST
		[%]			[%]	
1990	61.3	7.3	31.4	61.3	7.3	31.4
1991	62.9	6.1	31.0	62.9	6.1	31.0
1992	63.5	6.4	30.1	66.2	5.8	28.0
1993	64.1	6.6	29.3	69.5	5.4	25.1
1994	64.7	6.8	28.5	72.8	5.1	22.1
1995	65.3	7.1	27.6	76.1	4.7	19.1
1996	65.9	7.3	26.8	79.4	4.4	16.2
1997	66.5	7.5	26.0	82.8	4.0	13.2
1998	67.1	7.8	25.1	86.1	3.7	10.3
1999	67.7	8.0	24.3	89.4	3.3	7.3
2000	67.7	8.0	24.3	89.4	3.3	7.3
2001	72.0	7.0	21.1	87.8	4.3	7.9
2002	76.2	5.9	17.9	86.2	5.3	8.5
2003	80.5	4.8	14.7	84.6	6.3	9.1
2004	84.8	3.8	11.4	83.1	7.3	9.6
2005	84.8	3.8	11.4	83.1	7.3	9.6
2006	84.8	3.8	11.4	83.1	7.3	9.6
2007	83.6	4.0	12.5	82.3	9.5	8.2
2008	82.3	4.1	13.5	81.6	11.6	6.8
2009	83.7	4.6	11.7	81.8	10.6	7.6
2010	85.1	5.1	9.8	82.0	9.6	8.4
2011	85.2	5.0	9.9	84.0	8.2	7.8
2012	85.3	4.8	9.9	86.0	6.9	7.1
2013	85.3	4.6	10.1	85.4	7.7	6.9
2014	85.3	4.4	10.3	84.7	8.5	6.8
2015	85.3	4.4	10.3	84.7	8.5	6.8

3.1.6.2 Emission factors for main pollutants

Due to the wide variation of technologies, fuel quality and device maintenance the uncertainty of emission factors is rather high for almost all pollutants and technologies.

Country specific main pollutant emission factors from national studies (BMWA 1990), (BMWA 1996) and (UMWELTBUNDESAMT 2001a) are applied. In these studies emission factors are provided for the years 1987, 1995 and 1996.

Emission factors prior to 1996 are taken from (STANZEL et al. 1995) and mainly based on literature research.

Natural gas and heating oil emission factors 1996 are determined by means of test bench measurements of boilers and stoves sold in Austria. Solid fuels emission factors 1996 are determined by means of field measurements of Austrian small combustion devices.

NO_x emissions factors of heating oil and natural gas condensing boilers are taken from (LEUTGÖB et al. 2003).

For the years 1990 to 1994 emission factors were interpolated. From 1997 onwards the emission factors from 1996 are applied.

In some cases only VOC emission factors are provided in the studies, NMVOC emission factors are determined assuming that a certain percentage of VOC emissions is released as methane as listed in Table 124. The split follows closely (STANZEL et al. 1995).

Table 124: Share of CH₄ and NMVOC in VOC for small combustion devices.

	CH ₄	NMVOC	VOC
Coal	25%	75%	100%
Gas oil; Kerosene	20%	80%	100%
Residual fuel oil	25%	75%	100%
Natural gas; LPG	80%	20%	100%
Biomass	25%	75%	100%

The following Tables show the main pollutant emission factors by type of heating.

Table 125: NFR 1.A.4 NO_x emission factors by type of heating for the year 2015.

	Central heating [kg/TJ]	Apartment heating [kg/TJ]	Stove [kg/TJ]
Coal	78.0	78.0	132.0
Residual fuel oil < 1% S	115.0		
Residual fuel oil ≥ 1% S	235.0		
Heating oil, Kerosene, LPG	42.0/37.5 ⁽³⁾ 20.0 ⁽²⁾	43.0 20.0 ⁽²⁾	55.0
Natural gas	42.0 16.0 ⁽²⁾	43.0 16.0 ⁽²⁾	51.0
Solid biomass	107.0	107.0	106.0
Industrial waste	100.0 ⁽¹⁾		

⁽¹⁾ Default values for industrial boilers

⁽²⁾ Condensing boilers (LEUTGÖB et al. 2003)

⁽³⁾ The value of 42.0 G NO_x/Gj is used until the year 2008. Since 2009 most of the gasoil placed into market has a lowered sulphur content of 10 ppm which is reflected in an emission factor of 37.5 g NO_x/Gj.

Table 126: NFR 1.A.4 NMVOC emission factors by type of heating for the year 2015.

	Central heating [kg/TJ]	Apartment heating [kg/TJ]	Stove [kg/TJ]
Coal	284.4	284.4	333.3
Residual fuel oil < 1% S	0.8		
Residual fuel oil ≥ 1% S	8.0		
Heating oil, Kerosene	0.8	0.8	1.5

	Central heating [kg/TJ]	Apartment heating [kg/TJ]	Stove [kg/TJ]
LPG	0.5	0.5	
Natural gas	0.2	0.2	0.2
Solid biomass conventional	432.0	432.0	643.0 338.0 ⁽¹⁾
Wood gasification	325.0 ⁽¹⁾	312.0 ⁽¹⁾	
Wood chips	78.0 ⁽¹⁾		
Pellets	⁽³⁾ 35.0 (for all types of heating)		
Industrial waste	38.0 ⁽²⁾		

⁽¹⁾ NMVOC from new biomass boilers (LANG et al. 2003)

⁽²⁾ Default values for industrial boilers

⁽³⁾ Averaged emission factor for new pellet boilers (LANG et al. 2003)

Table 127: NFR 1.A.4 CO emission factors by type of heating for the year 2015.

	Central heating [kg/TJ]	Apartment heating [kg/TJ]	Stove [kg/TJ]
Coal	4 206.0	4 206.0	3 705.0
Residual fuel oil < 1% S	45.0		
Residual fuel oil ≥ 1% S	15.0		
Heating oil	67.0	67.0	150.0
Kerosene	15.0		
LPG	37.0	37.0	
Natural gas	37.0	37.0	44.0
Solid biomass conventional	4 303.0	4 303.0	4 463.0 2 345.0 ⁽²⁾
Wood gasification	3 237.0 ⁽²⁾	3 107.0 ⁽²⁾	
Industrial waste	200.0 ⁽¹⁾		

⁽¹⁾ Default values for industrial boilers

⁽²⁾ CO from new biomass heatings is calculated by means of ratio of NMVOC from new biomass heatings by NMVOC from conventional heatings

Table 128: NFR 1.A.4 SO₂ emission factors by type of heating for the year 2015.

	Central heating [kg/TJ]	Apartment heating [kg/TJ]	Stove [kg/TJ]
Coal	543.0	543.0	340.0
Residual fuel oil < 1% S	90.0		
Residual fuel oil ≥ 1% S	398.0		
Heating oil	0.47	0.47	0.47
Kerosene	90.0	90.0	90.0
LPG	6.0 ⁽¹⁾	6.0 ⁽¹⁾	6.0 ⁽¹⁾
Natural gas	NA	NA	NA
Solid biomass	11.0	11.0	11.0
Industrial waste	130.0 ⁽²⁾		

⁽¹⁾ From (LEUTGÖB et al. 2003)⁽²⁾ Default value for industrial boilers (BMWA 1990)Table 129: NFR 1.A.4 NH₃ emission factors for the year 2015.

	Central heating [kg/TJ]
Coal	0.01
Oil	2.68
Natural gas	1.00
Biomass	5.00
Industrial waste	0.02

3.1.6.3 Emission factors for heavy metals

Fuel Oil

For fuel oil the same emission factors as for 1.A.1 were used.

Coal and Biomass

NFR 1.A.4.c

For deciding on an emission factor for fuel wood results from (OBERNBERGER 1995), (LAUNHARDT et al. 2000) and (FTU 2000) were considered.

The emission factors for coal were derived from (CORINAIR 1995), Table 12, B112.

For mercury the emission factors for 1.A.4.c were also used for the other sub categories.

For lead the emission factors for 1.A.4.c were also used for 1.A.4.b Residential plants: central and apartment heating.

NFR 1.A.4.b

Emission factors for central and apartment heating boilers are based on findings from (HARTMANN, BÖHM & MAIER 2000), (LAUNHARDT, HARTMANN, LINK & SCHMID 2000), (PFEIFFER, STRUSCHKA & BAUMBACH 2000), (STANZEL, JUNGMEIER & SPITZER 1995).

Results of measurements (SPITZER et al. 1998): show that the TSP emission factor for stoves are about 50% higher than the emission factor for central heating boilers – thus the Cd and Pb emission factor was also assumed to be 50% higher.

Table 130: HM emission factors for Sector 1.A.4 Other Sectors (Commercial and Residential).

	Cadmium EF [mg/GJ]	Mercury EF [mg/GJ]	Lead EF [mg/GJ]
1A4a Commercial/Institutional plants (020103)			
1A4c 1 Plants in Agriculture/Forestry/Fishing (020302)			
102A Hard coal	5.4	10.7	90
104A Hard coal briquettes			
107A Coke oven coke			
105A Brown coal	3.7	9.2	22
106A Brown coal briquettes			
111A Fuel wood	7.0	1.9	23
116A Wood waste			
113A Peat			
1A4b Residential plants: central and apartment heating (020202)			
102A Hard coal	4.0	10.7	90
104A Hard coal briquettes			
107A Coke oven coke			
105A Brown coal	2.0	9.2	22
106A Brown coal briquettes			
111A Fuel wood	3.0	1.9	23
116A Wood waste			
113A Peat			
1A4b Residential plants: stoves (020205)			
102A Hard coal	6.0	10.7	135
104A Hard coal briquettes			
107A Coke oven coke			
105A Brown coal	3.0	9.2	33
106A Brown coal briquettes			
111A Fuel wood	4.5	1.9	35
116A Wood waste			
113A Peat			

3.1.6.4 Emission factors for POPs

Residential plants

For residential plants the dioxin emission factors for coal and wood were taken from (HÜBNER & BOOS 2000); for heating oil a mean value from (PFEIFFER et al. 2000), (BOOS & HÜBNER 2000) and measurements by FTU (FTU 2000) was used. Combustion of waste in stoves was not considered, as no activity data was available.

HCB emission factors are taken from the national study (HÜBNER 2002) and based on field measurements from 15 solid fuel residential boilers and stoves with a capacity less than 50 kW using the standard methodology according to Ö-NORM EN-1948-1. The results show a high variation in flue gas concentrations without any correlation between type of heating (stove, boiler) or fuel (log wood, pellets, wood chips, coal).

The PAK emission factors are trimmed mean values from values given in (UBA BERLIN 1998), (SCHEIDL 1996), (ORTHOFFER & VESSELY 1990), (SORGER 1993), (LAUNHARDT et al. 2000), (PFEIFFER et al. 2000) (LAUNHARDT et al. 1998), (STANZEL et al. 1995), (BAAS et al. 1995). How-

ever, it was not possible to determine different emission factors for stoves and central heating boilers from the values given in the cited literature. Thus for solid fuels the same proportions given from the dioxin EFs, and for oil the proportions of carbon black given in (HÜBNER et al. 1996), was used. For natural gas it was assumed that the values given in literature are valid for stoves and that the values for central heating boilers are assumed to be five times lower.

PCB emission factors have been selected as outlined in chapter 3.1.3.

Commercial and Institutional plants and Plants in Agriculture/Forestry/Fishing

The same emission factors as used for central heating in the residential sector and for small (and medium) plants of category 1.A.2 were used (the share of the different size classes is based on expert judgement). The values given in the following Table are averaged values per fuel category.

Table 131: POP emission factors for 1.A.4.

EF	PCDD/F [µg/GJ]	HCB [µg/GJ]	PAK4 [mg/GJ]	PCB [µg/GJ]
1.A.4.a Commercial/Institutional plants (SNAP 020103)				
Coal:102A, 104A, 105A, 106A, 107A	0.24	180 160/190 180	25 24 4.5	170
203B Light fuel oil 203C Medium fuel oil	0.002	0.19	0.24	NA
203D Heavy fuel oil	0.0009	0.12	0.24	85
204A Heating oil 206A Petroleum	0.0012	0.12	0.18	NA
224A Other Oil Products	0.0017	0.14	0.011	NA
301A Natural gas	0.0016	0.14	0.01	NA
303A LPG 310A Landfill gas	0.0017	0.14	0.011 0.0032	NA
309A Biogas 309B Sewage sludge gas	0.0006	0.072	0.0032	NA
111A Wood (IEF 2015)	0.17	171	19.8	0.0156
115A Industrial waste	0.3	250	26	0.027
116A Wood wastes	0.430	240	24	0.0387
1.A.4.c.1 Plants in Agriculture/Forestry/Fishing (SNAP 020302)				
Coal (102A, 104A, 105A, 106A, 107A)	0.24	180 190 180	24 25 4.5	170
203B Light fuel oil 204A Heating oil	0.0015	0.15	0.24 0.2	NA
301A Natural gas 303A LPG	0.0025	0.25	0.04	NA
111A Wood (IEF 2015)	0.18	324	39.2	0.0158
116A Wood wastes	0.38	600	85	0.0342
1.A.4.b Residential plants: central and apartment heating (SNAP 020202)				
Coal102A, 105A, 106A, 107A	0.38	600	85 12	170
203B Light fuel oil 204A Heating oil	0.0015	0.15	0.24 0.2	NA
224A Other Oil Products	0.0017	0.14	0.011	NA
301A Natural gas 303A LPG	0.0025	0.25	0.04	NA
111A Wood, 116A Wood wastes				
Central heating (IEF 2015)	0.18	324	39.2	0.0158
Apartment heating	0.38	600	85	0.0342
1.A.4.b Residential plants: stoves (SNAP 020205)				
Coal 102A, 104A, 105A, 106A, 107A	0.75	600	170 24	170
204A Heating oil	0.003	0.3	1.7	NA
301A Natural gas	0.006	0.6	0.2	NA
111A Wood 113A Peat 116A Wood wastes	0.75	600	170	0.0675

3.1.6.5 Emission factors for PM

As already described in chapter 1.4 the emission inventories of PM for different years were prepared by contractors and incorporated into the inventory system afterwards.

Emission factors were taken from (WINIWARTER et al. 2001) and were used for all years, except for the emission factors from 2000 onwards for wood waste, where the use of pellets (TSP = 30 kg/TJ; PM₁₀ = 27 kg/TJ) was considered (UMWELTBUNDESAMT 2006b).

As for the other pollutants, emission factors were distinguished for three types of heating devices: central heating, apartment heating, and stoves.

The shares of PM₁₀ (90%) and PM_{2.5} (80%) were also taken from (WINIWARTER et al. 2001).

Table 132: PM emission factors for NFR 1.A.4.

	TSP Emission Factors [g/GJ]		
	Central heating	Apartment heating	Stoves
Gas			
301A, 303A, 309A, 309B and 310A	0.5	0.5	0.5
Coal			
102A, 104A and 107A	45	94	153
105A and 106A	50	94	153
Oil			
203B, 204A	3	3	3
203D	65	65	65
224A	0.5	0.5	--
Solid biomass and Peat			
111A, 113A and 116A	55	90	148

The following Table 133 shows the TSP implied emission factors for 'wood waste and other solid biomass' by type of heating for category 1.A.4. The IEF considers the different share of wood pellets, wood chips and wood briquettes. Although pellets consumption is increasing, the IEF for the year 2005 is lower than for 2010 because the share of pellet consumption is considerably high in this year.

Table 133: TSP emission factors for "wood waste and other solid biomass" used in commercial, institutional or residential plants as well in stationary plants and other equipment in NFR 1.A.4.

	TSP IEF [g/GJ]					
	1990	1995	2000	2005	2010	2015
116A						
Central heating	55.00	55.00	51.83	36.74	39.46	38.56
Apartment heating	90.00	90.00	82.40	46.18	52.72	50.55
Stoves	148.00	148.00	133.05	61.81	74.67	70.41

Other sources of PM emissions

For the following sources it is assumed that particle sizes are equal or smaller than PM_{2.5}.

Barbecue

For activity data 11 kt of char coal has been calculated from foreign trade statistics and production data (Import 11 900 t, Export 1 900 t, Production 1 000 t). An emission factor of 2 237 g TSP/GJ char coal has been selected which is 69 347 g/t char coal assuming a calorific value of 31 GJ/t. This leads to 763 t PM/year for the whole time series.

Bonfire

It is assumed that one bonfire is sparked every year for each 5 000 rural inhabitants. This leads to 1 000 bonfires each year for all 5 Mio rural inhabitants. The average size of a fire is estimated to have 30 m³ of wood which is 10 m³ of solid wood. Assuming a heating value of 10 GJ/m³ wood and selecting an emission factor of 1 500 g/GJ (similar to open fire places, expert guess from literature) this leads to 150 kg PM for each fire and 150 t PM for each year.

Open fire pits

It is assumed that one open fire pit exists for each 2 500 inhabitants. Assuming 20 fires per year and fire pit this leads to 66 400 fires each year. Assuming 0.025 m³ of solid wood per fire which is 0.3 GJ and selecting an emission factor of 800 g/GJ (open fireplace, EPA 1998, KLIMONT et al. 2002) this leads to 240 g PM/fire and 16 t PM for each year.

3.1.6.6 Category-specific Recalculations

Revisions are mainly following the minor revisions of the energy balance. For the year 2014, NO_x emissions of the commercial sector (1A4ai) were revised by +0.08 kt, NO_x emissions of the residential sector (1.A.4.b.i) were revised by +0.01 kt and NO_x emissions of the agriculture sector (1.A.4.c.i) were revised by -0.16 kt. NMVOC emissions were revised by +0.59 kt for all of 1.A.4 stationary sources while PM_{2.5} emissions remained the same.

Updates of activity data and of NCVs follow the updates of the IEA-compliant energy balance compiled by the federal statistics authority *Statistik Austria* (Chapter 3.1.10).

3.1.7 NFR 1.A.4.c.2 Off-road Vehicles and Other Machinery – soil abrasion

PM emissions from abrasion of offroad machinery in agriculture and forestry are estimated by means of machinery stock, average operating hours and an PM emission factor of 30 [g TSP/machine operating hour]. The share in TSP emissions is 45% for PM₁₀ and 12% for PM_{2.5}. The following Table 134 presents the parameters used for 2012 emission calculation. Emission factors are taken from (WINIWARTER et al. 2007). Activity data is consistent with activity data used for calculation of exhaust emissions.

Table 134: Agriculture offroad machinery parameters for the year 2012.

Machinery	Stock	Avg. operating hours/year	Off-Site operating hours
Tractors	423 940	148	12%
Trucks	16 029	121	12%
Harvesters	10 805	97	12%
Mowers	102 095	27	12%

3.1.8 Quality Assurance and Quality Control (QA/QC)

Comparison with EPER and E-PRTR data

Comparison of emissions with reported 2004/2005 EPER and 2007–2015 E-PRTR data does not explicitly identify inconsistencies.

1.A.1.a

Activity data and GHG emissions are in general of high quality due to the needs of GHG calculation and CO₂-trading. The quality system which is well defined for GHG is basically also applied to non-GHG but is not always fully documented in the inventory system. The following QA/QC procedures are performed depending on resource availability.

1.A.1.a LPS data gap filling (DKDB)

It has to be noted that emissions from *DKDB* are reported for heating periods from October year_(n) to September year_(n+1). Due to this and in case of other missing values emissions and fuel consumption for an inventory year are completed by taking the monthly values from the previous inventory year if available. In some cases either activity data or emission data is not complete and gap filling is performed by using other monthly emission ratios of that plant. For boilers with mixed fuel consumption a linear regression model (MS-Excel function “RGP”) is sometimes used.

1.A.1.a LPS data validation (DKDB)

An outcome of the methodology as presented in Table 64 is the ratios of measured and calculated emissions by fuel type. Possible reasons for unexplainable ratios:

- Default emission factors are not appropriate because the group includes inhomogeneous boiler technologies.
- Changed technologies are not reflected.
- Boilers used for default emission factor derivation are not the consistent with boilers considered in the inventory approach.
- Emission declarations are not appropriate (fuel consumption is not consistent with emissions).

Activity data of large boilers and other large plants is checked with the national energy balance. For some fuels (coal, residual fuel oil, waste) and categories total national consumption is limited to a few boilers. In this case LPS consumption may be checked with data from *Statistik Austria* or with the spatial „Bundesländer“ energy balance. In some cases published environmental reports which are underlying a QA/QC system like EMAS have been used for validation purpose.

1.A.1.b Petroleum refining

Reported fuel consumption is checked with energy balance. Monthly data from *DKDB* provides emissions by boiler which is cross-checked with reported flue gas concentrations or mandatory limits.

3.1.9 Planned improvements

It is expected to decrease uncertainty of category 1.A.4 emissions significantly if emission factors are developed which are linked to statistical data more accurate. However, CO, NMVOC and TSP emissions of new residential biomass boilers should be updated according to already existing measurements. The current selected emission factors do not accurately consider the improved combustion efficiency of modern boilers.

3.1.10 Recalculations

This chapter presents the recalculation difference of fuel combustion activity data with respect to the previous submission.

Activity data has been updated with data from the new edition of the energy balance, affecting emissions of all pollutants.

Revision of the energy balance

- Gross natural gas consumption has been revised for the years 1999 (+0.7 PJ) and for 2002–2008 (between –0.8 to –5.9 PJ). The revision was due to harmonisation with official total natural gas consumption as published by the Austrian Energy regulator (e-Control). The revision affected the ‘own use’ of the energy sector as well as the ‘final energy consumption’.
- For liquid fuels minor revisions were made for the whole time series because of a switch from national energy balance to the Eurostat/IEA dataset which has rounded values. Larger shifts of gasoil between 1.A.4.a and 1.A.4.b categories were carried out for the years 2002–2003 (0.6–0.7 PJ) and 2005–2006 (8.7–4.6 PJ). For the year 2014 about 0.5 PJ of gasoil was shifted from manufacturing industries to the residential sector.
- For solid fuels minor revisions were made for the years 2002–2014 with the largest change in 2011 (–0.03 PJ).
- For ‘other fuels’ the major revision took place for the year 2014 where a shift of ‘industrial waste’ to municipal solid waste’ was reported by energy statistics.
- For biomass the major revision took place for the years 2005 and 2007–2014. For NFR 1.A.1.a biomass was revised downwards by –3.2 PJ in the year 2015. For NFR 1.A.4 sub categories biomass was revised downwards for the years 2007–2014 (between –1.1 to –2.6 PJ). For NFR 1.A.2.g.8 biomass was revised downwards by –1 PJ for the year 2013 and by –5.5 PJ for the year 2014.

3.2 NFR 1.A Mobile Fuel Combustion Activities

3.2.1 General description

In this chapter the methodology for estimating emissions of mobile sources in NFR 1.A.3, transport and NRMM (Non-Road Mobile Machinery) of NFR 1.A.2.g, NFR 1.A.4 and NFR 1.A.5, is described.

NFR Category 1.A.3 *Transport* comprises emissions from fuel combustion, gasoline evaporation, abrasion of brake and tyre wear and dust dispersion of dust by road traffic in the subcategories.

Table 135: NFR and SNAP categories of 1.A Mobile Fuel Combustion Activities.

Activity	NFR Category	SNAP	
NFR 1.A.2 Manufacturing Industry and Combustion			
Industry, Mobile Machinery	NFR 1.A.2.g.vii		
		0808	Other Mobile Sources and Machinery-Industry
NFR 1.A.3 Transport			
Civil Aviation	NFR 1.A.3.a		
● Civil Aviation	NFR 1.A.3.a	0805	
● Civil Aviation (Domestic, LTO)	NFR 1.A.3.a.2	080501	Domestic airport traffic (LTO cycles < 1 000 m)
● International Aviation (LTO)	NFR 1.A.3.a.1	080502	International airport traffic (LTO cycles < 1 000 m)
Road Transportation	NFR 1.A.3.b		
● R.T., Passenger cars	NFR 1.A.3.b.1	0701	Passenger cars
● R.T., Light duty vehicles	NFR 1.A.3.b.2	0702	Light duty vehicles < 3.5 t
● R.T., Heavy duty vehicles	NFR 1.A.3.b.3	0703	Heavy duty vehicles > 3.5 t and buses
● R.T., Mopeds & Motorcycles	NFR 1.A.3.b.4	0704	Mopeds and Motorcycles < 50 cm³
		0705	Motorcycles > 50 cm³
● Gasoline evaporation from vehicles	NFR 1.A.3.b.5	0706	Gasoline evaporation from vehicles
● Automobile tyre and brake wear	NFR 1.A.3.b.6	0707	Automobile tyre and brake wear
● Automobile road abrasion	NFR 1.A.3.b.7	0707	Automobile road abrasion
Railways	NFR 1.A.3.c	0802	Other Mobile Sources and Machinery-Railways
Navigation	NFR 1.A.3.d	0803	Other Mobile Sources and Machinery-Inland waterways
		0804	Other Mobile Sources and Machinery-Maritime activities
Other transportation	NFR 1.A.3.e	0810	Pipelines compressors and other transportation
NFR 1.A.4 Other Sectors			
● Residential	1.A.4.b.2	0809	Other Mobile Sources and Machinery-Household and gardening

Activity	NFR Category	SNAP	
● Agriculture/ Forestry/ Fisheries	1.A.4.c.2	0806	Other Mobile Sources and Machinery-Agriculture
		0807	Other Mobile Sources and Machinery-Forestry
NFR 1.A.5 Other			
	1.A.5.b	0801	Other Mobile Sources and Machinery-Military
Memo Items			
Civil Aviation (Domestic, cruise)	Mem 1.A.3.a.2	080503	Domestic cruise traffic (> 1 000 m)
International aviation (cruise)	Mem 1.A.3.a.1	080504	International cruise traffic (> 1 000 m)

3.2.1.1 Completeness

Table 136 provides information on the status of emission estimates of all sub categories. A “✓” indicates that emissions from this sub category have been estimated. Table 136 provides an overview about NFR categories and the corresponding SNAP codes.

Table 136: Completeness of 1.A Mobile Fuel Combustion Activities.

NFR Category	NO _x	CO	NM ₁₀ VOC	SO _x	NH ₃	TSP	PM ₁₀	PM _{2.5}	Pb	Cd	Hg	DIOX	PAH	HCB	PCB
1.A.2.g.7 Industry, Mobile Machinery	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1.A.3.a Civil Aviation - LTO	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	NE	NE	NE	NE
1.A.3.b Road Transportation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1.A.3.c Railways	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1.A.3.d Navigation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1.A.3.e Other transportation	✓	✓	✓	NA	✓	✓	✓	✓	NA	NA	NA	✓	NA	✓	NA
1.A.4.b.2 Residential: Household and gardening (mobile)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1.A.4.c.2 Agriculture/ Forestry/Fishing: Off-road Vehicles and Other Machinery	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1.A.5.b Other, Mobile (Including military)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mem.1.A.3.a.Civil Aviation - Cruise	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	NE	NE	NE	NE
Mem.1.A.3.d International maritime Navigation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

In the case of brake wear, tyre wear and road abrasion emissions occurring and being calculated, they are reported together under *1.A.3.b.7 Automobile road abrasion*.

3.2.2 Key Categories

Key category analysis is presented in Chapter 1.5. This chapter includes information on the transport sector. Key sources within this category are presented in Table 137.

Table 137: Key sources of sector Transport.

NFR Category	Category Name	Key Categories	
		pollutant	KS Assessment
1.A.3.a	Civil Aviation - LTO	NO _x	TA
1.A.3.b.1	R.T., Passenger cars	NO _x , NMVOC, CO, Pb ¹⁾ , TSP ¹⁾ , PM ₁₀ , PM _{2.5}	LA, TA
1.A.3.b.2	R.T., Light duty vehicles	NO _x , CO ¹⁾ , Pb ¹⁾	LA, TA
1.A.3.b.3	R.T., Heavy duty vehicles	NO _x , TSP ¹⁾ , PM ₁₀ ¹⁾ , PM _{2.5}	LA, TA
1.A.3.b.4	R.T., Mopeds & Motorcycles	CO	LA, TA
1.A.3.b.5	R.T., Gasoline evaporation	NMVOC	TA
1.A.3.b.7	R.T., Automobile road abrasion	Cd, TSP, PM ₁₀ , PM _{2.5}	LA, TA
1.A.3.c	Railways	TSP	LA

LA = Level Assessment (if not further specified – for the years 1990 and 2015)

TA = Trend Assessment 2015

Note: ¹⁾only TA, ²⁾only LA

3.2.3 Uncertainty Assessment

The following chapter provides a quantitative estimate of uncertainties with respect to NO_x, NH₃, NMVOC, SO₂ and PM_{2.5} emissions from Mobile Fuel Combustion Activities. In general the method applied for the assessment of uncertainty is according to the EMEP/EEA air pollutant emission inventory guidebook 2016 (EEA 2016), using an average of the default values, based on the definitions of the qualitative ratings (see Chapter 1.7 and Table 25). For estimating the uncertainty of the emission factors of NMVOC, PM_{2.5} and NH₃ for sector 1.A.3.b. Road Transport, experts from TU Graz have been consulted. For NMVOC, cold start and aged gasoline vehicles are very uncertain (rating level C - 125%); for PM_{2.5} lies the uncertainty before all in the non-exhaust emissions (rating level C – 125%); for NH₃ the rating level 3 (200%) has been suggested.

Table 138: Uncertainties for activity data, emission factors and combined uncertainties

Sector	Pollutant	Uncertainty Activity Data [%]	Uncertainty Emission Factor [%]	Combined uncertainties [%]
1.A.3.a Civil Aviation - LTO	SO ₂	3.0	20.0	20.22
	NO _x	3.0	40.0	40.11
	NMVOC	3.0	40.0	40.11
	NH ₃	3.0	125.0	125.04
	PM _{2.5}	3.0	40.0	40.11
1.A.3.b Road Transportation	SO ₂	3.0	20.0	20.22
	NO _x	3.0	40.0	40.11
	NMVOC	3.0	125.0	125.04
	NH ₃	3.0	200.0	200.02
	PM _{2.5}	3.0	125.0	125.04

Sector	Pollutant	Uncertainty Activity Data [%]	Uncertainty Emission Factor [%]	Combined uncertainties [%]
1.A.3.c Railways	SO ₂	3.0	20.0	20.22
	NO _x	3.0	40.0	40.11
	NMVOC	3.0	40.0	40.11
	NH ₃	3.0	125.0	125.04
	PM _{2.5}	3.0	40.0	40.11
1.A.3.d Navigation	SO ₂	3.0	20.0	20.22
	NO _x	3.0	40.0	40.11
	NMVOC	3.0	40.0	40.11
	NH ₃	3.0	125.0	125.04
	PM _{2.5}	3.0	40.0	40.11
1.A.3.e Other transportation	NO _x	2.0	10.0	10.20
	NMVOC	2.0	200.0	200.01
	NH ₃	2.0	750.0	750.00
	PM _{2.5}	2.0	125.0	125.02

3.2.4 NFR 1.A.3.a Civil Aviation - LTO

The category *1.A.3.a Civil Aviation-LTO* contains flights according to Visual Flight Rules (VFR) and Instrument Flight Rules (IFR) for domestic aviation (national LTO – landing/take off) and for international aviation (international LTO – landing/take off). Domestic cruise and international cruise is considered under *Memo Item 1.A.3.a Civil Aviation - Cruise*. Military Aviation is allocated in *1.A.5 Other*.

Methodological Issues

IFR – Instrument Flight Rules

For the years 1990–1999 a country-specific methodology was applied. The calculations are based on a study commissioned by the Umweltbundesamt finished in 2002 (KALIVODA/KUDRNA 2002). This methodology is consistent with the very detailed IPCC 2006 GL Tier 3B methodology (advanced version based on the MEET model (KALIVODA/KUDRNA 1997): air traffic movement data⁸⁸ (flight distance and destination per aircraft type) and aircraft/engine performances data were used for the calculation.

For the years from 2000 onwards the IPCC 2006 GL Tier 3A methodology has been applied. Tier 3A takes into account average fuel consumption and emission data for LTO phases and various flight lengths, for an array of representative aircraft categories.

VFR – Visual Flight Rules

The EMEP/EEA simple methodology (Tier 1 fuel-based methodology) was applied.

⁸⁸ This data is also used for the split between domestic and international aviation.

Activity Data

Fuel consumption (kerosene and gasoline) for 1.A.3.a Civil Aviation – LTO is presented below.

Table 139: Activities for 1.A.3.a.ii Civil Aviation – LTO: 1990–2015.

Year	Activity		
	dom. LTO	dom. LTO	int. LTO
	Kerosene [TJ]	Gasoline [TJ]	Kerosene [TJ]
1990	137	103	1 242
1991	148	106	1 418
1992	159	109	1 594
1993	170	113	1 770
1994	181	116	1 946
1995	192	93	2 122
1996	222	89	2 267
1997	253	100	2 413
1998	283	108	2 558
1999	290	115	2 615
2000	265	84	2 891
2001	217	77	2 745
2002	226	99	3 209
2003	221	107	3 344
2004	237	99	3 989
2005	226	115	3 716
2006	269	119	3 681
2007	275	118	3 981
2008	305	121	4 046
2009	280	135	3 701
2010	267	121	3 795
2011	231	182	4 316
2012	233	106	4 149
2013	232	95	4 035
2014	211	99	4 080
2015	205	111	4 309
Trend 1990–2015	50%	7%	247%

IFR flights

For the years 1990–1999 fuel consumptions for the different transport modes IFR national LTO, IFR international LTO, IFR national cruise and IFR international cruise as obtained from the MEET model (KALIVODA/KUDRNA 1997) were summed up to a total fuel consumption figure. This value was compared with the total amount of kerosene sold in Austria of the national energy balance. As „fuel sold” is a robust value, the fuel consumption of IFR international cruise was adjusted so that the total fuel consumption of the calculations according to the MEET model is consistent with national fuel sales figures from the energy balance. The reason for choosing IFR international cruise for this adjustment is that this mode is assumed to have the highest uncertainty.

For the years from 2000 onwards fuel consumption for the different transport modes IFR national LTO, IFR international LTO, IFR national cruise and IFR international cruise was calculated according to the IPCC 2006 GL Tier 3A method, with average consumption data per aircraft types and flight distances. The fuel consumption of IFR international cruise was adjusted as explained above.

The number of flight movements per aircraft type and airport (national and international) was obtained from special analyses by Statistik Austria (STATISTIK AUSTRIA 2008a⁸⁹, 2009a, 2010a, 2011a, 2012a, 2013a, 2014a, 2015a, 2016a) and by Austro Control (AUSTRO CONTROL 2007⁹⁰, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016). Moreover, for the calculation of passenger kilometres and ton kilometres input data was taken from the Austrian transport statistics (STATISTIK AUSTRIA 2016d). The total amount of jet kerosene and gasoline was taken from the energy balance.

VFR flights

Fuel consumption for VFR flights were directly obtained from the energy balance, as total fuel consumption for this flight mode is represented by the total amount of aviation gasoline sold in Austria.

The following table shows activity data and the numbers of national LTOs (IFR) which were obtained from the MEET Model (KALIVODA/KUDRNA 1997) for the years 1990–1999. Numbers of flight movements from 2000 onwards are taken from Statistik Austria.

Table 140: Fuel consumption for VFR and IFR flights and number of IFR LTO cycles, 1990–2015.

Year	Activity			
	VFR Gasoline [kt]	nat. LTO Kerosene [kt]	int. LTO Kerosene [kt]	nat. LTO IFR [no.]
1990	2.49	3.16	28.65	6 220
1991	2.56	3.42	32.71	6 644
1992	2.64	3.67	36.77	7 450
1993	2.72	3.92	40.83	7 947
1994	2.81	4.18	44.90	8 219
1995	2.24	4.43	48.96	8 923
1996	2.15	5.13	52.31	10 233
1997	2.42	5.83	55.67	11 013
1998	2.60	6.53	59.03	12 025
1999	2.77	6.70	60.34	12 210
2000	2.04	6.11	66.71	22 611
2001	1.87	5.01	63.33	20 325
2002	2.39	5.21	74.04	21 422
2003	2.60	5.10	77.15	20 243
2004	2.41	5.47	92.03	20 175
2005	2.79	5.20	85.74	20 179
2006	2.87	6.20	84.94	20 727
2007	2.86	6.33	91.85	20 740

⁸⁹ for the years 2000–2007

⁹⁰ for the years 2000–2006

Year	Activity			
	VFR Gasoline [kt]	nat. LTO Kerosene [kt]	int. LTO Kerosene [kt]	nat. LTO IFR [no.]
2008	2.94	7.04	93.35	21 457
2009	3.27	6.46	85.41	20 530
2010	2.92	6.16	87.57	20 532
2011	4.40	5.32	99.58	16 185
2012	2.57	5.37	95.73	16 405
2013	2.29	5.35	93.14	15 741
2014	2.38	4.87	94.11	14 776
2015	2.65	4.73	99.39	13 282
1990–2015	7%	50%	247%	114%

Emission Factors

NO_x, CO

IFR

For the years 1990–1999 emission estimates for fuel consumption, NO_x and CO were taken from an aviation study commissioned by the Umweltbundesamt (KALIVODA/KUDRNA 2002) and the emission factors are aircraft/ engine specific.

For the years from 2000 onwards the CORINAIR Tier 3A was applied. Tier 3a takes into account average fuel consumption and emission data for LTO phases and various flight lengths, for an array of representative aircraft categories.

VFR

For the years 1990–1999 emission estimates for fuel consumption, NO_x and CO were taken from an aviation study commissioned by the Umweltbundesamt (KALIVODA/KUDRNA 2002).

For the years from 2000 onwards emissions of VFR flights have been calculated with IEF's from the year 2000 by the study mentioned above (KALIVODA/KUDRNA 2002).

NMVOC

IFR

For the years 1990–1999 NMVOC emissions for IFR flights have been calculated like NO_x (VOC emissions calculated with a country specific method, (KALIVODA/KUDRNA 2002). According to the EMEP/CORINAIR Emission Inventory Guidebook (Version 2007) 90.4% of VOC of the LTO-IFR are assumed to be NMVOC. According to the Guidebook no CH₄ emissions during the cruise phase is emitted. That means total VOC emissions equals NMVOC emissions.

For the years from 2000 onwards NMVOC emissions for IFR flights have been calculated in this way:

Total VOC emissions have been calculated with the implied emission factor for the year 1999 as obtained in the study (KALIVODA/KUDRNA 2002). According to the EMEP/CORINAIR Guidebook 90.4% of VOC of the LTO-IFR are assumed to be NMVOC.

VFR

For the years 1990–1999 emission estimates were taken from an aviation study commissioned by the Umweltbundesamt (KALIVODA/KUDRNA 2002).

For the years from 2000 onwards NMVOC emissions of VFR flights have been calculated with an IEF from the year 2000 by the study mentioned above (KALIVODA/KUDRNA 2002).

NH₃**IFR**

For the years 1990–1999 NH₃ emissions for IFR flights have been calculated like NO_x (KALIVODA/KUDRNA 2002).

For the years from 2000 onwards NH₃ emissions for IFR flights have been calculated with an IEF from the year 2000 by the study mentioned above (KALIVODA/KUDRNA 2002).

VFR

For the years 1990–1999 emission estimates were taken from an aviation study commissioned by the Umweltbundesamt (KALIVODA/KUDRNA 2002).

For the years from 2000 onwards NH₃ emissions of VFR flights have been calculated with an IEF from the year 2000 by the study mentioned above (KALIVODA/KUDRNA 2002).

In the following tables the activities and IEFs for 1.A.3.a. *Civil Aviation* (domestic LTO + international LTO) are presented. Activity data of domestic and international LTO increased over the period from 1990–2015 by about 212%.

Table 141: Activities and Implied emission factors for NEC gases and CO for 1.A.3.a.ii Civil Aviation (domestic LTO + international LTO): 1990–2015.

Year	Activity [TJ]	IEF SO ₂	IEF NO _x	IEF NMVOC [t/PJ]	IEF NH ₃	IEF CO
1990	1 482	22.2	275.4	137.7	0.20	1 667.7
1991	1 672	22.3	276.7	128.4	0.19	1 528.1
1992	1 862	22.3	277.8	121.0	0.19	1 418.2
1993	2 052	22.4	278.6	114.9	0.19	1 329.5
1994	2 243	22.4	279.3	110.0	0.19	1 256.6
1995	2 406	22.6	282.2	101.9	0.18	993.7
1996	2 579	22.6	282.4	110.6	0.18	933.5
1997	2 765	22.6	281.6	120.1	0.18	977.8
1998	2 949	22.6	281.0	128.0	0.18	995.9
1999	3 020	22.6	284.2	124.9	0.18	1 021.2
2000	3 240	22.7	266.2	116.3	0.17	824.5
2001	3 039	22.7	265.3	115.4	0.17	831.3
2002	3 534	22.7	284.4	115.8	0.17	855.0
2003	3 672	22.7	286.1	116.0	0.17	877.6
2004	4 325	22.8	291.0	113.4	0.17	764.2
2005	4 057	22.7	269.5	115.4	0.17	841.1
2006	4 069	22.7	263.1	116.4	0.17	905.5

Year	Activity	IEF SO ₂	IEF NO _x	IEF NMVOC	IEF NH ₃	IEF CO
2007	4 373	22.7	267.1	115.4	0.17	877.1
2008	4 472	22.7	266.4	115.8	0.17	885.0
2009	4 117	22.7	269.4	117.8	0.18	991.7
2010	4 183	22.7	272.2	116.1	0.17	918.6
2011	4 728	22.6	271.4	118.5	0.18	1 117.1
2012	4 487	22.8	275.2	113.4	0.17	845.4
2013	4 362	22.8	283.9	112.9	0.17	828.1
2014	4 390	22.8	290.1	112.7	0.17	838.7
2015	4 624	22.8	295.4	112.9	0.17	873.1

Emission factors for heavy metals and PM are presented in chapter 3.2.8.

Category-specific Quality Assurance and Quality Control (QA/QC)

The following QAQC activities on time series consistency, completeness and comparison with international dataset were done for CO₂ and in response to the UNFCCC review. However, these activities also have effect on the quality of the air pollutants and are therefore described in the following.

Time series consistency (Example for CO₂)

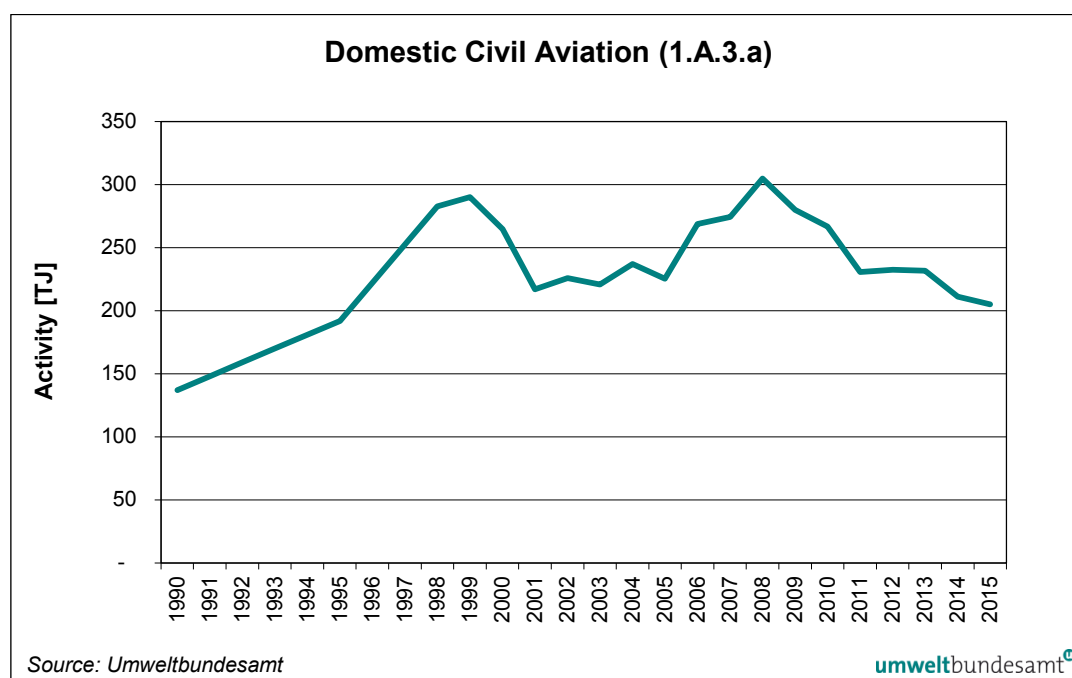


Figure 38: Activity data from 1.A.3.a domestic Civil Aviation 1990–2015.

From 1999 onwards a different methodology of emissions estimation has been applied. For the years 1990–1999 a country-specific methodology (consistent with the IPCC 2006 GL Tier 3B methodology), for the years from 2000 onwards the Tier 3A methodology was applied.

To show that there is no underestimation of domestic aviation emissions, domestic fuel consumption is multiplied with the default CO₂ emission factor of 3 150 kg CO₂/Mg fuel (CORINAIR, KALIVODA/KUDRNA. 2002). Total reported CO₂ emissions for domestic aviation in the year 2000 are consistent with the IPCC 2006 GL Tier 3A methodology (new method), whereas the Tier 3B methodology (old method) deviates by 22%.

Table 142: Methodology dependent calculation of CO₂ emissions from 1.A.3.a Civil Aviation in 2000.

	dom LTO	dom. LTO	dom. cruise	dom.	deviation
	gasoline	kerosene		total	
2000	CO ₂ [kt]				%
OLI2016 (1990–2015)	6.4	19.3	41.6	67.24	
CORINAIR CO ₂ default EF Tier 3B methodology	6.4	21.6	54.1	82.11	22.1
CORINAIR CO ₂ default EF Tier 3A methodology	6.4	19.2	41.5	67.18	-0.1

Since there is no systematic deviation between the two models' results, Austria has decided not to replace the more accurate data applied for the period 1990–1999 (FCCC/ARR/2011/AUT\$46).

The peak of activity data and GHG emissions in 1999, followed by a decrease within two years by nearly 30% is an artefact due to the shortcomings of the method used from 1999 onwards. The old methodology reflects much better real-world effects, because this methodology is consistent with the very detailed IPCC 2006 GL Tier 3B methodology (advanced version based on MEET (KALIVODA/KUDRNA 1997): air traffic movement data (flight distance and destination per aircraft type) and aircraft/engine performances data were used for the calculation. Due to budgetary constraints such a detailed study has not been repeated since then.

Harmonization inventory and IEA data

In 2013 the ERT detected inconsistencies of fuel consumption data of domestic aviation and domestic navigation between the CRF tables and the IEA data (ICR 2013). In response to that it was explained that Austria uses a bottom-up approach to estimate fuel consumption whilst IEA relies on top-down approach based on fuel consumption statistics reported by Statistics Austria

After having discussed this issue with Statistics Austria an Explanatory Note (30/09/2013) has been compiled by Statistics Austria declaring that a regular adoption of inventory data for the split between national and international fuel consumption in civil aviation and navigation in the national statistics will be adopted in the future, as far as the data can be submitted in time (early November).

As part of the regular QA/QC, the energy split between national and international aviation is provided to Statistics Austria for the IEA statistics based on the bottom-up model used to calculate the annual emission inventory.

Completeness

In response to a question raised by the ERT (ICR 2013) it was explained that emissions of ground activities at domestic airports are also included, even if they are not separately reported under 1.A.3.a Aviation. This can be assured as Austria reports emissions from **total fuel sold** from the energy balance.

The approach in the Austrian inventory is as follows: After calculating fuel consumption for inland road transport and off-road transport using a bottom-up approach (NEMO, GEORG), the sum of this fuel used is compared with the total fuel sold from the national energy balance (for details see 1.A.3.b Road Transport). The difference is then allocated to fuel export, which includes fuel consumption for ground activities at airports and harbors as well, including fuel consumption by unregistered vehicles. As the fuel consumption reported under fuel export is included in the national totals⁹¹, an underestimation of emissions can be excluded.

Comparison IEA (military jet kerosene data)

In 2014, the ERT noted a significant difference in jet kerosene consumption (civil aviation) between IEA data and CRF Table 1.C. In response to the draft ARR 2014, Austria explained that the IEA value also includes military jet kerosene data and that this is the reason for the difference.

Category-specific Recalculations

No recalculations have been made in this year's submission.

Category-specific Planned Improvements

Regarding activities it is planned to rely on Austro Control, Austria's national flight authority, as the future data supplier for flight movements. The current data supplier, Statistik Austria, uses a different definition of flights, therefore reporting a set of domestic flights which are slightly deviating from those reported by Eurocontrol. After this discrepancy has been examined thoroughly, the exchange of the data supplier will be necessary. This improvement is planned to be implemented during the preparation for the submission in 2018. During this process also an update of aircraft types and emission factors following the latest EMEP/EEA Guidebook 2016 is planned.⁹²

3.2.5 NFR Memo Item 1.A.3.a Civil Aviation – Cruise

In 2015, the share of Civil Aviation – Cruise in the total fuel consumption in the aviation sector in Austria amounted to 85%. Emissions and activity data from aviation assigned include the transport modes domestic and international cruise traffic for IFR-flights.

Methodological Issues

Emissions from International Bunkers have been calculated using the methodology and emission factors as described in Chapter 1.A.3.a *Civil aviation*.

⁹¹ GHG emissions from fuel export are included in 1.A.3.b, and are presented separately in Table 66 (Chapter 3.2.12.2)

⁹² For calculating emissions from 1.A.3.a Civil aviation emission factors are currently taken from the EMEP/CORINAIR Emission Inventory Guidebook 2007 (EEA 2007).

Activity Data

Activity data of domestic and international cruise increased over the period from 1990–2015 by about 128% which is shown in the following table.

Table 143: Activities for Civil Aviation – Cruise: 1990–2015.

Year	Kerosene	
	National cruise [TJ]	International cruise [TJ]
1990	195	10 948
1991	257	12 256
1992	319	13 230
1993	380	13 914
1994	442	14 367
1995	503	16 141
1996	558	17 908
1997	613	18 576
1998	667	19 155
1999	706	18 595
2000	571	20 415
2001	527	19 952
2002	526	17 970
2003	527	16 627
2004	543	19 721
2005	572	23 222
2006	594	24 481
2007	615	25 925
2008	541	25 946
2009	506	22 323
2010	480	24 376
2011	429	25 489
2012	409	24 340
2013	405	23 106
2014	371	23 098
2015	365	24 942
Trend 1990–2015	87%	128%

Emission Factors

In the following tables activities and IEF for *Civil Aviation – Cruise* are presented.

Table 144: Activities and Implied emission factors for NEC gases and CO for Civil Aviation - Cruise: 1990–2015.

Year	Activity	IEF SO ₂	IEF NO _x	IEF NMVOC	IEF NH ₃	IEF CO
	[TJ]			[t/PJ]		
1990	11 143	23.1	218.9	16.2	0.16	43.7
1991	12 513	23.1	220.2	16.3	0.16	43.7
1992	13 548	23.1	221.3	16.5	0.16	43.9
1993	14 294	23.1	222.4	16.7	0.16	44.3
1994	14 808	23.1	223.5	16.9	0.16	44.7
1995	16 644	23.1	224.4	17.2	0.16	45.0
1996	18 466	23.1	224.0	18.3	0.16	45.7
1997	19 189	23.1	223.8	19.2	0.16	46.2
1998	19 822	23.1	223.7	20.0	0.16	46.8
1999	19 301	23.1	224.1	20.0	0.16	45.9
2000	20 986	23.1	307.1	19.8	0.16	38.0
2001	20 480	23.1	308.7	19.8	0.16	37.9
2002	18 496	23.1	306.6	19.8	0.16	35.9
2003	17 154	23.1	303.7	19.9	0.16	37.6
2004	20 264	23.1	300.6	19.8	0.16	36.1
2005	23 794	23.1	293.7	19.8	0.16	38.4
2006	25 074	23.1	300.6	19.8	0.16	36.6
2007	26 540	23.1	301.2	19.8	0.16	36.1
2008	26 486	23.1	298.2	19.8	0.16	36.1
2009	22 830	23.1	300.7	19.8	0.16	35.9
2010	24 856	23.1	305.6	19.8	0.16	35.2
2011	25 918	23.1	307.8	19.7	0.16	33.3
2012	24 749	23.1	310.3	19.7	0.16	33.4
2013	23 512	23.1	317.4	19.7	0.16	31.5
2014	23 469	23.1	319.1	19.7	0.16	31.4
2015	25 307	23.1	323.3	19.7	0.16	30.8

Emission factors for heavy metals and PM are presented in chapter 3.2.8.

Category-specific Recalculations

No recalculations have been made in this year's submission.

Category-specific Planned Improvements

See planned improvements under Chapter 3.2.4 NFR 1.A.3.a Civil Aviation – LTO.

3.2.5.1 NFR Memo Item 1.A.3.d International maritime Navigation

Austria does not have any activities under *Memo 1 a 3 d International maritime navigation*. Activities under International inland waterways are included in the national total according to the reporting under CLRTAP.

3.2.6 NFR 1.A.3.b Road Transport

Emissions from road transportation are covered in this category. It includes emissions from passenger cars, light duty vehicles, heavy duty vehicles and busses, mopeds and motorcycles, gasoline evaporation from vehicles as well as vehicle tyre, brake and road surface wear.

Road Transport is the main emission source for NO_x, SO₂, NMVOC and NH₃ emissions of the transport sector. Up to 2005 especially classic air pollutants from road transport – NO_x and PM emissions – have increased mainly because of:

- steady increase of transport activity
- altered spatial structures: urban sprawl and centralization
- changing demand structures in the industry: growing division of labour and flexible production methods (just-in-time production) cause the inventory being replaced by means of transport
- disproportionately existing infrastructure for motorized individual transport and further development
- changed lifestyle and mobility needs of the population
- fuel exports by – especially in comparison with Germany and Italy – cheap fuel prices in Austria

Technical improvements and a stricter legislation, however, led to a reduction of emissions per vehicle or per mileage respectively of mostly all other air pollutants.

Methodological Issues

Mobile road combustion is differentiated into the categories *Passenger Cars*, *Light Duty Vehicles*, *Heavy Duty Vehicles* and *Buses, Mopeds and Motorcycles*. In order to apply the EMEP/EEA methodology a split of the fuel consumption of different vehicle categories is needed.

Bottom up Methodology – fuel consumed

Energy consumption and emissions of the different vehicle categories are calculated by multiplying the yearly road performance per vehicle category (km/vehicle and year) by the specific energy use (g/km) and by the emission factors in g/km (Model: NEMO).

NEMO also models the road performance and emissions per vehicle size, age and motor type based on dynamic vehicle specific drop out- and road performance functions.

To determine fuel consumption and emissions of domestic road transport, vehicle stock and total annual road performance (mileage driven per year) of the vehicle categories should be recorded as precisely as possible. The current traffic volumes up to and including 2007 are taken from Austrian National Transport Model “VMOe 2025+” Verkehrs-Mengenmodell-Österreich (Federal Transport Model, Ministry of Transport, BMVIT, not published). Mileage data after 2007 is calculated from the growth rates according to the final results of the automatic traffic counting stations and the toll data (ASFINAG 2016).

Top down Methodology – Fuel sold

Based on the NEMO model fuel consumption and emissions for road transport are calculated with a bottom-up approach. Calculated fuel consumption of road transport is then summed up with calculated fuel consumption of off road traffic and is compared with national total fuel sold.

The difference between the fuel consumption calculated in the bottom-up methodology for road traffic plus off-road transport within Austria and total fuel sales in Austria (obtained from the yearly Austrian energy balance) is allocated to fuel export (fuel sold in Austria but consumed abroad).

The emissions reported for Austria also include the emissions from the fuel exports.

Fuel export⁹³

Since the end of the nineties an increasing discrepancy between the total Austrian fuel sales and the computed domestic fuel consumption became apparent. From 2003 onward this gap accounts for roughly 30% of the total fuel sales. A possible explanation of this discrepancy is the „fuel export in the vehicle tank” – due to the relatively low fuel prices in Austria (in comparison to the neighbouring countries). Meaning that to a greater extent fuel is filled up in Austria and consumed abroad. This assumption is underpinned by two national studies (MOLITOR et al. 2004; MOLITOR et al. 2009).

It is assumed that the fuel export fleet (mainly travelling on highways) is similar to the Austrian fleet on highways, which means that no different efficiency rates are assumed for the fuel export fleet.

NEMO - Network Emission Model

Emissions from *Mobile Combustion* have so far been calculated with the model GLOBEMI (HAUSBERGER 1997; HAUSBERGER/SCHWINGSHACKL/REXEIS 2014). The calculations have been based on a detailed depiction of fleet composition, driving behaviour, related energy consumption and emission factors.

From submission 2015 (1990-2013) onwards calculations are based on the model NEMO – Network Emission Model (DIPPOLD/REXEIS/HAUSBERGER 2012; HAUSBERGER/ SCHWINGSHACKL/REXEIS 2015a, 2015b). NEMO is set up on the same methodology as the former model GLOBEMI and combines a detailed calculation of the fleet composition with the simulation of energy consumption and emission output on vehicle level. It is fully capable to depict the upcoming variety of possible combinations of propulsion systems (internal combustion engine, hybrid, plug-in-hybrid, electric propulsion, fuel cell ...) and alternative fuels (CNG, biogas, FAME, Ethanol, GTL, BTL, H₂ ...).

In addition, NEMO has been designed to be also suitable for all main application fields of simulation of energy consumption and emission output on a road-section based model approach. As there does not yet exist a complete road network for Austria on a highly resolved spatial level, the old methodology based on a categorisation of the traffic activity into “urban”, “rural” and “motorway” has been currently also applied in NEMO.

⁹³ Under the LRTAP Convention national emissions are reported based on fuel sold (including fuel export); under the NEC Directive national emissions are reported based on fuel used (excluding fuel export).

The model calculates vehicle mileages, passenger-km, ton-km, fuel consumption, all exhaust gas emissions, evaporative emissions and suspended TSP, PM₁₀, PM_{2.5}, PM₁ and PM_{0.1} exhaust and non-exhaust emissions of road traffic. The balances use the vehicle stock and functions of the km driven per vehicle and year to assess the total traffic volume of each vehicle category.

Model input is:

- 1) Vehicle stock of each category split into layers according to the propulsion system (SI, CI,...), cylinder capacity classes or vehicle mass;
- 2) Emission factors of the vehicles according to the year of first registration and the layers from 1);
- 3) Number of passengers per vehicle and tons payload per vehicle;
- 4) Optional either/or
 - total gasoline and diesel consumption of the area under consideration,
 - average km per vehicle and year.

Following data is calculated:

- a) Km driven per vehicle and year or total fuel consumption,
- b) Total vehicle mileages,
- c) Total passenger-km and ton-km,
- d) Specific emission values for the vehicle fleets [g/km], [g/t-km], [g/pass-km],
- e) Total emissions (CO, HC, NO_x, particulate matter, CO₂, SO₂ and several unregulated pollutants among them CH₄ and N₂O) and energy consumption (FC) of road traffic.

Figure 39 shows a schematic picture of the methodology of NEMO.

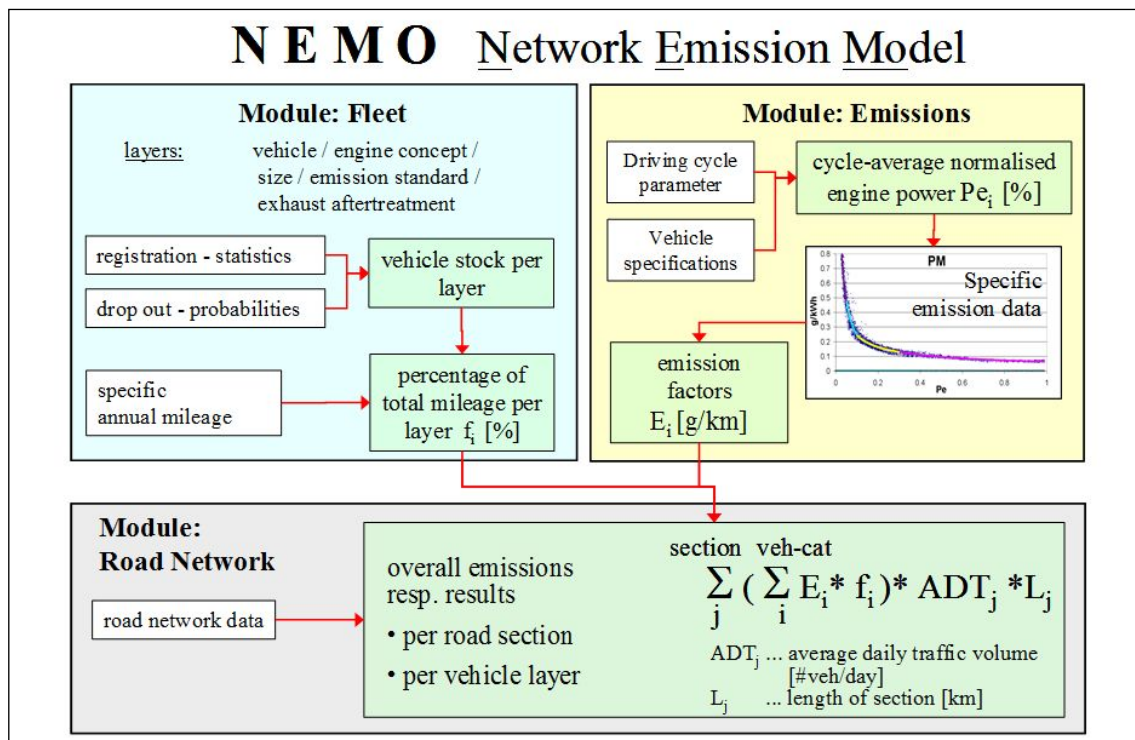


Figure 39: Schematic picture of the NEMO model.

The calculation is done according to the following method for each year:

- 1) Assessment of the vehicle stock split into layers according to the propulsion system (SI, CI,...), cylinder capacity classes (or vehicle mass for HDV) and year of first registration using the vehicle survival probabilities and the vehicle stock of the year before.

$$stock_{Jg_i, year\ i} = stock_{Jg_i, year\ i-1} \times \text{survival probability}_{Jg_i}$$

- 2) Assessment of the km per vehicle for each vehicle layer using age and size dependent functions of the average mileage driven. If option switched on, iterative adaptation of the km per vehicle to meet the total fuel consumption targets.
- 3) Calculation of the total mileage of each emission category (e.g. passenger car diesel, EURO 3)

$$\text{total mileage}_{E_i} = \sum_{Jg=\text{start}}^{\text{end}} (stock_{Jg, year\ i} \times \text{km/vehicle}_{Jg_i, year\ i})$$

- 4) Calculation of the total fuel consumption and emissions of each emission category

$$\text{Emission}_{E_i} = \text{total mileage}_{E_i} \times \text{emission factor}_{K_j, E_i}$$

- 5) Calculation of the total fuel consumption and emissions of each vehicle category

$$\text{Emission}_{\text{veh.category}} = \sum_{E_i=1}^{\text{end}} \text{Emission}_{E_i}$$

- 6) Calculation of the total passenger-km and ton-km

$$\text{transport volumes}_{\text{veh.category}} = \sum_{E_i=1}^{\text{end}} (\text{vehicle mileage}_{E_i} \times \text{loading}_{E_i})$$

- 7) Summation over all vehicle categories

with Jg_i ... Index for a vehicle layer (defined size class, propulsion type, year of first registration)

E_i Index for vehicles within a emission category (defined size class, propulsion type and exhaust certification level)

Activity Data

From 2014 to 2015 fuel consumption in TJ (gasoline, diesel and alternative fuels including liquid biomass) by road transport increased by 2.1%. Specific consumption per average vehicle kilometer per vehicle category did not decline considerably for diesel passenger cars between 2014 and 2015; it declined by 0.8% for gasoline passenger cars, by 0.2% for light duty vehicles and by 0.2% for heavy duty vehicles.

The following table gives an overview of the amount of fuel sold in Austria (including fuel export) differentiated by fuel type.

Table 145: Activities from 1.A.3.b Road Transport differentiated by fuel type: 1990–2015.

Year	Fuel consumption (based on fuel sold) [TJ]					
	Total	Gasoline	Diesel oil	LPG	Gaseous	Biomass
1990	176 826	103 899	72 514	413	-	-
1991	196 386	113 961	81 998	428	-	-
1992	196 215	108 960	86 811	444	-	-
1993	198 244	104 520	93 273	451	-	-
1994	199 009	100 775	97 772	462	-	-

Fuel consumption (based on fuel sold) [TJ]						
Year	Total	Gasoline	Diesel oil	LPG	Gaseous	Biomass
1995	202 791	97 340	104 957	494	-	-
1996	224 096	90 040	133 386	670	-	-
1997	210 964	85 343	125 092	530	-	-
1998	237 524	89 286	147 648	590	-	-
1999	229 403	82 983	145 799	622	-	-
2000	241 748	80 175	160 901	672	-	-
2001	259 856	80 755	178 379	722	-	-
2002	288 170	86 947	200 239	984	-	-
2003	311 792	88 916	221 744	1 132	-	-
2004	318 770	86 497	231 311	947	14	-
2005	325 935	84 059	238 304	977	16	2 579
2006	314 198	80 671	222 731	1 005	15	9 776
2007	317 803	78 772	227 071	968	76	10 916
2008	301 826	70 771	216 507	1 002	138	13 408
2009	297 235	70 553	208 000	945	331	17 407
2010	309 010	69 420	219 695	889	454	18 552
2011	298 771	66 868	212 371	854	486	18 192
2012	298 175	65 089	212 713	900	534	18 940
2013	311 498	63 803	227 571	904	650	18 570
2014	305 104	62 558	221 491	789	702	19 565
2015	311 426	63 136	225 382	618	725	21 566
Trend 1990–2015	76%	-39%	211%	50%	4 938%⁹⁴	736%⁹⁵

In the following table NO_x emissions are disaggregated by means of road transportation. Inland emissions and those from fuel export are shown separately in the two relevant vehicle categories passenger cars and heavy duty vehicles and must be summed up to get the total emissions for each vehicle category. The phenomenon of fuel export is explained in the subchapter Methodological Issues.

Table 146: NO_x emissions from 1.A.3.b Road Transport differentiated by means of transportation 1990–2015.

Year	Passenger cars		light duty vehicles	heavy duty vehicles		mopeds & motorcycles
	inland	fuel export	inland	inland	fuel export	inland
NO _x [kt]						
1990	61.32	3.06	7.01	35.91	14.71	0.14
1991	57.75	8.13	7.02	38.87	17.02	0.15
1992	54.52	4.15	7.03	39.21	18.18	0.16

⁹⁴ Trend 2004-onwards

⁹⁵ Trend 2005-onwards

Year	Passenger cars		light duty vehicles	heavy duty vehicles		mopeds & motorcycles
	inland	fuel export	inland	inland	fuel export	inland
NO _x [kt]						
1993	51.33	1.98	6.96	38.64	20.57	0.17
1994	49.99	-0.17	7.09	38.45	19.38	0.19
1995	47.69	-0.57	7.08	38.51	20.59	0.21
1996	46.58	-2.93	7.10	38.60	41.54	0.23
1997	45.62	-3.81	7.21	38.86	28.56	0.25
1998	44.75	-0.86	7.35	39.26	40.09	0.27
1999	44.01	-3.04	7.49	39.50	34.14	0.30
2000	43.17	-2.79	7.60	40.38	40.40	0.32
2001	42.69	-0.51	7.61	39.94	46.02	0.33
2002	42.69	4.73	7.50	39.53	48.92	0.35
2003	42.62	8.43	7.46	39.71	51.67	0.37
2004	41.98	9.66	7.44	39.38	49.36	0.38
2005	40.89	10.01	7.58	38.92	49.11	0.39
2006	38.89	9.51	7.80	38.72	36.60	0.40
2007	37.35	9.24	7.85	36.84	32.00	0.41
2008	35.76	6.28	7.50	33.05	25.63	0.42
2009	33.31	6.02	7.17	28.53	23.97	0.43
2010	32.10	4.51	7.02	27.15	27.14	0.44
2011	31.77	2.97	6.90	25.87	22.25	0.46
2012	31.00	2.72	6.75	23.78	20.60	0.47
2013	30.94	1.94	6.60	22.15	23.93	0.48
2014	31.12	1.23	6.56	20.45	19.20	0.49
2015	30.82	1.00	6.52	17.94	16.39	0.50
Trend 1990–2015	-50%	-67%	-7%	-50%	11%	247%

In 2015, the total share of fuel export in 1.A.3.b amounted to 24% or 17.4 kt NO_x of which 6% are attributed to passenger road transport and 94% to road freight transport.

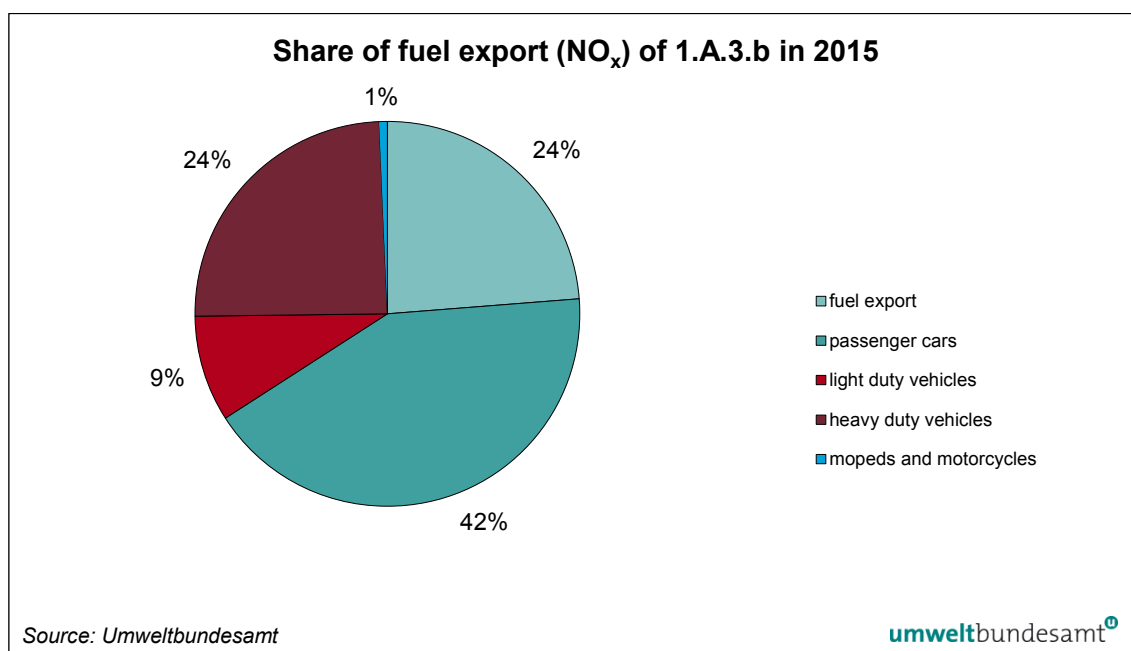


Figure 40: Share of fuel export (NO_x) in 1.A.3.b Road Transport in 2015.

