ENVIRONMENT AGENCY AUSTRIA umweltbundesamt

Austria's Informative Inventory Report (IIR) 2016

Submission under the UNECE Convention on Long-range Transboundary Air Pollution

AUSTRIA'S INFORMATIVE INVENTORY REPORT (IIR) 2016

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PREFACE

The report "Austria's Informative Inventory Report (IIR) 2016" 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 2016 submission under the Convention on Long-range Transboundary Air Pollution of the United Nations Economic Commission for Europe (UNECE/LRTAP).

As a party to the UNECE/LRTAP Convention, Austria is required to annually report data on emissions of air pollutants covered in the Convention and its Protocols: These are the main pollutants NO_x, SO_2, NMVOC, NH_3 and CO, Particulate Matter (PM), Persistent Organic Pollutants (POPs) and Heavy Metals (HM). To be able to meet this reporting requirement, 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 (**N**omenclature **f**or **R**eporting – 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. The NFR for 2014 and a summary of emission data is presented in the Annex of this report.

The IIR 2016 at hand complements the reported emission data by providing background information. It follows the template[5] 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 2016a).

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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.

Project leader for the preparation of the Austrian Air Emission Inventory is Stephan Poupa.

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- Data Management..Stephan Poupa
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- Fuel combustion mobile ....Gudrun Stranner ('Sector Lead')
- Fugitive emissions ....Marion Pinterits ('Sector Lead')
- Industrial processes ....Lorenz Moosmann ('Sector Lead')
- Solvent Use ....Maria Purzner ('Sector Lead')
- Agriculture ....Michael Anderl ('Sector Lead')
- Waste ....Katja Pazdernik ('Sector Lead')
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- Key Category Analysis ....Andreas Zechmeister
- Uncertainty Analysis...Andreas Zechmeister

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Specific responsibilities for the IIR 2016 have been as follows:

- Executive Summary .... Simone Haider
- Chapter 1 Introduction.................................. Simone Haider, Manuela Wieser
- Chapter 2 Trends .... Simone Haider
- Chapter 3 Energy .... Stephan Poupa, Günther Schmidt
- Chapter 3 Transport .... Gudrun Stanner, Barbara Schodl
- Chapter 3 Fugitive emission.......................... Marion Pinterits, Katja Pazdernik
- Chapter 4 Industrial Processes and
  Product Use………………………………... ..... Lorenz Moosmann, Maria Purzner,
  .... Michaela Titz, Manuela Wieser
- Chapter 5 Agriculture .... Michael Anderl, Simone Haider
- Chapter 6 Waste .... Katja Pazdernik, Christoph Lampert
- Chapter 7 Recalculations &
  Improvements… .... Simone Haider
- Chapter 8 Projections.................................... Andreas Zechmeister
- Annexes .... Simone Haider.

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EXECUTIVE SUMMARY

ES.1 Reporting obligation under UNECE/LRTAP

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-rage Transboundary Air Pollution (LRTAP). 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 a party to the UNECE/LRTAP Convention, 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 (NH_3) and carbon monoxide (CO);
- particulate matter (PM): primary PM (fine particulate matter ($PM_{2.5}$) and coarse particulate matter (PM_{10}) as well as total suspended particulates (TSPs);
- 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 this reporting requirement, 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 2014 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.[6]

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. PCB emissions from 1990 to 2014 are reported for the first time in the current submission.

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[6] 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

The main pollutant emissions – SO_2, NO_x, VOC, and NH_3 – are also reported under the EU National Emission Ceiling Directive (NEC-D), where a national Total based on *fuel used* (thus excluding emissions from fuel exports in the vehicle tank) is reported for compliance assessment. Under the CLRTAP Austria reports the same values for "National Total for Compliance" and "National Total".

The annual greenhouse gas reporting under the UNFCCC also requires the reporting of indirect GHGs (NO_x, CO, NMVOC) and SO_2 emissions based on *fuel sold*. In contrast to UNFCCC requirements, emissions from aviation under NEC and CLRTAP include domestic LTO and cruise. Furthermore, international navigation of inland waterways is covered additionally under NEC and CLRTAP.

ES.3 Overview of emission trends

Main Pollutants

In 1990, national total SO_2 emissions amounted to 74 kt. Since then emissions have decreased quite steadily. In the year 2014, emissions were down by 78% compared to 1990 and amounted to 16 kt, which was mainly due to lower emissions from residential heating, combustion in industries and in energy industries. The sharp decrease from 2008 to 2009 is due to a further reduction of the sulfur content of gasoil to 10ppm. From 2013 to 2014, emissions increased slightly, by 0.9%, mainly due higher emissions reported by oil refineries.

In 1990, national total NO_x emissions amounted to 216 kt. After an all-time high between 2003 and 2005, emissions have been decreasing continuously, mainly due to lower emissions from heavy duty vehicles. In 2014, NO_x emissions amounted to 151 kt and were about 30% lower than in 1990. From 2013 to 2014, emissions fell by 6.8%, again mainly due to declining emissions from road transportation, in particular from heavy duty vehicles. As emissions mainly arise from transport, the share of NO_x emissions caused by fuel sold in Austria but used abroad is notable. Emissions calculated based on fuel used are almost 21 kt lower in 2014 than when calculated based on fuel sold; the decrease between 1990 and 2014 is also slightly stronger.

In 1990, national total NMVOC emissions amounted to 281 kt. Emissions have decreased steadily since then and in the year 2014, they amounted to 110 kt, which is 61% lower than in 1990. From 2013 to 2014, emissions decreased by 4.4% due to lower biomass use for residential heating as a consequence of the mild winter temperatures in 2014.

National total NH_3 emissions in 1990 amounted to 66.5 kt; emissions were quite stable over the period from 1990 to 2014 and in 2014, they were 0.7% above 1990 levels (67.0 kt). NH_3 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 NH_3 emissions.

National total CO emissions in 1990 amounted to 1 286 kt. They decreased considerably from 1990 to 2014. In 2014, emissions were 58% below 1990 levels and amounted to 537 kt. This reduction was mainly due to declining emissions from road transport due to the establishment of catalytic converters.

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 2014: TSP emissions decreased by 11%, PM_{10} emissions were about 22% below the level of 1990, and $PM_{2.5}$ emissions dropped by about 34%. Between 2013 and 2014, PM emissions fell by 2.0% (TSP), 4.2% (PM_{10}) and 8.1% ($PM_{2.5}$) because of lower biomass consumption of the residential sector due to a mild winter 2014. Apart from industry and road transport, private households and the agricultural sector are the main contributors to PM emissions. Where for TSP the most important source is 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 28% from 1990 to 2014 is mainly due to a decline in the industrial processes and energy sector, which is due to loweruse of heavy fuel oil and lower emissions from iron and steel production.

The overall fall in Hg emissions of about 55% for the period 1990 to 2014 is 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 2014, which is mainly a result of the ban of lead in fuels. However, abatement techniques and product substitutions also contributed to the emission reduction.

Persistent Organic Pollutants (POPs)

Emissions of PAH and PCDD/F declined remarkably between 1990 and 2014. HCB and PCB emissions increased between 1990 and 2014.

The significant increase (53%) of HCB emissions is due to unintentional releases of HCB by an Austrian cement plant affecting the years 2012, 2013 and 2014.

The increase (12%) of PCB emissions between 1990 and 2014 is a result of increased activities in metal production, which is the main source category.

The most important source for PAH, PCDD/F and HCB emissions in Austria is residential heating. In the 1980s industry and waste incineration were still important sources regarding POP emissions. Due to emission abatement legislation, emissions from industry and waste incineration decreased remarkably from 1990 to 1993.

ES.4 Key categories

To determine key categories, a trend and a level assessment have been carried out, which resulted in 41 identified key categories. It shows that the residential sector has been identified as the most important key category: all air pollutants except NH_3 and PCB are found key in either the trend or the level assessment.

Table 1: Most relevant key categories in Austria for air emissions 2014

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, TSP, PM_{10}, $PM_{2.5}$)
1.A.2.g.8 – Other Stationary Combustion in Manufacturing Industries and Construction	16 times (SO_2, NO_x, Cd, Pb, PAH, DIOX, TSP, PM_{10}, $PM_{2.5}$)
2.C.1 – Iron and Steel Production	13 times (Cd, Pb, Hg, PAH, DIOX, PCB, TSP, PM_{10}, $PM_{2.5}$)
1.A.2.f - Non-metallic Minerals	10 times (SO_2, NO_x, CO, Cd, Hg, HCB)
1.A.3.b.1 – R.T., Passenger cars	10 times (NO_x, NMVOC, CO, Pb, PM_{10}, $PM_{2.5}$)

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 by 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 household census data evaluation affecting gaseous fuels from the year 2009 onwards. Furthermore, double counting of 2005-2013 emissions from waste incineration plants and double counting of iron and steel industries in 2013 has been eliminated.

In NFR sector *1.A.3 Transport*, emissions have been slightly revised due to the usage of the latest version of the NEMO model and revisions of the energy balance (LPG fuel amounts, CNG fuel amounts). Further revisions are due to the off-road model, where the fleet composition was reorganised in the course of integrating the future emission class "Stage V".

In NFR sector *2 Industrial Processes and Product Use*, recalculations have been carried out following the revision of the calculation model of *2.D.3 Solvent Use* and updated activity data of chipboard production for the years 2008-2013 in subsector *2.H.1 Pulp and Paper Industry*.

For NFR sector *3 Agriculture*, revisions were on the one hand due to methodological improvements like the usage of revised N_2O EFs for poultry in the sector manure management, resulting in slightly increased NH_3 and NO_x emissions as the inventory model follows the N-flow concept. On the other hand, recalculations have been carried out due to updated activity data (livestock data and land use data).

In NFR sector *5 Waste*, recalculations have been carried out due to the redesign of the First Order Decay Model in accordance with the IPCC 2006 Guidelines (*5.A Solid Waste Disposal*) and corrections of activity data (*5.B Compost Production*).

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 and the findings were commented on in the IIR 2011 (UMWELTBUNDESAMT 2011b). The next stage 3 review will take place in 2017. 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)[7] administrates Austria's reporting obligations to the

- Convention on Long-range Transboundary Air Pollution (LRTAP)[8] of the United Nations Economic Commission for Europe (UNECE),[9]
- United Nations Framework Convention on Climate Change (UNFCCC),[10]
- European Commission (EC),[11] and the
- European Environment Agency (EEA).[12]

The Environmental Control Act ("Umweltkontrollgesetz"; Federal Law Gazette 152/1998)[13] 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 and the UNECE LRTAP Convention. 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 1.2.1.

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 Arrangement for Inventory Preparation

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 Inventories*, Type A (Id.No. 241), in accordance with EN ISO/IEC 17020 and the Austrian Ac-

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7 http://www.bmlfuw.gv.at/

8 http://www.unece.org/env/lrtap/lrtap_h1.html

9 http://www.unece.org

10 http://unfccc.int/2860.php

11 http://ec.europa.eu/index_en.htm

12 http://www.eea.europa.eu/

13 http://www.umweltbundesamt.at/fileadmin/site/umweltkontrolle/gesetze/ukg.pdf

creditation Law (AkkG),[14] 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 personnel of the IBE is made up of staff from various organisational units of the Umweltbundesamt, who in the course of their inspection activity for the IBE are assigned to the IBE (see Figure 1). Keeping the quality system up to date is the responsibility of the Quality Manager.

The accreditation comprises the emission inventory for all GHGs and main 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).

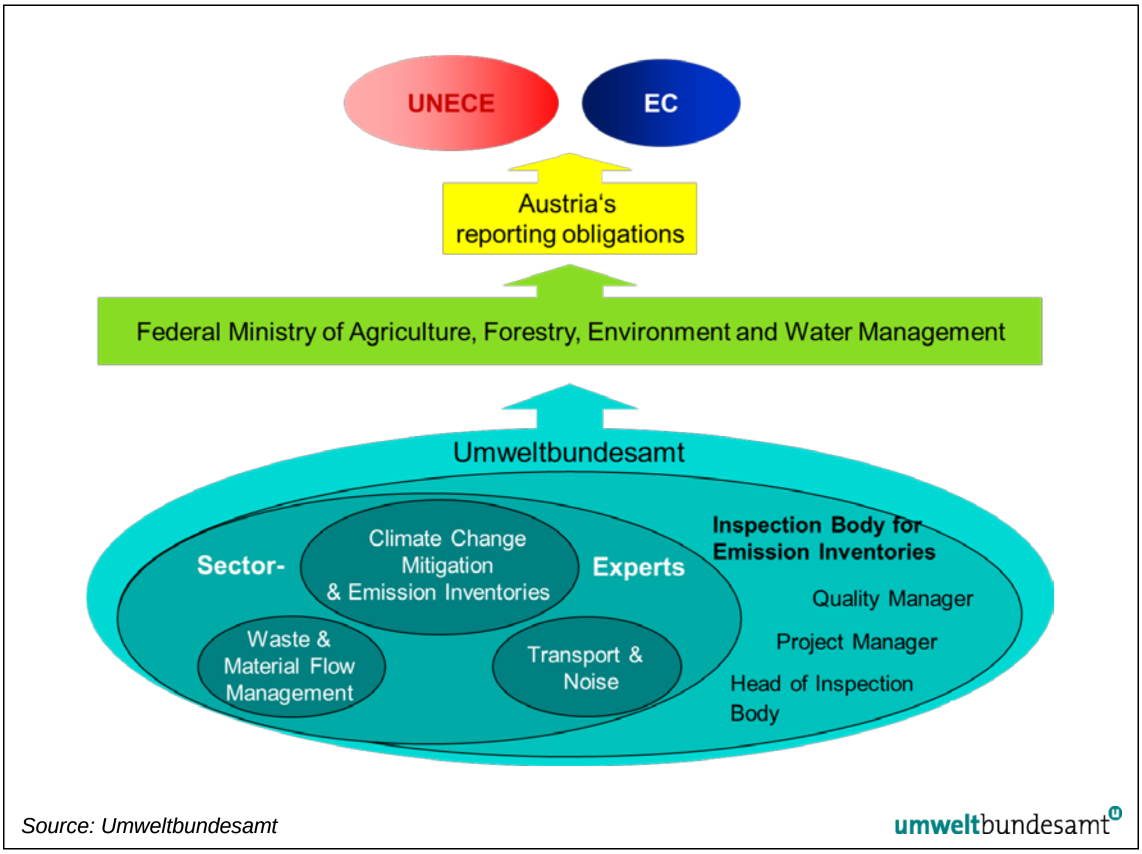

Figure 1: Responsibilities within the Austrian National Inventory System (Air Pollutants).

1.2.1 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 SO_2, NO_x, NMVOCs, NH_3, CO, TSP, PM_{10}, 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.

[14] Federal Law Gazette I No 28/2012 (Akkreditierungsgesetz 2012)

- Directive 2001/81/EC of the European Parliament and of the Council of 23.10.2001 on national emission ceilings for certain atmospheric pollutants (NEC-Directive).[15] The Austrian implementation of the European NEC-Directive[16] also entails the obligation for a national emissions inventory of the covered air pollutants NO_x, SO_2, NMVOC and NH_3.
- „United Nations Framework Convention on Climate Change" (UNFCCC) (1992)[17] and the Kyoto Protocol (1997).[18]
  - European Council Decision 525/2013/EC[19] "Monitoring 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"[20] comprising the reporting of national emission data on SO_2, NO_x, NMVOC, CO, heavy metals (Pb, Cd, Hg), benzene and particulate matter (PM).
- Industrial Emissions Directive 2010/75/EU[21] which requires the reporting of air emissions from various industrial activities.
- E-PRTR Regulation (EC) No 166/2006[22] 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.

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

16 Emissionshöchstmengengesetz-Luft *EG-L* (*air emissions ceilings law*) BGBl. I, 34/2003
http://www.umweltbundesamt.at/fileadmin/site/umweltkontrolle/gesetze/EG-L.pdf

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

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

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

20 Immissionsschutzgesetz-Luft *IG-L* (*ambient air quality law*) BGBl, I, 115/1997
http://www.umweltbundesamt.at/fileadmin/site/umweltkontrolle/gesetze/2001-IG-L.pdf

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

22 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)	46	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 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).[23]
- As an EFTA[24] country, Austria participated in CORINAIR 90,[25/26] an air emission inventory for Europe. It was part of the CORINE (Coordination d'Information Environmentale) 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 SO_2, NO_x as NO_2, NMVOC, CH_4, CO, CO_2, N_2O and NH_3.
- Austria signed the UNFCCC on June 8, 1992 and subsequently submitted its instrument of ratification on February 28, 1994.[27] 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 SF_6, 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"[28] 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).[29]

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,

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[23] http://www.emep.int/

[24] EFTA: European Free Trade Association; http://www.efta.int/

[25] 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/).

[26] http://www.eea.europa.eu/publications/topic_report_1996_21

[27] http://unfccc.int/essential_background/convention/status_of_ratification/items/2631.php

[28] http://www.umweltbundesamt.at/fileadmin/site/publikationen/REP0004.pdf

[29] http://unfccc.int/resource/docs/cop7/13a03.pdf#page=2

the Executive Body[30] adopted new guidelines for estimating and reporting emission data to ensure that the transparency, consistency, comparability, completeness and accuracy of reported emissions are adequate for current LRTAP Conventions needs (EB.AIR/GE.1/2002/7[31] 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 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 1.2.3).

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.

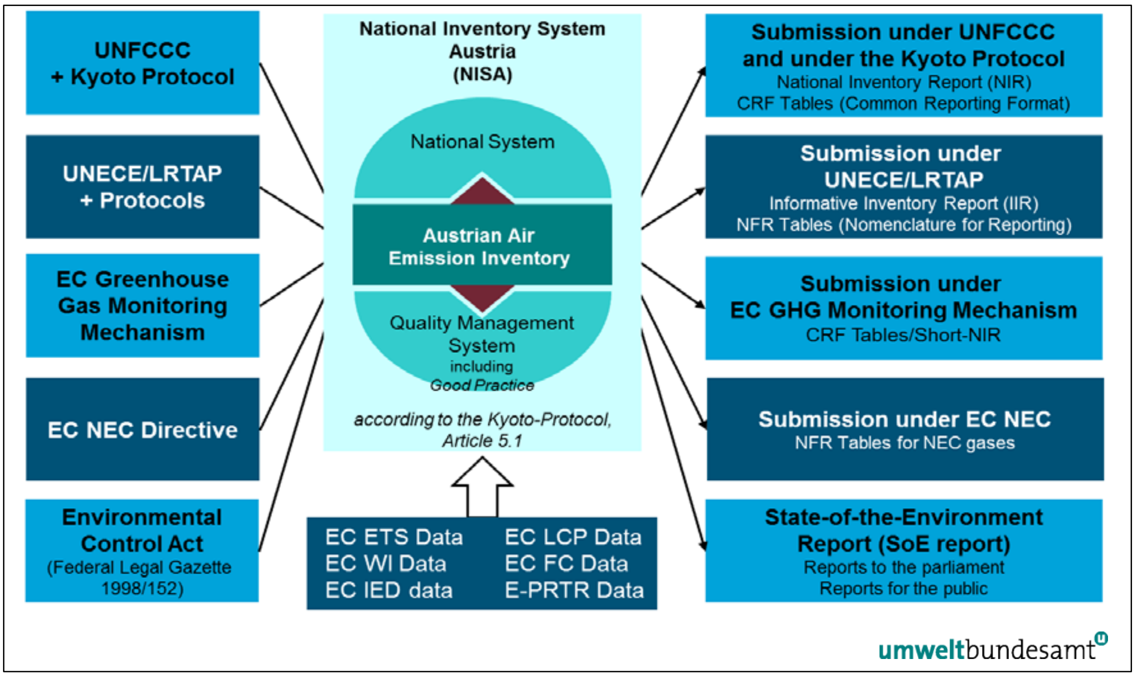

Figure 2: Structure of the National Emission Inventory System Austria (NISA).

[30] http://www.unece.org/environmental-policy/conventions/envlrtapwelcome/convention-bodies/executive-body.html

[31] http://www.unece.org/fileadmin/DAM/env/documents/2002/eb/ge1/eb.air.ge.1.2002.7.e.pdf

1.2.3 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 enfolds 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)[32/33] 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)[34] 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 (**N**omenclature **f**or **R**eporting – NFR (latest version of the templates 'NFR14'[35] dated 17.4.2014)) as well as standards for providing supporting documentation which should ensure the transparency of the inventory.

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[32] http://www.ceip.at/fileadmin/inhalte/emep/reporting_2009/Rep_Guidelines_ECE_EB_AIR_97_e.pdf

[33] 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.

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

[35] 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 2014
2. Particulate matter	$PM_{2.5}$, PM_{10}, TSP, (BC)	for 1990, 1995, and for 2000 to 2014
3. Heavy metals	Pb, Cd, Hg, (*As, Cr, Cu, Ni, Se, Zn)*	from 1990 to 2014
4. POPs	PCDD/PCDF, PAHs [2], HCB, PCBs	from 1990 to 2014
B. Emissions by NFR source category		
1. Main pollutants	SO_x, NO_x, NH_3, NMVOC, CO	from 1990 to 2014
2. Particulate matter	$PM_{2.5}$, PM_{10}, TSP, (BC)	for 1990, 1995, and for 2000 to 2014
3. Heavy metals	Pb, Cd, Hg, *As, Cr, Cu, Ni, Se, Zn*	from 1990 to 2014
4. POPs	PCDD/PCDF, PAHs [2], HCB, PCBs	from 1990 to 2014
C. Activity data by source category		**from 1990 to 2014**
D. Gridded data in the EMEP 0.1x0.1 long/lat grid		
1. Sector emissions 2. National totals	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
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}

1.3 Inventory Preparation Process

The present Austrian Air Emission Inventory (OLI) for the period 1990 to 2014 was compiled according to the recommendations for inventories as set out by the UNECE Executive Body[36] and in the guidelines mentioned above.

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

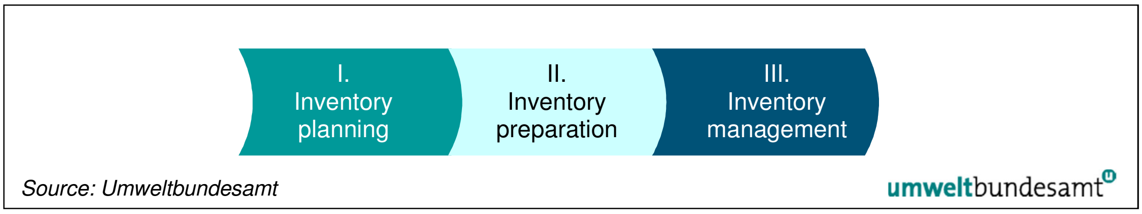

Figure 3: Three stages of inventory preparation.

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.

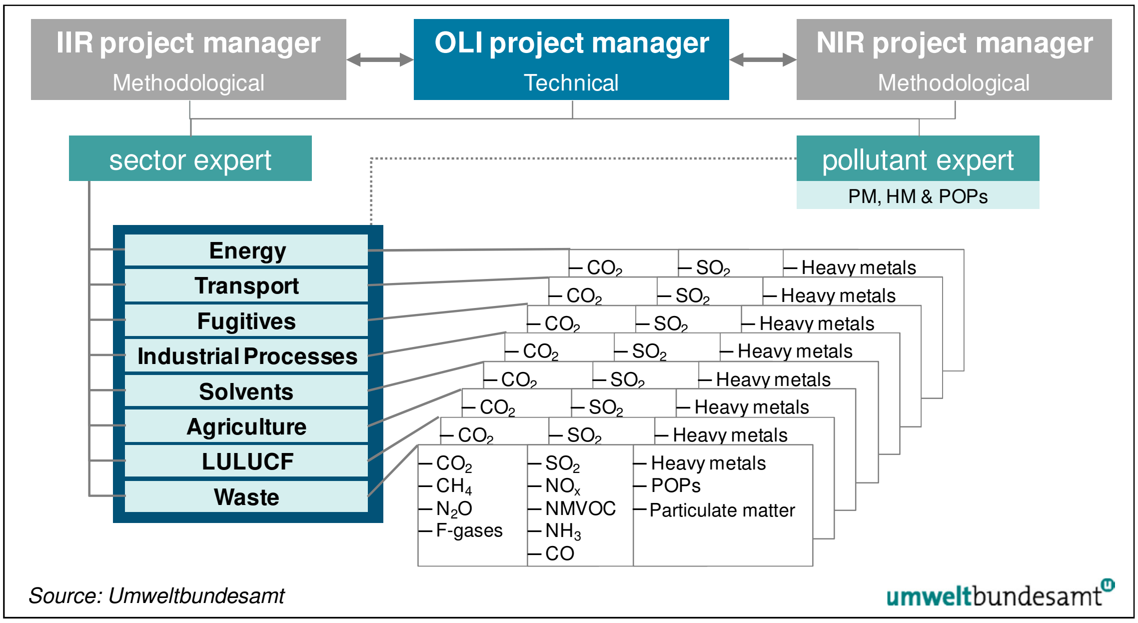

Figure 4: Roles and responsibilities within the National Emission Inventory System Austria (NISA).

[36] 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 CORINAIR[37] scheme, which was formerly also used as reporting format under the UNECE. This nomenclature was designed by the ETC/ACC[38] to estimate emissions of all kind of air pollutants as well as greenhouse gases.

The CORINAIR system's nomenclature is called SNAP,[39] 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 – the NFR[40] 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/LRTAP.

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.

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37 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)

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

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

40 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

1.4 Methodologies and Data Sources Used

The following table presents the main data sources used for activity data as well as information on who did the actual calculations (for unpublished studies a detailed description of the methodologies is given in this report).

Table 4: Main data sources for activity data and emission values.

Sector	Data Sources for Activity Data	Emission Calculation
1 Energy	Energy Balance from Statistik Austria; EU-ETS Steam boiler database direct information from industry or associations of industry	Umweltbundesamt, plant operators
1.A.3 Transport	Energy balance from STATISTIK AUSTRIA	Umweltbundesamt (Aviation) Technical University Graz (Road and Off-road transport)
2 Industry	National production statistics from STATISTIK AUSTRIA Austrian foreign trade statistics from STATISTIK AUSTRIA EU Emission Trading Scheme (ETS) Direct information from industry or associations of industry	Umweltbundesamt, plant operators F-gases based on a study by: Öko-Recherche GmbH (2010, update 2011)
2.D Solvent Use	Short term statistics for trade & services Austrian foreign trade statistics Structural business statistics Surveys at companies and associations	Umweltbundesamt, based on studies by: Forschungsinstitut für Energie u. Umweltplanung, Wirtschaft und Marktanalysen/Institut für industrielle Ökologie (IIÖ)[41]
3 Agriculture	National Studies national agricultural statistics obtained from Statistik Austria	Umweltbundesamt, based on studies by: University of Natural Resources and Applied Life Sciences, ARC Seibersdorf research GesmbH
5 Waste	Federal Waste Management Plan (Data sources: Database on landfills (1998–2007), Electronic Data Management (EDM) in environment and waste management)	Umweltbundesamt

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 prefers to use – after careful assessment of plausibility of these data – emission data that are reported by the "operator" of the source. 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 are not available, 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 are found, standard emission factors e.g. from the EMEP/EEA air pollutant emission inventory guidebook 2013 are applied.

[41] Research Institute for Energy and Environmental Planning, Economy and Market Analysis Ltd./Institute for Industrial Ecology, Austria

Table 5 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).

Main Data Suppliers

- The main data supplier for the Austrian Air Emission Inventory is *STATISTIK AUSTRIA*[42], providing the underlying energy source data. The Austrian energy balances are based on several databases mainly prepared by the Federal Ministry of Science, Research and Economy,[43] "Bundeslastverteiler" and Statistik Austria. Their methodology follows the International Energy Agency (IEA)[44] and Eurostat[45] 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[46] classification.
- Information about activity data and emissions of the industry sector is obtained from *Association of the Austrian Industries*[47] or directly from individual plants. If emission data are reported (e.g. by the plant owner), these data are – after assessment of plausibility – taken over into the inventory. Activity data for some sources are obtained from Statistik Austria, which provides statistics on production data.[48]
- Operators of steam boilers with more than 50 MW report their emissions and their activity data directly to the 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 based on these data. Since 2009, landfill operators have to register and report their waste input directly at the portal of the Electronic Data Mangement. These data are evaluated by the responsible body at federal level (BMLFUW) and are made available for emission calculation. This was done for the first time for reporting year 2008.
- Activity data needed for the calculation of non-energetic emissions are based on several statistics collected by Statistik Austria as well as national and international studies.
- Activity data for Solvent Use are based on import/export statistics, also prepared by STATISTIK AUSTRIA.

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[42] http://www.statistik.at/

[43] Bundesministerium für Wissenschaft, Forschung und Wirtschaft (BMWFW); http://www.bmwfw.gv.at/Seiten/default.aspx

[44] http://www.iea.org/

[45] http://ec.europa.eu/eurostat/de

[46] Classification of Economic Activities in the European Community

[47] Mainly organized in the Austrian Federal Economic Chamber; http://portal.wko.at/wk/startseite.wk

[48] "Industrie und Gewerbestatistik" published by STATISTIK AUSTRIA for the years until 1995; "Konjunkturstatistik im produzierenden Bereich" published by STATISTIK AUSTRIA for the years 1997 to 2006.

Data from the EU Emission trading Scheme

The European Emissions Trading Scheme (EU-ETS) has been established by Directive 2003/87/EC of the European Parliament and of the Council[49]. 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, CO_2 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.

At the moment, the greenhouse gases covered under the EU-ETS in Austria are CO_2 (since 2005) and N_2O (since 2010)[50]**.** About one third of total Austrian GHG emissions currently result from installations under the EU-ETS (~28 Mt CO_2 in 2014).

Plant operators have to report their activity data and emissions annually; 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.

An important feature of the activity data and CO_2 and N_2O emissions reported under the EU-ETS is that these emissions have to pass independent verification by an accredited verifier. In addition, the Ministry has to fulfil a quality control function, which is implemented by spot checks of emissions and verification reports that Umweltbundesamt performs on behalf of the Ministry.

Data from EPER/E-PRTR

The European Pollutant Emission Register (EPER) was the first Europe-wide register for emissions from industrial facilities both into air and water. The legal basis of EPER is Article 15 of the IPPC Directive (EPER Decision 2000/479/EG), which stipulates that information on environmental pollution has to be provided to the public.[51] The reporting years under EPER were 2001 or 2002 and 2004. EPER was replaced by the European Pollutant Release and Transfer Register (E-PRTR) in 2007, which was established by the E-PRTR Regulation (EC) No. 166/2006.[52]

E-PRTR 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 includes data on releases into soil, accidental releases, waste transfers and diffuse emissions.

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 Umweltbundesamt. Umweltbundesamt also checks the data for consistency with the national inventory.

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49 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

50 Austria unilaterally opted-in N_2O as of 2010. Since 2013 N_2O and PFCs have been included in the EU ETS at EU level.

51 Data can be downloaded from**:** http://www.umweltbundesamt.at/umweltdaten/datenbanken10/eper/

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

Data from EPER/E-PRTR has so far not been used as a data source for the national inventory. On the one hand, this is due to the high reporting thresholds. On the other hand, the EPER/E-PRTR 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, EPER/E-PRTR 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.

Thus 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.

Data from the 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 the 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) fulfilling their reporting obligations according to national legislation, e.g. on landfilled amounts.

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.[53] 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).

  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).

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[53] ORTHOFER, R. (1996); HÜBNER, C. (1996); HÜBNER, C. & WURST, F. (1997); HÜBNER, C. (2000)

- 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 österreischen 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.

Summary of methodologies applied for estimating emissions

In Table 5 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 5: 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	NMVOC	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															
3.B.1	Cattle				CS											
3.B.2	Sheep				D											
3.B.3	Swine				CS											
3.B.4.d	Goats				D											
3.B.4.e	Horses				D											
3.B.4.g	Poultry				D											
3.B.4.h	Other animals				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				
3.I	Agriculture – Other													D	D	D
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 2013" (EEA 2013)". It stipulates that a key category is one that is prioritised within the national inventory system because its 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, 2013).

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 the be slected for key categories. Invetory compilers should use the category specific methods presented in sectoral decision tress lin the sectoral volumes;
- that the analysis should be performed at the level of NFR categories or subcategoreis 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 subcategoreis are particulary significant usually, for this purpose, the subcategories should be ranked according to their contribution to the aggregate key categories. Those subcategoreis 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 2013.

The identification includes all NFR categories and all reported gases

- SO_2, NO_x, NMVOC, NH_3, CO
- PM: TSP, PM_{10}, $PM_{2.5}$
- 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 2013 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 2016 to the UNECE/LRTAP. For all gases a level assessment for all years 1990 (base year) and 2014 (last year), as well as a trend assessment for 1990 to 2014 was prepared.

1.A Combustion Activities

1.A Combustion Activities is the most important sector for emissions reported to UNECE. 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 (internatinal 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 procecces 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	Domextic 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 Producion	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. electricial 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 NH_3. 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 an 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 41 key sources were identified.

Table 6: Summary of Key Categories for the year 2014 – 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	LA	TA		
1.A.1.a	Public Electricity and Heat Production	8	7	7	4							11	8	12	7	16				5								3		5	6	***99***	***6***
1.A.1.b	Petroleum refining				5							15	17																			***36***	***19***
1.A.2.a	Iron and Steel	33	23							25	14																					***96***	***7***
1.A.2.b	Non-ferrous Metals																				27											***27***	***24***
1.A.2.d	Pulp, Paper and Print	7										9				8											3		3		4	***33***	***20***
1.A.2.f	Non-metallic Minerals	7	4	4						3	4		8			16	23					77	53									***200***	***3***
1.A.2.g.7	Mobile Combustion in Manufacturing Industries and Construction			4	11														4							4	5	4	3	3		***39***	***18***
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	17	14	4	8								9	6	4				5	9	8					3	6	5	9	9	16	***131***	***5***
1.A.3.b.1	R.T., Passenger cars			21	30	4	32			9	42				43													3		5	3	***193***	***4***
1.A.3.b.2	R.T., Light duty vehicles			4	4						5																					***13***	***27***
1.A.3.b.3	R.T., Heavy duty vehicles			27	12						3								7								4	2	5	4	7	***71***	***11***
1.A.3.b.4	R.T., Mopeds & Motorcycles									3	4																					***7***	***30***
1.A.3.b.5	R.T., Gasoline evap.						4																									***4***	***38***
1.A.3.b.7	R.T., Automobile road abrasion											8	9													17	16	10	10	6	7	***83***	***9***

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	LA	TA		
1.A.3.c	Railways																									3						***3***	***40***
1.A.4.a.1	Commer-cial/Institutional: Stationary		6																													***6***	***33***
1.A.4.b.1	Residential: sta-tionary	7	26	6		19				38	9	17		10	5	13	7	66	39	46	19	15	27			11	11	18	9	31	5	***455***	***1***
1.A.4.b.2	Residential: Household and gardening (mobile)									3																						***3***	***39***
1.A.4.c.1	Agriculture/ Forest-ry/ Fishing: Sta-tionary						2						6					12	23	8	7									3	3	***64***	***14***
1.A.4.c.2	Agriculture/ Forest-ry/ Fishing: Off-road ery			4																						2	4	3	5	5	7	***30***	***21***
1.B.2.a	Oil						4																									***4***	***34***
2.A.5	Mining, construc-tion/demolition and handling of prod-ucts																									23	15	20	15	4	4	***81***	***10***
2.B-10	Handling of prod-ucts and other chemical industry				7		3										18															***28***	***23***
2.C.1	Iron and Steel Production											21	15	47	21	35	32	4		11	12				25		19		18		14	***273***	***2***
2.C.3	Aluminium produc-tion																			4												***4***	***35***
2.C.5	Lead Production												7	6										54	25							***92***	***8***
2.C.7	Other metal produc tion																							29	35							***63***	***15***
2.D.3.a	Domestic solvent use including fun-gicides					21	29																									***50***	***16***

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	LA	TA	LA	TA		
2.D.3.d	Coating applica-tions					16																												***16***	***26***
2.D.3.e	Degreasing					7	4																											***10***	***28***
2.D.3.g	Chemical products					4																												***4***	***36***
2.D.3.h	Printing					4																												***4***	***37***
2.D.3.i	Other solvent use					7																												***7***	***32***
2.G	Other product manufacture and use																																2	***2***	***41***
2.H	Other Processes						4												6															***10***	***29***
3.B.1	Cattle							25	19																									***44***	***17***
3.B.3	Swine							9	19																									***29***	***22***
3.D.a.1	Inorganic N-fertilizers							8	13																	18		14	5	6	4	***66***	***13***
3.D.a.2	Organic fertilizers				3			42	23																									***68***	***12***
5.B.1	Composting								7																									***7***	***31***
5.C.1	Waste incineration												7								10													***17***	***25***

Table 7: Key Categories for SO_2 emissions for the year 2014.

Level Assessment				
NFR Code	**NFR Category**	**Latest Year (2014) Estimate [kt] $E_{x,t}$**	**Level Assessment $L_{x,t}$**	**Cumulative Total of $L_{x,t}$**
1.A.2.a	Iron and Steel	5.34	33.3%	33.3%
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	2.70	16.8%	50.2%
1.A.1.a	Public Electricity and Heat Production	1.31	8.2%	58.4%
1.A.4.b.1	Residential: stationary	1.19	7.4%	65.8%
1.A.2.f	Non-metallic Minerals	1.19	7.4%	73.2%
1.A.2.d	Pulp, Paper and Print	1.10	6.8%	80.0%
	National Total	**16.02**		

Trend Assessment						
NFR Code	**NFR Category**	**'Base Year' (1990) Estimate [kt] $E_{x,0}$**	**Latest Year (2014) Estimate [kt] $E_{x,t}$**	**Trend Assessment $L_{x,t}$**	**Contribution to the trend**	**Cumulative Total of $L_{x,t}$**
1.A.4.b.1	Residential: stationary	25.86	1.19	1.269	26.1%	26.1%
1.A.2.a	Iron and Steel	6.73	5.34	1.130	23.2%	49.3%
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	1.96	2.70	0.660	13.6%	62.8%
1.A.1.a	Public Electricity and Heat Production	11.79	1.31	0.355	7.3%	70.1%
1.A.4.a.1	Commercial/Institutional: Stationary	5.24	0.12	0.291	6.0%	76.1%
1.A.2.f	Non-metallic Minerals	2.23	1.19	0.205	4.2%	80.3%
	National Total	**74.45**	**16.02**			

Table 8: Key Categories for NO_x emissions for the year 2014.

Level Assessment				
NFR Code	**NFR Category**	**Latest Year (2014) 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	40.26	26.7%	26.7%
1.A.3.b.1	R.T., Passenger cars	32.38	21.4%	48.1%
1.A.1.a	Public Electricity and Heat Production	10.02	6.6%	54.7%
1.A.4.b.1	Residential: stationary	8.82	5.8%	60.6%
1.A.2.g.7	Mobile Combustion in Manufacturing Industries and Construction	6.77	4.5%	65.1%
1.A.4.c.2	Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	6.59	4.4%	69.4%
1.A.3.b.2	R.T., Light duty vehicles	6.56	4.3%	73.8%
1.A.2.f	Non-metallic Minerals	6.21	4.1%	77.9%
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	6.07	4.0%	81.9%
	National Total	**151.03**		

Trend Assessment						
NFR Code	**NFR Category**	**'Base Year' (1990) Estimate [kt] $E_{x,0}$**	**Latest Year (2014) 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	64.32	32.38	0.120	30.2%	30.2%
1.A.3.b.3	R.T., Heavy duty vehicles	50.60	40.26	0.046	11.5%	41.7%
1.A.2.g.7	Mobile Combustion in Manufacturing Industries and Construction	3.03	6.77	0.044	11.1%	52.8%
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	3.86	6.07	0.032	8.0%	60.9%
2.B-10	Handling of products and other chemical industry	4.07	0.08	0.026	6.6%	67.5%
1.A.1.b	Petroleum refining	4.32	1.02	0.019	4.8%	72.2%
1.A.3.b.2	R.T., Light duty vehicles	7.01	6.56	0.016	3.9%	76.2%
1.A.1.a	Public Electricity and Heat Production	12.05	10.02	0.015	3.8%	79.9%
3.D.a.2	Organic fertilizers	4.85	4.59	0.011	2.8%	82.8%
	National Total	**215.66**	**151.03**			

Table 9: Key Categories for NMVOC emissions for the year 2014.

Level Assessment

NFR Code	NFR Category	Latest Year (2014) Estimate [kt] $E_{x,t}$	Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$
2.D.3.a	Domestic solvent use including fungicides	23.30	21.1%	21.1%
1.A.4.b.1	Residential: stationary	21.07	19.1%	40.2%
2.D.3.d	Coating applications	17.21	15.6%	55.7%
2.D.3.i	Other solvent use	7.82	7.1%	62.8%
2.D.3.e	Degreasing	7.41	6.7%	69.5%
2.D.3.g	Chemical products	4.32	3.9%	73.4%
2.D.3.h	Printing	4.15	3.8%	77.2%
1.A.3.b.1	R.T., Passenger cars	4.13	3.7%	80.9%
	National Total	**110.46**		

Trend Assessment

NFR Code	NFR Category	'Base Year' (1990) Estimate [kt] $E_{x,0}$	Latest Year (2014) 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	58.39	4.13	0.433	32.1%	32.1%
2.D.3.a	Domestic solvent use including fungicides	16.30	23.30	0.388	28.8%	60.8%
1.B.2.a	Oil	11.44	1.90	0.060	4.4%	65.3%
2.H	Other Processes	2.29	3.32	0.056	4.1%	69.4%
2.D.3.e	Degreasing	13.26	7.41	0.050	3.7%	73.1%
1.A.3.b.5	R.T., Gasoline evaporation	5.88	0.24	0.048	3.5%	76.6%
2.B-10	Handling of products and other chemical industry	8.29	1.32	0.045	3.3%	79.9%
1.A.4.c.1	Agriculture/Forestry/Fishing: Stationary	0.35	1.58	0.033	2.5%	82.4%
	National Total	**280.68**	**110.46**			

Table 10: Key Categories for NH_3 emissions for the year 2014.

Level Assessment				
NFR Code	**NFR Category**	**Latest Year (2014) Estimate [kt] $E_{x,t}$**	**Level Assessment $L_{x,t}$**	**Cumulative Total of $L_{x,t}$**
3.D.a.2	Organic fertilizers	28.42	42.4%	42.4%
3.B.1	Cattle	16.78	25.0%	67.5%
3.B.3	Swine	6.28	9.4%	76.8%
3.D.a.1	Inorganic N-fertilizers	5.27	7.9%	84.7%
	National Total	**66.99**		

Trend Assessment						
NFR Code	**NFR Category**	**'Base Year' (1990) Estimate [kt] $E_{x,0}$**	**Latest Year (2014) 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	30.89	28.42	0.040	23.1%	23.1%
3.B.3	Swine	8.46	6.28	0.033	19.3%	42.4%
3.B.1	Cattle	14.48	16.78	0.032	18.8%	61.2%
3.D.a.1	Inorganic N-fertilizers	3.77	5.27	0.022	12.6%	73.8%
5.B.1	Composting	0.35	1.20	0.013	7.3%	81.0%
	National Total	**66.50**	**66.99**			

Table 11: Key Categories for CO emissions for the year 2014.

Level Assessment

NFR Code	NFR Category	Latest Year (2014) Estimate [kt] $E_{x,t}$	Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$
1.A.4.b.1	Residential: stationary	202.96	37.8%	37.8%
1.A.2.a	Iron and Steel	134.64	25.1%	62.8%
1.A.3.b.1	R.T., Passenger cars	48.51	9.0%	71.9%
1.A.3.b.4	R.T., Mopeds & Motorcycles	17.59	3.3%	75.1%
1.A.4.b.2	Residential: Household and gardening (mobile)	17.14	3.2%	78.3%
1.A.2.f	Non-metallic Minerals	16.92	3.1%	81.5%
	National Total	**537.33**		

Trend Assessment

NFR Code	NFR Category	'Base Year' (1990) Estimate [kt] $E_{x,0}$	Latest Year (2014) 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	437.47	48.51	0.598	41.6%	41.6%
1.A.2.a	Iron and Steel	210.72	134.64	0.208	14.5%	56.1%
1.A.4.b.1	Residential: stationary	416.15	202.96	0.130	9.0%	65.1%
1.A.3.b.2	R.T., Light duty vehicles	44.89	1.97	0.075	5.2%	70.3%
1.A.3.b.4	R.T., Mopeds & Motorcycles	9.86	17.59	0.060	4.2%	74.5%
1.A.2.f	Non-metallic Minerals	11.03	16.92	0.055	3.8%	78.3%
1.A.3.b.3	R.T., Heavy duty vehicles	8.94	14.06	0.046	3.2%	81.5%
	National Total	**1 286.26**	**537.33**			

Table 12: Key Categories for Cd emissions for the year 2014.

Level Assessment				
NFR Code	**NFR Category**	**Latest Year (2014) Estimate [t] $E_{x,t}$**	**Level Assessment $L_{x,t}$**	**Cumulative Total of $L_{x,t}$**
2.C.1	Iron and Steel Production	0.24	20.8%	20.8%
1.A.4.b.1	Residential: stationary	0.19	16.9%	37.7%
1.A.1.b	Petroleum refining	0.17	14.7%	52.4%
1.A.1.a	Public Electricity and Heat Production	0.13	10.9%	63.3%
1.A.2.d	Pulp, Paper and Print	0.10	8.5%	71.8%
1.A.3.b.7	R.T., Automobile road abrasion	0.10	8.3%	80.1%
	National Total	**1.15**		

Trend Assessment						
NFR Code	**NFR Category**	**'Base Year' (1990) Estimate [t] $E_{x,0}$**	**Latest Year (2014) Estimate [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	0.17	0.126	16.8%	16.8%
2.C.1	Iron and Steel Production	0.46	0.24	0.110	14.7%	31.5%
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	0.03	0.08	0.070	9.3%	40.8%
1.A.3.b.7	R.T., Automobile road abrasion	0.06	0.10	0.065	8.7%	49.6%
1.A.1.a	Public Electricity and Heat Production	0.10	0.13	0.060	8.1%	57.6%
1.A.2.f	Non-metallic Minerals	0.10	0.02	0.057	7.6%	65.2%
2.C.5	Lead Production	0.07	0.01	0.053	7.0%	72.3%
5.C.1	Waste incineration	0.06	0.00	0.050	6.7%	79.0%
1.A.4.c.1	Agriculture/Forestry/Fishing: Stationary	0.03	0.06	0.046	6.1%	85.1%
	National Total	**1.58**	**1.15**			

Table 13: Key Categories for Pb emissions for the year 2014.

Level Assessment

NFR Code	NFR Category	Latest Year (2014) Estimate [t] $E_{x,t}$	Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$
2.C.1	Iron and Steel Production	7.15	47.3%	47.3%
1.A.1.a	Public Electricity and Heat Production	1.82	12.0%	59.3%
1.A.4.b.1	Residential: stationary	1.52	10.1%	69.4%
2.C.5	Lead Production	0.89	5.9%	75.3%
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	0.88	5.9%	81.2%
	National Total	**15.11**		

Trend Assessment

NFR Code	NFR Category	'Base Year' (1990) Estimate [t] $E_{x,0}$	Latest Year (2014) 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	144.54	0.00	9.561	43.3%	43.3%
2.C.1	Iron and Steel Production	32.09	7.15	4.611	20.9%	64.1%
1.A.1.a	Public Electricity and Heat Production	0.90	1.82	1.649	7.5%	71.6%
1.A.4.b.1	Residential: stationary	3.82	1.52	1.183	5.4%	76.9%
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	0.14	0.88	0.824	3.7%	80.7%
	National Total	**215.07**	**15.11**			

Table 14: Key Categories for Hg emissions for the year 2014.

Level Assessment				
NFR Code	**NFR Category**	**Latest Year (2014) Estimate [t] $E_{x,t}$**	**Level Assessment $L_{x,t}$**	**Cumulative Total of $L_{x,t}$**
2.C.1	Iron and Steel Production	0.34	34.9%	34.9%
1.A.2.f	Non-metallic Minerals	0.15	16.1%	51.1%
1.A.1.a	Public Electricity and Heat Production	0.15	15.9%	67.0%
1.A.4.b.1	Residential: stationary	0.12	12.9%	79.9%
1.A.2.d	Pulp, Paper and Print	0.07	7.7%	87.7%
	National Total	**0.96**		

Trend Assessment						
NFR Code	**NFR Category**	**'Base Year' (1990) Estimate [t] $E_{x,0}$**	**Latest Year (2014) 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	0.34	0.512	32.4%	32.4%
1.A.2.f	Non-metallic Minerals	0.70	0.15	0.370	23.4%	55.8%
2.B-10	Handling of products and other chemical industry	0.27	0.00	0.281	17.8%	73.6%
1.A.4.b.1	Residential: stationary	0.39	0.12	0.114	7.2%	80.8%
	National Total	**2.14**	**0.96**			

Table 15: Key Categories for PAH emissions for the year 2014.

Level Assessment

NFR Code	NFR Category	Latest Year (2014) Estimate [t] $E_{x,t}$	Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$
1.A.4.b.1	Residential: stationary	3.20	65.5%	65.5%
1.A.4.c.1	Agriculture/Forestry/Fishing: Stationary	0.59	12.0%	77.5%
2.C.1	Iron and Steel Production	0.20	4.0%	81.6%
	National Total	**4.89**		

Trend Assessment

NFR Code	NFR Category	'Base Year' (1990) Estimate [t] $E_{x,0}$	Latest Year (2014) 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	7.92	3.20	0.561	38.7%	38.7%
1.A.4.c.1	Agriculture/Forestry/Fishing: Stationary	0.35	0.59	0.328	22.6%	61.3%
1.A.3.b.3	R.T., Heavy duty vehicles	0.05	0.16	0.101	7.0%	68.3%
2.H	Other Processes	0.55	0.04	0.086	6.0%	74.2%
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	0.02	0.11	0.072	4.9%	79.2%
1.A.2.g.7	Mobile Combustion in Manufacturing Industries and Construction	0.02	0.10	0.065	4.5%	83.6%
	National Total	**16.27**	**4.89**			

Table 16: Key Categories for PCDD/F/Furan emissions for the year 2014.

Level Assessment

NFR Code	NFR Category	Latest Year (2014) Estimate [g] $E_{x,t}$	Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$
1.A.4.b.1	Residential: stationary	14.57	46.1%	46.1%
2.C.1	Iron and Steel Production	3.42	10.8%	56.9%
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	2.78	8.8%	65.7%
1.A.4.c.1	Agriculture/Forestry/Fishing: Stationary	2.64	8.3%	74.1%
1.A.1.a	Public Electricity and Heat Production	1.44	4.6%	78.6%
2.C.3	Aluminium production	1.26	4.0%	82.6%
	National Total	**31.61**		

Trend Assessment

NFR Code	NFR Category	'Base Year' (1990) Estimate [g] $E_{x,0}$	Latest Year (2014) 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	1.459	27.1%	27.1%
1.A.4.b.1	Residential: stationary	41.73	14.57	1.022	19.0%	46.2%
2.C.1	Iron and Steel Production	37.21	3.42	0.626	11.7%	57.8%
5.C.1	Waste incineration	18.19	0.16	0.549	10.2%	68.1%
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	0.46	2.78	0.433	8.1%	76.1%
1.A.4.c.1	Agriculture/Forestry/Fishing: Stationary	1.68	2.64	0.371	6.9%	83.0%
	National Total	**160.69**	**31.61**			

Table 17: Key Categories for HCB emissions for the year 2014.

Level Assessment

NFR Code	NFR Category	Latest Year (2014) Estimate [kg] $E_{x,t}$	Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$
1.A.2.f	Non-metallic Minerals	107.91	76.6%	76.6%
1.A.4.b.1	Residential: stationary	21.79	15.5%	92.0%
	National Total	**140.95**		

Trend Assessment

NFR Code	NFR Category	'Base Year' (1990) Estimate [kg] $E_{x.0}$	Latest Year (2014) Estimate [kg] $E_{x.t}$	Trend Assessment $L_{x.t}$	Contribution to the trend	Cumulative Total of $L_{x.t}$
1.A.2.f	Non-metallic Minerals	0.06	107.91	0.499	53.4%	53.4%
1.A.4.b.1	Residential: stationary	50.28	21.79	0.256	27.4%	80.8%
	National Total	**91.93**	**140.95**			

Table 18: Key Categories for PCB emissions for the year 2014.

Level Assessment

NFR Code	NFR Category	Latest Year (2014) Estimate [kg] $E_{x,t}$	Level Assessment $L_{x,t}$	Cumulative Total of $L_{x,t}$
2.C.5	Lead Production	118.79	54.4%	54.4%
2.C.7	Other metal production	62.85	28.8%	83.2%
	National Total	**218.30**		

Trend Assessment

NFR Code	NFR Category	'Base Year' (1990) Estimate [kg] $E_{x.0}$	Latest Year (2014) Estimate [kg] $E_{x.t}$	Trend Assessment $L_{x.t}$	Contribution to the trend	Cumulative Total of $L_{x.t}$
2.C.7	Other metal production	71.77	62.85	0.073	34.6%	34.6%
2.C.1	Iron and Steel Production	19.34	34.73	0.053	25.3%	59.9%
2.C.5	Lead Production	94.40	118.79	0.052	24.7%	84.6%
	National Total	**194.23**	**218.30**			

Table 19: Key Categories for TSP emissions for the year 2014.

Level Assessment

NFR Code	NFR Category	Latest Year (2014) 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	12.97	23.5%	23.5%
3.D.a.1	Inorganic N-fertilizers	9.68	17.5%	41.0%
1.A.3.b.7	R.T., Automobile road abrasion	9.52	17.2%	58.2%
1.A.4.b.1	Residential: stationary	6.23	11.3%	69.5%
1.A.2.g.7	Mobile Combustion in Manufacturing Industries and Construction	2.09	3.8%	73.2%
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	1.91	3.4%	76.7%
1.A.3.c	Railways	1.64	3.0%	79.6%
1.A.4.c.2	Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	1.23	2.2%	81.9%
	National Total	**55.29**		

Trend Assessment

NFR Code	NFR Category	'Base Year' (1990) Estimate [kt] $E_{x,0}$	Latest Year (2014) 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	0.80	0.100	18.5%	18.5%
1.A.3.b.7	R.T., Automobile road abrasion	5.86	9.52	0.087	16.0%	34.5%
2.A.5	Mining, construction/demolition and handling of products	9.97	12.97	0.082	15.1%	49.6%
1.A.4.b.1	Residential: stationary	10.27	6.23	0.060	11.1%	60.7%
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	0.36	1.91	0.032	5.9%	66.6%
1.A.2.g.7	Mobile Combustion in Manufacturing Industries and Construction	0.89	2.09	0.026	4.8%	71.4%
1.A.3.b.3	R.T., Heavy duty vehicles	1.93	0.69	0.021	3.8%	75.3%
1.A.4.c.2	Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	2.46	1.23	0.020	3.6%	78.9%
1.A.2.d	Pulp, Paper and Print	1.06	0.24	0.014	2.6%	81.5%
	National Total	**61.80**	**55.29**			

Table 20: Key Categories for PM_{10} emissions for the year 2014.

Level Assessment

NFR Code	NFR Category	Latest Year (2014) 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	6.15	19.6%	19.6%
1.A.4.b.1	Residential: stationary	5.68	18.1%	37.7%
3.D.a.1	Inorganic N-fertilizers	4.36	13.9%	51.6%
1.A.3.b.7	R.T., Automobile road abrasion	3.17	10.1%	61.7%
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	1.72	5.5%	67.2%
1.A.2.g.7	Mobile Combustion in Manufacturing Industries and Construction	1.11	3.5%	70.7%
1.A.1.a	Public Electricity and Heat Production	1.03	3.3%	74.0%
1.A.4.c.2	Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	0.99	3.1%	77.1%
1.A.3.b.1	R.T., Passenger cars	0.88	2.8%	79.9%
1.A.3.b.3	R.T., Heavy duty vehicles	0.69	2.2%	82.1%
	National Total	**31.39**		

Trend Assessment

NFR Code	NFR Category	'Base Year' (1990) Estimate [kt] $E_{x,0}$	Latest Year (2014) 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	0.56	0.122	17.7%	17.7%
2.A.5	Mining, construction/demolition and handling of products	4.73	6.15	0.101	14.6%	32.4%
1.A.3.b.7	R.T., Automobile road abrasion	1.95	3.17	0.067	9.8%	42.2%
1.A.4.b.1	Residential: stationary	9.32	5.68	0.065	9.4%	51.6%
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	0.33	1.72	0.060	8.7%	60.3%
1.A.3.b.3	R.T., Heavy duty vehicles	1.93	0.69	0.033	4.8%	65.1%
3.D.a.1	Inorganic N-fertilizers	4.56	4.36	0.033	4.7%	69.8%
1.A.4.c.2	Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	2.24	0.99	0.031	4.5%	74.3%
1.A.2.g.7	Mobile Combustion in Manufacturing Industries and Construction	0.69	1.11	0.023	3.4%	77.7%
1.A.2.d	Pulp, Paper and Print	0.95	0.21	0.022	3.1%	80.8%
	National Total	**40.24**	**31.39**			

Table 21: Key Categories for $PM_{2.5}$ emissions for the year 2014.

Level Assessment				
NFR Code	**NFR Category**	**Latest Year (2014) Estimate [kt] $E_{x,t}$**	**Level Assessment $L_{x,t}$**	**Cumulative Total of $L_{x,t}$**
1.A.4.b.1	Residential: stationary	5.13	30.9%	30.9%
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Construction	1.43	8.6%	39.5%
3.D.a.1	Inorganic N-fertilizers	0.97	5.8%	45.4%
1.A.3.b.7	R.T., Automobile road abrasion	0.95	5.7%	51.1%
1.A.3.b.1	R.T., Passenger cars	0.88	5.3%	56.4%
1.A.1.a	Public Electricity and Heat Production	0.86	5.2%	61.5%
1.A.4.c.2	Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	0.84	5.0%	66.6%
1.A.3.b.3	R.T., Heavy duty vehicles	0.69	4.2%	70.8%
2.A.5	Mining, construction/demolition and handling of products	0.68	4.1%	74.9%
1.A.2.g.7	Mobile Combustion in Manufacturing Industries and Construction	0.52	3.1%	78.0%
1.A.4.c.1	Agriculture/Forestry/Fishing: Stationary	0.45	2.7%	80.8%
	National Total	**16.61**		

Trend Assessment						
NFR Code	**NFR Category**	**'Base Year' (1990) Estimate [kt] $E_{x,0}$**	**Latest Year (2014) Estimate [kt] $E_{x,t}$**	**Trend Assess-ment $L_{x,t}$**	**Contribution to the trend**	**Cumulative Total of $L_{x,t}$**
1.A.2.g.8	Other Stationary Combustion in Manufacturing Industries and Con-struction	0.27	1.43	0.114	15.8%	15.8%
2.C.1	Iron and Steel Production	2.07	0.25	0.101	14.0%	29.8%
1.A.3.b.3	R.T., Heavy duty vehicles	1.93	0.69	0.053	7.3%	37.0%
1.A.3.b.7	R.T., Automobile road abrasion	0.59	0.95	0.052	7.1%	44.2%
1.A.4.c.2	Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	2.11	0.84	0.050	6.9%	51.1%
1.A.1.a	Public Electricity and Heat Production	0.64	0.86	0.040	5.5%	56.6%
1.A.4.b.1	Residential: stationary	8.37	5.13	0.035	4.8%	61.4%
1.A.2.d	Pulp, Paper and Print	0.78	0.17	0.031	4.3%	65.7%
2.A.5	Mining, construction/demolition and handling of products	0.53	0.68	0.030	4.2%	69.9%
3.D.a.1	Inorganic N-fertilizers	1.01	0.97	0.027	3.8%	73.7%
1.A.3.b.1	R.T., Passenger cars	1.72	0.88	0.023	3.2%	76.9%
1.A.4.c.1	Agriculture/Forestry/Fishing: Stationary	0.36	0.45	0.020	2.8%	79.7%
2.G	Other product manufacture and use	0.41	0.45	0.017	2.3%	82.0%
	National Total	**25.20**	**16.61**			

1.6 Quality Assurance and Quality Control (QA/QC)

For fulfillment of the reporting obligations as described in Chapter 1.2.1 a basic QA/QC system is mandatory.

However, the (former)[54] *Department of Air Emissions* of the Umweltbundesamt has decided to implement a QMS based on the International Standard ISO/IEC 17020 *General Criteria for the operation of various types of bodies performing inspections* which goes beyond these requirements: beside the elements of a QMS as in the ISO 9000 series it also focusses on the competence of the personnel, and ensures strict independence, impartiality and integrity of the accredited bodies. The implementation is audited by the Austrian Accreditation Body regularly every 15 months, and has to be renewed every five years. The accreditation as *Inspection Body for Emission Inventories* (IBE) according to ISO/IEC 17020 has been awarded in 2005 and renewed in 2011; the latest Re- Accreditation audit was successfully passed at the end of 2015.

As stated in the Quality Manual, 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 fulfillment 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.

3. Compliance with the 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.

The aim of the IBE is to provide an 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 convince 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 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 equally by the QMS.

[54] Now: Climate Change Mitigation & Emission Inventories

The Austrian Quality Management System (QMS) and requirements of the 2006 IPCC GL as well as the EMEP/EEA Guidebook 2013

The implementation of QA/QC procedures as required by the IPCC-GPG and the Good Practice for LRTAP Emission Inventories support the development of national greenhouse gas 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 emission inventory guidebook 2013 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).

Table 22: Overview of obligatory QAQC elements in different technical and quality standards

EMEP/EEA GB 2013[55]	IPCC 2006 GL	ISO 9001[56]	ISO/IEC 17020[57]
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[58]	-	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

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

56 Basic international standard for quality management and quality assurance

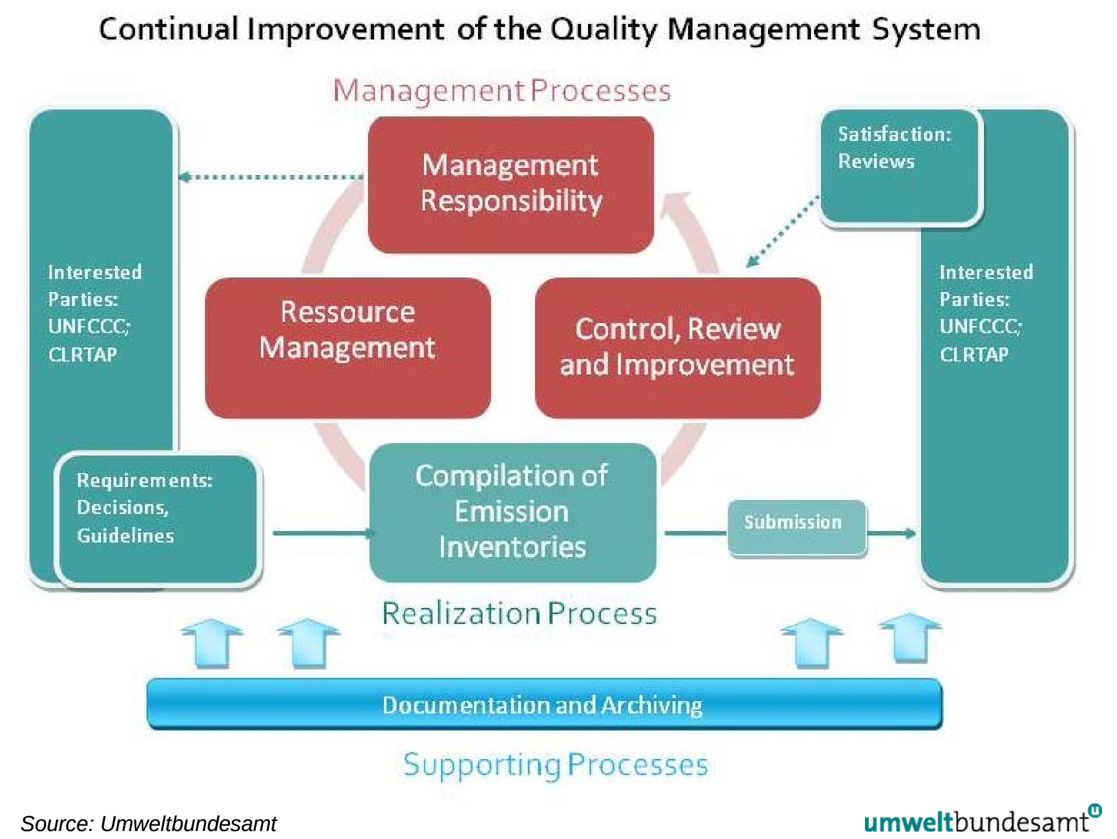
57 contains additional requirements compared to ISO 9001

58 According to the EMEP Guidebook 2013, it also is good practice to summarize lessons learned from previous inventory preparation cycles in an inventory management report.

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/



Source: Umweltbundesamt

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.

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,…)

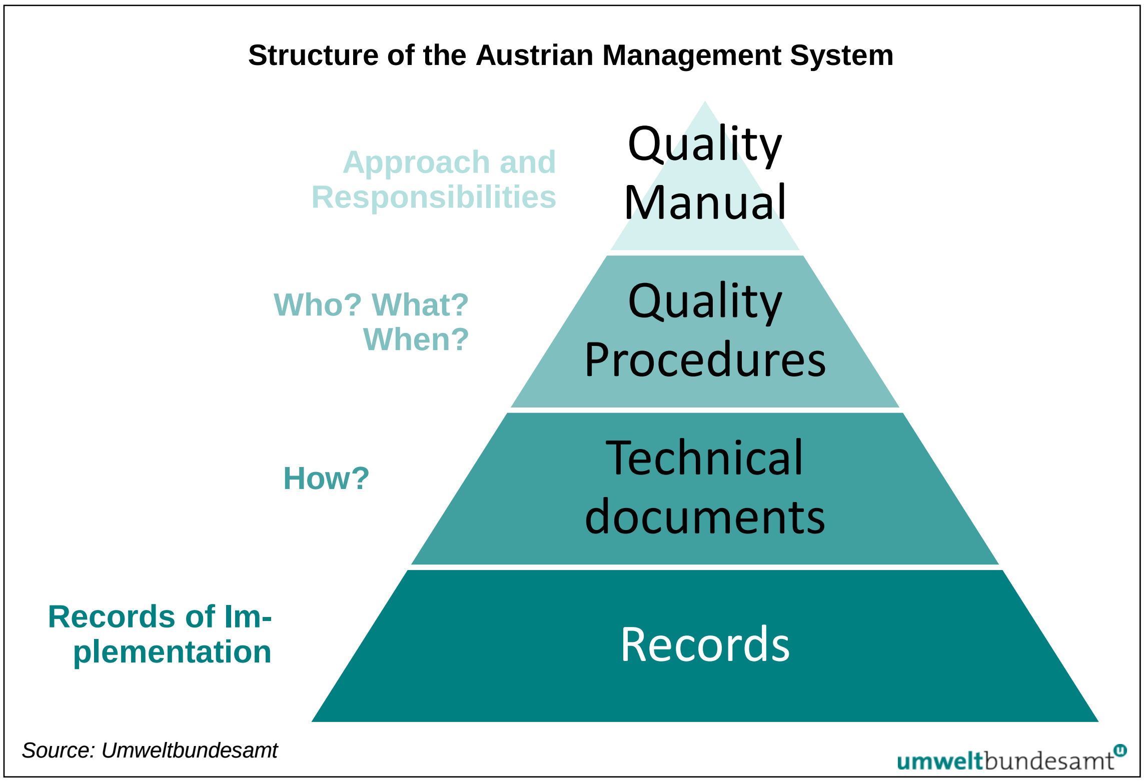


Figure 6: Structure of the Austrian Quality Management System (QMS).

QC Activities

QC activities are performed by the sector experts after inventory work has been finished. Where possible the checks are conducted by the sector expert that has not predominantly prepared the sectoral inventory in the particular year[59]. Additionally, electronic checks (e.g. check for completeness and comparison with last years' inventory) are performed by the project manager, who is also responsible for the data management of the inventory:

Tier 2/category specific: by the sector expert in the course of the inventory preparation

Tier 1/general:

- Step 1: QC by the sector expert after emissions have been estimated
- Step 2: QC by the data manager in the course of the preparation of the overall inventory
- Step 3: QC by the sector expert or deputy after inventory has been finished

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

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

The checklists cover all aspects as required according to Table 6.1 of the 2006 IPCC GL and Chapter 4.4 of the EMEP Guidebook 2013.

QC activities proved to be helpful to identify errors as well as lack in transparency before inventory data is published.

QA Activities

The following QA activities are performed:

Annual second party audits for every sector

Once a year the documentation of one emissions 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.

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[59] Within the inventory system specific responsibilities for the different emission source/sink categories ('Sector Experts') are defined. There are 8 sectors defined (Energy, Transport, Fugitive Emissions, IP, Solvents, Agriculture, LULUCF and Waste). Two experts form a sector team, whereas one team member is nominated as team leader ('Sector Lead').

Second party audits for work performed by sub-contractors

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

Accreditation audits *(*third party audits)

In the course of accreditation audits, the conformity of the QMS with the ISO/IEC 17020 and the implementation of the QMS are checked.

The last audit of the accreditation body took place in December 2015. These audits (obligatory every 15 months) 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.

Audits of data suppliers

Suppliers of annual data (activity data), that do not have in place a (certified) QMS or whose data are independently verified, are audited in a so-called input data audit. Since 2007, Statistik Austria (energy balance, agricultural statistical data, import/export as well as production statistics), the administrators of the landfill database, the data flow for landfill data in the EDM (electronic data management: replacement of the landfill database) and the Institute for Industrial Ecology (developed and updatet the solvent model) have been audited. Next, an audit of the National Forest Inventory is planned.

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:

- UNFCCC and UNECE/LRTAP Review: The last in-depth review (stage 3) took place in 2010; findings were commented in the IIR 2011 (UMWELTBUNDESAMT 2011b). The last stage 1 and 2 review took place in 2015.
- 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, project leader, sector experts etc.).

Archiving and documentation

Within the inventory system, a system for transparent documentation of inventory data and information (assumptions etc.) that allows the reproduction of the inventory is implemented. To allow clear references in documentation of the inventory, an archiving system for literature, mails, documents (e.g. review reports), calculations, with an access database containing the archived information is used. The archived documents are stored on a server and/or in the inventory archive (paper).

For each sector the documentation includes:

Documentation of the methodology:

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

Documentation of actual emission calculation:

- "logbook" (who did what and when),
- calculation file,
- references for activity data, emission factor and/or emissions, respectively,
- documentation of assumptions, sources of data and information, expert judgements etc. to allow full reproduction,
- recalculations,
- planned improvement,
- QC activitities.

Expert judements are documented following the 2006 IPCC GL and the EMEP/EEA GB 2013.

Focus of QA/QC activities in the year 2015

In 2015 the Re-Accreditation audit by a team of representatives appointed by the accreditation body has taken place 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. Such an audit is obligatory every 15 months. The final judgement of the auditor confirmed the compliance and practicability of the QM system, and stressed the high competence of the personnel.

The following QA/QC measures were implemented in 2015:

- Several adaptions of the Quality Manual and its procedures were made to better fit the technical requirements to practical circumstances (e.g. timely documentation, requirements on calculation sheets, obligatory write protection of xls sheets, etc.).
- New and adapted methods were described in more detail as technical instructions in 'Standard Operation Procedures' across all sectors. Excel sheets were validated.
- A new function 'Inventory Generalist' was established within the IBE.
- The Mutual Review New Zealand – Austria was continued in 2015. Focus was on QA/QC processes (tools and organizational aspects), experience with the CRF Reporter and the IPPU sector.

Furthermore the team was enlarged to form a team of two experts for every sector to enhance the resilience of the inventory system.

1.7 Uncertainty Assessment

The assessment of uncertainty is described in the "EMEP/EEA air pollutant emission inventory guidebook 2013" (EEA 2013)". General uncertainty evaluation has to be updated every 5 years or when major changes since the last report have occurred.

So far, no quantitative uncertainty assessment for any of the pollutants or pollutant groups relevant for this report has been made. For GHGs a comprehensive uncertainty assessment has already been performed.

However, the quality of estimates for all relevant pollutants has been rated using qualitative indicators as suggested in Chapter 5 of the EMEP/EEA emission inventory guidebook 2013 (EEA 2013). The definition of the ratings is given in Table 23, the ratings for the emission estimates are presented in Table 25.

Table 23: Definitions of qualitative rating.

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 2013.

Furthermore, for HM and POPs qualitative „quality indicators" have been assigned to each emission value, and based on these values, a „semi-quantitative" value for the overall uncertainty of the HM and POPs emission inventory was calculated. As uncertainties for HM and POP emissions are generally relatively high (related to uncertainties to e.g. main pollutants or CO_2) and often difficult to determine, this „semi-quantitative" approach is considered to be a good approximation.

First, the main influences on the uncertainty of emission data were identified and the criteria were graded for every emission source:

- Influence on the uncertainty mainly related to the emission factor
  - (i) data availability (1 = representative sample, 2–4 = fair/medium/poor data availability, 5 = no measured data/indirect estimation);
  - (ii) the variation of the emission values (difference of measured or reported values: 10^1 = 1, …, 10^5 or more = 5).
- Influence on the uncertainty mainly related to the activity data
  - (iii) the homogenity of emitters (1 = similar, …, 3 = different);
  - (iv) quality of activity data (1 = good, …, 3 = poor).

An arithmetic mean of the different grades was calculated; as the first two criteria have a higher impact on the uncertainty of the emission value, there were five grades were to choose from compared to three grades for the other two criteria. Thus the arithmetic mean is more dependent on the more important criteria. This resulted in a single quality indicator for each emission value.

To estimate the overall inventory uncertainty the quality indicators of the different emission sources were weighted according to the share in total emissions and the mean was calculated; This resulted in a single quality indicator for the overall inventory (for total emissions of one pollutant).

Statistically it can be deduced that an increase of the quality indicator by a value of 1 corresponds to a decrease in the quality and thus an increase in the variation by a factor of 2.

Finally, to calculate the variation of total emissions ("uncertainty") from of the weighted quality indicator the following assumption was made: as emission values are usually asymmetrically distributed, the „true" value (the value used for the inventory) reflects the geometrical mean value of the distribution. Using this assumption the variation of total emissions can be calculated using the following formula:

$$\frac{x}{\sqrt{2\exp(QI)}} \leq x \leq x \bullet \sqrt{2\exp(QI)}$$

QI…weighed quality indicator

x…"true" emission value (value used in the inventory)

The following table presents the results for HM and POPs. For POP emissions a factor of about 3 was determined, and a factor of about 2 for HM emissions. The same factors as for dioxins have been applied for PCB emissions.