The general equal distribution of pure biofuels to relevant vehicle categories was changed in the calculations of the 2016 submission. The allocation has been done based on expert judgement and was implemented in the model NEMO according to the road performance of each vehicle category:

- biodiesel B100 is assigned to HDV to 100%
- vegetable oil is assigned to HDV to 100%⁹⁶
- bioethanol (E85) is assigned to PC to 100%

The allocation of alternative fuels like liquefied petroleum gas (LPG) and compressed natural gas (CNG) is assumed in the model as follows:

- LPG is assigned to PC, HDV and LDV (only otto-motorised) according to their road performance.
- Natural gas (CNG) is distributed to passenger cars, HDV and LDV (only otto-motorised) according to their road performance.

Biofuels

Since 2005 biogenic fuel (biodiesel, bioethanol, plant oil) has been used in the Austrian road transport sector. Biodiesel and bioethanol are mainly used for blending fossil fuels, whereas plant oil is distributed in pure form. In 2015 the energetic substitution by biofuels amounted to 8.9% in the road transport sector (BMLFUW 2016a).⁹⁷ 2005, the first year of blending biofuels, the substitution amounted to only 0.8% (UMWELTBUNDESAMT 2006b, BMLFUW 2016a).

⁹⁶ An allocation to agriculture is not possible at the moment, because of the technical model framework.

⁹⁷ The required substitution target amounts to 5.75%, measured by energy content.

For the year 2015 a consumption of 528 944 tons of HVO⁹⁸ & biodiesel (for blending with diesel) and 89 557 tons of bioethanol (for blending with gasoline) are used as input data in the calculation models based on.⁹⁹ Following amounts are used in pure form: 15 262 tons of plant oil; 158 207 tons of biodiesel; 60 t of pure bioethanol in E85 (BMLFUW 2016a).

Table 147: Use of biofuels in absolute figures 2005–2015.

Year	pure	blended		biofuels total [t]
	biofuel pure [t]	biodiesel [t]	bioethanol [t]	
2005	17 000	75 000	0	92 000
2006	52 500	288 000	0	340 500
2007	89 209	298 828	20 391	408 428
2008	121 276	304 291	84 910	510 477
2009	133 690	405 909	99 424	639 023
2010	92 377	427 000	105 883	625 260
2011	101 824	422 072	102 755	626 650
2012	74 983	440 938	105 378	621 299
2013	80 536	443 389	88 842	612 767
2014	159 153	474 692	87 688	721 533
2015	173 529	528 944	89 557	792 030
2005–2015	921%	605%	339% ¹⁰⁰	761%

Emission Factors

Emission factors used for NEMO are based on a representative number of vehicles and engines measured in real-world driving situations taken from the „Handbook of Emission Factors” - HBEFA (HAUSBERGER & KELLER et al. 1998) and on ARTEMIS measurements (basically for passenger cars, light duty vehicles and motorcycles) which are taken into account in HBEFA. The latest HBEFA Version V3.2 has been applied.

Moreover, specific CO₂ emission factors of new passenger cars and light duty vehicles according to the national CO₂ monitoring data for the Austrian fleet, have been implemented (BMLFUW 2016b; BMLFUW 2016c).

Cold-start emissions

Cold-start emissions are calculated as an extra emission over the emissions that would be expected if all vehicles were only operated with hot engines and warmed-up catalysts. Cold-start emissions are only allocated for urban and rural driving, as the number of starts in highway conditions seems to be relatively limited. Cold-start emissions are calculated in NEMO for each vehicle category and each pollutant as follows:

$$\text{Additional impact per start [g / km]} = \frac{\text{cold-start surcharge [g / start]} \times \text{average trip length per cold start [km / start]}}{\text{average trip length per cold start [km / start]}}$$

⁹⁸ HVO...Hydrotreated Vegetable Oils

⁹⁹ Models: NEMO and GEORG (see 1.A.2.g.vii)

¹⁰⁰ Trend 2007-onwards

The cold start influence is in NEMO included in the calculation of fuel consumption and emissions of CO₂, NO_x, CO, hydrocarbons and PM. For N₂O and NH₃ no cold start emission factors were found in the literature.

The values used for cold-start surcharges come from:

- PC and LDV: cold-start model from HBEFA 3.2
- HDV: cold-start study commissioned by Umweltbundesamt (REXEIS et al. 2013)
- 2-wheelers: derived from cold-start emissions of PC gasoline

Relative factors used on top of commercial fuels incl. blending of biofuels (=reference fuels)

As a consequence of the provisional main findings in the CRR 2016 it shall be explained that all emission factors of alternative and pure biofuels used in NEMO are considered in the model by relative factors compared to commercial fuels. The following table provides the used relative factors compared to the reference fuels. The reference fuels are blended gasoline and blended diesel, because these fuels are commercially launched by fuelling stations on the market. The relative factors are multiplied with the EFs (in g/km) of every EURO-class and vehicle category per year. The relative factors are kept constant for the whole time series, but of course the final EFs change over time, because the basic EFs per EURO class improve as a consequence of the vehicles' advanced exhaust gas technologies. The relative factors are derived from literature research (EMEP Guidebook if available) or exhaust measurements.

Table 148: Relative factors used for bioethanol E85 and biogas.

Gasoline	blended gasoline	bioethanol E85	biogas
NO _x	1.00	1.51	1.00
HC	1.00	1.37	1.00
CO	1.00	0.88	1.00
PM exhaust	1.00	1.00	1.00
NO _{x_raw}	1.00	0.64	1.00
N ₂ O	1.00	0.64	1.00
NO ₂	1.00	1.51	1.00
NH ₃	1.00	1.00	1.00
CH ₄	1.00	1.94	1.00
Benzol	1.00	1.00	1.00

Table 149: Relative factors used for biodiesel, plant oil and diesel B20.

Diesel	blended diesel	biodiesel (RME)	plant oil	diesel B20
NO _x	1.00	1.20	1.20	1.04
HC	1.00	1.00	1.00	1.00
CO	1.00	0.74	0.74	0.95
PM exhaust	1.00	0.61	0.61	0.92
NO _{x_raw}	1.00	1.20	1.20	1.04
N ₂ O	1.00	1.20	1.20	1.04
NO ₂	1.00	1.00	1.00	1.00
NH ₃	1.00	1.00	1.00	1.00
CH ₄	1.00	1.15	1.15	1.03
Benzol	1.00	1.00	1.00	1.00

The following tables present the IEFs for *1.A.3.b Road Transport*. The IEFs change over time due to new technologies.

Table 150: Activities and Implied emission factors for NEC gases and CO for 1.A.3.b Road Transport: 1990–2015.

Year	Activity	IEF SO ₂	IEF NO _x	IEF NMVOC	IEF NH ₃	IEF CO
	[TJ]			[t/PJ]		
1990	176 826	27.5	690.8	416.2	6.4	2 836.7
1991	196 386	27.8	656.6	363.4	8.5	2 502.0
1992	196 215	29.2	628.2	311.5	10.1	2 153.2
1993	198 244	30.7	603.6	265.5	11.3	1 850.7
1994	199 009	31.5	577.5	231.6	12.2	1 631.8
1995	202 791	28.0	559.7	200.2	12.7	1 430.5
1996	224 096	12.5	585.1	159.1	11.5	1 143.9
1997	210 964	11.5	553.2	146.1	12.4	1 084.2
1998	237 524	11.0	551.0	124.1	12.3	950.9
1999	229 403	10.2	533.6	110.3	12.5	873.7
2000	241 748	9.6	534.0	95.0	11.9	775.1
2001	259 856	9.2	523.7	83.6	11.2	705.0
2002	288 170	7.9	498.7	74.7	10.6	657.9
2003	311 792	7.3	481.9	66.9	9.6	604.9
2004	318 770	0.6	464.9	61.2	8.8	556.6
2005	325 935	0.5	450.7	55.8	7.9	510.6
2006	314 198	0.4	419.9	48.8	7.6	462.1
2007	317 803	0.4	389.2	43.6	6.9	422.1
2008	301 826	0.4	360.0	39.6	6.3	388.8
2009	297 235	0.4	334.5	36.1	6.0	365.2
2010	309 010	0.4	318.4	32.1	5.5	333.1
2011	298 771	0.4	302.0	30.6	5.3	323.0
2012	298 175	0.4	286.1	28.5	5.0	305.7
2013	311 498	0.4	276.2	25.8	4.6	283.4
2014	305 104	0.4	259.1	24.5	4.4	268.5
2015	311 426	0.4	234.9	23.2	4.3	254.0

Emission factors for heavy metals, POPs and PM are presented in chapter 3.2.8.

Category-specific Quality Assurance and Quality Control (QA/QC)

Quality management for input data of *1.A.3.b Road Transport* is implemented by carrying out the following checklist after receipt of input data:

- ✓ Are the correct values used (check for transcription errors)?
- ✓ Check of plausibility of input data (time-series order of magnitude)!
- ✓ Is the data set complete for the whole time series?
- ✓ Check of calculation units!

- ✓ Check of plausibility of results (time-series order of magnitude)!
- ✓ Are all references clearly made?
- ✓ Are all assumptions documented?

Category-specific Recalculations

For the year 2014 marginal changes occurred due to revised levels for liquefied petroleum gas (LPG) and biogas in the national energy balance. However, there has been a recalculation in the subcategories 1.A.3.b.i and 1.A.3.b.ii as specific fuel consumption per vehicle kilometer has been revised upwards, which was also explained in response to a question raised during the initial checks of the annual ESD Review 2017. This recalculation resulted in a slight increase of domestic fuel consumption of road transport for the years 2011-2014. Affected vehicle categories for the recalculation in domestic road transport were passenger cars (2011, 2012, 2013, 2014) and light duty vehicles (2013, 2014). The reason for this recalculation was updated information especially on the specific diesel consumption of PCs and LDVs per vehicle kilometre according to the latest vehicle measurements in independent laboratories. This results vice versa in a reduced amount of diesel which can be allocated to fuel exports. This is due to the Austrian methodology for estimating GHG from road transport (please see NIR 2016, p.126 – fuel export), where the total fuel sold in Austria is subtracted by the inland road transport and the off-road transport to derive fuel exports. There cannot be any underestimation in total fuel consumption, because the amount of total fuel sold in Austria taken from the energy balance is the value which determines the GHG emissions of transport. The recalculation therefore did not change the total GHG emissions from transport but only the contributions from the subcategories. Since fuel export is mainly characterised by truck traffic with HDV the revision of inland consumption pops up in the category 1A3biii (heavy duty vehicles in fuel export).

Category-specific Planned Improvements

In response to the ERT's question on an update on the progress of CH₄ and N₂O emissions associated with biomass (ARR 2014 para 30) and the provisional main findings of the CRR 2016, Austria does not plan to separate emissions from biomass fuels, because most of these fuels is used in blended diesel and gasoline and therefore a separation of N₂O and CH₄ emissions from this fuels would be 'artificial'. From Austria's viewpoint the current reporting is more transparent in the manner that emissions from gasoline and diesel cars are reported adequately to the according fuels.

3.2.7 Other mobile sources – Off Road

Off-road sources are mobile engines and mobile machinery in the NFR sectors *1.A.2.g.vii Industry, 1.A.3.c Railways, 1.A.3.d Navigation, 1.A.4.b.2 Household and Gardening, 1.A.4.c.2 Agriculture and Forestry and 1.A.5.b Military activities*.

3.2.7.1 NFR 1.A.2.g.vii Off-road vehicles and other machinery

Methodological Issues

Energy consumption and emissions of off-road traffic in Austria are calculated with the model GEORG (Grazer Emissionsmodell für Off-Road Geräte). This model has been developed within a study about off-road emissions in Austria (HAUSBERGER 2000). The study was prepared to improve the poor data quality in this sector. The following categories were taken into account:

- 1.A.2.f Industry,

- 1.A.3.c Railways,
- 1.A.3.d Navigation,
- 1.A.4.b Household and Gardening,
- 1.A.4.c Agriculture and Forestry,
- 1.A.5 Military activities.

Input data to the model are:

- Machinery stock data (obtained from data on licences, through inquiries and statistical extrapolation);
- Assumptions on drop-out rates of machinery (broken down machinery will be replaced);
- Operating time (obtained through inquiries), related to age of machinery.

From machinery stock data and drop-out rates an age structure of the off-road machinery was obtained by GEORG. Four categories of engine types were considered. Depending on the fuel consumption of the engine the ratio power of the engine was calculated. Emissions were calculated by multiplying an engine specific emission factor (expressed in g/kWh) by the average engine power, the operating time and the number of vehicles.

With this method national fuel consumption and national emissions are calculated (bottom-up). Calculated fuel consumption of off-road traffic is then summed up with total fuel consumption of inland road transport and is compared with total fuel sold in Austria according to the national energy balance. The difference is allocated to fuel export (for details concerning fuel export see 1.A.3.b). The emissions reported for Austria also include the emissions from fuel exports assuming that the fuel export fleet (mainly travelling on highways) is similar to the Austrian fleet on highways. The used methodology conforms to the requirements of the EMEP/EEA Tier 3 methodology.

Activity Data

Activity data, vehicle stock and specific fuel consumption for vehicles and machinery (e.g. loaders, diggers, etc.), were taken from:

- Statistik Austria (fuel statistics),
- Questionnaire to vehicle and machinery users (HAUSBERGER 2000),
- Interviews with experts and expert judgment validating the questionnaire results (HAUSBERGER 2000) and
- Information from vehicle and machinery manufacturers (HAUSBERGER 2000).

An allocation of pure biofuels on the off-road sector has not been performed due to lack of data.

Activities used for estimating the emissions of mobile sources in 1.A.2.g.vii are presented in Table 155. Activities include liquid fuels (diesel, gasoline and biofuels).

Emission Factors

The following emission factors for four categories of engine types (average motor capacity) depending on the year of construction are used in the GEORG model. They represent emissions according to the engine power output and also fuel consumption. They are close to the emission standards for diesel NRMM (Non-Road Mobile Machinery). The values for 2014 represent the year where the latest emission standard Stage IV has been introduced on EU level.

Table 151: Emission factors for diesel engines > 80 kW.

Year	NO _x	NH ₃	NM VOC	PM
[g/kwh]				
1993	10.193	0.003	1.577	1.623
2001	12.392	0.002	1.183	0.885
2003	7.845	0.002	0.307	0.295
2006	5.187	0.001	0.502	0.173
2011	3.292	0.001	0.502	0.173
2014	0.600	0.001	0.188	0.023

Table 152: Emission factors for diesel engines < 80 kW.

Year	NO _x	NH ₃	NM VOC	PM
[g/kwh]				
1993	11.992	0.006	1.892	2.184
2001	10.923	0.005	1.446	1.682
2003	8.103	0.004	1.179	0.545
2006	6.300	0.003	0.653	0.277
2011	5.250	0.002	0.653	0.277
2014	3.023	0.002	0.214	0.048

Table 153: Emission factors for 4-stroke-petrol engines.

Year	NO _x	NH ₃	NM VOC	PM
[g/kwh]				
1993	3.070	0.002	15.917	0.025
2001	4.110	0.002	12.738	0.025
2003	4.490	0.002	12.167	0.025
2006	4.490	0.002	11.748	0.025
2011	4.490	0.002	10.844	0.025
2014	4.490	0.002	10.844	0.025

Table 154: Emission factors for 2-stroke-petrol engines.

Year	NO _x	NH ₃	NM VOC	PM
[g/kwh]				
1993	1.035	0.002	247.797	0.439
2001	1.135	0.002	174.290	0.291
2003	1.675	0.001	164.637	0.291
2006	1.395	0.001	50.490	0.291
2011	1.395	0.000	50.490	0.291
2014	1.395	0.000	50.490	0.291

Implied emission factors of 1.A.2.g.vii are presented below.

Table 155: Activities and Implied emission factors for NEC gases and CO for 1.A.2.f.2 Off-road – Industry: 1990–2015.

Year	Activity	IEF SO ₂	IEF NO _x	IEF NMVOC	IEF NH ₃	IEF CO
	[TJ]					
1990	3 448	59.5	878.5	149.7	0.32	1 113
1991	3 897	59.5	880.4	149.2	0.32	1 111
1992	4 127	59.5	882.1	148.8	0.32	1 110
1993	4 340	59.5	883.3	148.5	0.32	1 109
1994	4 555	50.4	897.2	146.1	0.31	1 097
1995	4 821	18.6	921.3	142.1	0.31	1 076
1996	6 008	18.6	956.6	136.0	0.30	1 043
1997	5 663	18.6	984.0	131.8	0.29	1 028
1998	6 660	18.6	1 004.3	128.4	0.28	1 010
1999	6 353	16.3	1 018.4	126.1	0.28	1 004
2000	7 426	16.3	1 027.9	124.2	0.28	997
2001	6 980	16.3	1 032.5	123.2	0.27	998
2002	6 793	16.3	1 025.8	121.4	0.27	993
2003	7 241	16.3	980.6	112.5	0.26	939
2004	7 965	2.4	892.4	99.8	0.25	845
2005	11 028	2.4	770.2	84.3	0.23	676
2006	13 736	2.4	671.0	73.1	0.21	592
2007	14 884	0.5	607.0	66.6	0.19	544
2008	16 419	0.5	556.7	62.4	0.18	504
2009	16 079	0.5	525.1	60.4	0.17	491
2010	15 422	0.5	510.2	59.4	0.17	484
2011	15 501	0.5	493.2	58.4	0.16	478
2012	16 067	0.5	465.2	54.8	0.15	467
2013	16 155	0.5	441.1	49.6	0.15	451
2014	15 837	0.5	427.6	45.6	0.14	442
2015	15 444	0.5	411.4	42.2	0.14	433

Emission factors for heavy metals and POPs are presented in chapter 3.2.8.

Category-specific Recalculations

No recalculations have been made in this year's submission.

3.2.7.2 NFR 1.A.3.c Railways

Methodological Issues

The applied methodology is described in the subchapter on mobile sources of 1.A.2.g.vii (see Chapter 3.2.7.1).

Activity Data

In this category emissions from diesel railcars and steam engines are considered. Activities used for estimating the emissions of *1.A.3.c Railways* are presented below. Activities include liquid fuels (diesel and biodiesel) as well as solid fuels (coal).

Table 156: Activities for 1.A.3.c Railways: 1990–2015.

Year	Liquid fuels	Solid fuels
	[TJ]	[TJ]
1990	2 311	70
1991	2 120	63
1992	2 099	66
1993	2 051	60
1994	2 071	59
1995	1 926	61
1996	1 736	61
1997	1 753	35
1998	1 730	31
1999	1 788	30
2000	1 788	26
2001	1 728	18
2002	1 869	20
2003	1 880	16
2004	1 880	6
2005	2 186	5
2006	2 196	6
2007	2 184	6
2008	2 181	5
2009	2 144	6
2010	2 046	5
2011	1 730	5
2012	1 781	5
2013	1 630	5
2014	1 706	5
2015	1 702	5
Trend 1990–2015	-26%	-93%

Emission Factors

Details concerning emission factors for mobile off-road sources are described in the subchapter on mobile sources of *1.A.2.g.vii*. Implied emission factors of *1.A.3.c Railways* are listed in the following table.

Table 157: Activities and Implied emission factors for NEC gases and CO for 1.A.3.c Railways: 1990–2015.

Year	Activity	IEF SO ₂	IEF NO _x	IEF NMVOC	IEF NH ₃	IEF CO
	[TJ]			[t/PJ]		
1990	2 380	163.1	781.2	161.6	0.4	900.1
1991	2 183	162.2	783.6	161.1	0.4	898.1
1992	2 165	167.6	786.7	161.3	0.4	900.2
1993	2 111	159.7	788.5	159.9	0.4	893.7
1994	2 129	157.2	794.9	158.8	0.4	889.3
1995	1 987	159.1	802.8	159.2	0.4	893.3
1996	1 796	143.6	810.7	159.6	0.4	897.6
1997	1 788	92.1	812.1	152.8	0.3	862.2
1998	1 761	85.6	818.5	151.2	0.3	855.0
1999	1 818	81.8	825.9	149.7	0.3	849.3
2000	1 814	74.3	833.4	147.8	0.3	841.0
2001	1 746	60.4	841.3	145.0	0.3	828.2
2002	1 889	61.5	848.9	141.2	0.3	812.1
2003	1 896	53.2	843.3	137.9	0.3	795.2
2004	1 886	35.0	836.9	133.4	0.2	772.1
2005	2 191	31.9	826.7	128.4	0.2	746.4
2006	2 202	33.0	819.0	124.0	0.2	724.6
2007	2 189	32.6	798.0	116.1	0.2	685.0
2008	2 186	31.4	777.2	108.1	0.2	644.2
2009	2 150	34.0	758.2	100.3	0.2	605.5
2010	2 051	31.6	736.9	91.9	0.2	563.1
2011	1 735	33.2	715.7	84.1	0.2	523.3
2012	1 786	33.4	693.8	79.8	0.2	499.9
2013	1 635	34.4	661.4	72.5	0.2	463.4
2014	1 711	34.0	630.2	65.0	0.2	426.2
2015	1 707	33.9	608.8	61.5	0.2	409.5

Emission factors for heavy metals and POPs are presented in chapter 3.2.8.

Category-specific Recalculations

For the year 2014 marginal changes are caused by revised levels for diesel consumption according to the national energy balance. All pollutants except HM, POPs and PAHs from solid fuels (coal) in 1.A.3.c Railways were recalculated due to a transcription error which was corrected in this year's submission.

3.2.7.3 NFR 1.A.3.d Navigation

Methodological Issues

Austria uses the bottom-up model GEORG to calculate fuel consumption in navigation which is made up of freight transport activities on the River Danube and passenger transport on rivers and lakes in Austria. Passenger transport is conducted with passenger ships, private motor

boats and sailing boats. The inland navigation fleet (stock) was obtained from registration statistics from provincial governments, the average yearly operating time as well as the average fuel consumption per hour from questionnaires to fleet operators and/or manufacturers' data. Statistical data (tkm) for freight activities on the River Danube were obtained from (STATISTIK AUSTRIA 2016e). Additionally fuel consumption for working boats is taken into account in the national fuel consumption of navigation.

Emissions are calculated bottom-up with the model GEORG. The inland navigation fleet (stock) was obtained from registration statistics from provincial governments, the average yearly operating time as well as the average fuel consumption per hour from questionnaires to fleet operators and/or manufacturers' data. Statistical data (tkm) for freight activities on the River Danube were obtained from (STATISTIK AUSTRIA 2016e). Methodological issues of the model GEORG are described in the subchapter on mobile sources of *1.A.2.g.vii* (see Chapter 3.2.7.1).

Activity Data

This sector includes emissions from fuels used by vessels of all flags that depart and arrive in Austria (excludes fishing) and emissions from international inland waterways, including emissions from journeys that depart in Austria and arrive in a different country. Activities used for estimating the emissions of *1.A.3.d Navigation* are presented in Table 158. Activities include liquid fuels (diesel, gasoline and biofuels).

Emission Factors

Details concerning emission factors for mobile off-road sources are described in the subchapter on mobile sources of *1.A.2.g.vii* (see Chapter 3.2.7.1). Implied emission factors of *1.A.3.d Navigation* are listed below.

Table 158: Activities and Implied emission factors for NEC gases and CO for 1.A.3.d Navigation: 1990–2015.

Year	Activities	IEF SO ₂	IEF NO _x	IEF NMVOC	IEF NH ₃	IEF CO
	[TJ]		[t/PJ]			
1990	863	52.4	673.9	716.2	0.2	3 690.4
1991	780	51.6	661.1	774.5	0.2	3 971.3
1992	763	51.4	661.3	786.6	0.2	4 017.4
1993	769	51.5	664.8	779.8	0.2	3 969.7
1994	922	52.7	689.2	667.8	0.2	3 411.6
1995	1 016	44.6	704.6	609.5	0.2	3 127.8
1996	1 037	21.2	713.4	590.0	0.2	3 037.1
1997	1 029	21.2	719.8	583.3	0.2	3 010.9
1998	1 108	21.4	732.9	542.6	0.2	2 814.7
1999	1 085	21.3	739.4	541.1	0.2	2 815.9
2000	1 172	21.5	753.3	502.6	0.2	2 631.1
2001	1 218	21.6	765.1	480.7	0.2	2 529.9
2002	1 336	21.7	778.8	440.2	0.2	2 331.3
2003	1 095	21.4	772.4	496.1	0.2	2 613.5
2004	1 314	21.2	794.5	421.5	0.2	2 257.9
2005	1 290	21.2	793.7	408.9	0.2	2 229.0
2006	1 145	21.0	786.1	425.1	0.2	2 361.2
2007	1 215	20.9	782.2	390.0	0.2	2 197.1
2008	1 113	20.7	760.3	395.6	0.2	2 274.9
2009	962	20.3	734.1	417.6	0.2	2 468.0
2010	1 113	20.8	728.1	359.4	0.2	2 164.1
2011	1 006	20.5	705.1	366.2	0.2	2 288.4
2012	1 031	20.6	695.9	342.1	0.2	2 211.7
2013	1 095	20.8	689.1	312.6	0.2	2 083.6
2014	1 018	20.7	676.0	311.9	0.2	2 176.0
2015	864	20.2	655.6	331.5	0.2	2 450.7

Emission factors for heavy metals and POPs are presented in chapter 3.2.8.

Category-specific Quality Assurance and Quality Control (QA/QC)

Harmonization CRF and IEA data

In 2013 the ERT detected inconsistencies of fuel consumption data of domestic aviation and domestic navigation between the CRF tables and the IEA data (ICR 2013). In response to that it was explained that Austria uses a bottom-up approach to estimate fuel consumption whilst IEA relies on top-down approach based on fuel consumption statistics reported by Statistics Austria

After having discussed this issue with Statistics Austria an Explanatory Note (30/09/2013) has been compiled by Statistics Austria declaring that a regular adoption of inventory data for the split between national and international fuel consumption in civil aviation and navigation in the national statistics will be adopted in the future, as far as the data can be submitted in time (early November).

As part of regular QA/QC the energy split between national and international navigation is provided to Statistics Austria for the IEA statistics based on the bottom up model used to calculate the annual emission inventory.

Completeness

In response to a question raised by the ERT (ICR 2013) it was explained that emissions of ground activities at domestic harbors are also included, even if they are not separately reported under *1.A.3.d Navigation*. This can be assured as Austria reports emissions from **total fuel sold** from the energy balance.

The approach in the Austrian inventory is as follows: After calculating fuel consumption for inland road transport and off-road transport using a bottom-up approach (NEMO, GEORG), the sum of this fuel used is compared with the total fuel sold from the national energy balance (for details see *1.A.3.b Road Transport*). The difference is then allocated to fuel export, which includes fuel consumption for ground activities at airports and harbors as well, including fuel consumption by unregistered vehicles. As the fuel consumption reported under fuel export is included in the national totals¹⁰¹, an underestimation of emissions can be excluded.

Category-specific Recalculations

No recalculations have been made in this year's submission.

3.2.7.4 NFR 1.A.4.b.2 Household and gardening – mobile sources

In addition to NRMM used in household and gardening this category contains mobile machinery such as ski slope machineries, skidoos or mowers. This type of machinery could not be split in commercial and non-commercial use.

Methodological Issues

The applied methodology is described in the subchapter on mobile sources of *1.A.2.g.vii* (see Chapter 3.2.7.1).

Activity Data

In addition to vehicles used in household and gardening this category contains ski slope machineries and snow vehicles. Activities used for estimating emissions of *1.A.4.b.2 Household and gardening – mobile sources* are presented in Table 159. Activities include liquid fuels (diesel, gasoline and biofuels).

¹⁰¹ GHG emissions from fuel export are included in 1.A.3.b and are presented separately in Table 66 (Chapter 3.2.12.2)

Emission Factors

Details concerning emission factors for mobile off-road sources are described in the subchapter on mobile sources of 1.A.2.g.vii (see Chapter 3.2.7.1). Implied emission factors of 1.A.4.b.2 *Household and gardening – mobile sources* are listed below.

Table 159: Activities and Implied emission factors for NEC gases and CO for 1.A.4.b.ii Off-road – Household and gardening: 1990–2015.

Year	Activity	IEF SO ₂	IEF NO _x	IEF NMVOC	IEF NH ₃	IEF CO
	[TJ]			[t/PJ]		
1990	1 916	29.5	419.2	2 499.5	0.2	11 329.2
1991	1 920	29.5	420.8	2 502.3	0.2	11 334.1
1992	1 937	29.6	424.5	2 493.1	0.2	11 290.7
1993	1 948	29.7	427.8	2 486.2	0.2	11 259.7
1994	1 937	25.5	433.4	2 455.5	0.2	11 189.4
1995	1 944	11.1	450.5	2 362.0	0.2	10 895.4
1996	1 923	11.1	460.6	2 299.2	0.1	10 741.4
1997	1 905	11.1	469.6	2 231.3	0.1	10 568.2
1998	1 889	11.1	478.9	2 159.2	0.1	10 379.6
1999	1 885	10.0	487.7	2 089.8	0.1	10 204.9
2000	1 885	10.0	497.4	2 024.2	0.1	10 031.8
2001	1 887	10.0	506.4	1 973.4	0.1	9 902.8
2002	1 885	10.0	509.4	1 937.7	0.1	9 764.4
2003	1 879	10.0	506.4	1 924.2	0.1	9 644.8
2004	1 867	2.4	499.2	1 845.5	0.1	9 586.9
2005	1 845	2.4	489.7	1 704.5	0.1	9 556.7
2006	1 823	2.4	479.3	1 563.9	0.1	9 549.7
2007	1 801	0.5	464.8	1 415.6	0.1	9 540.9
2008	1 777	0.5	447.1	1 266.0	0.1	9 562.4
2009	1 756	0.5	427.0	1 119.3	0.1	9 595.6
2010	1 740	0.5	403.8	989.6	0.1	9 641.2
2011	1 731	0.5	378.8	885.5	0.1	9 708.7
2012	1 724	0.5	353.2	810.1	0.1	9 765.0
2013	1 727	0.5	328.0	778.6	0.1	9 791.0
2014	1 741	0.5	303.4	767.9	0.1	9 845.7
2015	1 750	0.5	280.8	764.9	0.1	9 899.7

Emission factors for heavy metals and POPs are presented in chapter 3.2.8.

Category-specific recalculations

No recalculations have been made in this year's submission.

3.2.7.5 NFR 1.A.4.c.2 Agriculture and forestry – mobile sources

In this category emissions from NRMM used in agriculture and forestry (mainly tractors) are considered.

Methodological Issues

The applied methodology is described in the subchapter on mobile sources of 1.A.2.g.vii (see Chapter 3.2.7.1).

Activity Data

In this category emissions from off-road machinery in agriculture and forestry (mainly tractors) are considered.

Activities used for estimating emissions of 1.A.4.c.2 *Agriculture and Forestry – mobile sources* are presented in Table 160. Activities include liquid fuels (diesel, gasoline and biofuels).

Emission Factors

Details concerning emission factors for mobile off-road sources are described in the subchapter on mobile sources of 1.A.2.g.vii (see Chapter 3.2.7.1). Implied emission factors of 1.A.4.c.2 *Agriculture and Forestry – mobile sources* are presented below.

Table 160: Activities and Implied emission factors for NEC gases and CO for 1.A.4.c.ii Off-road Vehicles and Other Machinery – Agriculture/Forestry/Fishing: 1990–2015.

Year	Activity	IEF SO ₂	IEF NO _x	IEF NMVOC	IEF NH ₃	IEF CO
	[TJ]					
				[t/PJ]		
1990	10 377	57.9	907.7	390.4	0.4	1 820.6
1991	10 339	58.2	915.1	339.6	0.5	1 699.6
1992	10 429	58.2	917.5	345.8	0.5	1 704.2
1993	10 480	58.2	920.9	343.7	0.5	1 692.7
1994	10 569	49.2	921.1	362.8	0.5	1 725.1
1995	10 115	18.3	922.2	359.2	0.4	1 722.8
1996	10 520	18.3	923.7	359.0	0.4	1 697.7
1997	11 047	18.3	927.2	340.2	0.4	1 629.0
1998	10 847	18.3	928.8	330.8	0.4	1 607.2
1999	10 950	16.0	930.4	324.7	0.4	1 583.8
2000	10 621	16.0	931.1	317.3	0.4	1 571.4
2001	10 947	16.0	932.4	310.3	0.4	1 539.7
2002	10 900	16.0	921.4	320.0	0.4	1 543.0
2003	10 472	16.0	901.2	344.4	0.4	1 580.5
2004	10 775	2.4	880.6	319.0	0.4	1 490.7
2005	11 461	2.4	855.7	288.8	0.4	1 386.2
2006	11 533	2.4	828.8	289.8	0.4	1 372.0
2007	11 653	0.5	797.0	284.1	0.4	1 337.3
2008	11 808	0.5	764.6	266.9	0.3	1 273.0
2009	10 859	0.5	734.5	233.0	0.3	1 199.7

Year	Activity	IEF SO ₂	IEF NO _x	IEF NMVOC	IEF NH ₃	IEF CO
	[TJ]			[t/PJ]		
2010	10 619	0.5	700.8	228.2	0.3	1 175.7
2011	11 533	0.5	670.7	209.9	0.3	1 089.9
2012	11 049	0.5	641.9	201.2	0.3	1 063.8
2013	10 985	0.5	615.6	189.8	0.3	1 020.2
2014	11 146	0.5	591.5	179.1	0.3	974.0
2015	11 047	0.5	567.8	176.1	0.3	953.3

Emission factors for heavy metals and POPs are presented in chapter 3.2.8.

Category-specific recalculations

No recalculations have been made in this year's submission.

3.2.7.6 NFR 1.A.5.b Other – mobile

In this category emissions of NRMM used for military transport (off-road and aviation) are reported.

Military Off-Road Transport (ground operations)

Methodological Issues

The applied methodology is described in the subchapter on mobile sources of 1.A.2.g.vii (see Chapter 3.2.7.1).

Activity Data

Emission estimates for military activities were taken from (HAUSBERGER 2000). Information on the fleet composition was taken from official data presented in the internet as no other data were available. Also no information on the road performance of military vehicles was available, that's why emission estimates only present rough estimations, which were obtained making the following assumptions: for passenger cars and motorcycles the yearly road performance as calculated for civil cars was used. The yearly road performance for such vehicles was estimated to be 30 h/year (as a lot of vehicles are old and many are assumed not to be in actual use anymore).

Activities used for estimating the emissions of 1.A.5.b *Military Off-road* are presented below.

Emission Factors

For tanks and other special military vehicles the emission factors for diesel engines > 80 kW was used (for these vehicles a power of 300 kW was assumed). Details concerning emission factors for mobile off-road sources are described in the subchapter on mobile sources of 3.2.7 *Other mobile sources – Off Road*.

Emission factors for heavy metals and POPs are presented in chapter 3.2.8.

Military Aviation

Methodological Issues

For the years 1990–1999 fuel consumption for military flights was reported by the Ministry of Defence. For the years from 2000 onwards the trend has been extrapolated. The calculation of emissions from military aviation does not distinguish between LTO and cruise.

Activity Data

Activities used for estimating the emissions of Military Aviation (kerosene) and Military Off-Road Transport with diesel are presented in the following table.

Table 161: Activities from 1.A.5.b Other – mobile: 1990–2015.

Year	Kerosene [TJ]	Diesel [TJ]
1990	452	29
1991	481	29
1992	434	29
1993	513	28
1994	543	28
1995	419	28
1996	507	28
1997	482	28
1998	555	28
1999	544	27
2000	534	27
2001	541	27
2002	549	27
2003	557	27
2004	564	27
2005	572	27
2006	580	26
2007	588	26
2008	595	26
2009	603	25
2010	611	25
2011	619	25
2012	626	25
2013	634	25
2014	642	25
2015	650	25
Trend 1990–2015	44%	-12%

Emission Factors

For the years from 2000 onwards, emissions for military flights have been calculated with IEF from the year 2000 taken from (KALIVODA/KUDRNA 2002).

Emission factors for heavy metals and PM are presented in chapter 3.2.8.

Category-specific Recalculations

No recalculations have been made in this year's submission.

3.2.8 Emission factors for heavy metals, POPs and PM used in NFR 1.A.3 Transport

In the following chapter the emission factors for heavy metals, POPs and PM which are used in NFR 1.A.3 are described. For 1.A.3.a Civil Aviation and 1.A.5.b Military (Aviation) PAH-, Dioxin-, HCB- and PCB emissions are not estimated.

3.2.8.1 Cadmium, mercury and lead emissions

As can be seen in Table 70, the HM content of lighter oil products in Austria are below the detection limit. For Cd, Hg and for Pb from 1995 onwards 50% of the detection limit was used as emission factor for all years.

For Pb emission factors for gasoline before 1995 were calculated from the legal content limit for the different types of gasoline and the amounts sold of the different types in the respective year. Furthermore, it was considered that according to the CORINAIR 1997 Guidebook the emission rate for conventional engines is 75% and for engines with catalyst 40% (the type of fuel used in the different engine types was also considered).

The production and import of leaded gasoline has been prohibited in Austria since 1993. Earlier emission estimates are based on a lead content of 0.56 g Pb/litre for aviation gasoline. From 1996 on a lead content of 0,1 mg/GJ has been estimated for gasoline due to the assumed use of lead additives for old non-catalyst vehicles and that a lead content of 0.02 mg/GJ has been assumed for diesel oil and kerosene.

The same emission factors were also used for mobile combustion in Categories NFR 1.A.2, NFR 1.A.4 and NFR 1.A.5.b Military (Off-road sources).

For coal fired steam locomotives in NFR 1.A.3.c the emission factor for uncontrolled coal combustion from the CORINAIR 1997 Guidebook was used.

Table 162: HM emission factors for Sector 1.A.3 Transport and SNAP 08 Off-Road Machinery.

EF [mg/GJ]	Cd	Hg	Pb
Diesel, kerosene, gasoline, aviation gasoline (see also following table)	0.02	0.01	0.02
Coal (railways)	5.4	10.7	89
Automobile tyre- and break-wear: passenger cars, motorcycles	0.5	–	–
Automobile tyre- and break-wear: LDV and HDV	5.0	–	–

Table 163: Pb emission factors for gasoline for Sector 1.A.3 Transport and SNAP 08 Off-Road Machinery.

Pb EF [mg/GJ]	1985	1990	1995
gasoline (conventional)	2 200	2 060	0.1
gasoline (catalyst)	130	130	0.1
gasoline type jet fuel	23 990	15 915	0.1

3.2.8.2 POPs emissions

In the following the emission factors for POPs used in NFR 1.A.3 and in off-road transport are described.¹⁰²

PAH emission factors

For the 2016 submission the emission factors for 1.A.3.b Road Transport were updated in the model NEMO for the four PAHs relevant for the UNECE POPs protocol:

- indeno(1,2,3-cd)pyrene
- benzo(k)fluoranthene
- benzo(b)fluoranthene
- benzo(a)pyrene

According to the EMEP/EEA Guidebook 2013 (EEA 2013) specific exhaust emission factors were taken for each vehicle category and emission class given in [µg/km]. The non-exhaust emission factors (abrasion and suspension) were also taken from (EEA 2013) and implemented in the model NEMO as ratio factors of TSP non-exhaust (from tires and brake) in ppm (mass related). These emission factors are calculated in NEMO according to the Tier 2 methodology (HAUSBERGER/SCHWINGSHACKL/REXEIS, M. 2015c) via relationship factors from the tyre and brake TSP emission values.

For estimating PAK emissions from mobile off-road sources in NFR 1.A.2, NFR 1.A.3.c, NFR 1.A.3.d, NFR 1.A.4 and NFR 1.A.5.b trimmed averages from emission factors in (UBA BERLIN 1998), (SCHEIDL 1996), (ORTHOFFER & VESSELY 1990) and (SCHULZE et al. 1988) as well as measurements of emissions of a tractor engine by FTU (FTU 2000) were applied. For diesel fuelled mobile off-road sources the HDV emission factor was taken; for gasoline driven mobile sources in 1.A.3.d and 1.A.4.c (agriculture) the PC gasoline value; for gasoline fuelled mobile sources in 1.A.2, 1.A.4.b and 1.A.4.c.2 (forestry) the motorcycles <50 ccm value was taken.

For coal fired steam locomotives in NFR 1.A.3.c the same emission factor as for 1.A.4.b – stoves were used.

¹⁰² Emissions from off-road machinery are reported under 1.A.2.g.vii (machinery in industry), 1.A.4.b.2 (machinery in household and gardening), 1.A.4.c.2 (machinery in agriculture/forestry/fishing) and 1.A.5.b. (Military mobile sources).

Table 164: POP emission factors for Sector SNAP 08 Off-Road Machinery.

	PCDD/F EF [$\mu\text{gTE/GJ}$]	PAK4 [mg/GJ]
Passenger cars gasoline	0.046	5.3
PC. gasoline with catalyst	0.0012	0.32
Passenger cars diesel	0.0007	6.4
LDV	0.0007	6.4
HDV	0.0055	6.4
Motorcycles < 50 ccm	0.0031	21
Motorcycles < 50 ccm with catalyst	0.0012	2.1
Motorcycles > 50 ccm	0.0031	33
Coal fired steam locomotives	0.38	0.085

Dioxin emissions

Dioxin emission factors are presented in Table 164 and based on findings from (HÜBNER 2001).

HCB emissions

HCB emissions were calculated on the basis of dioxin emissions and assuming a factor of 200 (HÜBNER 2001).

PCB emission factors

PCB emissions from *1.A.3.b Road Transport* were calculated and reported for the first time in the current submission. For the calculation of PCB emissions in the model NEMO specific emission factors were taken from (EEA 2013) for each vehicle category and emission class given in [picograms/km]. Due to the low emission factors given in the Guidebook, the calculated PCB emissions from *1.A.3.b Road Transport* are a minor source (HAUSBERGER/SCHWINGSHACKL/REXEIS, M. 2015c).

PCB emissions from mobile off-road machinery in NFR 1.A.2, NFR 1.A.3.c, NFR 1.A.3.d, NFR 1.A.4 and NFR 1.A.5 were calculated for the first time in the current submission. Since no calculation method or values for these emissions are given in the literature, for diesel machines they were derived from truck emissions from road transport (approach: PCB emissions related to engine work). For gasoline-powered equipment, motorcycles have been used (approach: PCB emissions as a percentage of the HC emissions) (HAUSBERGER/SCHWINGSHACKL/REXEIS, M. 2015c).

3.2.8.3 PM emissions

Implied emission factors for Civil Aviation and Road Transport for PM can be found in Table 165 and Table 166. Emission factors for PM for Off-road transport are presented in chapter 3.2.7 Other mobile sources – Off Road.

The emission factors for 'automobile tyre and break wear' were taken from (VAN DER MOST & VELDT 1992), where it was considered that only 10% of the emitted particulate matter (PM) were relevant as air pollutants.

3.2.8.4 Implied emission factors per subcategory

NFR 1.A.3.a Civil Aviation - LTO

Emissions of lead are only relevant for aviation gasoline (only used for national VFR flights) and have significantly dropped between 1994 and 1995 in consequence of a prohibition of the production and import of leaded gasoline in Austria (also see chapter 3.2.8.1).

Table 165: Activities and Implied emission factors for heavy metals and PM₁₀ as well as activities for 1.A.3.a.ii Civil Aviation (domestic LTO + international LTO): 1990–2015.

Year	Activity	IEF Cd	IEF Hg	IEF Pb	IEF PM ₁₀
	[TJ]		[kg/PJ]		[t/PJ]
1990	1 482	0.03	0.01	1 636.7	34.8
1991	1 672	0.03	0.01	1 686.6	NE
1992	1 862	0.04	0.01	1 738.0	NE
1993	2 052	0.04	0.01	1 791.0	NE
1994	2 243	0.04	0.02	1 845.7	NE
1995	2 406	0.05	0.02	0.06	58.2
1996	2 579	0.05	0.02	0.06	NE
1997	2 765	0.06	0.02	0.06	NE
1998	2 949	0.06	0.02	0.07	NE
1999	3 020	0.06	0.02	0.07	NE
2000	3 240	0.06	0.02	0.07	79.2
2001	3 039	0.06	0.02	0.07	74.3
2002	3 534	0.07	0.02	0.08	86.2
2003	3 672	0.07	0.03	0.08	89.5
2004	4 325	0.09	0.03	0.09	106.0
2005	4 057	0.08	0.03	0.09	98.9
2006	4 069	0.08	0.03	0.09	99.2
2007	4 373	0.09	0.03	0.10	106.8
2008	4 472	0.09	0.03	0.10	109.2
2009	4 117	0.08	0.03	0.09	100.0
2010	4 183	0.08	0.03	0.09	102.0
2011	4 728	0.09	0.03	0.11	114.3
2012	4 487	0.09	0.03	0.10	109.9
2013	4 362	0.09	0.03	0.09	107.0
2014	4 390	0.09	0.03	0.10	107.6
2015	4 624	0.09	0.03	0.10	113.2

Memo Item 1.A.3.a Civil Aviation – Cruise

As aviation gasoline is only used for domestic VFR flights the significant drop of lead emissions in the 90ies is not visible in the cruise emissions. PAH -, Dioxin -, HCB – and PCB emissions are not estimated.

Table 166: Activities and Implied emission factors for heavy metals and PM₁₀ as well as activities for International Bunkers (domestic + international cruise traffic): 1990–2015.

Year	Activity	IEF Cd	IEF Hg	IEF Pb	IEF PM ₁₀
	[TJ]		[kg/PJ]		[t/PJ]
1990	11 143	0.02	0.01	0.02	25.0
1991	12 513	0.02	0.01	0.02	NE
1992	13 548	0.02	0.01	0.02	NE
1993	14 294	0.02	0.01	0.02	NE
1994	14 808	0.02	0.01	0.02	NE
1995	16 644	0.02	0.01	0.02	25.0
1996	18 466	0.02	0.01	0.02	NE
1997	19 189	0.02	0.01	0.02	NE
1998	19 822	0.02	0.01	0.02	NE
1999	19 301	0.02	0.01	0.02	NE
2000	20 986	0.02	0.01	0.02	25.0
2001	20 480	0.02	0.01	0.02	25.0
2002	18 496	0.02	0.01	0.02	25.0
2003	17 154	0.02	0.01	0.02	25.0
2004	20 264	0.02	0.01	0.02	25.0
2005	23 794	0.02	0.01	0.02	25.0
2006	25 074	0.02	0.01	0.02	25.0
2007	26 540	0.02	0.01	0.02	25.0
2008	26 486	0.02	0.01	0.02	25.0
2009	22 830	0.02	0.01	0.02	25.0
2010	24 856	0.02	0.01	0.02	25.0
2011	25 918	0.02	0.01	0.02	25.0
2012	24 749	0.02	0.01	0.02	25.0
2013	23 512	0.02	0.01	0.02	25.0
2014	23 469	0.02	0.01	0.02	25.0
2015	25 307	0.02	0.01	0.02	25.0

NFR 1.A.3.b Road Transport

Emissions of lead are only relevant for gasoline and have significantly dropped in the mid 90ies as a result of unleaded gasoline introduction.

Table 167: Activities and Implied emission factors for heavy metals and POPs for 1.A.3.b Road Transport: 1990–2015.

Year	Activity	IEF Cd	IEF Hg	IEF Pb	IEF PAH	IEF Diox	IEF HCB	IEF PCB
	[TJ]			[kg/PJ]			[g/PJ]	
1990	176 826	0.34	0.01	915.01	1.43	0.02	4.33	0.002
1991	196 386	0.32	0.01	654.54	1.44	0.02	3.76	0.002
1992	196 215	0.33	0.01	434.88	1.46	0.02	3.16	0.002
1993	198 244	0.34	0.01	272.01	1.49	0.01	2.65	0.002
1994	199 009	0.35	0.01	159.61	1.55	0.01	2.26	0.002
1995	202 791	0.35	0.01	0.06	1.61	0.01	1.92	0.003

Year	Activity	IEF Cd	IEF Hg	IEF Pb	IEF PAH	IEF Diox	IEF HCB	IEF PCB
1996	224 096	0.32	0.01	0.05	1.59	0.01	1.60	0.002
1997	210 964	0.35	0.01	0.05	1.61	0.01	1.43	0.003
1998	237 524	0.32	0.01	0.05	1.53	0.01	1.25	0.003
1999	229 403	0.34	0.01	0.05	1.48	0.01	1.13	0.003
2000	241 748	0.34	0.01	0.05	1.39	0.01	1.02	0.003
2001	259 856	0.32	0.01	0.04	1.31	0.00	0.94	0.003
2002	288 170	0.29	0.01	0.04	1.24	0.00	0.88	0.003
2003	311 792	0.28	0.01	0.04	1.18	0.00	0.83	0.003
2004	318 770	0.28	0.01	0.04	1.13	0.00	0.78	0.003
2005	325 935	0.28	0.01	0.04	1.10	0.00	0.82	0.003
2006	314 198	0.30	0.01	0.04	1.10	0.00	0.94	0.003
2007	317 803	0.30	0.01	0.04	1.07	0.00	0.94	0.003
2008	301 826	0.32	0.01	0.04	1.05	0.01	1.00	0.003
2009	297 235	0.32	0.01	0.04	1.02	0.01	1.11	0.003
2010	309 010	0.31	0.01	0.04	1.02	0.01	1.15	0.002
2011	298 771	0.33	0.01	0.04	1.01	0.01	1.16	0.002
2012	298 175	0.33	0.01	0.04	1.00	0.01	1.19	0.002
2013	311 498	0.32	0.01	0.04	1.02	0.01	1.17	0.002
2014	305 104	0.33	0.01	0.04	1.02	0.01	1.20	0.002
2015	311 426	0.33	0.01	0.03	1.02	0.01	1.25	0.001

PM emissions from tyre and brake wear are included in road abrasion and it is not possible to develop separate emission factors (by road and vehicle type) from field emission measurements which consider total vehicle emissions. Exhaust emissions as a result of engine combustion and non-exhaust emissions (tyre, brake-wear and road abrasion) for TSP, PM₁₀ and PM_{2.5} are shown in the table below.

Table 168: Activities and Implied emission factors for PM (exhaust and non-exhaust) for 1.A.3.b Road Transport: 1990–2015.

Year	Activity	IEF PM Exhaust	IEF TSP Non-exhaust	IEF PM ₁₀ Non-exhaust	IEF PM _{2.5} Non-exhaust
	[TJ]		[t/PJ]		
1990	176 826	23.98	33.15	11.05	3.31
1991	196 386	23.71	31.33	10.44	3.13
1992	196 215	24.12	32.48	10.83	3.25
1993	198 244	24.58	32.94	10.98	3.29
1994	199 009	25.14	34.15	11.38	3.41
1995	202 791	25.84	34.21	11.40	3.42
1996	224 096	26.98	31.74	10.58	3.17
1997	210 964	26.24	34.51	11.50	3.45
1998	237 524	25.27	31.47	10.49	3.15
1999	229 403	24.67	33.46	11.15	3.35
2000	241 748	23.88	32.52	10.84	3.25
2001	259 856	22.66	30.74	10.25	3.07

Year	Activity	IEF PM Exhaust	IEF TSP Non-exhaust	IEF PM₁₀ Non-exhaust	IEF PM_{2.5} Non-exhaust
2002	288 170	21.04	28.38	9.46	2.84
2003	311 792	19.68	26.85	8.95	2.69
2004	318 770	18.62	26.76	8.92	2.68
2005	325 935	17.50	26.66	8.89	2.67
2006	314 198	16.73	28.12	9.37	2.81
2007	317 803	14.99	28.21	9.40	2.82
2008	301 826	13.24	29.92	9.97	2.99
2009	297 235	11.60	29.84	9.95	2.98
2010	309 010	10.21	29.24	9.75	2.92
2011	298 771	9.22	30.83	10.28	3.08
2012	298 175	8.11	30.81	10.27	3.08
2013	311 498	7.08	29.81	9.94	2.98
2014	305 104	6.03	31.22	10.41	3.12
2015	311 426	5.20	31.28	10.43	3.13

3.3 NFR 1.B Fugitive Emissions

Fugitive Emissions arise from the production and extraction of coal, oil and natural gas; their storage, processing and distribution. These emissions are fugitive emissions and are reported in NFR Category 1.B. Emissions from fuel combustion during these processes are reported in NFR Category 1.A.

3.3.1 Completeness

Table 169 gives an overview of the NFR categories included in this chapter and on the status of emission estimates of all sub categories. A “✓” indicates that emissions from this sub category have been estimated.

Table 169: Overview of sub categories of Category 1.B Fugitive Emissions and status of estimation.

NFR Category		Status													
		NEC gas				CO	PM			Heavy metals			POPs		
		NO _x	SO _x	NH ₃	NM VOC	CO	TSP	PM ₁₀	PM _{2.5}	Cd	Hg	Pb	PCDD/F	PAH	HCB
1.B.1.a	i Coal Mining and Handling: Underground mines	NA	NA	NA	✓	NA	✓	✓	✓	NA	NA	NA	NA	NA	NA
	ii Coal Mining and Handling: Surface mines	NA	NA	NA	✓	NA	✓	✓	✓	NA	NA	NA	NA	NA	NA
1.B.1.b	Solid fuel transformation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B.1.c	Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B.2.a	i Exploration, Production, Transport	NA	NA	NA	IE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	iv Refining/Storage	NA	NA	NA	✓	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	v Distribution of oil products	NA	NA	NA	✓	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1.B.2.b	Natural gas ⁽¹⁾	NA	✓	NA	✓	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1.B.2.c	Venting and flaring ⁽²⁾	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE

⁽¹⁾ including emissions from 1.B.2.a.i (Exploration, Production and Transport of Oil) and oil pipelines

⁽²⁾ included in 1.A.1.b Petroleum Refining

3.3.2 NFR 1.B.1.a Coal mining and handling – Methodological issues

In this category NMVOC, TSP, PM₁₀ and PM_{2.5} emissions from coal mining and handling and TSP, PM₁₀ and PM_{2.5} emissions from storage of solid fuels, including coke oven coke, bituminous coal and anthracite, lignite and brown coal are considered.

NMVOC emissions were calculated based on activity data available in national statistics and reports (e.g. a report on mining by the Federal Ministry of Economy, Family and Youth (BMWFJ 2013)) and the tier 2 emission factor for open cast mining and underground mining given in the EMEP/EEA air pollutant emission inventory guidebook (EEA 2016). Before coal mining was stopped in 2007 (BMWFJ 2008) emissions decreased sharply (80 %) between 2003 and 2004.

The emissions of TSP, PM₁₀ and PM_{2.5} for Open Cast Mining were calculated by using the Tier 2 emission factors of the EMEP/EEA Guidebook 2016. For the calculation of emissions from Underground Mining the Tier 1 emission factors were applied as there is no activity data available to apply the Tier 2 emission factors.

TSP, PM₁₀ and PM_{2.5} emissions for the storage of solid fuels were calculated with the simple CORINAIR methodology. Activity data were taken from the national energy balance and are presented in Table 170 together with the national emission factors. The emission factors from the national study WINWARTER et al. 2001 were converted by multiplying the emission factor with the respective net calorific value (Bituminous coal/Anthracite: 29.07 GJ/t, Lignite/Brown coal 10 GJ/t, Coke oven coke 29 GJ/t) to obtain emission factors in kg/kt.

Table 170: Emission factors fugitive TSP, PM₁₀ and PM_{2.5} and NMVOC emissions from NFR category 1.B.1.a.

PM	Storage of solid fuels			Coal Mining and Handling	
	Bituminous coal/Anthracite	Lignite/Brown coal	Coke oven coke	Open Cast Mining	Underground Mining
	EF [kg/kt]			EF [g/t]	EF [g/t]
TSP	96	85	108	82	89
PM ₁₀	45	40	51	39	42
PM _{2.5}	14	12	16	6	5
NMVOC				200	3000

Table 171: Activity data for fugitive TSP, PM₁₀ and PM_{2.5} and NMVOC emissions from NFR category 1.B.1.a.

Year	Activity [kt]			Activity [kt]	
1990	1 822	2 504	2 403	1 577	870
1995	1 484	1 743	2 354	1 271	27
2000	1 847	1 343	2 436	1 249	NO
2001	2 039	1 586	2 320	1 206	NO
2002	1 943	1 502	2 590	1 412	NO
2003	2 412	1 583	2 481	1 152	NO
2004	2 424	1 150	2 443	235	NO
2005	2 145	1 211	2 732	6	NO
2006	2 341	679	2 803	7	NO
2007	2 375	13	2 739	NO	NO

Year	Activity [kt]			Activity [kt]	
2008	2 182	8	2 705	NO	NO
2009	1 530	31	2 109	NO	NO
2010	1 898	35	2 551	NO	NO
2011	2 037	32	2 561	NO	NO
2012	1 695	15	2 514	NO	NO
2013	1 696	11	2 614	NO	NO
2014	1 338	12	2 551	NO	NO
2015	1 896	11	2 360	NO	NO

3.3.3 NFR 1.B.2.a Oil – Methodological issues

As all oil fields are combined oil and gas production fields, total NMVOC emissions of combined oil and gas production are reported in this category. Further in this category, NMVOC emissions of transport and distribution of crude oil, oil products as well as from oil refining are considered.

Activity data for NMVOC emissions from natural gas extraction are reported from „Fachverband Mineralöl“ (Austrian association of oil industry). NMVOC emissions are reported from 1992 onwards, for the years before the emission value of 1992 was used.

Activity data for the transport of crude oil is reported by the Fachverband Mineralöl (Austrian association of oil industry). For the calculation of NMVOC emissions from this source an emission factor of 54 000 g/1 000m³ was used, taken from the 2006 IPCC Guidelines.

Emissions and activity data for refinery dispatch stations, transport and depots and from service stations and refueling of cars (petrol) were reported directly from „Fachverband Mineralöl“. Activity data for oil refining (crude oil refined) were taken from national statistics. An implied emission factor was calculated on the basis of emission and activity data. Activity data and implied emission factors are presented in Table 172.

Table 172: Activity data and implied emission factors for fugitive NMVOC emissions from NFR Category 1.B.2.a.

	Transport of crude oil ¹⁰³	Refinery dispatch station	Transport and depots	Service stations	Petrol	Gas extraction		Oil refining	
	Activity [1 000m ³]	IEF [g/t] NMVOC	IEF [g/t] NMVOC	IEF [g/t] NMVOC	Activity [kt]	IEF [g/1 000m ³] NMVOC	Natural gas extr. [1 000m ³]	IEF [g/t] NMVOC	Crude oil refined [kt]
1990	7 993	1 109	995	736	2 554	849	248 090	472	7 952
1995	8 721	916	986	662	2 402	676	405 638	174	8 619
2000	8 720	811	241	270	1 980	525	358 357	168	8 240
2001	8 855	296	238	269	1 998	485	393 492	62	8 799
2002	9 020	281	264	270	2 142	468	347 513	62	8 947
2003	9 309	269	233	270	2 223	465	408 198	62	8 819
2004	8 930	262	215	270	2 133	472	373 099	59	8 442

¹⁰³ Refinery crude oil throughput

	Transport of crude oil ¹⁰³	Refinery dispatch station	Transport and de- pots	Service stations	Petrol	Gas extraction		Oil refining	
	Activity [1 000m ³]	IEF [g/t] NMVOC	IEF [g/t] NMVOC	IEF [g/t] NMVOC	Activity [kt]	IEF [g/1 000m ³] NMVOC	Natural gas extr. [1 000m ³]	IEF [g/t] NMVOC	Crude oil refined [kt]
2005	9 000	205	206	270	2 073	557	338 349	59	8 778
2006	8 810	221	233	270	1 992	501	402 990	59	8 513
2007	9 090	228	233	270	1 966	284	444 029	60	8 496
2008	9 380	183	246	270	1 835	289	372 406	58	8 710
2009	8 930	186	151	270	1 842	300	466 628	57	8 286
2010	8 300	171	119	270	1 821	288	397 132	55	7 719
2011	8 900	181	112	270	1 756	295	375 168	50	8 170
2012	9 200	173	134	270	1 715	270	375 420	47	8 349
2013	9 300	169	134	270	1 665	319	335 874	40	8 566
2014	9 300	183	151	270	1 624	397	307 475	48	8 435
2015	9 500	161	160	270	1 640	383	297 102	44	8 881

Between 1990 and 2015 NMVOC emissions from the transport of crude oil increased by 19 % due to the increased refinery activity.

NMVOC emissions from refinery dispatch stations, transport and depots and from service stations and refueling of cars decreased remarkably (91 %, 89 % and 76 % respectively) between 1990 and 2015 due to installation of gas recovery units.

NMVOC emissions from oil refining and gas extraction also showed a notable decrease of 90 % and 59 % respectively between 1990 and 2015. This emission reduction has been achieved through technical improvements (e.g. improved tanks and loading units).

3.3.4 NFR 1.B.2.b Natural Gas – Methodological issues

In this category SO₂ emissions from the first treatment of sour gas and NMVOC gas distribution networks are considered.

SO₂ emissions and activity data for the first treatment of sour gas are reported from „Fachverband Mineralöl“ (Austrian association of oil industry). The drop in SO₂ emissions after 1996 is due to the implementation of pollution control measures. Emission data for 1990-1998 as well as for 2013-2015 were taken from the „Fachverband Mineralöl“, for the years in between (1999-2012) an EF of 120 g/1000m³ was used, based on an expert opinion on the sulphur emission level of desulfurization in Austria's refinery plant.

NMVOC emissions from gas distribution networks were calculated by applying the country-specific share of 1.2 % NMVOC in natural gas. This share is based on the natural gas composition in Austria. Emissions were directly linked to CH₄ emissions that were calculated applying a tier 3 method based on the material specific distribution pipeline lengths (reported by „Fachverband der Gas- und Wärmeversorgungsunternehmen“, „Association of Gas- and District Heating Supply Companies“) and material specific emission factors (WARTHA 2005).

Table 173: Activity data and implied emission factors for fugitive NMVOC and SO₂ emissions from NFR Category 1.B.2.b.

Year	First treatment desulfuration		Gas distribution	
	IEF [g/1 000 m ³] SO ₂	Raw gas Throughput [1 000 m ³]	IEF [g/km] NMVOC	Distribution mains [km]
1990	8 061.59	248 090	2 043	11 672
1995	3 771.84	405 638	1 248	17 778
2000	120.00	358 357	864	24 099
2001	120.00	393 492	829	25 042
2002	120.00	347 513	833	24 216
2003	120.00	408 198	797	25 699
2004	120.00	373 099	744	26 158
2005	120.00	338 349	724	26 958
2006	120.00	402 990	713	27 413
2007	120.00	444 029	696	27 945
2008	120.00	372 406	682	28 348
2009	120.00	466 628	673	28 533
2010	120.00	397 132	662	28 733
2011	120.00	375 168	659	29 023
2012	120.00	375 420	650	29 260
2013	116.11	335 874	634	29 469
2014	117.08	307 475	625	29 826
2015	139.73	279 102	617	30 067

3.3.5 Category-specific QA/QC

Activity Data received from the Austrian Association of oil industry (Fachverband der Mineralölindustrie) is compared with Energy Balance data on a regular basis. If differences occur these are clarified with external experts and are well explained and documented.

3.3.6 Uncertainty Assessment

Table 174 gives an overview of uncertainties for fugitive emissions, estimated according to the EMEP/EEA Emission Inventory Guidebook 2016 (EEA 2016). An average of the default values, based on the definitions of the qualitative ratings given in (EEA 2016) is used (see also chapter 1.7, Table 25).

Table 174: Uncertainties for activity data, emission factors and combined uncertainties for SO₂, NMVOC and PM_{2.5} for fugitive emissions.

Sector	Pollutant	Uncertainty AD	Uncertainty EF	Combined uncertainties
1.B.2.b	SO ₂	5.0%	20.0%	20.62%
1.B.1.a	NMVOC	5.0%	20.0%	20.62%
1.B.2.a	NMVOC	0.5%	20.0%	20.01%

Sector	Pollutant	Uncertainty AD	Uncertainty EF	Combined uncertainties
1.B.2.b	NMVOC	5.0%	20.0%	20.62%
1.B.1.a	PM _{2.5}	5.0%	200.0%	200.06%

3.3.7 Category-specific Recalculations

Recalculations in 1.B.1.a for TSP, PM₁₀, PM_{2.5} for the years 2005–2014 are due to revisions in the Energy balance (+0.4% in 2005 and +0.1% in 2014, respectively)

3.3.8 Planned Improvements

No improvements are currently planned.

4 INDUSTRIAL PROCESSES AND PRODUCT USE (NFR SECTOR 2)

4.1 Sector overview

This chapter includes information on the estimation of emissions of NEC gases, CO, particulate matter (PM), heavy metals (HM) and persistent organic pollutants (POPs) as well as references for activity data and emission factors reported under NFR Category 2 *Industrial Processes and Product Use* for the period from 1990 to 2015.

Emissions from this sector comprise emissions from the following categories:

- Mineral Products (2.A)
- Chemical Industry (2.B)
- Metal Production (2.C)
- Solvent use (2.D.3)
- Other product use (2.G)
- Other production (2.H)
- Wood processing (2.I)

Only process related emissions are considered in this sector; emissions due to fuel combustion in manufacturing industries are allocated to NFR Category 1.A.2 *Fuel Combustion – Manufacturing Industries and Construction* (see Chapter 3.1.4).

4.2 General description

Table 175 gives an overview of the NFR categories included in this chapter. A “✓” indicates that emissions from this sub category have been estimated, “NA” indicates that the pollutant in question is not emitted during the respective industrial process.

Some categories in this sector are not occurring (NO) in Austria as there is no such production/use. For some categories, emissions are included elsewhere (IE). In Chapter 1.8, a general description regarding completeness is given.

Table 175: Completeness of sub categories in sector 2 Industrial Processes and Product Use.

NFR Category		Status														
		NEC gas				CO	PM			Heavy metals			POPs			
		NO _x	SO ₂	NH ₃	NMVOC	CO	TSP	PM ₁₀	PM _{2.5}	Cd	Hg	Pb	Dioxin	PAH	HCB	PCB
2.A.1	Cement Production	NA	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA	NA	NA	NA
2.A.2	Lime Production	NA	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA	NA	NA	NA
2.A.3	Glass production	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
2.A.5	Mining, construction/demolition and handling of products	NA	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA	NA	NA	NA
2.A.6	Other Mineral products	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.B.1	Ammonia Production	✓	IE	✓	IE ⁽¹⁾	✓	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.B.2	Nitric Acid Production	✓	NA	✓	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.B.3	Adipic Acid Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.B.5	Carbide Production	NA	NA	NA	NA	NA	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA
2.B.6	Titanium Dioxide Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.B.7	Soda Ash Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.B.10	Chemical Industry: Other	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	NA ⁽²⁾	NA ⁽³⁾	NA ⁽³⁾	NA ⁽³⁾
2.C.1	Iron and steel production	✓	✓	IE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2.C.2	Ferroalloys production	NA	NA	NA	NA	NA	✓	✓	✓	NE	NE	NE	NE	NE	NE	NA
2.C.3	Aluminium production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	✓	✓	NE	✓	NA
2.C.4	Magnesium production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.C.5	Lead production	NA	NA	NA	NA	NA	NA	NA	NA	✓	NE	✓	✓	NA	NA	✓
2.C.6	Zinc production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.C.7.a	Copper production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.C.7.b	Nickel production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.C.7.c	Other metal production	✓	✓	NA	✓	✓	NE	NE	NE	IE	IE	IE	IE	IE	IE	✓
2.C.7.d	Storage, handling and transport of metal products	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.D.3.a	Domestic solvent use (incl. fungicides)	NA	NA	NA	✓	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.D.3.b	Road paving with asphalt	NA	NA	NA	IE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.D.3.c	Asphalt roofing	NA	NA	NA	IE	✓	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.D.3.d	Coating application	NA	NA	NA	✓	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.D.3.e	Degreasing	NA	NA	NA	✓	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.D.3.f	Dry Cleaning	NA	NA	NA	✓	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.D.3.g	Chemical Products	NA	NA	NA	✓	NA	NA	NA	NA	✓	NA	✓	NA	NA	NA	NA
2.D.3.h	Printing	NA	NA	NA	✓	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.D.3.i	Other solvent use	NA	NA	NA	✓	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.G	Other product use	NA	NA	✓	NA	NA	✓	✓	✓	NA	NA	NA	NE	NE	NE	NA

NFR Category		Status														
		NEC gas				CO	PM			Heavy metals			POPs			
		NO _x	SO ₂	NH ₃	NM VOC	CO	TSP	PM ₁₀	PM _{2.5}	Cd	Hg	Pb	Dioxin	PAH	HCB	PCB
2.H	OTHER PROCESSES	✓	NA	NA	✓	✓	✓	✓	✓	NA	NA	NA	✓	✓	✓	NA
2.I	WOOD PROCESSING	NA	NA	NA	NA	NA	✓	✓	✓	NA	NA	NA	NA	NA	NA	NA
2.J	PRODUCTION OF POPs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.K	CONSUMPTION OF POPs AND HEAVY METALS	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.L	OTHER	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

⁽¹⁾ included in 2.B.5 Other

⁽²⁾ PAH emissions from graphite production (production of graphite electrodes only) are not estimated, as no emission factor is available.