Table 24: Variation of total emissions ("uncertainty") of HM and POP emissions.

Uncertainty[60]	**1999**		**2000**		
	Emission [kg]	**Variation**		**Emission [t]**	**Variation**
PCDD/F/Furan	0.18	0.08–0.4	Cd	0.97	0.5–2.1
HCB	47	20–130	Hg	0.88	0.5–1.7
PAHs	28 000	10 000–80 000	Pb	12.4	6.0–26

[60] The analysis was performed in 2001 for emission data of 1999 for POPs and 2000 for HM. As emissions have been recalculated since then the presented emission values differ slightly from values reported now.

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	Manuf. Ind. & Constr. - stationary	A	B	D	E	C	C	B	C	C	E	D	E	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 mob	Other Sectors – mobile	A	B	B	C	B	C	C	C	D	D	D		B	B	B
1.A.4 stat	Other Sectors -stationary	A	B	C	E	C	C	C	D	D	E	D	E	C	C	C
1.A.5	Other	B	C	C	D	C	C	C	C	D	D	D	D	C	C	C
1.B	FUGITIVE EMISSIONS	A		A										D	D	D
2.A	MINERAL PRODUCTS					C								D	D	D
2.B	CHEMICAL INDUSTRY	B	B	D	A	D	A	A	B					A	A	A

NFR	Description	SO_2	NO_x	NMVOC	NH_3	CO	Cd	Hg	Pb	PAH	Diox	HCB	PCB	TSP	PM_{10}	$PM_{2.5}$
2.C	METAL PRODUCTION	C	B	C		B	B	B	C	C	C	C	C	B	B	B
2.D.3	NON ENERGY PRODUCTS FROM FUELS /SOLVENT USE			A			B		B							
2.H	Other Processes		B	B		B				E	E	E		D	D	D
2.L	Other production				E											
3.B.1	Cattle				B											
3.B.2	Sheep				B											
3.B.3	Swine				B											
3.B.4.d	Goats				B											
3.B.4.e	Horses				B											
3.B.4.g	Poultry				B											
3.B.4.h	Other animals				B											
3.D	Agricultural Soils		B	E	B									D	D	D
3.F	Field burning of agricultural residues	E	E	E	E	E	E	E	E	E	E	E				
3.I	Agriculture – Other													D	D	D
5	WASTE	D	D	C	C	C	B	B	B	D	D	B		D	D	D

Abbreviations: see Table 23;
(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)

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.

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 report emissions from road vehicles based on fuel used in the geographic area of the Party.

In the report to the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP) emissions of the Austrian road transport sector are reported on the basis of fuel sold whereas in the report[61] under the National Emissions Ceiling Directive (NECD) they are accounted on the basis of 'fuel used'. The Austrian NEC Totals therefore differ from the LRTAP Totals presented in this report (see Annex, Chapter 11.3).

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 1990–2014 for the main pollutants, from 1990 onwards for POPs and HMs and for the years 1990, 1995 and from 2000 onwards for PM. PCB emissions are reported for the first time in the current submission.

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[62].

Sources

Notation keys are used according to the revised 2014 Reporting guidelines (ECE/EB.AIR.125) (see Table 26) 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 2013.

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[61] For more information, see UMWELTBUNDESAMT (2016c): Austria's National Air Emission Inventory 1990–2014: Submission under Directive 2001/81/EC on national emission ceilings for certain atmospheric pollutants. Vienna. http://www.umweltbundesamt.at/fileadmin/site/publikationen/REP0568.pdf

[62] 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 26: 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 completeness

The status of completeness and transparency for all pollutants is analysed annually. The percentage of completeness and transparency is calculated by counting the total number of data records as well as those reported as "not estimated" and "included elsewhere" per pollutant. Then the share of "NE" and "IE" to total data records in each case is determined.

The result of this years' analysis is shown in Table 27. As can be seen the completeness parameter is very high, in particular for the main pollutants and particulate matter. 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: other[63], Ferroalloys Production, Aluminium Production, Other Product Use).

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

The transparency analysis for 2014 shows also a high transparency of the Austrian inventory. The most sources, which are included elsewhere, are reported for particulate matter (TSP, PM_{10} and $PM_{2.5}$) and in particular in sector Agriculture (Manure Management for all relevant livestock categories). Reason for this is that PM emissions from *3.B Manure Management* are included under *3.I Particle emissions from Animal Husbandry*.

Table 27: Completeness Analysis 2016 for reporting year 2014

Pollutant	**Completeness (NE)** **[%]**	**Transparency (IE)** **[%]**
NO_x (as NO_2)	99%	96%
NMVOC	99%	94%
SO_x (as SO_2)	99%	96%
NH_3	99%	96%
$PM_{2.5}$	98%	88%
PM_{10}	98%	88%
TSP	98%	88%
CO	99%	97%
Pb	98%	97%
Cd	98%	97%
Hg	98%	97%
PCDD/PCDF (dioxins/furans)	96%	97%
PAHs (total)	94%	97%
HCB	96%	97%
PCB	98%	98%

2 TREND IN TOTAL EMISSIONS

This chapter describes the trends and the drivers of air pollutant emissions which Austria is obliged to report based on the following listed protocols.

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 2014[64].

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 2014, Austria's SO_2 emissions were 78% 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 1987[65] 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, reaching an all-time high, 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 will have to reduce their emissions for these three metals below their levels in 1990 (or an alternative year between 1985 and 1995). Austria has chosen 1985 as a base year and current emissions are well below the level of the base 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. Austria has chosen 1985 as a base 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.

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[64] 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/

[65] 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 (1990–2014) for air pollutants covered by the Multi-Effect Protocol are shown in Table 28. Please note that emissions from mobile sources are calculated based on fuel sold in Austria, thus national total emissions include 'fuel export'.[66]

Table 28: National total emissions and trends 1990–2014 for air pollutants covered by the Multi-Effect Protocol and CO.

Year	Emission [kt]				
	SO_2	**NO_x**	**NMVOC**	**NH_3**	**CO**
1990	74.45	215.66	280.68	66.50	1 286.26
1991	71.54	223.40	276.57	68.02	1 285.48
1992	55.16	210.75	255.05	66.38	1 215.78
1993	53.53	201.87	240.69	67.21	1 149.80
1994	47.90	194.85	217.96	68.66	1 084.63
1995	47.49	194.28	204.25	69.92	987.00
1996	44.78	212.50	197.92	68.53	992.70
1997	40.24	200.97	177.18	69.02	923.41
1998	35.61	213.14	169.39	69.62	886.04
1999	33.64	204.91	161.69	68.20	783.85
2000	31.57	210.34	153.43	66.79	785.25
2001	32.68	220.14	149.80	66.97	760.71
2002	31.85	226.06	146.13	66.39	728.20
2003	31.91	235.42	143.78	66.38	732.14
2004	27.39	233.29	139.46	65.98	713.22
2005	26.40	234.77	136.57	66.04	685.38
2006	27.12	220.15	130.95	66.27	663.85
2007	24.15	211.39	126.76	67.56	631.23
2008	21.81	194.74	124.09	67.11	610.06
2009	16.41	178.21	118.15	68.27	568.12
2010	17.90	179.01	118.64	67.45	580.12
2011	16.80	169.19	114.95	66.74	563.49
2012	16.12	162.81	113.89	66.77	563.29
2013	15.88	162.11	115.53	66.54	582.07
2014	16.02	151.03	110.46	66.99	537.33
Trend 1990–2014	**-78.5%**	**-30.0%**	**-60.6%**	**0.7%**	**-58.2%**

[66] For NO_x the emissions calculated based on fuel used are by about 21 kt lower in 2014 and show a 34% decrease from 1990 to 2014.

Austria's emissions based on fuel used – thus excluding 'fuel export' – are presented in Chapter 11.3 'Austria's emissions for SO2, NOx, NMVOC and NH3 according to the submission under the NEC directive' (Annex I). The related report 'AUSTRIA'S ANNUAL AIR EMISSION INVENTORY 1990–2014, Submission under National Emission Ceilings Directive 2001/81/EC' is published on the following website:

http://www.umweltbundesamt.at/fileadmin/site/publikationen/REP0568.pdf

2.1.1 SO_2 Emissions

In 1990, national total SO_2 emissions amounted to 74 kt. Since then emissions have decreased quite steadily. In the year 2014, emissions were reduced by 78% compared to 1990 and amounted to 16 kt, which was mainly due to lower emissions from residential heating, combustion in industries and in energy industries. The sharp decrease from 2008 to 2009 is due to a further reduction of the sulfur content of gasoil to 10ppm. From 2013 to 2014 emissions slightly increased by 0.9% mainly due to higher emissions reported by oil refineries.

Main sources and emission trends in Austria

As shown in Table 29 the main source for SO_2 emissions in Austria, with a share of 94% in 1990 and 92% in 2014, is Category *1.A Fuel Combustion Activities*. Within this source, the main contributors to total SO_2 emissions are *1.A.2 Manufacturing Industries* (iron and steel industry) with 70%, *1.A.1 Energy Industries* with 11% and *1.A.4 Other Sectors* (residential heating) with 9.0% of the total share, respectively.

The constant decrease in 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 (e.g. Fuel Ordinance[67]),
- 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 (e.g. LCP directive[68]),
- abatement techniques like combined flue gas treatment.

The share in national total SO_2 emissions from NFR sector *2 Industrial Processes and Product Use* in 2014 is 7.6%. Within this source, SO_2 emissions result from Chemical Industry and Metal Production. 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.

NFR sectors *1.B Fugitive Emissions*, *3 Agriculture* and *5 Waste* are only minor contributors to total SO_2 emissions.

[67] BGBl_II_417-04_Kraftstoffverordnung; idF. BGBl. II Nr. 398/2012

[68] 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)

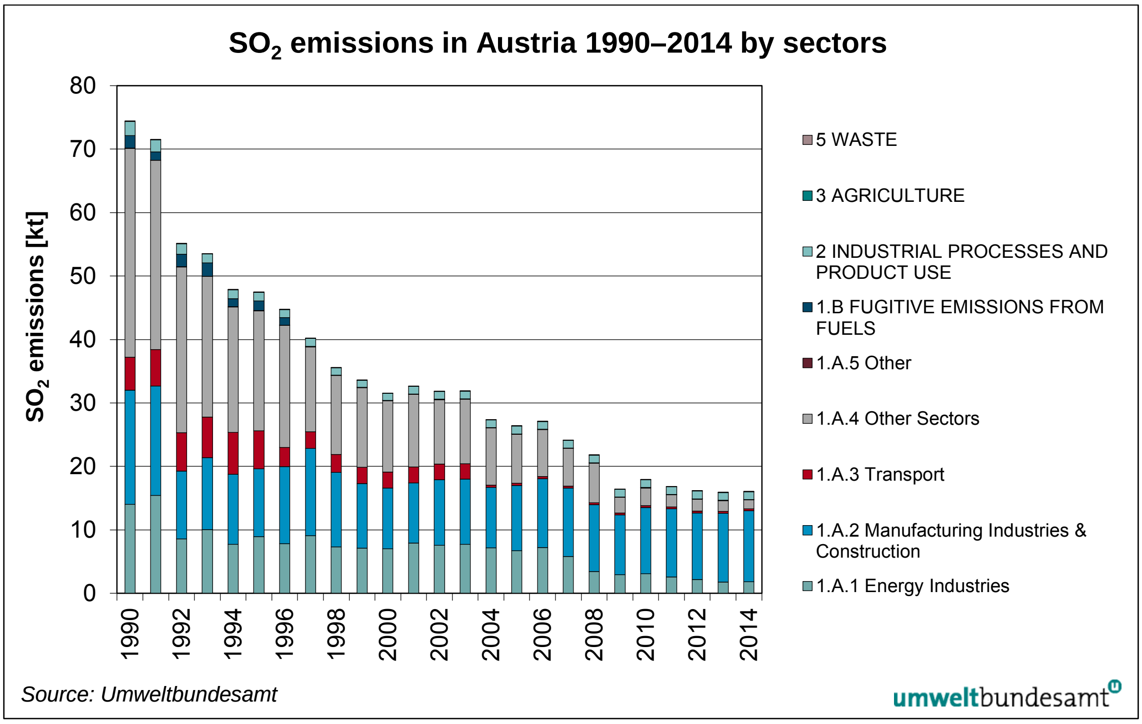

Figure 7: SO_2 emissions in Austria 1990–2014 by sectors in absolute terms.

Table 29: SO_2 emissions per NFR Category 1990 and 2014, their trend 1990–2014 and their share in total emissions.

NFR Category		SO_2 Emission in [kt]		Trend		Share in National Total	
		1990	**2014**	**1990–2014**	**2013–2014**	**1990**	**2014**
1	ENERGY	72.16	14.79	-79%	1%	97%	92%
1.A	FUEL COMBUSTION ACTIVITIES	70.16	14.76	-79%	1%	94%	92%
1.A.1	Energy Industries	14.04	1.83	-87%	4%	19%	11%
1.A.1.a	Public Electricity and Heat Production	11.79	1.31	-89%	-13%	16%	8%
1.A.1.b	Petroleum refining	2.25	0.52	-77%	102%	3%	3%
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	17.97	11.18	-38%	3%	24%	70%
1.A.2.a	Iron and Steel	6.73	5.34	-21%	1%	9%	33%
1.A.2.b	Non-ferrous Metals	0.15	0.10	-34%	7%	<1%	1%
1.A.2.c	Chemicals	0.76	0.55	-28%	-13%	1%	3%
1.A.2.d	Pulp, Paper and Print	4.30	1.10	-74%	3%	6%	7%
1.A.2.e	Food Processing, Beverages and Tobacco	1.65	0.21	-87%	-2%	2%	1%
1.A.2.f	Non-metallic Minerals	2.23	1.19	-47%	33%	3%	7%
1.A.2.g	Manufacturing Industries and Constr. - other	2.16	2.70	25%	3%	3%	17%
1.A.3	Transport	5.19	0.29	-94%	-1%	7%	2%
1.A.3.a	Civil Aviation	0.03	0.10	204%	1%	<1%	1%
1.A.3.b	Road Transportation	4.85	0.12	-97%	-3%	7%	1%
1.A.3.c	Railways	0.26	0.05	-81%	4%	<1%	<1%
1.A.3.d	Navigation	0.05	0.02	-53%	-8%	<1%	<1%
1.A.3.e	Other transportation	NA	NA	NA	NA	NA	NA
1.A.4	Other Sectors	32.94	1.43	-96%	-16%	44%	9%
1.A.4.a	Commercial/Institutional	5.24	0.12	-98%	-16%	7%	1%
1.A.4.b	Residential	25.92	1.19	-95%	-17%	35%	7%
1.A.4.c	Agriculture/Forestry/Fisheries	1.78	0.12	-93%	-8%	2%	1%
1.A.5	Other	0.01	0.01	22%	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	1.22	-45%	<1%	3%	8%
2.A	MINERAL PRODUCTS	NA	NA	NA	NA	NA	NA
2.B	CHEMICAL INDUSTRY	1.56	0.77	-51%	<1%	2%	5%
2.C	METAL PRODUCTION	0.66	0.45	-31%	<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	-62%	14%	<1%	<1%
5	WASTE	0.07	0.01	-87%	<1%	<1%	<1%
	Total without sinks	**74.45**	**16.02**	**-78%**	**1%**		

2.1.2 NO_x Emissions

In 1990, national total NO_x emissions amounted to 216 kt. After an all time high of emissions between 2003 and 2005 emissions are decreasing continously, which is mainly due to lower emissions from heavy duty vehicles. In 2014, NO_x emissions amounted to 151 kt and were about 30% lower than in 1990. From 2013 to 2014 emissions decreased by 6.8%, again mainly due to decreasing emissions of road transportation, in particular from heavy duty vehicles.

Main sources and emission trends in Austria

As can be seen in Table 30, the main sources for NO_x emissions in Austria, with a share of 95% in 1990 and in 2014, are *Fuel Combustion Activities.* Within this source, *Road Transportation*, with about 53% of national total emissions, 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 2014 based on fuel used amount to 130 kt.

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 diesel passenger cars do not show the desired reduction rate so far. A substantial reduction, however, will be only 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 slightly compared to 1990 (-8.2%) 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 furnances. 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 2014 mainly due to increased efficiency and modern fuel technology.

NFR sectors *2 Industrial Processes and Product Use*, *3 Agriculture* and *5 Waste* are minor sources regarding NO_x emissions.

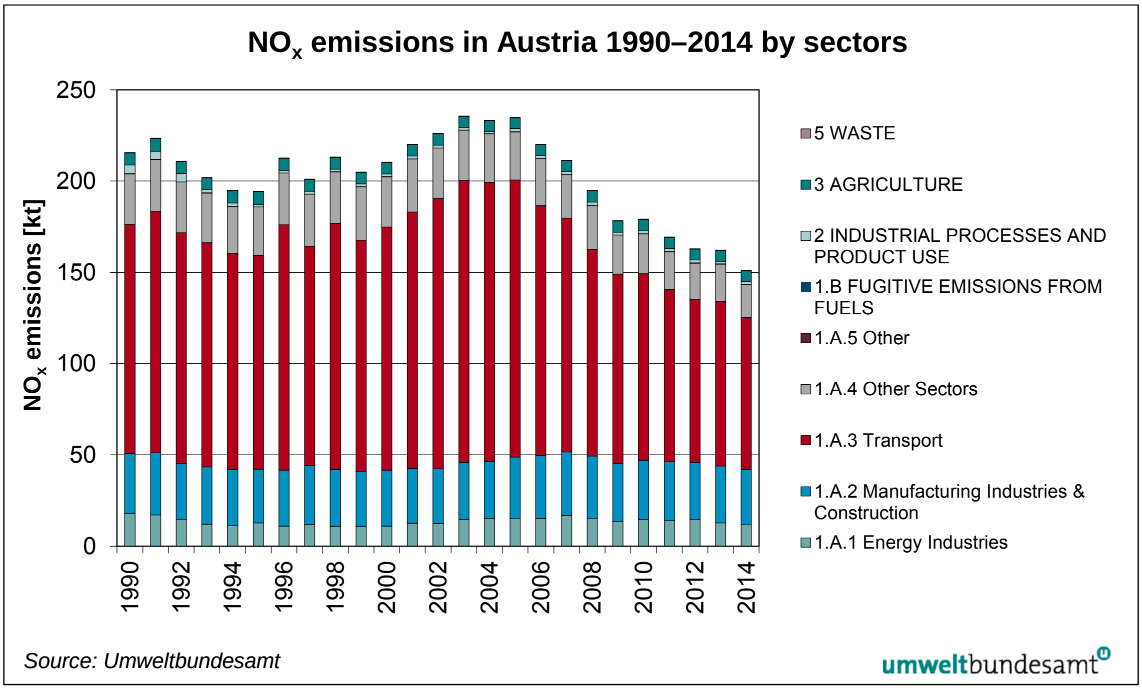

Figure 8: NO_x emissions in Austria 1990–2014 by sectors in absolute terms.

Table 30: NO_x emissions per NFR Category 1990 and 2014 their trend 1990–2014 and their share in total emissions.

NFR Category		NO_x Emission in [kt]		Trend		Share in National Total	
		1990	2014	1990–2014	2013–2014	1990	2014
1	ENERGY	204.01	143.45	-30%	-7%	95%	95%
1.A	FUEL COMBUSTION ACTIVITIES	204.01	143.45	-30%	-7%	95%	95%
1.A.1	Energy Industries	17.74	11.71	-34%	-8%	8%	8%
1.A.1.a	Public Electricity and Heat Production	12.05	10.02	-17%	-10%	6%	7%
1.A.1.b	Petroleum refining	4.32	1.02	-76%	11%	2%	1%
1.A.1.c	Manufacture of Solid fuels & Other Energy Ind.	1.37	0.67	-52%	-1%	1%	<1%
1.A.2	Manufacturing Industries and Construction	32.98	30.26	-8%	-3%	15%	20%
1.A.2.a	Iron and Steel	5.41	3.71	-31%	-6%	3%	2%
1.A.2.b	Non-ferrous Metals	0.25	0.23	-8%	2%	<1%	<1%
1.A.2.c	Chemicals	1.69	1.84	9%	-2%	1%	1%
1.A.2.d	Pulp, Paper and Print	7.00	4.59	-34%	-2%	3%	3%
1.A.2.e	Food Processing, Beverages & Tobacco	1.74	0.83	-52%	-3%	1%	1%
1.A.2.f	Non-metallic Minerals	9.99	6.21	-38%	-1%	5%	4%
1.A.2.g	Manufacturing Industries and Constr. - other	6.89	12.84	86%	-3%	3%	9%
1.A.3	Transport	125.49	83.19	-34%	-8%	58%	55%
1.A.3.a	Civil Aviation	0.41	1.27	212%	3%	<1%	1%
1.A.3.b	Road Transportation	122.08	79.69	-35%	-8%	57%	53%
1.A.3.c	Railways	1.82	1.07	-41%	-1%	1%	1%
1.A.3.d	Navigation	0.58	0.69	18%	-9%	<1%	<1%
1.A.3.e	Other transportation	0.61	0.48	-22%	-35%	<1%	<1%
1.A.4	Other Sectors	27.73	18.20	-34%	-11%	13%	12%
1.A.4.a	Commercial/Institutional	3.38	1.30	-61%	-5%	2%	1%
1.A.4.b	Residential	13.88	9.35	-33%	-17%	6%	6%
1.A.4.c	Agriculture/Forestry/Fisheries	10.47	7.55	-28%	-3%	5%	5%
1.A.5	Other	0.07	0.08	10%	<1%	<1%	<1%
1.B	FUGITIVE EMISSIONS FROM FUELS	IE	IE	IE	IE	IE	IE
2	INDUSTRIAL PROCESSES /PRODUCT USE	4.80	1.50	-69%	4%	2%	1%
2.A	MINERAL PRODUCTS	NA	NA	NA	NA	NA	NA
2.B	CHEMICAL INDUSTRY	4.07	0.33	-92%	3%	2%	<1%
2.C	METAL PRODUCTION	0.17	0.11	-37%	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	1.06	92%	4%	<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	6.75	6.08	-10%	1%	3%	4%
3.B	MANURE MANAGEMENT	0.52	0.38	-27%	<1%	<1%	<1%
3.D	AGRICULTURAL SOILS	6.20	5.69	-8%	1%	3%	4%
3.F	FIELD BURNING OF AGRICULTURAL RESIDUE	0.03	0.01	-73%	29%	<1%	<1%
3.I	Agriculture OTHER	NA	NA	NA	NA	NA	NA
5	WASTE	0.10	0.01	-87%	<1%	<1%	<1%
	Total without sinks	**215.66**	**151.03**	**-30%**	**-7%**		

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 2014 emissions had been reduced by 61% to 110 kt compared to 1990. From 2013 to 2014 emissions decreased by 4.4% due to lower biomass use for residential heating as a consequence of mild winter temperatures in 2014.

Main sources and emission trends in Austria

As can be seen in Table 31, in 2014 the main sources of NMVOC emissions in Austria are NFR *2.D.3 Solvent Use* (58% of the national total), which is included in sector *2 Industrial Processes and Product Use* according to the revised CLRTAP Reporting Guidelines, and *1.A Fuel Combustion Activities* (33% of the national total). Within sector *1.A Fuel Combustion Activities* the main contributors are *1.A.4 Other Sectors* (24% of the national total, mainly residential heating) and *1.A.3 Transport* (8% 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 systems and aftertreatment as a result of legal requirements. Please note that the Solvent and other Product Use sector has been subject to major recalculations, this is why trends might differ compared to previous submissions.

- *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 polulations 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.[69]
- *NFR 2.D.3.e and 2.D.3.f Degreasing and Dry Cleaning*: The emission reduction in this sub sector 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 2014 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 is a result of legal/abatement measures.
- *NFR 2.D.3.i Other solvent use*: The long term emission reduction could be achieved due to technical abatement measures such as closed loop processes, waste gas purification and recycling.

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

- *NFR 1.A.4 Other Sectors*: Emissions from residential heating decreased due to improved biomass heatings in households and due to lower fuel wood consumption of stoves.
- *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 of NMVOC emissions.

[69] see Chapter 4.6

NMVOC emissions resulting from NFR sectors *1.B Fugitive Emissions*, *3 Agriculture* and *5 Waste* are minor sources.

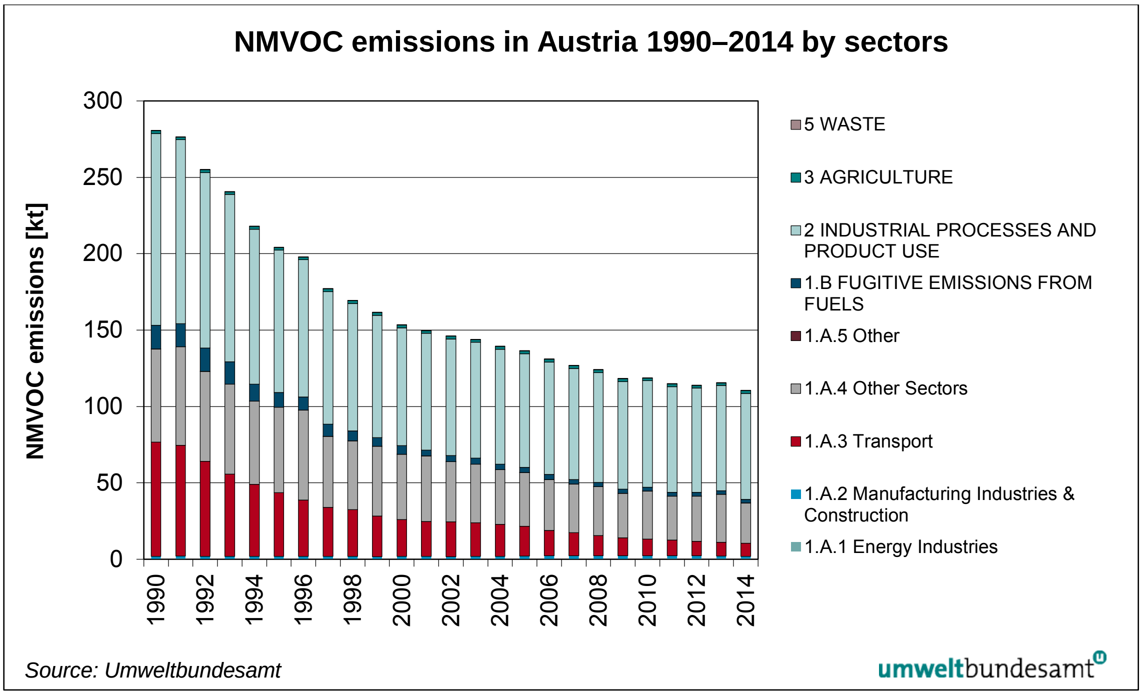

Figure 9: NMVOC emissions in Austria 1990–2014 by sectors in absolute terms.

Table 31: NMVOC emissions per NFR Category 1990 and 2014, their trend 1990–2014 and their share in total emissions.

NFR Category		**NMVOC Emission in [kt]**		**Trend**		**Share in National Total**	
		1990	**2014**	**1990–2014**	**2013–2014**	**1990**	**2014**
1	ENERGY	153.17	39.23	-74%	-13%	55%	36%
1.A	FUEL COMBUSTION ACTIVITIES	137.69	36.82	-73%	-14%	49%	33%
1.A.1	Energy Industries	0.33	0.37	11%	-5%	<1%	<1%
1.A.2	Manufacturing Industries and Construction	1.69	1.65	-2%	-9%	1%	1%
1.A.3	Transport	74.72	8.41	-89%	-6%	27%	8%
1.A.3.a	Civil Aviation	0.20	0.49	142%	<1%	<1%	<1%
1.A.3.b	Road Transportation	73.53	7.48	-90%	-6%	26%	7%
1.A.3.c	Railways	0.37	0.11	-70%	-7%	<1%	<1%
1.A.3.d	Navigation	0.62	0.32	-48%	-6%	<1%	<1%
1.A.3.e	Other transportation	0.00	0.00	124%	-17%	<1%	<1%
1.A.4	Other Sectors	60.94	26.37	-57%	-16%	22%	24%
1.A.4.a	Commercial/Institutional	0.55	0.39	-30%	-22%	<1%	<1%
1.A.4.b	Residential	55.99	22.41	-60%	-17%	20%	20%
1.A.4.c	Agriculture/Forestry/Fisheries	4.40	3.58	-19%	-7%	2%	3%
1.A.5	Other	0.01	0.02	10%	<1%	<1%	<1%
1.B	FUGITIVE EMISSIONS FROM FUELS	15.49	2.42	-84%	5%	6%	2%
2	INDUSTRIAL PROCESSES AND PRODUCT USE	125.53	69.31	-45%	1%	45%	63%
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	0.46	-13%	1%	<1%	<1%
2.D	NON ENERGY PRODUCTS/ SOLVENTS	114.43	64.22	-44%	1%	41%	58%
2.D.3	Solvent use	114.43	64.22	-44%	1%	41%	58%
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	17.21	-62%	2%	16%	16%
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	3.32	45%	<1%	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	1.81	1.86	3%	12%	1%	2%
5	WASTE	0.16	0.05	-66%	-6%	<1%	<1%
	Total without sinks	**280.68**	**110.46**	**-61%**	**-4%**		

2.1.4 NH_3 Emissions

In 1990, national total NH_3 emissions amounted to 66.5 kt; emissions have been quite stable over the period from 1990 to 2014. In 2014, emissions were 0.7% above 1990 levels and amounted to 67.0 kt. The reason for the slight increase of 0.7% between 2013 and 2014 is mainly due to the increased use of mineral fertilizer in consequence of expanded crop production in sector *Agriculture*.

Main sources and emission trends in Austria

As can be seen in Table 32, NH_3 emissions in Austria are almost exclusively emitted by the agricultural sector. The share in national total NH_3 emissions is about 94% for 2014 (see Table 32).

In 1990 national NH_3 emissions from the sector *Agriculture* amounted to 64 kt; emissions have decreased slightly since then and by the year 2014 emissions were reduced by 1.0% to 63 kt mainly due to decreasing animal numbers.

- *NFR 3.B Manure Management* has a share of 42% in national total NH_3 emissions in 2014. The emissions result from animal husbandry and the storage of manure. Within this source manure management of cattle has the highest contribution. The decreasing or increasing emissions are mainly due to declining or increasing livestock.
- *NFR 3.D Agricultural Soils* with a share of 52% has the highest contribution to national total NH_3 emissions in 2014. These emissions result from fertilization with mineral N-fertilizers as well as organic fertilizers (including the application of manure, sewage sludge and energy crops). Other sources of NH_3 emissions are biological nitrogen fixation (legume crops) and manure excreted on pastures by grazing animals.

NH_3 emissions from *1.A Fuel Combustion Activities* are the second largest source category but it is only a minor source of NH_3 emissions with a contribution to national total NH_3 emissions of 4.1% in 2014. NH_3 emissions from NFR *1.A* are increasing: in 1990, emissions amounted to about 2.3 kt. In the year 2014, they were about 19% higher than 1990 levels and amounted to about 2.7 kt.

NH_3 emissions resulting from NFR sectors *1.B Fugitive Emissions*, *2 Industrial Processes and Product Use* and *5 Waste* are minor sources.

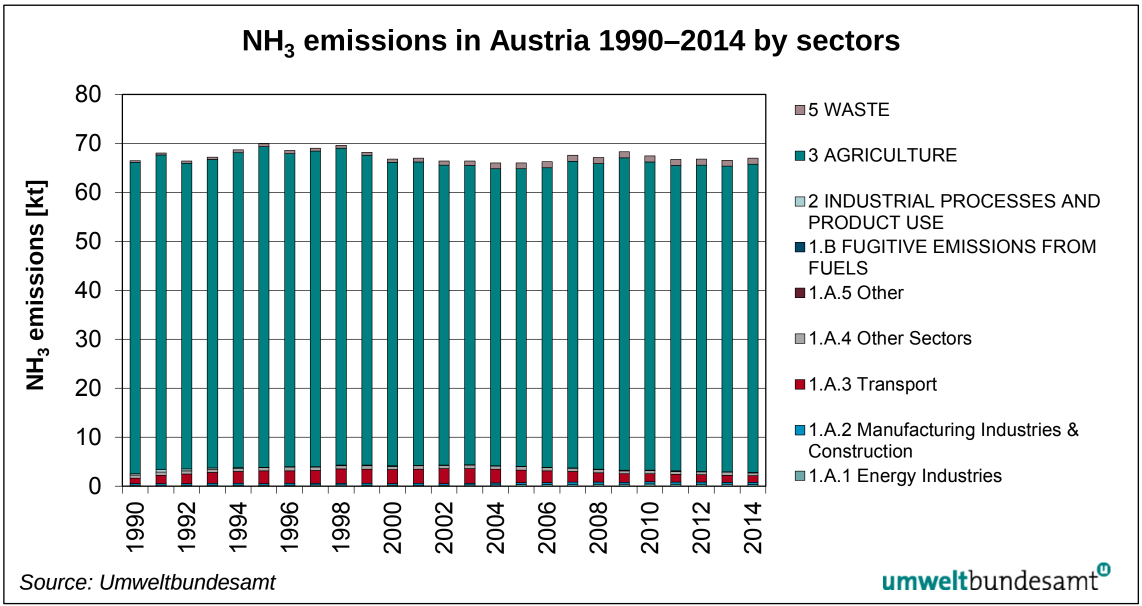

Figure 10: NH_3 emissions in Austria 1990–2014 by sectors in absolute terms.

Table 32: NH_3 emissions per NFR Category 1990 and 2014, their trend 1990 – 2014 and their share in total emissions.

NFR Category		NH_3 Emission in [kt]		Trend		Share in National Total	
		1990	2014	1990–2014	2013–2014	1990	2014
1	ENERGY	2.29	2.73	19%	-6%	3%	4%
1.A	FUEL COMBUSTION ACTIVITIES	2.29	2.73	19%	-6%	3%	4%
1.A.1	Energy Industries	0.19	0.38	97%	-5%	<1%	1%
1.A.2	Manufacturing Industries and Construction	0.33	0.44	32%	5%	1%	1%
1.A.3	Transport	1.13	1.36	20%	-5%	2%	2%
1.A.4	Other Sectors	0.63	0.55	-13%	-14%	1%	1%
1.A.5	Other	0.00	0.00	33%	1%	<1%	<1%
1.B	FUGITIVE EMISSIONS FROM FUELS	IE	IE	IE	IE	IE	IE
2	INDUSTRIAL PROCESSES AND PRODUCT USE	0.27	0.09	-67%	-7%	<1%	<1%
2.A	MINERAL PRODUCTS	NA	NA	NA	NA	NA	NA
2.B	CHEMICAL INDUSTRY	0.27	0.09	-67%	-7%	<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	63.58	62.97	-1%	1%	96%	94%
3.B	MANURE MANAGEMENT	27.55	28.34	3%	<1%	41%	42%
3.B.1	Cattle	14.48	16.78	16%	1%	22%	25%
3.B.2	Sheep	0.54	0.61	13%	-2%	1%	1%
3.B.3	Swine	8.46	6.28	-26%	-2%	13%	9%
3.B.4	Other livestock	4.07	4.68	15%	<1%	6%	7%
3.B.4.a	Buffalo	NO	NO	NO	NO	NO	NO
3.B.4.d	Goats	0.06	0.12	89%	-2%	<1%	<1%
3.B.4.e	Horses	0.67	1.10	62%	<1%	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	35.99	34.61	-4%	2%	54%	52%
3.D.a	Direct Soil Emissions	35.78	34.33	-4%	2%	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	0.20	0.28	39%	2%	<1%	<1%
3.D.f	Use of pesticides	NO	NO	NO	NO	NO	NO
3.F	FIELD BURNING OF AGRICULTURAL RES.	0.04	0.01	-64%	16%	<1%	<1%
3.I	Agriculture OTHER	NA	NA	NA	NA	NA	NA
5	WASTE	0.36	1.20	236%	3%	1%	2%
	Total without sinks	**66.50**	**66.99**	**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 1 286 kt. Emissions considerably decreased from 1990 to 2014. In 2014, emissions were down by 58% below 1990 levels at 537 kt. This reduction was mainly due to decreasing emissions from road transport (catalytic converters).

Main sources and emission trends in Austria

As can be seen in Table 33, 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 95% for 1990 and for 2014. The main sources of CO emission are NFR *1.A.4 Other Sectors,* NFR *1.A.2 Manufacturing Industries and Construction* and NFR *1.A.3 Transport.*

In the period 1990–2014, 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 emission reduction from *1.A.3 Transport* was mainly possible due to optimized combustion processes in the engine and the introduction of the catalytic converters. Regarding *residential heating*, CO emissions decreased also, due the switch-over to improved technologies and decreased use of coke.

CO emissions resulting from NFR sectors *2 Industrial Processes and Product Use, 3 Agriculture* and *5 Waste* are minor sources.