⁽³⁾ until 1992 from Tri-, Perchloroethylene Production; later NO

4.2.1 Key Categories

The key category analysis is presented in Chapter 1.5. This chapter includes information on the IPPU sector. Key sources within this category are presented in Table 176.

Table 176: Key sources of sector IPPU.

NFR Category	Source Categories	Key Categories	
		Pollutant	KS-Assessment
2.A.5	Mining, construction/demolition and handling of products	TSP, PM ₁₀ , PM _{2.5}	LA, TA
2.B-10	Handling of products and other chemical industry	NO _x , NMVOC, Hg	TA
2.C.1	Iron and Steel Production	Cd, Pb, Hg, PAH ⁽²⁾ , DIOX, PCB, HCB ⁽²⁾ , TSP ⁽¹⁾ , PM ₁₀ ⁽¹⁾ , PM _{2.5} ⁽¹⁾	LA, TA
2.C.3	Aluminium production	DIOX	LA
2.C.5	Lead Production	Cd ⁽¹⁾ , Pb ⁽²⁾ , PCB	LA, TA
2.C.7	Other metal production	PCB	LA
2.D.3.a	Domestic solvent use including fungicides	NMVOC	LA, TA
2.D.3.d	Coating applications	NMVOC	LA
2.D.3.e	Degreasing	NMVOC	LA, TA
2.D.3.g	Chemical products	NMVOC	LA
2.D.3.h	Printing	NMVOC	LA
2.D.3.i	Other solvent use	NMVOC	LA
2.G	Other product manufacture and use	PM _{2.5}	LA, TA
2.H	Other Processes	NMVOC, PAH	TA

TA = Trend Assessment 2015

LA = Level Assessment (if not further specified – for the years 1990 and 2015)

Note: ⁽¹⁾only TA, ⁽²⁾only LA

4.2.2 Methodology

The general method for estimating emissions for the industrial processes and product use sector involves multiplying production data for each process by an emission factor per unit of production (CORINAIR simple methodology).

In some categories, emission and production data were reported directly by industry or by associations of industries and thus represent plant-specific data.

4.2.3 Uncertainty Assessment

The table below gives an overview of uncertainties for Industrial Processes and Product Use. The method used for the assessment of uncertainty is according to the EMEP/EEA air pollutant emission inventory guidebook 2016 (EEA 2016). Further information on the uncertainty assessment of activity data can be found in Austria's National Inventory Report (UMWELT-BUNDESAMT 2017a). Where no specific information on uncertainties of emission factors was available, an average of the default values, based on the definitions of the qualitative ratings given in the EMEP/EEA Emission Inventory Guidebook 2016 is used (see chapter 1.7).

Table 177: Uncertainties for activity data, emission factor and combined uncertainties for NO_x, SO₂, NMVOC, NH₃ and PM_{2.5} for Industrial Processes and Product Use.

NRF sector	Pollutant	Activity data uncertainty (%)	Emission factor uncertainty (%)	Combined uncertainty (%)
2.A.1	PM _{2.5}	1.1	200.0	200.0
2.A.2	PM _{2.5}	1.6	200.0	200.0
2.A.5	PM _{2.5}	5.0	200.0	200.1
2.B.1	NO _x	2.0	40.0	40.0
2.B.1	NH ₃	2.0	20.0	20.1
2.B.2	NO _x	2.0	40.0	40.0
2.B.2	NH ₃	2.0	20.0	20.1
2.B-10	SO ₂	2.0	40.0	40.0
2.B-10	NO _x	2.0	40.0	40.0
2.B-10	NMVOC	2.0	200.0	200.0
2.B-10	PM _{2.5}	2.0	20.0	20.1
2.B-10	NH ₃	2.0	20.0	20.1
2.C.1	SO ₂	0.5	125.0	125.0
2.C.1	NO _x	0.5	40.0	40.0
2.C.1	NMVOC	0.5	125.0	125.0
2.C.1	PM _{2.5}	0.5	40.0	40.0
2.C.2	PM _{2.5}	5.0	40.0	40.3
2.C.7	SO ₂	5.0	125.0	125.1
2.C.7	NO _x	5.0	40.0	40.3
2.C.7	NMVOC	5.0	125.0	125.1
2.D	NMVOC	5.0	20.0	20.6
2.G	PM _{2.5}	20.0	40.0	44.7

NRF sector	Pollutant	Activity data uncertainty (%)	Emission factor uncertainty (%)	Combined uncertainty (%)
2.G	NH ₃	20.0	40.0	44.7
2.H	NO _x	10.0	40.0	41.2
2.H	NM VOC	10.0	40.0	41.2
2.H	PM _{2.5}	10.0	200.0	200.2
2.I	PM _{2.5}	1.0	40.0	40.0

4.2.4 Quality Assurance and Quality Control (QA/QC)

For the Austrian inventory, a quality management system is in place. For further information see Chapter 1.6. Concerning measurement and documentation of emission data there are also specific regulations in the Austrian legislation as presented in Table 178, which also address verification. Some plants that report emission data have quality management systems according to the ISO 9000 series or similar systems in place.

Table 178: Austrian legislation with specific regulations concerning measurement and documentation of emission data.

Source Category	Austrian legislation
2.A.1	BGBl. II Nr. 60/2007 Zementverordnung 2007
2.A.7	BGBl. 1994/498 Verordnung für Anlagen zur Glaserzeugung
2.C.1	BGBl. II Nr. 264/2014 Gießerei-Verordnung 2014
2.C.1	BGBl. II 1997/160 Verordnung für Anlagen zur Erzeugung von Eisen und Stahl BGBl. II 2007/290 Änderung der Verordnung über die Begrenzung der Emission von luftverunreinigenden Stoffen aus Anlagen zur Erzeugung von Eisen und Stahl
2.C.1	BGBl. II Nr. 160/1997 Begrenzung der Emission von luftverunreinigenden Stoffen
2.C.1	BGBl. III Nr. 141/2004 Protokoll zu dem Übereinkommen von 1979 über weiträumige grenzüberschreitende Luftverunreinigung betreffend Schwermetalle samt Anhängen und Erklärungen (in Anhang 2 angeführt)
2.A/2.B/2.C/2.D	BGBl. II 1997/331 Feuerungsanlagen-Verordnung
2.C 2/2.C 3/2.C 5	BGBl. II Nr. 86/2008 Begrenzung der Emission von luftverunreinigenden Stoffen aus Anlagen zur Erzeugung von Nichteisenmetallen und Refraktärmetallen – NER-V
2.A/2.B/2.C/2.D	BGBL I 115/1997 Immissionsschutzgesetz – Luft, IG-L
2.A/2.B/2.C/2.D	BGBl. I 127/2013 Emissionsschutzgesetz für Kesselanlagen – EG-K 2013

4.2.5 Planned Improvements

In chipboard production, gas and wood dust are used as fuels. As wood dust accumulates as waste material during chipboard production, it is not reported as a fuel in the energy balance, where fuel gas is reported and included in the fuel input of SNAP Category 03 Combustion in Production Processes.

As the emission factor used from SNAP Category 040601 Chipboard Production refers to all emissions from chipboard production, but emissions due to combustion of fuel gas in chipboard production are also included in SNAP 03, these emissions are double counted. However, it is not possible to separate emissions due to combustion of wood dust from gas as no detailed fuel input figures for chipboard production are available. Further investigation of this subject is planned and if possible the double count will be eliminated.

The methodology for calculating the emissions caused by non-ferrous metal and iron and steel production will be improved based on country specific data.

Further investigations concerning emission factors for full implementation of the data obtained from the VOC installations ordinance are still required. This evaluation is still ongoing. Also, more information on substances currently assumed as used as solvents is necessary. Due to the long process of obtaining data from reports of the VOC directive, it will only be possible to do a full investigation every few years, thus emissions are either bound to population growth or economic growth, or assumed constant for the time being.

4.3 NFR 2.A.1-2.A.3 Mineral Products

4.3.1 Fugitive Particulate Matter emissions

4.3.1.1 Source Category Description

In this category, fugitive PM emissions from bulk material handling are reported. These include emissions from quarrying and mining of minerals other than coal, construction and demolition and agricultural bulk materials. Most fugitive PM emissions are reported in NFR category 2.A.5, except emissions from cement that are reported in NFR category 2.A.1, from lime production that are reported in NFR category 2.A.2, and from agricultural bulk material that are reported in NFR category 3.D. Emissions from cement and lime production include point source emissions from kilns.

4.3.1.2 Methodological Issues

The general method for estimating fugitive particulate matter emissions involves multiplying the amount of bulk material by an emission factor (CORINAIR simple methodology). All emission factors were taken from a national study (WINIWARTER et al. 2001) and partly updated or amended (WINIWARTER et al. 2007). The update of 2007 includes

- new emission factors for handling bulk materials and updated methodology according to VDI¹⁰⁴ guidelines 3790;
- the inclusion of PM emissions from cement and limestone kilns from 1.A.2.f Other Industry under 2.A.1 and 2.A.2;
- updated methodology and emission factors for construction and demolition based on the CEPMEIP project¹⁰⁵.

¹⁰⁴ Association of German Engineers – VDI Verein Deutscher Ingenieure

¹⁰⁵ <http://www.air.sk/tno/cepmeip/>

In 2011, a confidential study was commissioned by the Association for Building Materials and Ceramic Industries, which contains a new EF for PM₁₀ for limestone (AMANN & DÄMON, 2011). The calculation was based on the evaluation of 20 studies, comparing different quarries, also for dolomite and basaltic rocks. It showed that the EF can be used for all three types of material. For the calculation of emission factors for PM_{2.5} and TSP, the relation TSP 100%, PM₁₀ 46.51%, PM_{2.5} 4.65% was used (WINIWARTER et al. 2007). For data before 2000, EFs were calculated using the same ratio, but a higher EF for dolomite, based on the study by WINIWARTER et al. (2001). Changes in emission factors over time can be explained by changes in material handling and dust abatement technology.

Emission factors are presented in Table 179. Activity data are mainly taken from national statistics and presented in Table 180.

Table 179: Emission factors (EF) for diffuse PM emissions from bulk material handling, mining and construction/demolition

Bulk material / mineral	EF TSP [g/t]	EF PM ₁₀ [g/t]	EF PM _{2.5} [g/t]
Magnesite ⁽¹⁾	216.20	101.61	10.81
Sand ⁽¹⁾	525.00	246.75	26.25
Gravel ⁽¹⁾	135.00	63.45	6.75
Silicates ⁽¹⁾	191.00	89.77	9.55
Dolomite ⁽⁴⁾ ⁽³⁾	141.90 (184.45)	66.00 (85.80)	6.60 (8.58)
Limestone ⁽³⁾	141.90	66.00	6.60
Basaltic rocks ⁽³⁾	141.90	66.00	6.60
Iron ore	216.78	104.70	30.43
Tungsten ore	25.12	11.86	3.75
Gypsum, Anhydride ⁽¹⁾	85.60	40.23	4.28
Lime ⁽¹⁾	122.70	110.43	79.76
Cement ⁽²⁾ ⁽¹⁾	11.4 (21.8)(41.9)	10.3 (19.6)(37.7)	9.2 (17.4)(33.5)
Cement & Lime milling	7.75	6.98	6.20
Rye flour	43.59	20.62	6.50
Wheat flour	43.59	20.62	6.50
Sunflower and rapeseed grist	24.76	11.85	3.79
Wheat bran and grist	10.90	5.16	1.63
Rye bran and grist	10.90	5.16	1.63
Concentrated feedingstuffs	30.28	14.32	4.51
Activity	EF TSP [g/m ²]	EF PM ₁₀ [g/m ²]	EF PM _{2.5} [g/m ²]
Total area under construction (for sub-category „Construction and demolition“ ⁽¹⁾)	173.4	86.7	8.67

⁽¹⁾ Source: WINIWARTER et al. 2007

⁽²⁾ Decreasing EF values are given for 2012 (2006)(1990)

⁽³⁾ Source: Amann & Dämon 2011

⁽⁴⁾ Decreasing EF values are given for 2012 (1990)

Table 180: Activity data for diffuse PM emissions from bulk material handling, mining and construction/demolition.

Activity data [t]	1990	1995	2000	2005	2010	2015
Magnesite	1 179 162	783 497	725 832	693 754	757 063	1 179 162
Sand	2 517 296	3 033 907	3 692 910	3 660 228	2 001 407	2 517 296
Gravel	14 264 676	17 192 140	20 978 974	25 361 797	28 304 033	14 264 676
Silicates	1 484 527	810 520	1 991 018	2 580 295	2 593 863	1 484 527
Dolomite	1 879 837	8 789 688	7 152 245	6 291 413	3 914 859	1 879 837
Limestone	15 371 451	19 079 581	23 823 529	22 643 754	21 189 887	15 371 451
Basaltic rocks	3 673 535	4 202 244	4 933 202	3 166 281	3 234 408	3 673 535
Iron ore	2 310 710	2 116 099	1 859 449	2 047 950	2 068 853	2 310 710
Tungsten ore	191 306	411 417	416 456	472 964	429 748	191 306
Gypsum, Anhydride	751 645	958 430	946 044	911 162	872 273	751 645
Lime, quick, slacked	512 610	522 934	654 437	788 328	764 845	512 610
Cement	3 693 539	2 929 973	3 052 974	3 221 167	3 097 043	3 693 539
Cement & Lime mill- ing	2 450 000	2 450 000	2 450 000	2 450 000	2 450 000	2 450 000
Rye flour	61 427	55 846	48 054	62 387	84 997	61 427
Wheat flour	259 123	287 461	291 482	324 160	451 086	259 123
Sunflower and rapeseed grist	19 900	108 600	121 200	121 200	121 200	19 900
Wheat bran and grist	64 781	71 865	73 303	100 185	126 075	64 781
Rye bran and grist	15 357	13 962	13 139	13 139	13 139	15 357
Concentrated feed- ing stuff	638 014	720 972	980 808	1 018 649	988 371	638 014
Activity data [m ²]	1990	1995	2000	2005	2010	2015
Total area under construction (for sub-category „Con- struction and demo- lition“	10 142 004	11 060 799	11 788 151	11 941 513	13 504 469	13 804 436

4.3.2 NFR 2.A.5 Mining, Construction/Demolition

4.3.2.1 Source Category Description

This category contains the sub categories “quarrying and mining of minerals other than coal” and “construction and demolition”. It covers, *inter alia*, particulate matter emissions from gypsum and anhydrite mining and from construction/demolition activities.

4.3.2.2 Methodological Issues

Mining activities for the years 1990, 1995 and 1999 were taken from WINIWARTER et al. (2001). From 2000 onwards, annual data from the Austrian mining handbook (e.g. BMWFW 2016) were used. Particulate matter emission factors for gypsum and anhydrite mining were taken from WINIWARTER et al. (2007).

Construction and demolition emissions are based on data from Statistik Austria on the total area under construction (in m²). This area is multiplied by emission factors for TSP, PM₁₀ and PM_{2.5} derived by WINIWARTER et al. (2007).

Emission factors and activity data for mining, construction/demolition and handling of products are presented in Table 179 and Table 180, above.

4.3.3 Category-specific Recalculations

- NFR 2.A.5.b, SNAP 040617 Other – Construction and demolition: Emissions changed, due to changes of the building-cost index
- The activity for 2012 until 2014 of the following categories provided by the Austrian mining handbook have changed (BMWWF 2016)
 - NFR 2.A.5.a, SNAP 04 06 17 Other – X4F
 - NFR 2.A.5.a, SNAP 040617 Other – X4G

4.4 NFR 2.B Chemical Products

4.4.1 NFR 2.B.1 Ammonia and 2.B.2 Nitric Acid Production

4.4.1.1 Source Category Description

Ammonia (NH₃) is produced by catalytic steam reforming of natural gas or other light hydrocarbons (e.g. liquefied petroleum gas, naphtha). Nitric acid (HNO₃) is produced from ammonia (NH₃), where in a first step NH₃ reacts with air to NO and NO₂ and then reacts with water to form HNO₃. Both processes are minor sources of NH₃ and NO_x emissions. During ammonia production, small amounts of CO are emitted.

In Austria there is only one producer of ammonia and nitric acid.

The following chart (Figure 41) depicts the process of ammonia synthesis, the main production lines (ammonia, urea, melamine, nitric acid, fertiliser etc.) with their main raw material as well their internal subsequent processing of related products (UMWELTBUNDESAMT 2004d).

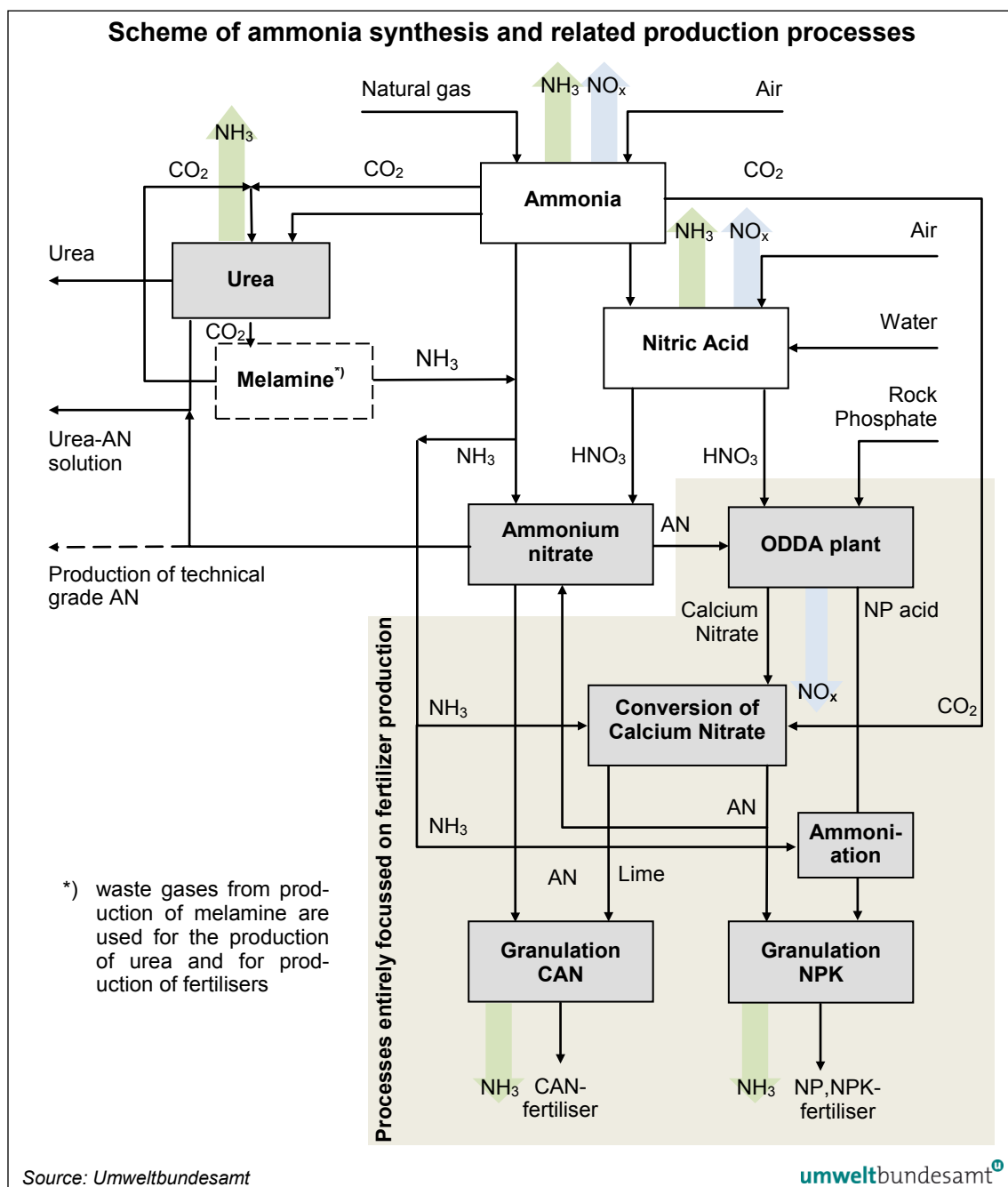


Figure 41: Scheme of ammonia synthesis and related production processes.

4.4.1.2 Methodological Issues

Activity data from 1990 and emission data from 1994 onwards were reported directly to UMWELTBUNDESAMT by the only producer in Austria and thus represent plant specific data. From emission and activity data, an implied emission factor (IEF) was calculated (see Table 181 and Table 182). The implied emission factor (IEF) that was calculated from activity and emission data from 1994 was applied to calculate emissions of the year 1993 for NO_x emissions and for the years 1990 to 1993 for NH_3 and CO emissions, as no emission data were available for these years. NO_x emissions decreased significantly in 2009, this is due to a change of combustion temperature in the plant. In 2010, and again in 2012, emissions increased due to process intrinsic fluctuations.

NO_x emissions from 1990 to 1992 are reported in category *2.B.5 Other processes in organic chemical industries*.

NH₃ emission factors vary depending on plant utilization and on the frequency of production process interruptions, e.g. because of catalyst change. The decrease of IEF and emissions in 2010 and 2011 is due to a new catalyst for nitrogen compounds. The following increase of NO_x and NH₃ emissions by about 12% in 2012 is a result of decreased activities of the catalyst. Exceptionally high NH₃ and CO emissions in 2013 can be attributed to a higher number of start-ups due to technical problems. A detailed process description of the Ammonia production and downstream processes can be found in the Austria's National Inventory Report (UMWELTBUNDESAMT 2017a).

Table 181: Emissions and implied emission factors for NO_x, NH₃ and CO from ammonia production (NFR Category 2.B.1).

Year	NO _x emission [t]	NO _x IEF [g/t]	NH ₃ emission [t]	NH ₃ IEF [g/t]	CO emission [t]	CO IEF [g/t]
1990	IE	NA	7.4	16.0	123.1	267.1
1995	285.9	604.4	10.7	22.6	95.1	201.1
2000	206.5	428.1	7.0	14.5	43.0	89.2
2005	244.0	509.9	9.9	20.7	52.6	109.9
2010	197.7	399.1	10.7	21.6	56.9	114.9
2011	184.7	367.6	10.7	21.3	49.0	97.5
2012	206.1	429.8	12.4	25.9	26.6	55.5
2013	169.4	389.2	26.3	60.4	75.5	173.5
2014	157.0	292.4	17.0	31.7	23.6	43.9
2015	198.4	381.6	9.5	18.3	61.2	117.7

Table 182: Emissions and implied emission factors for NO_x and NH₃ from nitric acid production (NFR Category 2.B.2).

Year	NO _x emission [t]	NO _x IEF [g/t]	NH ₃ emission [t]	NH ₃ IEF [g/t]
1990	IE	NA	1.4	2.6
1995	346.3	715.5	0.1	0.2
2000	406.5	761.6	0.4	0.7
2005	239.2	428.8	0.1	0.1
2010	144.0	262.9	7.8	14.2
2011	120.9	222.9	9.1	16.8
2012	120.2	224.8	7.1	13.3
2013	93.0	195.7	4.8	10.1
2014	92.3	167.2	3.4	6.2
2015	74.9	133.2	4.3	7.6

4.4.2 NFR 2.B.10 Other Chemical Industry

4.4.2.1 Source Category Description

This category includes NH₃ emissions from the production of ammonium nitrate, fertilizers and urea as well as NO_x emissions from fertilizer production. For the years 1990 to 1992, all NO_x emissions from inorganic chemical processes are reported as a total under this category.

This category furthermore includes SO₂ and CO emissions from inorganic chemical processes and NMVOC emissions from organic chemical processes, which were not further splitted into sub categories.

Emissions of minor importance are

- Heavy metals and particulate matter from fertilizers;
- PAH emissions from graphite production;
- Hg emissions from chlorine production (1999 changeover from mercury cell to membrane cell, thus no more emissions);
- HCB emissions from the production of per- and trichloroethylene (1992 cessation of production) and
- Particulate matter emissions from the production of ammonium nitrate.

4.4.2.2 Methodological Issues

Ammonium nitrate and urea production

For ammonium nitrate and urea production, activity data from 1990 and emission data from 1994 onwards were reported directly to UMWELTBUNDESAMT by the only producer in Austria and thus represent plant specific data.

NH₃ emissions were reported separately for each of the two production processes; CO emissions occur during urea production only. The implied emission factors for NH₃ and CO that were calculated from activity and emission data of 1994 were applied to calculate emissions of the years 1990 to 1993 as no emission data were available for these years.

TSP emissions from ammonium nitrate production were also reported directly to UMWELTBUNDESAMT by the only producer in Austria and represent plant specific data. The shares of PM₁₀ and PM_{2.5} are 90% and 80%, respectively, until 1996 (conventional plant) and 95% and 90% from 1997 onwards (modern plant), according to UMWELTBUNDESAMT (2001c).

Table 183: NH₃, TSP, PM₁₀ and PM_{2.5} emissions and implied emission factors for NH₃ emissions from Ammonium nitrate production.

Year	NH ₃ emission [t]	NH ₃ IEF [g/t]	TSP emission [t]	PM ₁₀ emission [t]	PM _{2.5} emission [t]
1990	0.71	72.39	12.80	11.52	10.24
1995	0.90	72.39	14.90	13.41	11.92
2000	0.20	12.89	0.20	0.19	0.18
2005	0.33	17.20	0.26	0.24	0.23
2010	0.30	23.08	0.20	0.19	0.18
2011	0.20	17.93	0.10	0.10	0.09
2012	0.40	29.64	0.10	0.10	0.09
2013	0.40	30.47	0.20	0.19	0.18
2014	0.30	23.23	0.10	0.10	0.09
2015	0.30	23.10	0.10	0.10	0.09

Table 184: Emissions and implied emission factors for NH₃ and CO emissions from urea production.

Year	NH ₃ emission [t]	NH ₃ IEF [g/t]	CO emission [t]	CO IEF [g/t]
1990	38.6	137.0	7.1	7.1
1995	47.7	121.4	9.7	9.7
2000	17.4	44.6	3.6	3.6
2005	30.1	72.3	3.8	3.8
2010	33.8	80.5	3.7	3.7
2011	41.1	96.3	3.6	3.6
2012	42.1	99.8	3.8	3.8
2013	34.3	97.5	3.3	3.3
2014	36.9	85.1	3.8	3.8
2015	42.8	98.5	3.7	3.7

Fertilizer production

For fertilizer production activity, data from 1990 to 1994 were taken from national production statistics¹⁰⁶ (Statistik Austria); NO_x and NH₃ emissions and activity data from 1995 onwards were reported by the main producer in Austria. For the years 1990 to 1993, NH₃ emissions were estimated using information on emissions from the main producer and extrapolation to total production. The emission estimate for 1994 was obtained by applying the average emission factor of the years 1995 to 1999. NO_x emissions from 1990 to 1992 are included in *Other processes in organic chemical industries*.

Cd, Hg and Pb emissions were calculated by multiplying the above mentioned activity data by national emission factors (HÜBNER 2001a) that derive from analysis of particulate matter fractions as described in MAGISTRAT DER LANDESHAUPTSTADT LINZ (1995). Particulate matter emissions (fugitive and non-fugitive) were estimated for the whole fertilizer production in Austria (WINIWARTER et al. 2007) for the years 1990, 1995 and 1999. Implied emission factors were calculated from emission and activity data that were used to calculate emissions from 2000 to 2005. The shares of PM₁₀ and PM_{2.5} are 58.6% and 30.9%, respectively, for the whole time-series.

Table 185: NO_x and NH₃ emissions from fertilizer production.

Year	NO _x emission [t]	NO _x IEF [g/t]	NH ₃ emission [t]	NH ₃ IEF [g/t]
1990	IE	IE	218.7	157.5
1995	60.0	65.5	37.2	40.6
2000	71.4	69.8	73.2	71.6
2005	89.4	85.6	25.4	24.3
2010	81.4	77.4	36.0	34.3
2011	76.5	72.3	37.8	35.7
2012	88.6	85.6	29.8	28.8
2013	58.9	66.1	28.3	31.8
2014	82.0	78.4	29.5	28.2
2015	115.9	111.0	22.8	21.8

¹⁰⁶ This results in an inconsistency of the time series, as activity data taken from national statistics represent total production in Austria, whereas the data obtained from the largest Austrian producer covers only the production of this producer. It is planned to prepare a consistent time series.

Table 186: Heavy metal and particulate matter emissions in fertilizer production.

Year	Cd [kg]	Hg [kg]	Pb [kg]	TSP [t]	PM ₁₀ [t]	PM _{2.5} [t]
1990	0.93	0.12	1.17	945	554	292
1995	0.62	0.08	0.77	434	254	134
2000	0.64	0.09	0.80	447	262	138
2005	0.65	0.09	0.81	456	267	141
2010	0.68	0.09	0.85	477	279	147
2011	0.56	0.08	0.70	390	228	120
2012	0.65	0.09	0.81	455	267	141
2013	0.54	0.07	0.67	375	220	116
2014	0.65	0.09	0.82	459	269	142
2015	0.66	0.09	0.82	462	271	143

Other processes in organic and inorganic chemical industries

All SO₂, NO_x and NMVOC process emissions from chemical industries (both organic and inorganic) are reported together as a total in category *2.B.10 Other Chemical Industry*. For NO_x emissions from 1993 onwards, emission data have been split and allocated to the respective emitting processes (ammonia production, fertilizer production and nitric acid production).

Activity data up to 1992 were taken from Statistik Austria. In the year 1997 a study commissioned by associations of industries was published (WINDSPERGER & TURI 1997). The activity figures for the year 1993 included in this study were used for all years afterwards, as no more up-to-date activity data are available.

Emission data for NO_x and CO were taken from the same study (WINDSPERGER & TURI 1997); they were obtained from direct inquiries at the industries. SO₂ emissions were re-evaluated by direct inquiries at the industries in 2004. NMVOC emissions were re-evaluated from 1994 onwards using data reported by the Austrian Association of Chemical Industry.

Activity data and emissions for NO_x, NMVOC, CO and SO₂ from other organic and inorganic chemical industries are presented in Table 187.

Table 187: Activity data and NMVOC, NO_x, SO₂ and CO emissions from other processes in organic and inorganic chemical industries.

Year	Processes in organic chemical industries		Processes in inorganic chemical industries			
	Activity	NMVOC emissions	Activity	NO _x emissions	SO ₂ emissions	CO emissions
	[t]		[t]			
1990	1 130 265	8 285	963 824	4 072	1 565	12 537
1995	1 193 928	9 207	908 640	IE	712	11 064
2000	1 066 788	1 665	908 640	IE	595	11 064
2005	1 066 788	1 325	908 640	IE	572	11 064
2010	1 066 788	1 325	908 640	IE	572	11 064
2011	1 066 788	1 325	908 640	IE	572	11 064
2012	1 066 788	1 325	908 640	IE	572	11 064
2013	1 066 788	1 325	908 640	IE	524	11 064
2014	1 066 788	1 325	908 640	IE	497	11 064
2015	1 066 788	1 325	908 640	IE	471	11 064

Chlorine, graphite and per- and trichloroethylene production

Hg emissions from chlorine production are calculated by multiplying production figures from industry by national emission factors (WINDSPERGER et al. 1999) that are based on WINIWARTER & SCHNEIDER (1995). In 1999 the chlorine producing company changed its production process from mercury cell to membrane cell. Therefore, for 1999 the EF was assumed to be half the value of the years before and since 2000 no Hg emissions result from chlorine production.

The production of graphite *electrodes* constitutes the only graphite production process in Austria. As no emission factor is available for this specific process, PAH emissions from graphite production are not estimated.

HCB emissions and production figures from per- and trichloroethylene production were evaluated in a national study (HÜBNER 2001b). The emission factor used is 60 mg/t product and is based on the study (UMWELTBUNDESAMT BERLIN 1998). From 1993 onwards there is no production of Per- and Trichloroethylene in Austria.

Table 188: Hg and HCB emission factors and emissions from other processes in organic and inorganic chemical industries.

Year	Chlorine production		Per- Trichloroethylene production	
	Hg EF [mg/t]	Hg emissions [kg]	HCB EF [mg/t]	HCB emissions [kg]
1990	3000	270.00	60	1.26
1995	2000	180.00	NO	NO
2000	NA	NA	NO	NO
2005	NA	NA	NO	NO
2010	NA	NA	NO	NO
2012	NA	NA	NO	NO
2013	NA	NA	NO	NO
2014	NA	NA	NO	NO
2015	NA	NA	NO	NO

4.4.3 Category-specific Recalculations

An update of the Sulfuric acid calculations leads to a decrease of SO₂ emissions from 2001 until 2009. One plant closed in 2009, which resulted in a further reduction of SO₂ emissions. For 2015 measured data became available, thus emissions were interpolated between 2015 and 2009, which led to a decrease of emissions in 2014 (-0.37 kt SO₂).

4.5 NFR 2.C Metal Production

In this category, emissions from iron and steel production and casting as well as process emissions from non-ferrous metal production and casting are considered.

4.5.1 NFR 2.C.1 Iron and Steel Production

4.5.1.1 Source Category Description

This sub category comprises emissions from blast furnace charging, basic oxygen furnace steel plants, electric furnace steel plants, rolling mills and iron casting operations.

4.5.1.2 Methodological issues

Blast Furnace Charging

In this category, PM, POP and heavy metal emissions are considered. SO₂, NO_x, NMVOC and CO emissions are included in category 1.A.2.a.

From 1990 to 2000 Heavy metals and POPs (dioxine, HCB) were calculated via multiplying activity data with emission factors. The emissions factors on process level (sinter, coke oven, blast furnace cowpers) were taken from unpublished national studies (HÜBNER 2001a¹⁰⁷), (HÜBNER 2001b¹⁰⁸). These emissions on process level have been summed up afterwards. From 2001 onwards the emissions were calculated by multiplying iron production by the implied emission factors for 2000, except dioxine emissions, which have been reported directly from plant operators since 2002.

Particulate matter emissions for the years 1990 to 2001 were taken from a national study (WINIWARTER et al. 2001). These emissions were taken from environmental declarations from the companies. For the years 2002 onwards, total particulate matter emissions are reported directly by the operator. Emission factors used for PCB are from the EMEP/EEA Emission Inventory Guidebook 2013 (EEA 2013).

Pig iron production figures were taken from national statistics. Activity data, POP, HM and PM emissions are presented in Table 189.

Table 189: Activity data and emissions from blast furnace charging.

Year	Activity [t]	Emissions [kg]			Emissions [g]				Emissions [t]		
	Iron	Cd	Hg	Pb	PAH	DIOX	HCB	PCB	TSP	PM ₁₀	PM _{2.5}
1990	3 444 000	342	218	26 307	341	33	7 241	8 610	6 209	4 346	1 863
1995	3 888 000	86	281	2 118	142	10	2 261	9 720	4 113	2 879	1 234
2000	4 320 000	98	236	2 557	139	12	2 657	10 800	4 174	2 922	1 252
2005	5 457 755	124	298	3 230	176	2	3 357	13 644	2 268	1 587	680
2010	5 643 855	129	308	3 340	182	2	3 472	14 110	849	595	255
2011	5 821 687	133	317	3 445	187	1	3 581	14 554	931	651	279
2012	5 751 357	131	314	3 404	185	1	3 538	14 378	821	575	246
2013	6 144 149	140	335	3 636	198	2	3 780	15 360	811	568	243
2014	6 015 000	137	328	3 560	194	2	3 700	15 038	779	545	234
2015	5 794 527	132	316	3 429	186	1	3 564	14 486	718	503	215

Following a recommendation from the last CLRTAP review, coke input in the sinter plant, coke oven output and blast furnace cowpers, are presented in Table 190: Activity data for the sub processes from 1990 until 2000 Table 190.

Table 190: Activity data for the sub processes from 1990 until 2000.

Year	Activity [GJ]		
	sinter	coke oven	blast furnace cowpers
	coke oven input	coke oven output	blast furnace gas
1990	6 544 261	49 157 826	9 370 000
1995	4 740 138	41 264 751	9 621 911
2000	5 561 462	39 472 500	14 403 000

¹⁰⁷ according to EUROPEAN COMMISSION IPPC BUREAU (2000); MAGISTRAT DER LANDESHAUPTSTADT LINZ (1995)

¹⁰⁸ according to HÜBNER (2000); EUROPEAN COMMISSION IPPC BUREAU (2000); UMWELTBUNDESAMT BERLIN (1998)

Basic Oxygen Furnace Steel Plant

In this category, POP and heavy metal emissions are considered. SO₂, NO_x, NMVOC and CO emissions are included in category 1.A.2.a. PM emissions are reported together with emissions from blast furnace charging.

Emission factors for heavy metal emissions were taken from national studies: 1990–1994 (WINDSPERGER et al. 1999), 1995–2000 (HÜBNER 2001a¹⁰⁷), the latter was also used for the years 2001 onwards, and multiplied with steel production to calculate HM emissions. POP emissions were calculated by multiplying steel production by national emission factors (HÜBNER 2001b¹⁰⁸) and, for PCB, with emission factors from the EMEP/EEA Emission Inventory Guidebook 2013 (EEA 2013).

Steel production data were taken from national production statistics, the amount of electric steel was subtracted. Activity data, POP and HM emission factors are presented in Table 191; particulate matter emissions are reported together with emissions from blast furnace charging.

Table 191: Activity data, HM and POP emission factors and PM emissions from basic oxygen furnace steel plants.

Year	Activity [t]	EF [mg/t]				EF [µg/t]			Emissions [t]		
		Cd	Hg	Pb	PAH	DIOX	HCB	PCB	TSP	PM ₁₀	PM _{2.5}
1990	3 921 341	19	3	984	0.04	0.69	138	2 500	IE	IE	IE
1995	4 538 355	13	1	470	0.01	0.23	46	2 500	IE	IE	IE
2000	5 183 461	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
2005	5 900 810	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
2010	6 570 357	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
2011	6 785 682	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
2012	6 746 210	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
2013	7 290 218	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
2014	7 185 000	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
2015	7 020 178	13	1	470	0.01	0.23	46	2 500	IE	IE	IE

Electric Furnace Steel Plant

Estimation of emissions from electric furnace steel plants was carried out by multiplying production data by an emission factor. Activity data was provided by the Association for Mining and Steel Industry from 2005 onwards. The emission factors used and their sources are summarized in Table 192 together with electric steel production figures.

Table 192: Activity data and emission factors for emissions from Electric Steel Production 1990–2015.

	1990	1995	2000	2005	2010	2015
Activity [t]	370 107	453 645	540 539	622 485	637 383	667 000
Emission factor [g/t Electric steel production]						
SO ₂	590 ⁽¹⁾	511 ⁽³⁾	119 ⁽³⁾	40 ⁽²⁾	→	40 ⁽²⁾
NO _x	330 ⁽¹⁾	295 ⁽³⁾	119 ⁽³⁾	84 ⁽²⁾	→	84 ⁽²⁾
NM VOC	70 ⁽¹⁾	→	→	→	→	70 ⁽¹⁾
CO	52 000 ⁽¹⁾	44 594 ⁽³⁾	7 565 ⁽³⁾	159 ⁽²⁾	→	159 ⁽²⁾
Emission factor [mg/t Electric steel production]						
Cd	80.0 ⁽⁴⁾	13.0 ⁽⁵⁾	13.0 ⁽⁵⁾	0.4 ⁽²⁾	→	0.4 ⁽²⁾
Hg	75.0 ⁽⁴⁾	1.0 ⁽⁵⁾	→	→	→	1.0 ⁽⁵⁾
Pb	4 125.0 ⁽⁴⁾	470.0 ⁽⁵⁾	470.0 ⁽⁵⁾	19.3 ⁽²⁾	→	19.3 ⁽²⁾
PAH	13.8 ⁽⁶⁾	4.6 ⁽⁶⁾	→	→	→	4.6 ⁽⁶⁾
Emission factor [µg/t Electric steel production]						
DIOX	4.2 ⁽⁶⁾	1.4 ⁽⁶⁾	1.4 ⁽⁶⁾	0.1 ⁽²⁾	→	0.1 ⁽²⁾
HCB	840.0 ⁽⁶⁾	280.0 ⁽⁶⁾	280.0 ⁽⁶⁾	20.0 ⁽²⁾	→	20.0 ⁽²⁾
PCB	2500 ⁽¹⁰⁾	→	→	→	→	2500 ⁽¹⁰⁾
Emission factor [g/t Electric steel production]						
TSP	610.0 ⁽⁷⁾	610.0 ⁽⁷⁾	30.0 ⁽⁷⁾	→	→	30.0 ⁽⁷⁾
PM ₁₀	579.5 ⁽⁸⁾	579.5 ⁽⁸⁾	28.5 ⁽⁸⁾	→	→	28.5 ⁽⁸⁾
PM _{2.5}	549.0 ⁽⁹⁾	549.0 ⁽⁹⁾	27.0 ⁽⁹⁾	→	→	27.0 ⁽⁹⁾

Emission factor sources:

⁽¹⁾ (WINDSPERGER & TURI 1997), study published by the Austrian chamber of commerce, section industry. This study reported total VOC and did not distinguish between methane and NMVOC. According to the 2006 IPCC Guidelines (IPCC 2006), chapter 4.2.2.2, VOC emissions in electric steel production consist of NMVOC only. Hence, it was assumed that the VOC emission factor according to this study equals the NMVOC emission factor.

⁽²⁾ Mean values as reported from industry (Association of Mining and Steel Industries).

⁽³⁾ Interpolated values (expert judgement UMWELTBUNDESAMT).

⁽⁴⁾ (WINDSPERGER et. al. 1999)

⁽⁵⁾ (HÜBNER 2001a¹⁰⁷)

⁽⁶⁾ (HÜBNER 2001b¹⁰⁸)

⁽⁷⁾ (EMEP/CORINAIR Emission Inventory Guidebook 2006, EEA 2007)

⁽⁸⁾ Expert judgement: 95% TSP

⁽⁹⁾ Expert judgement: 90% TSP

⁽¹⁰⁾ EMEP/EEA Air Pollutant Emission Inventory Guidebook 2013, Chapter 2.C.1 Iron and Steel Production, Page 24, EEA 2013)

Rolling Mills

The emission factor for VOC emissions from rolling mills was reported directly by industry and thus represents plant specific data. Similarly to electric steel production, emissions are restricted to NMVOC (i.e. no methane emissions). Hence, it was assumed that VOC emissions equal NMVOC emissions, resulting in an emission factor of 1 g NMVOC/t steel produced.

Steel production data were taken from national production statistics, the amount of electric steel was subtracted.

Iron cast

SO₂, NO_x, NMVOC and CO emissions were calculated by multiplying iron cast (sum of grey cast iron, cast iron and cast steel) by national emission factors. Activity data were obtained from „Fachverband der Gießereiindustrie Österreichs“ (association of the Austrian foundry industry). The emission factors were taken from data published by the Association of the Austrian foundry industry (Fachverband der Gießereiindustrie).

Table 193: Activity data and emission factors for cast iron 1990–2015.

	1990	1995	2000	2005	2010	2015
Activity [t]	196 844	176 486	191 420	196 017	167 854	163 318
Emission factor [g/t Iron cast]						
SO ₂	170	140	140	130	—————>	130
NO _x	170	160	160	151	—————>	151
NMVOC	1 450	1 260	1 260	1 180	—————>	1 180
CO	20 020	11 590	11 590	10 843	—————>	10 843

Steel Cast

Emission factors for POP emissions were taken from a national study (HÜBNER 2001b). The emission factors used are 4.6 mg PAH per t cast iron, 0.03 µg Dioxine per t cast iron and 6.4 µg HCB per t cast iron. Heavy metal emissions were calculated by multiplying national emission factors (1990–1994: WINDSPERGER et. al. 1999; 1995 onwards: HÜBNER 2001a) by the same activity data used for POP emissions. The emission factors used are 1 mg Hg per t cast iron, 80 mg Cd (1990: 110 mg) per t cast iron and 2 g Pb (1990: 4.6 g) per t cast iron. Activity data until 1995 is taken from a national study (HÜBNER 2001b). From 1996 onwards, data published by the Association of the Austrian foundry industry (Fachverband der Gießereiindustrie) has been used.

Ferroalloys

An emission factor for TSP (1 kg/t Alloy) was taken from the EMEP/EEA Emission Inventory Guidebook 2009 (EEA 2009), emission factors for PM₁₀ and PM_{2.5} are based on expert judgement (PM₁₀ 95% TSP, PM_{2.5} 90%; same as for electric steel production).

4.5.2 NFR 2.C.2 – 2.C.6 Non-ferrous Metals

4.5.2.1 Source Category Description

In this category, process emissions from non-ferrous metal production as well as from non-ferrous metal cast (light metal cast and heavy metal cast) are considered.

4.5.2.2 Methodological issues

Non-ferrous Metals Production

Gaseous emission estimates for non-ferrous metal production were taken from a study (WINDSPERGER & TURI 1997) and used for all years: 0.4 kt SO₂, 0.01 kt NMVOC and 0.2 kt CO.

POP emissions from aluminium production were estimated in a national study (HÜBNER 2001b) and were 6 090 kg PAH and 0.002 g Dioxine in 1990. Primary Aluminium production in Austria was terminated in 1992.

Secondary lead production (2.C.5) constitutes a key category due to its level of lead emissions and trend in cadmium emissions. Emissions were calculated from national data (BMWWF 2016) using national emission factors (HÜBNER 2001a) and emission factors from the EMEP/EEA Emission Inventory Guidebook 2013 (EEA 2013) for PCB.

Non-ferrous Metals Casting

Activity data were obtained from „Fachverband der Gießereiindustrie Österreichs“ (association of the Austrian foundry industry). The applied emission factors as presented below were taken from a study commissioned by the same association (Fachverband der Gießereiindustrie) and from direct information from this association.

Table 194: Activity data and emission factors for non-ferrous (light metal) cast 1990–2015.

	1990	1995	2000	2005	2010	2015
Activity [t]	46 316	59 834	92 695	109 927	121 426	140 749
Emission factor [g/t light metal cast]						
SO ₂	120	10	→			10
NO _x	330	230	230	170	→	170
NM VOC	4 040	1 740	1 740	1 289	→	1 289
CO	2 340	880	880	660	→	660

Table 195: Emission factors and activity data for heavy metal cast 1990–2015.

	1990	1995	2000	2005	2010	2015
Activity [t]	8 525	10 384	13 214	18 456	16 577	12 814
Emission factor [g/t heavy metal cast]						
SO ₂	100	80	→			80
NO _x	100	80	→			80
NM VOC	1 390	1 180	→			1 180
CO	3 290	2 770	→			2 770

4.5.3 Category-specific Recalculations

- NFR 2.C.5, SNAP 030307 Lead Production: activity data for 2013 until 2014 have changed due to a correction of the Austrian mining handbook (BMWWF 2016)
- NFR 2.C.3, SNAP 030310 Aluminium production: data for 2014 have been updated with ETS data

4.6 NFR 2.D.3-2.G Solvents and other Product use

This chapter describes the methodology used for calculating air emissions from Solvent and Other Product Use in Austria. Solvents are chemical compounds, which are used to dissolve substances as paint, glues, ink, rubber, plastic, pesticides or for cleaning purposes (degreasing). After application of these substances or other procedures of solvent use most of the solvents are released into air. Because solvents consist mainly of NMVOC, solvent use is a major source for anthropogenic NMVOC emissions in Austria. Once released into the atmosphere NMVOCs react with reactive molecules (mainly HO-radicals) or high energetic light to finally form CO₂.

Besides NMVOC further air pollutants from solvent use are relevant:

- Cd and Pb from NFR Sector 2.D.3.g Chemical products, as well as
- PAH, dioxins and HCB from NFR Sector 2.D.3.i Preservation of wood.
- PM from NFR 2.G Other (Fireworks and Tobacco Smoking)

The following activities are covered by NFR sector 2.D.3-G:

NFR category	Description
2.D.3.a	Domestic solvent use including fungicides
2.D.3.b	Road paving with asphalt
2.D.3.c	Asphalt roofing
2.D.3.d	Coating application
2.D.3.e	Degreasing
2.D.3.f	Dry cleaning
2.D.3.g	Chemical Products
2.D.3.h	Printing
2.D.3.i	Other solvent use
2.G	Other product use

4.6.1 Emission Trends

In the year 2015, 57.1% of total NMVOC emissions in Austria (112.89 kt) originated from *Solvent and Other Product Use*. Table 196 presents the trend in NMVOC emissions by subcategories.

Table 196: Total NMVOC emissions and trend from 1990–2015 by subcategories of Category 2.D.3 Solvent and Other Product Use.

	2.D.3	2.D.3.a	2.D.3.d	2.D.3.e	2.D.3.f	2.D.3.g	2.D.3.h	2.D.3.i
	kt NMVOC							
1990	114.43	16.30	45.79	13.26	0.44	12.79	12.65	13.20
1991	107.80	17.11	41.98	12.25	0.42	11.72	11.98	12.35
1992	101.17	17.92	38.16	11.23	0.41	10.64	11.30	11.50
1993	94.53	18.74	34.35	10.21	0.40	9.57	10.62	10.65
1994	87.90	19.55	30.53	9.19	0.39	8.49	9.94	9.80
1995	81.27	20.36	26.72	8.18	0.37	7.42	9.26	8.95

	2.D.3	2.D.3.a	2.D.3.d	2.D.3.e	2.D.3.f	2.D.3.g	2.D.3.h	2.D.3.i
kt NMVOC								
1996	79.45	20.66	25.51	8.16	0.37	7.28	8.76	8.71
1997	77.63	20.96	24.30	8.14	0.37	7.15	8.25	8.46
1998	75.81	21.25	23.09	8.13	0.37	7.01	7.74	8.21
1999	73.98	21.55	21.88	8.11	0.36	6.88	7.24	7.97
2000	72.16	21.85	20.67	8.09	0.36	6.74	6.73	7.72
2001	71.96	21.93	20.38	8.34	0.36	6.64	6.55	7.76
2002	71.77	22.04	20.09	8.59	0.36	6.53	6.36	7.80
2003	71.57	22.14	19.79	8.83	0.37	6.43	6.18	7.83
2004	70.64	22.28	19.38	8.68	0.33	6.19	5.95	7.83
2005	69.72	22.43	18.97	8.52	0.29	5.96	5.73	7.83
2006	68.77	22.55	18.55	8.36	0.25	5.72	5.50	7.83
2007	67.77	22.62	18.14	8.20	0.21	5.49	5.28	7.83
2008	66.77	22.69	17.73	8.04	0.17	5.26	5.05	7.82
2009	65.75	22.75	17.32	7.88	0.13	5.02	4.83	7.82
2010	64.74	22.80	16.90	7.72	0.09	4.79	4.60	7.82
2011	64.02	22.88	16.78	7.57	0.06	4.55	4.38	7.82
2012	63.34	22.98	16.65	7.41	0.02	4.32	4.15	7.82
2013	63.76	23.12	16.93	7.41	0.02	4.32	4.15	7.82
2014	64.22	23.30	17.21	7.41	0.02	4.32	4.15	7.82
2015	64.50	23.30	17.49	7.41	0.02	4.32	4.15	7.82
1990–2015	-43.6%	43.0%	-61.8%	-44.2%	-96.1%	-66.2%	-67.2%	-40.8%
Share in National Total								
1990	40.8%	5.8%	16.3%	4.7%	0.2%	4.6%	4.5%	4.7%
2015	57.1%	20.6%	15.5%	6.6%	0.02%	3.8%	3.7%	6.9%

NMVOC emissions in this sector decreased by 43.9% between 1990 and 2015, due to technological improvement also resulting from the enforced laws and regulations in Austria:

Already in the early 1990ies the VOC content of products such as paints, varnishes, preservatives and glues was limited in Austria, the use of CKWs and Benzol was largely prohibited, the content of aromatic compounds limited and measures for installations applying VOC containing products were set:

- Solvent Ordinance (1991)¹⁰⁹ (repealed by Solvent Ordinance 1995)
- Solvent Ordinance 1995¹¹⁰ (repealed by Solvent Ordinance 2005)
- Paint finishing systems Ordinance (1995)¹¹¹ (repealed by VOC Installations Ordinance)

¹⁰⁹ Verordnung des Bundesministers für Umwelt, Jugend und Familie über Verbote und Beschränkungen von organischen Lösungsmitteln (**Lösungsmittelverordnung**), BGBl. Nr. 492/1991

¹¹⁰ Verordnung des Bundesministers für Umwelt über Verbote und Beschränkungen von organischen Lösungsmitteln (**Lösungsmittelverordnung 1995 – LMVO 1995**), BGBl 872/1995

¹¹¹ Verordnung des Bundesministers für wirtschaftliche Angelegenheiten über die Begrenzung der Emission von luftverunreinigenden Stoffen aus Lackieranlagen in gewerblichen Betriebsanlagen (**Lackieranlagen-Verordnung**), BGBl. Nr. 873/1995

In the subsequent years the legislation was adapted to be in line with European legislation:

- VOC Installations Ordinance (2002)¹¹², implementation of “Solvent Emission Directive”¹¹³
- VOC Ordinance 2005¹¹⁴ – implementation of “Paints Directive”¹¹⁵
- Amendment of VOC Ordinance (2005)¹¹⁶ – implementation of “Industrial Emissions Directive” 2010/75/EC¹¹⁷

Measures implemented in emission intensive activity areas such as coating, painting and printing as well as in the pharmaceutical industry range from primary measures such as substitution of solvents, reduction of solvent contents and shift to lower or non-solvent emitting processes to secondary measures which basically is waste gas treatment.

4.6.2 NMVOC Emissions from Solvent and other product use (Category 2.D.3.a-i)

4.6.2.1 Methodological Issues

Emissions are estimated using a combination of

- Top-down data from national statistics which provide information on the overall solvent use in Austria
- with bottom-up information from inquiries in solvent consuming sectors

Top down data:

Data from national import/export and production statistics provide a balance for substances used as solvents and solvents contained in products:

$$\text{Solvent Balance per Substance}_i = (\text{Substance}_i \text{ Import} - \text{Substance}_i \text{ Export} + \text{Substance}_i \text{ Production})$$

From the Solvent Balance per Substance (or substance group, respectively) the non-solvent use of substances (i.e. where the substance is used as a reagent) is subtracted:

$$\text{Solvent Use per Substance}_i = \text{Solvent Balance per Substance}_i - \text{Non Solvent Use of Substance}_i$$

¹¹² Verordnung des Bundesministers für Wirtschaft und Arbeit zur Umsetzung der Richtlinie 1999/13/EG über die Begrenzung der Emissionen bei der Verwendung organischer Lösungsmittel in gewerblichen Betriebsanlagen (VOC-Anlagen-Verordnung – VAV) BGBl II Nr. 301/2002

¹¹³ Council Directive 1999/13/EC of 11 March 1999 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations

¹¹⁴ Verordnung des Bundesministers für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft über die Begrenzung der Emissionen flüchtiger organischer Verbindungen durch Beschränkung des Inverkehrsetzens und der Verwendung organischer Lösungsmittel in bestimmten Farben und Lacken (**Lösungsmittelverordnung 2005 – LMV 2005**), BGBl. II Nr. 398/2005

¹¹⁵ Directive 2004/42/EC of the European Parliament and of the Council of 21 April 2004 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in decorative paints and varnishes and vehicle refinishing products and amending Directive 1999/13/EC

¹¹⁶ Verordnung des Bundesministers für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft, mit der die Lösungsmittelverordnung 2005 geändert wird (**Änderung der Lösungsmittelverordnung 2005**), BGBl. II Nr. 25/2013

¹¹⁷ Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)

For products containing solvents, such as paints and glues, a balance of imports and exports is made, and the solvent content is estimated. The production of solvent containing products is not accounted for in this equation, as the amount of solvents used for their production are already accounted for in the above mentioned balance based on substance (groups):

$$\text{Solvents in Product}_p = (\text{Solvent-containing Product}_p \text{ Import} - \text{Solvent-containing Product}_p \text{ Export}) * \text{Solvent content of Product}_p$$

The overall solvent use in Austria is then calculated as the sum of the balances per substance and the amounts of solvents contained in products imported and exported:

$$\text{Overall solvent use in Austria} = \sum_i \text{Solvent Use per Substance}_i + \sum_p \text{Solvents in Product}_p$$

QA/QC measures as explained under “recalculations” showed that variations from year to year reflect market effects rather than actual changes in overall consumption, this is why a regression estimation of the top down data is used rather than annual data, which fluctuates. Where data on the overall consumption is available from the bottom up approach, it is used for those years; data for the years in between is interpolated. The reason behind this approach is that it became apparent that an analysis of the statistical data every year is far more difficult than retrospective analysis of a period of years. In an annual evaluation of statistical data, it is impossible to differentiate between short term market or consumption effects and long term developments (such as new non solvent application processes) that would make methodological changes or new further inquiries/data necessary.

Bottom up data

Extensive inquiries concerning solvent applications were made in several studies in the 90ies (WINDSPERGER et al. 2002a/2002b/2004/2008): for a reference year (2000) and several other years (1980, 1990, 1995, 2003) and the amount of solvents consumed in the different sub categories was estimated.

In a first step an extensive survey on the use of solvents in the year 2000 was carried out in 1 300 Austrian companies (WINDSPERGER et al. 2002b). In this survey data about the solvent content of paints, cleaning agents etc. and on solvents used (both substances and substance categories) like acetone or alcohols were collected.

- Furthermore information were gathered about;
- type of application of the solvents
 - final application,
 - cleaner,
 - product preparation;
- type of waste gas treatment
 - open application,
 - waste gas collection,
 - waste gas treatment.

For every category of application and waste gas treatment an emission factor was estimated to calculate solvent emissions in the year 2000 (see Table 197).

Table 197: Emission factors for NMVOC emissions from Solvent Use.

Category	Factor
final application	1.00
cleaner	0.85
product preparation	0.05
open application	1.00
waste gas collection	0.50
waste gas treatment	0.20

The above mentioned survey was carried out in all industrial branches with solvent applications; results for solvent use per substance category were collected at NACE-level-4. The total amounts of solvents used per industrial branch were extrapolated using the number of employees (the values of “solvent use per employee” of the sample was multiplied by total employment of the relevant branches taken from national employment statistics (STATISTIK AUSTRIA 2000 & 1998) and using information from (KSV1870 INFORMATION 2000).

For three years (1980, 1990, 1995) the values for solvent use were extrapolated using the factor “solvent use per employee” of the year 2000 and the number of employees of the respective year taken from national statistics (Statistik Austria 2001) (WINDSPERGER et al. 2004). For the pillar year 2005 the structural business statistics (number of employees (NACE Rev.1.1)) were taken from (EUROSTAT 2008).

In a second step a survey in 1 800 households was conducted (WINDSPERGER et al. 2002a) for estimating the domestic solvent use (37 categories in 5 main groups: cosmetic, do-it-yourself, household cleaning, car, fauna and flora). Also, solvent use in the context of moonlighting besides commercial work and do-it-yourself was calculated.

The comparison of top down and bottom up approach helped to identify several additional applications that contribute to a large extent to the total amount of solvents used. Thus in a third step the quantities of solvents used in these applications such as windscreens wiper fluids, anti-freeze, hospitals, de-icing agents of aeroplanes, tourism, cement- respectively pulp industry, were estimated in surveys.

The outcome of these three steps was the total stock of solvents used for each application in the year 2000 (at SNAP level 3) (WINDSPERGER et al. 2002a). To achieve a time series the development of the economic and technical situation in relation to the year 2000 was considered. It was distinguished between “general aspects” and “specific aspects”. The information about these defined aspects were collected for three pillar years (1980, 1990, 1995) and were taken from several studies (SCHMIDT et al. 1998, BARNERT 1998) and expert judgements from associations of industries (chemical industry, printing industry, paper industry) and other stakeholders. On the basis of this information calculation factors were estimated. With these factors and the data for solvent use and emission of 2000 data for the years 1980, 1990 and 1995 was estimated. For the years in between data was linearly interpolated. Up until 2015, the 2000 data was also used for the subsequent years as no new survey had been conducted.

In 2015, for the years 2003 onwards new data and methods were applied, mainly data available from reports under directive 1999/13/EC (VOC Solvents Directive)¹¹⁸ were implemented in the model (see above).

¹¹⁸ VOC-Anlagen-Verordnung (VAV), BGBl. II Nr. 301/2002 vom 26.7.2002

Statistical data used for estimating the overall solvent use in Austria was re-evaluated for the years 2000 onwards: import-export/production statistics were screened for items that weren't considered, but should have been considered, as well as for items that used to be considered, but might have included non-solvent uses. In addition, fluctuations in the timeline (i.e. significant differences between years) were checked and evaluated. Several changes were made resulting from this re-evaluation of the top-down data, the main changes were:

- non-methylated (un-denatured) ethanol is not considered any longer (as this normally is used for human consumption and because this category also included bioethanol used as fuel which is denatured after export; the category showed a strongly negative balance in the last years)
- non-solvent use of methanol in biodiesel production is now considered, thus subtracted from overall consumption.

Both changes (cumulated with other minor methodological changes as explained above) resulted in a decrease of the top down value for overall solvent consumption with the highest effect in the mid 00 years.

As the overall top down data shows fluctuations that reflect market effects rather than actual changes in overall consumption, interpolated top down data is now used, also for previous years (see further explanations under methodological issues). For the reporting year 2015, data based on the assumptions of growth of the sector was applied, or constant emissions assumed. An in-depth re-evaluation of data obtained from reports under the VOC solvents directive is currently being performed, as well as further re-evaluations of the top down approach.

Top down / bottom up combination

Data from the top down/bottom up approach (for the reference year 2000) were compared, and sub sectors further investigated, until the data matched. This was also done for the recalculation for the years after 2000. Data was then split into sub sectors (based on those investigations) and this data also used for the extra- and interpolation of data for those years, for which no data on the development of the market was available. Finally, emission factors mainly from the inquiries of the bottom up approach were applied, resulting in final emissions data per sub category.

For the years 2003 onwards the following improvements were made:

- new data collected in the course of the VOC installations ordinance mentioned above was used to update emissions data for 2012:

Data available from reports under directive 1999/13/EC (VOC Solvents Directive)¹¹⁹ was collected, and the allocation of the respective companies to different subsectors of the directive checked, and compare to those of the reporting requirements. It has to be noted that the reporting requirement under this directive (ordinance) comprises only emissions data, that's why the full implementation into the model requires further investigations concerning emission factors. Where no complete coverage was given, employment data was used to extrapolate emissions for total sub category emission in Austria. For those categories where the number of companies reporting was either too low or where the classification was unclear, trends of the VOC emissions reports were used. This concerns car repairing and maintenance, winding wire coating, surface cleaning (incl. electronics industry), and natural rubber.

- Domestic use: extrapolation using population data
- Paints: extrapolation using paint consumption

¹¹⁹ VOC-Anlagen-Verordnung (VAV), BGBl. II Nr. 301/2002 vom 26.7.2002

4.6.2.2 Activity data

Table 198: Activity data for solvent and other product use [t] 1990–2015

NFR		2.D.3.d						
SNAP	Total	060101	060102	060103	060104 ¹²⁰	060105	060107	060108
Unit	t Solvent							
1990	54 665	1 785	995	3 827	4 535	5 626	7 002	30 896
1991	48 827	1 515	889	3 542	3 558	5 061	6 139	28 124
1992	41 825	1 230	763	3 140	2 627	4 366	5 160	24 540
1993	45 119	1 254	823	3 502	2 382	4 742	5 460	26 956
1994	45 044	1 179	823	3 609	1 929	4 767	5 345	27 392
1995	52 085	1 280	953	4 304	1 714	5 550	6 059	32 226
1996	49 249	1 303	904	4 073	1 666	5 177	5 537	30 589
1997	52 612	1 495	968	4 355	1 830	5 452	5 702	32 809
1998	47 117	1 435	870	3 904	1 686	4 809	4 907	29 505
1999	42 917	1 399	796	3 559	1 581	4 311	4 281	26 991
2000	44 087	1 507	805	6 056	IE	4 272	4 116	27 331
2001	44 187	1 608	820	5 755	IE	4 256	4 051	27 696
2002	44 289	1 711	835	5 455	IE	4 240	3 986	28 062
2003	44 393	1 814	849	5 154	IE	4 224	3 920	28 431
2004	44 314	1 909	860	4 854	IE	4 188	3 836	28 667
2005	44 374	2 011	874	4 554	IE	4 166	3 764	29 004
2006	44 190	2 017	877	4 253	IE	4 178	3 776	29 089
2007	44 007	2 023	879	3 953	IE	4 190	3 787	29 174
2008	43 823	2 029	882	3 652	IE	4 202	3 798	29 260
2009	43 639	2 035	885	3 352	IE	4 215	3 809	29 345
2010	43 456	2 041	887	3 051	IE	4 227	3 820	29 430
2011	43 572	2 047	890	3 051	IE	4 239	3 831	29 515
2012	43 689	2 053	892	3 051	IE	4 251	3 842	29 600
2013	43 806	2 059	895	3 051	IE	4 264	3 853	29 685
2014	43 923	2 065	897	3 051	IE	4 276	3 864	29 770
2015	44 040	2 070	900	3 051	IE	4 288	3 875	29 855

*Due to methodological reasons 060104 emissions from 2000 onwards are included in 060103

NFR		2.D.3.e-f			
SNAP	Total	060201	060202	060203	060204
Unit	t Solvent				
1990	15 926	9 258	459	2 191	4 017
1991	14 001	7 866	408	1 902	3 826
1992	11 803	6 394	348	1 582	3 479
1993	12 527	6 528	373	1 655	3 971
1994	12 302	6 149	370	1 602	4 181
1995	13 990	6 687	426	1 794	5 083

¹²⁰ As it was impossible to distinguish between the domestic use of paints and construction, from 2000 onwards, numbers for domestic use are included in construction, buildings and DIY.

NFR		2.D.3.e-f			
SNAP	Total	060201	060202	060203	060204
Unit	t Solvent				
1996	13 989	6 626	417	1 694	5 252
1997	15 792	7 415	461	1 808	6 107
1998	14 933	6 955	428	1 617	5 933
1999	14 353	6 634	404	1 471	5 844
2000	15 259	7 002	422	1 481	6 354
2001	15 709	7 075	426	1 438	6 770
2002	16 162	7 148	430	1 395	7 189
2003	16 617	7 221	434	1 351	7 611
2004	16 996	7 261	436	1 301	7 999
2005	17 436	7 326	439	1 255	8 416
2006	17 488	7 348	441	1 259	8 440
2007	17 539	7 369	442	1 263	8 465
2008	17 590	7 391	443	1 266	8 490
2009	17 641	7 412	444	1 270	8 514
2010	17 692	7 434	446	1 274	8 539
2011	17 743	7 455	447	1 277	8 564
2012	17 794	7 477	448	1 281	8 588
2013	17 845	7 498	450	1 285	8 613
2014	17 897	7 520	451	1 288	8 638
2015	17 948	7 541	452	1 292	8 662

NFR		2.D.3.g								
SNAP	Total	060305	060306	060307	060308	060309	060310	060311	060312	060314
Unit	t Solvent									
1990	18 585	977	8 272	3 170	359	829	1 329	3	157	3 488
1991	15 609	853	6 886	2 582	313	743	1 158	3	131	2 940
1992	12 525	714	5 470	1 998	262	639	967	3	105	2 369
1993	12 603	752	5 440	1 926	275	691	1 017	3	104	2 394
1994	11 679	733	4 973	1 695	268	692	989	3	96	2 230
1995	12 465	826	5 223	1 697	302	803	1 114	4	101	2 395
1996	12 305	749	5 614	1 525	282	791	987	4	89	2 265
1997	13 722	764	6 749	1 541	297	879	980	4	87	2 420
1998	12 828	650	6 746	1 298	263	819	809	4	71	2 167
1999	12 196	561	6 812	1 104	236	777	671	4	57	1 974
2000	13 002	531	7 569	1 199	235	815	608	4	51	1 991
2001	12 806	507	7 455	1 199	236	755	604	4	48	1 999
2002	12 608	482	7 341	1 199	237	695	599	4	44	2 007
2003	12 408	457	7 225	1 199	238	635	595	4	41	2 015
2004	11 946	430	7 075	990	237	571	588	4	38	2 013
2005	11 721	404	6 949	980	238	509	583	4	35	2 019
2006	11 755	405	6 969	983	239	510	584	4	35	2 025
2007	11 789	406	6 990	986	240	512	586	4	35	2 031
2008	11 824	408	7 010	988	240	513	588	4	35	2 037

NFR		2.D.3.g								
SNAP	Total	060305	060306	060307	060308	060309	060310	060311	060312	060314
Unit		t Solvent								
2009	11 858	409	7 030	991	241	515	590	4	35	2 043
2010	11 892	410	7 051	994	242	516	591	4	35	2 049
2011	11 927	411	7 071	997	242	518	593	4	35	2 055
2012	11 961	412	7 092	1000	243	519	595	4	36	2 061
2013	11 996	414	7 112	1003	244	521	596	4	36	2 066
2014	12 030	415	7 132	1006	244	522	598	4	36	2 072
2015	12 064	416	7 153	1009	245	524	600	4	36	2 078

NFR		2.D.3.h/a/G							
SNAP	Total	060403	060404	060405	060406	060407	060408	060411	060412
Unit	t Solvent								
1990	48 748	14 729	510	836	677	217	13 842	4 984	12 952
1991	44 506	13 050	442	717	601	197	13 305	4 578	11 617
1992	38 946	11 089	366	588	512	171	12 200	4 029	9 992
1993	42 897	11 865	382	607	549	186	14 023	4 462	10 823
1994	43 705	11 749	369	579	545	188	14 857	4 569	10 849
1995	51 548	13 474	412	637	627	220	18 167	5 416	12 595
1996	49 960	12 541	369	601	594	203	18 238	5 265	12 149
1997	54 728	13 177	370	640	637	211	20 664	5 784	13 245
1998	50 278	11 594	309	571	572	183	19 608	5 329	12 110
1999	46 998	10 364	261	519	522	162	18 907	4 996	11 267
2000	48 643	10 242	241	521	528	158	20 161	5 186	11 607
2001	48 425	9 981	219	478	542	159	20 052	5 234	11 761
2002	48 202	9 718	196	434	555	159	19 942	5 282	11 916
2003	47 976	9 452	173	389	568	160	19 830	5 331	12 072
2004	47 523	9 141	150	343	579	160	19 624	5 355	12 172
2005	47 237	8 861	126	298	592	161	19 486	5 397	12 314
2006	47 376	8 887	127	299	594	161	19 544	5 413	12 350
2007	47 514	8 913	127	300	596	162	19 601	5 429	12 387
2008	47 653	8 939	128	301	597	162	19 658	5 445	12 423
2009	47 791	8 965	128	301	599	163	19 715	5 461	12 459
2010	47 930	8 991	128	302	601	163	19 772	5 476	12 495
2011	48 068	9 017	129	303	603	164	19 829	5 492	12 531
2012	48 207	9 043	129	304	604	164	19 886	5 508	12 567
2013	48 345	9 069	129	305	606	165	19 944	5 524	12 603
2014	48 484	9 095	130	306	608	165	20 001	5 540	12 639
2015	48 622	9 121	130	307	610	166	20 058	5 556	12 676

Table 199: Implied NMVOC Emission factors for Category 3 Solvent and Other Product Use 1990–2015.