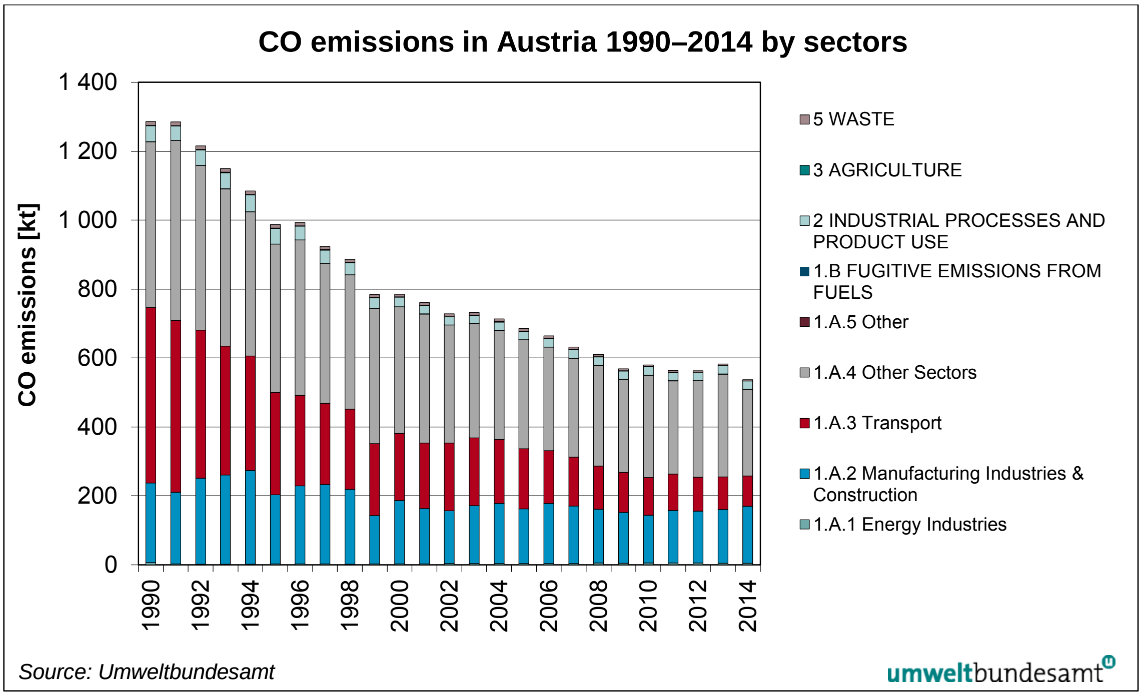

Figure 11: CO emissions in Austria 1990–2014 by sectors in absolute terms.

Table 33: CO emissions per NFR Category 1990 and 2014, their trend 1990–2014 and their share in total emissions.

NFR Category		CO Emission in [kt]		Trend		Share in National Total	
		1990	2014	1990–2014	2013–2014	1990	2014
1	ENERGY	1 227.64	509.04	-59%	-8%	95%	95%
1.A	FUEL COMBUSTION ACTIVITIES	1 227.64	509.04	-59%	-8%	95%	95%
1.A.1	Energy Industries	6.07	4.24	-30%	-8%	<1%	1%
1.A.2	Manufacturing Industries and Construction	231.58	164.80	-29%	6%	18%	31%
1.A.2.a	Iron and Steel	210.72	134.64	-36%	7%	16%	25%
1.A.2.b	Non-ferrous Metals	0.05	0.05	8%	6%	<1%	<1%
1.A.2.c	Chemicals	0.80	1.11	39%	-5%	<1%	<1%
1.A.2.d	Pulp, Paper and Print	4.09	1.88	-54%	-2%	<1%	<1%
1.A.2.e	Food Processing, Beverages and Tobacco	0.20	0.13	-34%	-3%	<1%	<1%
1.A.2.f	Non-metallic Minerals	11.03	16.92	53%	1%	1%	3%
1.A.2.g	Manufacturing Industries and Constr. - other	4.71	10.07	114%	-2%	<1%	2%
1.A.3	Transport	508.90	88.84	-83%	-6%	40%	17%
1.A.3.a	Civil Aviation	2.47	3.68	49%	2%	<1%	1%
1.A.3.b	Road Transportation	501.17	82.13	-84%	-6%	39%	15%
1.A.3.c	Railways	2.04	0.72	-65%	-4%	<1%	<1%
1.A.3.d	Navigation	3.19	2.22	-30%	-3%	<1%	<1%
1.A.3.e	Other transportation	0.04	0.09	124%	-17%	<1%	<1%
1.A.4	Other Sectors	480.87	250.87	-48%	-16%	37%	47%
1.A.4.a	Commercial/Institutional	11.38	5.09	-55%	-15%	1%	1%
1.A.4.b	Residential	437.87	220.10	-50%	-17%	34%	41%
1.A.4.c	Agriculture/Forestry/Fisheries	31.63	25.69	-19%	-7%	2%	5%
1.A.5	Other	0.22	0.29	31%	1%	<1%	<1%
1.B	FUGITIVE EMISSIONS FROM FUELS	IE	IE	IE	IE	IE	IE
2	INDUSTRIAL PROCESSES AND PRODUCT USE	46.37	23.88	-48%	<1%	4%	4%
2.A	MINERAL PRODUCTS	NA	NA	NA	NA	NA	NA
2.B	CHEMICAL INDUSTRY	12.67	11.09	-12%	<1%	1%	2%
2.C	METAL PRODUCTION	23.52	2.24	-90%	-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	0.77	92%	4%	<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	1.28	0.45	-65%	17%	<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	1.28	0.45	-65%	17%	<1%	<1%
3.I	AGRICULTURE OTHER	NA	NA	NA	NA	NA	NA
5	WASTE	10.98	3.96	-64%	-6%	1%	1%
5.A	SOLID WASTE DISPOSAL ON LAND	10.93	3.95	-64%	-7%	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	**1 286.26**	**537.33**	**-58%**	**-8%**		

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 12).

PM_{10} 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 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 PM_{10} 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.

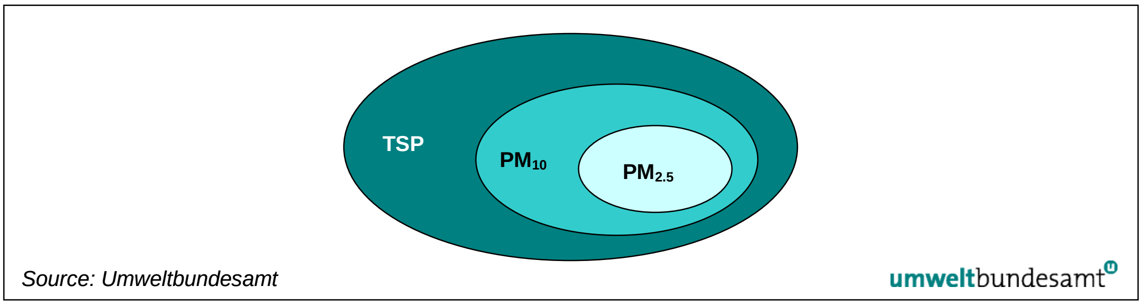

Figure 12: Distribution of TSP, PM_{10} and $PM_{2.5}$ (schematic).

Main sources and emission trends in Austria

Particulate matter emissions in Austria mainly arise from industrial processes, road transport, agriculture and small heating installations. Where for TSP the most important source is industrial processes, small heating installtations are the highest contributor for $PM_{2,5}$ emissions.

Particulate matter (PM) emissions show a decreasing trend over the period 1990 to 2014: TSP emissions decreased by 11%, PM_{10} emissions were about 22% below the level of 1990, and $PM_{2.5}$ emissions dropped by about 34%. Between 2013 and 2014 PM emissions decreased by 2.0% (TSP), 4.2% (PM_{10}) and 8.1% ($PM_{2.5}$) because of lower biomass consumption of the residential sector due to mild winter temperatures in 2014. 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 in the following.

One of the main sources of PM emissions is NFR sector *1.A Fuel Combustion Activities*. Within this source the main 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% PM_{10} and 19% $PM_{2.5}$ 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 equipment with particulate filter systems in the NOVA control (fuel consumption based taxation for passenger cars in Austria). 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, PM_{10} 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 were 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 CO_2-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 8.7% of the national total TSP emissions, 11% of PM_{10} emissions and 15% of $PM_{2.5}$ emissions. 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 CO_2-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.

- *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 2013 and 2014 a slight increase can be observed.
- *NFR 2.C Metal Production*, a decreasing trend of about 87% of all PM fractions can be noted for the period 1990 to 2014 because considerable efforts were made by introducing low-PM technologies, abatement techniques, flue gas collection and flue gas cleaning systems etc. In 2014 this sub category represents a minor source of PM emissions.
- *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 10% of the total agricultural $PM_{2.5}$ emissions. Total TSP and PM_{10} emissions from sector *3 Agriculture* decreased by 5.7% and 6.3% over the period 1990 to 2014.

NFR sectors *1.B Fugitive Emissions*, *2 Industrial Processes and Product Use (2.G Other product manufacture and use* including fireworks and smoking of tobacco) and *5 Waste* are minor sources regarding PM emissions.

Table 34: National total emissions and emission trends for particulate matter (PM) 1990–2014.

Year	**Emissions [kt]**		
	TSP	**PM_{10}**	**$PM_{2.5}$**
1990	61.803	40.242	25.197
:	NR	NR	NR
1995	62.387	39.601	24.342
:	NR	NR	NR
2000	62.578	39.111	23.608
2001	62.187	38.983	23.717
2002	61.154	37.899	22.905
2003	61.036	37.748	22.775
2004	61.453	37.649	22.362
2005	61.123	37.286	22.116
2006	59.478	35.941	21.198
2007	58.765	35.182	20.532
2008	59.459	35.256	20.091
2009	56.694	33.333	18.776
2010	57.104	33.660	19.072
2011	56.791	33.065	18.294
2012	56.144	32.562	17.917
2013	56.447	32.773	18.063
2014	55.291	31.386	16.608
Trend 1990–2014	**-11%**	**-22%**	**-34%**

PM_{10} emissions and emission trends in Austria

National total PM_{10} emissions amounted to 40 kt in 1990 and have decreased steadily so that by the year 2014 emissions were reduced by 22% (to 31 kt) – see Table 35.

As shown in Table 35, the main sources for PM_{10} emissions in Austria are combustion processes in the NFR category 1.A *Fuel Combustion Activities* (57% in national total emissions in 2014) 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*.

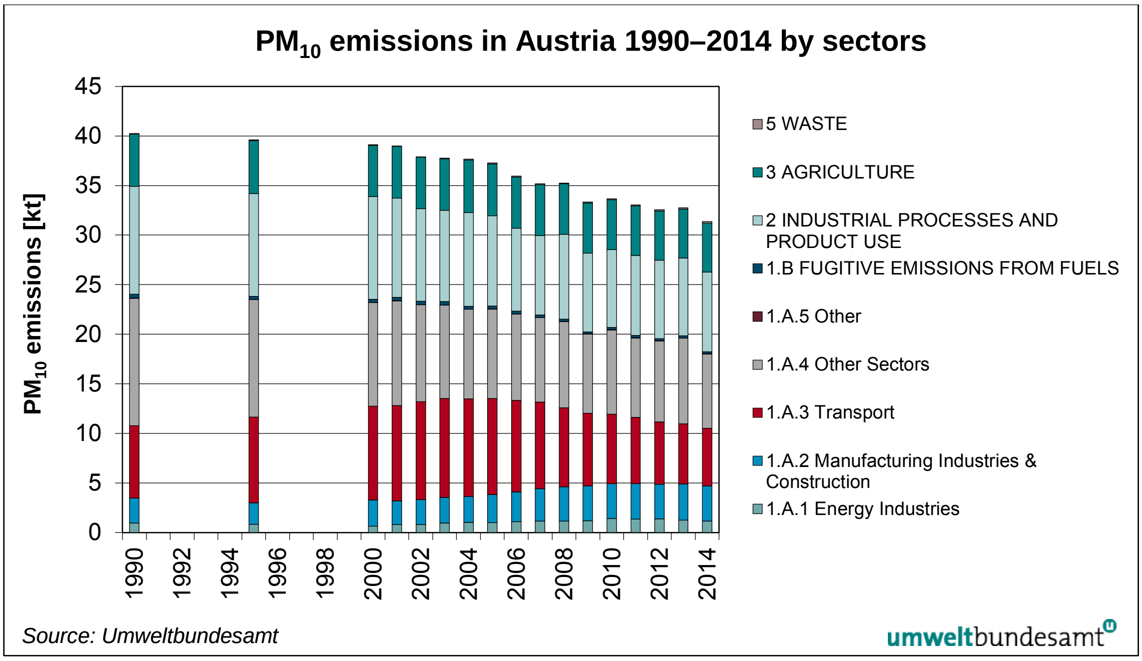

Figure 13: PM_{10} emissions in Austria 1990–2014 by sectors in absolute terms.

Table 35: PM_{10} emissions per NFR Category 1990 and 2014, their trend 1990–2014 and their share in total emissions.

NFR Category		PM_{10} Emission in [kt]		Trend		Share in National Total	
		1990	**2014**	**1990–2014**	**2013–2014**	**1990**	**2014**
1	ENERGY	24.05	18.24	-24%	-8%	60%	58%
1.A	FUEL COMBUSTION ACTIVITIES	23.65	18.04	-24%	-8%	59%	57%
1.A.1	Energy Industries	0.98	1.17	19%	-8%	2%	4%
1.A.2	Manufacturing Industries and Construction	2.50	3.56	43%	-2%	6%	11%
1.A.2.a	Iron and Steel	0.05	0.01	-79%	-22%	0%	0%
1.A.2.b	Non-ferrous Metals	0.01	0.01	2%	7%	0%	0%
1.A.2.c	Chemicals	0.29	0.37	27%	-6%	1%	1%
1.A.2.d	Pulp, Paper and Print	0.95	0.21	-78%	-22%	2%	1%
1.A.2.e	Food Processing, Beverages and Tobacco	0.11	0.02	-79%	-3%	0%	0%
1.A.2.f	Non-metallic Minerals	0.07	0.10	52%	18%	0%	0%
1.A.2.g	Manufacturing Ind. and Constr. - other	1.02	2.83	178%	-1%	3%	9%
1.A.3	Transport	7.32	5.79	-21%	-4%	18%	18%
1.A.3.a	Civil Aviation	0.03	0.11	209%	1%	0%	0%
1.A.3.b	Road Transportation	6.19	5.03	-19%	-5%	15%	16%
1.A.3.c	Railways	0.96	0.60	-37%	-2%	2%	2%
1.A.3.d	Navigation	0.13	0.05	-58%	-12%	0%	0%
1.A.3.e	Other transportation	0.00	0.00	124%	-17%	0%	0%
1.A.4	Other Sectors	12.84	7.50	-42%	-13%	32%	24%
1.A.4.a	Commercial/Institutional	0.75	0.30	-60%	-9%	2%	1%
1.A.4.b	Residential	9.46	5.70	-40%	-15%	23%	18%
1.A.4.c	Agriculture/Forestry/Fisheries	2.64	1.50	-43%	-7%	7%	5%
1.A.5	Other	0.02	0.02	6%	1%	0%	0%
1.B	FUGITIVE EMISSIONS FROM FUELS	0.40	0.20	-52%	-8%	1%	1%
2	INDUSTRIAL PROCESSES AND PRODUCT USE	10.86	8.05	-26%	3%	27%	26%
2.A	MINERAL PRODUCTS	4.94	6.29	27%	3%	12%	20%
2.A.1	Cement Production	0.16	0.05	-68%	0%	0%	0%
2.A.2	Lime Production	0.06	0.09	53%	1%	0%	0%
2.A.3	Glass production	IE	IE	IE	IE	IE	IE
2.A.5	Mining, construction, handling of products	4.73	6.15	30%	3%	12%	20%
2.A.6	Other Mineral products	NO	NO	NO	NO	NO	NO
2.B	CHEMICAL INDUSTRY	0.57	0.27	-53%	17%	1%	1%
2.C	METAL PRODUCTION	4.58	0.58	-87%	-4%	11%	2%
2.D	NON ENERGY PRODUCTS/ SOLVENTS	NA	NA	NA	NA	NA	NA
2.G	Other product manufacture and use	0.41	0.45	11%	1%	1%	1%
2.H	Other Processes	0.00	0.00	-17%	1%	0%	0%
2.I	Wood processing	0.37	0.46	25%	-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	5.26	4.93	-6%	0%	13%	16%
3.B	MANURE MANAGEMENT	IE	IE	IE	IE	IE	IE
3.D	AGRICULTURAL SOILS	4.58	4.39	-4%	-1%	11%	14%
3.F	FIELD BURNING OF AGRICUL. RESIDUES	0.14	0.07	-50%	7%	0%	0%
3.I	Agriculture OTHER	0.54	0.47	-13%	-1%	1%	2%
5	WASTE	0.07	0.17	147%	28%	0%	1%
	Total without sinks	**40.24**	**31.39**	**-22%**	**-4%**		

$PM_{2.5}$ 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 2014 emissions were reduced by 34% (to 17 kt) – see Table 36.

As shown in Table 36, $PM_{2.5}$ emissions in Austria mainly arose from combustion processes in the energy sector with a share of 81% in the total emissions in 2014. Besides the sources already mentioned in the context of TSP and PM_{10}, $PM_{2.5}$ emissions resulted on a big scale from power plants with flue gas cleaning systems, which filter larger particles. The NFR sectors *2 Industrial Processes and Product Use* and *3 Agriculture* 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.

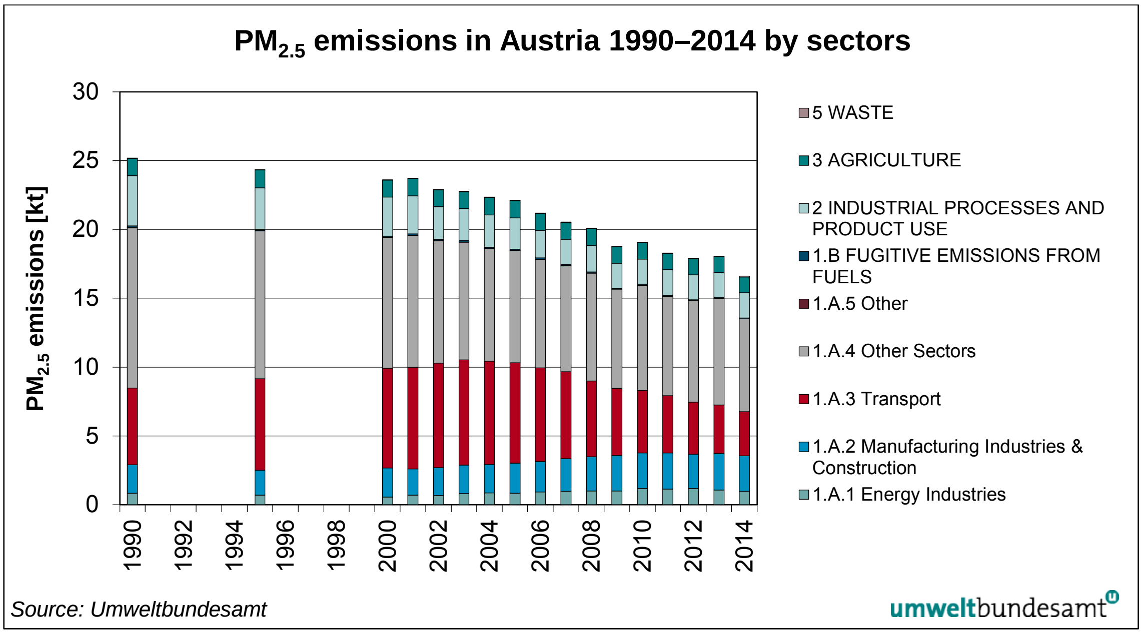

Figure 14: $PM_{2.5}$ emissions in Austria 1990–2014 by sectors in absolute terms.

Table 36: $PM_{2.5}$ emissions per NFR Category 1990 and 2014, their trend 1990–2014 and their share in total emissions.

NFR Category		$PM_{2.5}$ Emission in [kt]		Trend		Share in National Total	
		1990	2014	1990–2014	2013–2014	1990	2014
1	ENERGY	20.25	13.57	-33%	-10%	80%	82%
1.A	FUEL COMBUSTION ACTIVITIES	20.15	13.51	-33%	-10%	80%	81%
1.A.1	Energy Industries	0.83	0.99	19%	-8%	3%	6%
1.A.2	Manufacturing Industries and Construction	2.07	2.56	24%	-3%	8%	15%
1.A.2.a	Iron and Steel	0.04	0.01	-79%	-22%	<1%	<1%
1.A.2.b	Non-ferrous Metals	0.01	0.01	2%	7%	<1%	<1%
1.A.2.c	Chemicals	0.24	0.31	27%	-6%	1%	2%
1.A.2.d	Pulp, Paper and Print	0.78	0.17	-78%	-22%	3%	1%
1.A.2.e	Food Processing, Beverages and Tobacco	0.09	0.02	-79%	-3%	<1%	<1%
1.A.2.f	Non-metallic Minerals	0.06	0.09	52%	18%	<1%	1%
1 A 2 g	Manufacturing Industries and Constr. - other	0.84	1.95	132%	-1%	3%	12%
1.A.3	Transport	5.59	3.21	-43%	-9%	22%	19%
1.A.3.a	Civil Aviation	0.03	0.11	209%	1%	<1%	1%
1.A.3.b	Road Transportation	4.83	2.80	-42%	-10%	19%	17%
1.A.3.c	Railways	0.60	0.24	-60%	-6%	2%	1%
1.A.3.d	Navigation	0.13	0.05	-58%	-12%	1%	<1%
1.A.3.e	Other transportation	0.00	0.00	124%	-17%	<1%	<1%
1.A.4	Other Sectors	11.64	6.74	-42%	-13%	46%	41%
1.A.4.a	Commercial/Institutional	0.68	0.29	-58%	-8%	3%	2%
1.A.4.b	Residential	8.50	5.16	-39%	-14%	34%	31%
1.A.4.c	Agriculture/Forestry/Fisheries	2.46	1.29	-47%	-8%	10%	8%
1.A.5	Other	0.02	0.02	6%	1%	<1%	<1%
1.B	FUGITIVE EMISSIONS FROM FUELS	0.11	0.06	-43%	-8%	<1%	<1%
2	INDUSTRIAL PROCESSES AND PRODUCT USE	3.65	1.83	-50%	2%	14%	11%
2.A	MINERAL PRODUCTS	0.71	0.79	11%	3%	3%	5%
2.A.1	Cement Production	0.14	0.04	-68%	<1%	1%	<1%
2.A.2	Lime Production	0.04	0.06	53%	1%	<1%	<1%
2.A.3	Glass production	IE	IE	IE	IE	IE	IE
2.A.5	Mining, construction, handling of products	0.53	0.68	28%	3%	2%	4%
2.A.6	Other Mineral products	NO	NO	NO	NO	NO	NO
2.B	CHEMICAL INDUSTRY	0.30	0.14	-53%	17%	1%	1%
2.C	METAL PRODUCTION	2.08	0.27	-87%	-3%	8%	2%
2.D	NON ENERGY PRODUCTS/ SOLVENTS	NA	NA	NA	NA	NA	NA
2.G	Other product manufacture and use	0.41	0.45	11%	1%	2%	3%
2.H	Other Processes	0.00	0.00	-39%	1%	<1%	<1%
2.I	Wood processing	0.15	0.18	25%	-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	1.27	1.15	-10%	<1%	5%	7%
3.B	MANURE MANAGEMENT	IE	IE	IE	IE	IE	IE
3.D	AGRICULTURAL SOILS	1.02	0.98	-4%	-1%	4%	6%
3.F	FIELD BURNING OF AGRICULT. RES.	0.13	0.07	-49%	7%	1%	<1%
3.I	Agriculture OTHER	0.12	0.11	-13%	-1%	<1%	1%
5	WASTE	0.02	0.05	136%	28%	<1%	<1%
	Total without sinks	**25.20**	**16.61**	**-34%**	**-8%**		

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 2014 by 11% and amounted to 55 kt in 2014, as can be seen in Table 37. TSP emissions in Austria mainly derive from industrial processes with a share of 29% in national total emissions in 2014 as well as road transport with a share of 21%. Further important sources are agricultural soils and small heating installations.

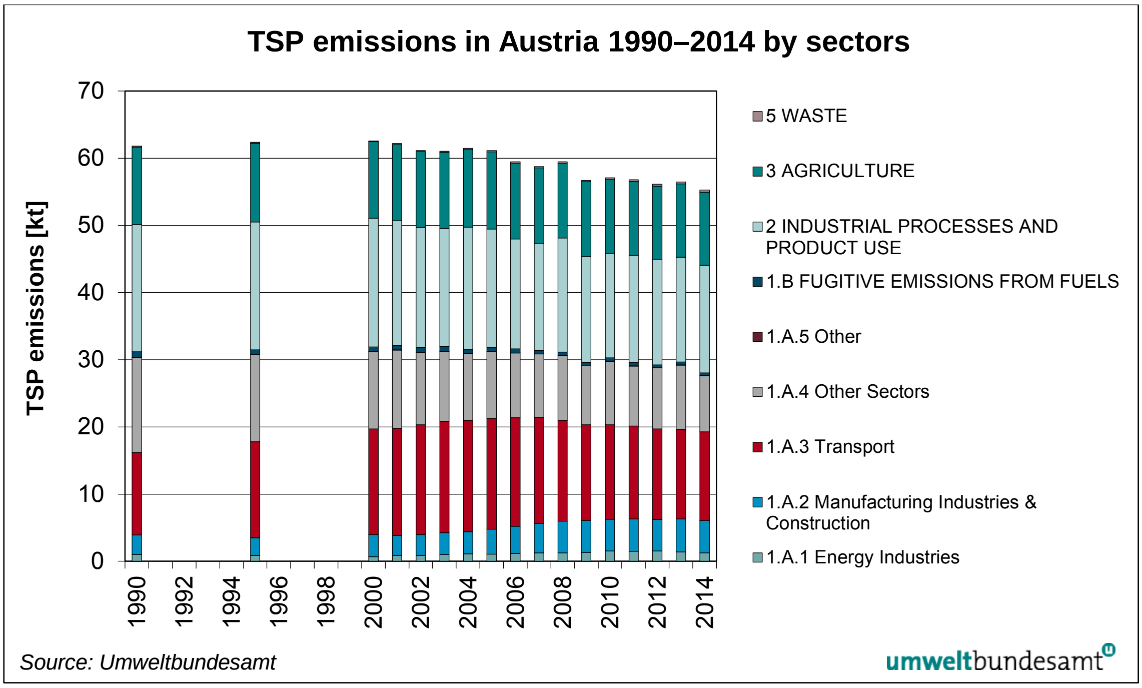

Figure 15: TSP emissions in Austria 1990–2014 by sectors in absolute terms.

Table 37: TSP emissions per NFR Category 1990 and 2014, their trend 1990 – 2014 and their share in total emissions.

NFR Category		TSP Emission in [kt]		Trend		Share in National Total	
		1990	**2014**	**1990–2014**	**2013–2014**	**1990**	**2014**
1	ENERGY	31.19	28.07	-10%	-5%	50%	51%
1.A	FUEL COMBUSTION ACTIVITIES	30.33	27.65	-9%	-5%	49%	50%
1.A.1	Energy Industries	1.03	1.28	24%	-8%	2%	2%
1.A.2	Manufacturing Industries and Construction	2.90	4.81	66%	-2%	5%	9%
1.A.2.a	Iron and Steel	0.06	0.01	-79%	-22%	<1%	<1%
1.A.2.b	Non-ferrous Metals	0.01	0.01	2%	7%	<1%	<1%
1.A.2.c	Chemicals	0.32	0.41	27%	-6%	1%	1%
1.A.2.d	Pulp, Paper and Print	1.06	0.24	-78%	-22%	2%	<1%
1.A.2.e	Food Processing, Beverages and Tobacco	0.12	0.03	-79%	-3%	<1%	<1%
1.A.2.f	Non-metallic Minerals	0.08	0.12	52%	18%	<1%	<1%
1 A 2 g	Manufacturing Industries and Constr. - other	1.25	4.00	219%	-1%	2%	7%
1.A.3	Transport	12.26	13.18	7%	-1%	20%	24%
1.A.3.a	Civil Aviation	0.03	0.11	209%	1%	<1%	<1%
1.A.3.b	Road Transportation	10.10	11.37	13%	-1%	16%	21%
1.A.3.c	Railways	2.00	1.64	-18%	-1%	3%	3%
1.A.3.d	Navigation	0.13	0.05	-58%	-12%	<1%	<1%
1.A.3.e	Other transportation	0.00	0.00	124%	-17%	<1%	<1%
1.A.4	Other Sectors	14.12	8.37	-41%	-13%	23%	15%
1.A.4.a	Commercial/Institutional	0.81	0.32	-61%	-9%	1%	1%
1.A.4.b	Residential	10.41	6.25	-40%	-15%	17%	11%
1.A.4.c	Agriculture/Forestry/Fisheries	2.90	1.80	-38%	-7%	5%	3%
1.A.5	Other	0.02	0.02	5%	1%	<1%	<1%
1.B	FUGITIVE EMISSIONS FROM FUELS	0.85	0.41	-52%	-8%	1%	1%
2	INDUSTRIAL PROCESSES AND PRODUCT USE	18.94	15.99	-16%	3%	31%	29%
2.A	MINERAL PRODUCTS	10.21	13.12	29%	3%	17%	24%
2.A.1	Cement Production	0.17	0.05	-68%	<1%	<1%	<1%
2.A.2	Lime Production	0.06	0.10	53%	1%	<1%	<1%
2.A.3	Glass production	IE	IE	IE	IE	IE	IE
2.A.5	Mining, construction, handling of products	9.97	12.97	30%	3%	16%	23%
2.A.6	Other Mineral products	NO	NO	NO	NO	NO	NO
2.B	CHEMICAL INDUSTRY	0.96	0.46	-52%	17%	2%	1%
2.C	METAL PRODUCTION	6.45	0.81	-87%	-4%	10%	1%
2.D	NON ENERGY PRODUCTS/ SOLVENTS	NA	NA	NA	NA	NA	NA
2.G	Other product manufacture and use	0.41	0.45	11%	1%	1%	1%
2.H	Other Processes	0.00	0.00	-13%	1%	<1%	<1%
2.I	Wood processing	0.92	1.15	25%	-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	10.87	-6%	<1%	19%	20%
3.B	MANURE MANAGEMENT	IE	IE	IE	IE	IE	IE
3.D	AGRICULTURAL SOILS	10.18	9.74	-4%	-1%	16%	18%
3.F	FIELD BURNING OF AGRICULTURAL RES.	0.14	0.07	-50%	7%	<1%	<1%
3.I	Agriculture OTHER	1.21	1.05	-13%	-1%	2%	2%
5	WASTE	0.15	0.36	150%	28%	<1%	1%
	Total without sinks	**61.80**	**55.29**	**-11%**	**-2%**		

2.3 Emission Trends for Heavy Metals

In general emissions of heavy metals decreased remarkably from 1990 to 2014. Emission trends for heavy metals from 1990 to 2014 are presented in Table 38. 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 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 2014[70].

Table 38: National total emissions and emission trends for heavy metals 1990–2014.

Year	Emissions [t]		
	Cd	**Hg**	**Pb**
1990	1.58	2.14	215.07
1991	1.53	2.04	176.33
1992	1.25	1.64	121.55
1993	1.16	1.39	84.85
1994	1.07	1.18	58.81
1995	0.98	1.20	16.08
1996	1.00	1.16	15.53
1997	0.97	1.13	14.47
1998	0.90	0.95	12.99
1999	0.95	0.93	12.43
2000	0.92	0.89	11.91
2001	0.95	0.96	11.98
2002	0.95	0.92	12.13
2003	0.99	0.96	12.42
2004	0.99	0.94	12.81
2005	1.07	0.98	13.25
2006	1.08	1.00	13.50
2007	1.13	1.00	14.30
2008	1.15	1.02	14.66
2009	1.05	0.89	12.77
2010	1.17	1.00	15.00
2011	1.15	0.98	14.88
2012	1.16	0.99	14.82
2013	1.21	1.02	15.79
2014	1.15	0.96	15.11
Trend 1990–2014	**-28%**	**-55%**	**-93%**

[70] 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

National total Cd emissions amounted to 1.58 t in 1990; emissions have decreased steadily and by the year 2014 emissions were reduced by 28% (1.15 t) in the period 1990–2014. 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).

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 in the last few years, which was due to the growing activities in the industrial processes sector and energy sector. Since then emissions remain quite stable. The decrease of 5.3% between 2013 and 2014 mainly results from lower biomass consumption of households.

The most important source for Cd emissions is the combustion of solid fuels (fossil and biomass). In the period from 1990 to 2014 Cd emissions of *1.A Fuel Combustion Activities* decreased by 10% to 0.90 t, which is a share of 78% in national total Cd emission in 2014 (see Table 39). 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 35% since 1990 to 0.27 t, representing a share of 24% in national total emissions in 2014. The reduction is mainly due to a decreased use of coal.
- *NFR 1.A.2 Manufacturing Industries and Construction*: Between 1990 and 2014 Cd emissions decreased by 28%, 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 NFR *1.A.1* and NFR *1.A.3*, Cd emissions have decreased steadily regarding the long-term trend, mainly due to an increase in efficiency, implementation and installation of flue gas treatment system as well as by dust removal systems.

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 39 in the period from 1990 to 2014 the Cd emissions decreased by 53% to 0.25 t, which is a share of 21% 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.

Cd emissions resulting from NFR sectors *3 Agriculture* and *5 Waste* are minor sources.

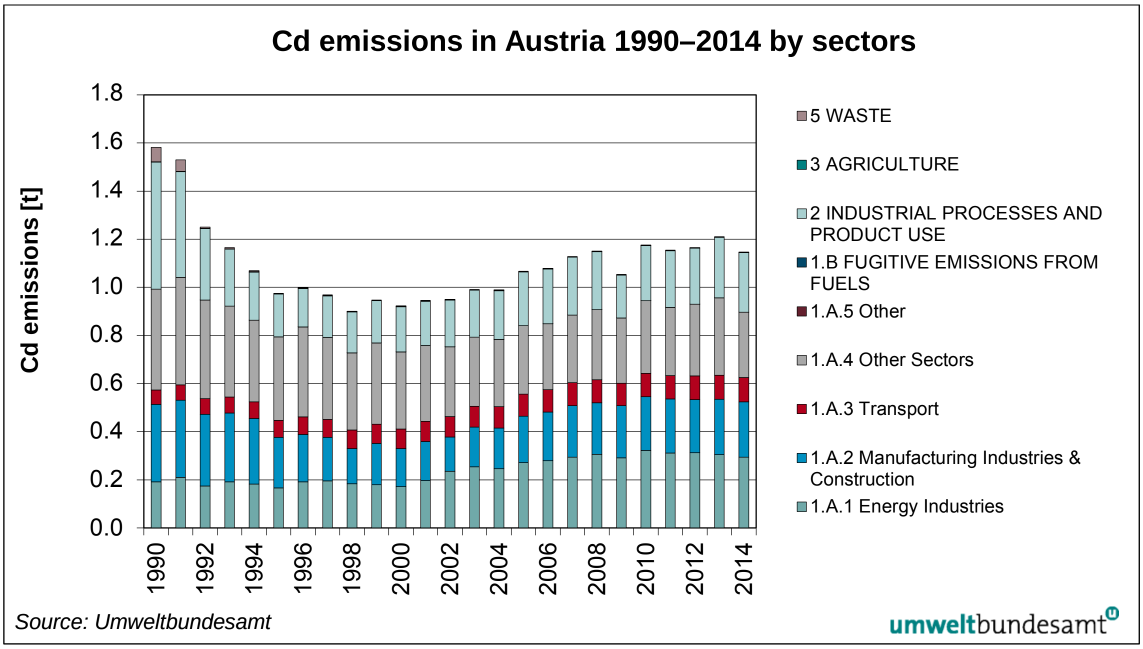

Figure 16: Cd emissions in Austria 1990–2014 by sectors in absolute terms.

Table 39: Cd emissions per NFR Category 1990 and 2014, their trend 1990–2014 and their share in total emissions.

NFR Category		**Cd Emission in [t]**		**Trend**		**Share in National Total**	
		1990	**2014**	**1990–2014**	**2013–2014**	**1990**	**2014**
1	ENERGY	0.99	0.90	-10%	-6%	63%	78%
1.A	FUEL COMBUSTION ACTIVITIES	0.99	0.90	-10%	-6%	63%	78%
1.A.1	Energy Industries	0.19	0.29	53%	-4%	12%	26%
1.A.1.a	Public Electricity and Heat Production	0.10	0.13	21%	-5%	7%	11%
1.A.1.b	Petroleum refining	0.09	0.17	91%	-3%	6%	15%
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	0.23	-28%	<1%	20%	20%
1.A.2.a	Iron and Steel	0.01	0.00	-46%	-3%	<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	-51%	-11%	2%	1%
1.A.2.d	Pulp, Paper and Print	0.14	0.10	-32%	<1%	9%	9%
1.A.2.e	Food Processing, Beverages and Tobacco	0.00	0.00	-90%	-15%	<1%	<1%
1.A.2.f	Non-metallic Minerals	0.10	0.02	-76%	2%	6%	2%
1.A 2.g	Manufacturing Industries and Constr. - other	0.03	0.08	166%	1%	2%	7%
1.A.3	Transport	0.06	0.10	67%	2%	4%	9%
1.A.3.a	Civil Aviation	0.00	0.00	196%	1%	<1%	<1%
1.A.3.b	Road Transportation	0.06	0.10	68%	2%	4%	9%
1.A.3.c	Railways	0.00	0.00	-86%	2%	<1%	<1%
1.A.3.d	Navigation	0.00	0.00	17%	-7%	<1%	<1%
1.A.3.e	Other transportation	NA	NA	NA	NA	NA	NA
1.A.4	Other Sectors	0.42	0.27	-35%	-15%	27%	24%
1.A.4.a	Commercial/Institutional	0.07	0.02	-77%	-26%	5%	2%
1.A.4.b	Residential	0.31	0.19	-38%	-16%	20%	17%
1.A.4.c	Agriculture/Forestry/Fisheries	0.03	0.06	90%	-9%	2%	5%
1.A.5	Other	0.00	0.00	39%	1%	<1%	<1%
1.B	FUGITIVE EMISSIONS FROM FUELS	NA	NA	NA	NA	NA	NA
2	INDUSTRIAL PROCESSES AND PRODUCT USE	0.53	0.25	-53%	-2%	33%	22%
2.A	MINERAL PRODUCTS	NA	NA	NA	NA	NA	NA
2.B	CHEMICAL INDUSTRY	0.00	0.00	-30%	17%	<1%	<1%
2.C	METAL PRODUCTION	0.53	0.25	-53%	-2%	33%	21%
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	0.00	0.00	-47%	6%	<1%	<1%
5	WASTE	0.06	0.00	-99%	-5%	4%	<1%
	Total without sinks	**1.58**	**1.15**	**-28%**	**-5%**		

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

In 1990 national total Hg emissions amounted to 2.1 t; emissions have decreased steadily. In the year 2014 national total Hg emissions were 55% below the level of 1990 (see Table 38). Between 2013 and 2014 emissions decreased by 5.6%.