NFR	2.D.3.d	2.D.3.d	2.D.3.d	2.D.3.d	2.D.3.d	2.D.3.d	2.D.3.d
SNAP	060101	060102	060103	060104	060105	060107	060108
Unit	[gNMVOC/t]						
1990	940 256	976 330	956 090	884 692	841 282	937 303	782 407
1991	995 278	1 079 452	1 042 770	987 644	876 001	996 312	773 410
1992	1 087 203	1 244 304	1 187 426	1 147 874	946 862	1 098 691	787 635
1993	930 283	1 138 812	1 074 975	1 056 727	808 490	956 376	627 194
1994	844 315	1 126 041	1 052 696	1 046 666	741 433	893 199	528 782
1995	644 408	961 188	890 970	887 692	582 884	714 144	374 290
1996	639 015	970 067	1 035 689	730 549	587 278	724 992	369 748
1997	562 120	864 713	1 056 730	498 707	521 971	649 233	321 819
1998	591 009	917 351	1 277 169	360 846	551 275	690 687	332 385
1999	612 007	954 447	1 508 643	192 460	569 886	718 814	335 500
2000	573 484	894 760	950 000	*	529 488	671 645	303 822
2001	577 070	891 965	950 000	*	527 394	671 485	299 166
2002	580 657	889 170	950 000	*	525 300	671 325	294 510
2003	584 243	886 375	950 000	*	523 207	671 166	289 854
2004	521 909	1 018 423	950 000	*	483 126	685 967	287 469
2005	463 879	1 143 144	950 000	*	440 782	698 949	284 123
2006	431 072	1 280 390	950 000	*	394 764	696 905	283 293
2007	398 457	1 416 836	950 000	*	349 014	694 873	282 467
2008	366 030	1 552 488	950 000	*	303 530	692 853	281 646
2009	333 792	1 687 354	950 000	*	258 310	690 845	280 829
2010	301 741	1 821 441	950 000	*	213 351	688 848	280 018
2011	269 874	1 954 755	950 000	*	168 651	686 863	279 211
2012	238 190	2 087 302	950 000	*	124 209	684 889	278 408
2013	242 257	2 122 948	950 000	*	126 330	696 586	283 163
2014	246 397	2 159 220	950 000	*	128 488	708 487	288 001
2015	250 664	2 195 871	950 000	*	130 685	720 598	292 924

* Due to methodological reasons emissions from 2000 onwards are included in 060103, that's why no IEF can be displayed here

NFR	2.D.3.e	2.D.3.f	2.D.3.e	2.D.3.e
SNAP	060201	060202	060203	060204
Unit	[gNMVOC/t]			
1990	934 873	950 000	777 577	722 712
1991	975 484	1 039 186	809 984	792 481
1992	1 046 492	1 184 334	870 514	908 204
1993	874 609	1 070 859	732 991	828 114
1994	768 729	1 045 245	655 312	817 272
1995	560 051	880 000	493 984	697 416
1996	546 592	891 107	495 071	704 360
1997	471 745	798 453	437 774	631 055
1998	485 181	853 166	460 145	675 667
1999	490 057	896 039	473 647	712 362
2000	446 651	850 000	438 516	679 438

NFR	2.D.3.e	2.D.3.f	2.D.3.e	2.D.3.e
SNAP	060201	060202	060203	060204
Unit	[gNMVOC/t]			
2001	442 449	848 808	426 636	678 723
2002	438 247	847 617	414 757	678 007
2003	434 045	846 425	402 878	677 292
2004	412 241	753 385	405 040	644 460
2005	389 301	658 842	405 922	612 534
2006	368 961	568 583	390 868	610 743
2007	348 740	478 850	375 902	608 962
2008	328 636	389 639	361 023	607 192
2009	308 648	300 945	346 230	605 432
2010	288 777	212 764	331 523	603 682
2011	269 020	125 091	316 901	601 942
2012	249 376	37 922	302 362	600 213
2013	248 661	37 813	301 496	598 493
2014	247 951	37 705	300 634	596 783
2015	247 244	37 598	299 778	595 083

NFR	2.D.3.g	2.D.3.g	2.D.3.g	2.D.3.g	2.D.3.g	2.D.3.g	2.D.3.g	2.D.3.g	2.D.3.g
SNAP	060305	060306	060307	060308	060309	060310	060311	060312	060314
Unit	[gMNVOC/t]								
1990	985 593	462 467	1 000 00	1 000 000	1 000 000	10 017	914 940	882 325	1 000 000
1991	1 090 003	482 792	1 113 928	1 110 237	1 108 816	11 122	1 013 206	981 620	1 112 035
1992	1 255 925	516 199	1 291 851	1 284 534	1 281 997	12 868	1 171 372	1 137 282	1 287 957
1993	1 148 044	426 939	1 187 146	1 179 378	1 176 981	11 815	1 076 468	1 044 598	1 182 844
1994	1 132 790	366 284	1 175 225	1 169 200	1 167 566	11 713	1 069 878	1 034 588	1 171 739
1995	963 984	252 837	1 000 000	1 000 000	1 000 000	10 017	918 806	882 325	1 000 000
1996	983 677	257 718	1 047 214	1 022 530	1 019 201	10 280	939 176	906 106	1 021 755
1997	885 891	233 090	971 699	924 021	919 380	9 313	850 358	821 456	922 897
1998	948 359	251 924	1 077 056	994 375	989 224	10 033	919 008	885 223	993 077
1999	993 801	268 052	1 176 003	1 050 159	1 046 408	10 579	976 998	933 260	1 049 175
2000	935 652	257 935	1 000 000	1 000 000	1 000 000	10 017	938 796	882 325	1 000 000
2001	934 525	258 140	1 000 000	1 000 000	1 000 000	10 021	939 598	882 737	1 000 000
2002	933 399	258 345	1 000 000	1 000 000	1 000 000	10 024	940 401	883 148	1 000 000
2003	932 272	258 549	1 000 000	1 000 000	1 000 000	10 028	941 204	883 560	1 000 000
2004	897 545	251 154	1 107 152	1 000 680	1 111 923	10 150	948 055	960 989	1 000 698
2005	855 033	242 575	1 014 177	997 837	1 247 466	10 238	951 639	1 049 467	997 873
2006	753 051	228 785	906 875	994 919	1 243 818	10 208	948 856	1 046 399	994 956
2007	651 663	215 074	800 199	992 019	1 240 192	10 178	946 090	1 043 348	992 055
2008	550 865	201 444	694 143	989 135	1 236 587	10 149	943 339	1 040 315	989 171
2009	450 651	187 892	588 702	986 268	1 233 002	10 119	940 605	1 037 300	986 304
2010	351 017	174 419	483 870	983 417	1 229 439	10 090	937 887	1 034 302	983 453
2011	251 956	161 023	379 643	980 583	1 225 896	10 061	935 184	1 031 321	980 619
2012	153 465	147 704	276 015	977 765	1 222 373	10 032	932 496	1 028 357	977 801
2013	153 025	147 281	275 224	974 964	1 218 871	10 003	929 824	1 025 411	975 000

NFR	2.D.3.g	2.D.3.g	2.D.3.g	2.D.3.g	2.D.3.g	2.D.3.g	2.D.3.g	2.D.3.g	2.D.3.g
SNAP	060305	060306	060307	060308	060309	060310	060311	060312	060314
Unit	[gMNVOc/t]								
2014	152 588	146 860	274 438	972 178	1 215 388	9 975	927 168	1 022 481	972 214
2015	152 153	146 442	273 656	969 408	1 211 926	9 946	927 168	1 019 568	969 444

NFR	2.D.3.h	2.G	2.G	2.G	2.G	2.D.3.a	2.D.3.a	2.G
SNAP	060403	060404	060405	060406	060407	060408	060411	060412
Unit	[gMNVOc/t]							
1990	859 068	200 885	859 961	990 475	850 000	838 540	940 864	890 009
1991	917 642	223 104	925 390	1 098 783	942 105	927 433	1 042 096	925 043
1992	1 018 855	258 180	1 032 642	1 270 750	1 089 030	1 071 460	1 204 237	997 275
1993	895 073	237 053	908 876	1 166 735	999 826	984 369	1 105 630	848 526
1994	846 216	234 969	857 128	1 157 232	992 032	978 360	1 097 388	774 480
1995	687 553	200 885	690 492	990 784	850 000	840 415	940 864	605 076
1996	698 261	291 011	696 672	1 012 326	869 948	855 778	959 656	609 277
1997	626 129	355 839	620 588	914 439	786 608	771 786	865 984	542 316
1998	667 882	504 663	657 603	984 126	846 634	830 724	931 761	575 036
1999	698 234	692 285	682 998	1 039 986	893 743	879 536	985 250	598 637
2000	657 120	851 108	638 702	991 618	850 000	841 680	940 864	562 242
2001	655 914	938 111	636 663	991 652	850 000	849 497	935 772	559 374
2002	654 708	1 045 958	634 625	991 685	850 000	858 436	931 784	556 506
2003	653 502	1 183 145	632 586	991 718	850 000	867 149	927 407	553 639
2004	651 134	1 231 817	772 171	973 138	849 478	881 781	929 129	549 113
2005	646 291	1 293 881	951 741	951 901	845 970	894 062	928 089	542 749
2006	619 085	1 127 193	1 011 270	949 118	843 496	896 072	930 176	541 162
2007	592 037	961 477	1 070 453	946 351	841 037	896 404	930 520	539 584
2008	565 147	796 725	1 129 291	943 600	838 592	896 637	930 762	538 016
2009	538 413	632 928	1 187 788	940 864	836 162	896 181	930 288	536 456
2010	511 834	470 078	1 245 947	938 145	833 745	895 689	929 778	534 906
2011	485 407	308 166	1 303 771	935 442	831 342	896 041	930 144	533 364
2012	459 133	147 185	1 361 262	932 754	828 953	897 490	931 647	531 832
2013	457 817	146 763	1 357 362	930 081	826 578	900 326	934 592	530 308
2014	456 509	146 344	1 353 484	927 424	824 216	904 818	939 254	528 793
2015	455 208	145 927	1 349 628	924 781	821 868	902 240	936 578	527 286

NMVOc emissions from road paving (2.D.3.b) with asphalt are accounted for in the solvents model (category 2.D.3.d chemical products) therefore emissions are reported as "IE".

NMVOc emissions from asphalt roofing (2.D.3.c) are accounted for in the solvents model (category 2.D.3.d chemical products) therefore emissions are reported as "IE".

In this category, CO emissions from the production of asphalt roofing are also considered. Emissions of this category are an important CO source under NFR Category 2 *Industrial Processes and Product Use*: In 2015, 41% of all CO emissions in this category originated from this category.

4.6.3 Emissions of Particulate Matter (PM) from Other Product Manufacture and Use (Category 2.G)

The category 2.G covers emissions which originate from the use of fireworks and tobacco.

	2.G other use (Use of fireworks (SNAP 0604))	2.G other use (Use of tobacco (SNAP 0604))
key category	no	no
pollutant	TSP, PM ₁₀ , PM _{2.5}	
activity	Inhabitants	
method	A country specific methodology is applied. ¹²¹	
	$\text{Emission}_{(\text{TSP, PM}_{10}, \text{PM}_{2.5})} = \text{activity} * \text{emission factor}_{(\text{TSP, PM}_{10}, \text{PM}_{2.5})}$	
emission factor	35 g PM _{2.5} / inhabitants (TSP = PM ₁₀ = PM _{2.5})	18 g PM _{2.5} / inhabitants (TSP = PM ₁₀ = PM _{2.5})
recalculation	no recalculation	

Table 200: PM₁₀ emission of Category 2.G Other Product Manufacture and Use 1990–2015.

NFR	PM ₁₀ emission of		
	2.G	2.G Use of fireworks	2.G Use of tobacco
SNAP	0604	0604	0604
Unit	t	t	t
1990	406.93	268.72	138.20
1995	421.26	278.19	143.07
2000	424.61	280.40	144.21
2001	426.24	281.48	144.76
2002	428.35	282.87	145.48
2003	430.27	284.14	146.13
2004	432.98	285.93	147.05
2005	435.94	287.88	148.06
2006	438.20	289.38	148.82
2007	439.65	290.33	149.31
2008	441.04	291.25	149.79
2009	442.10	291.95	150.15
2010	443.14	292.64	150.50
2011	444.59	293.60	150.99
2012	446.59	294.92	151.67
2013	449.29	296.70	152.59
2014	452.83	299.04	153.79
2015	456.90	301.73	155.17

¹²¹ Winiwarter, W.; Schmidt-Stejskal, H. & Windesperger, A. (2007): Aktualisierung und methodische Verbesserung der österreichischen Luftschadstoffinventur für Schwebstaub Endbericht. Dezember 2007. ARC—sys-0149.

4.6.4 Category-specific Recalculations

No recalculations have been carried out for this year's submission.

4.7 NFR 2.H Other processes

This category covers emissions in the pulp and paper and the food and beverages industry.

4.7.1 NFR 2.H.1 Pulp and Paper Industry

4.7.1.1 Source Category Description

As emissions from pulp and paper production mainly arise from combustion activities, they are included in *1.A.2 Combustion in Manufacturing Industries*.

In this category, gaseous emissions from chipboard production are considered. Particulate matter emissions from chipboard production and from supply and handling of wood chips for the paper and chipboard industry are reported under category *2.I Wood Processing*.

4.7.1.2 Methodological Issues

NO_x, NMVOC and CO emissions from chipboard production were calculated by applying national emission factors to production data (activity data). Activity data were taken from Statistik Austria. The values of 1995, 1998 and 2005 were also used for the following respective years because no data are available for these years. The emission factors applied were taken from a study (WURST et al. 1994), the values of 492 g NO_x/t, 361 g NMVOC/t and 357 g CO/t chipboard produced are averages of values obtained from inquiries with several chipboard producers.

Table 201: Activity data and gaseous emissions for chipboard production.

Year	Chipboard production [t]	Emissions [t]		
		NO _x	NMVOC	CO
1990	1 121 786	552	405	400
1995	1 194 262	588	431	426
2000	1 509 673	743	545	539
2005	2 182 251	1 074	788	779
2010	2 616 275	1 287	944	934
2011	2 715 207	1 336	980	969
2012	2 250 491	1 107	812	803
2013	2 073 551	1 020	749	740
2014	2 156 199	1 061	778	770
2015	2 485 766	1 223	897	887

4.7.2 NFR 2.H.2 Food and Beverages Industry

4.7.2.1 Source Category Description

This category includes NMVOC emissions from the production of bread, wine, spirits and beer and PM emissions from the production of beer. Furthermore this category includes POP emissions from smokehouses.

4.7.2.2 Methodological Issues

NMVOC emissions were calculated by multiplying the annual production by an emission factor. The following emission factors were applied:

- Bread4 200 g_{NMVOC}/t_{bread}
- Wine65 g_{NMVOC}/hl_{wine}
- Beer20 g_{NMVOC}/hl_{beer}
- Spirits2 000 g_{NMVOC}/hl_{spirit}

All emission factors were taken from BUWAL (1995) because of the very similar structures and standards of industry in Austria and Switzerland. Activity data were taken from national statistics (Statistik Austria). For the year 2008 no activity data are available, therefore the values of 2007 were also used for 2008.

PM emissions from beer production correspond to fugitive emissions from barley used for the production of malt. Emissions were estimated in a national study (WINIWARTER et al. 2001) and amount to:

- TSP..... 1990: 2.2 t, 1995: 2.1 t, 1999–2005: 1.9 t
- PM₁₀..... 1990: 1.1 t, 1995: 1.0 t, 1999–2005: 0.9 t
- PM_{2.5}..... 1990: 0.5 t, 1995: 0.3 t, 1999–2005: 0.3 t

POP emissions from smokehouses were estimated in an unpublished study (HÜBNER 2001b¹²²) that evaluates POP emissions in Austria from 1985 to 1999. The authors of this study calculated POP emissions using technical information on smokehouses and the number of smokehouses from literature (WURST & HÜBNER 1997), (MEISTERHOFER 1986). The amount of smoked meat was also investigated by the authors of this study. From 2000 onwards the emission values of 1999 have been used as no updated emissions are available. Activity data and emissions are presented in Table 202.

Table 202: POP emissions and activity data from smokehouses 1990–2015.

Year	Activity [t]	Emissions		
	Smoked meat	PAH [kg]	Diox [g]	HCB [g]
1990	15 318	545	1.8	358
1995	19 533	107	0.4	72
2000	19 533	37	0.1	26
↓	↓	↓	↓	↓
2015	19 533	37	0.1	26

¹²² according to MEISTERHOFER (1986)

4.7.3 Category-specific Recalculations

No recalculations have been carried out for this year's submission.

4.8 NFR 2.I Wood Processing

4.8.1 Source Category Description

This category includes particulate matter emissions from supply (production) and handling of wood-chips and sawmill-by-products for the use in chipboard and paper industry and for the use in combustion plants.

The following subcategories are included:

- Generic wood processing
- Supply and handling of wood chips and sawmill by-products for the use in chipboard and paper industry (split into two sub-categories)
- Use of wood chips and sawmill by-products in chipboard production
- Supply and handling of wood chips and sawmill by-products for use in combustion plants

Gaseous emissions from chipboard production are reported under category 2.H.1.

4.8.2 Methodological Issues

The methodology for emission calculation was developed in a national study (WINIWARTER et al. 2007) and emissions were calculated for 2001 applying emission factors of a Swiss study (EMPA 2004) to Austrian activities. Two major sources are identified: the sawmill industry including wood-processing and the chipboard industry.

Generic wood processing

For generic wood processing, the method developed by WINIWARTER et al. (2007) resulted in the following combined emission factors: TSP: 149.5 g/scm; PM₁₀: 59.8 g/scm; PM_{2.5}: 23.92.G/scm; applied to an activity of 4 Mio solid cubic metres (scm). Due to lack of activity data these values were used for the whole time-series.

Supply and handling of wood chips and sawmill by-products for the use in chipboard and paper industry

For this category, WINIWARTER et al. (2007) provided two distinct sets of emission factors for the following two situations:

- Wood chips produced on-site
- Wood chips and sawmill by-products acquired from off-site production

For the former situation, the mass of wood logs acquired and processed on-site was used as activity data. The same activity data was used for all years. Activity data and emission factors are shown in the following table.

Table 203: Activity data (used for all years) and emission factors for supply and handling of wood-chips and sawmill by-products for the use in chipboard and paper industry.

		Produced on-site	Produced off-site
		wood chips-industry-logs	wood chips-industry-byproduct
Emission factor [g/t]	TSP	30.0	20.0
	PM ₁₀	12.0	8.0
	PM _{2.5}	4.8	3.2

Use of wood chips and sawmill by-products in chipboard production

For chipboard production, emissions were calculated based on the amount of drawing-off air for production volume in 2001 (WINIWARTER 2007a, p 41). With these emissions an implied emission factor was calculated using chipboard production data from national statistics (Statistik Austria) that was applied to the whole time-series of chipboard production.

Supply and handling of wood chips and sawmill by-products for use in combustion plants

For supply and handling of wood chips and sawmill by-products for use in combustion plants, an implied emission factor was calculated using gross consumption of wood waste in the national energy balance that was applied to the whole time-series.

Table 204: Activity data and emissions for supply (production) and handling of wood-chips and sawmill by-products for the use in combustion plants.

Year	Wood waste – gross consumption [TJ]	Emissions [t]		
		TSP	PM ₁₀	PM _{2.5}
1990	11 788	25.81	10.32	4.13
1995	12 595	27.58	11.03	4.41
2000	29 982	65.65	26.26	10.50
2005	53 873	117.95	47.18	18.87
2010	104 029	227.77	91.11	36.44
2011	102 714	224.89	89.96	35.98
2012	107 372	235.09	94.04	37.61
2013	112 199	245.66	98.26	39.31
2014	99 448	217.74	87.10	34.84
2015	104 918	229.72	91.89	36.76

4.8.3 Category-specific Recalculations

NFR 2.I-Wood chips-boilers: Emissions from 2005 have been recalculated due to changes in the energy balances.

5 AGRICULTURE (NFR SECTOR 3)

5.1 Sector Overview

This chapter includes information on the estimation of the emissions of NEC gases, CO, particulate matter (PM), heavy metals (HM) and persistent organic pollutant (POP) of the sector *Agriculture* in Austria corresponding to the data reported in category 3 of the NFR format. It describes the calculations of source categories *3.B Manure Management*, *3.D Agricultural Soils* and *3.F Field Burning of Agricultural Residues*.

For the other pollutants the agricultural sector is only a minor source: emissions of SO₂, CO, heavy metals and POPs arise from category *3.F Field Burning of Agricultural Wastes*; the contribution to the national total for SO₂, CO, dioxin, HCBs and heavy metals was below 1.5% for the whole time series.

To give an overview of Austria's agricultural sector some information is provided below (according to the 2010 Farm Structure Survey – full survey and the Agriculture Structure Survey 2013) (BMLFUW 2000–2016): Agriculture in Austria is rather small-structured: 166 317 farms are managed, 56.4% of these farms manage less than 20 ha, whereas only 5.2% of the Austrian farms manage more than 100 ha cultivated area. 115 331 holdings are classified as situated in less favoured areas. Related to the federal territory Austria has the highest share of mountainous areas in the EU (70%).

The agricultural area comprises 2.73 million hectares that is a share of ~ 33% of the total territory (forestry ~ 41%, other area ~ 14%). The shares of the different agricultural activities are as follows:

- 50% arable land,
- 21% grassland (meadows mown several times and seeded grassland),
- 27% extensive grassland (meadows mown once, litter meadows, rough pastures, alpine pastures and mountain meadows),
- 2% other types of agricultural land-use (vineyards, orchards, house gardens, vine and tree nurseries).

5.2 General description

5.2.1 Completeness

Table 205 gives an overview of the NFR categories included in this chapter and presents the transformation matrix from SNAP categories. It also provides information on the status of emission estimates of all subcategories. A „✓“ indicates that emissions from this sub-category have been estimated.

Table 205: Overview of sub-categories of agriculture and status of estimation.

NFR Category		NEC gas				CO	PM				Heavy metals			POPs			
		NO _x	NM VOC	SO ₂	NH ₃	CO	TSP	PM ₁₀	PM _{2.5}		Cd	Hg	Pb	Dioxin	PAH	HCB	PCB
3.B.	MANURE MANAGEMENT	✓	NA	NA	✓	NA	✓	✓	✓		NA	NA	NA	NA	NA	NA	NA
3.B.1	Cattle	✓	NA	NA	✓	NA	✓	✓	✓		NA	NA	NA	NA	NA	NA	NA
3.B.1.a	Dairy Cattle	✓	NA	NA	✓	NA	✓	✓	✓		NA	NA	NA	NA	NA	NA	NA
3.B.1.b	Non-Dairy Cattle	✓	NA	NA	✓	NA	✓	✓	✓		NA	NA	NA	NA	NA	NA	NA
3.B.2	Sheep	✓	NA	NA	✓	NA	✓	✓	✓		NA	NA	NA	NA	NA	NA	NA
3.B.3	Swine	✓	NA	NA	✓	NA	✓	✓	✓		NA	NA	NA	NA	NA	NA	NA
3.B.4	Other Livestock	✓	NA	NA	✓	NA	✓	✓	✓		NA	NA	NA	NA	NA	NA	NA
	Buffalo	NO	NO	NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO	NO
	Goats	✓	NA	NA	✓	NA	✓	✓	✓		NA	NA	NA	NA	NA	NA	NA
	Horses	✓	NA	NA	✓	NA	✓	✓	✓		NA	NA	NA	NA	NA	NA	NA
	Mules and asses ¹⁾	IE	IE	IE	IE	IE	IE	IE	IE		IE	IE	IE	IE	IE	IE	IE
	Laying hens	✓	NA	NA	✓	NA	✓	✓	✓		NA	NA	NA	NA	NA	NA	NA
	Broilers	✓	NA	NA	✓	NA	✓	✓	✓		NA	NA	NA	NA	NA	NA	NA
	Turkeys	✓	NA	NA	✓	NA	✓	✓	✓		NA	NA	NA	NA	NA	NA	NA
	Other poultry	✓	NA	NA	✓	NA	✓	✓	✓		NA	NA	NA	NA	NA	NA	NA
	Other Animals	✓	NA	NA	✓	NA	✓	✓	✓		NA	NA	NA	NA	NA	NA	NA
3.D	AGRICULTURAL SOILS	✓	NA	NA	✓	NA	✓	✓	✓		NA	NA	NA	NA	NA	NA	NA
3.D.a.1	Inorganic N fertilizers	✓	NA	NA	✓	NA	✓	✓	✓		NA	NA	NA	NA	NA	NA	NA
3.D.a.2	Organic N fertilizers	✓	NA	NA	✓	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA	NA
3.D.a.2.a	Animal manure applied to soils	✓	NA	NA	✓	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA	NA
3.D.a.2.b	Sewage sludge applied to soils	✓	NA	NA	✓	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA	NA
3.D.a.2.c	Other organic fertilisers applied to soils (including compost)	✓	NA	NA	✓	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA	NA
3.D.a.3	Urine and dung deposited by grazing animals	IE	NA	NA	✓	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA	NA
3.D.a.4	Crop residues	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA	NA
3.D.b	Indirect emissions from managed soils	NO	NO	NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO	NO
3.D.c	Farm-level agricultural operations including storage, handling and transport of agricultural products	NO	NO	NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO	NO
3.D.d	Off-farm storage, handling and transport of bulk agricultural products	NA	NA	NA	NA	NA	✓	✓	✓		NA	NA	NA	NA	NA	NA	NA
3.D.e	Cultivated crops	NA	✓	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA	NA
3.D.f	Use of pesticides	NO	NO	NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO	NO
3.F	FIELD BURNING OF AGRICULTURAL RESIDUES	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	NA
3.I	Agriculture other	NO	NO	NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO	NO

¹⁾ included in 3.B.4 Horses

5.2.2 Key Categories

Austria's key category analysis is presented in Chapter 1.5. This chapter includes information on the agriculture sector. Key sources within this category are presented in Table 206.

Table 206: Key sources of sector Agriculture.

NFR Category	Source Categories	Key Categories	
		Pollutant	KS-Assessment
3.B.1	Manure Management (Cattle)	NH ₃	LA, TA
3.B.3	Manure Management (Swine)	NH ₃	LA, TA
3.B.4.e	Horses	NH ₃	TA
3.D.a.1	Inorganic N-fertilizers	NH ₃	LA, TA
3.D.a.1	Inorganic N-fertilizers	NO _x	TA
3.D.a.2	Organic fertilizers	NH ₃	LA, TA
3.D.a.2	Organic fertilizers	NO _x	LA, TA

LA = Level Assessment (if not further specified – for the years 1990 and 2015)

TA = Trend Assessment 1990–2015

5.2.3 Methodology

The Austrian sectorial inventory model follows the N-flow concept. NH₃ emissions are calculated on the basis of the amount of total ammoniacal nitrogen (TAN). TAN is present in the urine of animals and considered to be equivalent to the N content of urine. This calculation method is more precise than the calculation on the basis of total N excretion because emissions of NH₃ arise from TAN. The calculation addresses both N pools (N excretion and TAN) for the different stages of manure management (housing → storage → spreading) in terms of NH₃, NO_x and N₂O emissions and includes information of the total N amount within each relevant stage (N excretion), and the fraction of that amount that is present as TAN.

Table 207 includes a summary of the methodologies used in Austria's agriculture sector as recommended in the last CLRTAP review report for Austria (UNITED NATIONS, 2010).

Table : Summary of methodologies used in Austria's agriculture inventory.

NFR category		Methodology used
3.B Manure Management	3.B.1 Cattle	T3 (NH ₃), T1 (NO _x)
	3.B.2 Sheep	T2 (NH ₃), T1 (NO _x)
	3.B.3 Swine	T3 (NH ₃), T1 (NO _x)
	3.B.4 Other Livestock	T2 (NH ₃), T1 (NO _x)
3.D Agricultural Soils	3.D.a.1 Inorganic N fertilizers	T2 (NH ₃), T1 (NO _x)
	3.D.a.2.a Animal manure applied to soils	T3 (NH ₃), T1 (NO _x)
	3.D.a.2.b Sewage sludge applied to soils	T1
	3.D.a.2.c Other organic fertilisers applied to soils (including compost)	T1
	3.D.a.3 Urine and dung deposited by grazing animals	T3 (NH ₃)
	3.D.d Off-farm storage, handling and transport of bulk agricultural products	T1 (country-specific)
	3.D.e Cultivated crops	T1
3.F Field Burning of agricultural Residues		T1

The following table presents an overview of the country specific data used in the agriculture inventory including a short indication on the sources for this data.

Table 207: Information on country specific data used in sector agriculture

NFR category	Parameter	Source
3.B Manure Management		
3.B (all livestock)	AWMS distribution	AMON & HÖRTENHUBER (2010)
3.B (cattle, swine, chicken, horses)	Anaerobic digestion	AMON (2002), E-CONTROL (2016)
3.B (all livestock)	N excretion	PÖTSCH (2005), GRUBER & PÖTSCH (2006), STEINWIDDER & GUGGENBERGER (2003), UNTERARBEITSGRUPPE N-ADHOC (2004) UND ZAR (2004)
3.D. Agricultural Soils		
Austria's N-flow model	Country-specific consideration of N-losses	(AMON et al. 2002, 2008, 2010 & 2014)
Sewage sludge spreading	N content data	UMWELTBUNDESAMT (1997)
Compost application	N content data	Expert judgement by UMWELTBUNDESAMT (2015)

5.2.4 Uncertainty Assessment

The following chapter gives an estimate of uncertainties with respect to NO_x, NH₃, NMVOC, SO₂ and PM_{2.5} emissions from animal manures, agricultural soils as well as field burning of agricultural soils. Overall uncertainties result from uncertainties in the activity data and from uncertainties in the emission factors.

Activity data

In submission 2016 uncertainties of cattle and swine numbers were re-evaluated. Uncertainties were derived by analysing official Austrian livestock numbers published in June and December each year. Comparing these two data sets the standard deviation was calculated. As a conservative approach the doubled standard deviation was taken, leading to an uncertainty for dairy cattle of 2%, for non-dairy cattle of 1% and for swine of 4%.

Emission factors

Emission factors are rated based on the qualitative assessment (see Chapter 1.7, Table 25).

Table 209 presents uncertainties for emissions as well as for activity data and EFs used in sector agriculture according to the error propagation method (Tier 1).

Table 208: Uncertainties of emissions in sector 3 Agriculture.

NFR Categories		NO _x Emissions [%]	NH ₃ Emissions [%]	NMVOC Emissions [%]	SO ₂ Emissions [%]	PM _{2.5} Emissions [%]
3.B.1	Manure Management (Cattle)	+/-125.0%	+/-20.0%	NA	NA	+/-200.0%
3.B.2	Manure Management (Sheep)	+/-125.4%	+/-40.0%	NA	NA	+/-200.2%
3.B.3	Manure Management (Swine)	+/-125.1%	+/-20.0%	NA	NA	+/-200.0%

NFR Categories		NO _x Emissions [%]	NH ₃ Emissions [%]	NMVOC Emissions [%]	SO ₂ Emissions [%]	PM _{2.5} Emissions [%]
3.B.4	Manure Management (Other animals)	+/-125.4%	+/-40.0%	NA	NA	+/-200.2%
3.D.a.	Agricultural Soils	+/-125.1%	+/-40.3%	NA	NA	+/-200.1%
3.D.d	Off-farm storage	NA	NO	NA	NA	+/-200.1%
3.D.e	Cultivated Crops	NA	NA	+/-750.0%	NA	NA
3.F	Field Burning	+/-107.7%	+/-107.7%	+/-107.7%	+/-107.7%	+/-160.1%
Activity Data						
Animal Population - Cattle			+/- 1%			
Animal Population - Swine			+/- 4%			
Animal Population – Horses			+/- 10%			
Area Data & Fertilizer Input (combined)			+/- 5%			

5.2.5 Quality Assurance and Quality Control (QA/QC)

The following sector specific QA/QC procedures have been carried out:

1) Activity data check

- ✓ Check for transcription errors, comparison with published data (BMLFUW 2000–2016),
- ✓ Consistency checks of sub-categories with totals,
- ✓ Plausibility checks of dips and jumps;

2) Emission factors

- ✓ Comparison with EMEP/EEA default values and factors reported by other countries;

3) Calculation by spreadsheets

- ✓ Consistent use of livestock characterization,
- ✓ Cross-checks through all steps of calculation,
- ✓ Documentation of sources and correct use of units;

3) Results (emissions)

- ✓ Check of recalculation differences,
- ✓ Plausibility checks of dips and jumps;

4) Documentation

- ✓ Findings and corrections marked in the spreadsheets,
- ✓ Improvement list (internal and external findings).

In the Austrian QMS regularly extensive QA and verification activities are carried out (Tier 2 QA). In 2012 Agriculture was validated. Some minor inconsistencies with respect to the AWMS data have been found and corrected.

Due to the revision of the Austrian inventory model for sector agriculture according to the 2006 IPCC GL and the EMEP/EEA GB 2013 an external review by Austrian Agricultural experts within the framework of a stakeholder meeting was held in 2014. Applied values and parameters were discussed and validated by the national experts.

In the course of the most recent 'Re-Accreditation audit' (see chapter 1.6 on general QAQC) the technical auditor concentrated on the sector agriculture with a special focus on the technical process as well as internal documentation. The audit was successful, only some minor improvements in the internal documentation were suggested.

A general description of Austria's QMS (Quality Management System) is presented in Chapter 1.6.

5.2.6 Planned Improvements

Consultations and exploratory work for the planning of a new investigation on Austria's agriculture practice has been started in 2015. The official project start was in spring 2016 and the questionnaires were sent to the farmers by the end of 2016. The evaluation of data is planned for spring 2017 and the implementation to Austria's emission inventory is planned for submission 2018. Additionally it is planned to fully implement the EMEP/EEA 2016 Guidebook into the agriculture inventory within this revision.

5.3 NFR 3.B Manure Management

The Austrian sectorial inventory model follows the N-flow concept (AMON & HÖRTENHUBER 2014). In current air emission inventory, Austria started with the implementation of new methodologies and EFs provided in the EMEP/EEA GB 2016, published on 30th September 2016. The full implementation of the EMEP/EEA 2016 Guidebook is planned for submission 2018.

Data on animal husbandry and manure management systems all over Austria are based on the research project "Animal husbandry and manure management systems in Austria" (AMON et al. 2007) and led to a considerable improvement of the inventory quality (AMON & HÖRTENHUBER 2008 and AMON & HÖRTENHUBER 2010). An update of this study is scheduled for 2016–2017; the implementation of updated data on agricultural practice is planned for submission 2018.

5.3.1 Methodological Issues

NH₃ emissions from Sector 3 Agriculture are estimated according to the EMEP/EEA Air Pollutant Emission Inventory Guidebook (EEA 2013, EEA 2016). Emissions from cattle and swine are estimated using a country specific methodology which requires detailed information on animal characteristics and the manner in which manure is managed. NH₃ emissions from the non-key animal categories sheep, goats, poultry, horses and deer have been estimated using the detailed Tier 2 method following the current version of the EMEP/EEA Guidebook 2016. The Tier 2 method follows a mass flow analysis, which is more detailed and thus better reflects Austrian conditions.

NO_x emissions from manure management have been estimated using the default Tier 1 emission factors of the EMEP/EEA Guidebook 2016 (EEA 2016).

Animal numbers

The Austrian official statistics (STATISTIK AUSTRIA 2016b) provides national data of annual live-stock numbers on a very detailed level. These data are based on livestock counts held in December each year¹²³.

In Table 210 and Table 211 applied animal data are presented. Background information to the data is listed below:

From 1990 onwards: The continuous decline of dairy cattle numbers is connected with the increasing milk yield per cow: For the production of milk according to Austria's milk quota every year a smaller number of cows is needed.

1991: A minimum counting threshold for poultry was introduced. Farms with less than 11 poultry were not considered any more. However, the contribution of these small farms is negligible, both with respect to the total poultry number and to the trend.

The increase of the soliped population between 1990 and 1991 is caused by a better data collection from riding clubs and horse breeding farms.

1993: New characteristics for swine and cattle categories were introduced in accordance with Austria's entry into the European Economic Area and the EU guidelines for farm animal population categories. In 1993 part of the "Young cattle < 1 yr" category was included in the "Young cattle 1–2 yr" category. This shift is considered to be insignificant: no inconsistency in the emission trend of "Non-Dairy Cattle" category was recorded.

In the same year "Young swine < 50 kg" were shifted to "Fattening pigs > 50 kg" (before 1993 the limits were 6 months and not 50 kg which led to the shift) causing distinct inconsistencies in time series. Following a recommendation of the Centralized Review 2003, the age class split for swine categories of the years 1990–1992 was adjusted using the split from 1993.

1993: For the first time other animals e.g. deer (but not wild living animals) were counted. Following the recommendations of the Centralized Review 2004, to ensure consistency and completeness animal number of 1993 was used for the years 1990 to 1992.

1995: The financial support of suckling cow husbandry increased significantly in 1995 when Austria became a Member State of the European Union. The husbandry of suckling cows is used for the production of veal and beef; the milk yield of the cow is only provided for the suckling calves. Especially in mountainous regions with unfavourable farming conditions, suckling cow husbandry allows an extensive and economic reasonable utilisation of the pastures. Suckling cow husbandry contributes to the conservation of the traditional Austrian alpine landscape.

1996–1998: The market situation affected a decrease in veal and beef production, resulting in a declining suckling cow husbandry. Farmers partly used their former suckling cows for milk production. Thus, dairy cow numbers slightly increased at this time. Reasons are manifold: Changing market prices, BSE epidemic in Europe and change of consumer behaviour, milk quota etc.

1998–2000; 2006–2008: increasing/ decreasing swine numbers: The production of swine has a high elasticity to prices: Swine numbers are changing due to changing market prices very rapidly. Market prices change due to changes in costumer behaviour, saturation of swine production, epidemics etc.

¹²³ For cattle livestock counts are also held in June, but seasonal changes are very small (between 0% and 2%). Live-stock counts of sheep are only held in December (sheep is only a minor source for Austria and seasonal changes of the population are not considered relevant).

Table 209: Domestic livestock population and its trend 1990–2015 (I).

Year	Livestock category – Population size [heads] *						
	Dairy	Non-Dairy	Suckling Cows	Young Cattle < 1 yr	Breeding Heifers 1–2 yr	Fattening Heifers, Bulls, Oxen 1–2 yr	Other Cattle > 2 yr
1990	904 617	1 679 297	47 020	925 162	255 464	305 339	146 312
1991	876 000	1 658 088	57 333	894 111	253 522	301 910	151 212
1992	841 716	1 559 009	60 481	831 612	239 569	281 509	145 838
1993	828 147	1 505 740	69 316	705 547	257 939	314 982	157 956
1994	809 977	1 518 541	89 999	706 579	263 591	309 586	148 786
1995	706 494	1 619 331	210 479	691 454	266 108	298 244	153 046
1996	697 521	1 574 428	212 700	670 423	259 747	277 635	153 923
1997	720 377	1 477 563	170 540	630 853	259 494	254 986	161 690
1998	728 718	1 442 963	154 276	635 113	254 251	241 908	157 415
1999	697 903	1 454 908	176 680	630 586	255 244	233 039	159 359
2000	621 002	1 534 445	252 792	655 368	246 382	220 102	159 801
2001	597 981	1 520 473	257 734	658 930	241 556	214 156	148 097
2002	588 971	1 477 971	244 954	640 060	236 706	213 226	143 025
2003	557 877	1 494 156	243 103	641 640	229 150	216 971	163 292
2004	537 953	1 513 038	261 528	646 946	230 943	210 454	163 167
2005	534 417	1 476 263	270 465	628 426	229 874	206 429	141 069
2006	527 421	1 475 498	271 314	631 529	222 104	212 887	137 664
2007	524 500	1 475 696	271 327	634 089	211 044	226 014	133 222
2008	530 230	1 466 979	266 452	636 469	200 787	230 457	132 814
2009	532 976	1 493 284	264 547	643 441	196 476	249 486	139 334
2010	532 735	1 480 546	260 883	634 052	187 386	256 266	141 959
2011	527 393	1 449 134	256 831	623 364	184 160	245 770	139 009
2012	523 369	1 432 249	248 438	628 715	184 932	238 968	131 196
2013	529 560	1 428 722	236 655	626 970	191 002	243 546	130 549
2014	537 744	1 423 457	229 986	629 401	191 049	241 408	131 613
2015	534 098	1 423 512	224 348	624 483	194 493	244 588	135 600
Trend 90–15	-41.0%	-15.2%	377.1%	-32.5%	-23.9%	-19.9%	-7.3%

* adjusted age class split for swine as recommended in the UNFCCC centralized review (October 2003)

The FAO agricultural data base (FAOSTAT) provides worldwide harmonized data (FAO AGR. STATISTICAL SYSTEM 2001). In the case of Austria, these data come from the national statistical system (Statistik Austria). However, there are inconsistencies between these two data sets. Analysis shows that there is often a time gap of one year between the two data sets. FAOSTAT data are seemingly based on the official Statistik Austria data but there is an annual attribution error. In the Austrian inventory Statistik Austria data is used, they are the best available.

Table 210: Domestic livestock population and its trend 1990–2015 (II).

Year	Livestock category – Population size [heads] *							
	Swine	Young & Fattening Pigs > 20 kg	Breeding Sows > 50 kg	Young Swine < 20 kg	Sheep	Goats	Horses ¹⁾	Other (furred game) ^{**2)}
1990	3 687 981	2 347 001	382 335	958 645	309 912	37 343	49 200	37 100
1991	3 637 980	2 315 181	377 152	945 648	326 100	40 923	57 803	37 259
1992	3 719 600	2 367 123	385 613	966 864	312 000	39 400	61 400	37 418
1993	3 819 798	2 425 852	396 001	997 945	333 835	47 276	64 924	37 577
1994	3 728 991	2 368 061	394 938	965 992	342 144	49 749	66 748	37 736
1995	3 706 185	2 356 988	401 490	947 707	365 250	54 228	72 491	40 323
1996	3 663 747	2 311 988	398 633	953 126	380 861	54 471	73 234	41 526
1997	3 679 876	2 330 334	397 742	951 800	383 655	58 340	74 170	56 244
1998	3 810 310	2 456 935	386 281	967 094	360 812	54 244	75 347	50 365
1999	3 433 029	2 226 307	343 812	862 910	352 277	57 993	81 566	39 086
2000	3 347 931	2 160 338	334 278	853 315	339 238	56 105	82 943	39 612
2001	3 440 405	2 220 765	350 197	869 443	320 467	59 452	84 319	40 138
2002	3 304 650	2 146 968	341 042	816 640	304 364	57 842	85 696	40 664
2003	3 244 866	2 125 371	334 329	785 166	325 495	54 607	87 072	41 190
2004	3 125 361	2 016 005	317 033	792 323	327 163	55 523	89 816	42 102
2005	3 169 541	2 091 225	315 731	762 585	325 728	55 100	92 560	43 014
2006	3 139 438	2 038 170	321 828	779 440	312 375	53 108	95 304	43 926
2007	3 286 292	2 171 519	318 349	796 424	351 329	60 487	98 048	44 839
2008	3 064 231	2 023 536	297 830	742 865	333 181	62 490	100 792	45 751
2009	3 136 967	2 083 459	293 901	759 607	344 709	68 188	103 536	46 663
2010	3 134 156	2 084 923	284 691	764 542	358 415	71 768	106 280	47 575
2011	3 004 907	2 011 138	275 874	717 895	361 183	72 358	109 024	45 654
2012	2 983 158	2 001 150	263 200	718 808	364 645	73 212	111 768	43 733
2013	2 895 841	1 956 862	254 373	684 606	357 440	72 068	114 512	41 812
2014	2 868 191	1 928 596	246 870	692 725	349 087	70 705	117 256	41 812
2015	2 845 451	1 912 442	249 655	683 354	353 710	76 620	120 000	41 812
Trend 90–15	-22.8%	-18.5%	-34.7%	-28.7%	14.1%	105.2%	143.9%	12.7%

* from 1990 to 1992 adjusted age class split for swine as recommended in the centralized review (October 2003)

** furred game, mainly deer.

¹⁾ for the years 2000–2002 and 2004–2013: interpolated values

²⁾ for the years 1991–1993, 2000–2002, 2004–2009 and 2011–2012: interpolated values

For the year 2015 revised horse numbers were provided by the Ministry of Agriculture (BMLFUW 2016). Data used in previous inventories for the years from 2004 to 2014 (BMLFUW 2015) were based on agricultural structural surveys and INVEKOS data and did not fully cover all horse-owners in Austria. Horse numbers reported for the years before 2004 are based on livestock accountings and are assessed to be representative for Austria.

Table 211: Domestic livestock population and its trend 1990–2015 (III).

Year	Livestock category – Population size [heads] *					
	Total Poultry	Chicken **	Laying hens*	Broilers **	Turkeys***	Other Poultry***
1990	13 820 961	13 139 151	8 392 369	4 746 782	524 616	157 194
1991	14 397 143	13 478 820	8 340 068	5 138 752	759 307	159 016
1992	13 683 900	12 872 100	7 853 673	5 018 427	671 215	140 585
1993	14 508 473	13 588 850	8 307 661	5 281 189	793 431	126 192
1994	14 178 834	13 265 572	8 288 140	4 977 432	781 643	131 619
1995	13 959 316	13 157 078	7 899 011	5 258 067	679 477	122 761
1996	12 979 954	12 215 194	7 387 086	4 828 108	642 541	122 219
1997	14 760 355	13 949 648	7 894 150	6 055 498	693 010	117 697
1998	14 306 846	13 539 693	7 193 505	6 346 188	645 262	121 891
1999	14 498 170	13 797 829	6 786 341	7 011 488	585 806	114 535
2000	11 786 670	11 077 343	6 555 815	4 521 528	588 522	120 805
2001	12 571 528	11 905 111	6 974 146	4 930 965	547 232	119 185
2002	12 571 528	11 905 111	6 974 146	4 930 965	547 232	119 185
2003	13 027 145	12 354 358	6 525 623	5 828 735	550 071	122 716
2004	13 258 183	12 577 852	6 602 159	5 975 692	559 463	120 869
2005	13 489 222	12 801 345	6 678 696	6 122 650	568 854	119 022
2006	13 720 260	13 024 839	6 755 232	6 269 607	578 246	117 175
2007	13 951 298	13 248 332	6 831 768	6 416 564	587 638	115 328
2008	14 182 336	13 471 826	6 908 304	6 563 521	597 030	113 481
2009	14 413 375	13 695 319	6 984 841	6 710 479	606 421	111 634
2010	14 644 413	13 918 813	7 061 377	6 857 436	615 813	109 787
2011	15 020 126	14 305 565	7 373 407	6 932 158	610 708	103 853
2012	15 395 838	14 692 317	7 685 438	7 006 879	605 602	97 919
2013	15 771 551	15 079 069	7 997 468	7 081 601	600 497	91 985
2014	15 771 551	15 079 069	7 997 468	7 081 601	600 497	91 985
2015	15 771 551	15 079 069	7 997 468	7 081 601	600 497	91 985
Trend 90–15	14.1%	14.8%	-4.7%	49.2%	14.5%	-41.5%

* adjusted age class split for swine as recommended in the UNFCCC centralized review (October 2003)

** interpolated values for the years 2004–2009 and 2011–2012

*** value for 1999 is not available – value derived with average share of previous and following 5 years of total other poultry; interpolated values for the years 2004–2009 and 2011–2012

5.3.2 NH₃ emissions from cattle (3.B.1) and swine (3.B.3)

Key Sources: NH₃

5.3.2.1 Agricultural practice – cattle and swine

Animal Waste Management System Distribution (AWMS)

AWMS distribution data was obtained from the study 'Animal husbandry and manure management systems in Austria (TIHALO)' (AMON et al. 2007). In this research project a comprehensive survey on the agricultural practices in Austria has been carried out. Within this project, the Division of Agricultural Engineering (DAE) of the Department for Sustainable Agricultural Systems of the University of Natural Resources and Applied Life Sciences (BOKU) closely co-operated with the Swiss College of Agriculture, the Austrian Chamber of Agriculture, the Umweltbundesamt, the Agricultural Research and Education Centre Raumberg-Gumpenstein and the Statistics Austria. Firstly, a questionnaire was developed to assess animal housing, manure storage and manure application on typical Austrian farms. In November 2005, the questionnaire was sent to 5 000 Austrian farms. With the active assistance of the regional chambers of agriculture, a rate of questionnaire return of 39% was achieved. The statistical sampling plan was set up with the assistance of the Statistics Austria to guarantee the selection of a representative sample of Austrian farms.

As a result of TIHALO, for 2005 new representative data on animal husbandry and manure management systems all over Austria is available. For the year 1990 AWMS data based on (KONRAD 1995) is available. In this study data on existing Austrian conditions were derived from a research survey carried out on 720 randomly-chosen agricultural enterprises in the years 1989–1992.

For the creation of a plausible time series the AWMS distribution of 1990 (based on KONRAD 1995) partly had to be adopted. Changes to the year 1990 were derived from the new study results (AMON et al. 2007) and expert opinion carried out by DI Alfred Pöllinger (Agricultural Research and Education Centre Raumberg-Gumpenstein) in June 2008 (AMON & HÖRTENHUBER 2008). The AWMS data from 2005–2008 were derived by linear extrapolation. From 2008 onwards the AWMS distribution is held constant in order to prevent implausible trends.

Table 212: Share of N in animal waste management systems 1990 (cattle and swine).

Cattle category	Animal Waste Management Systems 1990					
	Buildings – tied systems		Buildings – loose housing systems		Excreted outside the buildings	
	liquid slurry [%]	solid manure [%]	liquid slurry [%]	solid manure [%]	yards [%]	pasture [%]
Dairy cows	23.6	50.4	11.0	3.4	0.9	10.7
Suckling cows	12.3	58.7	6.0	11.3	1.1	10.7
Cattle < 1 year	11.3	53.3	6.8	23.0	0.8	4.8
Breeding heifers 1–2 years	17.5	39.5	9.4	6.7	0.8	26.2
Fattening heifers, bulls & oxen, 1–2 years	30.4	37.3	18.2	12.8	0.8	0.6
(other) cattle > 2 years	20.6	44.9	9.2	6.6	1.0	17.8
Breeding sows plus litter	--	--	69.2	29.7	1.2	--
Fattening pigs	--	--	71.3	28.2	0.6	--

For yards the values for the year 1990 were estimated to be the half of the values from 2005 (PÖLLINGER 2008).

Table 213: Share of N in animal waste management systems 2005 (cattle and swine).

Cattle category	Animal Waste Management Systems 2005					
	Buildings – tied systems		Buildings – loose housing systems		Excreted outside the buildings	
	liquid slurry [%]	solid manure [%]	liquid slurry [%]	solid manure [%]	yards [%]	pasture [%]
Dairy cows	13.4	49.9	23.4	7.3	1.8	4.2
Suckling cows	6.1	45.1	11.4	21.6	2.1	13.7
Cattle < 1 year	4.6	30.8	13.8	46.8	1.6	2.4
Breeding heifers 1–2 years	9.9	40.1	22.9	16.4	1.5	9.2
Fattening heifers, bulls & oxen, 1–2 years	12.2	24.4	36.1	25.5	1.5	0.3
(other) cattle > 2 years	12.5	42.0	20.2	14.5	1.9	8.9
Breeding sows plus litter	--	--	60.0	37.7	2.3	--
Fattening pigs	--	--	88.2	10.7	1.1	--

Table 214: Share of N in animal waste management systems 2015 (cattle and swine).

Cattle category	Animal Waste Management Systems 2015					
	Buildings – tied systems		Buildings – loose housing systems		Excreted outside the buildings	
	liquid slurry [%]	solid manure [%]	liquid slurry [%]	solid manure [%]	yards [%]	pasture [%]
Dairy cows	11.3	49.8	25.9	8.1	2.0	2.9
Suckling cows	4.8	42.4	12.4	23.7	2.3	14.3
Cattle < 1 year	3.3	26.3	15.2	51.5	1.8	1.9
Breeding heifers 1–2 years	8.4	40.2	25.6	18.4	1.7	5.8
Fattening heifers, bulls & oxen, 1–2 years	8.5	21.8	39.7	28.1	1.7	0.2
(other) cattle > 2 years	10.9	41.4	22.5	16.0	2.1	7.1
Breeding sows plus litter	--	--	58.1	39.3	2.5	--
Fattening pigs	--	--	91.6	7.2	1.2	--

Trends in manure management of cattle

The time series shows that tied systems and systems with straw-litter decrease, but still account for the biggest part, whereas loose housing systems and slurry-based systems increase. Small farms use predominantly tied systems, especially with solid manure, while large farms take more use of loose housing systems in general and tied systems with liquid slurry.

While the share of pasture increases for suckling cows, it decreases for other cattle categories.

Trends in manure management of swine

The time series shows that houses with straw-litter for young and fattening pigs decrease, those with slatted floors increase. Houses with straw-litter for breeding sows plus litter seem to have increased during the period. The reason for this may be lie in the approximate and conservative estimate by expert Alfred Pöllinger (in November 2006) following Konrad's (1995) high values between 75 and nearly 100 percent sows on solid manure (with straw) for diverse houses of breeding sows plus litter. Small farms more frequently use systems with solid manure; large farms make more use of slurry systems.

Free range systems for pigs are uncommon in Austria. Data collected within (AMON et al. 2007) showed that hardly any pig had free access to a pasture.

N-input from straw as bedding material – cattle and swine

There is hardly any straw production in Austrian alpine grassland regions, which contribute to the production of a major proportion of Austrian milk. The import of straw from arable land regions is connected with remarkable costs (for collecting, pressing and transport) and that results in significantly reduced straw inputs into alpine litter-based systems compared to farms in the lowlands producing their own straw. As a consequence, overall N input from straw to manure management systems is comparatively low. Austrian assumptions for cattle are based on expert judgement of (DIETER KREUZHUBER 2013) and national literature (ÖKL 1991).

Information on N inputs from straw for breeding sows, fattening pigs, goats, sheep, soliped and other animals (furred game) is taken from EMEP/EEA-Guidebook 2016, Table 3.7, as for these animal categories in Austria hardly any information is available from expert estimates or national literature. For poultry, straw inputs are calculated according to Germany's National Inventory Report 2013 (FEDERAL ENVIRONMENT AGENCY GERMANY 2013). The following tables include the straw use per animal, day and year.

Table 215: Straw supply for cattle (per head).

	kg straw per animal and day and year							
	tied system with solid storage		tied system with liquid slurry		loose house systems with solid manure		loose house systems with liquid slurry	
	kg straw per day	kg straw per year	kg straw	kg straw per year	kg straw	kg straw per year	kg straw	kg straw per year
Dairy cattle and suckling cows	1.5	547.5	0.2	73	4.0* / 2.5*	1 460 / 912.5	0.5	182.5
Young cattle	1.2	438					0.3	109.5

* 4 kg straw for deep litter systems and 2.5 kg straw for the bedding in solid manure systems

Table 216: Straw supply for swine, sheep, goats, horses and poultry (per head)

	kg straw per animal and year	
	Solid storage	Liquid slurry (grazing)
	kg straw	kg straw
Fattening pigs	200	0
Breeding sows plus litter	600	0
Sheep, goats and 'other animals'	20	0
Horses etc.	500	0
Layers	0.5	0
Broilers	1.4	0
Turkeys	10.3	0
Other poultry (e.g. ducks)	19.5	0

In pastures and yards no straw is used. For the calculation of the N amounts the EMEP/EEA default N content of straw (0.004 kg N per kg straw) was used for all animal categories (EMEP/EEA Guidebook 2016, Table 3.7).

Manure storage – cattle and swine

Table 218 describes the share of composted and not composted solid manure for the years 1990, 2005 and 2015. The values for 2005 are taken from the TIHALO survey (AMON et al. 2007). Those for 1990 were estimated by the Austrian expert Alfred Pöllinger in June 2008 on the basis of TIHALO results (AMON & HÖRTENHUBER 2008). The data from 2005–2008 were derived by linear extrapolation and from 2008 onwards the share of composted and untreated solid manure is held constant in order to prevent implausible trends.

Table 217: Share of composted and untreated solid manure for cattle and swine in Austria in 1990, 2005 and 2015.

	1990		2005		2015	
	Composted solid manure [%]	Untreated solid manure [%]	Composted solid manure [%]	Untreated solid manure [%]	Composted solid manure [%]	Untreated solid manure [%]
Dairy cows	6.0	94.1	11.9	88.1	13.1	86.9
Suckling cows	5.9	94.2	11.7	88.3	12.9	87.1
Cattle < 1 year	5.9	94.1	11.8	88.2	13.0	87.0
Breeding heifers 1–2 years	5.9	94.1	11.8	88.2	13.0	87.0
Fattening heifers, bulls & oxen, 1–2 years	4.4	95.6	8.8	91.2	9.7	90.3
Cattle > 2 years	5.7	94.3	11.4	88.6	12.5	87.5
Breeding sows plus litter	6.4	93.7	12.7	87.3	14.0	86.0
Fattening pigs	4.2	95.8	8.4	91.6	9.2	90.8

Table 218: Slurry storage and treatment for cattle and swine in 1990, 2005 and 2015.

	Dairy cows	Suckling cows ¹	Cattle < 1 year	Breeding heifers 1–2 years	Fattening heifers, bulls & oxen, 1–2 years	(Other) cattle > 2 years	Breeding Sows plus litter	(Young &) Fattening Pigs
1990								
Solid cover	73.4	76.8	78.2	74.9	79.5	78.2	83.9	74.5
Uncovered and not aerated	14.1	12.2	10.3	15.9	11.3	9.4	10.8	16.3
Uncovered and aerated	5.7	5.8	6.8	4.2	4.1	8.2	2.6	1.9
Straw cover	0	0	0	0.1	0	0.1	0.3	0.4
Plastic foil	0	0	0	0	0	0	0.1	0.4
Natural crust	6.9	5.2	4.8	5.0	5.1	4.2	2.4	6.5
2005								
Solid cover	70.5	73.9	74.8	72.8	77.5	74.1	82.6	73.6
Uncovered and not aerated	11.2	9.3	6.9	13.8	9.3	5.3	9.5	15.4
Uncovered and aerated	11.4	11.5	13.5	8.3	8.2	16.3	5.1	3.7
Straw cover	0	0	0	0.1	0	0.1	0.3	0.4
Plastic foil	0	0	0	0	0	0	0.1	0.4
Natural crust	6.9	5.2	4.8	5.0	5.1	4.2	2.4	6.5

	Dairy cows	Suckling cows ¹	Cattle < 1 year	Breeding heifers 1–2 years	Fattening heifers, bulls & oxen, 1–2 years	(Other) cattle > 2 years	Breeding Sows plus litter	(Young &) Fattening Pigs
2015								
Solid cover	69.9	73.4	74.1	72.4	77.1	73.3	82.3	73.4
Uncovered and not aerated	10.6	8.7	6.2	13.4	8.8	4.5	9.2	15.2
Uncovered and aerated	12.5	12.7	14.9	9.1	9.0	17.9	5.6	4.1
Straw cover	0	0	0	0.1	0	0.1	0.3	0.4
Plastic foil	0	0	0	0	0	0	0.1	0.4
Natural crust	6.9	5.2	4.8	5.0	5.1	4.2	2.4	6.5

¹ values from TIHALO for suckling cows had to be replaced by mean values of all other classes of cattle because of wrong values for aeration

Note: The values for 2005 are taken from the TIHALO survey (AMON et al. 2007). Those for 1990 were estimated by Alfred Pöllinger in June 2008 on the basis of TIHALO results. The data from 2005–2008 were derived by linear extrapolation and from 2008 onwards it is held constant in order to prevent implausible trends.

5.3.2.2 Animal excretion – cattle and swine

N excretion

N excretion values as shown in Table 220 and Table 221 are based on the following literature: (GRUBER & PÖTSCH 2006, PÖTSCH et al. 2005, STEINWIDDER & GUGGENBERGER 2003, UNTERARBEITSGRUPPE N-ADHOC 2004 and ZAR 2004).

Table 219: Austria specific N excretion values of dairy cows for the period 1990–2015.

Year	Milk yield [kg yr ⁻¹]	Nitrogen excretion [kg/animal*yr]	Year	Milk yield [kg yr ⁻¹]	Nitrogen excretion [kg/animal*yr]
1990	3 791	76.62	2003	5 638	93.24
1991	3 800	76.70	2004	5 802	94.72
1992	3 905	77.64	2005	5 783	94.55
1993	3 948	78.03	2006	5 903	95.63
1994	4 076	79.18	2007	5 997	96.48
1995	4 619	84.07	2008	6 059	97.03
1996	4 670	84.53	2009	6 068	97.11
1997	4 787	85.58	2010	6 100	97.40
1998	4 924	86.82	2011	6 227	98.54
1999	5 062	88.06	2012	6 418	100.26
2000	5 210	89.39	2013	6 460	100.64
2001	5 394	91.05	2014	6 542	101.38
2002	5 487	91.89	2015	6 579	101.71

¹⁾ From 1995 onwards data have been revised by Statistik Austria, which led to significant higher milk yield data of Austrian dairy cows.

According to the requirements of the European nitrate directive, the Austrian N excretion data were recalculated following the guidelines of the European Commission. The revised nitrogen excretion coefficients were calculated based on the following input parameters:

Cattle: Feed rations represent data of commercial farms consulting representatives of the working groups “Dairy production”. These groups are managed by well-trained advisors. Their members, i.e. farmers, regularly exchange their knowledge and experience. Forage quality is based on field studies, carried out in representative grassland and dairy farm areas. The calculations depend on feeding ration, gain of weight, nitrogen and energy uptake, efficiency, duration of livestock keeping etc. On the basis of a national study (HÄUSLER 2009) for suckling cows an average milk yield of 3 500kg has been assumed for the years from 2004 onwards.

Table 220: Austria specific N excretion values of other cattle and swine.

Livestock category	Nitrogen excretion [kg/animal*yr]
Suckling cows ¹⁾ (1990)	69.5
Suckling cows ²⁾ (2015)	74.0
Cattle 1–2 years	53.6
Cattle < 1 year	25.7
Cattle > 2 years	68.4
Breeding sows	29.1
Fattening pigs	10.3

¹⁾ Annual milk yield: 3 000 kg

²⁾ Annual milk yield: 3 500 kg

Pigs: breeding pigs, piglets, boars, fattening pigs: number and weight of piglets, daily gain of weight, energy content of feeding, energy and nitrogen uptake, N-reduced feeding.

TAN content in excreta – cattle and swine

The detailed methodology makes use of the total ammoniacal nitrogen (TAN) when calculating emissions. The initial share of TAN must be known as well as any transformation rates between organic N and TAN. TAN content for Austrian cattle and pig manure is given in Schechtner (1991). Due to the improved data availability, the inventory revision estimates for the first time emissions from composted farmyard manure. The TAN content of composted farmyard manure was taken from BMLFUW (2006b).

Table 221: TAN content for Austrian cattle and pig manure after SCHECHTNER (1991) and BMLFUW (2006b) in case of composted farmyard manure.

	TAN content [kg NH ₄ -N per kg Nex]
Cattle – farmyard manure	0.15
Cattle – liquid manure	0.50
Swine – farmyard manure	0.15
Swine – liquid manure	0.65
Composted farmyard manure	(<) 0.01

5.3.2.3 Calculation of NH₃ emissions – cattle and swine

NH₃ emissions from cattle and swine were calculated using a country specific methodology following the N-flow model.

Emissions of Ammonia (NH₃) occur during animal housing, the storage of manure and the application of organic fertilizers on agricultural soils. Emissions of nitric oxide (NO_x) were calculated for manure management and field spreading of manure (4).

Following the revised CLRTAP Reporting Guidelines, NH₃ and NO_x-Emissions from the application of livestock manures to land have to be reported under *3.D Agricultural soils (3.D.a.2.a Animal manure applied to soils)*. In line with the new NFR reporting, the methodological description has been shifted to chapter 3.D of this report.

NH₃ emissions from Category *3.B.1 Cattle* and *3.B.3 Swine* are calculated as follows:

$$\text{NH}_3 \text{ (3.B)} = \text{NH}_3 \text{ (housing)} + \text{NH}_3 \text{ (storage)}$$

Where no national emission factors are available, emission factors are taken from the Swiss ammonia inventory which is calculated with the computer based programme “DYNAMO” (MENZI et al. 2003, REIDY et al. 2007, REIDY & MENZI 2005). Due to similar management strategies and geographic structures, Swiss animal husbandry is closest to Austrian animal husbandry.

NH₃ emissions from housing – cattle and swine

Table 223 gives NH₃ emission factors for emissions from animal housing. As far as possible, Swiss default values as given in the EMEP/EEA emission inventory guidebook 2007 have been chosen. Due to similar management strategies and geographic structures, Swiss animal husbandry is closest to Austrian animal husbandry. If no emission factors from Switzerland were available, the German default values were used.

Table 222: Emission factors for NH₃ emissions from animal housing.

Manure management system	Emission factor [kg NH ₃ -N (kg N excreted) ⁻¹]
Pasture/range/paddock – cattle	0.050
Cattle, tied systems, liquid slurry system	0.040
Cattle, tied systems, solid storage system	0.039
Cattle, loose houses, liquid slurry system	0.118
Cattle, loose houses, solid storage system	0.118
Fattening pigs, liquid slurry system	0.150
Fattening pigs, solid storage system	15% of total N + 30% of the remaining TAN
Sows plus litter, liquid slurry system	0.167
Sows plus litter, solid storage system	0.167

For yards the swiss emission factor has been taken (KECK 1997, MISSELBROOK et al 2001) as used in DYNAMO (MENZI et al. 2003, REIDY et al. 2007, REIDY & MENZI 2005).

Table 223: NH₃ emission factors for yards.

Manure management system	DYNAMO Emission factor [kg NH ₃ -N (kg TAN) ⁻¹]
Cattle, yard	0.8

N excretion per manure management system

Country-specific N excretion per animal waste management system for Austrian cattle and swine has been calculated using the following formula:

$$Nex_{(AWMS)} = \sum_{(T)} [N_{(T)} \times Nex_{(T)} \times AWMS_{(T)}]$$

- $Nex_{(AWMS)}$ = N excretion per animal waste management system [kg yr⁻¹]
 $N_{(T)}$ = number of animals of type T in the country (see Table 210, Table 211 and Table 212)
 $Nex_{(T)}$ = N excretion of animals of type T in the country [kg N animal⁻¹ yr⁻¹] (see Table 220, Table 221 and Table 228)
 $AWMS_{(T)}$ = fraction of $Nex_{(T)}$ that is managed in one of the different distinguished animal waste management systems for animals of type T in the country
 (T) = type of animal category

NH₃ emissions from manure storage – cattle and swine

NH₃ emissions from storage are estimated from the amount of N left in the manure when the manure enters the storage. This amount of N is calculated as following:

From total N excretion the N excreted during grazing and the NH₃-N losses from housing (see above) are subtracted. The remaining N enters the store.

Solid manure

According to the EMEP/EEA GB 2016 account must also be taken of the fraction (f_{imm}) of TAN that is immobilized in organic matter when manure is managed as solid. The default value of 0.0067 kg N kg⁻¹ straw for f_{imm} has been applied (EEA 2016).

Liquid manure

For slurries, a fraction (f_{min}) of the organic N is mineralized to TAN before the gaseous emissions are calculated according to the EMEP/EEA GB 2016. The default value of 0.1 for f_{min} has been applied (EEA 2016).

NH₃ emission factors – cattle and swine

NH₃-N losses are estimated with default emission factors given in Table 225.

Table 224: NH₃ emission factors for manure storage.

Manure storage system	Emission factor [kg NH ₃ -N (kg TAN) ⁻¹]
Cattle, liquid slurry system	0.15
Cattle, solid storage system	0.30
Pigs, liquid slurry system	0.12
Pigs, solid storage system	0.30

* 15% + 0.3 % of remaining TAN for deep litter (as used for fattening pigs in agriculture), otherwise 15% for daily removal of solid manure

Correction factors – cattle and swine

Table 226 shows correction factors (CF) to emission factors (EF) for a range of manure treatment options. Untreated variants systems, for example uncomposted solid manure, give the reference value '1'. EF for other treatment options, managements and systems get an associated CF, e.g. +20% for the composting of solid manure (CF = 1.2). The CF is multiplied with the

EF. Factors were taken from the Swiss ammonia inventory which is calculated with the computer based programme 'DYNAMO' (MENZI et al. 2003, REIDY et al. 2007, REIDY & MENZI 2005). Due to similar management strategies and geographic structures, Swiss animal husbandry is closest to Austrian animal husbandry.

DYNAMO is based on the N flow model and estimates ammonia emissions for each stage of the manure management continuum. Animal categories, manure management systems and a range of additional parameters are considered within DYNAMO. DYNAMO parameters were adapted to Austrian specific conditions. The DYNAMO model is peer reviewed by the EAGER¹²⁴ group and published in (REIDY et al. 2008, 2009).

Table 225: Correction factors (CF) for NH₃ emissions from manure storage.

Manure storage	[CF]
Uncomposted solid manure	1
Composted solid manure	1.2
Uncovered tank	1
Solid cover – liquid system	0.2
Aerated open tank – liquid system	1.1
Straw cover – liquid system	0.6
Plastic foil cover – liquid system	0.4
Natural crust – liquid system	0.6

¹²⁴ European Agricultural Gaseous Emissions Inventory Researchers Network (EAGER)

5.3.3 NH₃ emissions from sheep (3.B.2), goats (3.B.4.d), horses (3.B.4.e), poultry (3.B.4.g) and other animals (3.B.4.h)

Key Sources: No

For the non-key livestock categories sheep (3.B.2), goats (3.B.4.d), horses (3.B.4.e), poultry (3.B.4.g) and other animals (3.B.4.h) the EMEP/EEA Tier 2 methodology has been applied. Tier 2 uses a mass flow approach based on the concept of TAN (EEA 2016).

5.3.3.1 Agricultural practice – non-key livestock categories

Solid systems and pasture are the relevant AWMS for these animal categories in Austria.

Table 226: Share of N in animal waste management systems (non-key livestock).

Livestock category	Liquid/Slurry	Solid Storage	Pasture/Range/Paddock
	[%]	[%]	[%]
Sheep	0.0	50.0	50.0
Goats	0.0	50.0	50.0
Horses	0.0	80.0	20.0
Laying hens	0.0	100.0	0.0
Broilers	0.0	100.0	0.0
Turkeys	0.0	100.0	0.0
Other poultry	0.0	100.0	0.0
Other animals	0.0	20.0	80.0

N-input from straw as bedding material – non-key livestock categories

Information on N inputs from straw for goats, sheep, soliped and other animals (furred game) is taken from EMEP/EEA-Guidebook 2016, Table 3.7, as for these animal categories in Austria hardly any information is available from expert estimates or national literature. For poultry, straw inputs are calculated according to Germany's National Inventory Report 2013 (FEDERAL ENVIRONMENT AGENCY GERMANY 2013). The straw use per animal and year is presented in Table 217.

5.3.3.2 Animal excretion – non-key livestock categories

Country specific N excretion values are presented in the following table:

Table 227: Austria specific N excretion values of non-key livestock categories.

Livestock category	Nitrogen excretion [kg/animal*yr]
Sheep	13.1
Goats	12.3
Horses	47.9
Layers	0.73
Broilers	0.28
Turkeys	1.18

Livestock category	Nitrogen excretion [kg/animal*yr]
Other poultry	0.48
Other animals/furred game ¹⁾	13.1

¹⁾ N-ex value of sheep applied

5.3.3.3 Calculation of NH₃ emissions – non-key livestock categories

Table 229 presents the default EMEP/EEA Tier 2 NH₃-N emission factors and associated parameters used in the calculations for Austria's non-key livestock categories (EEA 2016, Table 3.9).

Table 228: Default Tier 2 NH₃-N EF and associated parameters for the Tier 2 methodology.

NFR	Livestock category	proportion of TAN	Housing period [days] ¹⁾	EF housing	EF storage	EF spreading
3.B.2	Sheep	0.50	183	0.22	0.28	0.90
3.B.4.d	Goats	0.50	183	0.22	0.28	0.90
3.B.4.e	Horses (mules, asses)	0.60	292	0.22	0.35	0.90
3.B.4.g.i	Laying hens	0.70	365	0.41	0.14	0.69
3.B.4.g.ii	Broilers	0.70	365	0.28	0.17	0.66
3.B.4.g.iii	Turkeys	0.70	365	0.35	0.24	0.54
3.B.4.g.iv	Other poultry	0.70	365	0.35 ^(**)	0.21 ^(**)	0.51 ^(**)
3.B.4.h	Other animals	0.50	73	0.22	0.28	0.90

¹⁾ values of housing period are country specific (ALFRED PÖLLINGER 2008)

^{**}) EF = weighted mean of ducks & geese 2003-2015

In Austria furred game, mainly deer, dominates the livestock category 'other animals'. As sheep is the most similar livestock category to deer, for 'other animals' the NH₃ emission factors of sheep have been used.

NH₃ emissions from housing and storage – non-key livestock categories

Country specific NH₃-N emission factors for the housing of non-key animals are calculated by using the following formula:

$$\text{kg N excreted [animal}^{-1} \text{ year}^{-1}] * \text{TAN proportion} * \text{housing period}/365 * \text{EF}_{\text{housing}}$$

The CS emission factors for the storage of animal manure take into account the NH₃-N losses from housing and the fraction of TAN that is immobilized in organic matter (f_{imm}) when manure is managed as solid. For f_{imm} the EMEP/EEA default value of 0.0067 has been applied (EEA 2016).

Table 230 presents the resulting country-specific NH₃-N emission factors for housing and storage of sheep, goats, horses, poultry and other animals.

Table 229: $\text{NH}_3\text{-N}$ emissions per head from housing and storage (non-key animals).

NFR	Livestock category	EF Housing [kg $\text{NH}_3\text{-N}$ year ⁻¹]	EF Storage [kg $\text{NH}_3\text{-N}$ year ⁻¹]
3.B.2	Sheep	0.72	0.71
3.B.4.d	Goats	0.68	0.67
3.B.4.e	Horses (mules, asses)	5.06	6.23
3.B.4.g.i	Laying hens	0.21	0.04
3.B.4.g.ii	Broilers	0.05	0.02
3.B.4.g.iii	Turkeys	0.29	0.13
3.B.4.g.iv	Other poultry	0.12	0.05
3.B.4.h	Other animals	0.29	0.28

5.3.4 NO_x emissions from manure management (3.B)

NO_x emissions from manure management have been calculated using the default Tier 1 emission factors per animal category as outlined in the EMEP/ EEA emission inventory guidebook 2016 (EEA 2016, Table 3.3).

5.3.5 Category-specific Recalculations

Update of activity data

Livestock population data

Revised numbers of horses have been implemented into the inventory. New data are provided by the Ministry of Agriculture and published in (BMLFUW 2016). Data were derived from interviews of relevant experts (e.g. from breeding associations) considering additional information from the data base of horses of the Ministry of Health and Women's Affairs.

Numbers of horses used in previous inventories for the years from 2004 to 2014 published in (BMLFUW 2015) were based on agricultural structural surveys and INVEKOS data. However, it was found out, that they did not fully cover all horse-owners in Austria.

Horse numbers reported for the years before 2004 are based on livestock accountings and were assessed to be representative for Austria.

The revision resulted in significantly increased animal numbers in 2014.

Methodological changes

Ammonia (NH_3)

Revised numbers of horses resulted in higher emissions from 2004 onwards (+512.4 t NH_3 in 2014).

Weighted EF of other poultry was updated according the share of geese and ducks from 2003 to 2015. The update resulted in slightly higher emissions (+0.3 t NH_3 in 2014).

Nitrogen Oxides (NO_x)

The inventory was updated by using the default Tier 1 EFs for NO from stored manure according the new EMEP/EEA emission inventory guidebook 2016. The revision resulted in a slight decrease of NO₂ emissions from sector Manure Management (-9.1 t NO₂ in 2014).

5.4 NFR 3.B Particle Emissions from Manure Management

Key Source: No

In NRF category 3.B *Manure Management* particle emissions from Animal Husbandry are included.

5.4.1 Methodological Issues

Particle emissions from animal husbandry are primary connected with the manipulation of forage, a smaller part arises from dispersed excrements and litter. Wet vegetation and mineral particles of soils are assumed to be negligible, thus particle emissions from free-range animals are not included.

The estimations of particle emissions from animal husbandry are related to the Austrian livestock number.

Activity data

The Austrian official statistics (STATISTIK AUSTRIA 2016b) provides national data of annual livestock numbers on a very detailed level.

Emission Factors

Measurements and emission estimates of 'primary biological aerosol particles' based on such measurements (WINIWARTER et al. 2009) don't indicate high amounts of cellulosic materials existing in the atmosphere. This is in contrast to the results of the first estimate approach following (EEA 2007) applied in the recent Austrian air emission inventory.

Due to the lack of more reliable up-to-date data, in this inventory the emission factors of the RAINS model (LÜKEWILLE et al. 2001) have been used, resulting in significant lower estimates.

In Table 231 the applied emission factors are listed.

Table 230: TSP emission factors animal housing.

Livestock	Emission Factor [kg TSP/animal]	Livestock	Emission Factor [kg TSP/animal]
Dairy cows	0.235	Laying hens	0.016
Other cattle	0.235	Broilers	0.016
Fattening pigs	0.108	Turkeys	0.016
Sows	0.108	Other poultry	0.016
Ovines	0.235	Goats	0.153
Horses	0.153	Other animals	0.016

Following (KLIMONT et al. 2002) the share of PM₁₀ in TSP is assumed to be 45% and the share of PM_{2.5} in TSP is assumed to be 10%.

5.4.2 Category-specific Recalculations

In previous submissions PM emissions from animal husbandry were reported for all livestock categories under 3.I Other. Following a recommendation of the CLRTAP stage 3-review 2010 in the current submission PM emissions are reported for the respective livestock categories under 3.B Manure Management.

5.5 NFR 3.D Agricultural Soils

NFR sector *3.D Agricultural Soils* includes emissions of ammonia (NH₃), nitric oxide (NO_x), NMVOC and particulate matter (TSP, PM). The methodology for estimating PM emissions is presented in a separate chapter (Chapter 5.6).

5.5.1 Methodological Issues

In the Austrian inventory source category *3.D Agricultural Soils* comprises NH₃ and NO_x emissions from:

- Application of inorganic N fertilizers(3.D.a.1);
- Application of organic N fertilizers (3.D.a.2) including:
 - Animal manure applied to soils (3.D.a.2.a). This emission source is reported under NFR category *3.D Agricultural Soils* in compliance with the revised CLRTAP Reporting Guidelines 2014. Up to submission 2015 NH₃ emissions from this source were reported under source category *4.B Manure management*.
 - Sewage sludge applied to soils (3.D.a.2.b) and
 - Other organic fertilizers applied to soils (3.D.a.2.c), which comprises N inputs from digested energy crops in biogas slurry and compost.

NH₃ emissions from:

- Urine and dung deposited by grazing animals (3.D.a.3) and

NMVOC emissions from:

- Cultivated crops (3.D.e)

5.5.2 Inorganic N-fertilizers (NFR 3.D.a.1)

Key source: NH_3

Activity Data

Austria's inventory distinguishes between urea fertilizers and other N-fertilizers ("mineral fertilizers"). Austria's official national mineral fertilizer statistics is compiled by Agrarmarkt Austria, AMA, and annually published by the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management in its official reports (BMLFUW 2000–2016). Mineral fertilizer data are available for total amounts, but not for fertilizer types.

Detailed data of different kind of fertilizers are available until 1994, because until then, a fertilizer tax („Düngemittelabgabe“) had been collected. For the years 1994 to 2012 annual sales figures about urea were provided Austria's leading fertilizer trading firm (RWA). Urea fertilizer data for 2013 and 2014 was provided by the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management. In 2016 Austria's mineral fertilizer statistics was improved including more detailed information on fertilizer types applied in Austria. Consequently, in the reporting year 2015 also urea fertilizer data are based on AMA statistics.

High inter-annual variations are caused by the effect of storage: Fertilizers have a high elasticity to prices. Sales data are changing very rapidly due to changing market prices. Not the whole amount purchased is applied in the year of purchase. The fertilizer tax intensified this effect at the beginning of the 1990ies. Considering this effect, the arithmetic average of each two years is used as fertilizer application data.

The time series for fertilizer consumption is presented in Table 232.

Table 231: Mineral fertilizer N consumption in Austria 1990–2015 and arithmetic average of each two years.

Year	Annual Nutrient Sales Data [t N/yr]	of which Urea	Data Source	Weighted Nutrient Consumption [t N/yr]	Weighted Urea Consumption [t N/yr]
1989	133 304	1 700	FAO		
1990	140 379	3 965	estimated GB	136 842	2 833
1991	180 388	3 965	GB	160 384	3 965
1992	91 154	3 886	GB	135 771	3 926
1993	123 634	3 478	GB	107 394	3 682
1994	177 266	4 917	GB	150 450	4 198
1995	128 000	5 198	RWA	152 633	5 058
1996	125 300	4 600	RWA	126 650	4 899
1997	131 800	6 440	RWA	128 550	5 520
1998	127 500	6 440	RWA	129 650	6 440
1999	119 500	6 808	RWA	123 500	6 624
2000	121 600	3 848	GB/AMA, RWA	120 550	5 328
2001	117 100	3 329	GB/AMA, RWA	119 350	3 589
2002	127 600	4 470	GB/AMA, RWA	122 350	3 900
2003	94 400	6 506	GB/AMA, RWA	111 000	5 488
2004	100 800	7 293	GB/AMA, RWA	97 600	6 900
2005	99 700	7 673	GB/AMA, RWA	100 250	7 483
2006	103 700	11 310	GB/AMA, RWA	101 700	9 491
2007	103 300	11 500	GB/AMA, RWA	103 500	11 405

Year	Annual Nutrient Sales Data [t N/yr]	of which Urea	Data Source	Weighted Nutrient Consumption [t N/yr]	Weighted Urea Consumption [t N/yr]
2008	134 400	9 568	GB/AMA, RWA	118 850	10 534
2009	86 300	18 400	GB/AMA, RWA	110 350	13 984
2010	90 629	6 500	GB/AMA, RWA	88 465	12 450
2011	116 751	16 867	GB/AMA, RWA	103 690	11 683
2012	97 721	10 733	GB/AMA, RWA	107 236	13 800
2013	112 005	16 638	GB/AMA,BMLFUW	104 863	13 685
2014	111 615	15 741	GB/AMA,BMLFUW	111 810	16 189
2015	130 252	14 308	AMA	120 934	15 025

GB: AMA data published in (BMLFUW 2000–2015): www.gruenerbericht.at

RWA: Raiffeisen Ware Austria, sales company: www.rwa.at

BMLFUW: Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft: www.bmlfuw.gv.at

AMA: Agrarmarkt Austria (AMA 2016): www.ama.at

Emissions of ammonia (NH₃)

For the calculation of NH₃ emissions from synthetic fertilizers the Tier 2 methodology according to the EMEP/EEA GB 2016 was applied. This method uses specific NH₃ emission factors for different types of synthetic fertilizers and for different climatic conditions. The EMEP/EEA GB 2016 refers to the IPCC 2006 Guidelines regarding the definitions of climatic zones. According to IPCC 2006, Austria belongs to Group III '*temperate and cool temperate countries*' with largely acidic soils. 65% of Austria's soils are classified as normal (pH<7) and 35% as high (pH>=7) based on Austrian Soil Information System – BORIS – (<http://www.borisdaten.at>).

In Austria, full time-series data only for urea and non-urea synthetic N fertilizers (see Table 232), but with no further specifications, are available. For urea the weighted average of the default emission factors for normal pH soils (1.55 kg NH₃/kg N applied) and high pH soils (0.164 kg NH₃/kg N applied) (EEA 2016, table 3.2) has been calculated, resulting in an emission factor for urea of 0.158 kg NH₃ per kg of fertilizer-N applied. As calcium-ammonium-nitrate and ammonium-nitrate fertilizers represent the dominant form of non-urea synthetic fertilizers being used (FREIBAUER & KALTSCHMITT 2001), an average emission factor of 0.02 kg NH₃-N per kg of fertilizer-N is applied for fertilizers other than urea (STREBL et al. 2003).

Emissions of nitric oxide (NO_x)

The Tier 1 methodology according to the EMEP/EEA GB 2016 is applied. Emissions of NO_x are calculated as a fixed percentage of total fertilizer nitrogen applied to soil. For all mineral fertilizer types the default emission factor of 4% (i.e. 0.04 kg NO per kg applied fertilizer-N) is used.

5.5.3 Organic N-fertilizers applied to soils (NFR 3.D.a.2.a)

Key source: NH₃

NFR source category 3.D.a.2 *Organic fertilizers* comprise emissions from Animal manure applied to soils (3.D.a.2.a), Sewage sludge applied to soils (3.D.a.2.b) and Other organic fertilizers applied to soils (3.D.a.2.c) including N inputs from digested energy crops (biogas plants) and compost.

5.5.3.1 Animal manure applied to soils (NFR 3.D.a.2.a)

Emissions of ammonia (NH₃) and nitric oxide (NO_x) occur during the application of animal manure on agricultural soils. Following the revised CLRTAP Reporting Guidelines, emissions are now reported under Agricultural Soils (NFR 3.D.a.2.a *Animal manure applied to soils*).

Activity Data

Livestock numbers and information on AWMS are described in chapter 5.3.

Nitrogen left for spreading

After housing and storage, manure is applied to agricultural soils. Manure application is connected with NH₃-N, NO_x-N and N₂O-N losses that depend on the amount of manure N. With regard to a comprehensive treatment of the nitrogen budget, Austria established a link between the ammonia and nitrous oxide emissions inventory. A detailed description of the methods applied for the calculation of N₂O emissions is given in the report “Austria's National Inventory Report 2017 – Submission under the United Nations Framework Convention on Climate Change and the Kyoto Protocol” (UMWELTBUNDESAMT 2017a).

From total N excretion the following losses were subtracted:

- N excreted during grazing
- NH₃-N losses from housing
- NH₃-N losses during manure storage
- NO_x-N losses from manure management
- N₂O-N losses from manure management
- The remaining N is applied to agricultural soils.

NH₃ emissions from animal manure applied to soils – cattle and swine

A country specific methodology has been applied.

This method distinguishes between the types of waste produced by each animal sub category: solid manure and liquid slurry. This is relevant, because TAN contents and therefore NH₃ emissions are highly dependent on the quality of waste and organic matter content in slurry. According to the EMEP/EEA Emission Inventory Guidebook 2016 the N input from straw use in manure management systems is taken into account.

NH₃ emissions from manure nitrogen applied to soils have been calculated using the following formula:

$$\text{NH}_3\text{-N}_{\text{spread}} = \text{N}_{\text{exLFS}} * (\text{Frac}_{\text{SS}} * \text{F}_{\text{TAN SS}} * \text{EF-NH}_3\text{-N}_{\text{spread SS}} + \text{Frac}_{\text{LS-bc}} * \text{F}_{\text{TAN LS}} * \text{EF-NH}_3\text{-N}_{\text{spread LS}} + \text{Frac}_{\text{LS-bs}} * \text{F}_{\text{TAN LS}} * \text{EF-NH}_3\text{-N}_{\text{spread LS}} * \text{CF}_{\text{bs}})$$

$\text{NH}_3\text{-N}_{\text{spread}}$ = NH₃-N emissions driven by intentional spreading of animal waste from Manure Management systems on agricultural soils (droppings of grazing animals are not included!)

N_{exLFS} = Annual amount of nitrogen in animal excreta left for spreading on agricultural soils, corrected for losses during manure management; it does not include nitrogen from grazing animals

Frac_{SS} = Fraction of nitrogen left for spreading produced as farmyard manure in a solid waste management system

$Frac_{LS-bc}$	=	Fraction of nitrogen left for spreading produced as liquid slurry in a liquid waste management system (broadcast spreading)
$Frac_{LS-bs}$	=	Fraction of nitrogen left for spreading produced as liquid slurry in a liquid waste management system (band spreading)
CF_{bs}	=	Correction factor band spreading
$F_{TAN SS}$	=	Fraction of total ammoniacal nitrogen (TAN) in animal waste produced in a solid waste management system including N input from straw
$F_{TAN LS}$	=	Fraction of total ammoniacal nitrogen (TAN) in animal waste produced as slurry in a liquid waste management system including N input from straw
$EF-NH_3-N_{spread SS}$	=	NH_3-N Emission factor of animal waste from a solid manure system (farmyard manure) spread on agricultural soils (broadcast spreading)
$EF-NH_3-N_{spread LS}$	=	NH_3-N Emission factor of animal waste from a liquid slurry waste management system spread on agricultural soils (broadcast spreading)

Application technologies – cattle and swine

Since inventory revision 2008 the agriculture inventory considers band spreading application of liquid manure. Table 233 gives information on slurry application for the years 1990, 2005 and 2015. The values for the year 1990 are expected to be the half of the ones in 2005 (expert estimation by Alfred Pöllinger, June 2008).

Table 232: Cattle and pig slurry application in Austria 1990, 2005 and 2015.

Animal category:	1990		2005		2015	
	Broadcast application (%)	Band spreading (%)	Broadcast application (%)	Band spreading (%)	Broadcast application (%)	Band spreading (%)
Dairy cows	96.2	3.8	92.4	7.6	91.6	8.4
Suckling cows	97.1	2.9	94.2	5.8	93.6	6.4
Cattle < 1 year	96.6	3.5	93.1	6.9	92.4	7.6
Breeding heifers 1–2 years	96.3	3.7	92.6	7.4	91.9	8.1
Fattening heifers, bulls & oxen, 1–2 years	98.4	1.7	96.7	3.3	96.4	3.6
Cattle > 2 years	94.7	5.3	89.4	10.6	88.3	11.7
Breeding sows plus litter	98.0	2.1	95.9	4.1	95.5	4.5
Fattening pigs	97.0	3.0	94.0	6.0	93.4	6.6

The findings of TIHALO (AMON et al. 2007) show that sleigh foot application and slurry injection apparently do not exist in Austria's agriculture. Only a small percentage of slurry is applied with band spreading technologies.

NH₃ emission factors

The following default NH₃ emission factors for spreading of slurry and farmyard manure (expressed as share of TAN) have been used (EEA 2009):

Table 233: Emission factors for NH₃ emissions from animal waste application.

Application technique	Emission factor [kg NH ₃ -N (kg TAN) ⁻¹]
spreading solid manure cattle	0.79
spreading solid manure pigs	0.81
broadcast spreading liquid manure cattle	0.50
broadcast spreading liquid manure pigs	0.25

Correction factors

Table 235 presents the correction factor (CF) for band spreading. The CF is multiplied with the EF of broadcast spreading (reference value: 1). Factors were taken from the Swiss computer based programme “DYNAMO” (MENZI et al. 2003, REIDY et al. 2007, REIDY & MENZI 2005).

Table 234: Correction factors for NH₃ emissions from animal waste application.

Application technique	[CF]
Broadcast spreading	1
Band spreading	0.7

NH₃ emissions from animal manure applied to soils – non-key livestock categories

For sheep, goats, horses, poultry and other animals the default EMEP/EEA Tier 2 NH₃-N emission factors and the default TAN values have been used (EEA 2016, Table 3.9). All N-losses (NH₃-N, NO_x-N, N₂ and N₂O-N losses) at the previous stages of manure (housing and storage) have been subtracted in line with the N-flow approach. As already described above, Austria established a link between the ammonia and nitrous oxide emissions inventory. In line with the EMEP/EEA Guidebook 2016 the N input from straw use in manure management systems has been taken into account.

Table 236 presents the resulting NH₃-N emission factors for manure application of sheep, goats, horses, poultry and other animals.

Table 235: Country specific emission factors for NH₃ emissions from manure spreading (other livestock categories)

NFR	Livestock category	EF Spreading [kg NH ₃ -N year ⁻¹]
3.B.2	Sheep	1.36
3.B.4.d	Goats	1.30
3.B.4.e	Horses (mules, asses)	8.31
3.B.4.g.i	Laying hens	0.12
3.B.4.g.ii	Broilers	0.05
3.B.4.g.iii	Turkeys	0.15
3.B.4.g.iv	Other Poultry (ducks, geese, turkeys)	0.09
3.B.4.h	Other animals	0.54

NO_x Emissions from animal manure applied to soils

The Tier 1 methodology according to the EMEP/EEA GB 2016 is applied. The default emission factor of 0.04 kg NO per kg of organic fertilizer-N spread on agricultural soils is used, which has been taken from table 3.1 (EEA 2016).

5.5.3.2 Sewage sludge applied to soils (NFR 3.D.a.2.b)

Ammonia emissions (NH₃)

The default emission factor of sewage sludge taken from (EEA 2016, Annex 1) has been applied (0.13 kg NH₃/kg fertilizer N).

Emissions of nitrogen oxide (NO_x)

NO_x emissions were estimated according to the EMEP/EEA GB 2016 (EEA 2016, Annex 2) using the default Tier 1 EF of NO for sewage sludge (0.04 kg NO₂/kg sewage sludge N).

Activity Data

In the frame of the reporting obligation under the Urban Wastewater Directive (91/271/EEC) the annual amount of sewage sludge as ton dry substance per year (t DS/a) is collected by the authorities of the Austrian Provincial Governments. After quality assessment and aggregation the data are reported once a year to the National authorities.

Table 236: Amount of sewage sludge (dry matter) produced in Austria, 1990–2015.

Year	Total [t dm]	agriculturally applied [t dm]	agriculturally applied [%]
1990	161 936	31 507	19.5
1991	161 936	31 507	19.5
1992	200 000	30 000	15.0
1993	300 000	45 000	15.0
1994	350 000	38 500	11.0
1995	390 500	42 400	10.9
1996	390 500	42 955	11.0
1997	390 500	42 955	11.0
1998	392 909	43 220	11.0
1999	392 909	43 220	11.0
2000	392 909	43 220	11.0
2001	398 800	41 600	10.4
2002	322 096	36 065	11.2
2003	315 130	39 186	12.4
2004	294 942	35 357	12.0
2005	290 110	35 541	12.3
2006	241 364	39 369	16.3
2007	245 202	40 713	16.6
2008	248 169	39 247	15.8
2009	252 181	39 945	15.8
2010	262 805	44 354	16.9
2011	265 962	43 796	16.5
2012	266 949	41 487	15.5
2013	238 273	38 231	16.0
2014	239 044	39 626	16.6
2015	234 880	46 861	20.0

Amounts of agriculturally applied sewage sludge were obtained from: Water Quality Report 2000 (PHILIPPITSCH et al. 2001), Report on sewage sludge (UMWELTBUNDESAMT 1997), Austrian report on water pollution control (BMLFUW 2002a) and deliveries from Austria's federal provinces to Umweltbundesamt (UMWELTBUNDESAMT 2011a, 2013a, 2014a, 2015a, 2016a).

Data on N content of sewage sludge was obtained from (UMWELTBUNDESAMT 1997). The study contains sewage sludge analyses carried out by the Umweltbundesamt. Digested sludge samples from 17 municipal sewage sludge treatment plants taken in winter 1994/1995 were investigated with regard to more than one hundred inorganic, organic and biological parameters in order to get an idea of the quality of municipal sewage sludge. Following this study a mean value of 3.9% N in dry matter was taken.

In 2007 the N-content value of sewage sludge was re-examined. The comparison with national Studies (ZESSNER, M. 1999) and (ÖWAV-Regelblatt Nr. 17 – Landwirtschaftliche Verwertung von Klärschlamm 2004 – www.oewav.at) approved the value of 3.9% N/dm.

The amount of nitrogen input from agriculturally applied sewage sludge was calculated according following formula:

$$F_{Sslu} = Sslu_N * Sslu_{agric}$$

F_{Sslu} = Annual nitrogen input to soils by agriculturally applied sewage sludge [t N]

$Sslu_N$ = Nitrogen content in dry matter [%] – 3.9%

$Sslu_{agric}$ = Annual amount of sewage sludge agriculturally applied [t/t] (see Table 237)

5.5.3.3 Other organic fertilizers applied to soils (NFR 3.D.a.2.c)

In addition to N from digested manure the N inputs from energy crops applied to soils as fertilizer after the digestion process in biogas plants (digestates) are reported as well. Furthermore, from submission 2017 onwards the N from compost applied on agricultural soils has been implemented.

Activity Data

Energy crops

The calculation of N from anaerobically digested energy crops (digestates) was done for the years 2007, 2009 and 2011 on the basis of three detailed raw material and energy balances reported by E-Control (E-CONTROL 2008, 2011 & 2013).

N content of digested energy crops was derived from specific literature (RESCH et al. 2006; DLG 1997; LANDESBETRIEB LANDWIRTSCHAFT HESSEN 2013).

Amounts of digested manure N are calculated in sector manure management. N amounts of digested energy crops for the years before 2007 were derived on the basis of digested manure N amounts and the share of energy crop N (digested manure N amount/ digested crop-N amount) in 2007. N amounts of digested energy crops for the years 2008 and 2010 were calculated by interpolation. For 2012 onwards the proportions of the 2011 balance were used.

Compost

Activity data for agricultural compost application was derived by expert judgement by Umweltbundesamt (2015) on the basis of treated amounts and application pathways (BUCHGRABER et al. 2003) and (EGLE 2014). Based on (LANDWEHR 2000; KRANERT & LANDWEHR 2010; RÖMPP 1996-1999) and (BRUNSTERMANN 2007) an organic mass loss of 50% during the composting process has been applied. For compost a dry matter content of 40% (RÖMPP 1996-1999) was used. The N-content of dry matter of 1.4% was derived from (AMLINGER et al. 2005).

Total amounts of compost (composting plants and home composting) were taken from Table 258 (chapter waste). Based on (BUCHGRABER et al. 2003 and EGLE 2014) a share of 45% of the compost from composting plants is applied in sector agriculture. The dry matter content of 40% for compost is derived from (RÖMPP 1996-1999).

Table 237: Amount of compost (dry matter) produced in Austria, 1990–2015.

Year	Total amount of compost [t dm]	agriculturally applied [t dm]	agriculturally applied [%]	Applied compost N [t N]
1990	83,561	4,303	5.1	60
1991	90,673	7,053	7.8	99
1992	119,341	12,304	10.3	172
1993	163 281	27 577	16.9	386
1994	205 698	39 915	19.4	559
1995	230 215	49 597	21.5	694
1996	246 700	55 575	22.5	778
1997	248 815	52 335	21.0	733
1998	260 179	54 397	20.9	762
1999	271 131	56 104	20.7	785
2000	293 394	62 568	21.3	876
2001	342 284	69 031	20.2	966
2002	390 128	75 023	19.2	1 050
2003	432 221	78 427	18.1	1 098
2004	472 354	80 949	17.1	1 133
2005	474 990	81 236	17.1	1 137
2006	470 750	78 641	16.7	1 101
2007	473 800	79 575	16.8	1 114
2008	483 450	82 744	17.1	1 158
2009	496 492	87 971	17.7	1 232
2010	504 530	93 140	18.5	1 304
2011	521 839	100 612	19.3	1 409
2012	546 948	111 488	20.4	1 561
2013	533 965	105 092	19.7	1 471
2014	545 256	109 334	20.1	1 531
2015	543 623	107 489	19.8	1 505

Table 238: N from biogas slurry (vegetable part) and compost.

Year	Digestates (livestock manures) [kg N year ⁻¹]	Digestates (veg. part) [kg N year ⁻¹]	N from compost [kg N year ⁻¹]
1990	49 840	175 293	60 236
1991	67 837	238 589	98 742
1992	75 303	264 850	172 251
1993	100 154	352 251	386 072
1994	283 275	996 309	558 816
1995	327 613	1 152 251	694 352
1996	359 014	1 262 692	778 047
1997	460 707	1 620 357	732 696
1998	546 005	1 920 361	761 553
1999	752 947	2 648 198	785 463
2000	871 032	3 063 517	875 945
2001	996 191	3 503 715	966 428
2002	1 108 080	3 897 238	1 050 323
2003	1 209 113	4 252 582	1 097 984
2004	1 296 492	4 559 906	1 133 292
2005	1 365 534	4 802 732	1 137 307
2006	1 429 936	5 029 242	1 100 971
2007	1 577 004	5 546 496	1 114 044
2008	1 610 693	6 478 924	1 158 411
2009	1 635 722	7 614 425	1 231 597
2010	1 660 440	7 102 316	1 303 964
2011	1 694 441	6 687 875	1 408 564
2012	1 713 829	6 764 400	1 560 827
2013	1 726 782	6 815 522	1 471 292
2014	1 704 494	6 727 555	1 530 673
2015	1 718 852	6 784 225	1 504 839

Ammonia emissions (NH₃)

The Tier 1 approach according to the EMEP/EEA Emission Inventory Guidebook 2016 is applied. The default emission factor for other organic wastes of 0.08 kg NH₃ per kg N applied has been taken (EEA 2016, Table 3.1).

Emissions of nitric oxide (NO_x)

NO_x emissions were estimated applying the Tier 1 methodology following the EMEP/EEA Emission Inventory Guidebook 2016. The default NO emission factor for other organic wastes of 0.04 kg NO/kg waste N applied (EEA 2016, Table 3.1) has been used.

5.5.4 Urine and dung deposited by grazing animals (NFR 3.D.a.3)

Key source: No

Cattle and Swine

The emission factor of 0.05 kg NH₃-N/ kg N excreted has been taken from (Eidgenössische Forschungsanstalt 1997).

The share of N excreted on pastures is presented in Table 213 to Table 215. Free range systems for pigs are uncommon in Austria, there are no emissions occurring from that source.

Nitrogen excretion values of cattle and swine are presented in Table 221.

Sheeps, goats, horses, poultry and other animals

Tier 2 default NH₃-N EFs have been taken (EEA 2016, Table 3.9). For other animals (furred game) the EF of sheep has been used. N-excretion values and TAN proportion are described in chapter 5.3.3.

5.5.5 Cultivated crops (3.D.e)

Key source: No

5.5.5.1 NMVOC emissions from vegetation

The Tier 1 methodology according to the EMEP/EEA GB 2016 has been applied. In line with assumptions used in previous inventories for simplification wheat has been considered to be representative for the vegetation cover of agricultural cropland (0.32 kg NMVOC/ha/yr following the EMEP/EEA GB 2016, Table 3.3). Austria has cold climate conditions. The average temperature in Austria varies from 8.4°C in Klagenfurt to 10.5°C in Vienna. Grassland is predominately located in mountainous (cold) regions. Therefore, the emission factor for grass (15°C) of 0.41 kg NMVOC/ha/yr following the EMEP/EEA GB 2016, Table 3.3, has been taken. Emissions are calculated with the following formula.

$$E_{\text{NMVOC}_{\text{cl,gl}}} = \sum A_{\text{cl,gl}} * EF_{\text{cl,gl}}$$

$E_{\text{NMVOC}_{\text{cl,gl}}}$ = annual NMVOC emission flux from cropland and grassland areas (kg NMVOC)

$A_{\text{cl,gl}}$ = annual cropland area, annual grassland area (ha)

$EF_{\text{cl,gl}}$ = EF of wheat for cropland and grass (15°C) for grassland (kg NMVOC/ha)

Activity data

Data of agricultural land use are taken from (STATISTIK AUSTRIA, 1990-2016) and (BMLFUW 2000–2016). Land use areas (cropland, grassland, alpine grassland) are harmonized with sector Land Use, Land Use Change and Forestry (LULUCF) of Austria's GHG inventory to be consistent within the Austrian Inventory and across all sectors. Cropland areas are based on data from the national FSS (Farm Structure Survey) and IACS (Integrated Administration and Control System). As Farm Structure Survey (FSS) data are only available for the years 1990, 1995, 1999 and 2010 and complemented with random sample FSS which were undertaken in 1993, 1997, 2003, 2005, 2007 and 2013, adjusted IACS data has been used for the intermediate years. AI-

pine grassland areas have been revised as an improved topographical surveying in the alpine regions has been undertaken. Subsequently the estimation led to different, reduced areas of alpine pastures and larger areas of other grassland.

Further details are given in “Austria’s National Inventory Report 2017, chapters 6.3 *Cropland (Category 4.B)* and 6.4 *Grassland (Category 4.C)* (UMWELTBUNDESAMT 2017a).

Table 239: Agricultural land use 1990–2015.

Year	Land Use Areas [1000 ha]		
	Cropland (total)	Grassland (total)	Grassland (extensive)
1990	1 405	1 715	456
1991	1 423	1 713	450
1992	1 415	1 712	443
1993	1 399	1 710	437
1994	1 403	1 690	431
1995	1 404	1 669	425
1996	1 414	1 670	419
1997	1 397	1 671	413
1998	1 396	1 661	407
1999	1 395	1 651	401
2000	1 378	1 652	398
2001	1 376	1 654	396
2002	1 375	1 655	393
2003	1 376	1 657	390
2004	1 404	1 633	387
2005	1 405	1 609	385
2006	1 390	1 581	382
2007	1 389	1 554	379
2008	1 377	1 539	376
2009	1 375	1 524	373
2010	1 373	1 509	371
2011	1 370	1 494	368
2012	1 365	1 479	365
2013	1 364	1 463	363
2014	1 352	1 463	363
2015	1 346	1 463	363

5.5.6 Category-specific Recalculations

Update of activity data

Other organic fertilisers applied to soils (3.D.a.2.c)

Compost application was considered as a new activity for the first time. The consideration of this additional source resulted in additional NH₃ and NO_x emissions for all reported years.

Improvement of methodologies and emission factors

Ammonia (NH₃)

Inorganic N-fertilizers including urea application (3.D.a.1)

The inventory was updated by using the default Tier 2 NH₃ EF for urea fertilizer according to the new EMEP/EEA emission inventory guidebook 2016. The revision resulted in a decrease of NH₃ emissions (-388.4 t NH₃ in 2014).

Animal manure applied to soils (3.D.a.2.a)

Revised numbers of horses resulted in higher emissions from 2004 onwards (+377.0 t NH₃ in 2014).

Weighted EF of other poultry was updated according to the share of geese and ducks from 2003 to 2015. The update resulted in slightly lower emissions.

Sewage sludge applied to soils (3.D.a.2.b)

The inventory was updated by using the default Tier 1 NH₃ EF for sewage sludge application according to the new EMEP/EEA emission inventory guidebook 2016. The revision resulted in a decrease of NH₃ emissions (-80.6 t NH₃ in 2014).

Other organic fertilisers applied to soils including digestate and compost (3.D.a.2.c)

Additionally to digested energy crops already considered in previous submissions compost application was introduced as a new activity. For both activities (digestate and compost) the default Tier 1 NH₃ EF for other organic fertilisers according to the new EMEP/EEA emission inventory guidebook 2016 has been used. In previous submissions in a simple approach the EF of urea has been used for digestate. The revision resulted in a considerable decrease of emissions from source category other organic fertilisers applied to soils (-564.6 t NH₃ in 2014).

Urine and dung deposited by grazing animals (3.D.a.3)

Revised numbers of horses resulted in higher emissions from 2004 onwards (+75.2 t NH₃ in 2014).

Cultivated Crops (3.D.e)

In submission 2016 Austria reported an amount of 284 t NH₃ emissions from legume cropland for 2014. Calculations followed the CORINAIR detailed methodology as provided in the EMEP/CORINAIR atmospheric emission inventory guidebook 1999.

However, due to the lack of evidence of emissions arising from the fixation process itself, the EMEP/EEA Guidebook 2016 (and the 2006 IPCC Guidelines) do not consider biological N fixation as a source of emissions anymore. Source category and default methodologies were removed from the guidebooks and no specific category is provided for reporting in the NFR (and CRF). Consequently, when updating the inventory using the new EMEP/EEA Guidebook 2016, Austria removed estimates for biological N fixation based on the outdated default methodology.

In submission 2017 Austria reports 'NA' for NH₃ in source category cultivated crops for all years. Following the EMEP/EEA Guidebook 2016, Table 2.1 no EFs are available for the estimation of ammonia emissions arising from standing or 'cultivated' crops.

Nitrogen Oxides (NO₂)

Inorganic N-fertilizers including urea application (3.D.a.1)

Inventory update with the default Tier 1 EF for NO from N applied in fertilisers according to the new EMEP/EEA emission inventory guidebook 2016 resulted in significantly increased emissions (+3 370.3 t NO₂ in 2014).

Animal manure applied to soils (3.D.a.2.a)

The inventory was updated by using the default Tier 1 EF for NO from N applied in fertilisers according to the new EMEP/EEA emission inventory guidebook 2016. The revision resulted in significantly increased emissions (+976.5 t NO₂ in 2014).

Sewage sludge applied to soils (3.D.a.2.b)

The inventory was updated by using the default Tier 1 EF for NO from sewage sludge according to the new EMEP/EEA emission inventory guidebook 2016. The revision resulted in increased emissions (+11.0 t NO₂ in 2014).

Other organic fertilisers applied to soils including digestate and compost (3.D.a.2.c)

Additionally to digested energy crops already considered in previous submissions compost application was introduced as a new activity. For both activities (digestate and compost) the default Tier 1 EF for NO according to the new EMEP/EEA emission inventory guidebook 2016 has been used. The revision resulted in a considerable increase of emissions from source category other organic fertilisers applied to soils (+109.3 t NO₂ in 2014).

NMVOC

Cultivated Crops (3.D.e)

The inventory was updated by using the default Tier 1 EF for NMVOC from agricultural crops according to the new EMEP/EEA emission inventory guidebook 2016. The revision resulted in decreased emissions (-764.9 t NMVOC in 2014).

5.6 NFR 3.D Particle Emissions from Agricultural Soils

Particle emissions reported under source category 3.D result from the following activities:

- Certain steps of farm work such as soil cultivation and harvesting (field operations). Calculations are based on (WINIWARTER et al. 2007). In accordance with the EMEP/EEA Guidebook 2013, chapter 3.2.2, emissions are allocated to NFR source category *3.D.a.1 Inorganic N-fertilizers*.
- Agricultural bulk material handling. These emissions are estimated under source category *2.A Mineral Products* (see Chapter 4.3) and reported under NFR source category *3.D.d Off-farm storage, handling and transport of bulk agricultural products*.

5.6.1 Methodological Issues

5.6.1.1 PM emissions from field operations

Emissions of particulate matter from field operations are linked with the usage of machines on agricultural soils. They are considered in relationship with the treated areas.

Activity Data

Agricultural land use data applied for the calculation of particle emissions are taken from (STATISTIK AUSTRIA 1990-2016) and (BMLFUW 2000-2016). Land use areas were harmonized with sector Land Use, Land Use Change and Forestry (LULUCF) of Austria's GHG inventory to be consistent within the Austrian Inventory and across all sectors. Cropland areas are now based on data from the national FSS (Farm Structure Survey) and IACS (Integrated Administra-

tion and Control System). As Farm Structure Survey (FSS) data are only available for the years 1990, 1995, 1999 and 2010 and complemented with random sample FSS which were undertaken in 1993, 1997, 2003, 2005, 2007 and 2013, adjusted IACS data has been used for the intermediate years.

Further details are given in “Austria’s National Inventory Report 2017, chapters 6.3 *Cropland (Category 4.B)* (UMWELTBUNDESAMT 2017a).

Table 240: Agricultural land use data 1990–2015.

Land Use Area Data					
Year	arable farm land [1 000 ha]	grassland (intensive used) [1 000 ha]	Year	arable farm land [1 000 ha]	grassland (intensive used) [1 000 ha]
1990	1 405	877	2003	1 376	909
1991	1 423	886	2004	1 404	909
1992	1 415	896	2005	1 405	908
1993	1 399	905	2006	1 390	889
1994	1 403	915	2007	1 389	870
1995	1 404	926	2008	1 377	864
1996	1 414	932	2009	1 375	858
1997	1 397	938	2010	1 373	851
1998	1 396	924	2011	1 370	843
1999	1 395	910	2012	1 365	835
2000	1 378	910	2013	1 364	826
2001	1 376	910	2014	1 352	826
2002	1 375	909	2015	1 346	826

Due to the limited number of measurements, a separate parameterization of different field crops as well as a different treatment of cropland and grassland activities is not yet possible. Thus, as activity data the sum of cropland and intensively used grassland area is taken.

Emission factors

For the estimation of emissions from field operations an emission factor of 5kg/ha PM₁₀ has been applied (OETTL & FUNK 2007). PM emissions occurring from harvesting have been calculated using an emission factor of 5kg/ha PM₁₀ (HINZ & VAN DER HOEK 2006). Both emission factors are based on measurements carried out directly on the field (two meters above soil and on the harvester).

Emission factors reflect constant dry conditions and are consistent with other reported emission factors e.g. (EPA 1999). Nevertheless, resulting emissions would exceed their actual atmospheric occurrence. They are rather ‘potential emissions’ marking the upper boundaries. To get more reliable data, the wet situation in Austria has to be taken into account.

Wet conditions in Austria

Following Hinz, under wet conditions only a small part of the particle emissions stays in the atmosphere. In this inventory a value of 10% has been applied.

Operations under dry conditions

Dry weather conditions have been considered by the use of a variable climate factor. This factor represents the share of operations under dry conditions. As currently no solid data for operations under dry conditions is available, a share of 0.1 has been assumed. Activities under dry conditions cause 10 times higher emissions compared to wet conditions.

The calculations resulted in following emissions per hectare:

Table 241: Resulting implied PM emission factors.

Implied Emission Factor [g/ha]		
TSP	PM ₁₀	PM _{2.5}
4 444	2 000	444

The following fractions have been used for conversion:

PM_{2.5}..... TSP*10%

PM₁₀..... TSP*45%

5.6.1.2 PM emissions from bulk material handling

These emissions are estimated under source category *2.A Mineral Products* (see Chapter 4.3) but reported under sector *3.D.d Off-farm storage, handling and transport of agricultural products*.

A simple methodology was applied. Emissions were estimated multiplying the amount of bulk material by an emission factor.

Activity data

Activity data was taken from official Statistik Austria production statistics (see Chapter 4.3, Table 180).

Emission factors

The EMEP/EEA GB 2016 does not provide emission factors for this source category. Emission factors are taken from a national study (WINIWARTER et al. 2001) (see Chapter 4.3, Table 179).

5.6.1.3 Recalculations

No recalculations have been carried out since last years' submission.

5.7 NFR 3.F Field Burning of Agricultural Residues

This category comprises burning straw from cereals and residual wood of vinicultures on open fields in Austria.

Burning agricultural residues on open fields in Austria is legally restricted by provincial law and since 1993 additionally by federal law and is only occasionally permitted on a very small scale. Therefore the contribution of emissions from field burning of agricultural waste to the total emissions is very low.

5.7.1 Methodological Issues

Activity Data

According to the Austrian Chamber of Agriculture (personal communication to Mag. Längauer), in Austria about 420 ha were burnt in 2015. This value corresponds to about 0.1% of the relevant cereal area in 2015. For 1990 an average value of 2 500 ha was indicated for Austria's main cultivation regions (Dr. Reindl 2004). The extrapolation to Austria's total cereal production area gave a value of 2 630 ha.

Activity data on Austrian viniculture area was obtained from (STATISTIK AUSTRIA 1990-2016) and harmonized with sector LULUCF of Austria's GHG inventory. A vineyard survey was undertaken in 2009 leading to a figure of 45 533 ha of planted vineyards for 2009 (STATISTIK AUSTRIA 2010). 1 102 ha of the total vine area is out of production and thus had to be subtracted from the total vineyard area. For the years 2011 and 2012 an interpolated value between 2010 and 2013 (STATISTIK AUSTRIA 2013 and 2014a) has been calculated.

Further details are given in "Austria's National Inventory Report 2017, chapter 6.3 *Cropland (Category 4.B)*" (UMWELTBUNDESAMT 2017a).

According to an expert judgement from the *Federal Association of Viniculture* (Bundesweinbauverband Österreich) the amount of residual wood per hectare viniculture is 1.5 to 2.5 t residual wood and the part of it that is burnt is estimated to be 1 to 3%. For the calculations the upper limits (3% of 2.5 t/ha) have been used resulting in a factor of 0.075 t burnt residual wood per hectare viniculture area.

Table 242: Activity data for field burning of agricultural residues 1990–2015.

Year	Viniculture Area [ha]	Burnt Residual Wood [t]
1990	58 364	4 377
1991	57 981	4 349
1992	57 599	4 320
1993	57 216	4 291
1994	56 422	4 232
1995	55 627	4 172
1996	54 061	4 055
1997	52 494	3 937
1998	51 854	3 889
1999	51 214	3 841
2000	50 304	3 773
2001	49 393	3 704
2002	48 483	3 636
2003	47 572	3 568
2004	48 846	3 663
2005	50 119	3 759
2006	49 981	3 749
2007	49 842	3 738
2008	47 688	3 577
2009	45 533	3 415
2010	45 480	3 411

Year	Viniculture Area [ha]	Burnt Residual Wood [t]
2011	45 427	3 407
2012	45 373	3 403
2013	45 320	3 399
2014	45 320	3 399
2015	45 439	3 408

The amount of agricultural waste burned is multiplied with a default or a country specific emission factor.

5.7.1.1 Cereals

NH_3 , NO_x , SO_2 , NMVOC, CO, Particulate Matter (TSP, PM_{10} , $PM_{2.5}$), Heavy metals (Cd, Hg, Pb)

The EMEP/EEA Tier 1 default approach (EEA 2016) referring to the IPCC default method was used. The IPCC default combustion factor of wheat residues provided in Table 2.6 of the 2006 IPCC GL (IPCC 2006) has been applied for wheat, barley, oats, rye and other cereals. For dry matter fraction the Austrian specific value of 0.86 was used (LÖHR 1990). Residue/crop product ratios were calculated on the basis of the IPCC 2006 default methodology (see Austria's National Inventory Report 2017, chapter on N from crop residues).

For wheat and barley Tier 2 emission factors are available (EEA 2016, Table 3-3). For oats, rye and other grains the EMEP/EEA Tier 1 emission factors were applied.

Table 243: Default emission factors per crop type and pollutant.

	Emission factors										
	NH_3	NO_x	SO_2	NMVOC	CO	TSP	PM_{10}	$PM_{2.5}$	Pb	Cd	Hg
	[g/kg dm burnt]					[mg/kg dm burnt]					
Wheat	2.4	2.3	0.5	0.5	66.7	5.8	5.7	5.4	0.11	0.88	0.14
Barley	2.4	2.7	0.1	11.7	98.7	7.8	7.7	7.4	0.004	0.240	0.096
Oats	2.4	2.3	0.5	0.5	66.7	5.8	5.7	5.4	0.11	0.88	0.14
Rye	2.4	2.3	0.5	0.5	66.7	5.8	5.7	5.4	0.11	0.88	0.14
Other grains	2.4	2.3	0.5	0.5	66.7	5.8	5.7	5.4	0.11	0.88	0.14

POPs (PAH, HCB, dioxin/furan)

A country specific method was applied (HÜBNER 2001b). National emission factors were taken from HÜBNER (2001b):

- PAH 70 000 mg/ha
- PCDD/F .. 50 µgTE/ha
- HCB 10 000 µg/ha.

5.7.1.2 Viniculture

SO_2 , NO_x , NMVOC and NH_3

A country specific method was applied. National emission factors for SO_2 , NO_x and NMVOC were taken from (JOANNEUM RESEARCH 1995). A calorific value of 7.1 MJ/kg burnt wood which corresponds to burning wood logs in poor operation furnace systems was used to convert the

emission factors from [kg/TJ] to [kg/Mg]. For NH₃ the Corinair emission factor of 1.9 kg per ton burnt wood was taken. Table 245 presents the resulting emission factors.

Table 244: Emission factors for burning straw and residual wood of vinicultures.

	SO ₂ [g/Mg Waste]	NO _x [g/Mg Waste]	NMVOC [g/Mg Waste]	NH ₃ [g/Mg Waste]
Residual wood of vinicultures	78	284	14 200	1 900

Heavy metals (Cd, Hg, Pb)

A country specific method was applied: The dry matter content of residual wood was assumed to be 80%, national emission factors were taken from (HÜBNER 2001a):

- Cd 0.37 mg/kg dm_{wood}, 20% remaining in ash
- Pb 2.35 mg/kg dm_{wood}, 20% remaining in ash
- Hg 0.038 mg/kg dm_{wood}, 0% remaining in ash

POPs (PAH, HCB, PCDD/F)

A country specific method was applied. The national emission factors per ton burnt wood were taken from (HÜBNER 2001b):

- PAH 15.000 mg/Mg Waste
- PCDD/F .. 12 µgTE/Mg Waste
- HCB 2 400 µg/Mg Waste

Particulate Matter (TSP, PM₁₀, PM_{2.5})

The same methodology like for the estimation of PM emissions from bonfires (WINIWARTER et al. 2007) was applied. An emission factor of 1 500 g/GJ (similar to open fire places, expert guess from literature) was taken. Under the assumption of a heating value of 10 GJ per ton residual wood the following emission factor has been derived:

- EF_{TSP} = EF_{PM10} = EF_{PM2.5} = 15kg/t residual wood

5.7.2 Category-specific Recalculations

Improvement of methodologies and emission factors

The use of the default methodology according to the EMEP/EEA Guidebook 2016 and improved consistency with the parameters used in the GHG inventory (residue/crop product ratio) resulted in slightly revised emissions.

6 WASTE (NFR SECTOR 5)

6.1 Sector Overview

This chapter includes information on and descriptions of methodologies applied for estimating emissions of NEC gases, CO, heavy metals, persistent organic pollutants (POPs) and particulate matter (PM), as well as references for activity data and emission factors concerning waste management and treatment activities reported under NFR Category 5 *Waste* for the period from 1990 to 2015.

Emissions addressed in this chapter include emissions from the sub categories

- *Solid Waste Disposal on Land* (NFR Sector 5.A);
- *Composting* (NFR Sector 5.B), comprising composting as well as mechanical-biological treatment of waste;
- *Waste Incineration* (NFR Sector 5.C), which comprises the incineration of corpses, municipal waste and waste oil;
- *Wastewater Handling* (NFR Sector 5.D).

The following Table 246 presents the contribution of sector Waste to national total emissions of the different pollutants.

Table 245: Contribution to National Total Emissions from NFR sector 5 Waste in 2015.

Pollutant	Source Category: 5 Waste	Pollutant	Source Category: 5 Waste
SO ₂	0.06%	PAH	< 0.01%
NO _x	0.01%	Diox	0.50%
NM VOC	0.06%	HCB	0.09%
NH ₃	1.82%	TSP	0.82%
CO	0.64%	PM ₁₀	0.68%
Cd	0.05%	PM _{2.5}	0.41%
Hg	2.05%		
Pb	0.01%		

The overall emission trend reflects changes in waste management policies as well as waste treatment facilities. According to the Landfill Ordinance¹²⁵ waste has to be treated before being deposited in order to reduce the organic carbon content. Decreasing amounts of deposited waste result in decreasing NH₃ emissions. Although an increasing amount of waste is incinerated, NO_x, NM VOC and NH₃ emissions from 5.C (waste incineration without energy recovery) are decreasing. This is because – apart from some clinical and hazardous waste – most waste is combusted in district heating or industrial plants, where the energy is used and emissions are thus allocated to 1.A. Emissions arising from incineration of waste with energy recovery are taken into account in NFR Sector 1.A. NH₃ emissions arising from category 5.B Composting show an increasing trend due to increasing amounts of biologically treated waste, a result of the separate collection of organic waste (regulated in an Austrian act on collection of biogenic waste¹²⁶)

¹²⁵ Verordnung über die Ablagerung von Abfällen (Deponieverordnung), BGBl. Nr. 164/1996, BGBl. II Nr. 49/2004; geltende Fassung: Deponieverordnung 2008 (BGBl. II Nr. 39/2008).

¹²⁶ Verordnung über die getrennte Sammlung biogener Abfälle (BGBl. Nr. 68/1992)

and the since 2009 obligatory pre-treatment of waste¹²⁷ before deposition (regulated in Austrian Landfill Ordinance¹²⁸).

The following list comprises primary and secondary measures which were implemented over the last years:

- Primary measures
 - waste avoidance in households: savings in packaging materials; returnable (plastic) bottles instead of non-returnable packages; intensive waste separation, composting of biological waste; reuse; separate collection of hazardous waste like solvents, paints or (car) batteries.
 - waste avoidance in industry and energy industry: waste separation regarding material, recyclable waste, hazardous waste; more efficient process lines; use of co- and by-product process line; (scap) recycling; substitution of raw material/fuel; reduction in use of raw material/fuel and additive raw material; higher product quality.
 - recycling of old cars (recycling certificate).
- Secondary measures
 - general strategy: waste avoidance prior to waste recycling/reuse prior to landfilling;
 - recovery of (recyclable) material from waste like steel and aluminium recycling, and recycling of paper, glass, plastic;
 - recovery of (recyclable) material from electronic waste;
 - composting of biogenic material;
 - mechanical-biological treatment of waste;
 - fermentation of biogenic material;
 - energetic use in waste incineration.

The following figure shows the main streams of treatment and disposal of waste from households and similar sources. It also aims to transparently show the distinction between residual and non-residual waste (with regard to municipal solid waste¹²⁹) and to demonstrate that all relevant activity data are taken into account in the inventory.

¹²⁷ Since 2004 respectively – without exemption – 2009 no waste is allowed to be deposited any more without being pre-treated (in thermal or bio-technical treatment plants)

¹²⁸ Ordinance on Landfills (Landfill Ordinance 2004), Federal Law Gazette No 164/1996 as amended by Federal Law Gazette No 49/2004; Ordinance on Landfills (Landfill Ordinance 2008), Federal Law Gazette II No 39/2008 as amended by Federal Law Gazette II No 185/2009

¹²⁹ In fact non-residual waste also comprises waste from other (industrial) sources.

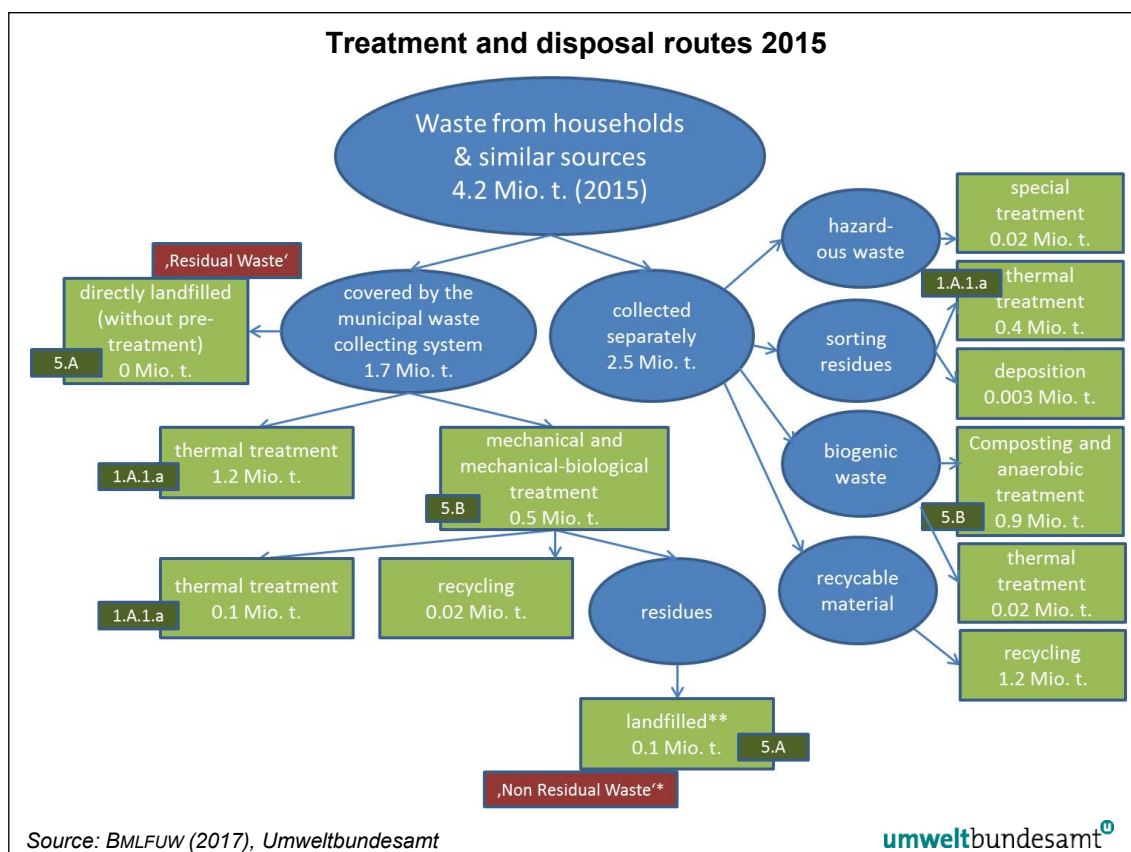


Figure 42: Main streams of treatment and disposal of waste from households and similar sources.

Almost 100% of waste from households and similar sources is incinerated, recycled or treated mechanical-biologically. Since 2009 only minor amounts of stabilized residues have been still directly deposited.

Table 246: Recycling and treatment of waste from households and similar sources.

Treatment	1989 ¹⁾	1999 ³⁾	2004 ³⁾	2006 ⁴⁾	2008 ⁵⁾	2009 ⁶⁾	2010 ⁷⁾	2012 ⁸⁾	2013 ⁹⁾	2014 ¹⁰⁾	2015 ¹¹⁾
bio-technical treatment	16.7% ²⁾	6.3%	11.2%	17.9%	8.8%	10.4%	8.5%	11.0%	10.9%	10.4%	7.2%
thermal treatment (incineration)	5.9%	14.7%	28.3%	23.7%	34.7%	36.4%	40.2%	38.2%	38.8%	38.6%	41.4%
treatment in plants for hazardous waste	0.4%	0.8%	1.2%	1.8%	2.3%	2.4%	2.5%	2.4%	2.1%	2.0%	2.1%
recycling	12.9%	34.3%	35.6%	34.8%	32.3%	31.7%	30.7%	26.8%	27.2%	26.9%	27.1%
bio-technical treatment/composting	1.0%	15.4%	16.0%	17.9%	18.2%	18.7%	17.7%	21.6%	20.9%	22.0%	22.1%
direct deposition at landfills	63.1%	28.5%	7.7%	3.8%	3.7%	0.4% ^{*)}	0.4% ^{*)}	<0.1% ^{*)}	0.1% ^{*)}	0.1% ^{*)}	0.1% ^{*)}

¹⁾ Federal Waste Management Plan (BMLFUW 2001)

²⁾ This value also includes plants used in the past to reduce odour emissions.

³⁾ Federal Waste Management Plan (BMLFUW 2006a)

⁴⁾ Annual update (2008) of the Federal Waste Management Plan (BMLFUW 2006a)

⁵⁾ Annual update (2009) of the Federal Waste Management Plan (BMLFUW 2006a)

⁶⁾ Federal Waste Management Plan (BMLFUW 2011)

⁷⁾ Annual update (2012) of the Federal Waste Management Plan (BMLFUW 2011)

⁸⁾ Annual update (2013) of the Federal Waste Management Plan (BMLFUW 2011)

⁹⁾ Annual update (2014) of the Federal Waste Management Plan (BMLFUW 2011)

¹⁰⁾ Annual update (2015) of the Federal Waste Management Plan 2011 (BMLFUW 2011) (BMLFUW 2015a)

¹¹⁾ Federal Waste Management Plan 2017 (BMLFUW 2017)

^{*)} deposition of (sorting-, processing-) residues from separately collected waste

6.2 General description

6.2.1 Completeness

Table 248 gives an overview of the NFR categories included in this chapter and also provides information on the status of emission estimates of all sub categories. A “✓” indicates that emissions from this sub category have been estimated.

Table 247: Overview of sub categories of Category 5 Waste and status of estimation.

NFR Category		Status														
		NEC gas				CO		PM		Heavy metals			POPs			
		NO _x	SO ₂	NH ₃	NM VOC	CO	TSP	PM ₁₀	PM _{2.5}	Cd	Hg	Pb	Dioxin	PAK	HCB	PCB
5.A	Solid Waste Disposal on Land	IE ⁺	IE ⁺	✓	✓	✓	✓	✓	✓	✓	✓	✓	NA	NA	NA	NA
5.B	Biological Treatment of Waste (Composting)	NA	NA	✓	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5.C	Waste Incineration	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	NA
5.D	Wastewater Handling	NA	NA	NA	✓	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

* related emissions are covered under sector Energy

6.2.2 Key Categories

In the following table the key categories of sector waste are presented.

NFR Category	Source Category	Key Category	
		Pollutant	KS-Assessment
5.B.1	Biological treatment of waste (composting)	NH ₃	TA
5.C.1	Waste incineration	Cd, Diox	TA

6.2.3 Methodology

In general the CORINAIR simple methodology, multiplying activity data for each sub category with an emission factor, is applied. For waste disposal the IPCC methodology (FOD method) was used to calculate the amount of landfill gas, the methodology is described in detail below.

6.2.4 Uncertainty Assessment

The Uncertainties determined for air pollutants largely correspond to those of greenhouse gases as underlying data is the same in most cases. The Assessment for 5.A Solid Waste Disposal is based on a national study WINIWARTER 2007b).

The uncertainties have been determined based on the following considerations

- IPCC Tier 2 method applied;
- Country-specific activity data taken from Austrian databases;
- Availability of data on landfill recovered on a regular basis.

Table 248: Uncertainty assessment for managed waste disposal on land

	Activity data	Emission factor
5.A Solid Waste Disposal on Land – NH ₃ , NMVOC	12%	25%
5.A Solid Waste Disposal on Land – PM _{2.5}	12%	200%
5.B Biological Treatment of Waste – NH ₃	20%	125%
5.C Waste Incineration – NH ₃ , NMVOC	7%	125%
5.C Waste Incineration – PM _{2.5} , NO _x , SO ₂	7%	200%

6.2.5 Quality Assurance and Quality Control (QA/QC)

To ensure, that most up-to-date data and parameters (e.g. landfill gas recovery, connection rate, etc.) are considered, national waste experts, mostly within the Umweltbundesamt are contacted. After finalisation of the calculation but prior to submission, the respective section of the IIR is sent to relevant experts for a final check of descriptions and trend analysis. Moreover, Activity data is checked for plausibility and time series consistency. If dips and jumps exceeding 20% compared to the year before are observed, other experts or data providers are consulted to either provide the explanation or to identify a possible inconsistency or an error.

Recalculations are validated in detail by comparing several parameters and partial results over the whole time series. Explanations for recalculations are documented.

Input Data Audit 2014/2015

End of 2014/beginning 2015 a multi-step audit was conducted at the BMLFUW (Department responsible for analysis and quality check of EDM data on landfilled waste) and the Umweltbundesamt (Department responsible for data query on behalf of the BMLFUW). The aim was to get insight into collection, processing and quality control of data, i.e. waste amounts deposited, and clarify issues on transparency, accuracy, completeness, consistency, comparability and timely availability of data. The audit focussed on waste amounts deposited, but partly also covered the data basis and procedures for the compilation of data on waste amounts composted. The audit showed a very strong commitment on quality. There is close cooperation with relevant data providers, in particular related to waste treating facilities. QA/QC takes place at different stages, and an improvement program ensures adaption of the system to changing requirements. Some recommendations on improvements have been given by the IBE, but mainly with regard to documentation and archiving.

6.2.6 Planned Improvements

No improvements are currently planned.

6.3 NFR 5.A Waste Disposal on Land

6.3.1 NMVOC, NH₃, CO and heavy metals emissions

6.3.1.1 Source Category Description

NFR 5.A.1 *Managed waste disposal on land* accounts for the main source of NH₃ and NMVOC emissions of NFR Category 5 Waste. In Austria all waste disposal sites are managed landfills.

In the Austrian inventory two main categories of waste are distinguished: residual waste and non-residual waste. Residual waste refers only to the part of municipal solid waste¹³⁰ collected by the municipal system (mixed composition) that is directly deposited without any pre-treatment. Non-residual waste comprises among others municipal solid waste having been pre-treated, sludges from wastewater treatment and waste from industrial sources.

‘Residual waste’ corresponds to waste:

- originating from households and similar sources (private households, administrative facilities of commerce, industry and public administration, kindergartens, schools, hospitals, small enterprises, agriculture, market places and other generation points)
- remaining after separation of paper, glass, plastic etc. at the source
- covered by the municipal waste collecting system
- directly landfilled without having passed any pre-treatment

It has to be noted that from 2009 on no waste is allowed to be deposited any more without being pre-treated (due to the Landfill Ordinance¹³¹), so since 2009 no disposal of ‘residual waste’ is reported by landfill operators and therefore no new depositions of residual waste is taken into account in the inventory. Emissions from this subcategory are therefore only affected by historical depositions.

Waste from households and similar sources covered by the municipal waste collecting system but undergoing a pre-treatment before deposition is not included in this category, but in category “non-residual waste” (sub-category “sorting residues”, among others from mechanical-biological treatment) and in sector “energy” respectively, as incineration is a pre-treatment option too.

‘Non-residual waste’:

- comprises pre-treated waste from households (e.g. residues from mechanical-biological treatment) and waste with biodegradable lots from other (industrial) sources
- is divided into the categories wood, construction waste, paper, green waste, sludge, sorting residues/stabilized material (incl. bulky waste), textiles and fats

Stabilized material and sorting residues remaining after mechanical, biological and mechanical-biological treatment and bulky waste are the main fraction deposited (98%). Some minor amounts of sludge, construction waste and paper with little TOC content (below the threshold for TOC disposal) are landfilled as well. Bio waste, paper and wood are mainly composted, recycled or reused due to the implementing of the Waste Management Law, fats and textiles are not deposited any more.

¹³⁰ i.e. waste from households as well as other waste which, because of its nature or composition, is similar to waste from household (Article 2 (b): Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste).

¹³¹ Ordinance on Landfills (Landfill Ordinance 2004), Federal Law Gazette No 164/1996 as amended by Federal Law Gazette No 49/2004; Ordinance on Landfills (Landfill Ordinance 2008), Federal Law Gazette II No 39/2008 as amended by Federal Law Gazette II No 185/2009

6.3.1.2 Methodological Issues

The anaerobic degradation of land filled organic substances results in the formation of landfill gas.

NM VOC and NH₃ emissions are calculated based on their respective content in the emitted landfill gas (after consideration of gas recovery). For NM VOC a concentration of 300 mg per m³ landfill gas, for NH₃ a concentration of 10 mg per m³ landfill gas is assumed.

The amount of generated landfill gas from disposed solid waste is calculated by taking into account:

- the amounts of deposited waste, reported by landfill operators for different waste categories,
- the carbon contents of each waste fraction and
- several other parameters, among others on landfill gas recovery¹³².

For the calculation of emissions the IPCC Tier 2 method (First Order Decay) is applied, consisting of two equations: first, calculating the amount of methane accumulated up to the year of the inventory; second, calculating the emitted methane after subtracting the recovered and oxidised methane amounts. As far as available country-specific parameters are taken (e.g. the recovered landfill gas).