The overall reduction of about 55% for the period 1990 to 2014 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:

- *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.
- *NFR 2.C Metal Production:* Emissions from iron and steel production are the main source within this source category and increased by about 30% since 1990 due to implemented extensive abatement measures which were compensated by increased activities.
- *NFR 2.B Chemical Industry:* Hg emissions from this source were remarkable in 1990 but decreased steadily to a share of less than 1% in 2014. 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.

NFR sectors *3 Agriculture* and *5 Waste* are only minor Hg sources.

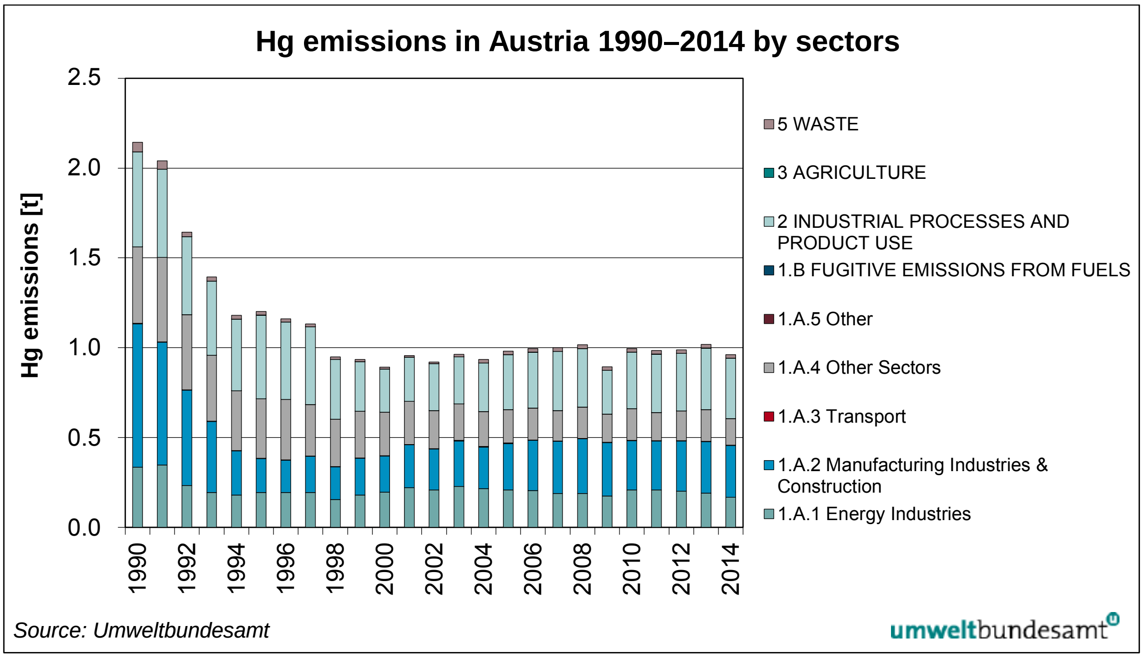

Figure 17: Hg emissions in Austria 1990–2014 by sectors in absolute terms.

Table 40: Hg emissions per NFR Category 1990 and 2014, their trend 1990–2014 and their share in total emissions.

NFR Category		**Hg Emission in [t]**		**Trend**		**Share in National Total**	
		1990	**2014**	**1990–2014**	**2013–2014**	**1990**	**2014**
1	ENERGY	1.56	0.61	-61%	-8%	73%	63%
1.A	FUEL COMBUSTION ACTIVITIES	1.56	0.61	-61%	-8%	73%	63%
1.A.1	Energy Industries	0.33	0.17	-50%	-13%	16%	17%
1.A.1.a	Public Electricity and Heat Production	0.33	0.15	-53%	-13%	15%	16%
1.A.1.b	Petroleum refining	0.01	0.01	105%	-4%	<1%	1%
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	-64%	1%	37%	30%
1.A.2.a	Iron and Steel	0.00	0.00	-40%	-3%	<1%	<1%
1.A.2.b	Non-ferrous Metals	0.01	0.01	12%	<1%	<1%	1%
1.A.2.c	Chemicals	0.01	0.01	-18%	-2%	1%	1%
1.A.2.d	Pulp, Paper and Print	0.07	0.07	12%	<1%	3%	8%
1.A.2.e	Food Processing, Beverages and Tobacco	0.00	0.00	-63%	9%	<1%	<1%
1.A.2.f	Non-metallic Minerals	0.70	0.15	-78%	1%	33%	16%
1.A.2.g	Manufacturing Industries and Constr. - other	0.01	0.04	264%	2%	1%	4%
1.A.3	Transport	0.00	0.00	4%	-2%	<1%	<1%
1.A.3.a	Civil Aviation	0.00	0.00	196%	1%	<1%	<1%
1.A.3.b	Road Transportation	0.00	0.00	61%	-3%	<1%	<1%
1.A.3.c	Railways	0.00	0.00	-92%	<1%	<1%	<1%
1.A.3.d	Navigation	0.00	0.00	17%	-7%	<1%	<1%
1.A.3.e	Other transportation	NA	NA	NA	NA	NA	NA
1.A.4	Other Sectors	0.43	0.15	-66%	-16%	20%	15%
1.A.4.a	Commercial/Institutional	0.03	0.01	-78%	-24%	1%	1%
1.A.4.b	Residential	0.39	0.12	-68%	-16%	18%	13%
1.A.4.c	Agriculture/Forestry/Fisheries	0.01	0.02	24%	-9%	1%	2%
1.A.5	Other	0.00	0.00	39%	1%	<1%	<1%
1.B	FUGITIVE EMISSIONS FROM FUELS	NA	NA	NA	NA	NA	NA
2	INDUSTRIAL PROCESSES AND PRODUCT USE	0.53	0.34	-36%	-2%	25%	35%
2.A	MINERAL PRODUCTS	NA	NA	NA	NA	NA	NA
2.B	CHEMICAL INDUSTRY	0.27	0.00	-100%	17%	13%	<1%
2.C	METAL PRODUCTION	0.26	0.34	30%	-2%	12%	35%
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	-51%	8%	<1%	<1%
5	WASTE	0.05	0.02	-63%	<1%	3%	2%
	Total without sinks	**2.14**	**0.96**	**-55%**	**-6%**		

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

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 2014 emissions were 93% lower than in 1990 and amounted to 15 t. As it is shown in Table 41, today's Pb emissions mainly arise from the NFR *1.A Fuel Combustion Activities* and *2.C Metal Production.*

- *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 2014 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. From 1990 to 1995 Pb emissions from this sub-sector decreased by nearly 100%.
- *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.

Pb emissions resulting from NFR sectors *3 Agriculture* and *5 Waste* are minor sources.

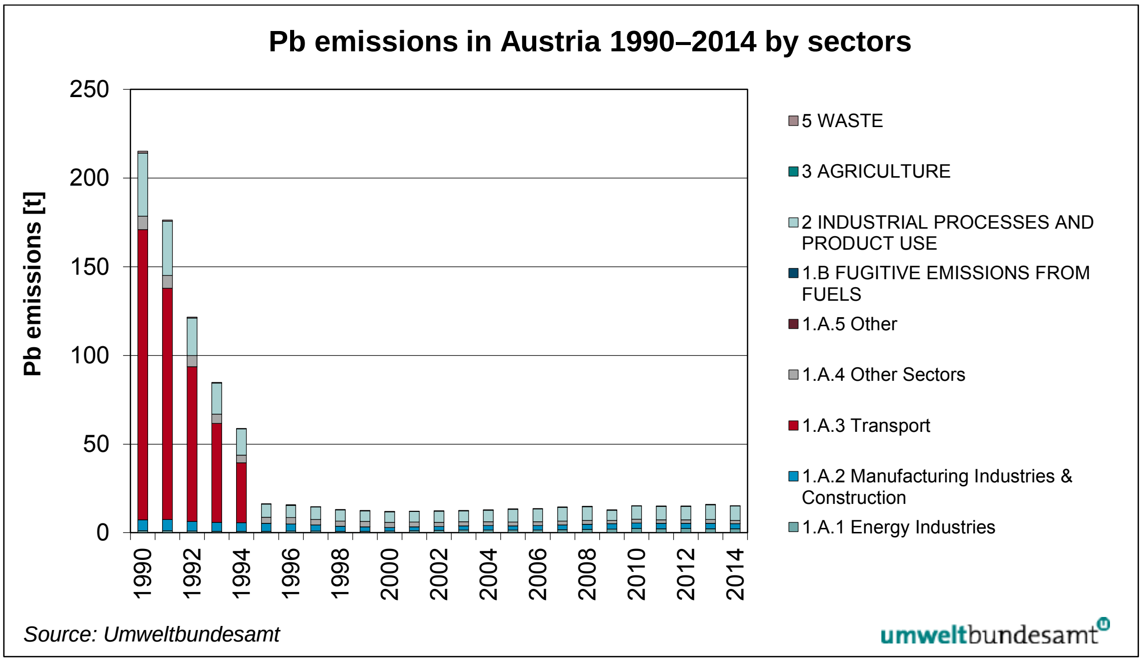

Figure 18: Pb emissions in Austria 1990–2014 by sectors in absolute terms.

Table 41: Pb emissions per NFR Category 1990 and 2014, their trend 1990–2014 and their share in total emissions.

NFR Category		**Pb Emission in [t]**		**Trend**		**Share in National Total**	
		1990	**2014**	**1990–2014**	**2013–2014**	**1990**	**2014**
1	ENERGY	178.40	7.01	-96%	-7%	83%	46%
1.A	FUEL COMBUSTION ACTIVITIES	178.40	7.01	-96%	-7%	83%	46%
1.A.1	Energy Industries	1.08	2.18	101%	-6%	1%	14%
1.A.1.a	Public Electricity and Heat Production	0.90	1.82	101%	-7%	<1%	12%
1.A.1.b	Petroleum refining	0.18	0.36	105%	-4%	<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	6.14	2.97	-52%	<1%	3%	20%
1.A.2.a	Iron and Steel	0.26	0.16	-41%	-3%	<1%	1%
1.A.2.b	Non-ferrous Metals	0.54	0.48	-12%	<1%	<1%	3%
1.A.2.c	Chemicals	0.21	0.27	32%	-13%	<1%	2%
1.A.2.d	Pulp, Paper and Print	0.62	0.84	35%	<1%	<1%	6%
1.A.2.e	Food Processing, Beverages and Tobacco	0.01	0.00	-64%	-4%	<1%	<1%
1.A.2.f	Non-metallic Minerals	4.27	0.34	-92%	1%	2%	2%
1.A.2.g	Manufacturing Industries and Constr. - other	0.23	0.88	279%	6%	<1%	6%
1.A.3	Transport	163.70	0.01	-100%	-57%	76%	<1%
1.A.3.a	Civil Aviation	1.64	0.00	-100%	-9%	1%	<1%
1.A.3.b	Road Transportation	161.80	0.00	-100%	-59%	75%	<1%
1.A.3.c	Railways	0.01	0.00	-92%	<1%	<1%	<1%
1.A.3.d	Navigation	0.25	0.00	-100%	-37%	<1%	<1%
1.A.3.e	Other transportation	NA	NA	NA	NA	NA	NA
1.A.4	Other Sectors	7.48	1.85	-75%	-17%	3%	12%
1.A.4.a	Commercial/Institutional	0.45	0.13	-72%	-26%	<1%	1%
1.A.4.b	Residential	6.01	1.52	-75%	-17%	3%	10%
1.A.4.c	Agriculture/Forestry/Fisheries	1.02	0.20	-80%	-9%	<1%	1%
1.A.5	Other	0.00	0.00	39%	1%	<1%	<1%
1.B	FUGITIVE EMISSIONS FROM FUELS	NA	NA	NA	NA	NA	NA
2	INDUSTRIAL PROCESSES AND PRODUCT USE	35.65	8.10	-77%	-2%	17%	54%
2.A	MINERAL PRODUCTS	NA	NA	NA	NA	NA	NA
2.B	CHEMICAL INDUSTRY	0.00	0.00	-30%	17%	<1%	<1%
2.C	METAL PRODUCTION	35.63	8.08	-77%	-2%	17%	53%
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	-45%	5%	<1%	<1%
5	WASTE	1.02	0.00	-100%	-2%	<1%	<1%
	Total without sinks	**215.07**	**15.11**	**-93%**	**-4%**		

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 2014[71]. PCB emissions are reported for the first time in the current submission.

Emissions of PAH and PCDD/F decreased remarkably from 1990 to 2014, where the highest achievement was made until 1995. HCB and PCB emissions increased between 1990 and 2014.

The significant increase (53%) of HCB emissions is due to unintentional releases of HCB by an Austrian cement plant affecting the years 2012, 2013 and 2014.

The increase (12%) of PCB emissions between 1990 and 2014 is directly linked with activities in metal production, mainly influenced by a significant jump of activity data in reported secondary lead production between 2012 and 2013.

In 2014 the emissions from all POPs decreased compared to the previous year. PAH and Dioxin emissions decreased between 2013 and 2014 due to warm winter temperatures affecting the heating demand. The short term trend of HCB is influenced by the accidental release, as already mentioned, and the slight decrease of PCB between 2013 and 2014 is dependent on production activities in secondary lead production.

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. Due to the unintentional HCB emissions in the years 2012 to 2014 within source category *1.A.2 Manufacturing Industries* this source is the main emissions source for HCB in the latest years.

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 42: Emissions and emission trends for POPs 1990–2014.

Year	**Emission**			
	PAH [t]	**PCDD/F [g]**	**HCB [kg]**	**PCB [kg]**
1990	16.27	160.69	91.93	194.23
1991	16.90	135.39	84.62	175.76
1992	12.16	76.81	69.67	147.97
1993	9.49	67.03	64.02	142.96
1994	8.50	56.26	51.93	159.73
1995	8.85	58.48	53.09	161.98
1996	9.40	59.84	55.80	159.26
1997	8.44	59.32	51.91	162.91
1998	8.05	56.33	49.34	163.23
1999	8.03	53.62	47.57	161.86

[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/

Year	Emission			
	PAH [t]	**PCDD/F [g]**	**HCB [kg]**	**PCB [kg]**
2000	7.40	52.04	44.28	163.35
2001	7.50	51.56	45.65	163.88
2002	6.75	37.60	41.81	164.77
2003	6.48	36.36	40.77	165.08
2004	6.40	36.19	40.77	171.63
2005	6.65	37.77	42.77	175.74
2006	6.23	36.89	40.14	188.13
2007	6.07	36.32	39.11	190.75
2008	6.09	36.54	39.35	185.35
2009	5.48	33.14	35.21	161.43
2010	6.04	36.91	40.25	179.04
2011	5.44	33.69	36.56	182.04
2012	5.58	34.44	61.88	176.17
2013	6.21	37.72	144.20	224.12
2014	4.89	31.61	140.95	218.30
Trend 1990–2014	**-70%**	**-80%**	**53%**	**12%**

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)fluoranthen, benzo(k)fluoranthen 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 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 2014 emissions were reduced by about 70% (to 4.9 t in 2014).

In 1990 the main emission sources for PAH emissions were NFR 1.A *Fuel Combustion Activities* (55%) and *Industrial processes and Product Use* (44%). *Agriculture* (1.5%) and *Waste* (<1%) are minor sources. In 2014 PAH emissions are mainly emitted by *1.A Fuel Combustion Activities* with a share of 93%. Within this source, PAH emissions mainly result from sector *1.A.4 Other Sectors,* and to a smaller extent from NFR sector *1.A.3 Transport*. In sector *1.A.4* emissions decreased since 1990 by 54% because of a decreased use of coal and an increased share of efficient biomass boilers with lower specific emissions. In sector *1.A.3* an emission increase by 21% can be observed due to increased activity (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.

From 1990 to 2014 PAH emissions from Agriculture decreased remarkably by 64% due to prohibition of open field burning, PAH emissions from the sector *Industrial processes and Product Use* decreased by 97% due to the shutdown of primary aluminium production in Austria, which was a main source for PAH emissions.

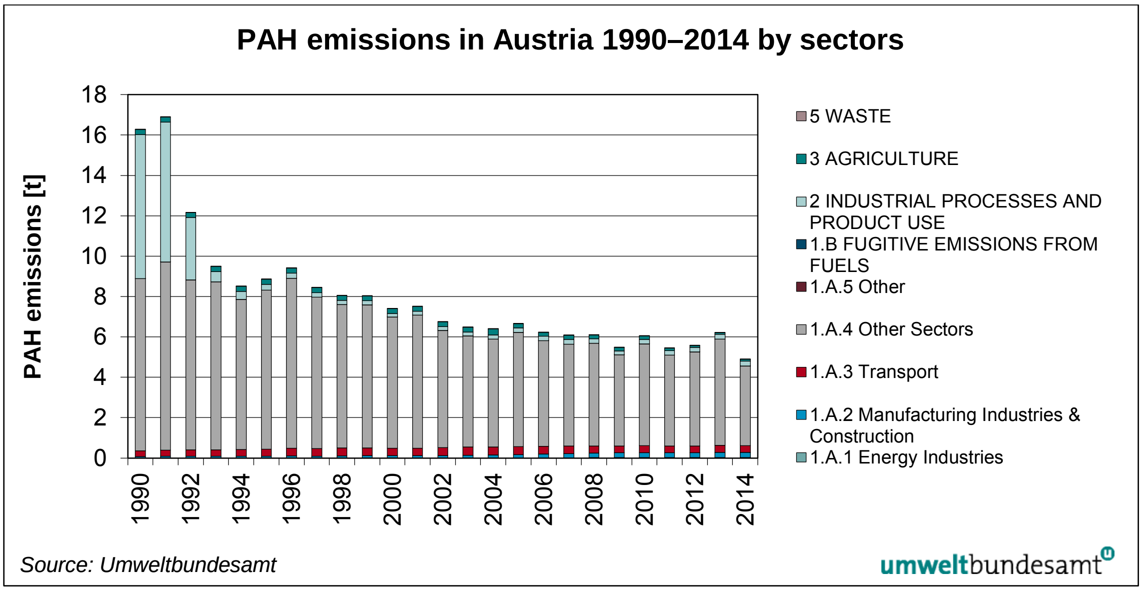

Figure 19: PAH emissions in Austria 1990–2014 by sectors in absolute terms.

Table 43: PAH emissions per NFR Category 1990 and 2014, their trend 1990–2014 and their share in total emissions.

NFR Category		**PAH Emission in [t]**		**Trend**		**Share in National Total**	
		1990	**2014**	**1990–2014**	**2013–2014**	**1990**	**2014**
1	ENERGY	8.88	4.56	-49%	-23%	55%	93%
1.A	FUEL COMBUSTION ACTIVITIES	8.88	4.56	-49%	-23%	55%	93%
1.A.1	Energy Industries	0.00	0.02	368%	-1%	<1%	<1%
1.A.2	Manufacturing Industries and Construction	0.07	0.25	262%	<1%	<1%	5%
1.A.2.a	Iron and Steel	0.00	0.00	-39%	-7%	<1%	<1%
1.A.2.b	Non-ferrous Metals	0.00	0.00	12%	8%	<1%	<1%
1.A.2.c	Chemicals	0.02	0.02	24%	-7%	<1%	<1%
1.A.2.d	Pulp, Paper and Print	0.00	0.00	10%	-3%	<1%	<1%
1.A.2.e	Food Processing, Beverages and Tobacco	0.00	0.00	-51%	-6%	<1%	<1%
1.A.2.f	Non-metallic Minerals	0.00	0.01	121%	11%	<1%	<1%
1.A.2.g	Manufacturing Industries and Constr. - other	0.04	0.21	413%	<1%	<1%	4%
1.A.3	Transport	0.29	0.35	21%	-2%	2%	7%
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%	7%
1.A.3.c	Railways	0.02	0.01	-46%	4%	<1%	<1%
1.A.3.d	Navigation	0.01	0.01	19%	-7%	<1%	<1%
1.A.3.e	Other transportation	NA	NA	NA	NA	NA	NA
1.A.4	Other Sectors	8.53	3.94	-54%	-25%	52%	81%
1.A.4.a	Commercial/Institutional	0.16	0.06	-63%	-27%	1%	1%
1.A.4.b	Residential	7.94	3.22	-59%	-27%	49%	66%
1.A.4.c	Agriculture/Forestry/Fisheries	0.42	0.66	57%	-12%	3%	14%
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%	-2%	44%	5%
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	0.20	-97%	-2%	40%	4%
2.C.1	Iron and Steel Production	0.35	0.20	-43%	-2%	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	0.09	-64%	8%	2%	2%
5	WASTE	0.00	0.00	-95%	<1%	<1%	<1%
	Total without sinks	**16.27**	**4.89**	**-70%**	**-21%**		

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 organochlorinated 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

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 2014 emissions were reduced by about 80% (to 32 g in 2014).

The main source for dioxin and furan emissions in Austria, with a share of 84% in 2014, is Category *1.A Fuel Combustion Activities*. The second largest source is sector *2 Industrial Processes and Product Use* with a share of 16% in national total emissions.

In more detail, the main sources of dioxin and furan emissions are:

- *NFR 1.A.4 Other Sectors:* has the highest contribution (58%) to national total dioxin/furan (PCDD/F) emissions in 2014 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 amount to 15% of national dioxin/furan (PCDD/F) emissions in 2014.
- *NFR 2.C Metal Production:* Dioxin/furan (PCDD/F) emissions decreased remarkably due to extensive abatement measures. 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*.
- *NFR 5 Waste*: From 1990 to 2014 dioxin/furan (PCDD/F) emissions from sector *Waste* decreased by 99% due to stringent legislation and modern technology. As shown in Table 44 in the period from 1990 to 2014 dioxin/furan emissions decreased to 0.16 g, which is a share of less than 1% in total dioxin/furan emissions, whereas in 1990 dioxin/furan (PCDD/F) emissions contribute 11% to the total dioxin/furan emissions. Emissions of dioxin/furan (PCDD/F) from NFR subsector *5.C Incineration and open burning of waste* are not rated as key source of the Austrian Inventory.

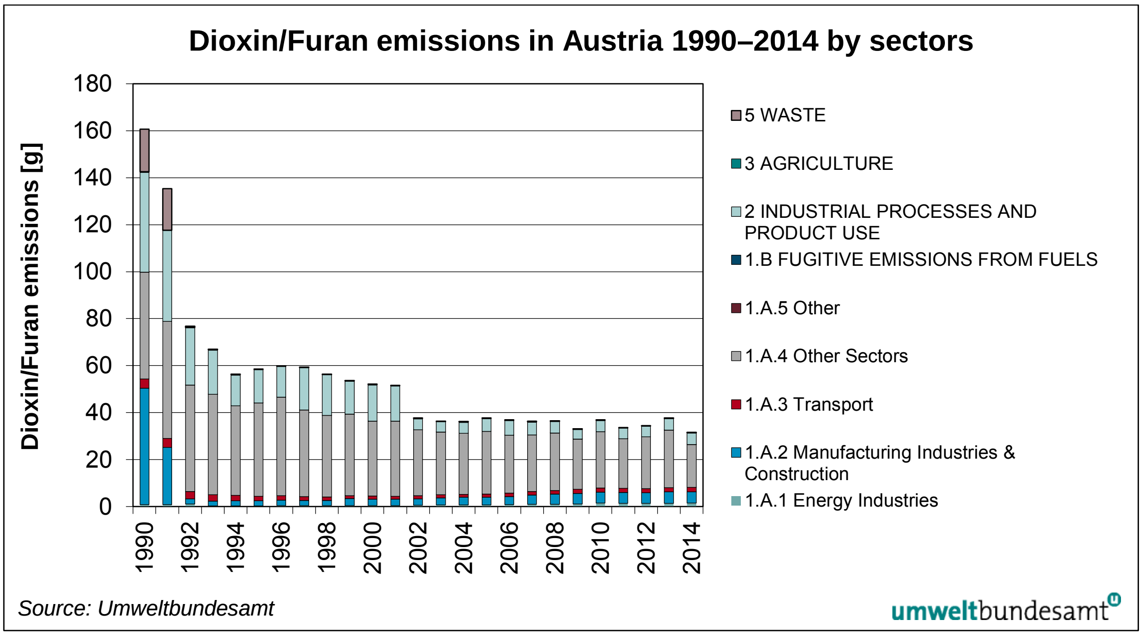

Figure 20: Dioxin/Furan emissions in Austria 1990–2014 by sectors in absolute terms.

Table 44: Dioxin/Furan (PCDD/F) emissions per NFR Category 1990 and 2014, their trend 1990 – 2014 and their share in total emissions.

NFR Category		Dioxin Emission in [g]		Trend		Share in National Total	
		1990	2014	1990–2014	2013–2014	1990	2014
1	ENERGY	99.78	26.45	-73%	-19%	62%	84%
1.A	FUEL COMBUSTION ACTIVITIES	99.78	26.45	-73%	-19%	62%	84%
1.A.1	Energy Industries	0.82	1.46	79%	2%	1%	5%
1.A.2	Manufacturing Industries and Construction	49.62	4.84	-90%	1%	31%	15%
1.A.2.a	Iron and Steel	0.03	0.02	-27%	-5%	<1%	<1%
1.A.2.b	Non-ferrous Metals	47.87	0.35	-99%	<1%	30%	1%
1.A.2.c	Chemicals	0.44	0.55	26%	-7%	<1%	2%
1.A.2.d	Pulp, Paper and Print	0.49	0.54	10%	-3%	<1%	2%
1.A.2.e	Food Processing, Beverages and Tobacco	0.03	0.02	-26%	2%	<1%	<1%
1.A.2.f	Non-metallic Minerals	0.29	0.45	52%	2%	<1%	1%
1.A.2.g	Manufacturing Industries and Constr. - other	0.48	2.92	508%	3%	<1%	9%
1.A.3	Transport	3.88	1.86	-52%	<1%	2%	6%
1.A.3.a	Civil Aviation	NE	NE	NE	NE	NE	NE
1.A.3.b	Road Transportation	3.83	1.84	-52%	<1%	2%	6%
1.A.3.c	Railways	0.04	0.02	-60%	6%	<1%	<1%
1.A.3.d	Navigation	0.01	0.01	-1%	-4%	<1%	<1%
1.A.3.e	Other transportation	0.00	0.00	124%	-17%	<1%	<1%
1.A.4	Other Sectors	45.46	18.28	-60%	-25%	28%	58%
1.A.4.a	Commercial/Institutional	1.92	0.93	-52%	-28%	1%	3%
1.A.4.b	Residential	41.78	14.61	-65%	-27%	26%	46%
1.A.4.c	Agriculture/Forestry/Fisheries	1.76	2.74	56%	-13%	1%	9%
1.A.5	Other	0.00	0.00	42%	3%	<1%	<1%
1.B	FUGITIVE EMISSIONS FROM FUELS	NA	NA	NA	NA	NA	NA
2	INDUSTRIAL PROCESSES AND PRODUCT USE	42.53	4.92	-88%	1%	26%	16%
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	4.79	-88%	1%	25%	15%
2.C.1	Iron and Steel Production	37.21	3.42	-91%	2%	23%	11%
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	0.11	58%	-4%	<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	0.07	-62%	7%	<1%	<1%
5	WASTE	18.19	0.16	-99%	<1%	11%	1%
	Total without sinks	**160.69**	**31.61**	**-80%**	**-16%**		

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

Emissions of HCB are generally decreasing over the observed period, where the highest reduction was achieved in NFR category 1.A.2.b non-ferrous metals from 1990 to 1992. However, due to an unintentional relase from 2012 onwards 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.

Aside that unintentional release, the small combustion sector (i.e. residential heating) is the most important sector (*1.A.4 Other Sectors* had a share of 51% in 1990 and 83% in 2011). The second largest source for HCB emissions in 2011 was sector *2 Industrial Processes and Product Use* (Iron and Steel Production) with a share of 12% in national total emissions. HCB emissions of these two sectors decreased by 51% and 50%, respectively from 1990 to 2014.

From 1990 to 2014 HCB emissions from the sectors NFR 3 *Agriculture* as well as NFR *5 Waste* decreased remarkably by 62% and 92%, respectively, more due to stringent legislation and modern technology. Both sectors are minor sources of HCB emissions in 2014.

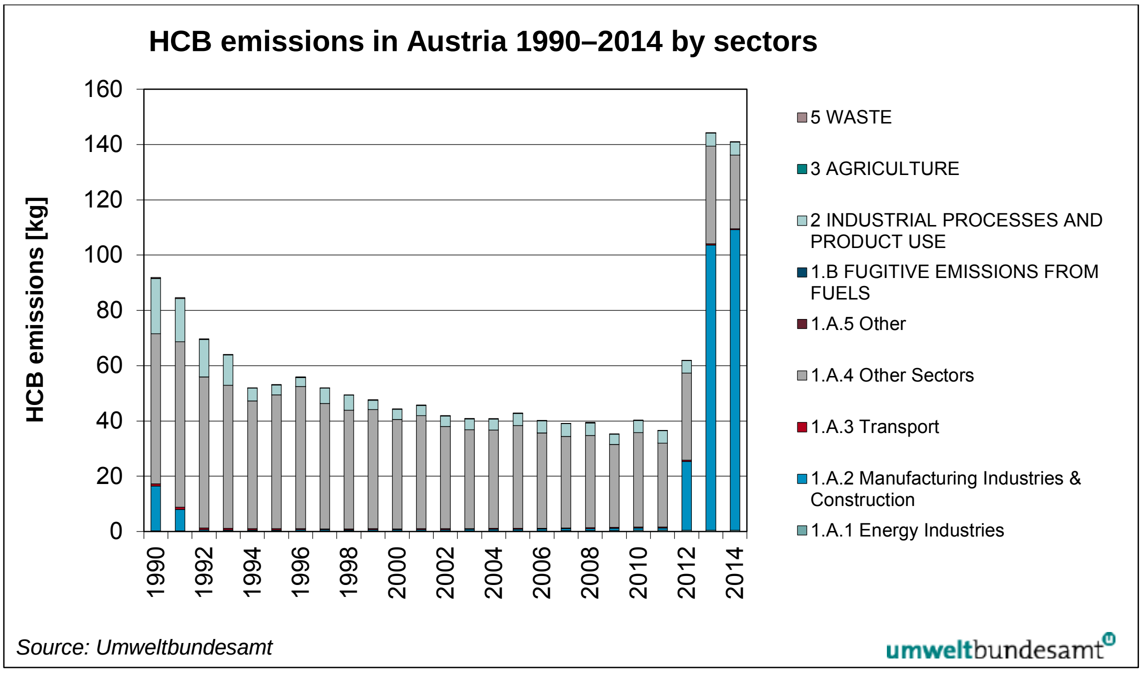

Figure 21: HCB emissions in Austria 1990–2014 by sectors in absolute terms.

Table 45: Hexachlorbenzene (HCB) emissions per NFR Category 1990 and 2014, their trend 1990–2014 and their share in total emissions.

NFR Category		HCB Emission in [kg]		Trend		Share in National Total	
		1990	2014	1990–2014	2013–2014	1990	2014
1	ENERGY	71.54	136.21	90%	-2%	78%	97%
1.A	FUEL COMBUSTION ACTIVITIES	71.54	136.21	90%	-2%	78%	97%
1.A.1	Energy Industries	0.21	0.49	137%	5%	<1%	<1%
1.A.2	Manufacturing Industries and Construction	16.25	108.66	569%	5%	18%	77%
1.A.2.a	Iron and Steel	0.01	0.00	-33%	-4%	<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	26%	-8%	<1%	<1%
1.A.2.d	Pulp, Paper and Print	0.10	0.11	10%	-3%	<1%	<1%
1.A.2.e	Food Processing, Beverages and Tobacco	0.00	0.00	-31%	-1%	<1%	<1%
1.A.2.f	Non-metallic Minerals	0.06	107.91	190 755%	5%	<1%	77%
1.A.2.g	Manufacturing Industries and Constr. - other	0.07	0.46	532%	3%	<1%	<1%
1.A.3	Transport	0.78	0.37	-52%	<1%	1%	<1%
1.A.3.a	Civil Aviation	NE	NE	NE	NE	NE	NE
1.A.3.b	Road Transportation	0.77	0.37	-52%	<1%	1%	<1%
1.A.3.c	Railways	0.01	0.00	-60%	6%	<1%	<1%
1.A.3.d	Navigation	0.00	0.00	-1%	-4%	<1%	<1%
1.A.3.e	Other transportation	0.00	0.00	124%	-17%	<1%	<1%
1.A.4	Other Sectors	54.30	26.69	-51%	-24%	59%	19%
1.A.4.a	Commercial/Institutional	1.45	0.56	-62%	-27%	2%	<1%
1.A.4.b	Residential	50.29	21.80	-57%	-26%	55%	15%
1.A.4.c	Agriculture/Forestry/Fisheries	2.56	4.33	69%	-13%	3%	3%
1.A.5	Other	0.00	0.00	42%	3%	<1%	<1%
1.B	FUGITIVE EMISSIONS FROM FUELS	NA	NA	NA	NA	NA	NA
2	INDUSTRIAL PROCESSES AND PRODUCT USE	19.96	4.70	-76%	-2%	22%	3%
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	4.67	-50%	-2%	10%	3%
2.C.1	Iron and Steel Production	8.09	4.05	-50%	-2%	9%	3%
2.C.2	Ferroalloys Production	NE	NE	NE	NE	NE	NE
2.C.3	Aluminium production	1.20	0.63	-48%	<1%	1%	<1%
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	-62%	7%	<1%	<1%
5	WASTE	0.39	0.03	-92%	<1%	<1%	<1%
	Total without sinks	**91.93**	**140.95**	**53%**	**-2%**		

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)[72].

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 Pollutants[73] in 2001 because of its environmental toxicity and classification as a persistant 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 exlusively emitted in NFR sector *2 Industrial Processes and Product Use* with a share of 99% in national total PCB emissions in 2014. 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 54% of national total PCB emissions in 2014, followed by NFR *2.C.7 Other Metal Production* with 29% and NFR *2.C.1 Iron and Steel Production* with 16%. Since 1990 emissions from subcategory 2.C increased by 17%; the emissions generally follow the production activities (e.g. the significant jump of emissions between 2012 and 2013 is due to rising production activities in secondary lead production).

A minor source of PCB emissions is *NFR 1.A Fuel Combustion Activities*, both from stationary and mobile sources (*NFR 1.A.3 Transport*), with a share of 0.9% in total emissions in 2014. 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.

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[72] http://chm.pops.int/Implementation/PCBs/Overview/tabid/273/Default.aspx

[73] http://chm.pops.int/default.aspx

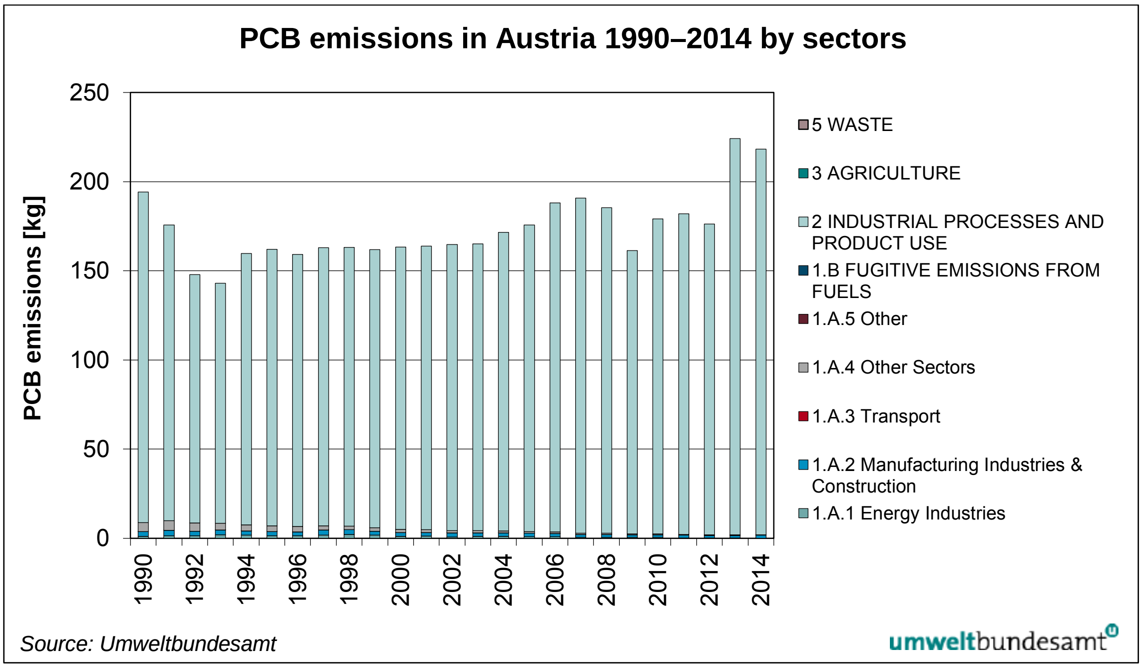

Figure 22: PCB emissions in Austria 1990–2014 by sectors in absolute terms.

Table 46: Polychlorinated biphenyl (PCB) emissions per NFR Category 1990 and 2014, their trend 1990–2014 and their share in total emissions.

NFR Category		PCB Emission in [kg]		Trend		Share in National Total	
		1990	2014	1990–2014	2013–2014	1990	2014
1	ENERGY	8.73	1.93	-78%	1%	4%	1%
1.A	FUEL COMBUSTION ACTIVITIES	8.73	1.93	-78%	1%	4%	1%
1.A.1	Energy Industries	1.16	0.10	-92%	-30%	1%	<1%
1.A.2	Manufacturing Industries and Construction	2.64	1.64	-38%	7%	1%	1%
1.A.2.a	Iron and Steel	0.08	0.02	-73%	-14%	<1%	<1%
1.A.2.b	Non-ferrous Metals	0.04	0.03	-31%	15%	<1%	<1%
1.A.2.c	Chemicals	0.21	0.25	22%	32%	<1%	<1%
1.A.2.d	Pulp, Paper and Print	1.49	0.75	-50%	-1%	1%	<1%
1.A.2.e	Food Processing, Beverages and Tobacco	0.15	0.03	-78%	13%	<1%	<1%
1.A.2.f	Non-metallic Minerals	0.48	0.49	2%	13%	<1%	<1%
1.A.2.g	Manufacturing Industries and Constr. - other	0.19	0.07	-64%	-3%	<1%	<1%
1.A.3	Transport	0.00	0.00	11%	-9%	<1%	<1%
1.A.4	Other Sectors	4.92	0.19	-96%	-19%	3%	<1%
1.A.4.a	Commercial/Institutional	0.30	0.02	-93%	-15%	<1%	<1%
1.A.4.b	Residential	4.53	0.17	-96%	-19%	2%	<1%
1.A.4.c	Agriculture/Forestry/Fisheries	0.09	0.01	-94%	-10%	<1%	<1%
1.A.5	Other	0.00	0.00	-22%	-15%	<1%	<1%
1.B	FUGITIVE EMISSIONS FROM FUELS	NA	NA	NA	NA	NA	NA
2	INDUSTRIAL PROCESSES AND PRODUCT USE	185.50	216.36	17%	-3%	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	216.36	17%	-3%	96%	99%
2.C.1	Iron and Steel Production	19.34	34.73	80%	-1%	10%	16%
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	118.79	26%	-4%	49%	54%
2.C.6	Zinc production	NO	NO	NO	NO	NO	NO
2.C.7	Other metal production	71.77	62.85	-12%	<1%	37%	29%
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%	29%
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**	**218.30**	**12%**	**-3%**		

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 2016a) which is part of the submission under the UNFCCC.

- Additionally to information provided in this document, Annex 2 of (UMWELTBUNDESAMT 2016a) 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 2016a).

Completeness

Table 47 provides information on the status of emission estimates of all sub categories. A "✓" indicates that emissions from this sub category have been estimated.

Table 47: Completeness of "1.A Stationary Fuel Combustion Activities".

NFR Category	NO_x	CO	NMVOC	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)	✓ IE(5)	✓ IE(5)	✓ IE(5)	✓ IE(5)	✓ IE(5)	✓ IE(5)	✓ IE(5)	✓ IE(5)	✓ 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)	✓ (8)	✓ (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) NH_3 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 48 shows the correspondence of NFR and SNAP categories.

Table 48: NFR and SNAP categories of "1.A Stationary Fuel Combustion Activities".

NFR Category		SNAP
1.A.1.a Public Electricity and Heat Production	0101 0102	Public power 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 010503 010504	Solid fuel transformation plants Oil/Gas Extraction plants Gas Turbines
1.A.2.a Iron and Steel	0301 030302 030326	Comb. In boilers, gas turbines and stationary engines (Iron and Steel Industry) Reheating furnaces steel and iron Processes with Contact-Other(Iron and Steel Industry)
1.A.2.b Non-ferrous Metals	0301 030307 030309 030310 030324	Comb. In boilers, gas turbines and stationary engines (Non-ferrous Metals Industry) Secondary lead production Secondary copper production Secondary aluminium production 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 030317 030312 030319 030323	Cement Glass Lime Bricks and Tiles 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

3.1.2 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, SO_2, 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, SO_2, 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. NH_3 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.

NH_3

Emission factors are constant for the whole time series.

SO_2, 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 CH_4 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 49: 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 it's lower taxes.

Activity data

A description of methodology and activity data will be provided in (UMWELTBUNDESAMT 2016a). 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 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 50 gives an overview of methodologies and data sources of sub category *1.A.1 Energy Industries*.

Table 50: 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). 2005–2014: 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 2005–2014: 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) 2005–2014: ETS data	Reported by plant operator: SO_2, NO_x, CO, NMVOC (yearly)	NH_3: national study
1.A.1.c	Energy balance 2005–2014: ETS data		All pollutants: national studies

For 2005–2014 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 8% *(from 2014 on about 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 50 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 51: 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	58 096	37 787	18 955	2	21	1 331	56 987
2006	56 076	37 089	17 210	3	22	1 752	55 119
2007	55 914	38 066	15 785	2	24	2 037	54 600
2008	57 951	39 481	16 427	2	30	2 011	61 628
2009	60 603	42 414	16 184	2	49	1 954	64 249
2010	61 649	40 500	18 995	1	89	2 064	76 171
2011	56 359	36 816	17 432	1	174	1 936	71 543
2012	64 045	47 167	14 078	1	337	2 462	74 331
2013	60 178	45 225	11 219	0	582	3 152	76 335
2014	57 730	44 251	9 051	0	582	3 846	69 824

[1)] *including pumped storage; Source: STATISTIK AUSTRIA 2015C*

As shown in Table 52 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 2014 shows an historical maximum of net imports which contribute to 14% of total electricity supply.

Table 52: 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	66 408	20 397	17 732	2 665
2006	65 595	64 499	21 257	14 407	6 850
2007	66 706	64 757	22 130	15 511	6 619
2008	66 144	66 877	19 796	14 933	4 863
2009	63 266	69 088	19 542	18 762	780
2010	65 906	71 128	19 898	17 567	2 331
2011	65 836	65 813	24 972	16 777	8 195
2012	66 788	72 617	23 264	20 455	2 809
2013	66 757	68 277	24 960	17 689	7 271
2014	66 147	65 421	26 712	17 437	9 275

Source: Statistik Austria

[1)] *Excluding own use and heat pumps, boilers and pumped storage use. Including losses*

[2)] *Public and autoproducer gross production*

Total fuel consumption data is taken from the energy balance (IEA JQ 2015) 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 53 shows activity data of category 1.A.1.a.

Table 53: Fuel consumption from NFR 1.A.1.a Public Electricity and Heat Production 1990–2014.

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	140.54	15.63	61.40	59.46	1.63	2.41
1991	149.40	19.04	67.33	57.55	2.57	2.90
1992	114.73	18.78	39.97	49.50	3.00	3.48

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]			
1993	117.58	25.99	30.81	53.89	3.12	3.76
1994	122.53	24.01	32.97	58.34	3.39	3.82
1995	135.18	19.69	45.49	62.07	4.02	3.91
1996	157.80	19.64	47.52	79.74	6.12	4.77
1997	154.77	24.35	50.96	68.42	6.15	4.89
1998	148.84	27.91	35.81	73.53	6.81	4.78
1999	146.87	22.05	37.88	75.73	6.47	4.74
2000	139.09	14.88	49.16	62.36	8.05	4.64
2001	159.55	19.93	59.76	63.20	11.08	5.58
2002	155.05	10.31	56.18	68.72	13.07	6.77
2003	187.72	14.11	70.94	80.81	14.01	7.85
2004	187.12	14.77	69.09	77.33	15.84	10.09
2005	206.36	14.06	61.63	96.98	23.48	10.22
2006	197.37	12.52	60.19	81.38	30.35	12.91
2007	187.20	8.93	54.46	72.94	38.12	12.76
2008	197.62	8.83	47.87	82.54	45.46	12.92
2009	191.20	7.93	32.46	85.79	48.13	16.90
2010	221.00	8.61	41.47	93.93	58.80	18.18
2011	211.25	4.83	45.64	84.69	56.26	19.83
2012	195.35	2.86	37.18	74.56	60.00	20.75
2013	174.91	2.39	35.78	60.81	55.69	20.24
2014	156.99	2.00	24.74	50.75	57.19	22.31
Trend 1990–2014	-10.2%	-16.6%	-30.8%	-16.5%	2.7%	10.3%
Trend 2013–2014	11.7%	-87.2%	-59.7%	-14.7%	3413.0%	824.1%

Boilers and gas turbines ≥ 50 MW_{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 ≥ 50 MW_{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 SO_2 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 ≥ *300 MW_{th}* and ≥ *50 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 54 shows some selected aggregated results for 2014. The ratios of measured to calculated emissions show that the application of a simple Tier 2 Approach would introduce a high uncertainty for CO and SO_2. The ratio of 1.31 for NO_x leads to the conclusion that NO_x emission factors are representing legal limits which are not under-run due to high DeNOX operating costs.

Table 54: NFR 1.A.1.a ≥ 50 MW_{th} emission factors fuel consumption and emissions ratios for the year 2014.

	Fuel consumption [TJ]	NO_x [kg/TJ]	CO [kg/TJ]	SO_2 [kg/TJ]
NFR 1.A.1.a ≥ 50 MWth		1.16(1)	0.18(1)	0.23(1)
SNAP 010101		1.33(1)	1.56(1)	0.43(1)
Hard Coal	24 739	50.0	1	57.0
Oil	97	26.0	3.0	50.0
Natural gas	29 719	30.0	4.0	NA
Sewage sludge	17	100.0	200.0	130.0
Biomass	998	94.0	72.0	11.0
SNAP 010102		1.84 1)	2.36(1)	13.4(1)
Natural gas	4 816	30.0	4.0	NA
Waste	10 508	100.0	200.0	130.0
SNAP 010201		5.21)	9.17(1)	4.06(1)
Oil	314	100.0	4.0	127.0
Natural gas	2 151	25.0	4.0	NA
SNAP 010202		0.37(1)	0.02(1)	0.02(1)
Oil	783	85.0	4.0	196.0
Natural gas	5 370	25.0	4.0	NA
Waste	11 805	48.0	200.0	130.0
Sewage Sludge	2 135	100.0	200.0	130.0

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

Boilers and gas turbines < 50 MW_{th}

Table 55 shows main pollutant emission factors used for calculation of emissions from boilers < 50 MW_{th} for the year 2014. Increasing biomass consumption of smaller plants is a main source of NO_x emissions from this category in 2014.

Table 55: NFR 1.A.1.a < 50 MW_{th} main pollutant emission factors and fuel consumption for the year 2014.

Fuel	Activity [TJ]	NO_x [kg/TJ]	CO [kg/TJ]	NMVOC [kg/TJ]	SO_2 [kg/TJ]	NH_3 [kg/TJ]
Light Fuel Oil	102	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	538	317.4	3/15[(1)]	8.0	50/398[(1)]	2.7
Gasoil	156	65	10	4.8	0.5	2.7
Diesel oil	0	700	15	0.8	18.8	2.7
Liquified Petroleum Gas	8	150	5	0.5	6	1
Natural Gas/power and CHP	6 689	30	4	0.5	NA	1
Natural Gas/district heating	2 002	41	5	0.5	NA	1
Solid Biomass	44 140	94	72	5.0	11	5
Biogas, Sewage Sludge Gas, Landfill Gas	9 811	150	4	0.5	NA	1

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

Sources of emission factors

Sources of NO_x, SO_2, 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).

NH_3 emission factors for coal, oil and gas are taken from (UMWELTBUNDESAMT 1993). For waste the emission factor of coal is selected. NH_3 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 CH_4 emission factors as shown in Table 56. The split follows closely (STANZEL et al. 1995).

Table 56: 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 DeNOX equipment but a certain amount of primary NO_x control has been achieved since 1990 by switching to low NO_x burners (UMWELTBUNDESAMT 2006b). SO_2 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 SO_2 by about 65% and NO_X emissions by about 55%.

The Austrian association of mineral oil industry (*Fachverband der Mineralölindustrie*) communicates yearly fuel consumption, SO_2, 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. NH_3, heavy metals and POPs emissions are calculated with the simple CORINAIR methodology. The following Table 57 shows the fuel consumption of the refinery.

Table 57: Fuel consumption from NFR 1.A.1.b Petroleum Refining 1990–2014.

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	35.33	27.45	-	7.88	-	-
1991	35.66	26.28	-	9.37	-	-
1992	34.90	26.37	-	8.53	-	-
1993	37.77	27.89	-	9.88	-	-
1994	36.12	29.19	-	6.93	-	-
1995	34.25	26.64	-	7.61	-	-
1996	39.45	31.07	-	8.38	-	-
1997	39.75	31.01	-	8.74	-	-
1998	38.84	30.52	-	8.32	-	-
1999	31.53	26.38	-	5.14	-	-
2000	32.99	26.64	-	6.36	-	-
2001	34.64	27.26	-	7.38	-	-
2002	36.65	30.19	-	6.47	-	-
2003	38.84	31.59	-	7.25	-	-
2004	40.49	33.29	-	7.20	-	-
2005	41.87	32.70	-	9.17	-	-
2006	42.12	33.57	-	8.55	-	-
2007	42.75	34.71	-	8.04	-	-
2008	41.99	33.10	-	8.89	-	-
2009	39.60	35.41	-	4.19	-	-
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		
Trend 1990–2014	-3.9%	-2.1%		-8.2%		
Trend 2013–2014	11.3%	3.7%		37.9%		

Sources of emission factors

NH_3 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 58: Fuel consumption from NFR 1.A.1.c Manufacture of Solid fuels and Other Energy Industries 1990–2014.

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	-	4.71
1997	5.03	-	5.00
1998	6.39	-	6.36
1999	7.28	-	7.25
2000	6.04	-	6.01

NFR	1.A.1.c	1.A.1.c	1.A.1.c
Fuel		Liquid	Gaseous
		[PJ]	
2001	6.06	-	6.03
2002	6.28	-	6.25
2003	10.65	-	10.62
2004	13.79	-	13.75
2005	10.18	-	10.14
2006	8.62	-	8.59
2007	8.68	-	8.65
2008	7.87	-	7.83
2009	9.06	-	9.02
2010	8.17	-	8.13
2011	9.16	-	9.13
2012	8.39	-	8.35
2013	4.53	-	4.49
2014	4.47	-	4.44
Trend 1990-2014	**-1.2%**	**-100.0%**	**-1.1%**
Trend 2013-2014	**-51.5%**	**-**	**-51.4%**

Emission factors and activity data 2014

Table 59 summarizes the selected emission factors for main pollutants and activity data for the year 2014. It is assumed that emissions are uncontrolled.

Table 59: NFR 1.A.1.c main pollutant emission factors and fuel consumption for the year 2014.

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)	4 438	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*

NH_3 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 used (from the ranges given in the guidebook the mean value was used). For 1995, the value for "DBB, Dust Control + FGD" was used, 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 60). It is assumed that imported oil products have a similar metal content.

Table 60: 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 61: 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 62: 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 63: 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

Mercury EF [mg/GJ]	1985	1990	1995	2010
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 64: 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 65: 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 66: 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), (ORTHOFER & 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 67: POP emission factors for Sector 1.A.1 Energy Industries.

EF	PCDD/Fµg /GJ]	HCB [µg/GJ]	PAK4 [mg/GJ]	PCB [µg/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				
114B Municipal Waste 115A Industrial waste/unspecified	0.024	14.5	0.17	0.0005 0.0008

EF	PCDD/Fµg /GJ]	HCB [µg/GJ]	PAK4 [mg/GJ]	PCB [µg/GJ]
Biomass				
111A Wood (> 1 MW) 116A Wood waste (> 1 MW)	0.01	2.0	0.2	0.0009
111A Wood (< 1 MW) 116A Wood waste (< 1 MW)	0.14	28.0	2.4	0.0009
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 68: 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 (EDM[74]) 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 ≥ *300* MW_{th} and ≥ *50* MW_{th} *to 300* MW_{th} of thermal capacity. Currently about 50 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 ≥ 20 $MW_{th.}$ 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 ≥ 50 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 69.

[74] www.edm.gv.at

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

The shares of PM_{10} and $PM_{2.5}$ were taken from (WINIWARTER et al. 2001).

Table 69: 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**	**2014**	**[%]**	**[%]**
Public Power (0101)[(1)]	5.51	3.34	2.74	1.75	95	80
District Heating (0102) [(1)]	3.89	1.41	0.75	0.64	95	80
Petroleum Refining (010301)[(2)]	3.9	2.4	3.1	1.5	95	80
Wood waste (116A)	55	55	22	22	90	75

(1) *Used fuels are 102A, 105A, 111A, 115A, 118A, 203B, 203C, 203D, 301A*

(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. [75]

For diesel the emission factors for heavy duty vehicles and locomotives as described in chapter 0 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 PM_{10} and $PM_{2.5}$ were taken from (WINIWARTER et al. 2001).

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

Table 70: 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	2014	[%]	[%]
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 Recalculations

The waste NMVOC emission factor has been revised from from 38 g/GJ to 5.9 g/GJ (Guidebook default value for 5.C.1.a) which results in -0.5 kt lower emissions in 2013.

Consideration of emission declarations of public waste incineration plants since the year 1998 shows lower emissions for NO_x (2013: -0.2 kt), SO_2 (2013: -0.7 kt).

The revision of NO_x, SO_2 and CO refinery emission declarations for the years 2012-2013 results in slightly higher values. Update of refinery PM_{10} emissions 2007 to 2013 with emission declarations.

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 3.2).

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)[76]
- Other Stationary Combustion in Manufacturing Industries and Construction (NFR 1.A.2.g.8).

[76] methodologies for mobile sources are described in Chapter 3.3.5.1

3.1.4.1 General Methodology

Table 71 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 71: 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 2005–2014: ETS data.		All pollutants: National studies
1.A.2.b	Non-ferrous Metals	Energy balance 2005–2014: ETS data.		All pollutants: National studies
1.A.2.c	Chemicals	Energy balance 2005–2014: ETS data.		All pollutants: National studies
1.A.2.d	Pulp, Paper and Print	Energy balance 2005–2014: 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 2005–2014: ETS data.		All pollutants: National studies
1.A.2.f	Cement Clinker Production	National Studies 2005–2014: 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 2005–2014: 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 2005–2014: ETS data.		All pollutants: National studies
1.A.2.f	Bricks and Tiles Production	Association of Bricks and Tiles Industry 2005–2014: ETS data.		All pollutants: National studies
1.A.2.g	Other	Energy balance 2005–2014: 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. Emissions from this category are presented in the following table.

Integrated steelworks (two units)

Two companies report their yearly NO_x, SO_2, 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 where reconstructed and equipped with PM emission controls which has also led to lower heavy metal and POP emissions. Reduction of SO_2 and NO_x emissions of in-plant power stations was achieved by switching from coal and residual fuel oil to natural gas.

Table 72: 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

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 2014. It is assumed that emissions are uncontrolled.

Table 73: NFR 1.A.2.a - area source – 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]
Hard coal	(BMWA 1990) [(1)]	0	250.0	150.0	15.0	600.0	0.01
Coke oven coke	(BMWA 1990) [(1)]	87	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)]	83	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)]	5 473	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)*

NH_3 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 enfolds 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 2015).

Table 74: Fuel consumption from NFR 1.A.2.b Non-ferrous Metals 1990–2014.

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	4.16	2.59	2.29	3.43	2.08	2.08
1991	3.95	2.57	2.25	3.28	2.08	2.08
1992	4.19	2.53	2.15	3.66	2.08	2.08
1993	4.64	2.54	2.26	4.00	2.08	2.08
1994	6.52	2.64	2.22	5.81	2.08	2.08
1995	6.44	2.65	2.17	5.77	2.08	2.08
1996	4.92	2.76	2.23	4.09	2.08	2.08
1997	5.57	3.02	2.27	4.45	2.08	2.08
1998	5.36	2.90	2.24	4.38	2.08	2.08
1999	5.11	2.74	2.29	4.23	2.08	2.08
2000	5.20	2.72	2.25	4.39	2.08	2.08
2001	5.49	2.80	2.17	4.67	2.08	2.08
2002	5.50	2.68	2.23	4.75	2.08	2.08
2003	5.61	2.64	2.23	4.90	2.08	2.08
2004	5.76	2.59	2.23	5.10	2.08	2.08
2005	5.78	2.53	2.21	5.20	2.08	2.08
2006	5.87	2.52	2.20	5.30	2.08	2.08
2007	6.39	2.48	2.22	5.85	2.08	2.08
2008	6.44	2.39	2.21	5.99	2.08	2.08
2009	6.07	2.30	2.24	5.68	2.08	2.08
2010	6.17	2.33	2.15	5.85	2.08	2.08
2011	6.37	2.37	2.15	6.02	2.08	2.08
2012	6.30	2.37	2.14	5.95	2.08	2.08
2013	6.58	2.37	2.21	6.11	2.11	2.09
2014	6.68	2.33	2.23	6.23	2.12	2.09
Trend 1990–2014	**60.8%**	**-10.2%**	**-2.5%**	**81.6%**	**1.9%**	**0.5%**
Trend 2013–2014	**1.6%**	**-1.7%**	**1.0%**	**2.0%**	**0.3%**	**-0.2%**

The following Table 75 shows fuel consumption and main pollutant emission factors of category *1.A.2.b* for the year 2014.

Table 75: NFR 1.A.2.b 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]
Coke oven coke	(BMWA 1990) [(1)]	87	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)]	83	235.0	15.0	8.0	398.0	2.70
Heating oil	(BMWA 1996) [(2)]	0	65.0	15.0	4.8	[(6)]0.5	2.70
Kerosene	(BMWA 1996) [(3)]	0	118.0	15.0	4.8	92.0	2.70
Natural Gas	(BMWA 1996) [(1)]	5 473	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 2015). 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 2015).

Table 76: Fuel consumption from NFR 1.A.2.c Chemicals 1990–2014.

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	1.27	1.41	8.33	2.90	2.12
1992	17.39	0.93	1.95	8.83	3.26	2.42
1993	17.75	1.12	1.96	10.89	2.18	1.60
1994	16.50	1.34	1.58	9.97	1.81	1.79
1995	17.05	1.28	1.58	10.33	1.72	2.15
1996	18.91	1.33	1.94	10.35	2.66	2.63
1997	20.32	1.82	2.66	10.87	2.91	2.05

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**
1998	18.56	1.54	2.63	10.48	2.20	1.72
1999	25.46	1.08	3.24	14.65	4.98	1.51
2000	25.39	0.79	2.61	15.78	3.95	2.26
2001	23.90	1.14	2.65	15.46	1.84	2.82
2002	24.21	0.91	2.64	14.95	1.58	4.13
2003	26.67	1.00	2.62	15.12	2.11	5.82
2004	27.51	0.97	2.48	15.13	1.68	7.26
2005	27.30	1.11	1.57	18.93	2.26	3.43
2006	23.81	1.11	1.12	15.78	2.33	3.48
2007	23.39	1.19	0.84	15.82	2.75	2.79
2008	28.25	1.53	0.75	17.39	2.52	6.05
2009	30.01	1.96	0.74	17.79	2.32	7.21
2010	30.86	2.38	0.81	18.23	2.97	6.46
2011	35.00	2.12	0.72	22.95	2.65	6.55
2012	30.26	2.17	0.73	20.22	2.85	4.30
2013	34.73	1.60	0.88	25.33	3.60	3.31
2014	34.80	1.08	1.29	26.14	3.52	2.77
Trend 1990–2014	**114.4%**	**-10.6%**	**18.3%**	**179.1%**	**21.6%**	**65.9%**
Trend 2013–2014	**0.2%**	**-32.5%**	**46.9%**	**3.2%**	**-2.2%**	**-16.4%**

Table 77 summarizes activity data and emission factors for 2014. Underlined values indicate non default emission factors.

Table 77: NFR 1.A.2.c 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]
Hard coal	(BMWA 1990) [(1)]	1 287	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)]	496	118.0	10.0	0.8	92.0	2.70
Residual fuel oil ≥ 1% S	(BMWA 1996) [(1)]	388	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)]	26 138	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)]	2 769	47.0[(6)]	200.0	0.54	65.00[(6)]	0.02
Solid biomass	(BMWA 1996) [(1)]	2 953	100.0[(7)]	72.00	5.0	30.0	5.00
Biogas	(BMWA 1990) [(8)]	572	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 SO_2 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 SO_2 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 Chemical*s 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. SO_2 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 2015).

Table 78: Fuel consumption from NFR 1.A.2.d Pulp, Paper and Print 1990–2014.

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	54.92	8.53	4.71	18.49	22.93	0.26
1993	56.51	8.80	4.45	16.02	27.02	0.23
1994	68.31	8.39	3.81	27.11	28.68	0.32
1995	65.72	6.72	3.97	24.57	29.99	0.48
1996	64.84	5.13	3.87	28.24	26.79	0.81
1997	75.39	6.62	4.69	33.48	30.54	0.07
1998	69.93	5.60	4.68	31.56	28.02	0.07
1999	69.68	2.97	3.79	31.28	31.50	0.14
2000	67.11	2.20	4.70	31.83	28.38	0.00
2001	71.29	2.30	4.02	30.33	34.53	0.11
2002	64.16	1.96	4.83	29.53	27.71	0.12
2003	68.53	2.13	4.42	33.04	28.74	0.20
2004	66.80	1.70	4.63	30.65	29.57	0.25
2005	74.78	1.79	5.02	31.06	36.81	0.11
2006	70.74	1.63	5.24	29.05	34.68	0.15
2007	72.10	1.26	4.01	30.98	35.68	0.17
2008	72.39	1.07	3.68	32.05	35.50	0.10
2009	72.79	1.33	3.80	32.18	35.39	0.10
2010	77.08	0.94	3.55	35.10	37.41	0.08
2011	71.59	0.72	3.94	29.37	37.48	0.09
2012	71.28	0.49	3.95	28.55	38.23	0.06
2013	61.72	0.60	4.23	18.79	37.92	0.17
2014	59.65	0.55	4.19	16.89	37.85	0.18
Trend 1990–2014	**10.2%**	**-95.0%**	**1.3%**	**-0.8%**	**73.0%**	**-7.1%**
Trend 2013–2014	**-3.4%**	**-9.2%**	**-1.1%**	**-10.2%**	**-0.2%**	**5.8%**

Table 79 shows activity data and emission factors for 2014. SO_2 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 79: NFR 1.A.2.d 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]
Hard coal	(BMWA 1990) [(1)]	4 186	120.0[(9)]	150.0	15.0	111.2	0.01
Brown coal	(BMWA 1990) [(1)]	0	170.0	150.0	23.0	91.2	0.02
Brown coal briquettes	(BMWA 1990) [(1)]	0	170.0	150.0	23.0	91.2	0.02
Coke oven coke	(BMWA 1990) [(1)]	0	220.0	150.0	8.0	120.5	0.01
Residual fuel oil < 1% S	(BMWA 1996) [(1)]	43	118.0	10.0	0.8	15.8	2.70
Residual fuel oil ≥ 1% S	(BMWA 1996) [(1)]	462	235.0	15.0	8.0	68.5	2.70
Heating oil	(BMWA 1996) [(2)]	43	65.0	15.0	4.8	0.1	2.70
Kerosene	(BMWA 1996) [(6)]	0	118.0	15.0	4.8	15.8	2.7
LPG	(BMWA 1996) [(3)]	0	41.0	5.0	0.5	6.0[(4)]	1.00
Natural Gas	(BMWA 1996) [(1)]	16 885	41.0	5.0	0.5	NA	1.00
Industrial waste	(BMWA 1990) [(1)]	180	100.0	200.0	0.54	19.8	0.02
Black liquor	(BMWA 1990) [(1)]	30 329	77.0[(7)]	20.0	4.0	19.8	0.02
Fuel wood	(BMWA 1996) [(8)]	0	110.0	370.0	5.00	9.1	5.00
Solid biomass	(BMWA 1996) [(1)]	6 380	120.0[(9)]	72.00	5.0	9.1	5.00
Biogas	(BMWA 1990) [(5)]	861	150.0	5.0	0.5	NA	1.00
Sewage sludge gas	(BMWA 1990) [(5)]	4 186	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 2015).

Table 80: Fuel consumption from NFR 1.A.2.e Food Processing, Beverages and Tobacco 1990–2014.

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	13.91	4.45	0.18	9.15	0.13	0.000
1991	14.76	5.11	0.20	9.33	0.12	0.000
1992	13.65	4.43	0.10	9.03	0.09	0.000
1993	13.97	4.99	0.20	8.62	0.15	0.000
1994	14.67	4.55	0.18	9.84	0.10	0.000
1995	15.10	4.40	0.06	10.53	0.10	0.000
1996	14.63	3.27	0.11	11.22	0.03	0.006
1997	17.08	4.02	0.13	12.91	0.02	0.006
1998	15.64	3.21	0.11	12.31	0.01	0.006
1999	14.27	2.14	0.08	11.83	0.23	0.000
2000	15.16	2.18	0.21	12.53	0.24	0.000
2001	15.74	3.13	0.12	12.22	0.27	0.000
2002	19.12	2.35	0.15	16.36	0.27	0.000
2003	16.04	2.94	0.15	12.71	0.23	0.000
2004	15.98	3.34	0.12	12.29	0.23	0.000
2005	16.61	3.19	0.13	12.79	0.50	0.000
2006	16.25	3.23	0.10	12.40	0.52	0.000
2007	15.51	2.77	0.11	12.09	0.55	0.000
2008	15.33	2.50	0.12	12.23	0.48	0.000
2009	15.67	2.69	0.14	12.43	0.42	0.000
2010	16.54	2.73	0.14	13.48	0.19	0.005
2011	16.47	2.65	0.15	13.42	0.25	0.002
2012	17.27	2.63	0.16	13.81	0.66	0.003
2013	16.16	2.46	0.15	13.21	0.35	0.001
2014	15.87	2.09	0.17	13.27	0.34	0.000
Trend 1990–2014	**14.1%**	**-53.1%**	**-2.4%**	**45.1%**	**157.5%**	**-**
Trend 2013–2014	**-1.8%**	**-15.2%**	**18.4%**	**0.5%**	**-3.6%**	**-67.9%**

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 81 summarizes activity data and emission factors for 2014.

Table 81: NFR 1.A.2.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]
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)	172	220.0	150.0	8.0	500.0	0.01
Residual fuel oil < 1% S	(BMWA 1996) (1)	1 117	118.0	10.0	0.8	92.0	2.70
Residual fuel oil ≥ 1% S	(BMWA 1996) (1)	51	235.0	15.0	8.0	398.0	2.70
Heating oil	(BMWA 1996) (2)	687	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)	231	41.0	5.0	0.5	6.0 (4)	1.00
Natural Gas	(BMWA 1996) (1)	13 269	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)	38	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)	299	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 82: Fuel consumption from NFR 1.A.2.f Non-metallic Minerals 1990–2014.

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	23.36	6.28	5.69	10.09	0.00	1.31
1991	23.57	6.58	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	23.96	7.82	3.98	10.22	0.00	1.94
1995	22.06	4.36	4.63	11.10	0.00	1.98
1996	22.96	3.32	5.55	11.93	0.00	2.17
1997	24.60	3.39	5.85	13.25	0.00	2.10
1998	24.56	3.40	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	23.32	1.92	4.89	11.97	0.00	4.55
2002	25.04	3.28	3.62	13.59	0.00	4.56
2003	24.80	3.37	3.26	14.01	0.00	4.15
2004	27.62	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
Trend 1990–2014	**1.7%**	**-73.1%**	**-49.4%**	**13.8%**	**-**	**396.3%**
Trend 2013–2014	**2.6%**	**-7.6%**	**6.3%**	**1.1%**	**-14.4%**	**10.8%**

Table 83 shows total fuel consumption and emissions of main pollutants for sub categories of *1.A.2.f Non-metallic Minerals* for the year 2014.

Table 83: NFR 1.A.2.f Non-metallic Minerals - Fuel consumption and emissions of main pollutants by sub category for the year 2014.

Category	Fuel Consumption [TJ]	NO_x [kt]	CO [kt]	NMVOC [kt]	SO_2 [kt]	NH_3 [kt]
SNAP 030311 Cement Clinker Production	10 074	2.44	16.53	0.23	0.32	0.093
SNAP 030312 Lime Production	2 936	0.75	0.19	0.02	0.55	0.002
SNAP 030317 Glass Production	3 403	1.01	0.02	0.00	0.15	0.003
SNAP 030319 Bricks and Tiles Production	2 803	0.73	0.07	0.01	0.12	0.005
SNAP 030323 Magnesia Production	4 544	1.27	0.11	0.01	0.05	0.005
Total	**23 760**	**6.21**	**16.92**	**0.26**	**1.19**	**0.108**

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, 2010-2015) and (ZEMENTINDUSTRIE 2009). Table 84 shows detailed fuel consumption data for 2014.

Table 84: Cement clinker manufacturing industry. Fuel consumption for the year 2014.

Fuel	**Activity [TJ]**
Hard coal	901
Brown coal	1 033
Petrol coke	920
Residual fuel oil < 1% S	11
Residual fuel oil 0.5% S	0
Residual fuel oil ≥ 1% S	37
Heating oil	17
Natural Gas	64
Industrial waste	6 482
Pure biogenic residues	610
Total	**10 074**

HCB accidental release

Between the years 2012 and 2014 high amounts of HCB were released from a cement plant unintentionally[77]. 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.

The releases are estimated to be the following:

Table 85: HCB accidental releases for the years 2012, 2013 and 2014.

Year	**HCB (kg)**
2012	24
2013	102
2014	108

[77] http://www.ktn.gv.at/302524_DE-HCB-Messberichte

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 86. Heavy metals emission factors are presented in the following subchapter. Fuel consumption and main pollutant emission factors are shown in Table 88.

Table 86: Lime production 1990 to 2014.

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

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, SO_2 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 SO_2 emissions for missing years of the time series are calculated by implied emission factors derived from years were complete data is available. SO_2 emissions include process emissions. Fuel consumption and main pollutant emission factors are shown in Table 88. Table 87 shows the sum of flat and packaging glass production data. The share of flat glass in total glass production is about 5%.

Table 87: Glass production 1990 to 2014.

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

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 2014 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 88 presents fuel consumption and main pollutant emission factors.

1.A.2.f Fuel consumption and main pollutant emission factors

Table 88 shows activity data and main pollutant emission factors of 1.A.2.f sub categories except for SNAP 030311 cement industry were emission factors are not available by type of fuel. Underlined cells indicate emission factors other than default values for industrial boilers.

Table 88: NFR 1.A.2.f main pollutant emission factors and fuel consumption for the year 2014 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]	862	170.0	150.0	23.0	630.0	0.02
Petrol coke	(BMWA 1990) [1]	14	220.0	150.0	8.0	81.0 [8]	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]	1	65.0	15.0	4.8	0.5	2.70
Natural Gas	(BMWA 1996) [1]	2 057	294.0 [5]	30.0 [6]	0.5	NA	1.00
Industrial waste	(BMWA 1990) [1]	2	100.0	200.0	38.0	130.0	0.02
SNAP 030317 Glass manufacturing							
Residual fuel oil	(BMWA 1996) [1]	47	299.1	15.0	8.0	432.1 [7]	2.70
LPG	(BMWA 1996) [3]	NO	299.1	5.0	0.5	34.1 [7]	1.00
Natural Gas	(BMWA 1996) [1]	3 356	299.1	5.0	0.5	34.1 [7]	1.00
SNAP 030319 Bricks and tiles manufacturing							
Brown coal	(BMWA 1990) [1]	84	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]	68	220.0	150.0	8.0	81.0 [8]	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]	4	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]	2 136	294.0 [5]	5.0	0.5	NA	1.00
Industrial waste	(BMWA 1990) [1]	10	100.0	200.0	38.0	130.0	0.02
Solid biomass	(BMWA 1996) [1]	457	143.0	72.00	5.0	60.0	5.00
SNAP 030323 Magnesia Production							
Petrol coke	(BMWA 1990) [1]	523	220.0	150.0	8.0	81.0 [9]	0.01
Natural Gas	(BMWA 1996) [1]	3 864	294.0 [5]	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]	144	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 SO_2 emission factors of fuels used for glass manufacturing include emissions from product processing.