Activity data

For emissions calculation waste deposited from 1950 onwards has been taken into account. Table 250 presents the waste amounts considered 1990-2015.

Table 249: Activity data for “Residual waste” and “Non-Residual Waste” 1990–2015.

Year	Non-Residual waste [t]	Residual waste [t]	Total waste [t]
1990	648 702	1 995 747	2 644 448
1991	661 676	1 799 718	2 461 394
1992	674 909	1 614 157	2 289 067
1993	688 407	1 644 718	2 333 126
1994	702 175	1 142 067	1 844 242
1995	716 219	1 049 709	1 765 928
1996	730 543	1 124 169	1 854 713
1997	745 154	1 082 634	1 827 788
1998	760 057	1 081 114	1 841 171
1999	822 179	1 084 625	1 906 804
2000	826 874	1 052 061	1 878 935
2001	772 786	1 065 592	1 838 378
2002	792 753	1 174 543	1 967 296
2003	890 640	1 385 944	2 276 584
2004	344 747	282 656	627 403
2005	389 660	241 733	631 393
2006	425 091	260 068	685 159
2007	464 109	154 517	618 626
2008	319 927	129 324	449 251
2009	256 340	0	256 340
2010	244 969	0	244 969

¹³² Most active landfills in Austria have gas collection systems – regulated in §31 Landfill Ordinance (Federal Law Gazette BGBl. Nr 39/2008).

Year	Non-Residual waste [t]	Residual waste [t]	Total waste [t]
2011	273 313	0	273 313
2012	166 263	0	166 263
2013	185 156	0	185 156
2014	174 500	0	174 500
2015	131 959	0	131 959
1990–2015	-80%	-100%	-95%

In 1990 the Austrian Waste Management Law¹³³ entered into force. As a consequence, from 1990 to 1995, the amount of deposited waste decreased and waste separation and reuse as well as recycling activities increased. After 1994/1995 the potential of waste prevention and waste recycling was exhausted, so amounts of deposited waste did not decrease any further. The amount of deposited waste peaked in 2003 and then dropped as from the beginning of 2004 only pre-treated waste was allowed to be deposited. This is due to the implementation of the Landfill Ordinance, which prohibits the disposal of untreated waste and therefore leads to reduced waste volumes as well as decreased carbon content in deposited waste.

However, under certain circumstances there were some exceptions to this pre-treatment-obligation granted to some Austrian provinces.¹³⁴ In four of the nine Austrian provinces it was still allowed to deposit waste directly without any pre-treatment until the end of 2008. From 2009 on no residual waste¹³⁵ is allowed to be deposited any more.

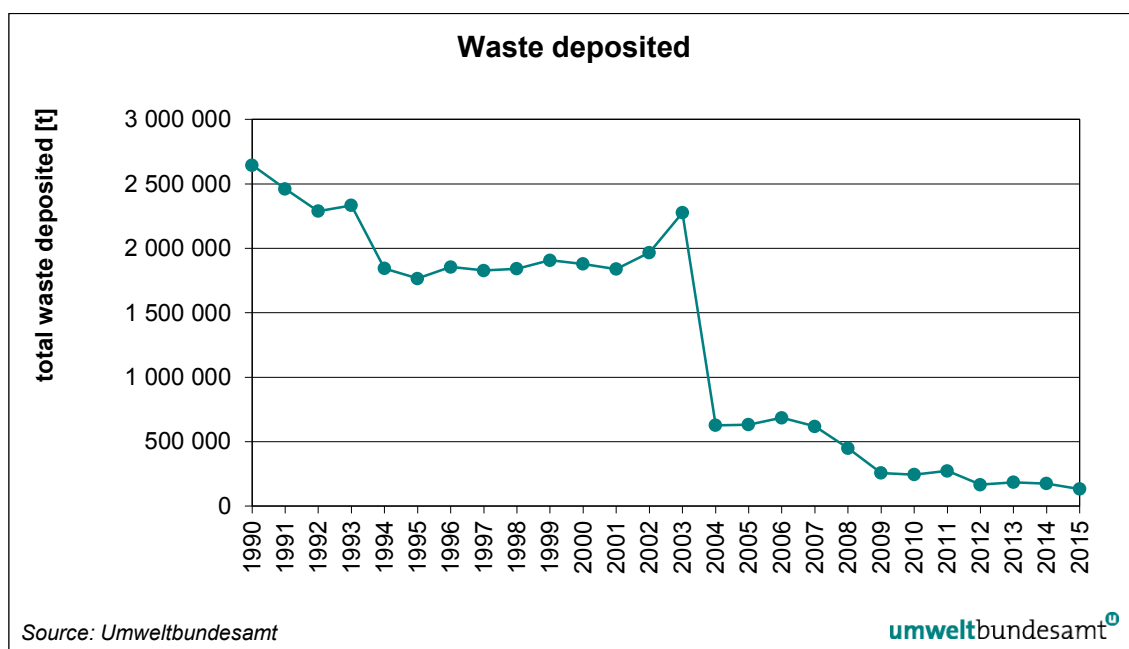


Figure 43: Deposited waste (residual and non-residual waste) 1990–2015.

¹³³ Waste Management Act of 2002, Federal Law Gazette I No 102/2002 as amended by Federal Law Gazette I No 9/2011

¹³⁴ Regulated in § 76.Abs. 7 AWG 2002

¹³⁵ as defined at the beginning of this sub-chapter

The quantities of “residual waste” have been taken from the following sources:

- Data for 2008–2015 have been taken from the EDM¹³⁶, an electronic database administered by the BMLFUW. Since the beginning of 2009 landfill operators are obliged to register their data directly and electronically (per upload) at the portal of <http://edm.gv.at>¹³⁸.
- Data for 1998–2007 were taken from a database for solid waste disposals called “Deponie-datenbank” (‘Austrian landfill database’), a database administered and maintained by the Umweltbundesamt until the end of 2008.
- Data for 1950–1997 on the amounts of deposited residual waste were taken from national studies (HACKL & MAUSCHITZ 1999, UMWELTBUNDESAMT 2001c) and the respective Federal Waste Management Plans (BUNDESABFALLWIRTSCHAFTPLAN 1995, 2001).

In the national study (HACKL & MAUSCHITZ 1999) as well as in the Federal Waste Management Plans the amounts of residual waste from administrative facilities of businesses and industries were not considered and therefore originally not included in the data of the years 1950 to 1999. Waste from these sources is however deposited and hence reported by the operators of landfill sites (therefore included in the Austrian landfill database) and thus considered in the time series from 1998 onwards. To achieve a consistent time series, data of the two overlapping years¹³⁹ (1998 and 1999) were examined and the difference – which represents the residual waste from administrative facilities of industries and businesses – was calculated. This difference, relative to the change of residual waste from households, was then applied to the years 1950 to 1997 accordingly.

The quantities of “non-residual waste” from 1998 to 2007 were taken from the database for solid waste disposal “Deponiedatenbank” (‘Austrian landfill database’), the values for 2008 onwards were taken from the EDM¹⁴⁰ (Electronic Data Management). Only the amounts of waste with biodegradable lots were considered. Table 251 presents a summary of all considered waste types and the corresponding numbers (list of waste). For calculating the emissions of residual waste the waste types were aggregated to the categories wood, paper, sludge, other waste, bio waste, textiles, construction waste and fats. There are no data available for the years before 1998. Thus extrapolation was done using the Austrian GDP (gross domestic product) per inhabitant (KAUSEL 1998) as indicator using a 20 year average value in order to get a more robust estimate.

¹³⁶ Electronic Data Management

¹³⁷ According to § 41 (1) Landfill Ordinance, Federal Law Gazette BGBl. Nr 39/2008

¹³⁸ According to §41 (1) Landfill Ordinance, Federal Law Gazette BGBl. Nr 39/2008

¹³⁹ Data available from the Federal Waste Management Plan (Bundesabfallwirtschaftsplan - BAWP) as well as from the Austrian landfill database.

¹⁴⁰ Electronic Data Management (EDM): part of the eGovernment-strategy of the Austrian Government, registration requirements and reports in the field of environment.

https://secure.umweltbundesamt.at/edm_portal/home.do?wfjs_enabled=true&wfjs_orig_req=/home.do

Table 250: Considered types of waste (list of waste¹⁴¹).

Waste Identification No	Type of Waste	Waste Identification No	Type of Waste
0303	wastes from pulp, paper and cardboard production and processing	170204	Glass, plastic and wood containing or contaminated with dangerous substances
1905	wastes from aerobic treatment of solid waste	170903	other construction and demolition wastes (including mixed wastes) containing dangerous substances
1908	wastes from wastewater treatment plants not otherwise specified	170904	mixed construction and demolition waste
1909	wastes from the preparation of water intended for human consumption or water for industrial use	190805	sludge from treatment of urban wastewater
1912	wastes from the mechanical treatment of waste (for example sorting, crushing, compacting, pelletising) not otherwise specified	190809	grease and oil mixture from oil/water separation containing only edible oil and fats
20303	waste from solvent extraction	200101/ 200102	paper and cardboard
30105	Sawdust, shavings, cuttings, wood, particle board and veneer	200108	biodegradable kitchen and canteen waste
30304	de-inking sludge from paper recycling	200111	textiles
30307	mechanically separated rejects from pulping of waste paper and cardboard	200201	Bio-degradable wastes
30310	fibre rejects, fibre-, filler- and coating sludge from mechanical separation	200302	waste from markets
40106	Sludge, in particular from on-site effluent treatment containing chromium	200307	bulky waste
40109	waste from dressing and finishing	190811–14	sludge from treatment of industrial wastewater
40221	wastes from unprocessed textile fibres	200125	edible oil and fat
150103	wooden packaging	170201	wood

Methodology

Where available, country specific factors are used. If these were not available IPCC default values are taken. Table 252 summarises the parameters used and the corresponding references.

¹⁴¹ Commission Decision of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste.

Table 251: Parameters for calculating landfill gas from SWDS.

Waste category/ Parameters	residual waste	wood	paper	sludges	Sorting residues/ output MBT ¹⁴² / bulky waste	Bio-waste	textiles	Construction waste	fats
Methane correction factor (MCF)	1 IPCC default for managed SWDS								
Fraction of degradable organic carbon dissimilated (DOC_F)	0.6	0.5	0.55	0.55	0.55	0.55	0.55	0.55	0.77
	national waste expertise (UMWELTBUNDESAMT 2005b) ¹⁴³								
DOC (kt C/kt waste)	see Table 254	0.45	0.3	0.11	0.16	0.16	0.5	0.09	0.2
	(HACKL & MAUSCHITZ 1999) (UMWELTBUNDESAMT 2003c) (BAWP 2006a)				(BAUMEIER et al. 1998) (UMWELTBUNDESAMT 2005b)				
Half life period (t_{1/2})	7	25	15	7	20	10	15	20	4
	National waste experts	(GILBERG et al. 2005)	(GILBERG et al. 2005)	Assumption: same as residual waste	IPCC default slow decay	Assumption: similar to paper	Assumption: same as paper	IPCC default slow decay	(GILBERG et al. 2005)
Fraction of CH₄ in Landfill Gas (F)	0.55 as cited in various Austrian and German literature (FLÖGL, W. 2002, ÖWAV 2003, LFU 1992, UMWELTBUNDESAMT (2008a) UMWELTBUNDESAMT (2014)								
Methane Oxidation in the upper layer (OX)	10% IPCC default								
Landfill gas recovery (R)	see Figure 46 (UMWELTBUNDESAMT 2004c, 2008a, 2014b)								
Process start (M)	13 Delay time of 6 months, with an average residence time of 6 months (IPCC default)								

¹⁴² MBT: Mechanical-biological treatment¹⁴³ Higher DOC_F values than 0.5 (the IPCC 2006 default) are applied for most of the waste types (except wood) as the composition data shows a low share of lignin in the waste deposited. The DOC_F for fats is set to 0.77 as lignin C is excluded here. The lower share of lignin C deposited can be justified by the fact that in Austria a high share of e.g. garden or park waste is treated biologically (considered under 5.B.1 composting).

DOC

The DOCs of the different waste categories under '**non-residual waste**' are constant for the entire time series and are shown in Table 252. As these categories are clearly defined (wood, paper, sludge, etc.) and can therefore be considered as quite 'homogenous', there was no need to change the DOC over the years.

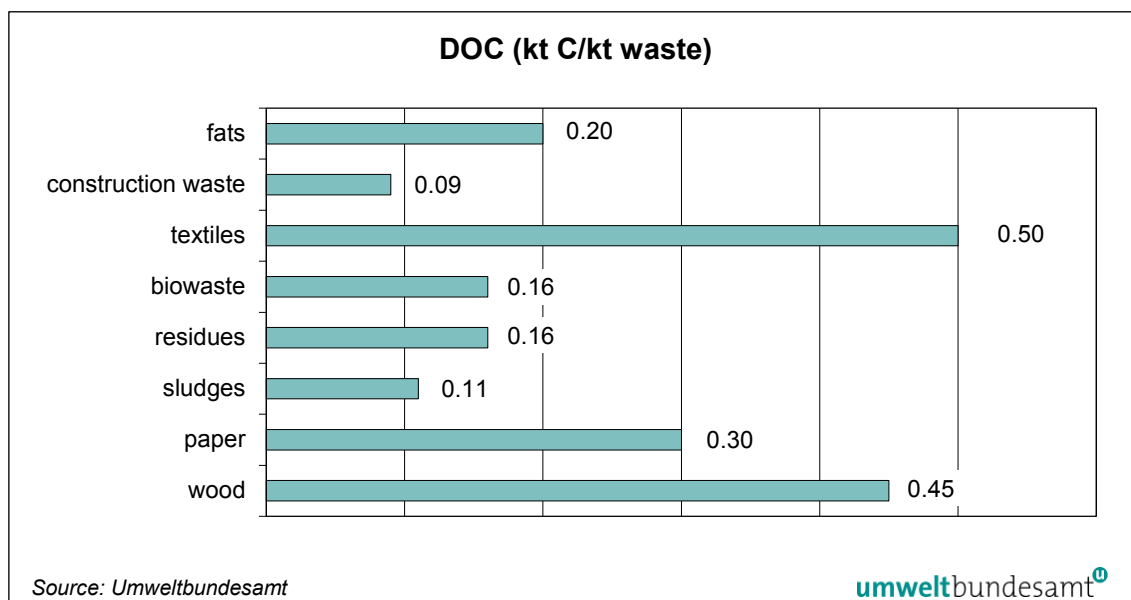


Figure 44: DOC of non-residual waste fractions.

The DOC of '**residual waste**' however has changed over the years in accordance with its changing composition. The separate collection of biogenic waste, paper and cardboard, and glass, and the increase of food waste in recent years, etc. have clearly influenced the trend of the DOC.

For the year 1990 a DOC content of 200 g/kg residual waste was taken (UMWELTBUNDESAMT 2003c). For 2008, the last year in which this waste category has been deposited, the DOC was 169 g/kg waste. It was calculated on basis of updated information on the composition of residual waste published in the Annual update (2009) of the Federal Waste Management Plan 2006 (BMLFUW 2006a), taking into account the different carbon content of the fractions as published in (UMWELTBUNDESAMT 2003c). From 2009 on, only pre-treated waste, referred to as non-residual waste, is allowed to be deposited in Austria. Hence, only historical amounts are relevant and the DOC does not need to be updated any more.

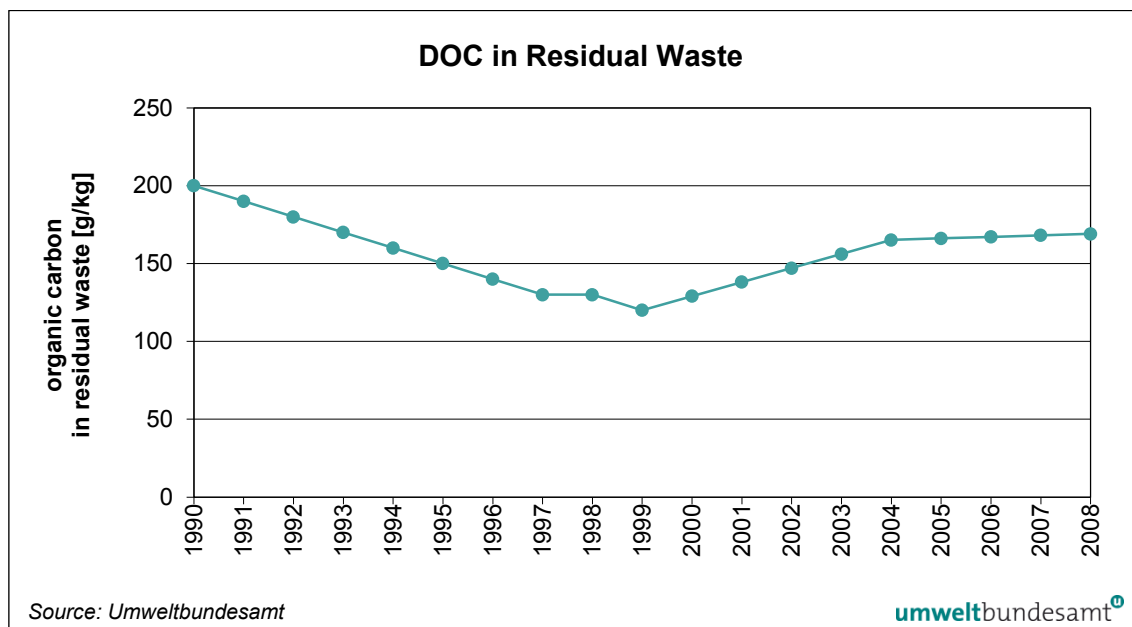


Figure 45: Development of DOC in residual waste.

The decrease during the 1990ies in DOC-content was due to the introduction of separate collection of bio-organic waste and paper waste. The amount of bio-waste that is collected separately increased over the time, while the organic share in residual waste decreased. This resulted in a change of waste composition with the effect of a decreasing DOC content. Since 2000 biogenic components in residual waste are increasing; this is due to the increasing share of biogenic components, especially of food waste, in residual waste.

Table 253 presents the composition of residual waste for several years between 1990 and 2008. On the basis of this information a time series for DOC was estimated (see Table 254). For the years before 1990, quantities according to a national study (HACKL & MAUSCHITZ 1999) were used.

Table 252: Composition of residual waste.

Residual waste	1990 ¹⁾	1996 ¹⁾	1999 ¹⁾	2004 ²⁾	2008 ³⁾
	[% of moist mass]	[% of moist mass]	[% of moist mass]	[% of moist mass]	[% of moist mass]
Paper, cardboard	21.9	13.5	14	11	12
Glass	7.8	4.4	3	5	4
Metal	5.2	4.5	4.6	3	3
Plastic	9.8	10.6	15	10	10
Composite materials	11.3	13.8	–	8	10
Textiles	3.3	4.1	4.2	6	6
Hygiene materials	–	–	12	11	8
Biogenic components	29.8	29.7	17.8	37	40
Hazardous household waste	1.4	0.9	0.3	2	1
Mineral components	7.2	3.8	–	4	3

Residual waste	1990 ¹⁾	1996 ¹⁾	1999 ¹⁾	2004 ²⁾	2008 ³⁾
	[% of moist mass]	[% of moist mass]	[% of moist mass]	[% of moist mass]	[% of moist mass]
Wood, leather, rubber, other components	2.3	1.1	2.6	1	–
Residual fraction	–	13.6	26.5	2	2

¹⁾ (UMWELTBUNDESAMT 2003c)

²⁾ (BMLFUW 2006a)

³⁾ Annual update (2009) of the Federal Waste Management Plan (BMLFUW 2006a)

Table 253: Time series of bio-degradable organic carbon content (DOC) of residual waste (mixed MSW, directly deposited)

Year	kt C/kt Residual Waste	Year	kt C/kt Residual Waste
1950–1959	0.20 ¹⁾	1998	0.13 ²⁾
1960–1969	0.20 ¹⁾	1999	0.12 ²⁾
1970–1979	0.22 ¹⁾	2000	0.13 ^{*)}
1980–1989	0.21 ¹⁾	2001	0.14 ^{*)}
1990	0.20 ²⁾	2002	0.15 ^{*)}
1991	0.19 ²⁾	2003	0.16 ^{*)}
1992	0.18 ²⁾	2004	0.17 ³⁾
1993	0.17 ²⁾	2005	0.17 ^{*)}
1994	0.16 ²⁾	2006	0.17 ^{*)}
1995	0.15 ²⁾	2007	0.17 ^{*)}
1996	0.14 ²⁾	2008	0.17 ⁴⁾
1997	0.13 ²⁾	2009–2015	n.r.**)

¹⁾ assumed to be equal to the DOC of 1990

²⁾ (UMWELTBUNDESAMT 2003c)

³⁾ calculated according to waste composition 2001 (BMLFUW 2006a)

⁴⁾ calculated according to waste composition 2009 (Status Report to BMLFUW 2006a)

^{*)} interpolated values (2000–2003) and (2005–2007)

***) no deposition of residual waste any more

DOCf

The DOCf values used for calculation are shown in Table 252.

Austria does not apply the bulk DOCf option of the IPCC 2006 GL as detailed information is available on the waste deposited. The composition of the different landfilled waste fractions (waste types) is well known, allowing for adapting the default DOCf (0.5) as provided by the IPCC 2006 GL accordingly (see UMWELTBUNDESAMT 2005). Higher DOCf values than the IPCC 2006 default (0.5) are applied for most of the waste types (except wood) as the composition data shows a low share of lignin in the waste deposited. The DOCf for fats is set to 0.77 as lignin C is excluded here.

The higher DOCf values used compared to the bulk DOCf can be justified by the fact that in Austria a high share of e.g. garden or park waste (i.e. branches from trees and bushes) is treated biologically in composting plants (considered under 5.B.1 composting).

Landfill gas recovery

In 2004, the Umweltbundesamt investigated the amount of annually collected landfill gas by questionnaires sent to landfill operators (UMWELTBUNDESAMT 2004c), showing that in 2001, the amount of collected landfill gas was more than 5 times higher than in 1990. In 1990 only 9 landfills were equipped with landfill gas wells. In 2001, at all operating mass landfills landfill gas was collected.

In 2008 and 2013 further surveys were conducted (UMWELTBUNDESAMT 2008a, UMWELTBUNDESAMT 2014b) to get new data on collected landfill gas as well as information on its use from landfill operators. Results show that from 2002 on the amount of landfill gas recovered decreased (despite a consistent recovery practice) as a consequence of

- the reduced carbon content of deposited waste and consequently reduced landfill gas production
- the slightly decreasing methane concentration in recovered landfill gas¹⁴⁴ – an effect that is due to the extensive capturing of landfill gas which can lead to the dilution of the landfill gas captured.

Compared to 2002 (maximum amount of landfill gas captured), landfill gas recovered decreased by 70% by 2015.

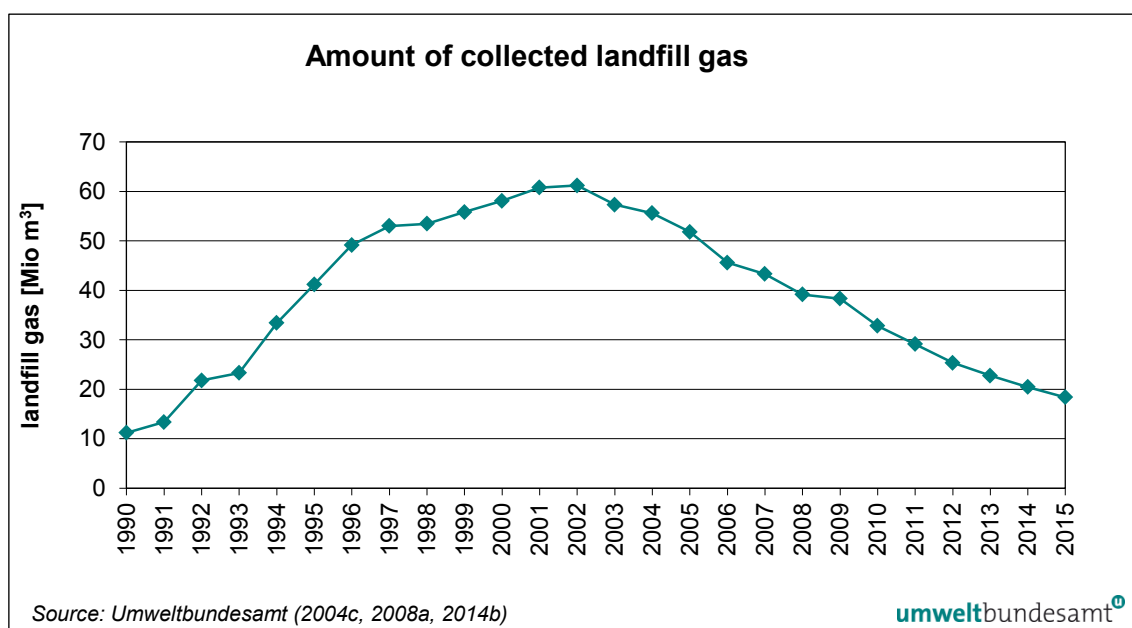


Figure 46: Amount of collected landfill gas 1990 to 2015.

Emission Factors

NMVOC, CO, NH₃ and heavy metal emissions are calculated according to their content in the emitted landfill gas (after consideration of gas recovery).¹⁴⁵

¹⁴⁴ a methane concentration of 55 % (default) is used for the estimation of the landfill gas **produced** ('F') over the whole time-series.

¹⁴⁵ according to UMWELTBUNDESAMT (2001b)

Table 254: Emission factors for CO, NMVOC, NH₃ and heavy metals.

	CO	NMVOC	NH ₃	Cd	Hg	Pb
	Vol. %	Vol. %	Vol. %	mg/Nm ³	mg/Nm ³	mg/Nm ³
concentration in landfill gas	2	300	10	0.003	0.00002	0.003

6.3.1.3 Category-specific Recalculations

In earlier submissions Austria has assumed high concentrations of DOC in its residual waste fraction for the years 1950-1989 (based on UMWELTBUNDESAMT 2003). However, waste composition is monitored only since 1990, and for the period before an increasing DOC was originally assumed, as the amounts of organic material in the waste were expected to be higher in earlier years. Reliable literature (incl. sorting analyses) supporting the higher DOCs in the decades prior to 1990 was however not available, so it was decided to freeze the DOC for pre-1990-levels at 200 kg/t (level of 1990). This revision leads to a reduction of emissions for the whole time period (2014: -22 kt CO₂e)

Moreover, some small correction was necessary on the amounts of deposited construction waste and tar paper.

6.3.2 PM emissions

6.3.2.1 Source Category Description

PM emissions reported here are from waste handling at landfill sites. Only specific waste types are considered such as residues from iron and steel production (slags, dusts), clinker, dust and ashes from thermal waste treatment and combustion plants, as well as some mineral and construction waste.

6.3.2.2 Methodological Issues

PM emissions are calculated by multiplying the waste amounts with the respective emission factors for TSP, PM₁₀ and PM_{2.5}.

Activity Data and Emission Factors

Activity data have been taken from a database for landfill disposal and – since 2008 – the EDM¹⁴⁶. For the calculation only specific waste types are considered such as residues from iron and steel production (slags, dust), from thermal waste treatment and combustion plants (clinker, dust and ashes), as well as some mineral and construction waste.

Activities and emissions for the years 1990 and 1995 originate from the national study on particulate matter (WINIWARTER et al. 2007).

¹⁴⁶ Electronic Data Management

Table 255: Activity data (waste amounts deposited) considered for the calculation of particulate matter.

Year	residues from iron and steel production (slags, dusts)	clinker, dust and ashes	mineral waste	construction waste
	[t]	[t]	[t]	[t]
1990		7 970 000		
1995		8 850 000		
1998	65 927	303 384	3 974 912	36 338
1999	29 402	274 628	3 002 883	46 008
2000	37 998	300 914	4 632 071	56 725
2001	43 911	352 403	4 380 050	54 386
2002	147 484	407 571	5 505 821	32 987
2003	172 444	480 221	6 515 947	24 665
2004	96 182	585 360	8 690 991	14 475
2005	156 764	685 349	9 643 097	16 555
2006	159 642	914 500	9 234 534	21 805
2007	150 822	860 544	10 957 137	14 465
2008	163 684	716 616	9 049 317	3 486
2009	85 798	668 522	8 663 035	350
2010	61 929	562 328	10 156 901	471
2011	69 075	596 097	11 805 373	628
2012	71 987	558 869	14 728 289	229
2013	167 368	765 275	14 775 275	619
2014	213 661	962 200	19 011 447	486
2015	191 802	974 180	23 983 199	27
1998–2015	191%	221%	503%	-100%

Amounts of all relevant waste types have increased over the time series, especially mineral waste due to enhanced soil excavation activities. Remarkable increases can also be observed in the iron and steel production as well as the thermal waste treatment and consequently in their residues landfilled.

The following emission factors are used [WINIWARTER et al 2007]

Table 256: Emission factors for PM.

TSP	PM ₁₀	PM _{2.5}
g/t WASTE	g/t WASTE	g/t WASTE
18.00	8.52	2.68

6.3.2.1 Category-specific Recalculations

Some small correction was necessary on the amounts of deposited residues from iron and steel production in order to exclude stabilised and solidified waste, leading to slightly lower amounts considered.

6.4 NFR 5.B Composting

6.4.1 Source Category Description

In this category NH₃ emissions from mechanical-biological treatment and composting of waste is addressed. NH₃ emissions arising from this subcategory increased over the time period as a result of the increasing amount of biologically treated waste.

6.4.2 Methodological Issues

Emissions were estimated using a simple methodology based on EMEP/EEA Guidebook. Two different fractions were considered:

- mixed waste treated in Mechanical-Biological Treatment (MBT) plants, covering waste from households and similar sources covered by the municipal waste collecting system, but also significant amounts of waste from waste water treatment (e.g. sewage sludge) or smaller amounts of waste from industrial sources (e.g. residues from processing of recovered paper) are included).
- biogenic waste composted, comprising green/biogenic waste collected and treated in composting plants¹⁴⁷ (centralised composting) and biogenic waste composted at the place it is generated (home composting).

NH₃ emissions were calculated by multiplying an emission factor with the quantity of waste.

$$NH_3 \text{ Emissions} = M_i * EF_i$$

Where:

- M_i mass of organic waste treated by biological treatment type i (composting, MBT)
 EF_i emission factor for treatment i (MBT, composting)

Activity data

Historical activity data were taken from national publications and regional sources as listed in Table 258.

In most recent years the 'Electronic Data Management' (EDM) is the primary data basis¹⁴⁸, providing data for the 'Federal Waste Management Plan' 'BAWP' (BMLFUW 2006a, BMLFUW 2011, BMLFUW 2017), which is (in part) updated annually ('Status Reports' 2007, 2008, 2009, 2012, 2013, 2014, 2015). For years where no reliable data were available inter- or extrapolation was done.

The EDM is an information network operated by the Environment Agency Austria. It is a central *eGovernment* initiative by the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management (www.edm.gv.at) enabling enterprises, waste collectors and conditioners as well as authorities to handle registration, notification and reporting obligations in the waste and environment sectors online. Waste amounts collected and treated (input-output records) have to be reported on an annual basis via this electronic tool.

Home composted amounts are calculated based on a per-capita value of 215 kg/person/a, whereas for Vienna only 15% of the population is considered due to the lower number of gardens in this urban area. This approach is in line with the method applied for the BAWP (BMLFUW 2011).

¹⁴⁷ A certain part of this waste undergoes an anaerobic treatment (digestion), but currently all bio waste generated is assumed to be treated aerobically (composted).

¹⁴⁸ In subcategory 5.A *Solid Waste Disposal* waste amounts have been taken from EDM reports already since 2008.

Mechanical-biologically treated waste for most recent years is taken directly from the EDM.

The EDM is also the main data source of biogenic waste treated in composting plants. Research by waste experts at the Umweltbundesamt (2015) indicates higher amounts of waste being composted than covered by the EDM due to some minor exemptions in the EDM reporting requirements and in some cases missing reports. Based on a study conducted in 2015 on municipal green waste (UMWELTBUNDESAMT 2016b), it is assumed that in 2011 10% of waste volumes reported are additionally composted, whereas this additional share is expected to decrease linearly to 5% in 2014 as it is expected that reporting irregularities will be further decreased. The 5% assumption is continued for 2015 as still reporting irregularities are expected.

Table 257: Activity data for NFR Category 5.B Composting.

	Total waste	Mechanical-Biological Treatment (MBT)		Composting		Anaerobic treatment	
				Composting plants	Home composting		
	[kt]	[kt]	Data source	[kt]	Data source	[kt]	Data source
1990	763	345	BAUMELER et al 1998	48	sum of data reported by the Austrian Federal Provinces, (AMLINGER 2003)	0	Activity not occurring
1991	798	345		78		0	
1992	942	345		137		0	
1993	1 161	345		306		0	
1994	1 373	345		444		0	
1995	1 446	295	ANGERER 1997	551		0	
1996	1 515	281	interpolated	617		0	
1997	1 488	244	UMWELTBUNDESAMT 1998	582		0	
1998	1 541	240	UMWELTBUNDESAMT 2000b	604		0	
1999	1 621	266	UMWELTBUNDESAMT 2001e	623		0	
2000	1 721	254	Interpolated	695	interpolated	0	intrapolated based on EJ by Umweltbundesamt (2015)
2001	1 953	242		767		0	
2002	2 186	230		834		5	
2003	2 418	218	UMWELTBUNDESAMT 2008b	871		39	
2004	2 932	488		899		83	
2005	3 150	623		903		152	
2006	3 266	660		874		252	
2007	3 367	684		884		314	
2008	3 387	619	interpolated	919		350	
2009	3 401	555	EDM	977		364	
2010	3 452	551		1 035		378	
2011	3 495	519		1 118	EDM + EJ UMWELTBUNDESAMT (2015)	367	EDM
2012	3 573	453		1 239		385	
2013	3 416	379		1 168		367	
2014	3 538	413		1 215		399	
2015	3 596	439		1 194		438	

Emission factors

Due to different emission factors in different national references an average value was used for each of the two fractions of bio-technically treated waste.

Table 258: Emission factors for IPCC Category 5.B Composting.

	NH ₃ [kg/t FS]	References
Mechanical-biologically treated waste	0.6	(UMWELTBUNDESAMT BERLIN 1999) (AMLINGER ET AL. 2003, 2005) (ANGERER & FRÖHLICH 2002) (DOEDENS ET AL. 1999)
Composted waste (bio-waste, gardening waste, home composting)	0.4	(AMLINGER et al. 2003, 2005)

6.4.3 Category-specific Recalculations

NH₃ emissions were recalculated from 2000 onwards (2013: –0.13 kt) due to corrections of activity data. A national study on municipal green waste in Austria was conducted in 2015, showing significant lower amounts of green waste compared to estimates made for previous submissions. Waste amounts treated in composting plants thus had to be revised, by changing the assumptions made on biologically treated waste not covered by the Electronic Data Management¹⁴⁹ on activity data 2011–2013. The former assumption of 400 kt waste additional to EDM data (see NIR 2015 page 437) was replaced by a decreasing supplement to the amounts reported in the EDM system, ranging from +10 % in 2011 to 5 % (linear decrease assumed). Moreover based on the study it can be assumed that historical amounts (prior to 2011) indicated in the Federal Waste Management Plan (BMLFUW 2011) and previous plans probably were overestimated. Consequently, activity data for 2000 to 2010 had to be interpolated.

Moreover, home composted amounts for the years since 2010 are calculated in accordance with the – more accurate – methodology based on a per-capita generation rate applied for the Federal Waste Management Plan (BMLFUW 2011).

¹⁴⁹ E.g. small composters are not obliged to report their waste amounts via “Abfallbilanzmeldung”. Their waste amounts however affect emissions and are thus included in the inventory.

6.5 NFR 5.C Incineration and open burning of waste

6.5.1 Source Description

In this category emissions are included from

- incineration of corpses (NFR 5.C.1.b.5),
- hospital waste (NFR 5.C.1.b.3),
- waste oil (NFR 5.C.1.b.i),
- incineration of domestic or municipal solid waste without energy recovery (NFR 5.C.1.a).

Additionally heavy metal and POPs emissions of a single plant without emission control 1990 to 1991 are included here. From 1992 the plant was equipped with ESP. Emissions 1992 to 2000 are included in category 1.A.4.a and from 2001 on in category 1.A.1.a. Emissions from incineration of carcasses are not estimated. Waste incineration plants are allocated to category 1.A.4.a if heat is recovered for own usage but not used for generation of public electricity or heat or if the plant operator claims that the main economic activity (NACE code 38) of the plant is treatment of waste rather than the production of heat or electricity. This approach is consistent with national energy statistics.

In Austria waste oil is incinerated in especially designed so called “USK-facilities” (Umweltschutzkomponenten). The emissions of waste oil combustion for energy use (e.g. in cement industry) are reported under NFR sector 1.A Fuel Combustion.

In general, municipal, industrial and hazardous waste are combusted in district heating plants or in industrial sites and the energy is used. Therefore their emissions are reported in NFR category 1.A Fuel Combustion. There is only one waste incineration plant which has been operated until 1991 with a capacity of 22 000 tons of waste per year without energy recovery and emission controls. This plant has been rebuilt as a district heating plant starting operation in 1996. Therefore the emissions of this plant are reported under NFR category 1.A Fuel Combustion from 1996 onwards.

Small scale waste burning

Emissions from wood waste are considered in categories 3.F. It is assumed that other (illegal) small scale residential combustion occurs in heatings or stoves (included in category 1.A.4). Especially when considering POPs emissions from this source the national emission factors consider this issue due to the fact that POP emission factors are derived from field measurements which consider the “memory effect” of illegal waste co-incineration. Residential biomass heatings are widely used in Austria and wood use is based on a bottom up model by using household census data. It is assumed that illegal waste incineration just replaces other solid fuels and therefore other pollutants such as TSP, heavy metals and NO_x from wood waste are also expected to be included in category 1.A.4.

6.5.2 Methodology

The simple CORINAIR methodology is used. Emission factors are specific to type of waste and combustion technology.

Activity data

For municipal solid waste the capacity (22 000 tons of waste per year) of one operating waste incineration plant without energy recovery was used.

Waste oil activity data 1990 to 1999 were taken from (UMWELTBUNDESAMT 1995). For 2000 to 2005 the activity data of 1999 was used. (UMWELTBUNDESAMT 2001b) quotes that in 2001 total waste oil accumulation was about 37 500 t. Nevertheless, waste oil is mainly used for energy recovery in cement kilns or public power plants and it is consequently accounted for in the energy balance as *Industrial Waste*.

Activity data of clinical waste is determined by data interpretation of the waste flow database at the *Umweltbundesamt* considering the waste key number “971” (“Abfälle aus dem medizinischen Bereich”) for the years 1990 and 1994 and extrapolated for the remaining time series.

Since 2005 the Austrian waste incineration regulation gives strong limits for air pollution for all kind of waste incineration without any limit of quantity. Since then all operators which do have an allowance for incineration of a specific type of waste needs to be registered in a federal database. The number of waste incineration plants which are not considered under sector 1.A is:

- Waste oil: 8
- Clinical waste: 1
- Municipal solid waste: None

The average yearly quantity of each waste incineration plant has been estimated as 500 t for hazardous clinical waste (plastics only). For waste oil the maximum USK facility capacity of 60.8 t per year (UMWELTBUNDESAMT 2001b) has been selected as activity data for each facility operating in 2010 which leads to a rounded value of 500 tons/year. Activity data for the years 2006–2009 has been interpolated.

Table 259: Activity data for IPCC Category 5.C Waste Incineration.

Year	Municipal Waste [t]	Industrial waste [t]	Sewage sludge [t]	Clinical Waste [t]	Waste Oil [t]
1990	22 000	70 720	61 651	9 000	2 200
1991	22 000	70 720	61 651	7 525	1 500
1992	NO	NO	NO	6 050	1 800
1993	NO	NO	NO	4 575	2 100
1994	NO	NO	NO	3 100	2 500
1995	NO	NO	NO	3 100	2 600
1996	NO	NO	NO	3 100	2 700
1997	NO	NO	NO	3 100	2 800
1998	NO	NO	NO	3 100	2 900
1999–2005	NO	NO	NO	3 100	3 000
2006	NO	NO	NO	2 500	2 500
2007	NO	NO	NO	2 000	2 000
2008	NO	NO	NO	1 500	1 500
2009	NO	NO	NO	1 000	1 000
2010	NO	NO	NO	500	500
2011	NO	NO	NO	500	500
2012	NO	NO	NO	500	500
2013	NO	NO	NO	500	500
2014	NO	NO	NO	500	500
2015	NO	NO	NO	500	500

Emission factors

Heavy metal emission factors are taken from (HÜBNER 2001a). POPs emission factors are taken from (HÜBNER 2001b). Main pollutant emission factors: For municipal waste the industrial waste emissions factors from (BMWA 1990) are taken and converted by means of a NCV of 8.7 TJ/kt. Waste oil emission factors are selected similar to uncontrolled industrial residual fuel oil boilers. Clinical waste emission factors selected by means of industrial waste emissions factors from (BMWA 1990). PM emission-factors are Table 261 shows emission factors of main pollutants.

Table 260: NFR 5.C Waste Incineration: emission factors for main pollutants by type of waste.

Type of waste		NO _x	CO	NMVOC	SO ₂	NH ₃
Waste oil	[g/t]	8 060.0	604.5	403.0	18 135.0	110.0
Municipal waste	[g/t]	870.0	1 740.0	330.6	1 131.0	0.2
Clinical waste	[g/t]	7 000.0	840.0	330.0	700.0	0.2
Cremation	[g/corps]	300.0	430.0	32.0	-	-

Table 261: NFR 5.C Waste Incineration: emission factors for PM by type of waste.

Type of waste		TSP	PM ₁₀	PM _{2.5}
Waste oil	[g/t]	10.00	7.00	4.00
Municipal waste	[g/t]	IE ⁽¹⁾	IE ⁽¹⁾	IE ⁽¹⁾
Industrial waste	[g/t]	28.00	25.00	21.00
Clinical waste	[g/t]	10.00	7.00	4.00
Cremation	[g/corps]	14.60	13.14	11.68

⁽¹⁾ PM emissions for MSW are Included in NFR category 1A1a.

Table 262: NFR 5.C. Waste incineration: emission factors for heavy metals and POPs.

Municipal waste	Cd	Hg	Pb	PAH	DIOX	HCB
	[mg/t]				[µg/t]	
1990	71.0	299.0	1 170.0	0.7	250.0	850.0
1991	59.2	263.2	966.0	0.7	250.0	850.0

Industrial Waste	Cd	Hg	Pb	PAH	DIOX	HCB
	[mg/t]				[µg/t]	
1990	510.0	112.0	2 400.0	1.6	160.0	970.0
1991	414.0	99.4	1 922.0	1.6	160.0	970.0

Sludges from waste water treatment	Cd	Hg	Pb	PAH	DIOX	HCB
	[mg/t]				[µg/t]	
1990	235.0	55.0	730.0	1.6	1.5	300.0
1991	191.8	45.8	585.2	1.6	1.5	300.0

Clinical waste	Cd	Hg	Pb	PAH	DIOX	HCB
	[mg/t]				[µg/t]	
1990	4.77	5.76	540.00	0.00	1.08	216.00
1991	3.99	4.82	451.50	0.00	0.68	135.45
1992	3.21	3.87	363.00	0.00	0.36	72.60
1993	2.42	2.93	274.50	0.00	0.14	27.45
1994	1.64	1.98	186.00	0.00	0.00	0.19
1995–2005	0.62	0.71	7.75	0.00	0.00	0.19
2006	0.50	0.58	6.25	0.00	0.00	0.16
2007	0.40	0.46	5.00	0.00	0.00	0.12
2008	0.30	0.35	3.75	0.00	0.00	0.09
2009	0.20	0.23	2.50	0.00	0.00	0.06
2010–2015	0.10	0.12	1.25	0.00	0.00	0.03

Waste oil	Cd	Hg	Pb	PAH	DIOX	HCB
	[mg/t]				[µg/t]	
1990	360.0	30.0	106 300.0	6.7	17.0	17 020.0
1991			87 560.0		0.4	370.0
1992			68 820.0			
1993			50 080.0			
1994			31 340.0			
1995–2015	13.0		60.0			

Table 263: NFR 5.C.1.b.5 cremation of corpses: emission factors.

Hg	Pb	PAH	Dioxin	HCB
[mg/corps]			[µg/corps]	
3 000 ⁽⁴⁾	0.02 ⁽¹⁾	0.40 ⁽¹⁾	16.60 ⁽²⁾	3 320 ⁽²⁾
2 500 ⁽⁵⁾			8.30 ⁽³⁾	1 660 ⁽³⁾
2 000 ⁽⁶⁾				
1 000 ⁽⁷⁾				

⁽¹⁾ for all years⁽²⁾ for 1990–1992⁽³⁾ for 1993–2015⁽⁴⁾ for 1990⁽⁵⁾ for 1991⁽⁶⁾ for 1992–1995⁽⁷⁾ for 2000–2015

6.5.3 Category-specific Recalculations

No recalculations have been made in this years' submission.

6.6 NFR 5.D Wastewater handling

6.6.1 Source Category Description

In this category NMVOC emissions from domestic wastewater handling (5.D.1) are included, covering wastewater of domestic origin – treated in municipal wastewater treatment plants, domestic wastewater treatment plants and cesspools – as well as commercial and industrial wastewater treated together with domestic wastewater in municipal wastewater treatment plants.

6.6.2 Methodological Issues

Emissions were calculated following the Tier 1 approach by multiplying the wastewater amounts with the emission factor taken from the EMEP/EEA 2016 Guidebook (15 mg/m³ wastewater).

$$\text{NMVOC Emissions} = AD * EF$$

Where:

AD activity data / volume of total wastewater treated in municipal wastewater treatment plants (m³)
EF emission factor

Activity data

Most recent data (2010–2015) on the volumes of wastewater treated in municipal wastewater treatment plants are retrieved from the Electronic Emission Register of Surface Water Bodies (“Emissionsregister – Oberflächenwasserkörper”, abbreviated “EMREG-OW”¹⁵⁰), an electronic register of material emissions to surface water bodies from point sources, especially municipal sewage treatment plants. It is administered by the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW) and serves the collection of information for the National Water Management Plan and for management plans for international river catchment areas. Data for 2006–2008 were taken from the Austrian sewage sludge database administered by the Umweltbundesamt. Historical data (1991, 1995, 1998, 2001, 2003) were obtained from the Water Quality Reports (BMLFUW 1993–2002); data in between were interpolated.

Data on volumes of wastewater collected in domestic wastewater treatment plants and cesspools are calculated based on the Austrian population not connected to municipal wastewater treatment plants and the factor 135 litre per population equivalent per day (ÖWAV 2015). Data on wastewater disposal routes and connection rates were taken from the situation reports on municipal wastewater (BMLFUW 2006c, BMLFUW 2008b, BMLFUW 2010, BMLFUW 2012, BMLFUW 2014c, BMLFUW 2016d).

¹⁵⁰ BGBl. II Nr. 29/2009: Verordnung des Bundesministers für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft über ein elektronisches Register zur Erfassung aller wesentlichen Belastungen von Oberflächenwasserkörpern durch Emissionen von Stoffen aus Punktquellen (EmRegV-OW)

Table 264: Activity data for 5.D Wastewater handling.

Year	Municipal Wastewater treatment plants [m ³]	Domestic wastewater treatment [m ³]	Total wastewater treated [m ³]
1990	–	–	811 786 584
1991	–	–	819 806 717
1992	–	–	827 826 850
1993	–	–	835 846 983
1994	–	–	843 867 116
1995	–	–	851 887 250
1996	–	–	927 538 166
1997	–	–	1 003 189 083
1998	–	–	1 078 840 000
1999	–	–	1 075 226 667
2000	–	–	1 071 613 333
2001	–	–	1 068 000 000
2002	–	–	1 064 500 000
2003	–	–	1 061 000 000
2004	–	–	1 070 201 502
2005	–	–	1 079 403 004
2006	1 054 663 363	33 941 143	1 088 604 506
2007	1 075 978 754	34 021 586	1 110 000 339
2008	1 061 381 223	30 054 497	1 091 435 720
2009	–	–	1 114 220 585
2010	1 111 589 652	25 415 798	1 137 005 449
2011	996 666 022	24 160 697	1 020 826 719
2012	1 058 654 346	22 905 597	1 081 559 943
2013	1 165 341 536	22 091 808	1 187 433 343
2014	1 109 792 568	21 278 018	1 131 070 586
2015	1 036 886 326	20 464 229	1 057 350 555

* status of data: November 30th 2016

** missing values indicated as “–” had to be interpolated (under column “total wastewater treated”)

In the year 2014¹⁵¹ 95.0% of the Austrian population is connected to municipal wastewater treatment plants. The remaining wastewater is treated either in septic tanks (3.1%), domestic wastewater handling systems (1.7%), or disposed otherwise (‘unspecified disposal routes’: 0.2%).

6.6.3 Category-specific Recalculations

This category was estimated for the first time in this years’ submission.

¹⁵¹ the latest year for which data on connection rate is currently available

7 RECALCULATIONS AND IMPROVEMENTS

7.1 Relation to data reported earlier

As a result of the continuous improvement of Austria's National Air Emission Inventory, emissions of some sources have been recalculated based on updated data or revised methodologies, thus emission data for 1990 to 2014 submitted this year might differ from data reported previously.

The stage 1 review (initial check of submissions for timeliness, completeness and formats) and stage 2 review (check of consistency, comparability, KCA, trends and IEFs) are carried out annually. The last in-depth (stage 3) review of the Austrian Inventory took place in 2010 (UNITED NATIONS 2010); the findings are summarized in Table 280. The next stage 3 review will take place in 2017. In addition to the CLRTAP review, from 2017 onwards the national emission inventory data will be also checked by the European Commission as set out in Article 10 of Directive 2016/2284 (NEC Directive). The inventories will be reviewed to verify the transparency, accuracy, consistency, comparability and completeness of information submitted and to identify possible inconsistencies with the requirements set out under international law, in particular under the LRTAP Convention.

The figures presented in this report replace data reported earlier by the Umweltbundesamt under the reporting framework of the UNECE/LRTAP Convention and NEC Directive of the European Union.

7.2 Explanations and Justifications for Recalculations, including in response to the review process

Explanations for recalculations per sector are given in the respective chapters, the tables indicating the recalculations can be found in the Chapter 7.3.

Compiling an emission inventory includes data collecting, data transfer and data processing. Data has to be collected from different sources, for instance

- national statistics,
- associations,
- plant operators,
- studies,
- personal information,
- other publications.

The provided data must be transferred from different data formats and units into a unique electronic format to be processed further. The calculation of emissions by applying methodologies on the collected data and the final computing of time series into a predefined format (NFR) are further steps in the preparation of the final submission. Finally the submission must be delivered in due time. Even though a QA/QC system gives assistance so that potential error sources are avoided as far as possible it is necessary to make some revisions – so called recalculations – under the following circumstances:

- An emission source was not considered in the previous inventory.
- A source/data supplier has delivered new data because previous data were preliminary data only (by estimation, extrapolation) or the methodology has been improved.

- Occurrence of errors in data transfer or processing: wrong data, unit-conversion, software errors, et al.
- Methodological changes: a new methodology must be applied to fulfill the reporting requirements because one of the following reasons:
 - to decrease uncertainties;
 - an emission source becomes a key source;
 - consistent input data needed for applying the methodology is no longer accessible;
 - input data for more detailed methodology is now available;
 - the methodology is no longer appropriate.

The following sections describe the methodological changes made to the inventory since the previous submission (for each sector).

7.2.1 ENERGY (NFR sector 1)

Activity data has been updated with data from the new edition of the energy balance, affecting emissions of all pollutants.

Revision of the energy balance

- Gross natural gas consumption has been revised for the years 1999 (+0.7 PJ) and for 2002–2008 (between –0.8 to –5.9 PJ). The revision was due to harmonisation with official total natural gas consumption as published by the Austrian Energy regulator (e-Control). The revision affected the ‘own use’ of the energy sector as well as the ‘final energy consumption’.
- For liquid fuels minor revisions were made for the whole time series because of a switch from national energy balance to the Eurostat/IEA dataset which has rounded values. Larger shifts of gasoil between 1.A.4.a and 1.A.4.b categories were carried out for the years 2002–2003 (0.6–0.7 PJ) and 2005–2006 (8.7–4.6 PJ). For the year 2014 about 0.5 PJ of gasoil was shifted from manufacturing industries to the residential sector.
- For solid fuels minor revisions were made for the years 2002–2014 with the largest change in 2011 (–0.03 PJ).
- For ‘other fuels’ the major revision took place for the year 2014 where a shift of ‘industrial waste’ to municipal solid waste’ was reported by energy statistics.

For biomass the major revision took place for the years 2005 and 2007–2014. For NFR 1.A.1.a biomass was revised downwards by –3.2 PJ in the year 2015. For NFR 1.A.4 sub categories biomass was revised downwards for the years 2007–2014 (between –1.1 to –2.6 PJ). For NFR 1.A.2.g.8 biomass was revised downwards by –1 PJ for the year 2013 and by –5.5 PJ for the year 2014.

Public Electricity and Heat Production (1.A.1.a)

Update and error correction of large combustion plants emissions declarations 2007–2014. For the year 2014 the update results in revisions for SO₂, NO_x, CO and PM₁₀, e.g. –0.07 kt SO₂, –0.8 kt NO_x and –0.01 kt PM₁₀ emissions.

Manufacture of Solid fuels and Other Energy Industries (1.A.1.c)

Recalculations 1999 to 2012 follow the revisions of the energy balance and result in updates for all relevant air emissions, e.g. lower NO_x emissions in the range from +0.1 kt to -1.2 kt.

Updates of activity data and of NCVs follow the updates of the IEA-compliant energy balance compiled by the federal statistics authority *Statistik Austria* (Chapter 3.1.10).

Manufacturing Industries and Construction (1.A.2)

The changes in this category mainly resulted from the revisions of the energy balance. Therefore, recalculations have been carried out for all relevant air pollutants. The largest recalculations took place for category 1.A.2.g with e.g. -0.8 kt lower NO_x, -0.7 kt lower SO₂ and -0.4 kt lower CO emissions in 2014.

Households and Institutional/Commercial sector (1.A.4.a.i, 1.A.4.b.i)

Revisions are mainly following the minor revisions of the energy balance affecting all relevant air pollutants. For the year 2014, NO_x emissions of the commercial sector (1.A.4.a.i) were revised by +0.08 kt, NO_x emissions of the residential sector (1.A.4.b.i) were revised by +0.01 kt and NO_x emissions of the agriculture sector (1.A.4.c.i) were revised by -0.16 kt. NMVOC emissions were revised by +0.59 kt for all of 1.A.4 stationary sources and PM_{2.5} emissions by -0.003 kt.

Updates of activity data and of NCVs follow the updates of the IEA-compliant energy balance compiled by the federal statistics authority *Statistik Austria* (Chapter 3.1.10).

Road Transport (1.A.3.b)

Minor changes occur in all emission components by using the most recent version of the emission calculation model "NEMO". Domestic consumption on the road has been slightly revised upwards for 2012-2014. In the model this results in a reduction in energy consumption of fuel export. Since the fuel export is mainly characterised by truck traffic which has by now low specific NO_x emissions, the absolute values for NO_x are marginally lower during these years. In addition, the LPG and biogas fuel quantities for individual years were revised according to the national energy balance. The main emissions changes for 2014 are: -0.6 kt NO_x, -0.02 kt NMVOC.

Rail transport (1.A.3.c)

The year 2014 was revised due to the revised use of diesel according to the current national energy balance. These changes have an effect on all relevant air pollutants. The main emissions changes for 2014 are: +0.01 kt NO_x, +0.01 kt SO₂, +0.01 kt CO.

7.2.2 INDUSTRIAL PROCESSES AND PRODUCT USE (NFR sector 2)

Mineral Products (2.A)

NFR 2.A.5.b, SNAP 040617 Other – Construction and demolition: Emissions changed, due to changes of the building-cost index.

The activity for 2012 until 2014 of the following categories provided by the Austrian mining handbook have changed (BMFWF 2016)

- NFR 2.A.5.a, SNAP 04 06 17 Other – X4F
- NFR 2.A.5.a, SNAP 040617 Other – X4G

Other chemical industry (2.B.10.)

An update of the calculation sheet leads to a decrease of emissions from 2001 until 2009. One plant closed in 2009, which lead to a further reduction of SO₂ emission. For 2015 measured data became available, thus emissions were interpolated between 2015 and 2009, which led to a decrease of emissions in 2014 (-0.37 kt SO₂).

Metal Production (2.C)

NFR 2.C.5, SNAP 030307 Lead Production: activity data for 2013 until 2014 have changed due to a correction of the Austrian mining handbook (BMFWF 2016)

NFR 2.C.3, SNAP 030310 Aluminium production: data for 2014 have been updated with ETS data

Wood Processing (2.I)

Emissions from 2005 have been recalculated due to changes in the energy balances.

7.2.3 AGRICULTURE (NFR sector 3)

Update of activity data

Livestock population data

Revised numbers of horses have been implemented into the inventory. New data are provided by the Ministry of Agriculture and published in (BMLFUW 2016). Data were derived from interviews of relevant experts (e.g. from breeding associations) considering additional information from the data base of horses of the Ministry of Health and Women's Affairs.

Numbers of horses used in previous inventories for the years from 2004 to 2014 published in (BMLFUW 2015) were based on agricultural structural surveys and INVEKOS data. However, it was found out, that they did not fully cover all horse-owners in Austria.

Horse numbers reported for the years before 2004 are based on livestock accountings and were assessed to be representative for Austria.

The revision resulted in significantly increased animal numbers in 2014.

Other organic fertilisers applied to soils (3.D.a.2.c)

Compost application was considered as a new activity for the first time in Austria's air emission inventory. The consideration of this additional source resulted in additional emissions of NH₃ and NO_x for all reported years.

Methodological changes

Manure Management (3.B) – NH₃

Revised numbers of horses resulted in higher emissions from 2004 onwards (+512.4 t NH₃ in 2014).

Weighted EF of other poultry was updated according the share of geese and ducks from 2003 to 2015. The update resulted in slightly higher emissions (+0.3 t NH₃ in 2014).

Manure Management (3.B) – NO_x

The inventory was updated by using the default Tier 1 EFs for NO from stored manure according the new EMEP/EEA emission inventory guidebook 2016. The revision resulted in a slight decrease of NO₂ emissions from sector management (-9.1 t NO₂ in 2014).

Manure Management (3.B) – Particulate matter (TSP, PM₁₀, PM_{2.5})

In previous years total PM Emissions for all livestock categories from animal husbandry were reported under 3.I Other. In the current submission the PM emissions were calculated and reported for the respective livestock categories and reported under 3.B Manure Management.

Agricultural Soils (3.D) – NH₃

Inorganic N-fertilizers including urea application (3.D.a.1)

The inventory was updated by using the default Tier 2 NH₃ EF for urea fertilizer according the new EMEP/EEA emission inventory guidebook 2016. The revision resulted in a decrease of NH₃ emissions (-388.4 t NH₃ in 2014).

Animal manure applied to soils (3.D.a.2.a)

Revised numbers of horses resulted in higher emissions from 2004 onwards (+377.0 t NH₃ in 2014).

Weighted EF of other poultry was updated according the share of geese and ducks from 2003 to 2015. The update resulted in slightly lower emissions.

Sewage sludge applied to soils (3.D.a.2.b)

The inventory was updated by using the default Tier 1 NH₃ EF for sewage sludge application according to the new EMEP/EEA emission inventory guidebook 2016. The revision resulted in a decrease of NH₃ emissions (-80.6 t NH₃ in 2014).

Other organic fertilisers applied to soils including digestate and compost (3.D.a.2.c)

Additionally to digested energy crops already considered in previous submissions compost application was introduced as a new activity. For both activities (digestate and compost) the default Tier 1 NH₃ EF for other organic fertilisers according to the new EMEP/EEA emission inventory guidebook 2016 has been used. In previous submissions in a simple approach the EF of urea has been used for digestate. The revision resulted in a considerable decrease of emissions from source category other organic fertilisers applied to soils (-564.6 t NH₃ in 2014).

Urine and dung deposited by grazing animals (3.D.a.3)

Revised numbers of horses resulted in higher emissions from 2004 onwards (+75.2 t NH₃ in 2014).

Cultivated Crops (3.D.e)

In submission 2016 Austria reported an amount of 284 t NH₃ emissions from legume cropland for 2014. Calculations followed the CORINAIR detailed methodology as provided in the EMEP/CORINAIR atmospheric emission inventory guidebook 1999.

However, due to the lack of evidence of emissions arising from the fixation process itself, the EMEP/EEA Guidebook 2016 (and the 2006 IPCC Guidelines) do not consider biological N fixation as a source of emissions anymore. Source category and default methodologies were removed from the guidebooks and no specific category is provided for reporting in the NFR (and CRF). Consequently, when updating the inventory using the new EMEP/EEA Guidebook 2016, Austria removed estimates for biological N fixation based on the outdated default methodology.

In submission 2017 Austria reports 'NA' under source category cultivated crops for all years. Following the EMEP/EEA Guidebook 2016, Table 2.1 no EFs are available for the estimation of ammonia emissions arising from standing or 'cultivated' crops.

Agricultural Soils (3.D) – NO₂*Inorganic N-fertilizers including urea application (3.D.a.1)*

Inventory update with the default Tier 1 EF for NO from N applied in fertilisers according to the new EMEP/EEA emission inventory guidebook 2016 resulted in significantly increased emissions (+3 370.3 t NO₂ in 2014).

Animal manure applied to soils (3.D.a.2.a)

The inventory was updated by using the default Tier 1 EF for NO from N applied in fertilisers according to the new EMEP/EEA emission inventory guidebook 2016. The revision resulted in significantly increased emissions (+976.5 t NO₂ in 2014).

Sewage sludge applied to soils (3.D.a.2.b)

The inventory was updated by using the default Tier 1 EF for NO from sewage sludge according to the new EMEP/EEA emission inventory guidebook 2016. The revision resulted in increased emissions (+11.0 t NO₂ in 2014).

Other organic fertilisers applied to soils including digestate and compost (3.D.a.2.c)

Additionally to digested energy crops already considered in previous submissions compost application was introduced as a new activity. For both activities (digestate and compost) the default Tier 1 EF for NO according to the new EMEP/EEA emission inventory guidebook 2016 has been used. The revision resulted in a considerable increase of emissions from source category other organic fertilisers applied to soils (+109.3 t NO₂ in 2014).

Agricultural Soils (3.D) – NMVOC*Cultivated Crops (3.D.e)*

The inventory was updated by using the default Tier 1 EF for NMVOC from agricultural crops according to the new EMEP/EEA emission inventory guidebook 2016. The revision resulted in decreased emissions (-764.9 t NMVOC in 2014).

Field burning of agricultural residues (3.F)

The use of the default methodology according to the EMEP/EEA Guidebook 2016 and improved consistency with the parameters used in the GHG inventory (residue/crop product ratio) resulted in slightly revised emissions (NO_x, SO₂, NH₃, NMVOC, CO, PM, Cd, Hg and Pb).

7.2.4 WASTE (NFR sector 5)

Update of activity data

5.A Solid Waste Disposal

A small correction was made on the amounts of deposited construction waste and tar paper for the year 2010, having a slightly increasing effect on emissions from 2011 onwards.

Improvements of methodologies and emission factors

5.A Solid Waste Disposal

Austria has adapted its DOC of residual waste for the historical years 1950–1989 in response to the recommendation by the Technical Expert Review Team (TERT) in the course of the ESD¹⁵² comprehensive review on greenhouse gases in 2016. This has affected the amount of landfill gas generated and thus also the emission value for NMVOC and NH₃ (revision downwards by 0.8 t NMVOC and 0.03 t NH₃ in 2014).

5.D Wastewater Treatment and Discharge

NMVOC emissions were estimated and reported for the first time in this years' submission. This was done in response to the latest CLRTAP Stage 3 Review.

¹⁵² Effort-Sharing Decision

7.3 Recalculations per Pollutant

The following tables present the changes in emissions¹⁵³ for all relevant pollutants compared to the previous submission (IIR 2016). Detailed explanations are provided in the sectoral chapters.

Table 265: Recalculation difference of SO₂ emissions [kt] with respect to submission 2016.

SO ₂ emissions [kt]	1990			2014			Absolute Diff.	
	Δ%	Subm. 2016	Subm. 2017	Δ%	Subm. 2016	Subm. 2017	1990	2014
1.A.1 Energy Industries	<0.1%	14.04	14.04	-3.7%	1.83	1.76	<0.01	-0.07
1.A.2 Manufacturing Industries & Construction	-0.1%	17.97	17.96	-7.4%	11.18	10.35	-0.01	-0.83
1.A.3 Transport	2.4%	5.19	5.32	2.7%	0.29	0.30	0.13	0.01
1.A.4 Other Sectors	<0.1%	32.94	32.94	1.6%	1.43	1.46	<0.01	0.02
1.A.5 Other	=	0.01	0.01	=	0.01	0.01	-	-
1.B Fugitive Emissions	=	2.00	2.00	=	0.04	0.04	-	-
2 Industrial Processes and Product Use	=	2.22	2.22	-30.8%	1.22	0.84	-	-0.37
3 Agriculture	247.2%	0.00	0.00	203.0%	0.00	0.00	<0.01	<0.01
5 Waste	=	0.07	0.07	=	0.01	0.01	-	-
Total Emissions	0.2%	74.45	74.57	-7.8%	16.02	14.78	0.12	-1.24

Table 266: Recalculation difference of NO_x emissions [kt] with respect to submission 2016.

NO _x emissions [kt]	1990			2014			Absolute Diff.	
	Δ%	Subm. 2016	Subm. 2017	Δ%	Subm. 2016	Subm. 2017	1990	2014
1.A.1 Energy Industries	<0.1%	17.74	17.73	-6.5%	11.71	10.95	-0.01	-0.76
1.A.2 Manufacturing Industries & Construction	<0.1%	32.98	32.97	-3.2%	30.26	29.29	-0.01	-0.96
1.A.3 Transport	0.1%	125.49	125.61	-0.8%	83.19	82.56	0.11	-0.63
1.A.4 Other Sectors	<0.1%	27.73	27.72	-0.4%	18.20	18.13	-0.01	-0.07
1.A.5 Other	=	0.07	0.07	=	0.08	0.08	-	-
1.B Fugitive Emissions	=	IE	IE	=	IE	IE	-	-
2 Industrial Processes and Product Use	=	4.80	4.80	=	1.50	1.50	-	-
3 Agriculture	76.1%	6.75	11.89	73.4%	6.08	10.53	5.14	4.46
5 Waste	=	0.10	0.10	=	0.01	0.01	-	-
Total Emissions	2.4%	215.66	220.89	1.3%	151.03	153.07	5.23	2.03

¹⁵³ An equals sign "=" in the field for relative difference indicates that reported emissions do not differ from the previous submission; blank fields indicate that no such emissions occur from this sector;

Table 267: Recalculation difference of NMVOC emissions [kt] with respect to submission 2016.

NMVOC emissions [kt]	1990			2014			Absolute Diff.	
	Δ%	Subm. 2016	Subm. 2017	Δ%	Subm. 2016	Subm. 2017	1990	2014
1.A.1 Energy Industries	<0.1%	0.33	0.33	-0.4%	0.37	0.37	<0.01	<0.01
1.A.2 Manufacturing Industries & Construction	<0.1%	1.69	1.69	-2.0%	1.65	1.62	<0.01	-0.03
1.A.3 Transport	0.1%	74.72	74.80	-0.3%	8.41	8.39	0.08	-0.02
1.A.4 Other Sectors	0.7%	60.94	61.36	2.2%	26.37	26.96	0.42	0.59
1.A.5 Other	=	0.01	0.01	=	0.02	0.02	-	-
1.B Fugitive Emissions	=	15.49	15.49	=	2.42	2.42	-	-
2 Industrial Processes and Product Use	=	125.53	125.53	=	69.31	69.31	-	-
3 Agriculture	-29.8%	1.81	1.27	-41.4%	1.86	1.09	-0.54	-0.77
5 Waste	2.2%	0.16	0.16	30.3%	0.05	0.07	<0.01	0.02
Total Emissions	<0.1%	280.68	280.63	-0.2%	110.46	110.24	-0.04	-0.22

Table 268: Recalculation difference of NH₃ emissions [kt] with respect to submission 2016.

NH ₃ emissions [kt]	1990			2014			Absolute Diff.	
	Δ%	Subm. 2016	Subm. 2017	Δ%	Subm. 2016	Subm. 2017	1990	2014
1.A.1 Energy Industries	<0.1%	0.19	0.19	-0.2%	0.38	0.38	<0.01	<0.01
1.A.2 Manufacturing Industries & Construction	-0.1%	0.33	0.33	-7.1%	0.44	0.41	<0.01	-0.03
1.A.3 Transport	0.1%	1.13	1.14	-0.2%	1.36	1.36	<0.01	<0.01
1.A.4 Other Sectors	<0.1%	0.63	0.63	-0.7%	0.55	0.54	<0.01	<0.01
1.A.5 Other	=	0.00	0.00	=	0.00	0.00	-	-
1.B Fugitive Emissions	=	IE	IE	=	IE	IE	-	-
2 Industrial Processes and Product Use	=	0.27	0.27	=	0.09	0.09	-	-
3 Agriculture	-0.6%	63.58	63.23	-0.6%	62.97	62.61	-0.35	-0.35
5 Waste	-0.1%	0.36	0.36	<0.1%	1.20	1.20	<0.01	<0.01
Total Emissions	-0.5%	66.50	66.15	-0.6%	66.99	66.60	-0.35	-0.39

Table 269: Recalculation difference of CO emissions [kt] with respect to submission 2016.