(8 The same SO_2 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 89: Fuel consumption from NFR 1.A.2.g.8 Other Stationary Combustion in Manufacturing Industries and Construction 1990–2014.

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	32.15	8.20	0.88	18.30	4.73	0.05
1991	34.61	8.95	0.84	19.16	5.07	0.58
1992	35.76	6.97	0.35	22.92	4.82	0.71
1993	36.18	10.65	0.64	19.59	4.78	0.52
1994	37.63	8.70	0.34	23.39	4.51	0.68
1995	41.15	10.55	0.17	25.68	4.08	0.67
1996	43.38	12.97	0.23	24.39	5.04	0.74
1997	38.15	18.44	0.49	16.91	0.84	1.46
1998	36.60	15.28	0.42	16.72	2.74	1.44
1999	35.32	8.31	1.17	15.87	9.10	0.87
2000	36.48	8.18	0.29	19.32	8.27	0.43
2001	35.81	9.12	0.07	17.29	8.53	0.80
2002	32.99	6.91	0.13	17.16	8.21	0.58
2003	37.44	8.67	0.12	18.19	9.75	0.72
2004	38.58	8.87	0.13	18.40	10.07	1.11
2005	47.25	9.42	0.35	23.74	12.22	1.52
2006	49.52	9.64	0.40	23.75	14.17	1.55
2007	53.09	7.80	0.41	22.96	19.62	2.32
2008	53.00	6.65	0.34	23.66	19.18	3.17
2009	58.03	6.58	0.15	25.69	21.08	4.53
2010	61.70	6.82	0.16	27.84	23.78	3.10
2011	60.87	7.04	0.15	25.29	25.03	3.37
2012	59.60	6.93	0.00	24.87	25.31	2.48
2013	62.87	6.13	0.01	24.06	30.38	2.29
2014	59.60	5.24	0.02	20.70	30.65	2.99
Trend 1990–2014	85.4%	-36.2%	-98.2%	13.1%	548.3%	6 407.1%
Trend 2013–2014	-5.2%	-14.6%	88.8%	-13.9%	0.9%	30.6%

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 88.

Table 90 shows activity data and main pollutant emission factors of category 1.A.2.g.8.

Table 90: NFR 1.A.2.g.8 main pollutant emission factors and fuel consumption for the year 2014 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 0301 Other boilers							
Coke oven coke	(BMWA 1990)[(1)]	15	220.0	150.0	8.0	500.0	0.01
Residual fuel oil < 1% S	(BMWA 1996)[(1)]	1 933	118.0	10.0	0.8	92.0	2.70
Residual fuel oil ≥ 1% S	(BMWA 1996)[(1)]	790	235.0	15.0	8.0	398.0	2.70
Heating oil, Diesel oil	(BMWA 1996)[(2)]	1 223	65.0	15.0	4.8	0.5	2.70
LPG	(BMWA 1996)[(3)]	1 291	41.0	5.0	0.5	6.0[(4)]	1.00
Natural gas	(BMWA 1996)[(1)]	20 703	41.0	5.0	0.5	NA	1.00
Industrial waste	(BMWA 1990)[(1)]	2 993	100.0	200.0	0.54	130.0	0.02
Fuel wood	(BMWA 1996)[(6)]	409	110.0	370.0	5.00	11.0	5.00
Solid biomass	(BMWA 1996)[(1)]	29 904	143.0	72.00	5.0	60.0	5.00
Sewage sludge	(BMWA 1996)[(1)]	35	100.0	200.0	38.00	NA	0.02
Biogas	(BMWA 1990)[(5)]	303	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 91: Cd emission factors for NFR 1.A.2 Manufacturing Industries and Construction.

Cadmium EF [mg/GJ]	1985	1990	1995	2014
Coal				
102A Hard coal 107A Coke oven coke	0.20	0.15	0.10	0.10
105A Brown coal 106A brown coal briquettes	0.80	0.60	0.40	0.40
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	0.50 (all years)			
203D heavy fuel oil	1.00	0.75	0.50	0.50
Other Fuels				
111A Fuel wood 215A Black liquor	6.10	6.10	2.50	2.50
116A Wood waste 115A Industrial waste	6.10	6.10	2.35	2.35

Table 92: Hg emission factors for NFR 1.A.2 Manufacturing Industries and Construction.

Mercury EF [mg/GJ]	1985	1990	1995	2014
Coal				
102A Hard coal 107A Coke oven coke	3.40	2.55	1.70	1.70
105A Brown coal 106A brown coal briquettes	8.80	6.60	4.40	4.40
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	0.75 (all years)			
Other Fuels				
111A Fuel wood 215A Black liquor 116A Wood waste 115A Industrial waste	1.90	1.90	1.25	1.25

Table 93: Pb emission factors for NFR 1.A.2 Manufacturing Industries and Construction.

LEAD EF [mg/GJ]	1985	1990	1995	2014
Coal				
102A Hard coal 107A Coke oven coke	12.00	9.00	6.00	6.00
105A Brown coal 106A brown coal briquettes	7.80	5.85	3.90	3.90
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	1.20 (all years)			
203D heavy fuel oil	0.25	0.19	0.13	0.13
Other Fuels				
111A Fuel wood 215A Black liquor 116A Wood waste	26.3	26.3	21.15	21.15
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 94: 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
2014	21 869	69 830	179 358	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 95: Activity data for calculation of HM and POP emissions with EF not related to fuel input.

Year	Cast Iron Production [t]	Cement clinker [t]	Cement [kt]
1990	110 000	3 693 539	4 679 409
1991	101 000	3 635 462	4 821 480
1992	83 000	3 820 397	4 822 304
1993	65 000	3 678 293	4 858 012
1994	68 000	3 791 131	4 762 651
1995	69 000	2 929 973	3 839 415
1996	64 997	2 915 956	3 779 074
1997	66 283	3 103 312	3 909 083
1998	74 118	2 869 035	3 668 076
1999	70 863	2 891 785	3 658 102
2000	74 654	3 052 974	4 046 916
2001	75 031	3 061 338	4 035 382
2002	70 680	3 118 227	4 060 949
2003	68 584	3 119 808	4 128 826
2004	75 704	3 222 802	4 355 735
2005	76 447	3 221 167	4 559 654
2006	80 782	3 653 477	4 885 515
2007	87 012	3 992 376	5 202 513
2008	86 639	3 996 243	5 309 156
2009	54 111	3 428 140	4 646 019
2010	65 463	3 097 043	4 254 004
2011	67 475	3 175 642	4 426 900
2012	62 979	3 206 055	4 455 162
2013	66 612	3 156 286	4 384 876
2014	64 756	3 143 495	4 434 531

Table 96: Asphalt concrete production 1990 and 2014.

Year	Asphalt concrete [kt]
1990	403
2014	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 97: HM emission factors not related to fuel input for NFR 1.A.2 Manufacturing Industries and Construction.

NFR	SNAP	Category Description	EF [mg/MG Product]		
			Cd	Hg	Pb
1.A.2.a	030302 X47	Iron and Steel: reheating furnaces	50	–	2 400
1.A.2.b	030307	Secondary lead	3 500–200[78]	–	389 000–24 000[78]
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[78]	50–30[78]	12 000–200[78]
1.A.2.f	030320	Fine ceramic materials	150	–	5 000
1.A.2.b	030324	Nickel production	5	570	230

[78] 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% O_2 (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 99.

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 98: 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[79].

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.

[79] 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 99: POP emission factors (average EF per fuel category) for 1.A.2 Manufacturing Industries and Construction.

EF	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 hexachloroethan 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 100: 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[80]	200 000–1 300[80]	–
030310 Secondary aluminium	130/40–7[80]	65 000–3 500[80]	–
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[80]	–

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 PM_{10} and $PM_{2.5}$ were taken from (WINIWARTER et al. 2001).

Table 101: 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

[80] 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 PM_{10} and 12% for $PM_{2.5}$. The following Table 102 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 102: Industry offroad machinery parameters for the year 2012.

Machinery	Stock	Avg. operating hours/year
Large construction equipment	14 177	1 260
Small construction equipment	89 113	441
Large industry equipment	1 147	421
Small industry equipment	1 674	303
Total	**106 111**	

3.1.4.13 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 3.2).

The changes in this subsector mainly resulted from the revisions of the energy balance. Elimination of coal consumption double counting of iron and steel industries (1A2a) shows 0.2 kt lower NO_x and 0.5 kt lower SO_2 emissions in the year 2013.

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. For 1990 to 2006 the simple CORINAIR methodology is used for emissions calculation.

Activity data is taken from the energy balance. The following Table 103 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 103: 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)] 52.3[(3)]	5.0	0.5	NA	1.00

[(1)] *Default emission factors for industry.*

[(2)] *Emission factor 1990 to 2006.*

[(3)] *Implied emission factor 2014.*

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 Oher 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 housholds 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 104 presents non-combustion PM emission sources.

Table 104: PM emissions from non-combustion sources in 2014.

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 105 shows NFR 1.A.4 category definitions partly taken from the IPCC 2006 Guidelines.

Table 105: 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. *Bonfire and open fire pits.*

Code Number and Name				Definitions
1.A.4	b	Residential		Fuel combustion in households.
1.A.4	b	1	Residential:stationary	Fuel combustion in buildings. *Barbecue.*
1.A.4	b	2	Residential: Household and gardening (mobile) [76] (see page 132)	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 [76] (see page 132)	Fuels combusted in traction vehicles and other mobile machinery on farm land and in forests.
1.A.4	c	3	National Fishing[76] (see page 132)	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 2014. 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 2015) is combusted in devices similar to central heating boilers and therefore the respective emission factors are applied.

Table 106: Fuel consumption from NFR 1.A.4.a.1 Commercial/Institutional: Stationary *1990–2014.*

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	37.81	18.69	0.96	12.75	2.05	3.36
1991	39.52	17.92	1.27	15.64	2.08	2.62
1992	48.63	18.29	0.92	24.22	1.95	3.25
1993	51.89	17.70	0.86	28.86	2.63	1.84
1994	43.26	15.58	0.80	22.32	2.58	1.98
1995	53.45	17.63	0.64	30.79	2.66	1.74
1996	54.60	23.71	0.67	24.80	2.53	2.90
1997	54.78	27.52	0.92	20.93	2.88	2.54
1998	51.31	24.72	0.74	21.37	2.88	1.61
1999	60.40	27.74	0.92	25.81	4.47	1.46
2000	50.29	17.82	1.10	25.24	4.74	1.38
2001	63.69	23.64	1.23	35.03	3.16	0.63
2002	61.05	24.93	0.86	31.67	2.98	0.62
2003	71.61	30.55	1.18	35.80	3.43	0.65
2004	71.61	23.38	0.83	42.79	4.09	0.52
2005	63.15	20.86	1.01	38.41	2.48	0.40
2006	66.75	22.88	0.87	40.17	2.56	0.27
2007	54.02	14.89	0.46	34.40	4.13	0.15
2008	61.62	20.82	0.39	35.62	4.77	0.02
2009	51.35	18.82	0.18	28.76	3.53	0.05
2010	50.09	14.61	0.20	31.10	4.12	0.06
2011	41.36	11.26	0.15	26.52	3.41	0.02
2012	33.69	5.59	0.15	24.19	3.73	0.02
2013	36.06	7.71	0.14	24.44	3.70	0.07
2014	35.69	10.31	0.12	22.15	3.03	0.08
Trend 1990–2014	-1.0%	33.7%	-15.4%	-9.4%	-18.0%	15.9%
Trend 2013–2014	-5.6%	-44.8%	-88.0%	73.6%	48.2%	-97.5%

Table 107: Fuel consumption from NFR 1.A.4.c.1 Agriculture/Forestry/Fishing: Stationary 1990–2014.

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	10.45	5.34	0.55	0.37	4.19	0.00
1991	10.46	4.71	0.61	0.44	4.70	0.00
1992	9.71	4.21	0.56	0.43	4.50	0.00
1993	8.43	2.89	0.44	0.47	4.62	0.00
1994	7.03	2.10	0.39	0.45	4.09	0.00
1995	7.92	2.30	0.39	0.49	4.73	0.00
1996	8.72	2.60	0.37	0.55	5.21	0.00
1997	8.68	2.70	0.30	0.56	5.11	0.00
1998	8.89	2.87	0.24	0.61	5.17	0.00
1999	9.17	3.17	0.23	0.58	5.20	0.00
2000	8.56	2.79	0.18	0.54	5.06	0.00
2001	9.09	2.73	0.16	0.60	5.60	0.00
2002	8.32	2.28	0.12	0.56	5.36	0.00
2003	8.90	2.56	0.09	0.59	5.66	0.00
2004	9.13	2.44	0.09	0.58	6.03	0.00
2005	9.20	1.42	0.07	0.61	7.11	0.00
2006	8.67	1.28	0.06	0.59	6.74	0.00
2007	8.89	1.00	0.06	0.55	7.28	0.00
2008	9.24	1.03	0.06	0.56	7.59	0.00
2009	9.14	0.60	0.04	0.58	7.93	0.00
2010	10.14	0.56	0.05	0.65	8.88	0.00
2011	9.94	0.30	0.03	0.57	9.04	0.00
2012	10.36	0.22	0.03	0.58	9.53	0.00
2013	10.37	0.14	0.03	0.59	9.61	0.00
2014	9.47	0.14	0.03	0.54	8.76	0.00
Trend 1990–2014	**-8.7%**	**0.1%**	**-9.4%**	**-8.8%**	**-8.9%**	**-**
Trend 2013–2014	**-9.4%**	**-97.5%**	**-94.2%**	**47.8%**	**109.0%**	**-**

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 2014 it is assumed that 38% of oil central heating boilers and 18% 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 2014 (750 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 108: Fuel consumption from NFR 1.A.4.b.1 Residential: stationary 1990–2014.

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	190.95	72.50	26.62	33.34	58.49	0.00
1991	213.38	79.16	29.27	39.82	65.13	0.00
1992	198.28	72.69	25.21	38.79	61.59	0.00
1993	200.08	73.98	20.82	42.37	62.91	0.00
1994	186.07	69.12	18.52	40.17	58.26	0.00
1995	199.26	75.59	17.56	43.19	62.93	0.00
1996	218.17	83.89	16.64	48.58	69.06	0.00
1997	193.66	68.05	12.59	48.52	64.51	0.00
1998	196.74	71.31	11.05	51.37	63.01	0.00
1999	198.41	73.12	10.23	50.91	64.15	0.00
2000	189.33	72.60	9.05	47.49	60.19	0.00
2001	197.14	71.55	8.57	53.11	63.91	0.00
2002	185.34	68.92	6.88	49.65	59.89	0.00
2003	186.61	69.07	5.78	52.45	59.30	0.00
2004	180.31	66.55	5.50	51.19	57.07	0.00
2005	183.83	70.08	3.70	47.64	62.40	0.00
2006	171.76	62.67	3.57	45.45	60.07	0.00
2007	159.23	54.20	3.03	43.34	58.66	0.00
2008	163.07	55.96	3.13	43.75	60.23	0.00
2009	152.42	48.57	2.27	43.88	57.69	0.00
2010	169.85	53.21	2.52	49.50	64.63	0.00
2011	152.06	46.08	1.52	43.45	61.01	0.00
2012	157.92	47.56	1.63	44.76	63.97	0.00

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	167.89	44.38	1.20	50.31	72.00	0.00
2014	140.25	37.02	0.97	41.90	60.36	0.00
Trend 1990–2014	**-16.5%**	**-16.6%**	**-19.1%**	**-16.7%**	**-16.2%**	**-**
Trend 2013–2014	**-26.6%**	**-48.9%**	**-96.4%**	**25.7%**	**3.2%**	**-**

Table 109 shows the selected share of each heating type for category *1.A.4.b.1.i*

Table 109: Share of 1.A.4.b.1 heating type on fuel category for the year 2014.

	Central Heating	Apartment Heating	Stove
Hard Coal Brown Coal Brown Coal Briquettes Coke	88%	1%	11%
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 CH_4 emissions than equipment installed before 2000. The estimated accumulated consumption in 2014 is 60 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 110: Number of biomass boiler sales 2000–2014 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
Accumulated total number	113 955	38 184	48 769	81 124
Avg. estimated yearly consumption per boiler or stove [GJ]	203	48	331	236
Total estimated consumption of new boilers 2014 [TJ] [1)]	23 144	1 833	16 129	19 107

[1)] Assuming an average heating demand.

Figure 23 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 2014.

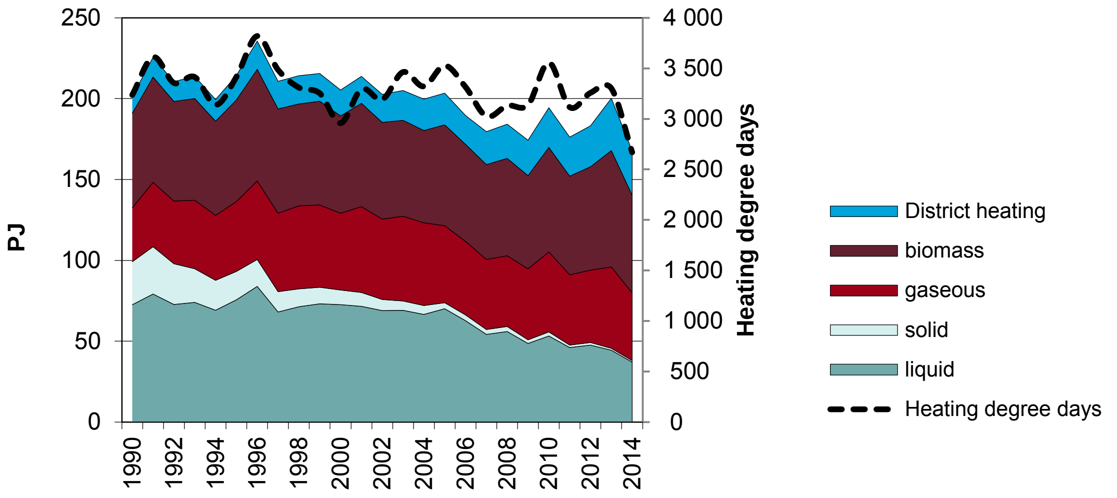

Figure 23: Energy consumption [PJ] of residential sector by type of fuel and number of heating degree days 1990–2014.

Table 111: 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
1992	28.6	37.8	33.5	100	76.2	9.4	14.4	62.0	8.8	29.3

Year	Natural Gas			Fuel Oil, LPG	Gasoil			Coal (+ Briquettes)		
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

Table 112: 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

Year	Fuel Wood (log wood)			Wood chips, pellets and other biomass		
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

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 113. The split follows closely (STANZEL et al. 1995).

Table 113: Share of CH_4 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 114: NFR 1.A.4 NO_x emission factors by type of heating for the year 2014.

	Central heating [kg/TJ]	Apartement 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.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 115: NFR 1.A.4 NMVOC emission factors by type of heating for the year 2014.

	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
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 116: NFR 1.A.4 CO emission factors by type of heating for the year 2014.

	Central heating [kg/TJ]	Apartement 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		

	Central heating [kg/TJ]	Apartement heating [kg/TJ]	Stove [kg/TJ]
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 117: NFR 1.A.4 SO_2 emission factors by type of heating for the year 2014.

	Central heating [kg/TJ]	Apartement 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 118: NFR 1.A.4 NH_3 emission factors for the year 2014.

	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 119: 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 104A Hard coal briquettes 107A Coke oven coke	5.4	10.7	90
105A Brown coal 106A Brown coal briquettes	3.7	9.2	22
111A Fuel wood 116A Wood waste 113A Peat	7.0	1.9	23
1A4b Residential plants: central and apartment heating (020202)			
102A Hard coal 104A Hard coal briquettes 107A Coke oven coke	4.0	10.7	90
105A Brown coal 106A Brown coal briquettes	2.0	9.2	22
111A Fuel wood 116A Wood waste 113A Peat	3.0	1.9	23
1A4b Residential plants: stoves (020205)			
102A Hard coal 104A Hard coal briquettes 107A Coke oven coke	6.0	10.7	135
105A Brown coal 106A Brown coal briquettes	3.0	9.2	33
111A Fuel wood 116A Wood waste 113A Peat	4.5	1.9	35

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), (ORTHOFER & VESSELY 1990), (SORGER 1993), (LAUNHARDT et al. 2000), (PFEIFFER et al. 2000) (LAUNHARDT et al. 1998), (STANZEL et al. 1995), (BAAS et al. 1995). However, 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 120: 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 2014)	0.17	173	20.3	0.0153
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 20142)	0.17	365	46	0.015
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 2014) Apartment heating	 0.17 0.38	 365 600	 46 85	 0.015 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; PM_{10} = 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 PM_{10} (90%) and $PM_{2.5}$ (80%) were also taken from (WINIWARTER et al. 2001).

Table 121: 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	--
Other Fuels			
111A, 113A and 116A	55	90	148

Table 122: PM emission factor for "wood waste and other" used in commercial, institutional or residential plants as well in stationary plants and other equipment in NFR 1.A.4.

	TSP IEF [g/GJ]			
116A	**1990**	**1995**	**2000**	**2014**
Central heating	55.00	55.00	52.06	37.99
Apartment heating	90.00	90.00	82.95	49.17
Stoves	148.00	148.00	134.14	67.70

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 Recalculations

Revisions are following the revisions of the energy balance and the improved evaluation of household census data which shows a shift of fuel consumption from single oven to central heating. For the year 2013, NO_x emissions of the commercial sector (1A4ai) were revised by +0.4 kt and those of the residential sector (1A4bi) were revised by -0.2 kt. NMVOC emissions of the residential sector were revised by +0.8 kt in the year 2013.

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 3.2).

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 PM_{10} and 12% for $PM_{2.5}$. The following Table 123 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 123: 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 QA/QC

Comparison with EPER and E-PRTR data

Comparison of emissions with reported 2004/2005 EPER and 2007–2012 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 CO_2-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 54 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.

3.2 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

The most important revisions were made for gross natural gas consumption from 2009 onwards, which was revised upwards by 7.6 PJ in 2009 and by 2 PJ in the year 2013. Natural gas consumption was shifted from households to the commercial sector from the year 2005 onwards. In the year 2013 the revision resulted in 8 PJ higher consumption of the commercial sector (1.A.4.a.i) and in 2 PJ lower consumption of households (1.A.4.b.i).

The most important reason of the shift was a revision of the household census data evaluation which also induces a shift of gasoil (2005: 8 PJ. 2013: 7 PJ) from households to the commercial sector. Solid biomass consumption of households was revised downwards for 2005 to 2012 with the highest decrease in 2012 (−7 PJ) while 2013 biomass consumption was revised upwards by 0.4 PJ.

Natural gas

2013: upwards revision of gross inland consumption (production) by +2.8 PJ.

2009–2012: downwards revision of gross inland consumption (production) between -3.4 and -3.9 PJ.

Liquid fuels

Residual fuel oil 2013: shift of 1.2 PJ from final consumption (industry) to 'refinery fuels'.

Gasoil 2009-2013: shift from residential to commercial sector (6.4 PJ in 2013).

Solid fuels

Coke oven coke

2005-2012: downwards revision of gross inland consumption (production, stock change) with the largest change in 2011 (-2.5 PJ).

2013: upwards revision of gross inland consumption (production, stock change) by +0.1 PJ

Other fuels

Industrial waste: Revision of transformation input 2013 (-0.5 PJ) and final energy consumption 2012 (-1.9 PJ) of wood industries.

Biomass

Fuel wood 2005–2013: Revision of final energy consumption of *1.A.4 other sectors* (-3.3 PJ in 2005 and +1.2 PJ in 2013).

Other solid biomass

2005-2013: revision of final consumption (mainly *1.A.4 other sectors*) between -0.4 (2013) and -5.6 PJ (2012).

2005, 2009-2013: revision of transformation sector (public heat plants and pulp/paper industries). E.g.: +3.2 PJ in 2005 and -0.5 PJ in 2013.

3.3 NFR 1.A Mobile Fuel Combustion Activities

3.3.1 General description

In this chapter the methodology for estimating emissions of mobile sources in NFR *1.A.3,* transport and mobile sources 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 124: 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 cm^3
		0705	Motorcycles > 50 cm^3
• 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
• Agriculture/ Forestry/ Fisheries	1.A.4.c.2	0806	Other Mobile Sources and Machinery-Agriculture

Activity	NFR Category	SNAP	
		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)

Completeness

Table 125 provides information on the status of emission estimates of all sub categories. A "✓" indicates that emissions from this sub category have been estimated. Table 124 provides an overview about NFR categories and the corresponding SNAP codes.

Table 125: Completeness of 1.A Mobile Fuel Combustion Activities.

NFR Category	NO_x	CO	NMVOC	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 Household and gardening (mobile)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1.A.4.c.2 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

If brake wear, tyre wear and road abrasion emissions occur and being calculated, they are reported together under *1.A.3.b.7 Automobile road abrasion.*

3.3.2 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 (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 data[81] (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.

3.3.2.1 Activity Data

Fuel consumption (kerosene and gasoline) for *1.A.3.a Civil Aviation - LTO* is presented below.

Table 126: Activities for 1.A.3.a.ii Civil Aviation – LTO: 1990–2014.

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

81 This data is also used for the split between domestic and international aviation.

Year	Activity		
	dom. LTO	dom. LTO	int. LTO
	Kerosene [TJ]	Gasoline [TJ]	Kerosene [TJ]
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
Trend 1990–2014	***54%***	***-4%***	***229%***

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 2008[82], 2009, 2010, 2011, 2012, 2013, 2014, 2015) and by Austro Control (AUSTRO CONTROL 2007[83], 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015). Moreover, for the calculation of passenger kilometres and ton kilometres input data was taken from the Austrian transport statistics (STATISTIK AUSTRIA 2015a). 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.

[82] for the years 2000–2007

[83] for the years 2000–2006

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 127: Number of IFR LTO cycles and fuel consumption as obtained from the MEET model: 1990–2014.

Year	Activity			national
	dom. LTO Kerosene [t]	VFR Gasoline [t]	int. LTO Kerosene [t]	LTO IFR [no.]
1990	3 164	2 487	28 651	6 220
1991	3 417	2 563	32 712	6 644
1992	3 670	2 641	36 773	7 450
1993	3 924	2 722	40 834	7 947
1994	4 177	2 805	44 895	8 219
1995	4 430	2 241	48 957	8 923
1996	5 128	2 153	52 315	10 233
1997	5 827	2 417	55 673	11 013
1998	6 525	2 602	59 032	12 025
1999	6 697	2 771	60 336	12 210
2000	6 109	2 039	66 708	22 611
2001	5 010	1 868	63 328	20 325
2002	5 214	2 389	74 041	21 422
2003	5 096	2 596	77 152	20 243
2004	5 470	2 405	92 035	20 175
2005	5 205	2 787	85 742	20 179
2006	6 202	2 868	84 942	20 727
2007	6 334	2 856	91 854	20 740
2008	7 039	2 938	93 348	21 457
2009	6 464	3 268	85 405	20 530
2010	6 159	2 920	87 570	20 532
2011	5 323	4 397	99 584	16 185
2012	5 366	2 565	95 727	16 405
2013	5 352	2 292	93 141	15 741
2014	4 874	2 377	94 108	14 776
Trend 1990–2014	***54%***	***-4%***	***229%***	***138%***

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 CH_4 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).

NH_3

IFR

For the years 1990–1999 NH_3 emissions for IFR flights have been calculated like NO_x (KALIVODA/KUDRNA 2002).

For the years from 2000 onwards NH_3 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 NH_3 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 1990–2014 by about 196%.

Table 128: Activities and Implied emission factors for NEC gases and CO for 1.A.3.a.ii Civil Aviation (domestic LTO + international LTO): 1990–2014.

Year	Activity	IEF SO_2	IEF NO_x	IEF NMVOC	IEF NH_3	IEF CO
	[TJ]			[t/PJ]		
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
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

Emission factors for heavy metals and PM are presented in chapter 3.3.6.

Quality Assurance and Quality Control (QA/QC)

QA/QC issues are described in Austria's National Inventory Report (UMWELTBUNDESAMT 2016a) under *1.A.3.a Civil Aviation*.

Recalculations

Revisions of the amount of aviation gasoline for the years 2012 and 2013 according to the national energy balance resulted in minor adjustments of the total sectorial domestic fuel consumption data (-1.7% in 2013). The most important changes in emissions for 2013 are: -0.3 kt CO.

Planned improvements

Update of aircraft types and emission factors. 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), but are planned to be adapted according to the EMEP/EEA air pollutant emission inventory guidebook 2013 (EEA 2013).

3.3.3 NFR Memo Item 1.A.3.a Civil Aviation - Cruise

In 2014, the share of Civil Aviation - Cruise in the total fuel consumption in the aviation sector in Austria amounted to 84%. 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*.

Activity Data

Table 129: Activities for Civil Aviation - Cruise: 1990–2014.

Year	Kerosene	
	Domestic 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

Year	Kerosene	
	Domestic cruise [TJ]	International cruise [TJ]
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
Trend 1990–2014	***90%***	***111%***

Emission Factors

In the following tables activities and IEF for *Civil Aviation - Cruise* are presented. Activity data of domestic and international cruise increased over the period from 1990–2014 by about 111%.

Table 130: Activities and Implied emission factors for NEC gases and CO for Civil Aviation - Cruise: 1990–2014.

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

Year	Activity	IEF SO_2	IEF NO_x	IEF NMVOC	IEF NH_3	IEF CO
	[TJ]			[t/PJ]		
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

Emission factors for heavy metals and PM are presented in chapter 3.3.6.

Recalculations

No recalculations have been made in this year's submission.

Planned improvements

Update of aircraft types and emission factors. 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), but are planned to be adapted according to the EMEP/EEA air pollutant emission inventory guidebook 2013 (EEA 2013).

3.3.3.1 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.

3.3.4 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, SO_2, NMVOC and NH_3 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 labor 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 2015).

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 export

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 neighboring 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, H_2 …).

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.

The model calculates vehicle mileages, passenger-km, ton-km, fuel consumption, all exhaust gas emissions, evaporative emissions and suspended TSP, PM_{10}, $PM_{2.5}$, PM_1 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, CO_2, SO_2 and several unregulated pollutants among them CH_4 and N_2O) and energy consumption (FC) of road traffic.

Figure 24 shows a schematic picture of the methodology of NEMO.

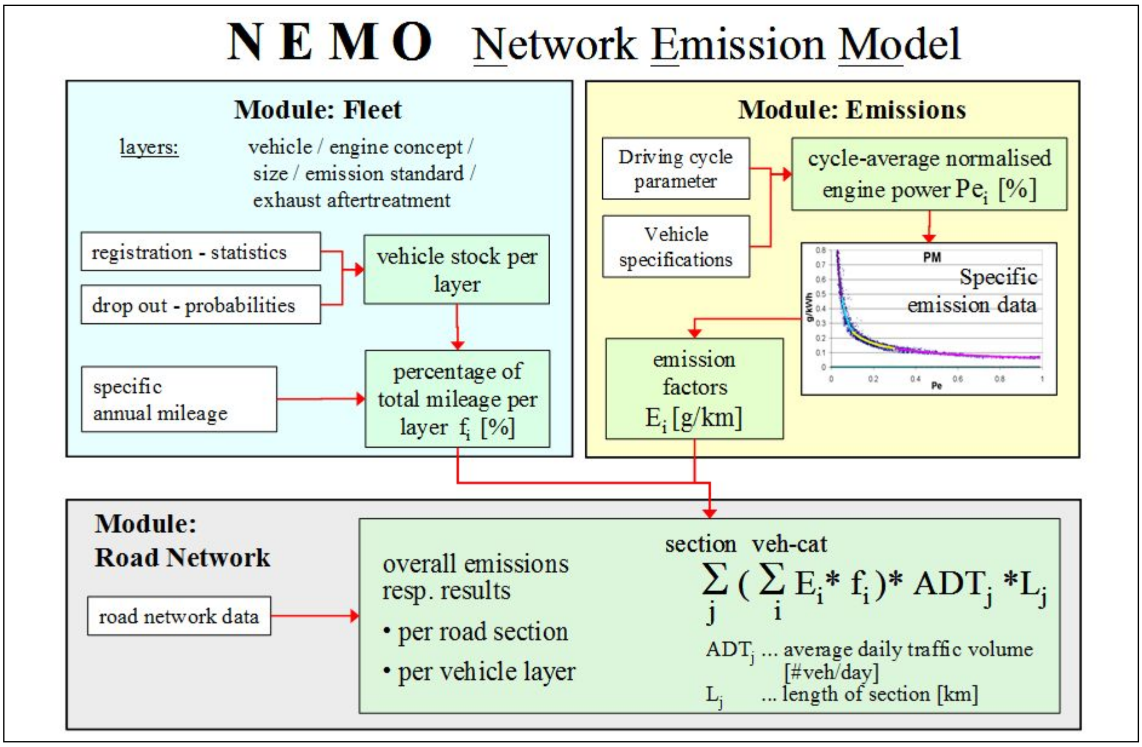

Figure 24: Schematic picture of the NEMO model.

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.

$$stock_{Jg_i,\text{year i}} = stock_{Jg_i,\text{year i}-1} \times \text{survival probability}_{Jg_i}$$

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)

$$\text{total mileage}_{E_i} = \sum_{Jg=\text{start.}}^{\text{end}} (\text{stock}_{Jg,\text{year i}} \times \text{km/vehicle}_{Jg_i,\text{year i}})$$

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

$$\text{Emission}_{\text{veh.category}} = \sum_{E_i=1}^{end} \text{Emission}_{E_i}$$

6) Calculation of the total passenger-km and ton-km

$$\text{transport volumes}_{\text{veh.category}} = \sum_{E_i=1}^{end} (\text{vehicle mileage}_{E_i} \times \text{loading}_{E_i})$$

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 2013 to 2014 fuel consumption (gasoline, diesel and alternative fuels including liquid biomass) of road transport decreased by 2.0%. Specific consumption per average vehicle kilometer per vehicle category declined between 2013 and 2014 by 0.7% for diesel passenger cars, by 1.0% for gasoline passenger cars, by 0.4% for light duty vehicles and increased by 0.4% 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 131: Activities from 1.A.3.b Road Transport differentiated by fuel type: 1990–2014.

	Fuel consumption (based on fuel sold) [TJ]					
Year	**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	-	-
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	17 406
2010	309 010	69 420	219 696	889	454	18 551
2011	298 771	66 868	212 371	854	486	18 193
2012	298 174	65 089	212 711	900	534	18 941
2013	311 491	63 803	227 567	897	650	18 574
2014	305 112	62 558	221 493	789	702	19 571
Trend 1990-2014	***73%***	***-40%***	***205%***	***91%***	***4780%***[84]	***659%***[85]

[84] Trend 2004-onwards

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 CO_2 emission factors of new passenger cars and light duty vehicles according to the national CO_2 monitoring data for the Austrian fleet, have been implemented (BMLFUW 2015b; BMLFUW 2015c).

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:

Additional impact per start [g / km] =
cold-start surcharge [g / start] / average trip length per cold start [km / start]

The cold start influence is in NEMO included in the calculation of fuel consumption and emissions of CO_2, NO_x, CO, hydrocarbons and PM. For N_2O and NH_3 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

The following tables present the IEFs for *1.A.3.b Road Transport*. The IEFs change over time due to new technologies.

Table 132: Activities and Implied emission factors for NEC gases and CO for 1.A.3.b Road Transport: 1990–2014.

Year	Activity	IEF SO_2	IEF NO_x	IEF NMVOC	IEF NH_3	IEF CO
	[TJ]			[t/PJ]		
1990	176 826	27.4	690.4	415.8	6.4	2 834.2
1991	196 386	27.8	656.2	363.1	8.5	2 499.8
1992	196 215	29.1	627.8	311.3	10.1	2 151.4
1993	198 244	30.6	603.2	265.3	11.3	1 849.2
1994	199 009	31.5	577.2	231.5	12.2	1 630.5
1995	202 791	28.0	559.4	200.1	12.7	1 429.4
1996	224 096	12.5	584.8	159.0	11.5	1 143.1
1997	210 964	11.5	552.9	146.0	12.4	1 083.3
1998	237 524	11.0	550.7	124.0	12.3	950.2
1999	229 403	10.2	533.3	110.2	12.5	873.1

[85] Trend 2005-onwards

Year	Activity	IEF SO_2	IEF NO_x	IEF NMVOC	IEF NH_3	IEF CO
	[TJ]			[t/PJ]		
2000	241 748	9.6	533.8	94.9	11.9	774.5
2001	259 856	9.2	523.4	83.6	11.1	704.5
2002	288 170	7.9	498.5	74.7	10.5	657.5
2003	311 792	7.3	481.7	66.8	9.6	604.5
2004	318 770	0.6	464.7	61.2	8.7	556.2
2005	325 935	0.5	450.5	55.8	7.9	510.3
2006	314 198	0.4	419.7	48.7	7.6	461.8
2007	317 803	0.4	389.0	43.6	6.9	421.8
2008	301 826	0.4	359.8	39.5	6.3	388.5
2009	297 235	0.4	334.3	36.1	6.0	365.0
2010	309 010	0.4	317.3	31.8	5.4	329.2
2011	298 771	0.4	302.3	30.6	5.3	323.0
2012	298 174	0.4	286.9	28.5	5.0	305.8
2013	311 491	0.4	277.2	25.7	4.5	281.2
2014	305 112	0.4	261.2	24.5	4.4	269.2

Emission factors for heavy metals, POPs and PM are presented in chapter 3.3.6.