CO emissions [kt]	1990			2014			Absolute Diff.	
	Δ%	Subm. 2016	Subm. 2017	Δ%	Subm. 2016	Subm. 2017	1990	2014
1.A.1 Energy Industries	<0.1%	6.07	6.07	-0.1%	4.24	4.23	<0.01	-0.01
1.A.2 Manufacturing Industries & Construction	<0.1%	231.58	231.58	-0.3%	164.80	164.28	<0.01	-0.52
1.A.3 Transport	0.1%	508.90	509.44	-0.2%	88.84	88.64	0.55	-0.20
1.A.4 Other Sectors	0.2%	480.87	482.00	0.7%	250.87	252.69	1.13	1.82
1.A.5 Other	=	0.22	0.22	=	0.29	0.29	-	-
1.B Fugitive Emissions	=	IE	IE	=	IE	IE	-	-
2 Industrial Processes and Product Use	=	46.37	46.37	=	23.88	23.88	-	-
3 Agriculture	-5.9%	1.28	1.20	-5.5%	0.45	0.42	-0.08	-0.02
5 Waste	-6.1%	10.98	10.31	-1.6%	3.96	3.90	-0.67	-0.06
Total Emissions	0.1%	1 286.3	1 287.2	0.2%	537.33	538.34	0.93	1.01

Table 270: Recalculation difference of Cd emissions [t] with respect to submission 2016.

Cd emissions [t]	1990			2014			Absolute Diff.	
	Δ%	Subm. 2016	Subm. 2017	Δ%	Subm. 2016	Subm. 2017	1990	2014
1.A.1 Energy Industries	<0.1%	0.19	0.19	13.1%	0.29	0.33	<0.01	0.04
1.A.2 Manufacturing Industries & Construction	<0.1%	0.32	0.32	-5.2%	0.23	0.22	<0.01	-0.01
1.A.3 Transport	=	0.06	0.06	<0.1%	0.10	0.10	-	<0.01
1.A.4 Other Sectors	-0.2%	0.42	0.42	-3.2%	0.27	0.26	<0.01	-0.01
1.A.5 Other	=	0.00	0.00	=	0.00	0.00	-	-
1.B Fugitive Emissions	=	NA	NA	=	NA	NA	-	-
2 Industrial Processes and Product Use	=	0.53	0.53	-1.0%	0.25	0.24	-	<0.01
3 Agriculture	352.5%	0.00	0.01	199.4%	0.00	0.00	0.01	<0.01
5 Waste	-0.1%	0.06	0.06	-1.3%	0.00	0.00	<0.01	<0.01
Total Emissions	0.4%	1.58	1.59	1.5%	1.15	1.16	0.01	0.02

Table 271: Recalculation difference of Hg emissions [t] with respect to submission 2016.

Hg emissions [t]	1990			2014			Absolute Diff.	
	Δ%	Subm. 2016	Subm. 2017	Δ%	Subm. 2016	Subm. 2017	1990	2014
1.A.1 Energy Industries	<0.1%	0.33	0.33	-0.2%	0.17	0.17	<0.01	<0.01
1.A.2 Manufacturing Industries & Construction	<0.1%	0.80	0.80	11.2%	0.29	0.32	<0.01	0.03
1.A.3 Transport	<0.1%	0.00	0.00	<0.1%	0.00	0.00	-	<0.01
1.A.4 Other Sectors	<0.1%	0.43	0.43	-1.6%	0.15	0.14	<0.01	<0.01
1.A.5 Other	=	0.00	0.00	=	0.00	0.00	-	-
1.B Fugitive Emissions	=	NA	NA	=	NA	NA	-	-
2 Industrial Processes and Product Use	=	0.53	0.53	=	0.34	0.34	-	-
3 Agriculture	451.1%	0.00	0.00	252.5%	0.00	0.00	<0.01	<0.01
5 Waste	<0.1%	0.05	0.05	<0.1%	0.02	0.02	<0.01	<0.01
Total Emissions	0.1%	2.14	2.14	3.1%	0.96	0.99	<0.01	0.03

Table 272: Recalculation difference of Pb emissions [t] with respect to submission 2016.

Pb emissions [t]	1990			2014			Absolute Diff.	
	Δ%	Subm. 2016	Subm. 2017	Δ%	Subm. 2016	Subm. 2017	1990	2014
1.A.1 Energy Industries	<0.1%	1.08	1.08	-1.0%	2.18	2.15	<0.01	-0.02
1.A.2 Manufacturing Industries & Construction	<0.1%	6.14	6.14	-6.4%	2.97	2.78	<0.01	-0.19
1.A.3 Transport	<0.1%	163.70	163.69	125.4%	0.01	0.01	<0.01	0.01
1.A.4 Other Sectors	<0.1%	7.48	7.48	-1.2%	1.85	1.83	<0.01	-0.02
1.A.5 Other	=	0.00	0.00	=	0.00	0.00	-	-
1.B Fugitive Emissions	=	NA	NA	=	NA	NA	-	-
2 Industrial Processes and Product Use	=	35.65	35.65	-3.5%	8.10	7.81	-	-0.29
3 Agriculture	-34.6%	0.01	0.01	-14.5%	0.01	0.01	<0.01	<0.01
5 Waste	<0.1%	1.02	1.02	-0.5%	0.00	0.00	<0.01	<0.01
Total Emissions	<0.1%	215.07	215.07	-3.4%	15.11	14.60	-0.01	-0.52

Table 273: Recalculation difference of PAH emissions [t] with respect to submission 2016.

PAH emissions [t]	1990			2014			Absolute Diff.	
	Δ%	Subm. 2016	Subm. 2017	Δ%	Subm. 2016	Subm. 2017	1990	2014
1.A.1 Energy Industries	<0.1%	0.00	0.00	-1.3%	0.02	0.02	<0.01	<0.01
1.A.2 Manufacturing Industries & Construction	<0.1%	0.07	0.07	-8.2%	0.25	0.23	<0.01	-0.02
1.A.3 Transport	-1.2%	0.29	0.28	-3.0%	0.35	0.34	<0.01	-0.01
1.A.4 Other Sectors	0.2%	8.53	8.54	-1.4%	3.94	3.89	0.02	-0.05
1.A.5 Other	=	0.00	0.00	<0.1%	0.00	0.00	-	-
1.B Fugitive Emissions	=	NA	NA	=	NA	NA	-	-
2 Industrial Processes and Product Use	=	7.13	7.13	=	0.23	0.23	-	-
3 Agriculture	=	0.25	0.25	=	0.09	0.09	-	-
5 Waste	=	0.00	0.00	=	0.00	0.00	-	-
Total Emissions	0.1%	16.27	16.28	-1.7%	4.89	4.80	0.02	-0.08

Table 274: Recalculation difference of Dioxin/Furan (PCDD/F) emissions [g] with respect to submission 2016.

Dioxin/Furan emissions [g]	1990			2014			Absolute Diff.	
	Δ%	Subm. 2016	Subm. 2017	Δ%	Subm. 2016	Subm. 2017	1990	2014
1.A.1 Energy Industries	<0.1%	0.82	0.82	-0.2%	1.46	1.46	<0.01	<0.01
1.A.2 Manufacturing Industries & Construction	<0.1%	49.62	49.62	-9.5%	4.84	4.38	<0.01	-0.46
1.A.3 Transport	<0.1%	3.88	3.88	-0.5%	1.86	1.86	<0.01	-0.01
1.A.4 Other Sectors	0.1%	45.46	45.51	-1.4%	18.28	18.03	0.06	-0.25
1.A.5 Other	=	0.00	0.00	<0.1%	0.00	0.00	-	-
1.B Fugitive Emissions	=	NA	NA	=	NA	NA	-	-
2 Industrial Processes and Product Use	=	42.53	42.53	-0.6%	4.92	4.89	-	-0.03
3 Agriculture	=	0.18	0.18	=	0.07	0.07	-	-
5 Waste	=	18.19	18.19	=	0.16	0.16	-	-
Total Emissions	<0.1%	160.69	160.74	-2.4%	31.61	30.86	0.06	-0.75

Table 275: Recalculation difference of HCB emissions [kg] with respect to submission 2016.

HCB emissions [kg]	1990			2014			Absolute Diff.	
	Δ%	Subm. 2016	Subm. 2017	Δ%	Subm. 2016	Subm. 2017	1990	2014
1.A.1 Energy Industries	<0.1%	0.21	0.21	0.8%	0.49	0.49	<0.01	<0.01
1.A.2 Manufacturing Industries & Construction	<0.1%	16.25	16.25	-0.1%	108.66	108.59	<0.01	-0.07
1.A.3 Transport	<0.1%	0.78	0.78	-0.5%	0.37	0.37	<0.01	<0.01
1.A.4 Other Sectors	<0.1%	54.30	54.31	-2.3%	26.69	26.08	<0.01	-0.61
1.A.5 Other	=	0.00	0.00	<0.1%	0.00	0.00	-	-
1.B Fugitive Emissions	=	NA	NA	=	NA	NA	-	-
2 Industrial Processes and Product Use	=	19.96	19.96	0.1%	4.70	4.70	-	<0.01
3 Agriculture	=	0.04	0.04	=	0.01	0.01	-	-
5 Waste	=	0.39	0.39	=	0.03	0.03	-	-
Total Emissions	0.0%	91.93	91.94	-0.5%	140.95	140.28	<0.01	-0.67

Table 276: Recalculation difference of TSP emissions [kt] with respect to submission 2016.

TSP emissions [kt]	1990			2014			Absolute Diff.	
	Δ%	Subm. 2016	Subm. 2017	Δ%	Subm. 2016	Subm. 2017	1990	2014
1.A.1 Energy Industries	<0.1%	1.03	1.03	-0.7%	1.28	1.27	<0.01	-0.01
1.A.2 Manufacturing Industries & Construction	<0.1%	2.90	2.90	-8.5%	4.81	4.40	<0.01	-0.41
1.A.3 Transport	0.3%	12.26	12.30	-0.1%	13.18	13.17	0.03	-0.01
1.A.4 Other Sectors	0.1%	14.12	14.13	<0.1%	8.37	8.36	0.01	<0.01
1.A.5 Other	=	0.02	0.02	=	0.02	0.02	-	-
1.B Fugitive Emissions	=	0.85	0.85	0.1%	0.41	0.41	-	<0.01
2 Industrial Processes and Product Use	<0.1%	18.94	18.94	-1.1%	15.99	15.82	<0.01	-0.18
3 Agriculture	0.1%	11.53	11.53	0.1%	10.87	10.87	0.01	0.01
5 Waste	=	0.15	0.15	<0.1%	0.36	0.36	-	<0.01
Total Emissions	0.1%	61.80	61.86	-1.1%	55.29	54.69	0.05	-0.60

Table 277: Recalculation difference of PM₁₀ emissions [kt] with respect to submission 2016.

PM ₁₀ emissions [kt]	1990			2014			Absolute Diff.	
	Δ%	Subm. 2016	Subm. 2017	Δ%	Subm. 2016	Subm. 2017	1990	2014
1.A.1 Energy Industries	<0.1%	0.98	0.98	-0.7%	1.17	1.16	<0.01	-0.01
1.A.2 Manufacturing Industries & Construction	<0.1%	2.50	2.50	-10.3%	3.56	3.19	<0.01	-0.37
1.A.3 Transport	0.5%	7.32	7.35	-0.1%	5.79	5.79	0.03	-0.01
1.A.4 Other Sectors	0.1%	12.84	12.85	<0.1%	7.50	7.50	0.01	<0.01
1.A.5 Other	=	0.02	0.02	=	0.02	0.02	-	-
1.B Fugitive Emissions	=	0.40	0.40	0.1%	0.20	0.20	-	<0.01
2 Industrial Processes and Product Use	<0.1%	10.86	10.86	-1.0%	8.05	7.97	<0.01	-0.08
3 Agriculture	0.1%	5.26	5.27	0.1%	4.93	4.93	0.01	<0.01
5 Waste	=	0.07	0.07	0.0%	0.17	0.17	-	<0.01
Total Emissions	0.1%	40.24	40.29	-1.5%	31.39	30.92	0.05	-0.46

Table 278: Recalculation difference of PM_{2.5} emissions [kt] with respect to submission 2016.

PM _{2.5} emissions [kt]	1990			2014			Absolute Diff.	
	Δ%	Subm. 2016	Subm. 2017	Δ%	Subm. 2016	Subm. 2017	1990	2014
1.A.1 Energy Industries	<0.1%	0.83	0.83	-0.6%	0.99	0.98	<0.01	-0.01
1.A.2 Manufacturing Industries & Construction	<0.1%	2.07	2.06	-12.0%	2.56	2.25	<0.01	-0.31
1.A.3 Transport	0.6%	5.59	5.62	-0.3%	3.21	3.20	0.03	-0.01
1.A.4 Other Sectors	0.1%	11.64	11.65	<0.1%	6.74	6.73	0.01	<0.01
1.A.5 Other	=	0.02	0.02	=	0.02	0.02	-	-
1.B Fugitive Emissions	=	0.11	0.11	0.1%	0.06	0.06	-	<0.01
2 Industrial Processes and Product Use	<0.1%	3.65	3.65	-0.5%	1.83	1.82	<0.01	-0.01
3 Agriculture	0.6%	1.27	1.28	0.2%	1.15	1.15	0.01	<0.01
5 Waste	=	0.02	0.02	<0.1%	0.05	0.05	-	<0.01
Total Emissions	0.2%	25.20	25.25	-2.0%	16.61	16.28	0.05	-0.33

7.4 Planned improvements, including in response to the review process, and planned improvements to the inventory

Improvements made in response to the review process

Improvements made in response to the issues raised in the last CLRTAP stage 3 review process (UNITED NATIONS 2010) are summarized in Table 280.

Planned improvements

Planned improvements on sectoral level are presented in the respective sectoral Chapters 3–6.

Goals

The overall goal is to produce emission inventories which are fully consistent with the 2014 CLRTAP Reporting Guidelines and the EMEP/EEA Air Pollutant Emission Inventory Guidebook. An improvement programme has been established to help meet this goal.

Linkages

The improvement programme is driven by the results of the various review processes, as e.g. the internal Austrian review, review under the European Union Monitoring Mechanism, under the UNFCCC and/or under the Kyoto Protocol, under the UNECE/LRTAP Convention and under Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants. Improvement is triggered by the improvement programme that plans improvements sector by sector and also identifies actions outside the Umweltbundesamt.

The improvement programme is supported by the QA/QC programme based on the international standard EN ISO/IEC 17020:2012.

Updating

The improvement programme is updated every year after each review.

Responsibilities

The Umweltbundesamt is responsible for the management of the improvement programme.

Table 279: Improvements made in response to the CLRTAP Stage 3 Review in 2010.

Finding	Reference	Improvement made	Chapter
General (cross-cutting)			
<u>KCA</u> : Austria does not provide a full level assessment for key categories in its IIR. The ERT recommends that Austria completely separates the level and trend assessment for key categories, and revises this chapter of the IIR accordingly.	Para 10, 28	The Key Category Analysis and the respective methodological chapter have been improved accordingly.	Chapter 1.5
Austria's IIR is generally well presented, but does not fully follow the IIR structure as proposed by the Guidelines. In particular the chapters on projections and improvement are missing (although the information is available elsewhere).	Para 12, 29	The Austrian IIR follows the recommended structure closely as outlined in the revised 2014 Reporting Guidelines (ECE/EB.AIR.125). Chapters on Projections and Improvements are included in the IIR.	Chapter 7 & 7.4
<u>Transparency</u> : Austria's IIR provides a lot of detailed information on methodologies. However, it does not indicate the Tier level which methods are considered to be equivalent to. Including this information as a summary table, or with teach sector would be very helpful in improving transparency.	Para 13, 30	In Table 6 information on used methodologies for the emission estimates per sector is presented for improving transparency.	Chapter 1.4
<u>Recalculations</u> are generally explained in the major changes section (chapter 3.3) of the IIR, but the ERT recommend that the link between the changes in methodology and the resulting emission numbers are explained in more detail, to provide improved clarity. The ERT encourages Austria to give more detailed information about the links between improvements of the methodologies and resulting recalculations in future IIR.	Para 17, 31	Chapter 'Recalculations and Improvements' has been improved accordingly.	Chapter 7
Austria's data submission for NECD and CLRTAP differ significantly. As explained by the party, this is due to the usage of emission totals derived from fuel used in the case of the NEC directive as opposed to fuel sold for the CLRTAP submission. The ERT encourages Austria to improve the transparency of its reporting by including an explanatory note at the beginning of the IIR.	Para 19, 32	Information on the difference between data reported under NEC and CLRTAP is described in the Executive Summary as well as in Chapter 'Explanations of Key Trends', where the chapter 'National emission total calculated on the basis of fuels used' is included.	Chapter 2.5
Austria compiled a qualitative uncertainty analysis and presents this clearly in its IIR. Austria uses both the results from their uncertainty analysis and key category analysis for the prioritisation of inventory improvement activities. The ERT encourages Austria to assess the possibilities for compilation of a quantitative uncertainty analysis in the future. Result of such analysis could be used to prioritize planned improvements.	Para 20, 33	From submission 2017 onwards a quantitative uncertainty analysis for SO ₂ , NO _x , NMVOC, NH ₃ and PM _{2.5} has been compiled. The results are described in the IIR.	Chapter 1.7

Finding	Reference	Improvement made	Chapter
Energy (stationary)			
<u>Transparency:</u> Emission trends are described in a thorough manner. The focus of the trend description is on 1990 and the base year. The ERT suggests that more information could be included for the entire time series.	Para 38	Trend descriptions for all pollutants are included in Chapter 'Explanations of Key Trends'.	Chapter 2
<u>Transparency:</u> The ERT recommends that rationales for choice of emission factors, when significantly different from default Guidebook emission factors, should be stated.	Para 39	Information is included in the IIR.	Chapter 3.1
<u>Accuracy:</u> The ERT encourages Austria to undertake a quantitative uncertainty analysis for the stationary energy sector in order to help identify potential areas for further improvements and to provide an indication of the reliability of the inventory data.	Para 40	A quantitative uncertainty analysis has been undertaken for NO _x , SO ₂ , NMVOC, NH ₃ and PM _{2.5} (see Table 58).	Chapter 1.7 & 3.1.1.3
<u>Accuracy:</u> Austria has detailed QA/QC checks by the sector experts themselves, and there is a second audit for every sector. The ERT encourages Austria to specify source-specific QA/QC procedures.	Para 41	A description of the source-specific QA/QC procedures is included in the IIR.	Chapter 3.1.8
<u>Recalculations:</u> The recalculations in the Austrian inventory are thoroughly explained in the IIR, including a description of how the recalculations affect the emissions. However, the IIR does not explain the rationale for all recalculations. The ERT encourages Austria to provide the rationale for all recalculations in its IIR.	Para 45	The recalculations are described in the sectoral subchapters as well as in chapter 7 Recalculations and Improvements.	Chapters 3.1.10 & 7
<u>Improvement:</u> The ERT encourages Austria to perform a quantitative uncertainty analysis in order to identify other areas of the stationary energy sector where improvements of activity data or emission factors could be appropriate.	Para 46	A quantitative uncertainty analysis has been undertaken for NO _x , SO ₂ , NMVOC, NH ₃ and PM _{2.5} (see Table 58).	Chapter 1.7 & 3.1.1.3
<u>1.A.4.c.i: All pollutants:</u> The ERT has noted that the emission factors used in sector 1.A.4 are somewhat unclear. The ERT recommends that Austria clarifies this chapter by a more detailed description of the emission factors used for each fuel type throughout the time series.	Para 48	Emission factors for main pollutants, heavy metals, POPs and PM are provided in tables of chapters 3.1.6.2, 3.1.6.3, 3.1.6.4 and 3.1.6.5.	Chapter 3.1.6
<u>1.A.4.c.i: NMVOC and CO:</u> The ERT noted a jump in NMVOC emissions from 1 A 4 c i between 1996 and 1997. Austria provided information stating that this was due to a change in methodology, with new emission factors arising from this change. No interpolation method has been used to smooth the resulting jump in the emission time series. The ERT recommends that Austria uses interpolation to splice the two time series more gradually.	Para 49	It was foreseen to update emission factors for the residential sector based on a planned measurement program and update the whole time series accordingly. However, the measurement project was skipped and therefore the methodology remained unchanged.	-
Energy (mobile)			
<u>Areas for improvement:</u> Introduction of an updated version of the "Handbook on Emission Factors" for transport.	Para 25	The latest HBEFA Version V3.2 has been applied (see chapter for NFR 1.A.3.b Road Transport Emission Factors).	Chapter 3.2.6

Finding	Reference	Improvement made	Chapter
<u>Transparency & Comparability:</u> The ERT commends the already good levels of detail in the methodology descriptions for the main sources within the transport sector (1A3a, b), encouraging the Party to further improve the transparency and comparability of its inventory by providing even more details where necessary.	Para 51	The methodological chapter on emissions from the transport sector has been continuously improved.	Chapter 3.2
<u>Transparency & Comparability:</u> Compared to the main transport sub-categories, little information is provided on the “off-road” vehicles. The Party provides information for all off-road vehicles together without further separation of subcategories such as railways or navigation. The ERT therefore recommends that the Party includes much more detailed information and descriptions in its next submission for the subcategories summed up under “off-road” at the moment.	Para 52	Austria enhanced transparency in the respective subchapters. The separation of the different off-road categories (rail, navigation, mobile machinery etc.) has been retained, as it does not seem feasible to discuss emissions from ships, locomotives or NRMM in industry or agriculture at an aggregated level. A new study on fuel consumption and pollutant emissions of NRMM is considered for future submissions. Then, input-data for the off-road sector will be updated and recalculated with the model GEORG.	Chapter 3.2.7
<u>Accuracy:</u> The ERT encourages Austria to undertake specific uncertainty analysis for the Transport Sector in order to help inform the improvement process and to provide an indication of the reliability of the inventory data.	Para 54	A quantitative uncertainty analysis has been undertaken for NO _x , SO ₂ , NMVOC, NH ₃ and PM _{2.5} (see Table 138).	Chapter 1.7 & 3.2.3
<u>Recalculations:</u> Austria has recalculated its inventory for almost all sectors in the year 2010, providing not only good information on the reasons within the IIR but also detailed data on the recalculated emissions on a very detailed level. The ERT commends the Party's efforts, encouraging Austria to try and provide such data on a level as disaggregated as possible.	Para 55	Detailed information on recalculations is provided in the respective sectoral chapters as well as in chapter 7 ‘Recalculations and Improvements’.	Chapter 7.2
<u>Improvements:</u> The ERT commends the Party for its improvements carried out and still planned within the transport sector, encouraging the Party to further improve its inventory by attaching more attention to off-road mobile sources.	Para 56	Austria enhanced transparency in the respective chapters. A new study on fuel consumption and pollutant emissions of NRMM is considered for future submissions. Then, input-data for the off-road sector will be updated and recalculated with the model GEORG.	Chapter 3.2.7

Finding	Reference	Improvement made	Chapter
1.A.3a ii - Air Transport: Pb: The Party stated that production and import of leaded gasoline has been prohibited since 1993. In Austria and that earlier emission estimates are based on a lead content of 0.56 g Pb/litre for aviation gasoline. The Party also provided further explanatory information on the issue of emission factors used for lead emissions from avgas. The ERT recommends that the Party provides additional explanatory information within the relevant IIR chapters in its next submission.	Para 57	The information on the lead content of aviation gasoline has been included in the IIR (see chapter on emission factors for heavy metals, POPs and PM).	Chapter 3.2.8
1.A.3.bi & ii Road transport – Pb: Austria provided additional information on the development of Pb emissions reported for 1.A.3.bi & ii. From 1996 on a lead content of 0,1 mg/GJ has been estimated for gasoline due to the assumed use of lead additives for old non-catalyst vehicles and that a lead content of 0.02 mg/GJ has been assumed for diesel oil. The ERT asking the Party to include these assumptions in its IIR.	Para 58	The information on the lead content of aviation gasoline has been included in the IIR (see chapter on emission factors for heavy metals, POPs and PM).	Chapter 3.2.8
1.A.3.b.i: NMVOC, CO, NH₃: The ERT noted some dips in the trends reported for 1990 emissions of NH ₃ , NMVOC and CO, asking the Party to provide some explanation on these issues. The ERT recommends that the Party include explanations in its IIR.	Para 59	Trend descriptions for all pollutants can be found in chapter 2 'Explanation of Key Trends'.	Chapter 2
1.A.3.b vi & vii: PM, TSP: Particle emissions from tyre and brake wear (1A3bvi) are reported as 'IE'. Austria states that PM emissions from tyre and brake wear are included in road abrasion and that it is not possible to develop separate emission factors (by road and vehicle type) from field emission measurements which consider total vehicle emissions. The ERT accepts this answer but wants to encourage the Party to further develop its models and to provide separate estimates for both sub-categories in future submissions.	Para 60	Austria still reports particle emissions from tyre and brake wear together with road abrasion under 1.A.3.b.vii. Explanations can be found in the sectoral chapter of NFR sector 1.A.3.b Road Transport.	Chapter 3.2.8.3
1.A.3.b vi & vii: Other HM: Austria reports emissions of all HM (besides Cd, Hg and Pb) as not reported (NR). The Party states that no such estimations have been carried out up to now. The ERT accepts this answer but anyhow wants to encourage Austria to provide estimates for 'Other HMs' in its next submission.	Para 61	At current we do not estimate - any of the "other heavy metals", which are not mandatory to report. Austria reports Hg, Pb, Diox and HCB emissions from 1.A.3.b.vi and vii as NA. In the case of Cd and PAH emissions from tyre and brake wear are reported in 1.A.3.b.vii.	

Finding	Reference	Improvement made	Chapter
1.A.4.a ii – All pollutants: Austria reports all emissions from 1A4a ii as 'IE', giving no information, where these emissions are included. In contrast, under activity data only 'NO' occurs. The Party stated that emissions from mobile machinery are included in category 1A4b ii and that it is not possible to split the data into commercial and non-commercial use. The ERT encourages the Party to provide more information on the notation keys used in its inventory in both IIR and NFR in its next submission. The ERT also encourages Austria to investigate whether it will be possible to gather new data to allow these two sources to be reported separately in the future.	Para 62	The information has been included in the IIR (see chapter 1.A.4.b.ii on Household and gardening – mobile sources). A new study on fuel consumption and pollutant emissions of NRRM is considered for future submissions. Then, input-data for the off-road sector will be updated and recalculated with the model GEORG.	Chapter 3.2.7.4
Fugitive Emissions			
1 B 1 a: NMVOC: Austria does not estimate emissions of NMVOCs from coal mining and handling. Emission factors for NMVOC from this sector are provided in the EMEP/EEA Guidebook. Austria notes that there has been no coal mining in Austria after 2007. The ERT encourages Austria to apply the default emission factors from the Guidebook and to estimate NMVOC emissions from coal mining and handling for the years prior to 2007.	Para 47	NMVOC emissions from coal mining and handling are reported for the years prior to 2007.	NFR Tables, Chapter 3.3
Industrial Processes and Other Product Use			
Completeness: The ERT considers the industrial processes sector to be almost complete. Only an emissions estimate for the Ferroalloys production is missing. TSP emissions are assumed to be negligible and would contribute 0.02% to the national total.	Para 63	PM emissions from Ferroalloys production are included in Austria's submission and methodology is described in the sectoral chapter.	NFR Tables, Chapter 4.5.1
Accuracy: The ERT encourages Austria to undertake sector-specific quantitative uncertainty analysis for the industrial processes in order to help inform the improvement process and to provide an indication of the reliability of the inventory data.	Para 65	A quantitative uncertainty analysis has been undertaken for NO _x , SO ₂ , NMVOC, NH ₃ and PM _{2.5} (see Table 177).	Chapter 4.2.3
Accuracy: Austria has implemented a quality management system (QMS) which is based on ISO/IEC 17020 General criteria for the operation of various types of bodies performing inspections and which incorporate many of the EMEP/EEA emission inventory guidebook 2009 requirements. ERT encourages Austria to provide more sector-specific information in the next submission.	Para 66	A chapter on sectoral QA/QC activities is included in the IIR.	Chapters 4.2.4
Improvement: The Austrian IIR includes only very limited information about sector-specific improvements plans. The ERT encourages Austria to provide more sector-specific information about planned improvements in the next submission.	Para 68	A chapter of sector-specific planned improvements is included in the IIR 2017.	Chapter 4.2.5

Finding	Reference	Improvement made	Chapter
2.A.1 Cement production: Austria reported SO ₂ emissions from Cement production as NA as the methodology does not allow combustion and process emissions to be split. The ERT encourages Austria to try and separate emissions from combustion and from processes and to report them under the relevant categories in future submissions. Where this is not possible the ERT encourages Austria to use the IE notation key and to provide comments in the IIR and NFR.	Para 69	Currently, the EMEP/EEA GB 2016 does not provide a methodology for SO ₂ from 2.A.1. However, all SO ₂ emissions from cement kilns are reported under 1.A.2.f. We decided therefore to report a 'NA' for SO ₂ emissions from 2.A.1.	NFR Tables
2.C.1 Iron and steel production: Some data used for HM estimates are provided in table 162 of the IIR. However, the ERT suggests that Austria should present some activity data more clearly – in particular activity data for coke production, coke consumption in sinter plants and blast furnace gas production.	Para 70	Activity data for coke production, coke consumption in sinter plants and blast furnace gas production has been included in the sectoral chapter (see Table 190).	Chapter 4.5.1
2.C.3 Aluminium production: The Austrian IIR does not use terminology used in NFR for chapter titles. The ERT recommends that Austria should increase the transparency of industrial processes reporting by ensuring that each category is described under individual and appropriately named chapters.	Para 71	Information is included in the sectoral chapter.	Chapter 4.5.2
Product Use			
Accuracy: The IIR indicates that no quantitative uncertainty assessment for any of the pollutants or pollutant groups has been made. The qualitative assessment provides the typical error range of 10-30% for NMVOC emissions in solvent sector. The ERT encourages Austria to present quantitative uncertainty assessments for the categories in the solvent sector to support future submissions.	Para 75	A quantitative uncertainty analysis has been undertaken for NO _x , SO ₂ , NMVOC, NH ₃ and PM _{2.5} (see Table 177).	Chapter 4.2.3
Consistency: Austria used the 2000 data (e.g. solvent content in paints, waste gas purification efficiency) for the subsequent years to estimate solvent use data as no new survey has been conducted. The approach is conservative though it might significantly overestimate NMVOC emissions in the solvent sector as some solvent uses and regulations associated with mitigating emissions were amended after 2000. The ERT encourages Austria to consider improving the estimates of data for 2000 onwards, and recalculating emissions.	Para 78	Currently an update of the model taking into account emissions reported under the VOC emissions directive has been performed and is currently ongoing.	Chapter 4.6
3.A. Paints and Coatings – NMVOC: Austria uses the "NA" notation key for the NMVOC emissions from the 3.A.3 "Other coating application" category. However, the Party explained that the paint use, and hence associated emissions, under 3.A.3 are accounted for in 3.A.1. The ERT recommends that Austria should use the appropriate notation key IE ("Included Elsewhere") and provide an explanation in the IIR that all paint use emissions are included under 3.A.1.	Para 81	Austria reports NMVOC emissions under NFR source category 2.D.3.d Coating applications.	NFR Tables, Chapter 4.6

Finding	Reference	Improvement made	Chapter
Agriculture			
<u>Transparency:</u> PM emissions from animal husbandry could be reported in 4B NFR sub-sectors instead of being reported in 4G or, at the minimum, reported as IE “Included Elsewhere” (instead of NA). The ERT also recommends that Austria provides a summary table indicating the tier levels used for each of the agriculture sources.	Para 83	PM emissions from animal husbandry are reported under NFR sector 3.B for each livestock category. Methodology is described in the sectoral chapter. Furthermore, a summary table indicating the Tier level for each agricultural source is included Table 207.	NFR Tables, Chapter 5.2
<u>Accuracy:</u> The uncertainty analysis provided is qualitative (level B for agriculture). The ERT encourages Party to undertake a quantitative uncertainty analysis for the agriculture sector in order to help inform the improvement process and to provide an indication of the reliability of the inventory data.	Para 84	A quantitative uncertainty analysis has been undertaken for NO _x , SO ₂ , NMVOC, NH ₃ and PM _{2.5} (see Table 209).	Chapter 5.2.4
Waste			
<u>Transparency:</u> It would help to improve transparency in 6.C if the data in the IIR were clearly allocated to the different NFR sub-categories (6.C a,b,c,d,e), and the ERT recommends that this should be undertaken. The NFR tables report emissions for each sub-category, and the corresponding data is thus assumed to be readily available.	Para 91	The IIR chapter has been improved accordingly.	Chapter 6.5
<u>Accuracy:</u> Uncertainty analyses are presented for the waste sector. The majority are defined as category “C” or “D” which presents quite a high error range. The ERT notes that Austria uses the uncertainty assessment in prioritising improvements, and therefore encourages Austria to try and improve data to achieve a lower error range for the waste sectors.	Para 93	For some source categories (5.A and 5.B) uncertainties could be reduced due to improved input data. Furthermore, a quantitative uncertainty analysis for NO _x , SO ₂ , NMVOC, NH ₃ and PM _{2.5} has been undertaken (see Table 249).	Chapter 6.2.4
<u>6.A Solid waste disposal on land: SO_x, NO_x, TSP, PM₁₀, PM_{2.5}:</u> No emissions of SO _x and NO _x were reported under 6.A. Austria has indicated that they are reported under Chapter 1, energy. However, Austria mentions in its IIR (page 269, 8.2.1) that most active landfills in Austria have gas collection systems. For those without energy recovery systems, NO _x and SO ₂ emissions arise when burning (flaring) occurs and they should be reported as waste emissions. The ERT therefore recommends that Austria should use the notation key “IE” in the NFR Tables instead of “NA” to improve the transparency of the way in which emissions from flaring are reported. Or, if data on flaring are available, emissions should be reported in the Waste chapter.	Para 97	The notation key was changed from “NA” to “IE” as related emissions are covered under sector Energy.	NFR Tables, Chapter 6.2.1

Finding	Reference	Improvement made	Chapter
<u>6.A Solid waste disposal on land: SO_x, NO_x, TSP, PM₁₀, PM_{2.5}</u> : The ERT were not able to understand whether the emissions of TSP, PM ₁₀ and PM _{2.5} which are reported under 6.A.1 came from burning (flaring) or from deposition of waste (e.g. handling). Austria has confirmed that the emissions are from waste handling at landfills, and the ERT recommends that this explanation is included in the IIR.	Para 98	An explanation is included in the sectoral chapter.	Chapter 6.3.2
<u>6.B Wastewater handling: All pollutants</u> : No emissions are reported in category 6.B (the notation keys NA or NR are used). Following questions from the ERT, Austria has explained that activity data are unknown for this category. Consequently, the ERT strongly recommends the use of the "NE" notation key instead of "NA". However, the ERT encourages Austria to try and obtain activity data for this category to make emission estimates, and therefore improve the IIR and the NFR tables.	Para 99	NMVOC emissions have been calculated and reported for this source category.	NFR Tables, Chapter 6.6
<u>6.C Waste incineration</u> : Austria's IIR explains that some emissions from hazardous waste and sewage sludge incineration are reported in 1 A 4 a (and 1 A 1 a) for 1992 onwards. Where a plant recovers heat or generates electricity from waste burning for its own purposes, allocation to 1 A 4 a is correct. However, this is not a particularly common occurrence across Europe. So the ERT recommends that some text is added to explain this logic.	Para 100	An explanation has been added to the methodological chapter of 5.C.	Chapter 6.5
<u>6.C.a Clinical waste incineration: TSP, PM₁₀, PM_{2.5}, AD</u> : Emissions from TSP, PM ₁₀ and PM _{2.5} are not reported (NE) although activity data are known and EFs are provided in the EMEP Guidebook 2009 (at least for TSP). The ERT has recommended that Austria should include emission estimates in its next submission.	Para 101	PM emissions from clinical waste incineration are now included in Austria's submission.	NFR Tables, Chapter 6.5
<u>6.C.a Clinical waste incineration: TSP, PM₁₀, PM_{2.5}, AD</u> : The IIR also explains that activity data are based on a waste flow database at the Umweltbundesamt which only has data for the years 1990 and 1994, the remaining time series being extrapolated from these data. This estimation is probably a good first approximation, but long extrapolations such as this should be avoided or supported by some new data. Consequently, the ERT recommends that Austria should investigate ways of obtaining new activity data to improve emission reporting.	Para 102	Activity data has been updated and is presented in the chapter on methodology.	Chapter 6.5
<u>6.C.b Industrial waste incineration: TSP, PM₁₀, PM_{2.5}, AD</u> : Emissions from TSP, PM ₁₀ and PM _{2.5} are not reported (NE) whereas activity data are known and EFs are provided in the EMEP Guidebook. The ERT has recommended that Austria should include emission estimates in its next submission.	Para 103	PM emissions from industrial waste incineration are now included in Austria's submission.	NFR Tables, Chapter 6.5

Finding	Reference	Improvement made	Chapter
<u>6.C.b Industrial waste incineration: TSP, PM₁₀, PM_{2.5}, AD:</u> The IIR does not provide details on the activity data used for the category 6 C b (the ERT thinks that this is possibly Waste Oil). The ERT encourages Austria to describe the sub-categories reported in the NFR tables in the IIR.	Para 104	Details on activity data is provided in the IIR (see Table 260.	Chapter 6.5.2
<u>6.C.c All pollutants:</u> No emissions are reported under 6.C.c but the ERT has noticed from page 267 of the IIR ("Although an increasing amount of waste is incinerated, NO _x , NMVOC and NH ₃ emissions from Waste Incineration (without energy recovery) are decreasing. Emissions arising from incineration of waste with energy recovery are taken into account in NFR Sector 1 A.") that waste incineration without energy recovery is still present and the ERT therefore presumes that emissions are still produced. It leads to a small inconsistency because these emissions are not reported. The ERT encourages Austria to clarify this point, and update reporting accordingly.	Para 105	In the submission 2017 we consider that all relevant pollutants of 5.C are estimated.	NFR Tables, Chapter 6.5
<u>6.C.d Cremation: TSP, PM₁₀, PM_{2.5}, AD:</u> Activity data for 6.C.d are based on expert judgement and have been constant since 2005. For more accurate emissions reporting, the ERT suggests that Austria should try to obtain statistical data from crematoria. Furthermore, emissions from TSP, PM ₁₀ and PM _{2.5} , are not reported (NE) although activity data are known and EFs are provided in the EMEP Guidebook 2009 (at least for TSP). The ERT has recommended that Austria should include emission estimates in its next submission.	Para 106	PM emissions from cremation are now included in Austria's submission.	NFR Tables, Chapter 6.5
<u>6.C.e Small-scale waste burning: All pollutants:</u> No emissions for 6.C.e are reported. Austria explained that any biomass waste incineration is prohibited in Austria. However, illegal waste incineration does takes place, but Austria sets it as "NE". The ERT suggests that even if it is banned, illegal fires will happen, and therefore the ERT recommends making an emissions estimate - particularly because emissions (mostly PM) are still quite important. Austria may benefit from considering the methodologies used by other countries which report emissions from this source (for example the UK).	Para 107	There is still no reliable data for this source available. Furthermore the new NFR format does not provide a category for 'Small-scale waste burning' anymore.	Chapter 6.5

8 PROJECTIONS

As outlined in the 'Guidelines for Reporting Emission Data under the Convention on Long-Range Transboundary Air Pollution' (ECE/EB.AIR/125, Update on 13 March 2014)

§ 44 Parties to the Gothenburg Protocol within the scope of EMEP shall regularly update their projections and report every four years from 2015 onward their updated projections for the years 2020, 2025 and 2030 and, where available, also for 2040 and 2050. Parties to the Protocols are encouraged to regularly update their projections and report every four years from 2015.

§ 45 Projected emissions for substances listed in paragraph 7 (i.e. sulphur dioxide (SO₂), nitrogen oxides (NO_x), ammonia (NH₃), PM_{2.5} and non-methane volatile organic compounds (NMVOCs etc.) and, where appropriate black carbon should be reported using the template within Annex IV to these Guidelines. Parties should complete the tables at the requested level of aggregation. Where values for individual categories or aggregated NFR categories are not available, the notation keys defined in paragraph 12 to these Guidelines should be used.

§ 46 Quantitative information on parameters underlying emission projections should be reported using the templates set out in annex IV to these Guidelines. These parameters should be reported for the projection target year and the historic year chosen as the starting year for the projections.

Austria's latest emission projections for the scenario 'with existing measures' for the year 2020, 2025 and 2030 are published in the report 'Austria's National Air Emission Projections 2017 for 2020, 2025 and 2030' (UMWELTBUNDESAMT 2017b). The report includes background information to enable a quantitative understanding of the key socioeconomic assumptions used in the preparation of the projections. It updates previous projections for air pollutants published in 2015 (UMWELTBUNDESAMT 2015c).

The scenario "with existing measures" leads to significant reductions in emissions by 2030 for all pollutants but NH₃. The most substantial reduction with about 66% (fuel sold) or 56% (fuel used) from 2005 until 2030 is projected for the pollutant NO_x, provided that the latest and new emission standards for road vehicles meet their specifications.

Emission reductions for the other pollutants are in the range from 22% to 48%; NH₃ emissions, however, is projected to increase by 8–9%.

The following table shows Austria's national total emissions and projections based on fuel sold as well as on fuel used. Emissions have to be reported based on fuel sold under the UNECE LRTAP Convention as well as under the NEC Directive 2016/2284/EU. With respect to compliance under the NEC Directive Austria reports emissions and projections based on fuel used. When referring to emissions based on 'fuel used', 'fuel exports in the vehicle tank' are not considered. According to the revised NEC Directive, ceilings were established for the five air pollutants: nitrogen oxides (NO_x), sulphur dioxide (SO₂), non-methane volatile organic compounds (NMVOC), ammonia (NH₃) and particulate matter (PM_{2.5}).

The scenario "with existing measures" leads to significant reductions in emissions by 2030 for all pollutants but NH₃. The most substantial reduction with about 66% (fuel sold) or 56% (fuel used) from 2005 until 2030 is projected for the pollutant NO_x, provided that the latest and new emission standards for road vehicles meet their specifications.

Emission reductions for the other pollutants are in the range from 22% to 48%; NH₃ emissions, however, is projected to increase by 8–9% (see Table 281).

Table 280: Austrian national total emissions in kt and trend in comparison with the base year 2005 in % based on (a) **fuel sold** and (b) **fuel used**.

Pollutant	Emission inventory 2017				Emission scenario			Type of scenario
[kt]	1990	2005	2010	2015	2020	2025	2030	
NO_x	220.89	238.06	181.08	149.12	113.69	92.82	82.04	fuel sold
		0%	– 24%	– 37%	– 52%	– 61%	– 66%	
	203.12	178.94	149.42	131.74	106.67	89.03	79.23	fuel used
		0%	– 16%	– 26%	– 40%	– 50%	– 56%	
SO₂	74.57	25.95	16.70	14.90	13.98	13.70	13.55	fuel sold
		0%	– 36%	– 43%	– 46%	– 47%	– 48%	
	73.66	25.89	16.66	14.87	13.94	13.67	13.52	fuel used
		0%	– 36%	– 43%	– 46%	– 47%	– 48%	
NM VOC	280.63	136.62	118.73	112.89	108.69	105.08	103.28	fuel sold
		0%	– 13%	– 17%	– 20%	– 23%	– 24%	
	277.27	132.43	117.19	112.36	108.35	104.80	103.04	fuel used
		0%	– 12%	– 15%	– 18%	– 21%	– 22%	
NH₃	66.15	65.30	66.80	66.87	70.29	70.31	70.37	fuel sold
		0%	2%	2%	8%	8%	8%	
	66.09	64.70	66.53	66.80	70.23	70.25	70.31	fuel used
		0%	3%	3%	9%	9%	9%	
PM_{2.5}	25.25	22.11	19.02	16.62	14.57	13.64	12.99	fuel sold
		0%	– 14%	– 25%	– 34%	– 38%	– 41%	
	24.67	20.48	18.33	16.33	14.46	13.58	12.95	fuel used
		0%	– 11%	– 20%	– 29%	– 34%	– 37%	

9 REPORTING OF GRIDDED EMISSIONS AND LPS

According to the UNECE Convention on Long-Range Transboundary Air Pollution parties are obligated to report gridded emissions and large point sources (LPS). Being in line with the revised 2014 CLRTAP Reporting Guidelines (ECE/EB.AIR.125) both datasets shall be reported every four years from 2017 onwards for the year x-2.

In the current submission Austria reports data on gridded emissions based on fuel sold and on fuel used as well as LPS data for 2015. The data for previous years (1990, 1995, 2000, 2005 and 2010) was reported in submission 2012¹⁵⁴.

This chapter includes descriptions on input data, methodology and results of the Austrian gridded emissions for 2015 as well as on large point sources (LPS) for 2015.

9.1 Gridded Emissions

9.1.1 Background Information

At the 36th session of the EMEP Steering Body it was suggested to increase the spatial resolution of the EMEP grid from 50 km x 50 km to 0.1° x 0.1° in order to improve quality of monitoring. So, in the revised 2014 CLRTAP Reporting Guidelines (ECE/EB.AIR.125) the new “EMEP grid” refers to a 0.1° x 0.1° latitude-longitude projection in the geographic coordinate World Geodetic System (WGS) latest revision, WGS 84. Therefore, the spatial allocation of the current Austrian Air Emission Inventory had to be adapted accordingly. There was a need to adjust the base data and the statistical background to latest databases and updated GIS data.

The mandatory reporting of gridded emissions includes the following 14 pollutants: SO_x, NO_x, NH₃, NMVOC, CO, PM₁₀, PM_{2.5}, Pb, Cd, Hg, PCDD/F, PAHs, HCB and PCBs.

The applied method is based on (ORTHOFFER et al. 2002 and ORTHOFFER 2007) but had to be adapted accordingly due to the improved resolution. So the number of grid cells for Austria increased from about 60 (50 km x 50 km) to 1 144 (0.1° x 0.1°).

9.1.2 Emissions according to the GNFR-Code

In Table 282 the NFR sectors are listed which were used for reporting of gridded emission data based on the Austrian Air Emission Inventory. This is in line with the EMEP/EEA GB 2016 (EEA 2016).

Table 281: GNFR categories and corresponding NFR categories.

GNFR ID	GNFR Name	NFR categories	Note
A_PublicPower	Public Power	1.A.1.a	
B_Industry	Industry	1.A.1.b, 1.A.1.c, 1.A.2.a, 1.A.2.b, 1.A.2.c, 1.A.2.d, 1.A.2.e, 1.A.2.f.i, 1.A.2.g.viii, 2.A., 2.B, 2.C, 2.D.3.b, 2.D.3.c, 2.H, 2.I, 2.J, 2.K, 2.L	

¹⁵⁴ http://www.ceip.at/ms/ceip_home1/ceip_home/status_reporting/2012_submissions/

GNFR ID	GNFR Name	NFR categories	Note
C_OtherStationaryComb	Other stationary combustion	1.A.4.a.i, 1.A.4.b.i, 1.A.4.c.i, 1.A.5.a	
D_Fugitive	Fugitive Emissions	1.B.1, 1.B.2	
E_Solvents	Solvents	2.D.3.a, 2.D.3.d, 2.D.3.e, 2.D.3.f, 2.D.3.g, 2.D.3.h, 2.D.3.i, 2.G	
F_RoadTransport	Road Transport	1.A.3.b	
G_Shipping	Shipping	1.A.3.d.i(ii), 1.A.3.d.ii	
H_Aviation	Aviation	1.A.3.a.i(i), 1.A.3.a.ii(i)	
I_Offroad	Offroad	1.A.2.f.ii, 1.A.2.g.vii, 1.A.3.c, 1.A.3.e.i, 1.A.3.e.ii, 1.A.4.a.ii, 1.A.4.b.ii, 1.A.4.c.ii, 1.A.4.c.iii, 1.A.5.b	
J_Waste	Waste	5	
K_AgriLivestock	Agriculture - Livestock	3.B	
L_AgriOther	Agriculture - Other	3.D, 3.F, 3.I	
M_Other	Other emission sources	-	Not occurring

9.1.3 Allocation of emissions

The following chapter describes the GIS based method and the proxy data, which was used for the allocation of national emissions to the EMEP Grid. The same method was applied for data based on fuel sold and fuel used. The data was intersected with the EMEP Grid and weighted within ArcGIS 10.4. In a second step the emissions were distributed via database calculations.

Austria is located in central Europe and has a heterogeneous topography. The main part is influenced by alpine climate with more balanced temperatures and precipitation, whereas the eastern part of the country is characterized by continental climate. So it was considered necessary to take into account the regional heterogeneity in case of source categories with a broad spatial distribution.

9.1.3.1 Applied data sources for gridded emission

Information about the main proxy data is listed in Table 283 and is also described in more detail below. These data are the basis for the disaggregation of the national emissions, which was carried out on NFR level. In a final step the results were aggregated to the GNFR sectors as it is required in the CLRTAP reporting template for the gridded emissions (Annex V).

It was not possible to create a fully homogenous set of proxy data that always refers to the year 2015, due to lack of data availability. The data sources cover a time frame from 2011 to 2016, e.g. economic activities on municipal level, where the latest data set is from 2011. This information is also included in Table 283.

Table 282: Overview of proxy data.

Data set	Data description	Data source	Year	Resolution/data specification
Topographic map	Administrative units, territorial borders according to the needed database	Federal Office for Metrology and Surveying (BEV) ¹⁵⁵	2011–2016	Cadaster
River network	Danube, Shipping area	BMLFUW ¹⁵⁶	2015	Vector data
Employees in the manufacturing industries sector	Economic activities on municipal level (NACE classification), register census 2011	Statistik Austria ¹⁵⁷	2011	Municipal level; cadaster
Population	Population per municipality	Statistik Austria	2015	Municipal level
Permanent settlement area	Statistical processed data according to Corine Landcover	Statistik Austria	2013	25 m raster
Corine Land cover 2012	Raster data on land cover	Environment Agency Austria ¹⁵⁸	2012	25 x 25 m raster
Commuters	Amount of commuters leaving place of residence	Statistik Austria	2014	Municipal level
Road and railway network	Vector data for classified road and railway network	Graph Integration Platform (GIP) Austria ¹⁵⁹	2016	Vector data
Traffic census points	Geo-referenced information on traffic census on motorways	ASFINAG ¹⁶⁰	2015	Points, coordinates
Register of buildings and dwellings	Geo-referenced information on dwellings and buildings	Statistik Austria	2016	Address data
Rural- urban typology	Statistical processed data	Statistik Austria	2015	Municipal level
Animal livestock numbers	INVEKOS data base	Agrarmarkt Austria (AMA) ¹⁶¹	2012	1 km raster
Large Point Sources (LPS)	Geo-referenced information on power plants, large industrial plants	Official data submissions 2017 under Regulation (EC) No 166/2006 and Directive 2010/75/EU	2015	Address data
Waste treatment	Geo-referenced information on large point plants in the waste sector (LPS); correlation with population numbers	Official data submissions 2017 under Regulation (EC) No 166/2006 and Directive 2010/75/EU, Statistik Austria	2015	Municipal level

¹⁵⁵ <http://inspire.ec.europa.eu/LMOS/federal-office-metrology-and-surveying-bev>

¹⁵⁶ <https://www.bmlfuw.gv.at/>

¹⁵⁷ https://www.statistik.at/web_de/statistiken/index.html

¹⁵⁸ <http://www.eea.europa.eu/data-and-maps/data/external/corine-land-cover-2012>

¹⁵⁹ <http://www.gip.gv.at/>

¹⁶⁰ <http://www.asfinag.at/home-en>

¹⁶¹ <https://www.ama.at/Intro>

Economic activities

There is a strong correlation between the NACE classification (ÖNACE 2008 classification) and the NFR sectors of manufacturing industries. The amount of employees in the different NACE sectors within the manufacturing industry sector at the municipal level was taken as basis to generate the proxy for the respective NFR sectors. These proxies were finally combined to the aggregated GNFR sector *B_Industry*.

Population and permanent settlement data

Data from population for 2015 is available from national official statistics at municipal level.

The permanent settlement area combines Corine Landcover data and economic statistics and is a data set compiled by Statistik Austria. The latest one is available for 2013 and in a resolution of 25 m.

As described before, the topographical heterogeneity within Austria had to be considered. So, the population data on municipal level and the permanent settlement area was combined for sectors and categories with a wide spatial distribution spectrum. As an example for this approach the NFR sector Solvent Use can be mentioned.

Land use statistics

Land use statistics were taken from the Corine Land cover statistics as basis for soil related emissions which are included in GNFR sector *L_AgriOther*. The Corine Land cover also provides the base for calculations of the permanent settlement areas, which was described above.

Traffic- network and traffic census data

The river network as well as the road network builds the line based emission data. These vector data is intersected with the EMEP Grid. All shipping emissions are allocated to the Danube River.

The traffic network is taken from a national harmonized street and railway dataset. The preparation of these proxies required a few steps. First the traffic network was divided in motorways, streets in built-up areas and rural traffic net. In a second step the different street levels were weighted in three different ways. The motorways were combined with traffic census data from measuring points. The main routes with intense traffic were weighted with a higher level than less frequented sections. The built-up areas were weighted with commuters in a working distance of 1-4 km and local stationary inhabitants. For rural traffic commuters within a distance between 5 and 50 km the street segments were taken for assessment. It was assumed that these commuters leave their place of residence and travel all days. These weighted databases were finally combined with the national CLRTAP emission data according to the NFR subsectors. In a last step the NFR sectors were aggregated to the respective GNFR sectors. These calculations were done for all pollutants separately.

Register of buildings and dwellings

Geo-referenced information on dwellings and buildings (e.g. heating systems, age of buildings, etc.) are the proxy data for emissions from stationary fuel combustion in buildings and in agriculture, forestry, fishing and fishing industries (NFR categories 1.A.4.b.i and 1.A.4.c.i). Due to the information in the register of buildings and dwellings an index was created to distribute the

emissions of the Austrian Air Emission Inventory on federal level (BLI) combined with the usage of heating systems and type of buildings. These indices distinguish between all pollutants.

Rural- urban typology

Rural- urban typology is a statistical data base which defines the main regional centres and the urban areas through population density, infrastructures, commuter traffic and reachability. This proxy was taken to calculate the transport emissions from GNFR sector *I_Offroad*.

Animal livestock numbers

For the GNFR sector *K_AgriLivestock* the animal livestock numbers taken from the INVEKOS data base, available as 1 km raster, were used as proxy. The respective animal categories are consistent with those included in the Austrian Air Emission Inventory on NFR level. Another approach could have been the amount of employees within the farming business. However, the animal livestock numbers represent the reported emissions of manure management better than the employees as they are not relevant for emissions. So, the usage of livestock data is fully in line with the calculation of agricultural emissions from NFR sector Manure Management.

Large Point Sources

The large point emission sources were directly allocated to their grid cells considering two classes of emission levels (emission high above and below 100 t/a). LPS data for 2015 are reported by Austrian plants according to Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control) (Large Combustion Plants – LCP) as well as under Regulation (EC) No 166/2006 on the establishment of a European Pollutant Release and Transfer Register. The required information on emission values, coordinates, stack heights etc. was matched for each relevant NFR sector and aggregated to the respective GNFR sectors to be in line with the CLRTAP reporting obligation (see reporting template Annex VI). For further information please refer to Chapter 9.2.

Waste treatment

Two different data bases have been taken as proxy for GNFR sector *J_Waste*. On the one hand the respective large point sources with activities in the waste sector have been used as proxy data for waste treatment. On the other hand the population in permanent settlement areas was applied for disaggregating the emissions from waste.

9.1.3.2 Austria's allocation of emissions for the EMEP Grid

Method of allocation

Emissions from point sources were directly allocated to the coordinates of the individual emitters. Line based emissions and emissions from area sources were disaggregated from the national total emissions to the described proxy data (see Table 283). In some cases, the set of proxy data could be used as one pure proxy. However, in several cases (e.g. traffic network) a combination and weighted proxy, respectively, was necessary.

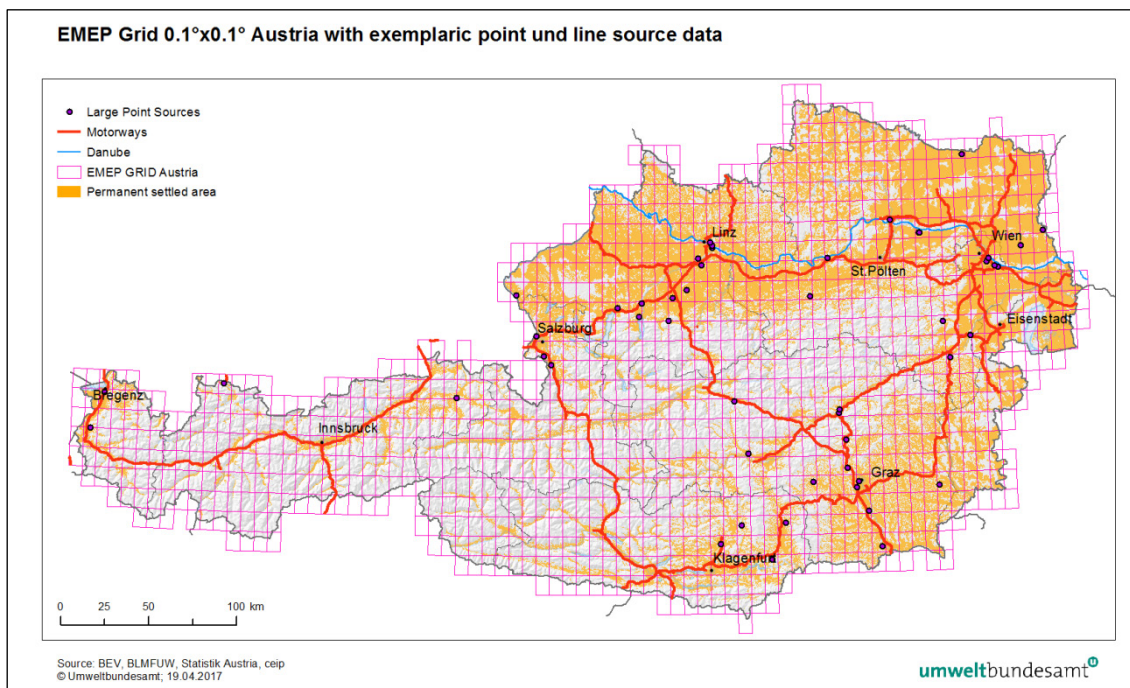


Figure 47: EMEP Grid Austria – example for allocation of the motorway network and waterways (Danube).

A short and simple example of the allocation of the motorway network and waterways (Danube) is illustrated in Figure 47 to point out the method. The length of the segments within the grid cell is multiplied with the national emission divided by the total emissions.

9.1.4 Results of gridded data

In this chapter the EMEP grid results for the main pollutants NO_x , SO_2 , NMVOC and NH_3 as well as for $\text{PM}_{2.5}$ based on fuel sold are presented. In the case of NO_x there is a significant difference between results for fuel sold and fuel used, therefore maps have been generated for both.

Emissions of grid cells exceeding the national border have been adjusted proportionally. This methodology is only applied for the purpose of illustrating the results in the following maps.

9.1.4.1 Spatial distribution of NO_x emissions in 2015

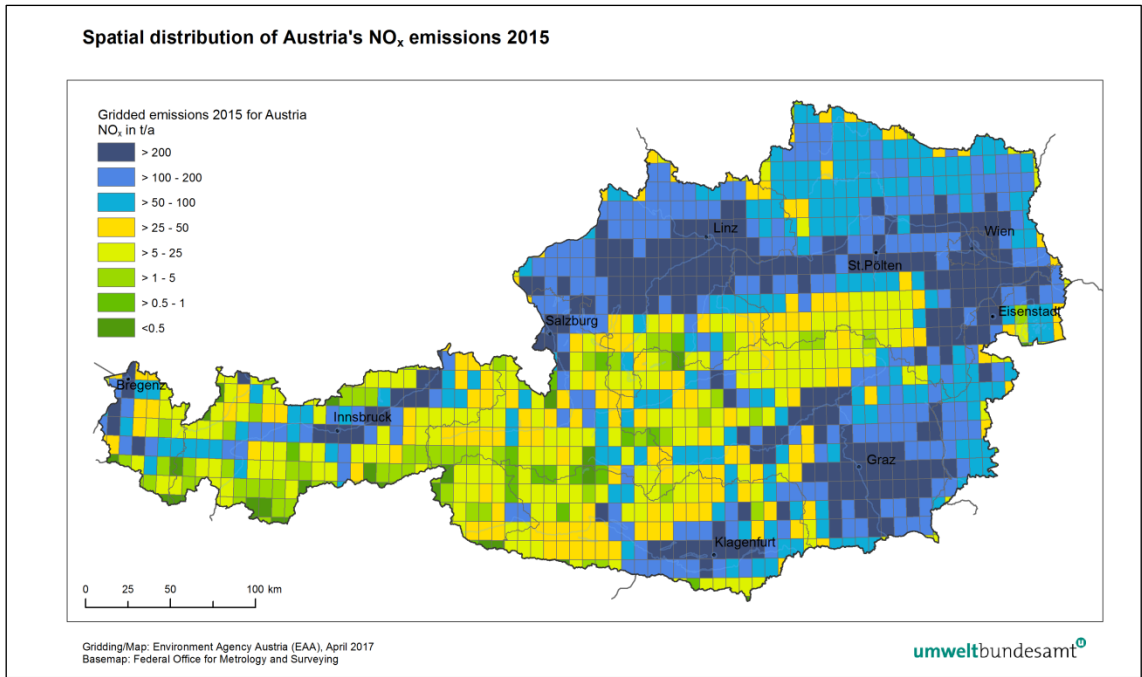


Figure 48: Spatial distribution of Austria's NO_x emissions 2015 based on fuel sold.

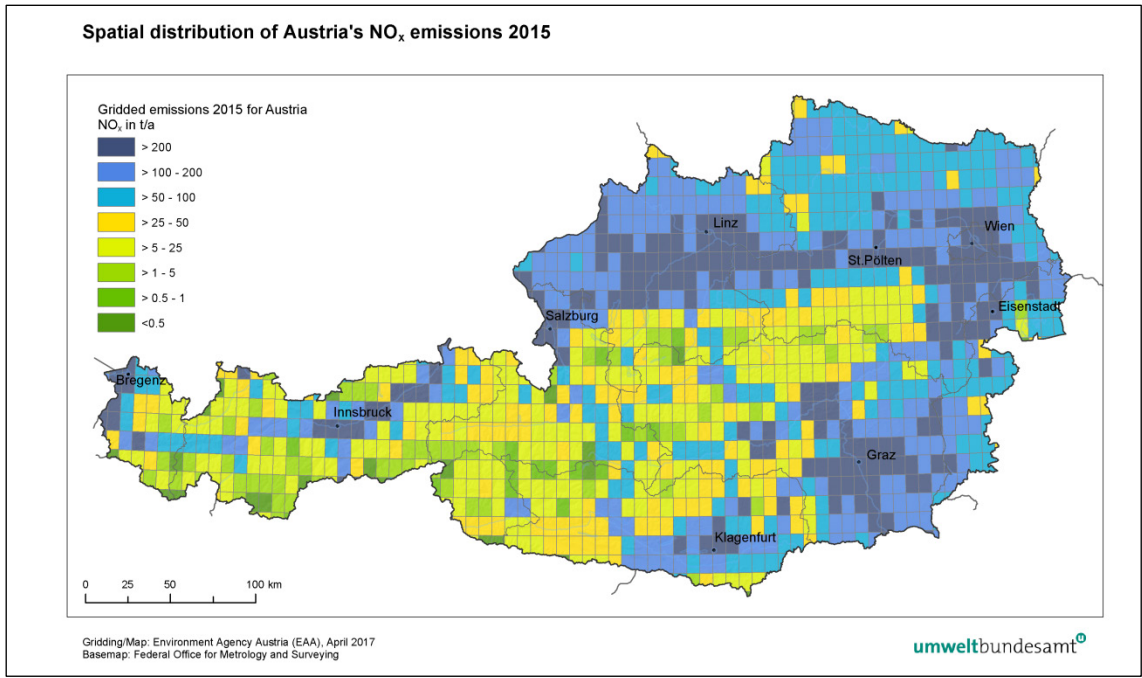


Figure 49: Spatial distribution of Austria's NO_x emissions 2015 based on fuel used.

9.1.4.2 Spatial distribution of SO₂ emissions in 2015

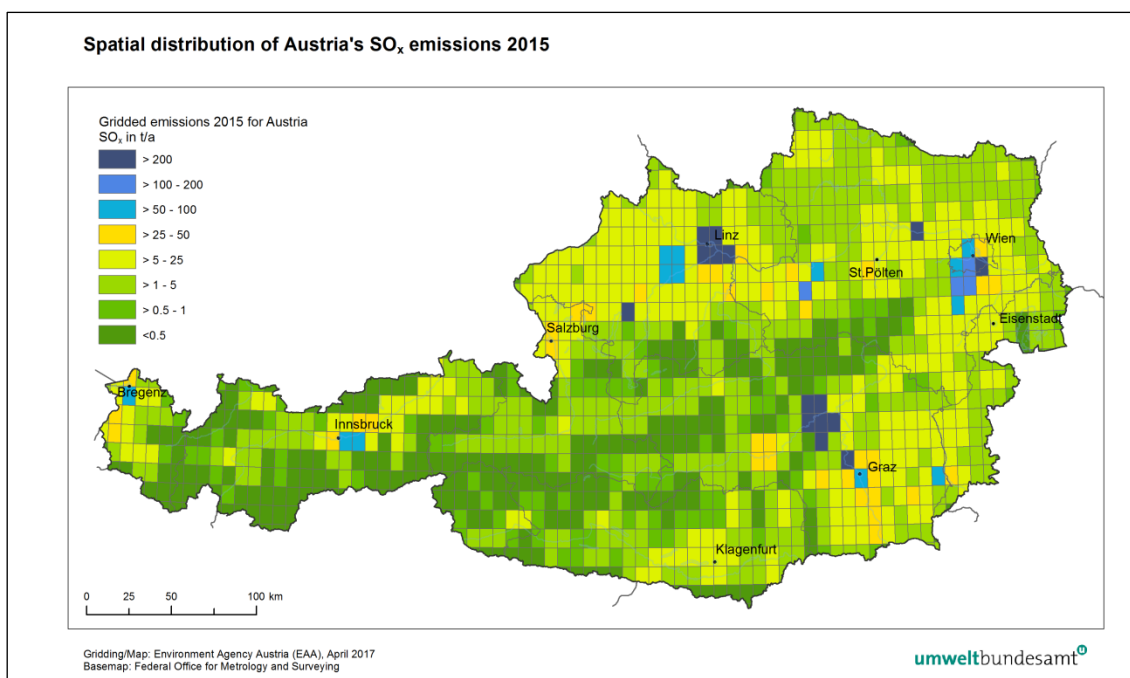


Figure 50: Spatial distribution of Austria's SO₂ emissions 2015 based on fuel sold.

9.1.4.3 Spatial distribution of NMVOC emissions in 2015

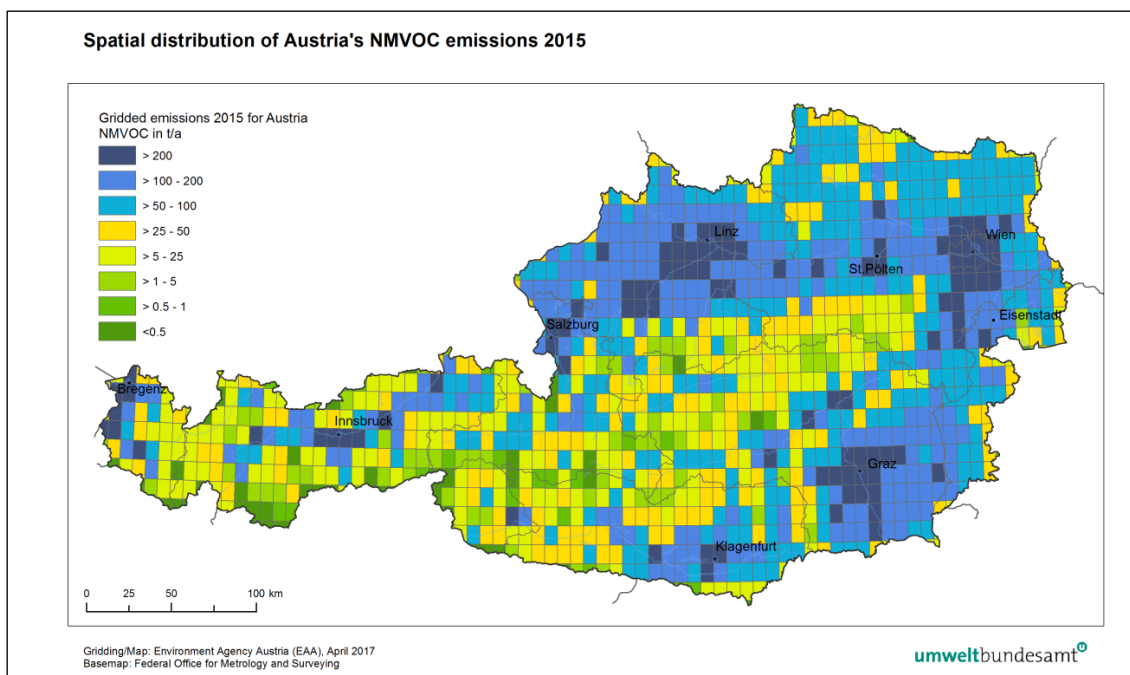


Figure 51: Spatial distribution of Austria's NMVOC emissions 2015 based on fuel sold.

9.1.4.4 Spatial distribution of NH₃ emissions in 2015

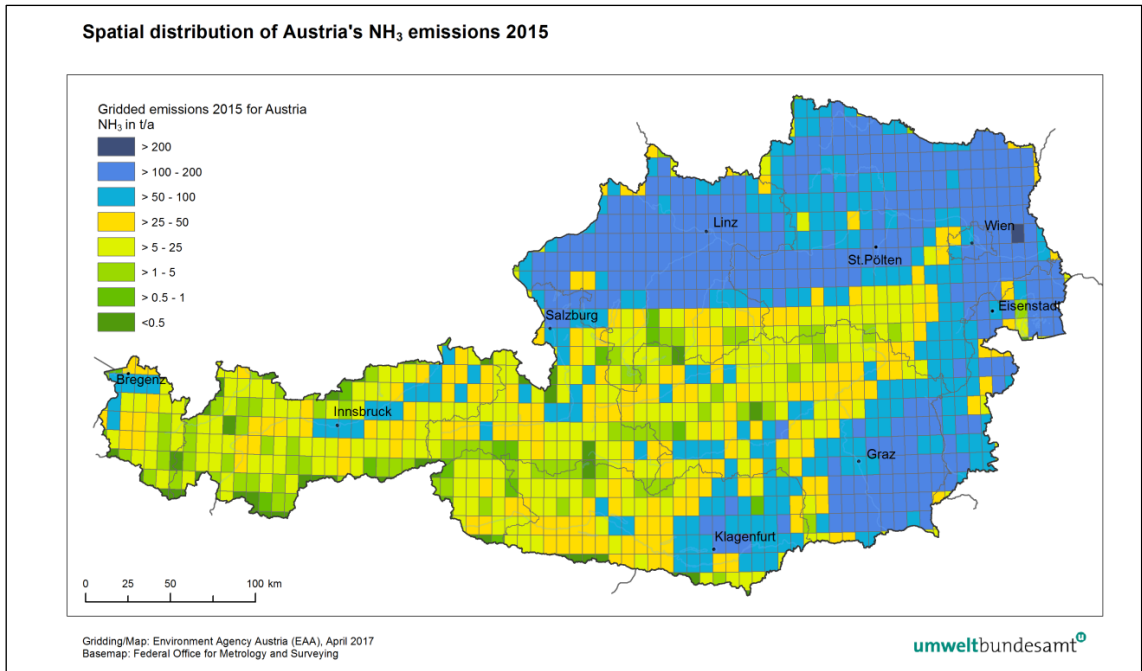


Figure 52: Spatial distribution of Austria's NH₃ emissions 2015 based on fuel sold.

9.1.4.5 Spatial distribution of PM_{2.5} emissions in 2015

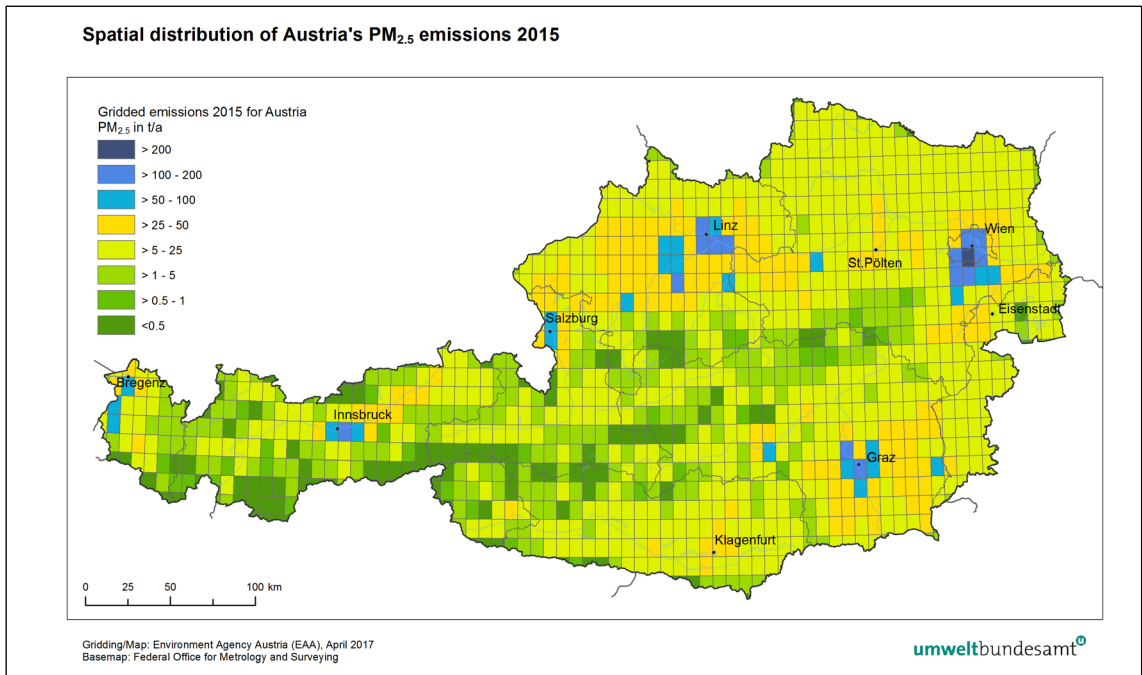


Figure 53: Spatial distribution of Austria's PM_{2.5} emissions 2015 based on fuel sold.

9.2 Large Point Sources (LPS)

“Large point sources” (LPS) are defined as facilities whose combined emissions, within the limited identifiable area of the site premises, exceed the pollutant emission thresholds identified in Table 1 of the revised 2014 CLRTAP Reporting Guidelines. These thresholds have been extracted from the full list of pollutants in Regulation (EC) No. 166/2006 concerning the establishment of a European Pollutant Release and Transfer Register.

Austria reported 55 LPS for the year 2015. The data is distributed to the following GNFR sectors:

- 11 LPS in GNFR sector A_PublicPower
- 35 LPS in GNFR sector B_Industry
- 1 LPS in GNFR sector D_Fugitive
- 5 LPS in GNFR sector E_Solvents
- 3 LPS in GNFR sector I_Offroad

9.2.1 Activity Data

Emission values taken for LPS of 2015 are reported by Austrian plants according to Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control) (Large Combustion Plants – LCP) as well as under Regulation (EC) No 166/2006 on the establishment of a European Pollutant Release and Transfer Register. The data for 2015 was taken from Austria's official submissions on 31st of March 2017.

Emissions from LCPs are available on installation level; E-PRTR data is reported on facility level (one or more installations on the same site operated by the same natural or legal person). So, it was necessary to sum up the respective LCP installations for comparison with the related E-PRTR facility. In case of differences between LCP emissions and E-PRTR emissions the upper emission value was taken. In the following table an overview of the required information and the respective data source is presented.

Table 283: Overview of data sources for LPS (required in ANNEX VI).

Activity data	Data source
LPS	Facility name according to E-PRTR reporting
GNFR	Expert judgement
PRTR Facility ID	PRTR ID according to E-PRTR reporting
Height Class (1-5)	Height Class according to LCP reporting*
Longitude/latitude	Longitude/latitude according to E-PRTR reporting

**If there were more than one height classes available, the upper value was taken.*

9.2.2 Methodological Issues

The applied methodology is in accordance with the revised 2014 CLRTAP Reporting Guidelines. The Austrian LPS data is prepared in line with the list of pollutants to be reported if the applicable threshold value is exceeded as demonstrated in Table 1 of the CLRTAP Reporting Guidelines. Finally, the activity data (E-PRTR data and LCP data) was matched for each relevant NFR sector and aggregated as required in ANNEX VI (Template for LPS data for each relevant aggregated Gridding NFR sectors (GNFR)).

PM emissions

Under Directive 2010/75/EU on industrial emissions (IED) PM_{2.5} and PM₁₀ emissions are not reported separately, but as total dust emissions. TSP (total suspended particles) was assumed to represent the total dust emissions. PM_{2.5} and PM₁₀ emissions were calculated as fractions of TSP in line with the Austrian Air Emission Inventory.

PM_{2.5} emissions are also not reported under the E-PRTR Regulation. However, PM₁₀ emissions are submitted under E-PRTR, and so PM_{2.5} could be calculated based on the sectoral composition of TSP and PM₁₀ as described before.

9.3 Recalculations

No recalculations for gridded data and LPS have been carried out since last submission in 2012. In 2017 data for 2015 only was reported.

9.4 Planned Improvements

Currently, no improvements are planned.

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11 ABBREVIATIONS

AMA	Agrarmarkt Austria
ASFINAG	Autobahnen- und Schnellstraßen-Finanzierungs-Aktiengesellschaft
AWMS	Animal Waste Management System
BAWP	Bundes-Abfallwirtschaftsplan (Federal Waste Management Plan)
BLI	Austrian Air Emission Inventory on federal level ("Bundesländer Luftschadstoff-inventur")
BMLFUW	Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft (Federal Ministry for Agriculture, Forestry, Environment and Water Management)
BMUJF	Bundesministerium für Umwelt, Jugend und Familie (Federal Ministry for Environment, Youth and Family (before 2000, now domain of Environment: BMLFUW))
BUWAL	Bundesamt für Umwelt, Wald und Landschaft. Bern (The Swiss Agency for the Environment, Forests and Landscape (SAEFL), Bern)
CAN	Calcium Ammonium Nitrate (Fertilizer)
CORINAIR	Core Inventory Air
CORINE	Coordination d'information Environmentale
CRF	Common Reporting Format
DKDB	Dampfkesseldatenbank (Austrian annual steam boiler inventory)
EC	European Community
EDM	Electronic Data Management
EEA	European Environment Agency
EIONET	European Environment Information and Observation NETwork
EMEP	Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe
ETS	Emission Trading System
EPER	European Pollutant Emission Register
E-PRTR	European Pollutant Release and Transfer Register
GDP	Gross Domestic Product
GLOBEMI	Globale Modellbildung für Emissions- und Verbrauchsszenarien im Verkehrssektor ((Global Modelling for Emission- and Fuel consumption Scenarios of the Transport Sector) see (Hausberger 1998))
GPG	Good Practice Guidance (of the IPCC)
HBEFA	"Handbook of Emission Factors"
HM	Heavy Metals
IEA	International Energy Agency
IEF	Implied emission factor
IFR	Instrument Flight Rules
IIR	Informative Inventory Report
IPCC	Intergovernmental Panel on Climate Change

LTO	Landing/Take-Off cycle
MCF	Methane Conversion Factor
MEET	MEET – Methodology for calculating transport emissions and energy consumption
NACE	Nomenclature des activites economiques de la Communaute Europeenne
NAPFUE	Nomenclature for Air Pollution Fuels
NEC	National Emissions Ceiling (Directive 2001/81/EC of The European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants – NEC Directive)
NEMO	Network Emission Model
NFR	Nomenclature for Reporting (Format of Reporting under the UNECE/LRTAP Convention)
NIR.....	National Inventory Report (Submission under the United Nations Framework Convention on Climate Change)
NISA	National Inventory System Austria
NPK.....	Nitrogen (N) Phosphorus (P) and Potassium (K) (Fertilizer)
OECD	Organisation for Economic Co-operation and Development
ODS	Ozone depleting substances
OLI	Österreichische Luftschadstoff InventurAustrian Air Emission Inventory
PHARE	Phare is the acronym of the Programme's original name: 'Poland and Hungary: Action for the Restructuring of the Economy'. It covers now 14 partner countries: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, the Czech Republic, Estonia, the Former Yugoslav Republic of Macedonia (FYROM), Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia, (However, Croatia was suspended from the Phare Programme in July 1995.)
PM	Particulate Matter
POP	Persistent Organic Pollutants
PRTR	Pollutant Release and Transfer Register
QA/QC	Quality Assurance/Quality Control
QMS.....	Quality Management System
RWA	Raiffeisen Ware Austria (see www.rwa.at)
SNAP	Selected Nomenclature on Air Pollutants
SOP	Standard Operation Procedure
TAN.....	Total ammoniacal nitrogen
Umweltbundesamt..	Umweltbundesamt (Environment Agency Austria)
UNECE/LRTAP	United Nations Economic Commission for Europe.Convention on Long-range Trans-boundary Air Pollution
UNFCCC.....	United Nations Framework Convention on Climate Change
VFR.....	Visual Flight Rules
VRF.....	Variable Refrigerant Flow
VMOe.....	Verkehrs-Mengenmodell-Oesterreich
WIFO	Wirtschaftsforschungsinstitut (Austrian Institute for Economic Research)

Chemical Symbols

Symbol.....Name

Greenhouse gases

CH₄Methane
 CO₂Carbon Dioxide
 N₂ONitrous Oxide
 HFCsHydrofluorocarbons
 PFCsPerfluorocarbons
 SF₆Sulphur hexafluoride
 NF₃Nitrogen Trifluoride

Further chemical compounds

COCarbon Monoxide
 CdCadmium
 NH₃Ammonia
 HgMercury
 NO_xNitrogen Oxides (NO plus NO₂)
 NO₂Nitrogen Dioxide
 NMVOCNon-Methane Volatile Organic Compounds
 PAHPolycyclic Aromatic Hydrocarbons
 PbLead
 POPPersistent Organic Pollutants
 SO₂Sulfur Dioxide
 SO_xSulfur Oxides

Units and Metric Symbols

UNIT	Name	Unit for
g	gram	mass
t	ton	mass
W	watt	power
J	joule	calorific value
m	meter	length

Mass Unit Conversion

1g		
1kg	= 1 000 g	
1t	= 1 000 kg	= 1 Mg
1kt	= 1 000 t	= 1 Gg
1Mt	= 1 Mio t	= 1 Tg

Metric Symbol	Prefix	Factor
P	peta	10 ¹⁵
T	tera	10 ¹²
G	giga	10 ⁹
M	mega	10 ⁶
k	kilo	10 ³
h	hecto	10 ²
da	deca	10 ¹
d	deci	10 ⁻¹
c	centi	10 ⁻²
m	milli	10 ⁻³
μ	micro	10 ⁻⁶
n	nano	10 ⁻⁹

12 Appendix

12.1 Emission Trends per Sector – Submission under UNECE/LRTAP

Table A-1: Emission trends for SO₂ [kt] 1990–2015 – Submission under UNECE/LRTAP.

SO ₂	NFR Sectors								
	1	1.A	1.B	2	3	5	6		
	ENERGY	FUEL COMBUSTION ACTIVITIES	FUGITIVE EMISSIONS FROM FUELS	INDUSTRIAL PROCESSES and PRODUCT USE	AGRICULTURE	WASTE	OTHER EMISSION SOURCES	NATIONAL TOTAL	International Bunkers
1990	72.27	70.27	2.00	2.22	0.00	0.07	NO	74.57	0.26
1991	69.62	68.32	1.30	1.90	0.00	0.06	NO	71.59	0.29
1992	53.49	51.49	2.00	1.67	0.00	0.04	NO	55.20	0.31
1993	52.12	50.02	2.10	1.42	0.00	0.04	NO	53.58	0.33
1994	46.46	45.18	1.28	1.42	0.00	0.05	NO	47.93	0.34
1995	46.11	44.58	1.53	1.37	0.00	0.05	NO	47.53	0.38
1996	43.46	42.26	1.20	1.29	0.00	0.05	NO	44.81	0.43
1997	38.80	38.74	0.07	1.27	0.00	0.05	NO	40.13	0.44
1998	34.26	34.21	0.04	1.18	0.00	0.05	NO	35.49	0.46
1999	32.41	32.37	0.04	1.12	0.00	0.06	NO	33.59	0.45
2000	30.41	30.37	0.04	1.09	0.00	0.06	NO	31.56	0.48
2001	31.35	31.30	0.05	1.02	0.00	0.06	NO	32.43	0.47
2002	30.54	30.50	0.04	1.02	0.00	0.06	NO	31.62	0.43
2003	30.59	30.54	0.05	1.02	0.00	0.06	NO	31.67	0.40
2004	25.99	25.95	0.04	1.02	0.01	0.06	NO	27.08	0.47
2005	24.86	24.82	0.04	1.02	0.00	0.06	NO	25.95	0.55
2006	25.55	25.50	0.05	1.03	0.00	0.05	NO	26.63	0.58
2007	22.09	22.04	0.05	1.03	0.00	0.04	NO	23.17	0.61
2008	19.52	19.48	0.04	1.03	0.00	0.03	NO	20.58	0.61
2009	14.13	14.07	0.06	0.97	0.00	0.02	NO	15.12	0.53
2010	15.74	15.69	0.05	0.95	0.00	0.01	NO	16.70	0.57
2011	14.63	14.59	0.05	0.92	0.00	0.01	NO	15.57	0.60
2012	14.16	14.11	0.05	0.89	0.00	0.01	NO	15.06	0.57
2013	14.06	14.02	0.04	0.87	0.00	0.01	NO	14.94	0.54
2014	13.92	13.89	0.04	0.84	0.00	0.01	NO	14.78	0.54
2015	14.08	14.04	0.04	0.81	0.00	0.01	NO	14.90	0.58

Table A-2: Emission trends for NO_x [kt] 1990–2015 – Submission under UNECE/LRTAP.

NO _x	NFR Sectors								
	1	1.A	1.B	2	3	5	6		
	ENERGY	FUEL COMBUSTION ACTIVITIES	FUGITIVE EMISSIONS FROM FUELS	INDUSTRIAL PROCESSES and PRODUCT USE	AGRICULTURE	WASTE	OTHER EMISSION SOURCES	NATIONAL TOTAL	International Bunkers
1990	204.10	204.10	IE	4.80	11.89	0.10	NO	220.89	2.44
1991	212.00	212.00	IE	4.48	12.77	0.09	NO	229.34	2.76
1992	199.69	199.69	IE	4.55	11.62	0.06	NO	215.92	3.00
1993	193.59	193.59	IE	1.98	10.58	0.05	NO	206.19	3.18
1994	186.19	186.19	IE	1.92	12.33	0.04	NO	200.49	3.31
1995	185.96	185.96	IE	1.46	12.54	0.05	NO	200.00	3.73
1996	204.56	204.56	IE	1.42	11.40	0.05	NO	217.43	4.14
1997	192.88	192.88	IE	1.50	11.46	0.05	NO	205.89	4.29
1998	205.08	205.08	IE	1.46	11.52	0.05	NO	218.11	4.43
1999	196.98	196.98	IE	1.44	11.16	0.05	NO	209.64	4.33
2000	202.53	202.53	IE	1.54	10.97	0.05	NO	215.09	6.44
2001	212.38	212.38	IE	1.57	10.93	0.05	NO	224.93	6.32
2002	218.13	218.13	IE	1.63	10.95	0.05	NO	230.76	5.67
2003	227.15	227.15	IE	1.34	10.48	0.05	NO	239.01	5.21
2004	225.03	225.03	IE	1.28	9.93	0.05	NO	236.29	6.09
2005	226.26	226.26	IE	1.75	9.99	0.05	NO	238.06	6.99
2006	211.73	211.73	IE	1.82	10.05	0.04	NO	223.65	7.54
2007	201.09	201.09	IE	1.71	10.22	0.04	NO	213.05	7.99
2008	184.38	184.38	IE	1.91	10.82	0.03	NO	197.13	7.90
2009	168.61	168.61	IE	1.54	10.61	0.02	NO	180.78	6.86
2010	169.54	169.54	IE	1.81	9.71	0.01	NO	181.08	7.60
2011	159.30	159.30	IE	1.83	10.23	0.01	NO	171.37	7.98
2012	152.49	152.49	IE	1.63	10.34	0.01	NO	164.47	7.68
2013	152.61	152.61	IE	1.45	10.24	0.01	NO	164.31	7.46
2014	141.02	141.02	IE	1.50	10.53	0.01	NO	153.07	7.49
2015	136.48	136.48	IE	1.72	10.91	0.01	NO	149.12	8.18

Table A-3: Emission trends for NMVOC [kt] 1990–2015 – Submission under UNECE/LRTAP.

NMVOC	NFR Sectors								
	1	1.A	1.B	2	3	5	6		
	ENERGY	FUEL COMBUSTION ACTIVITIES	FUGITIVE EMISSIONS FROM FUELS	INDUSTRIAL PROCESSES and PRODUCT USE	AGRICULTURE	WASTE	OTHER EMISSION SOURCES	NATIONAL TOTAL	International Bunkers
1990	153.67	138.18	15.49	125.53	1.27	0.16	NO	280.63	0.18
1991	154.79	139.67	15.12	120.38	1.28	0.16	NO	276.60	0.20
1992	138.75	123.56	15.19	114.95	1.27	0.15	NO	255.13	0.22
1993	129.81	115.16	14.65	109.59	1.26	0.15	NO	240.82	0.24
1994	115.04	103.92	11.12	101.48	1.26	0.15	NO	217.92	0.25
1995	109.69	100.20	9.49	93.22	1.24	0.14	NO	204.29	0.29
1996	106.78	98.32	8.46	89.82	1.25	0.13	NO	197.98	0.34
1997	88.87	80.92	7.95	86.69	1.24	0.13	NO	176.94	0.37
1998	84.14	77.71	6.43	83.53	1.24	0.13	NO	169.03	0.40
1999	79.94	74.26	5.67	80.03	1.23	0.12	NO	161.32	0.39
2000	74.79	69.10	5.69	77.13	1.21	0.12	NO	153.24	0.42
2001	72.24	68.41	3.84	76.34	1.22	0.11	NO	149.91	0.41
2002	68.57	64.53	4.03	76.35	1.21	0.11	NO	146.24	0.37
2003	66.95	63.00	3.96	75.83	1.21	0.11	NO	144.11	0.34
2004	63.23	59.66	3.57	75.04	1.24	0.12	NO	139.62	0.40
2005	60.88	57.53	3.34	74.44	1.20	0.11	NO	136.62	0.47
2006	56.25	52.90	3.36	73.64	1.18	0.11	NO	131.18	0.50
2007	52.37	49.39	2.98	72.67	1.17	0.10	NO	126.30	0.53
2008	50.27	47.51	2.75	71.81	1.15	0.10	NO	123.32	0.52
2009	46.40	43.81	2.59	70.48	1.14	0.09	NO	118.11	0.45
2010	47.85	45.40	2.45	69.67	1.13	0.09	NO	118.73	0.49
2011	44.26	41.85	2.41	69.25	1.12	0.08	NO	114.70	0.51
2012	44.34	41.94	2.40	68.41	1.10	0.08	NO	113.93	0.49
2013	45.76	43.46	2.30	68.85	1.09	0.07	NO	115.78	0.46
2014	39.76	37.35	2.42	69.31	1.09	0.07	NO	110.24	0.46
2015	41.96	39.61	2.35	69.78	1.09	0.07	NO	112.89	0.50

Table A-4: Emission trends for NH₃ [kt] 1990–2015 – Submission under UNECE/LRTAP.

NH ₃	NFR Sectors								
	1	1.A	1.B	2	3	5	6		
	ENERGY	FUEL COMBUSTION ACTIVITIES	FUGITIVE EMISSIONS FROM FUELS	INDUSTRIAL PROCESSES and PRODUCT USE	AGRICULTURE	WASTE	OTHER EMISSION SOURCES	NATIONAL TOTAL	International Bunkers
1990	2.291	2.291	IE	0.269	63.229	0.358	NO	66.147	0.002
1991	2.919	2.919	IE	0.507	63.826	0.370	NO	67.622	0.002
1992	3.186	3.186	IE	0.369	61.950	0.421	NO	65.925	0.002
1993	3.500	3.500	IE	0.219	62.536	0.498	NO	66.753	0.002
1994	3.647	3.647	IE	0.168	63.763	0.572	NO	68.150	0.002
1995	3.814	3.814	IE	0.099	64.956	0.584	NO	69.453	0.003
1996	3.931	3.931	IE	0.097	63.420	0.605	NO	68.053	0.003
1997	3.937	3.937	IE	0.103	63.819	0.586	NO	68.445	0.003
1998	4.237	4.237	IE	0.103	64.030	0.603	NO	68.973	0.003
1999	4.200	4.200	IE	0.119	62.549	0.638	NO	67.505	0.003
2000	4.107	4.107	IE	0.100	61.226	0.669	NO	66.102	0.003
2001	4.220	4.220	IE	0.079	61.254	0.747	NO	66.302	0.003
2002	4.301	4.301	IE	0.061	60.498	0.824	NO	65.683	0.003
2003	4.326	4.326	IE	0.076	60.298	0.890	NO	65.591	0.003
2004	4.127	4.127	IE	0.059	59.904	1.123	NO	65.213	0.003
2005	3.996	3.996	IE	0.068	60.024	1.209	NO	65.296	0.004
2006	3.801	3.801	IE	0.074	60.436	1.223	NO	65.533	0.004
2007	3.661	3.661	IE	0.077	61.828	1.243	NO	66.809	0.004
2008	3.399	3.399	IE	0.081	61.691	1.220	NO	66.391	0.004
2009	3.187	3.187	IE	0.088	62.978	1.204	NO	67.457	0.004
2010	3.237	3.237	IE	0.091	62.254	1.216	NO	66.797	0.004
2011	3.035	3.035	IE	0.101	61.862	1.227	NO	66.224	0.004
2012	2.952	2.952	IE	0.094	62.031	1.231	NO	66.309	0.004
2013	2.901	2.901	IE	0.096	62.023	1.164	NO	66.184	0.004
2014	2.689	2.689	IE	0.089	62.613	1.204	NO	66.595	0.004
2015	2.786	2.786	IE	0.082	62.783	1.217	NO	66.867	0.004

Table A-5: Emission trends for CO [kt] 1990–2015 – Submission under UNECE/LRTAP.

CO	NFR Sectors								
	1	1.A	1.B	2	3	5	6		
	ENERGY	FUEL COMBUSTION ACTIVITIES	FUGITIVE EMISSIONS FROM FUELS	INDUSTRIAL PROCESSES and PRODUCT USE	AGRICULTURE	WASTE	OTHER EMISSION SOURCES	NATIONAL TOTAL	International Bunkers
1990	1 229.31	1229.31	IE	46.37	1.20	10.31	NO	1 287.20	0.49
1991	1 233.30	1233.30	IE	41.67	1.17	10.51	NO	1 286.65	0.55
1992	1 160.35	1160.35	IE	44.97	1.19	10.36	NO	1 216.87	0.59
1993	1 092.56	1092.56	IE	47.15	1.07	10.26	NO	1 151.04	0.63
1994	1 025.89	1025.89	IE	48.65	1.16	9.95	NO	1 085.65	0.66
1995	932.31	932.31	IE	45.08	1.15	9.46	NO	987.99	0.75
1996	944.17	944.17	IE	39.44	1.10	8.92	NO	993.63	0.84
1997	876.18	876.18	IE	38.30	1.16	8.52	NO	924.17	0.89
1998	841.81	841.81	IE	34.86	1.14	8.19	NO	886.00	0.93
1999	744.55	744.55	IE	30.58	1.17	7.85	NO	784.15	0.89
2000	750.01	750.01	IE	27.38	1.03	7.52	NO	785.94	0.80
2001	730.98	730.98	IE	24.20	1.15	7.21	NO	763.54	0.78
2002	698.90	698.90	IE	23.87	1.08	7.19	NO	731.04	0.66
2003	703.69	703.69	IE	23.59	1.03	7.18	NO	735.48	0.65
2004	683.92	683.92	IE	23.86	1.61	7.30	NO	716.68	0.73
2005	655.90	655.90	IE	24.23	0.96	6.88	NO	687.97	0.91
2006	634.87	634.87	IE	24.51	0.89	6.53	NO	666.80	0.92
2007	596.58	596.58	IE	24.70	0.91	6.16	NO	628.35	0.96
2008	573.02	573.02	IE	24.74	0.88	5.85	NO	604.49	0.96
2009	540.15	540.15	IE	23.62	0.82	5.44	NO	570.02	0.82
2010	552.96	552.96	IE	24.09	0.78	5.09	NO	582.91	0.87
2011	535.34	535.34	IE	24.18	0.57	4.76	NO	564.85	0.86
2012	536.41	536.41	IE	23.86	0.41	4.47	NO	565.14	0.83
2013	557.25	557.25	IE	23.95	0.37	4.17	NO	585.74	0.74
2014	510.14	510.14	IE	23.88	0.42	3.90	NO	538.34	0.74
2015	539.12	539.12	IE	24.00	0.36	3.65	NO	567.13	0.78

Table A-6: Emission trends for Cd [kg] 1990–2015 – Submission under UNECE/LRTAP.

Cd	NFR Sectors								
	1	1.A	1.B	2	3	5	6		
	ENERGY	FUEL COMBUSTION ACTIVITIES	FUGITIVE EMISSIONS FROM FUELS	INDUSTRIAL PROCESSES and PRODUCT USE	AGRICULTURE	WASTE	OTHER EMISSION SOURCES	NATIONAL TOTAL	International Bunkers
1990	992.0	992.0	NA	527.3	8.7	59.0	NO	1 587.1	0.2
1991	1 040.0	1040.0	NA	439.2	8.5	48.3	NO	1 536.0	0.3
1992	945.6	945.6	NA	296.9	8.6	5.2	NO	1 256.3	0.3
1993	920.0	920.0	NA	237.2	7.7	4.5	NO	1 169.4	0.3
1994	863.2	863.2	NA	199.5	8.6	3.9	NO	1 075.2	0.3
1995	792.4	792.4	NA	177.3	8.9	1.9	NO	980.5	0.3
1996	832.5	832.5	NA	160.2	8.1	1.8	NO	1002.6	0.4
1997	788.5	788.5	NA	174.0	8.7	1.8	NO	973.0	0.4
1998	723.0	723.0	NA	169.4	8.6	1.7	NO	902.7	0.4
1999	765.9	765.9	NA	174.5	9.0	1.7	NO	951.1	0.4
2000	728.3	728.3	NA	187.4	8.2	1.7	NO	925.7	0.4
2001	759.4	759.4	NA	184.1	9.3	1.6	NO	954.4	0.4
2002	771.3	771.3	NA	194.1	8.9	1.6	NO	975.9	0.4
2003	830.1	830.1	NA	194.8	8.1	1.6	NO	1 034.7	0.3
2004	824.8	824.8	NA	202.8	13.9	1.6	NO	1 043.2	0.4
2005	872.9	872.9	NA	223.2	7.8	1.6	NO	1 105.4	0.5
2006	887.1	887.1	NA	228.0	6.9	1.4	NO	1 123.4	0.5
2007	915.7	915.7	NA	241.1	7.5	1.2	NO	1 165.5	0.5
2008	938.0	938.0	NA	239.9	7.2	1.1	NO	1 186.2	0.5
2009	896.0	896.0	NA	177.9	6.7	0.9	NO	1 081.5	0.5
2010	967.7	967.7	NA	228.4	6.4	0.8	NO	1 203.4	0.5
2011	940.6	940.6	NA	235.7	4.4	0.7	NO	1 181.4	0.5
2012	953.3	953.3	NA	232.7	2.9	0.7	NO	1 189.5	0.5
2013	992.3	992.3	NA	249.1	2.5	0.7	NO	1 244.6	0.5
2014	914.5	914.5	NA	244.7	3.1	0.6	NO	1 162.9	0.5
2015	945.6	945.6	NA	237.3	2.4	0.6	NO	1 185.8	0.5

Table A-7: Emission trends for Hg [kg] 1990–2015 – Submission under UNECE/LRTAP.

Hg	NFR Sectors								
	1	1.A	1.B	2	3	5	6		
	ENERGY	FUEL COMBUSTION ACTIVITIES	FUGITIVE EMISSIONS FROM FUELS	INDUSTRIAL PROCESSES and PRODUCT USE	AGRICULTURE	WASTE	OTHER EMISSION SOURCES	NATIONAL TOTAL	International Bunkers
1990	1 561.8	1561.8	NA	527.6	1.6	53.6	NO	2 144.6	0.1
1991	1 501.7	1501.7	NA	492.2	1.6	45.5	NO	2 040.9	0.1
1992	1 182.9	1182.9	NA	435.4	1.6	23.9	NO	1 643.8	0.1
1993	958.4	958.4	NA	412.0	1.4	22.8	NO	1 394.6	0.1
1994	760.7	760.7	NA	398.1	1.6	21.4	NO	1 181.8	0.1
1995	714.5	714.5	NA	466.2	1.6	20.3	NO	1 202.6	0.1
1996	710.8	710.8	NA	430.8	1.5	18.3	NO	1 161.3	0.1
1997	682.4	682.4	NA	433.6	1.6	16.1	NO	1 133.7	0.1
1998	600.4	600.4	NA	333.5	1.6	14.0	NO	949.4	0.1
1999	646.0	646.0	NA	275.9	1.6	12.1	NO	935.5	0.1
2000	639.6	639.6	NA	241.4	1.5	10.0	NO	892.5	0.1
2001	702.3	702.3	NA	244.9	1.7	9.8	NO	958.6	0.1
2002	651.8	651.8	NA	260.9	1.6	9.9	NO	924.2	0.1
2003	690.3	690.3	NA	261.4	1.5	14.6	NO	967.8	0.1
2004	644.6	644.6	NA	271.7	2.5	19.3	NO	938.1	0.1
2005	651.2	651.2	NA	304.8	1.4	20.6	NO	978.0	0.2
2006	665.0	665.0	NA	310.7	1.2	20.5	NO	997.4	0.2
2007	648.4	648.4	NA	328.8	1.3	20.3	NO	998.8	0.2
2008	665.7	665.7	NA	326.5	1.3	20.2	NO	1013.6	0.2
2009	627.1	627.1	NA	244.4	1.2	20.1	NO	892.8	0.2
2010	654.3	654.3	NA	315.1	1.1	19.9	NO	990.4	0.2
2011	634.1	634.1	NA	325.0	0.8	19.9	NO	979.8	0.2
2012	643.1	643.1	NA	321.1	0.5	19.9	NO	984.7	0.2
2013	685.7	685.7	NA	343.1	0.4	19.9	NO	1049.2	0.2
2014	634.8	634.8	NA	336.0	0.5	19.9	NO	991.3	0.2
2015	630.3	630.3	NA	323.8	0.4	19.9	NO	974.4	0.2

Table A-8: Emission trends for Pb [kg] 1990–2015 – Submission under UNECE/LRTAP.

Pb	NFR Sectors								
	1	1.A	1.B	2	3	5	6		
	ENERGY	FUEL COMBUSTION ACTIVITIES	FUGITIVE EMISSIONS FROM FUELS	INDUSTRIAL PROCESSES and PRODUCT USE	AGRICULTURE	WASTE	OTHER EMISSION SOURCES	NATIONAL TOTAL	International Bunkers
1990	178 392.6	178 392.6	NA	35 651.4	7.4	1015.7	NO	215 067.1	0.2
1991	145 147.3	145 147.3	NA	30 390.2	7.4	777.5	NO	176 322.3	0.3
1992	99 889.1	99 889.1	NA	21 155.1	7.3	488.2	NO	121 539.8	0.3
1993	66 911.7	66 911.7	NA	17 537.8	7.2	381.0	NO	84 837.7	0.3
1994	43 715.6	43 715.6	NA	14 817.2	7.2	265.7	NO	58 805.7	0.3
1995	8 719.3	8 719.3	NA	7 336.3	7.2	9.2	NO	16 071.9	0.3
1996	8 581.2	8 581.2	NA	6 919.6	6.9	9.1	NO	15 516.7	0.4
1997	7 486.0	7 486.0	NA	6 953.3	6.8	9.0	NO	14 455.2	0.4
1998	6 614.3	6 614.3	NA	6 340.7	6.7	9.0	NO	12 970.7	0.4
1999	6 372.2	6 372.2	NA	6 018.7	6.7	9.0	NO	12 406.6	0.4
2000	5 801.0	5 801.0	NA	6 066.7	6.5	8.9	NO	11 883.2	0.4
2001	6 038.3	6 038.3	NA	5 936.7	6.5	8.9	NO	11 990.4	0.4
2002	5 919.1	5 919.1	NA	6 236.0	6.4	8.9	NO	12 170.4	0.4
2003	6 223.2	6 223.2	NA	6 262.8	6.2	8.9	NO	12 501.1	0.3
2004	6 280.4	6 280.4	NA	6 528.8	7.0	8.9	NO	12 825.1	0.4
2005	6 066.1	6 066.1	NA	7 135.4	6.4	8.8	NO	13 216.8	0.5
2006	6 180.9	6 180.9	NA	7 340.4	6.3	7.3	NO	13 534.9	0.5
2007	6 533.6	6 533.6	NA	7 743.1	6.4	5.9	NO	14 289.1	0.5
2008	6 946.7	6 946.7	NA	7 677.9	6.1	4.6	NO	14 635.3	0.5
2009	6 967.7	6 967.7	NA	5 746.8	5.8	3.3	NO	12 723.7	0.5
2010	7 582.4	7 582.4	NA	7 314.6	5.8	2.0	NO	14 904.7	0.5
2011	7 269.4	7 269.4	NA	7 545.2	5.5	1.9	NO	14 822.0	0.5
2012	7 335.1	7 335.1	NA	7 429.6	5.4	1.9	NO	14 771.9	0.5
2013	7 554.8	7 554.8	NA	7 939.9	5.3	1.8	NO	15 501.8	0.5
2014	6 778.4	6 778.4	NA	7 812.8	5.4	1.8	NO	14 598.3	0.5
2015	7 134.8	7 134.8	NA	7 583.4	5.3	1.8	NO	14 725.2	0.5

Table A-9: Emission trends for PAH [kg] 1990–2015 – Submission under UNECE/LRTAP.

PAH	NFR Sectors								
	1	1.A	1.B	2	3	5	6		
	ENERGY	FUEL COMBUSTION ACTIVITIES	FUGITIVE EMISSIONS FROM FUELS	INDUSTRIAL PROCESSES and PRODUCT USE	AGRICULTURE	WASTE	OTHER EMISSION SOURCES	NATIONAL TOTAL	International Bunkers
1990	8 900.8	8 900.8	NA	7 134.1	249.8	0.2	NO	16 285.0	NE
1991	9 733.3	9 733.3	NA	6 932.2	249.3	0.2	NO	16 915.1	NE
1992	8 842.5	8 842.5	NA	3 083.5	248.9	0.0	NO	12 174.9	NE
1993	8 746.3	8 746.3	NA	515.2	248.5	0.0	NO	9 510.0	NE
1994	7 875.0	7 875.0	NA	401.2	247.6	0.0	NO	8 523.8	NE
1995	8 332.4	8 332.4	NA	287.9	246.7	0.0	NO	8 867.0	NE
1996	8 922.6	8 922.6	NA	250.1	244.9	0.0	NO	9 417.7	NE
1997	7 986.4	7 986.4	NA	221.8	243.2	0.0	NO	8 451.4	NE
1998	7 592.2	7 592.2	NA	195.3	242.4	0.0	NO	8 030.0	NE
1999	7 607.7	7 607.7	NA	197.4	241.7	0.0	NO	8 046.8	NE
2000	7 008.1	7 008.1	NA	179.1	240.7	0.0	NO	7 427.9	NE
2001	7 135.8	7 135.8	NA	181.1	239.7	0.0	NO	7 556.5	NE
2002	6 377.7	6 377.7	NA	190.3	238.6	0.0	NO	6 806.7	NE
2003	6 119.0	6 119.0	NA	190.7	237.6	0.0	NO	6 547.3	NE
2004	5 960.9	5 960.9	NA	196.9	305.6	0.0	NO	6 463.3	NE
2005	6 283.0	6 283.0	NA	216.1	207.6	0.0	NO	6 706.7	NE
2006	5 869.8	5 869.8	NA	219.7	196.9	0.0	NO	6 286.4	NE
2007	5 533.5	5 533.5	NA	230.4	205.2	0.0	NO	5 969.1	NE
2008	5 529.8	5 529.8	NA	229.1	178.9	0.0	NO	5 937.9	NE
2009	5 011.6	5 011.6	NA	181.0	178.6	0.0	NO	5 371.3	NE
2010	5 522.8	5 522.8	NA	222.1	170.9	0.0	NO	5 915.8	NE
2011	4 938.4	4 938.4	NA	228.1	118.2	0.0	NO	5 284.7	NE
2012	5 097.1	5 097.1	NA	225.7	98.7	0.0	NO	5 421.5	NE
2013	5 850.9	5 850.9	NA	238.3	84.4	0.0	NO	6 173.6	NE
2014	4 475.6	4 475.6	NA	234.3	90.9	0.0	NO	4 800.8	NE
2015	5 005.8	5 005.8	NA	227.1	80.5	0.0	NO	5 313.4	NE

Table A-10: Emission trends for Dioxin/Furan (PCDD/F) [g] 1990–2015 – Submission under UNECE/LRTAP.

DIOX	NFR Sectors								
	1	1.A	1.B	2	3	5	6		
	ENERGY	FUEL COMBUSTION ACTIVITIES	FUGITIVE EMISSIONS FROM FUELS	INDUSTRIAL PROCESSES and PRODUCT USE	AGRICULTURE	WASTE	OTHER EMISSION SOURCES	NATIONAL TOTAL	International Bunkers
1990	99.84	99.84	NA	42.53	0.18	18.19	NO	160.74	NE
1991	78.87	78.87	NA	38.66	0.18	17.75	NO	135.46	NE
1992	51.80	51.80	NA	24.36	0.18	0.53	NO	76.87	NE
1993	47.81	47.81	NA	18.88	0.18	0.22	NO	67.09	NE
1994	42.93	42.93	NA	13.13	0.18	0.08	NO	56.32	NE
1995	44.15	44.15	NA	14.09	0.18	0.08	NO	58.51	NE
1996	46.55	46.55	NA	13.03	0.18	0.08	NO	59.84	NE
1997	41.18	41.18	NA	17.92	0.18	0.08	NO	59.35	NE
1998	38.76	38.76	NA	17.22	0.18	0.08	NO	56.24	NE
1999	39.38	39.38	NA	14.00	0.18	0.08	NO	53.63	NE
2000	36.39	36.39	NA	15.45	0.18	0.08	NO	52.09	NE
2001	36.62	36.62	NA	14.95	0.18	0.08	NO	51.82	NE
2002	32.97	32.97	NA	4.62	0.18	0.08	NO	37.85	NE
2003	32.01	32.01	NA	4.36	0.17	0.12	NO	36.66	NE
2004	31.45	31.45	NA	4.68	0.22	0.16	NO	36.51	NE
2005	32.28	32.28	NA	5.40	0.15	0.17	NO	38.00	NE
2006	30.72	30.72	NA	6.14	0.15	0.17	NO	37.18	NE
2007	30.08	30.08	NA	5.46	0.15	0.17	NO	35.85	NE
2008	30.63	30.63	NA	4.91	0.13	0.17	NO	35.84	NE
2009	28.27	28.27	NA	4.08	0.13	0.17	NO	32.64	NE
2010	31.32	31.32	NA	4.71	0.13	0.16	NO	36.32	NE
2011	28.29	28.29	NA	4.50	0.09	0.16	NO	33.04	NE
2012	29.07	29.07	NA	4.48	0.07	0.16	NO	33.79	NE
2013	32.53	32.53	NA	4.83	0.06	0.16	NO	37.59	NE
2014	25.73	25.73	NA	4.89	0.07	0.16	NO	30.86	NE
2015	28.53	28.53	NA	4.40	0.06	0.16	NO	33.15	NE

Table A-11: Emission trends for HCB [kg] 1990–2015 – Submission under UNECE/LRTAP.

HCB	NFR Sectors								
	1	1.A	1.B	2	3	5	6		
	ENERGY	FUEL COMBUSTION ACTIVITIES	FUGITIVE EMISSIONS FROM FUELS	INDUSTRIAL PROCESSES and PRODUCT USE	AGRICULTURE	WASTE	OTHER EMISSION SOURCES	NATIONAL TOTAL	International Bunkers
1990	71.54	71.54	NA	19.96	0.04	0.39	NO	91.94	NE
1991	68.69	68.69	NA	15.62	0.04	0.28	NO	84.63	NE
1992	55.89	55.89	NA	13.63	0.04	0.11	NO	69.67	NE
1993	52.87	52.87	NA	11.08	0.04	0.04	NO	64.02	NE
1994	47.32	47.32	NA	4.61	0.04	0.02	NO	51.98	NE
1995	49.44	49.44	NA	3.57	0.04	0.02	NO	53.06	NE
1996	52.36	52.36	NA	3.34	0.04	0.02	NO	55.76	NE
1997	46.30	46.30	NA	5.51	0.04	0.02	NO	51.86	NE
1998	43.69	43.69	NA	5.35	0.04	0.02	NO	49.09	NE
1999	44.10	44.10	NA	3.42	0.04	0.02	NO	47.57	NE
2000	40.51	40.51	NA	3.74	0.04	0.02	NO	44.30	NE
2001	42.16	42.16	NA	3.64	0.04	0.02	NO	45.86	NE
2002	38.14	38.14	NA	3.83	0.04	0.02	NO	42.02	NE
2003	37.12	37.12	NA	3.83	0.03	0.02	NO	41.02	NE
2004	37.00	37.00	NA	3.95	0.04	0.03	NO	41.03	NE
2005	38.57	38.57	NA	4.34	0.03	0.03	NO	42.97	NE
2006	35.90	35.90	NA	4.41	0.03	0.03	NO	40.37	NE
2007	33.59	33.59	NA	4.63	0.03	0.03	NO	38.28	NE
2008	33.53	33.53	NA	4.60	0.03	0.03	NO	38.18	NE
2009	30.63	30.63	NA	3.61	0.03	0.03	NO	34.29	NE
2010	34.66	34.66	NA	4.45	0.03	0.03	NO	39.17	NE
2011	30.71	30.71	NA	4.57	0.02	0.03	NO	35.33	NE
2012	56.03	56.03	NA	4.52	0.01	0.03	NO	60.60	NE
2013	138.98	138.98	NA	4.79	0.01	0.03	NO	143.81	NE
2014	135.53	135.53	NA	4.70	0.01	0.03	NO	140.28	NE
2015	31.18	31.18	NA	4.56	0.01	0.03	NO	35.78	NE

Table A-12: Emission trends for PCB [kg] 1990–2015 – Submission under UNECE/LRTAP.

PCB	NFR Sectors								
	1	1.A	1.B	2	3	5	6		
	ENERGY	FUEL COMBUSTION ACTIVITIES	FUGITIVE EMISSIONS FROM FUELS	INDUSTRIAL PROCESSES and PRODUCT USE	AGRICULTURE	WASTE	OTHER EMISSION SOURCES	NATIONAL TOTAL	International Bunkers
1990	8.73	8.73	NA	185.50	NA	NA	NO	194.23	NE
1991	9.95	9.95	NA	165.81	NA	NA	NO	175.76	NE
1992	8.63	8.63	NA	139.34	NA	NA	NO	147.97	NE
1993	8.44	8.44	NA	134.52	NA	NA	NO	142.96	NE
1994	7.61	7.61	NA	152.13	NA	NA	NO	159.73	NE
1995	6.95	6.95	NA	155.03	NA	NA	NO	161.98	NE
1996	6.72	6.72	NA	152.55	NA	NA	NO	159.26	NE
1997	7.05	7.05	NA	155.86	NA	NA	NO	162.91	NE
1998	6.86	6.86	NA	156.37	NA	NA	NO	163.23	NE
1999	5.95	5.95	NA	155.90	NA	NA	NO	161.86	NE
2000	5.07	5.07	NA	158.28	NA	NA	NO	163.35	NE
2001	4.96	4.96	NA	158.92	NA	NA	NO	163.88	NE
2002	4.32	4.32	NA	160.45	NA	NA	NO	164.77	NE
2003	4.32	4.32	NA	160.76	NA	NA	NO	165.08	NE
2004	4.10	4.10	NA	167.53	NA	NA	NO	171.63	NE
2005	3.72	3.72	NA	172.01	NA	NA	NO	175.73	NE
2006	3.53	3.53	NA	184.57	NA	NA	NO	188.10	NE
2007	2.81	2.81	NA	187.92	NA	NA	NO	190.73	NE
2008	2.77	2.77	NA	182.54	NA	NA	NO	185.31	NE
2009	2.42	2.42	NA	158.98	NA	NA	NO	161.40	NE
2010	2.42	2.42	NA	176.57	NA	NA	NO	178.99	NE
2011	2.04	2.04	NA	179.95	NA	NA	NO	182.00	NE
2012	1.94	1.94	NA	174.19	NA	NA	NO	176.13	NE
2013	1.89	1.89	NA	178.00	NA	NA	NO	179.89	NE
2014	1.89	1.89	NA	178.01	NA	NA	NO	179.89	NE
2015	2.10	2.10	NA	174.63	NA	NA	NO	176.73	NE

Table A-13: Emission trends for TSP [kt] 1990–2015 – Submission under UNECE/LRTAP.

TSP	NFR Sectors								
	1	1.A	1.B	2	3	5	6		
	ENERGY	FUEL COMBUSTION ACTIVITIES	FUGITIVE EMISSIONS FROM FUELS	INDUSTRIAL PROCESSES and PRODUCT USE	AGRICULTURE	WASTE	OTHER EMISSION SOURCES	NATIONAL TOTAL	International Bunkers
1990	31.23	30.38	0.85	18.94	11.53	0.15	NO	61.86	0.28
1995	31.52	30.87	0.65	19.05	11.71	0.16	NO	62.43	0.42
2000	31.90	31.24	0.66	19.20	11.41	0.09	NO	62.60	0.52
2001	32.22	31.53	0.68	18.54	11.41	0.09	NO	62.26	0.51
2002	31.90	31.18	0.72	17.84	11.38	0.11	NO	61.22	0.46
2003	32.05	31.31	0.73	17.55	11.38	0.13	NO	61.11	0.43
2004	31.65	31.03	0.62	18.17	11.55	0.17	NO	61.53	0.51
2005	31.85	31.24	0.61	17.56	11.50	0.19	NO	61.10	0.59
2006	31.66	31.07	0.59	16.34	11.34	0.19	NO	59.53	0.63
2007	31.28	30.74	0.53	15.86	11.28	0.22	NO	58.64	0.66
2008	30.98	30.47	0.51	16.94	11.18	0.18	NO	59.27	0.66
2009	29.50	29.12	0.38	15.77	11.16	0.17	NO	56.60	0.57
2010	30.19	29.72	0.47	15.52	11.12	0.19	NO	57.02	0.62
2011	29.41	28.93	0.48	15.97	11.04	0.22	NO	56.64	0.65
2012	29.14	28.70	0.44	15.61	10.97	0.28	NO	56.00	0.62
2013	29.66	29.21	0.45	15.54	10.93	0.28	NO	56.41	0.59
2014	27.64	27.22	0.41	15.82	10.87	0.36	NO	54.69	0.59
2015	28.36	27.92	0.45	15.57	10.85	0.45	NO	55.24	0.63

Table A-14: Emission trends for PM₁₀ [kt] 1990–2015 – Submission under UNECE/LRTAP.

PM ₁₀	NFR Sectors								
	1	1.A	1.B	2	3	5	6		
	ENERGY	FUEL COMBUSTION ACTIVITIES	FUGITIVE EMISSIONS FROM FUELS	INDUSTRIAL PROCESSES and PRODUCT USE	AGRICULTURE	WASTE	OTHER EMISSION SOURCES	NATIONAL TOTAL	International Bunkers
1990	24.10	23.70	0.40	10.86	5.27	0.07	NO	40.29	0.28
1995	23.84	23.54	0.31	10.38	5.34	0.08	NO	39.65	0.42
2000	23.55	23.24	0.31	10.34	5.20	0.04	NO	39.13	0.52
2001	23.77	23.45	0.32	10.02	5.21	0.04	NO	39.05	0.51
2002	23.38	23.04	0.34	9.34	5.19	0.05	NO	37.96	0.46
2003	23.37	23.02	0.35	9.20	5.19	0.06	NO	37.82	0.43
2004	22.89	22.60	0.29	9.46	5.29	0.08	NO	37.72	0.51
2005	22.81	22.52	0.29	9.12	5.24	0.09	NO	37.27	0.59
2006	22.37	22.09	0.28	8.37	5.16	0.09	NO	35.99	0.63
2007	21.83	21.58	0.25	8.00	5.14	0.10	NO	35.07	0.66
2008	21.36	21.12	0.24	8.55	5.09	0.08	NO	35.09	0.66
2009	20.14	19.96	0.18	7.95	5.08	0.08	NO	33.25	0.57
2010	20.61	20.39	0.22	7.83	5.06	0.09	NO	33.59	0.62
2011	19.74	19.51	0.23	8.07	5.02	0.11	NO	32.93	0.65
2012	19.46	19.25	0.21	7.88	4.98	0.13	NO	32.44	0.62
2013	19.83	19.61	0.21	7.84	4.95	0.13	NO	32.75	0.59
2014	17.85	17.65	0.20	7.97	4.93	0.17	NO	30.92	0.59
2015	18.35	18.13	0.21	7.84	4.92	0.21	NO	31.32	0.63

Table A-15: Emission trends for PM_{2.5} [kt] 1990–2015– Submission under UNECE/LRTAP.

PM _{2.5}	NFR Sectors								
	1	1.A	1.B	2	3	5	6		
	ENERGY	FUEL COMBUSTION ACTIVITIES	FUGITIVE EMISSIONS FROM FUELS	INDUSTRIAL PROCESSES and PRODUCT USE	AGRICULTURE	WASTE	OTHER EMISSION SOURCES	NATIONAL TOTAL	International Bunkers
1990	20.30	20.19	0.11	3.65	1.28	0.02	NO	25.25	0.28
1995	20.04	19.95	0.09	3.03	1.29	0.02	NO	24.39	0.42
2000	19.54	19.45	0.09	2.82	1.25	0.01	NO	23.63	0.52
2001	19.73	19.64	0.09	2.77	1.26	0.01	NO	23.78	0.51
2002	19.34	19.24	0.10	2.36	1.25	0.02	NO	22.96	0.46
2003	19.24	19.14	0.10	2.33	1.25	0.02	NO	22.84	0.43
2004	18.77	18.68	0.09	2.33	1.30	0.03	NO	22.43	0.51
2005	18.56	18.47	0.09	2.26	1.26	0.03	NO	22.11	0.59
2006	17.97	17.88	0.09	2.01	1.23	0.03	NO	21.24	0.63
2007	17.35	17.27	0.08	1.82	1.23	0.03	NO	20.43	0.66
2008	16.77	16.69	0.08	1.93	1.22	0.03	NO	19.94	0.66
2009	15.67	15.61	0.06	1.80	1.21	0.03	NO	18.71	0.57
2010	15.98	15.91	0.07	1.81	1.20	0.03	NO	19.02	0.62
2011	15.11	15.04	0.07	1.86	1.18	0.03	NO	18.18	0.65
2012	14.81	14.74	0.07	1.81	1.16	0.04	NO	17.82	0.62
2013	15.07	15.00	0.07	1.80	1.15	0.04	NO	18.06	0.59
2014	13.25	13.19	0.06	1.82	1.15	0.05	NO	16.28	0.59
2015	13.60	13.53	0.07	1.81	1.15	0.07	NO	16.62	0.63

12.2 National emission total for SO₂, NO_x, NMVOC, NH₃ and PM_{2.5} calculated on the basis of fuels used

In the following tables Austria's emissions 1990–2015 are listed according to Directive (EU) 2016/2284 (NEC Directive). Austria uses the national emission totals calculated on the basis of *fuel used* (thus excluding emissions from fuel exports in the vehicle tank) for compliance assessment under the NEC Directive. Emissions are reported on the basis of fuel used (without 'fuel export').

The complete tables of the NFR Format are submitted separately in digital form only (excel files).

Table A-16: Emission trends 1990–2015 on the basis of fuel used.

	SO ₂ [kt]	NO _x [kt]	NMVOC [kt]	NH ₃ [kt]	PM _{2.5} [kt]
1990	73.66	203.12	277.27	66.09	24.67
1991	70.42	204.18	268.80	67.41	NR
1992	54.02	193.58	250.97	65.78	NR
1993	52.26	183.64	238.45	66.66	NR
1994	46.70	181.27	217.22	68.15	NR
1995	46.40	179.98	203.75	69.48	23.63
1996	43.99	178.81	197.87	68.22	NR
1997	39.63	181.14	177.77	68.69	NR
1998	34.76	178.88	167.81	69.02	NR
1999	33.05	178.54	161.32	67.73	NR
2000	30.96	177.48	152.81	66.31	22.73
2001	31.72	179.42	148.39	66.33	22.66
2002	30.86	177.11	142.94	65.33	21.52
2003	30.85	178.92	139.84	65.02	21.16
2004	27.02	177.26	135.30	64.61	20.77
2005	25.89	178.94	132.43	64.70	20.48
2006	26.59	177.53	127.94	64.98	19.93
2007	23.13	171.81	123.44	66.29	19.28
2008	20.55	165.22	121.36	66.04	19.13
2009	15.08	150.79	116.33	67.12	17.98
2010	16.66	149.42	117.19	66.53	18.33
2011	15.54	146.16	113.62	66.05	17.67
2012	15.03	141.16	112.99	66.15	17.36
2013	14.90	138.43	114.92	66.07	17.58
2014	14.75	132.64	109.62	66.52	15.92
2015	14.87	131.74	112.36	66.80	16.33

Table A-17: Emission trends for SO_x [kt] 1990–2015 on the basis of fuel used.

SO _x	NFR Sectors								International Bunkers
	1	1.A	1.B	2	3	5	6	NATIONAL TOTAL	
	ENERGY	FUEL COMBUSTION ACTIVITIES	FUGITIVE EMISSIONS FROM FUELS	INDUSTRIAL PROCESSES and PRODUCT USE	AGRICULTURE	WASTE	OTHER		
	kt								
1990	71.36	69.36	2.00	2.22	0.00	0.07	NO	73.66	0.26
1991	68.45	67.15	1.30	1.90	0.00	0.06	NO	70.42	0.29
1992	52.31	50.31	2.00	1.67	0.00	0.04	NO	54.02	0.31
1993	50.79	48.69	2.10	1.42	0.00	0.04	NO	52.26	0.33
1994	45.23	43.95	1.28	1.42	0.00	0.05	NO	46.70	0.34
1995	44.98	43.45	1.53	1.37	0.00	0.05	NO	46.40	0.38
1996	42.65	41.45	1.20	1.29	0.00	0.05	NO	43.99	0.43
1997	38.31	38.24	0.07	1.27	0.00	0.05	NO	39.63	0.44
1998	33.52	33.48	0.04	1.18	0.00	0.05	NO	34.76	0.46
1999	31.87	31.83	0.04	1.12	0.00	0.06	NO	33.05	0.45
2000	29.81	29.77	0.04	1.09	0.00	0.06	NO	30.96	0.48
2001	30.64	30.59	0.05	1.02	0.00	0.06	NO	31.72	0.47
2002	29.78	29.74	0.04	1.02	0.00	0.06	NO	30.86	0.43
2003	29.77	29.72	0.05	1.02	0.00	0.06	NO	30.85	0.40
2004	25.93	25.89	0.04	1.02	0.01	0.06	NO	27.02	0.47
2005	24.81	24.77	0.04	1.02	0.00	0.06	NO	25.89	0.55
2006	25.51	25.46	0.05	1.03	0.00	0.05	NO	26.59	0.58
2007	22.06	22.00	0.05	1.03	0.00	0.04	NO	23.13	0.61
2008	19.49	19.45	0.04	1.03	0.00	0.03	NO	20.55	0.61
2009	14.10	14.04	0.06	0.97	0.00	0.02	NO	15.08	0.53
2010	15.71	15.66	0.05	0.95	0.00	0.01	NO	16.66	0.57
2011	14.60	14.56	0.05	0.92	0.00	0.01	NO	15.54	0.60
2012	14.13	14.08	0.05	0.89	0.00	0.01	NO	15.03	0.57
2013	14.03	13.99	0.04	0.87	0.00	0.01	NO	14.90	0.54
2014	13.89	13.86	0.04	0.84	0.00	0.01	NO	14.75	0.54
2015	14.04	14.01	0.04	0.81	0.00	0.01	NO	14.87	0.58

Table A-18: Emission trends for NO_x [kt] 1990–2015 on the basis of fuel used.

NO _x	NFR Sectors								
	1	1.A	1.B	2	4	6	7		
	ENERGY	FUEL COMBUSTION ACTIVITIES	FUGITIVE EMISSIONS FROM FUELS	INDUSTRIAL PROCESSES and PRODUCT USE	AGRICULTURE	WASTE	OTHER	NATIONAL TOTAL	International Bunkers
	kt								
1990	186.33	186.33	IE	4.80	11.89	0.10	NO	203.12	2.44
1991	186.84	186.84	IE	4.48	12.77	0.09	NO	204.18	2.76
1992	177.35	177.35	IE	4.55	11.62	0.06	NO	193.58	3.00
1993	171.04	171.04	IE	1.98	10.58	0.05	NO	183.64	3.18
1994	166.98	166.98	IE	1.92	12.33	0.04	NO	181.27	3.31
1995	165.94	165.94	IE	1.46	12.54	0.05	NO	179.98	3.73
1996	165.94	165.94	IE	1.42	11.40	0.05	NO	178.81	4.14
1997	168.13	168.13	IE	1.50	11.46	0.05	NO	181.14	4.29
1998	165.86	165.86	IE	1.46	11.52	0.05	NO	178.88	4.43
1999	165.88	165.88	IE	1.44	11.16	0.05	NO	178.54	4.33
2000	164.92	164.92	IE	1.54	10.97	0.05	NO	177.48	6.44
2001	166.87	166.87	IE	1.57	10.93	0.05	NO	179.42	6.32
2002	164.47	164.47	IE	1.63	10.95	0.05	NO	177.11	5.67
2003	167.05	167.05	IE	1.34	10.48	0.05	NO	178.92	5.21
2004	166.01	166.01	IE	1.28	9.93	0.05	NO	177.26	6.09
2005	167.15	167.15	IE	1.75	9.99	0.05	NO	178.94	6.99
2006	165.62	165.62	IE	1.82	10.05	0.04	NO	177.53	7.54
2007	159.85	159.85	IE	1.71	10.22	0.04	NO	171.81	7.99
2008	152.46	152.46	IE	1.91	10.82	0.03	NO	165.22	7.90
2009	138.62	138.62	IE	1.54	10.61	0.02	NO	150.79	6.86
2010	137.88	137.88	IE	1.81	9.71	0.01	NO	149.42	7.60
2011	134.09	134.09	IE	1.83	10.23	0.01	NO	146.16	7.98
2012	129.18	129.18	IE	1.63	10.34	0.01	NO	141.16	7.68
2013	126.73	126.73	IE	1.45	10.24	0.01	NO	138.43	7.46
2014	120.59	120.59	IE	1.50	10.53	0.01	NO	132.64	7.49
2015	119.10	119.10	IE	1.72	10.91	0.01	NO	131.74	8.18

Table A-19: Emission trends for NMVOC [kt] 1990–2015 on the basis of fuel used.

NMVOC	NFR Sectors								International Bunkers
	1	1.A	1.B	2	4	6	7	NATIONAL TOTAL	
	ENERGY	FUEL COMBUSTION ACTIVITIES	FUGITIVE EMISSIONS FROM FUELS	INDUSTRIAL PROCESSES	AGRICULTURE	WASTE	OTHER		
	kt								
1990	150.30	134.82	15.49	125.53	1.27	0.16	NO	277.27	0.18
1991	146.99	131.87	15.12	120.38	1.28	0.16	NO	268.80	0.20
1992	134.59	119.41	15.19	114.95	1.27	0.15	NO	250.97	0.22
1993	127.45	112.80	14.65	109.59	1.26	0.15	NO	238.45	0.24
1994	114.34	103.22	11.12	101.48	1.26	0.15	NO	217.22	0.25
1995	109.15	99.66	9.49	93.22	1.24	0.14	NO	203.75	0.29
1996	106.68	98.21	8.46	89.82	1.25	0.13	NO	197.87	0.34
1997	89.70	81.74	7.95	86.69	1.24	0.13	NO	177.77	0.37
1998	82.92	76.49	6.43	83.53	1.24	0.13	NO	167.81	0.40
1999	79.94	74.26	5.67	80.03	1.23	0.12	NO	161.32	0.39
2000	74.36	68.66	5.69	77.13	1.21	0.12	NO	152.81	0.42
2001	70.71	66.88	3.84	76.34	1.22	0.11	NO	148.39	0.41
2002	65.27	61.24	4.03	76.35	1.21	0.11	NO	142.94	0.37
2003	62.68	58.72	3.96	75.83	1.21	0.11	NO	139.84	0.34
2004	58.90	55.33	3.57	75.04	1.24	0.12	NO	135.30	0.40
2005	56.69	53.34	3.34	74.44	1.20	0.11	NO	132.43	0.47
2006	53.00	49.65	3.36	73.64	1.18	0.11	NO	127.94	0.50
2007	49.50	46.52	2.98	72.67	1.17	0.10	NO	123.44	0.53
2008	48.30	45.54	2.75	71.81	1.15	0.10	NO	121.36	0.52
2009	44.62	42.03	2.59	70.48	1.14	0.09	NO	116.33	0.45
2010	46.31	43.86	2.45	69.67	1.13	0.09	NO	117.19	0.49
2011	43.18	40.77	2.41	69.25	1.12	0.08	NO	113.62	0.51
2012	43.40	41.00	2.40	68.41	1.10	0.08	NO	112.99	0.49
2013	44.91	42.60	2.30	68.85	1.09	0.07	NO	114.92	0.46
2014	39.15	36.73	2.42	69.31	1.09	0.07	NO	109.62	0.46
2015	41.43	39.08	2.35	69.78	1.09	0.07	NO	112.36	0.50

Table A-20: Emission trends for NH₃ [kt] 1990–2015 on the basis of fuel used.

NH ₃	NFR Sectors							
	1	1.A	1.B	2	4	6	7	
	ENERGY	FUEL COMBUSTION ACTIVITIES	FUGITIVE EMISSIONS FROM FUELS	INDUSTRIAL PROCESSES	AGRICULTURE	WASTE	OTHER	NATIONAL TOTAL
								International Bunkers
	kt							
1990	2.235	2.235	IE	0.269	63.229	0.358	NO	66.091
1991	2.710	2.710	IE	0.507	63.826	0.370	NO	67.414
1992	3.041	3.041	IE	0.369	61.950	0.421	NO	65.780
1993	3.411	3.411	IE	0.219	62.536	0.498	NO	66.664
1994	3.650	3.650	IE	0.168	63.763	0.572	NO	68.153
1995	3.841	3.841	IE	0.099	64.956	0.584	NO	69.480
1996	4.100	4.100	IE	0.097	63.420	0.605	NO	68.222
1997	4.181	4.181	IE	0.103	63.819	0.586	NO	68.689
1998	4.287	4.287	IE	0.103	64.030	0.603	NO	69.023
1999	4.422	4.422	IE	0.119	62.549	0.638	NO	67.727
2000	4.315	4.315	IE	0.100	61.226	0.669	NO	66.310
2001	4.246	4.246	IE	0.079	61.254	0.747	NO	66.327
2002	3.946	3.946	IE	0.061	60.498	0.824	NO	65.328
2003	3.754	3.754	IE	0.076	60.298	0.890	NO	65.019
2004	3.520	3.520	IE	0.059	59.904	1.123	NO	64.606
2005	3.404	3.404	IE	0.068	60.024	1.209	NO	64.704
2006	3.247	3.247	IE	0.074	60.436	1.223	NO	64.980
2007	3.144	3.144	IE	0.077	61.828	1.243	NO	66.292
2008	3.052	3.052	IE	0.081	61.691	1.220	NO	66.044
2009	2.852	2.852	IE	0.088	62.978	1.204	NO	67.122
2010	2.973	2.973	IE	0.091	62.254	1.216	NO	66.533
2011	2.860	2.860	IE	0.101	61.862	1.227	NO	66.050
2012	2.798	2.798	IE	0.094	62.031	1.231	NO	66.154
2013	2.785	2.785	IE	0.096	62.023	1.164	NO	66.068
2014	2.613	2.613	IE	0.089	62.613	1.204	NO	66.519
2015	2.721	2.721	IE	0.082	62.783	1.217	NO	66.802

Table A-21: Emission trends for PM_{2.5} [kt] 1990–2015 on the basis of fuel used.

PM _{2.5}	NFR Sectors								International Bunkers
	1	1.A	1.B	2	4	6	7	NATIONAL TOTAL	
	ENERGY	FUEL COMBUSTION ACTIVITIES	FUGITIVE EMISSIONS FROM FUELS	INDUSTRIAL PROCESSES	AGRICULTURE	WASTE	OTHER		
	kt								
1990	19.72	19.61	0.11	3.65	1.28	0.02	NO	24.67	0.28
1991	NR	NR	NR	NR	NR	NR	NR	NR	NR
1992	NR	NR	NR	NR	NR	NR	NR	NR	NR
1993	NR	NR	NR	NR	NR	NR	NR	NR	NR
1994	NR	NR	NR	NR	NR	NR	NR	NR	NR
1995	19.28	19.19	0.09	3.03	1.29	0.02	NO	23.63	0.42
1996	NR	NR	NR	NR	NR	NR	NR	NR	NR
1997	NR	NR	NR	NR	NR	NR	NR	NR	NR
1998	NR	NR	NR	NR	NR	NR	NR	NR	NR
1999	NR	NR	NR	NR	NR	NR	NR	NR	NR
2000	18.64	18.55	0.09	2.82	1.25	0.01	NO	22.73	0.52
2001	18.62	18.52	0.09	2.77	1.26	0.01	NO	22.66	0.51
2002	17.89	17.80	0.10	2.36	1.25	0.02	NO	21.52	0.46
2003	17.56	17.46	0.10	2.33	1.25	0.02	NO	21.16	0.43
2004	17.11	17.02	0.09	2.33	1.30	0.03	NO	20.77	0.51
2005	16.93	16.84	0.09	2.26	1.26	0.03	NO	20.48	0.59
2006	16.66	16.57	0.09	2.01	1.23	0.03	NO	19.93	0.63
2007	16.20	16.12	0.08	1.82	1.23	0.03	NO	19.28	0.66
2008	15.96	15.88	0.08	1.93	1.22	0.03	NO	19.13	0.66
2009	14.95	14.89	0.06	1.80	1.21	0.03	NO	17.98	0.57
2010	15.29	15.22	0.07	1.81	1.20	0.03	NO	18.33	0.62
2011	14.59	14.52	0.07	1.86	1.18	0.03	NO	17.67	0.65
2012	14.35	14.28	0.07	1.81	1.16	0.04	NO	17.36	0.62
2013	14.59	14.52	0.07	1.80	1.15	0.04	NO	17.58	0.59
2014	12.89	12.83	0.06	1.82	1.15	0.05	NO	15.92	0.59
2015	13.31	13.24	0.07	1.81	1.15	0.07	NO	16.33	0.63