Quality Assurance and Quality Control (QA/QC)

QA/QC issues are described in Austria's National Inventory Report (UMWELTBUNDESAMT 2016a) under section *1.A.3.b Road Transport*.

Recalculations

Update/Improvement of activity data

In the national energy balance the levels for CNG and LPG were revised. CNG levels show a strong increased revision from 2009 onwards with an increase of 63.1% for 2013. LPG levels show a minor increase of 0.1% for 2013.

Update of methodology and emission factors

PAH emission factors in the model NEMO (HAUSBERGER/SCHWINGSHACKL/REXEIS, M. 2015c) were updated according to the EMEP/EEA 2013 Guidebook (EEA 2013), which lead to a reduction of PAH emissions over the whole time series. In 2013 PAH emissions have been revised by -1.3 kt.

The general equal distribution of pure biofuels to relevant vehicle categories was changed in the calculations for the 2016 submission. This did not lead to revised total amounts of biofuels used in road transport.

3.3.5 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*.

3.3.5.1 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 (PISCHINGER 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. leaders, diggers, etc.), were taken from:

- Statistik Austria (fuel statistics),
- Questionnaire to vehicle and machinery users (PISCHINGER 2000),

- Interviews with experts and expert judgment
  validating the questionnaire results (PISCHINGER 2000) and
- Information from vehicle and machinery manufacturers (PISCHINGER 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 137. Activities include liquid fuels (diesel, gasoline and biofuels).

Emission Factors

The following technical 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.

Table 133: Emission factors for diesel engines > 80 kW.

Year	NO_x	NH_3	NMVOC	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 134: Emission factors for diesel engines < 80 kW.

Year	NO_x	NH_3	NMVOC	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 135: Emission factors for 4-stroke-petrol engines.

Year	NO_x	NH_3	NMVOC	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 136: Emission factors for 2-stroke-petrol engines.

Year	NO_x	NH_3	NMVOC	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 137: Activities and Implied emission factors for NEC gases and CO for 1.A.2.f.2 Off-road – Industry: 1990–2014.

Year	Activity	IEF SO_2	IEF NO_x	IEF NMVOC	IEF NH_3	IEF CO
	[TJ]			[t/PJ]		
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

Emission factors for heavy metals and POPs are presented in chapter 3.3.6.

Recalculations

No recalculations have been made in this year's submission.

3.3.5.2 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 *3.3.5.1).*

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 138: Activities for 1.A.3.c Railways: 1990–2014.

Year	Liquid fuels [TJ]	Solid fuels [TJ]
1990	2 311	69.72
1991	2 120	63.39
1992	2 099	66.19
1993	2 051	59.81
1994	2 071	58.83
1995	1 926	60.98
1996	1 736	60.79
1997	1 753	34.55
1998	1 730	30.80
1999	1 788	29.85
2000	1 788	25.98
2001	1 728	18.16
2002	1 869	20.25
2003	1 880	15.83
2004	1 880	6.09
2005	2 186	5.16
2006	2 196	5.82
2007	2 184	5.54
2008	2 181	4.77
2009	2 144	6.27
2010	2 046	4.59
2011	1 730	4.64
2012	1 781	4.87
2013	1 630	4.93
2014	1 697	4.91
Trend 1990–2014	**-27%**	**-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 tableTable 139.

Table 139: Activities and Implied emission factors for NEC gases and CO for 1.A.3.c Railways: 1990–2014.

Year	Activity	IEF SO_2	IEF NO_x	IEF NMVOC	IEF NH_3	IEF CO
	[TJ]			[t/PJ]		
1990	2 380	110.8	764.1	153.4	0.30	855.2
1991	2 183	110.3	766.6	153.0	0.30	853.7
1992	2 165	113.0	768.8	152.7	0.30	853.4
1993	2 111	109.1	771.9	152.0	0.30	850.3
1994	2 129	107.9	778.7	151.1	0.29	847.0
1995	1 987	104.3	784.9	150.6	0.30	846.3
1996	1 796	83.2	790.9	150.2	0.30	845.7
1997	1 788	57.6	800.8	147.4	0.28	832.6
1998	1 761	54.3	808.3	146.3	0.27	828.2
1999	1 818	52.4	816.3	145.1	0.27	824.1
2000	1 814	48.8	825.1	143.8	0.27	819.1
2001	1 746	41.9	835.2	142.1	0.26	812.3
2002	1 889	42.4	842.6	138.2	0.26	795.7
2003	1 896	38.2	838.4	135.6	0.25	782.4
2004	1 886	29.2	835.0	132.5	0.24	767.1
2005	2 191	27.7	825.3	127.7	0.24	742.8
2006	2 202	28.3	817.4	123.2	0.23	720.6
2007	2 189	28.1	796.6	115.4	0.22	681.1
2008	2 186	27.5	775.9	107.5	0.22	640.9
2009	2 150	28.8	756.5	99.5	0.21	601.0
2010	2 051	27.6	735.6	91.3	0.20	559.7
2011	1 735	28.4	714.2	83.3	0.19	519.2
2012	1 786	28.5	692.2	79.0	0.19	495.8
2013	1 635	29.0	659.6	71.7	0.18	458.8
2014	1 702	28.9	628.6	64.2	0.17	421.8

Emission factors for heavy metals and POPs are presented in chapter 3.3.6.

Recalculations

The traffic performance for the year 2013 has been revised in accordance with current statistical data. Revisions of the energy consumption (diesel) for 2012 and 2013 taken from the national energy balance also lead to slightly changed data (-0.2% in 2013).

The changes of emissions in the time series follow a change in the off-road model GEORG caused by reorganizing the fleet composition in the course of integrating the future emission class "Stage V" (HAUSBERGER/SCHWINGSHACKL/REXEIS, M. 2015c).

The most important changes in emissions for 2013 are: -0.2 kt NO_x, -0.1 kt NMVOC, -0.3 kt CO, +0.04 kt PM.

3.3.5.3 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 2015b). 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 2015b). Methodological issues of the model GEORG are described in the subchapter on mobile sources of *1.A.2.g.vii (*see Chapter *3.3.5.1).*

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 140. 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 3.3.5.1). Implied emission factors of *1.A.3.d Navigation* are listed below.

Table 140: Activities and Implied emission factors for NEC gases and CO for 1.A.3.d Navigation: 1990–2014.

Year	Activities	IEF SO_2	IEF NO_x	IEF NMVOC	IEF NH_3	IEF CO
	[TJ]			[t/PJ]		
1990	863	52.4	673.9	718.3	0.2	3 690.4
1991	780	51.6	661.1	769.3	0.2	3 971.3
1992	763	51.4	661.3	786.7	0.2	4 017.4
1993	769	51.5	664.8	780.7	0.2	3 969.7
1994	922	52.7	689.2	672.5	0.2	3 411.6
1995	1 016	44.6	704.6	610.4	0.2	3 127.8
1996	1 037	21.2	713.4	588.3	0.2	3 037.1
1997	1 029	21.2	719.8	583.2	0.2	3 010.9
1998	1 108	21.4	732.9	541.6	0.2	2 814.7
1999	1 085	21.3	739.4	543.7	0.2	2 815.9
2000	1 172	21.5	753.3	503.4	0.2	2 631.1
2001	1 218	21.6	765.1	484.6	0.2	2 529.9
2002	1 336	21.7	778.8	441.8	0.2	2 331.3
2003	1 095	21.4	772.4	493.2	0.2	2 613.5
2004	1 314	21.2	794.5	418.6	0.2	2 257.9
2005	1 290	21.2	793.7	410.9	0.2	2 229.0
2006	1 145	21.0	786.1	428.1	0.2	2 361.2
2007	1 215	20.9	782.2	386.8	0.2	2 197.1
2008	1 113	20.7	760.3	395.4	0.2	2 274.9
2009	962	20.3	734.1	415.8	0.2	2 468.0
2010	1 113	20.8	728.1	359.5	0.2	2 164.1
2011	1 006	20.5	705.1	367.8	0.2	2 288.4
2012	1 031	20.6	695.9	339.4	0.2	2 211.7
2013	1 095	20.8	689.1	310.5	0.2	2 083.6
2014	1 018	20.7	676.0	314.3	0.2	2 176.0

Emission factors for heavy metals and POPs are presented in chapter 3.3.6.

Quality Assurance and Quality Control (QA/QC)

QA/QC issues are described in Austria's National Inventory Report (UMWELTBUNDESAMT 2016a) under *1.A.3.d Navigation*.

Recalculations

The year 2013 has been revised in accordance with current statistical traffic performance data on the River Danube. Revisions of the national transport statistics on the Danube (STATSTIK AUSTRIA 2015b) also resulted in minor adjustments of the sectorial diesel consumption data for domestic navigation (+0.1% in 2013) (HAUSBERGER/ SCHWINGSHACKL/REXEIS 2015c). The most important changes in emissions for 2013 are: +0.1 kt NMVOC, -0.2 kt CO, -0.05 kt PM.

3.3.5.4 NFR 1.A.4.b.2 Household and gardening – mobile sources

Methodological Issues

The applied methodology is described in the subchapter on mobile sources of *1.*A.2.*g.vii* (see Chapter *3.3.5.1).*

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 141. 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 3.3.5.1). Implied emission factors of *1.A.4.b.2 Household and gardening – mobile sources* are listed below.

Table 141: Activities and Implied emission factors for NEC gases and CO for 1.A.4.b.ii Off-road – Household and gardening: 1990–2014.

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

Year	Activity	IEF SO_2	IEF NO_x	IEF NMVOC	IEF NH_3	IEF CO
	[TJ]	[t/PJ]				
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

Emission factors for heavy metals and POPs are presented in chapter 3.3.6.

Recalculations

No recalculations have been made in this year's submission.

3.3.5.5 NFR 1.A.4.c.2 Agriculture and forestry – mobile sources

Methodological Issues

The applied methodology is described in the subchapter on mobile sources of *1.A.2.g.vii (*see Chapter *3.3.5.1).*

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 142. 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 3.3.5.1). Implied emission factors of *1.A.4.c.2 Agriculture and Forestry – mobile sources* are presented below.

Table 142: 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: 1990–2014.

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

Year	Activity	IEF SO_2	IEF NO_x	IEF NMVOC	IEF NH_3	IEF CO
	[TJ]			[t/PJ]		
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
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

Emission factors for heavy metals and POPs are presented in chapter 3.3.6.

Recalculations

Emissions of mobile off-road sources have only been changed for forestry. Due to changes in the implementation periods for chainsaws and other mobile equipment in the model GEORG (HAUSBERGER/SCHWINGSHACKL/REXEIS, M. 2015c), emissions have been revised downwards for the whole time series. The most important changes in emissions for 2013 are: −1.1 kt NMVOC, -8.1 kt CO.

3.3.5.6 NFR 1.A.5.b Other - mobile

In this category emissions of 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 *3.3.5.1).*

Activity Data

Emission estimates for military activities were taken from (PISCHINGER 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 3.3.5 *Other mobile sources – Off Road*.

Emission factors for heavy metals and POPs are presented in chapter 3.3.6.

Recalculations

No recalculations have been made in this year's submission.

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 and Military Off-Road Transport are presented in the following table.

Table 143: Activities from 1.A.5.b Other – mobile: 1990–2014.

Year	Kerosene [TJ]	Diesel [TJ]
1990	452	28.61
1991	481	28.56
1992	434	28.51
1993	513	28.47
1994	543	28.33
1995	419	28.12
1996	507	27.93
1997	482	27.75
1998	555	27.56
1999	544	27.40
2000	533	27.28
2001	541	27.20
2002	549	27.12
2003	557	27.02
2004	564	27.00
2005	572	27.01
2006	580	26.94
2007	588	26.99
2008	595	27.05

Year	Kerosene [TJ]	Diesel [TJ]
2009	603	27.06
2010	611	27.10
2011	619	27.12
2012	626	27.13
2013	634	27.14
2014	642	27.06
Trend 1990–2014	***42%***	***-5%***

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 3.3.6.

Recalculations

No recalculations have been made in this years' submission.

3.3.6 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.

3.3.6.1 Cadmium, mercury and lead emissions

As can be seen in Table 60, 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.

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 144: 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 145: 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

3.3.6.2 POPs emissions

In the following the emission factors for POPs used in NFR 1.A.3 and in off-road transport are described.[86]

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), (ORTHOFER & 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

[86] 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).

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.

Table 146: POP emission factors for Sector SNAP 08 Off-Road Machinery.

	PCDD/F EF [µgTE/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 146 and based on findings from (HAGENMAIER et al. 1995).

HCB emissions

HCB emissions were calculated on the basis of dioxin emissions and assuming a factor of 200.

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).

3.3.6.3 PM emissions

Implied emission factors for Civil Aviation and Road Transport for PM can be found in Table 147 and Table 148. Emission factors for PM for Off-road transport are presented in chapter 3.3.5 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.

3.3.6.4 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 domestic VFR flights) and have significantly dropped in the mid 90ies as a result of unleaded gasoline introduction.

Table 147: Activities and Implied emission factors for heavy metals and PM_{10} as well as activities for 1.A.3.a.ii Civil Aviation (domestic LTO + international LTO): 1990–2014.

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	0.09	107.6

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 148: Activities and Implied emission factors for heavy metals and PM_{10} as well as activities for International Bunkers (domestic + international cruise traffic): 1990–2014.

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

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 149: Activities and Implied emission factors for heavy metals and POPs for 1.A.3.b Road Transport: 1990–2014.

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	915.03	1.47	0.02	4.33	0.002
1991	196 386	0.32	0.01	654.55	1.48	0.02	3.76	0.002
1992	196 215	0.33	0.01	434.90	1.50	0.02	3.16	0.002
1993	198 244	0.34	0.01	272.02	1.53	0.01	2.65	0.002
1994	199 009	0.35	0.01	159.62	1.60	0.01	2.26	0.002
1995	202 791	0.35	0.01	0.06	1.65	0.01	1.92	0.003
1996	224 096	0.32	0.01	0.05	1.63	0.01	1.60	0.002
1997	210 964	0.35	0.01	0.05	1.65	0.01	1.43	0.003
1998	237 524	0.32	0.01	0.05	1.57	0.01	1.25	0.003
1999	229 403	0.34	0.01	0.05	1.52	0.01	1.13	0.003
2000	241 748	0.34	0.01	0.05	1.43	0.01	1.02	0.003
2001	259 856	0.32	0.01	0.04	1.36	0.00	0.94	0.003
2002	288 170	0.29	0.01	0.04	1.28	0.00	0.88	0.003
2003	311 792	0.28	0.01	0.04	1.23	0.00	0.83	0.003
2004	318 770	0.28	0.01	0.04	1.18	0.00	0.78	0.003
2005	325 935	0.28	0.01	0.04	1.14	0.00	0.82	0.003
2006	314 198	0.30	0.01	0.04	1.14	0.00	0.94	0.003
2007	317 803	0.30	0.01	0.04	1.12	0.00	0.94	0.003
2008	301 826	0.32	0.01	0.04	1.10	0.01	1.00	0.003
2009	297 235	0.32	0.01	0.04	1.07	0.01	1.11	0.003
2010	309 010	0.31	0.01	0.04	1.06	0.01	1.15	0.002
2011	298 771	0.33	0.01	0.04	1.06	0.01	1.16	0.002
2012	298 174	0.33	0.01	0.04	1.05	0.01	1.19	0.002
2013	311 491	0.32	0.01	0.04	1.07	0.01	1.18	0.002
2014	305 112	0.33	0.01	0.01	1.08	0.01	1.20	0.002

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, PM_{10} and $PM_{2.5}$ are shown in the table below.

Table 150: Activities and Implied emission factors for PM (exhaust and non-exhaust) for 1.A.3.b Road Transport: 1990–2014.

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	23.70	31.33	10.44	3.13
1992	196 215	24.11	32.48	10.83	3.25

Year	Activity	IEF PM Exhaust	IEF TSP Non-exhaust	IEF PM_{10} Non-exhaust	IEF $PM_{2.5}$ Non-exhaust
1993	198 244	24.57	32.94	10.98	3.29
1994	199 009	25.13	34.15	11.38	3.41
1995	202 791	25.82	34.21	11.40	3.42
1996	224 096	26.97	31.74	10.58	3.17
1997	210 964	26.23	34.51	11.50	3.45
1998	237 524	25.26	31.47	10.49	3.15
1999	229 403	24.66	33.46	11.15	3.35
2000	241 748	23.87	32.52	10.84	3.25
2001	259 856	22.65	30.74	10.25	3.07
2002	288 170	21.03	28.38	9.46	2.84
2003	311 792	19.67	26.85	8.95	2.69
2004	318 770	18.61	26.76	8.92	2.68
2005	325 935	17.49	26.66	8.89	2.67
2006	314 198	16.72	28.12	9.37	2.81
2007	317 803	14.99	28.21	9.40	2.82
2008	301 826	13.23	29.92	9.97	2.99
2009	297 235	11.59	29.84	9.95	2.98
2010	309 010	10.07	29.25	9.75	2.92
2011	298 771	9.23	30.83	10.28	3.08
2012	298 174	8.12	30.81	10.27	3.08
2013	311 491	6.98	29.81	9.94	2.98
2014	305 112	6.06	31.22	10.41	3.12

3.4 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.

3.4.1 Completeness

Table 151 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 151: 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	NMVOC	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(1)	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(2)	NA	✓	NA	✓	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1.B.2.c	Venting and flaring(3)	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE

(1) included in 1.A.2.a Iron and Steel

(2) including emissions from 1.B.2.a.i (Exploration, Production and Transport of Oil) and oil pipelines

(3) included in 1.A.1.b Petroleum Refining

3.4.2 NFR 1.B.1.a Coal mining and handling – Methodological issues

In this category NMVOC, TSP, PM_{10} and $PM_{2.5}$ emissions from coal mining and handling and TSP, PM_{10} 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 2013). Before coal mining was stopped in 2007 (BMWFJ 2008) emissions decreased sharply (80 %) between 2003 and 2004.

The emissions of TSP, PM_{10} and $PM_{2.5}$ for Open Cast Mining were calculated by using the Tier 2 emission factors of the EMEP/EEA Guidebook 2013. 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, PM_{10} 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 152 together with the national emission factors. The emission factors from the national study WINIWARTER 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 152: Emission factors fugitive TSP, PM_{10} and $PM_{2.5}$ and NMVOC emissions from NFR category 1.B.1.a.

	Storage of solid fuels			Coal Mining and Handling	
PM	**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 153: Activity data for fugitive TSP, PM_{10} and $PM_{2.5}$ and NMVOC emissions from NFR category 1.B.1.a.

Year		Activity [kt]		Activity [kt]	
1990	1 822.00	2 504.00	2 403.00	1 577	870
1995	1 987.00	2 770.00	2 483.00	1 271	27
2000	1 487.00	1 460.00	2 171.00	1 249	NO
2001	1 166.00	1 344.00	2 095.00	1 206	NO
2002	1 188.00	1 242.00	2 171.00	1 412	NO
2003	1 484.00	1 743.00	2 354.00	1 152	NO
2004	1 701.00	1 621.00	2 201.00	235	NO
2005	1 960.00	1 316.00	2 369.00	6	NO
2006	1 556.00	866.00	2 264.00	7	NO

Year	Activity [kt]			Activity [kt]	
2007	1 306.00	1 568.00	2 230.00	NO	NO
2008	1 847.00	1 381.00	2 436.00	NO	NO
2009	2 039.00	1 630.00	2 320.00	NO	NO
2010	1 943.00	1 561.00	2 590.00	NO	NO
2011	2 412.00	1 655.00	2 481.00	NO	NO
2012	2 424.00	1 215.00	2 443.00	NO	NO
2013	2 143.00	1 275.00	2 712.00	NO	NO
2014	2 341.00	757.00	2 782.00	NO	NO

3.4.3 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 000m^3 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 154.

Table 154: Activity data and implied emission factors for fugitive NMVOC emissions from NFR Category 1.B.2.a.

	Transport of crude oil[87]	Refinery dispatch station	Transport and depots	Service stations	Petrol	Gas extraction		Oil refining	
	Activity [1000m^3]	IEF [g/t] NMVOC	IEF [g/t] NMVOC	IEF [g/t] NMVOC	Activity [kt]	IEF [g/1000m^3] NMVOC	Natural gas extr. [1000m^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
2005	9 000	205	206	270	2 073	557	338 349	59	8 778

87 Refinery crude oil throughput

	Transport of crude oil[87]	Refinery dispatch station	Transport and de-pots	Service stations	Petrol	Gas extraction		Oil refining	
	Activity [1000m³]	IEF [g/t] NMVOC	IEF [g/t] NMVOC	IEF [g/t] NMVOC	Activity [kt]	IEF [g/1000m³] NMVOC	Natural gas extr. [1000m³]	IEF [g/t] NMVOC	Crude oil refined [kt]
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	110	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	8 372

Between 1990 and 2014 NMVOC emissions from the transport of crude oil increased by 16 % 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 (89 %, 90 % and 77 % respectively) between 1990 and 2014 due to installation of gas recovery units.

NMVOC emissions from oil refining and gas extraction also showed a notable decrease of 89 % and 55 % respectively between 1990 and 2014. This emission reduction has been achieved through technical improvements (e.g. improved tanks and loading units).

3.4.4 NFR 1.B.2.b Natural Gas – Methodological issues

In this category SO_2 emissions from the first treatment of sour gas and NMVOC gas distribution networks are considered.

SO_2 emissions and activity data for the first treatment of sour gas are reported from „Fachverband Mineralöl" (Austrian association of oil industry). The drop in SO_2 emissions after 1996 is due to the implementation of pollution control measures. Emission data for 1990-1998 as well as for 2014 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 CH_4 emissions that were calculated applying a tier 3 method based on the material specific distribution pipeline lengths (reported by "Fachverband der Gas- und Wärmeversorgungsunternehmungen", "Association of Gas- and District Heating Supply Companies") and material specific emission factors (WARTHA 2005).

Table 155: Activity data and implied emission factors for fugitive NMVOC and SO_2 emissions from NFR Category 1.B.2.b.

Year	First treatment desulfuration		Gas distribution	
	IEF [g/1000 m^3] SO_2	Raw gas Throughput [1000 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	636	29 417
2014	117.08	307 475	616	30 226

3.4.5 Recalculations

- Recalculations for the storage of solid fuels in TSP, $PM_{2.5}$ and PM_{10} are due to revisions in the Energy Balance.
- Reporting of oil and natural gas exploration, production and transport is now under 1.B.2.b (previously reported under 1.B.2.a.i) due to the fact, that emissions from these activities are dominated of those from natural gas exploration, production and transport.

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 2014.

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

4.2.1 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.

4.2.2 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 156, 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 156: 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

4.2.3 Completeness

Table 157 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 production/use. For some categories, emissions are included elsewhere (IE). In Chapter 1.8, a general description regarding completeness is given.

Table 157: 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	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

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.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	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
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	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.B.10	Chemical Industry: Other	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	NA	NE(2)	✓	NA
2.C	METAL PRODUCTION	✓	✓	IE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2.D.3	Solvent use	NA	NA	NA	✓	✓	NA	NA	NA	✓	NA	✓	✓	✓	✓	NA
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
2.D.3.f	Dry Cleaning	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
2.G	Other product use	NA	NA	✓	NA	NA	✓	✓	✓	NA	NA	NA	NE	NE	NE	NA
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-, Perchlorethylene Production; later NO*

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 VDI[88] 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 project[89].

In 2011, a confidential study was commissioned by the Association for Building Materials and Ceramic Industries, which contains a new EF for PM_{10} 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%, PM_{10} 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 158. Activity data are mainly taken from national statistics and presented in Table 159.

Table 158: 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 (3) (4)	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

[88] Association of German Engineers – VDI Verein Deutscher Ingenieure

[89] http://www.air.sk/tno/cepmeip/

Bulk material / mineral	EF TSP [g/t]	EF PM_{10} [g/t]	EF $PM_{2.5}$ [g/t]
Cement [(1)(2)]	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/m²]**	**EF PM_{10} [g/m²]**	**EF $PM_{2.5}$ [g/m²]**
Total area under construction (for sub-category „Construction and demolition" [(1)]	173.40	86.70	8.67

(1) *Source: WINIWARTER et al. 2007*

(2) *Decreasing EF; values given for 2012 (2006)(1990)*

(3) *Source: Amann & Dämon 2011*

(4) *Decreasing EF; values given for 2012 (1990)*

Table 159: Activity data for diffuse PM emissions from bulk material handling, mining and construction/demolition

Activity data [t]	1990	1995	2000	2005	2010	2014
Magnesite	1 179 162	783 497	725 832	693 754	757 063	754 096
Sand	2 517 296	3 033 907	3 692 910	3 660 228	2 001 407	2 376 800
Gravel	14 264 676	17 192 140	20 978 974	25 361 797	28 304 033	28 051 922
Silicates	1 484 527	810 520	1 991 018	2 580 295	2 593 863	1 958 430
Dolomite	1 879 837	8 789 688	7 152 245	6 291 413	3 914 859	4 462 409
Limestone	15 371 451	19 079 581	23 823 529	22 643 754	21 189 887	22 695 477
Basaltic rocks	3 673 535	4 202 244	4 933 202	3 166 281	3 234 408	3 526 814
Iron ore	2 310 710	2 116 099	1 859 449	2 047 950	2 068 853	2 436 675
Tungsten ore	191 306	411 417	416 456	472 964	429 748	499 883
Gypsum, Anhydride	751 645	958 430	946 044	911 162	872 273	729 892
Lime, quick, slacked	512 610	522 934	654 437	788 328	764 845	786 565
Cement	3 693 539	2 929 973	3 052 974	3 221 167	3 097 043	3 143 495
Cement & Lime milling	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	83 257
Wheat flour	259 123	287 461	291 482	324 160	451 086	499 489
Sunflower and rapeseed grist	19 900	108 600	121 200	121 200	121 200	121 200
Wheat bran and grist	64 781	71 865	73 303	100 185	126 075	150 746
Rye bran and grist	15 357	13 962	13 139	13 139	13 139	13 139
Concentrated feeding stuff	638 014	720 972	980 808	1 018 649	988 371	1 116 748

Activity data [t]	1990	1995	2000	2005	2010	2014
Activity data [m^2]	**1990**	**1995**	**2000**	**2005**	**2010**	**2014**
Total area under construction (for sub-category „Construction and demolition“	10 142 004	11 060 799	11 788 151	11 941 513	13 504 469	14 075 536

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 2014) 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, PM_{10} 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 158 and Table 159, above.

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 (NH_3) is produced by catalytic steam reforming of natural gas or other light hydrocarbons (e.g. liquefied petroleum gas, naphtha). Nitric acid (HNO_3) is produced from ammonia (NH_3), where in a first step NH_3 reacts with air to NO and NO_2 and then reacts with water to form HNO_3. Both processes are minor sources of NH_3 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 25) 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).

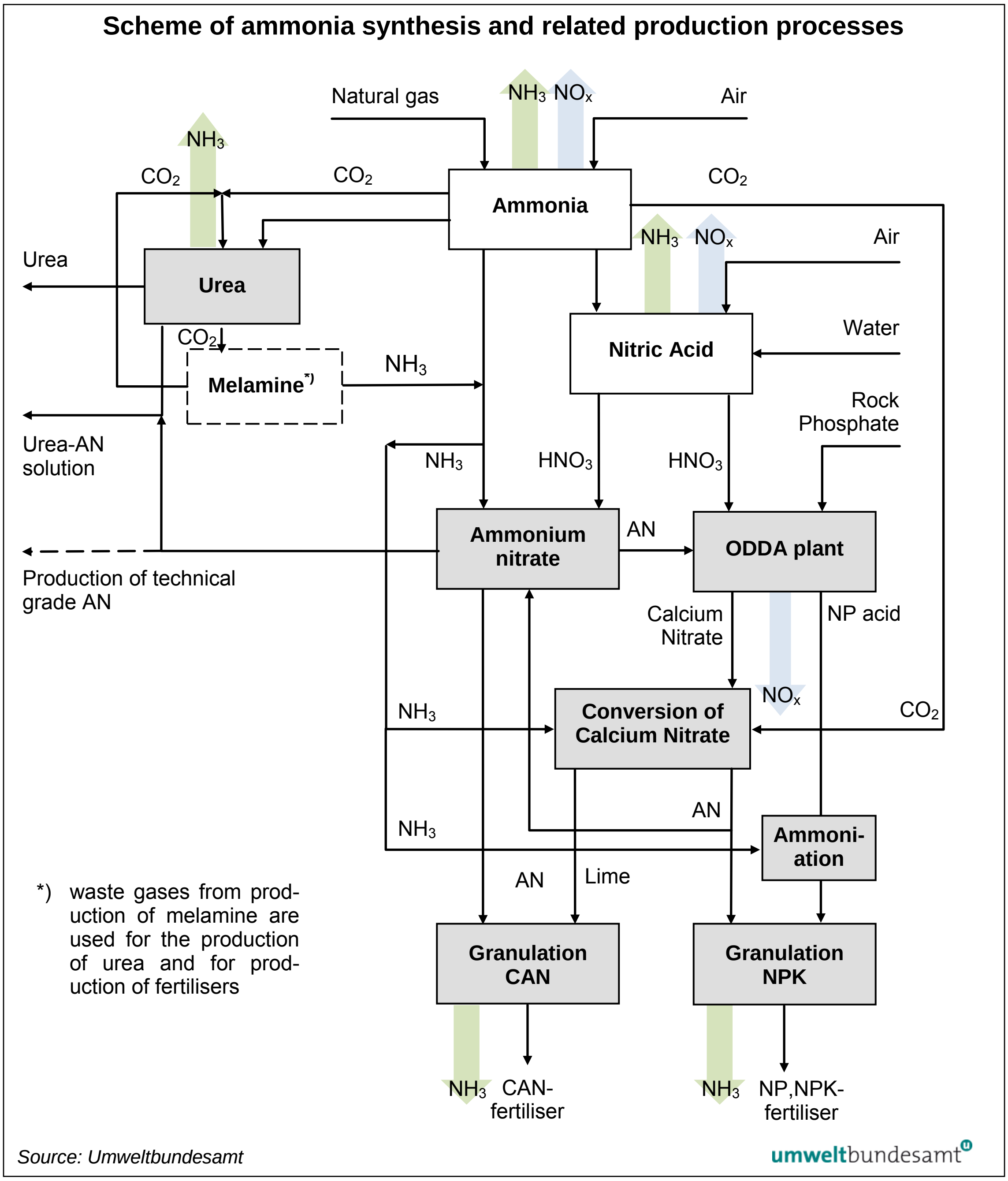

Figure 25: Scheme of ammonia synthesis and related production processes.

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 160 and Table 161). 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*.

NH_3 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 NH_3 emissions by about 12% in 2012 is a result of decreased activities of the catalyst. Exceptionally high NH_3 and CO emissions in 2013 can be attributed to a higher number of start-ups due to technical problems.

Table 160: Emissions and implied emission factors for NO_x, NH_3 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

Table 161: Emissions and implied emission factors for NO_x and NH_3 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

4.4.2 NFR 2.B.10 Other Chemical Industry

4.4.2.1 Source Category Description

This category includes NH_3 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 SO_2 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.

NH_3 emissions were reported separately for each of the two production processes; CO emissions occur during urea production only. The implied emission factors for NH_3 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 PM_{10} 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 162: NH_3, TSP, PM_{10} and $PM_{2.5}$ emissions and implied emission factors for NH_3 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

Table 163: Emissions and implied emission factors for NH_3 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

Fertilizer production

For fertilizer production activity, data from 1990 to 1994 were taken from national production statistics[90] (Statistik Austria); NO_x and NH_3 emissions and activity data from 1995 onwards were reported by the main producer in Austria. For the years 1990 to 1993, NH_3 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 PM_{10} and $PM_{2.5}$ are 58.6% and 30.9%, respectively, for the whole time-series.

Table 164: NO_x and NH_3 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

[90] 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 165: 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	0.65	0.09	0.82	459	269	142
2011	0.66	0.09	0.82	462	271	143
2012	0.64	0.09	0.81	452	265	140
2013	0.55	0.07	0.69	389	228	120
2014	0.65	0.09	0.81	457	268	141

Other processes in organic and inorganic chemical industries

All SO_2, 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. SO_2 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 SO_2 from other organic and inorganic chemical industries are presented in Table 166.

Table 166: Activity data and NMVOC, NO_x, SO_2 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	766	11 064
2010	1 066 788	1 325	908 640	IE	766	11 064
2011	1 066 788	1 325	908 640	IE	766	11 064
2012	1 066 788	1 325	908 640	IE	766	11 064
2013	1 066 788	1 325	908 640	IE	766	11 064
2014	1 066 788	1 325	908 640	IE	766	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 167: 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	1990	3000	270.00	60
1995	1995	2000	180.00	NO
2000	2000	NA	NA	NO
2005	2005	NA	NA	NO
2010	2010	NA	NA	NO
2012	2012	NA	NA	NO
2013	2013	NA	NA	NO
2014	2014	NA	NA	NO

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. SO_2, NO_x, NMVOC and CO emissions are included in category 1.A.2.a.

Heavy metal and POP emissions (dioxine, HCB) from 1990 to 2000 were calculated by multiplying activity data by emission factors from unpublished national studies (HÜBNER 2001a[91]), (HÜBNER 2001b[92]) for each of the processes (sinter, coke oven, blast furnace cowpers) and summing up the emissions. Emission factors for PCB are from the EMEP/EEA Emission Inventory Guidebook 2013 (EEA 2013). From 2001 onwards, emissions were calculated by multiplying iron production by the implied emission factors for 2000, except dioxine emissions that 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.

Pig iron production figures were taken from national statistics. Activity data, POP, HM and PM emissions are presented in Table 168.

Table 168: 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

[91] according to EUROPEAN COMMISSION IPPC BUREAU (2000); MAGISTRAT DER LANDESHAUPTSTADT LINZ (1995)

[92] 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. SO_2, 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 2001a[91]), 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 2001b[92]) 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 169; particulate matter emissions are reported together with emissions from blast furnace charging.

Table 169: 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]		
	Steel	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	6 407 738										
2010	6 570 357										
2011	6 785 682										
2012	6 746 210										
2013	7 290 218										
2014	7 185 000	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 170 together with electric steel production figures.

Table 170: Activity data and emission factors for emissions from Electric Steel Production 1990–2014.

	1990	1995	2000	2005	2010	2014
Activity [t]	370 107	453 645	540 539	622 485	637 383	691 000
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]
NMVOC	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 2001a[91])

(6) (HÜBNER 2001b[92])

(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 2C1 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

SO_2, 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 171: Activity data and emission factors for cast iron 1990–2014.

	1990	1995	2000	2005	2010	2014
Activity [t]	196 844	176 486	191 420	196 017	167 854	166 042
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 PM_{10} and $PM_{2.5}$ are based on expert judgement (PM_{10} 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 SO_2, 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 (BMWFW 2015) 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 172: Activity data and emission factors for non-ferrous (light metal) cast 1990–2014.

	1990	**1995**	**2000**	**2005**	**2010**	**2014**
Activity [t]	46 316	59 834	92 695	109 927	121 426	138 029
Emission factor [g/t light metal cast]						
SO_2	120	10	→	→	→	10
NO_x	330	230	230	170	→	170
NMVOC	4 040	1 740	1 740	1 289	→	1 289
CO	2 340	880	880	660	→	660

Table 173: Emission factors and activity data for heavy metal cast 1990–2014.

	1990	**1995**	**2000**	**2005**	**2010**	**2014**
Activity [t]	8 525	10 384	13 214	18 456	16 577	13 883
Emission factor [g/t heavy metal cast]						
SO_2	100	80	→	→	→	80
NO_x	100	80	→	→	→	80
NMVOC	1 390	1 180	→	→	→	1 180
CO	3 290	2 770	→	→	→	2 770

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 CO_2.

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 2014, 58.1% of total NMVOC emissions in Austria (110.46 kt) originated from *Solvent and Other Product Use*. Table 174 presents the trend in NMVOC emissions by subcategories.

Table 174: Total NMVOC emissions and trend from 1990–2014 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
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

	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				
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
1990–2014	***-43.9%***	***43.0%***	***-62.4%***	***-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%**
2014	**58.1%**	**21.1%**	**15.6%**	**6.7%**	**0.02%**	**3.9%**	**3.8%**	**7.1%**

NMVOC emissions in this sector decreased by 43.9% between 1990 and 2014, 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)[93] (repealed by Solvent Ordinance 1995)
- Solvent Ordinance 1995[94] (repealed by Solvent Ordinance 2005)
- Paint finishing systems Ordinance (1995)[95] (repealed by VOC Installations Ordinance)

In the subsequent years the legislation was adapted to be in line with European legislation:

- VOC Installations Ordinance (2002)[96], implementation of "Solvent Emission Directive"[97]
- VOC Ordinance 2005[98] – implementation of "Paints Directive"[99]

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[93] Verordnung des Bundesministers für Umwelt, Jugend und Familie über Verbote und Beschränkungen von organischen Lösungsmitteln (**Lösungsmittelverordnung**), BGBl. Nr. 492/1991

[94] Verordnung des Bundesministers für Umwelt über Verbote und Beschränkungen von organischen Lösungsmitteln (**Lösungsmittelverordnung 1995 – LMVO 1995**), BGBl 872/1995

[95] 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

[96] 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

[97] 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

[98] 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

- Amendment of VOC Ordinance (2005) [100] – implementation of "Industrial Emissions Directive" 2010/75/EC[101]

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 inquires 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:

$$\text{Solvent Use per Substance}_i = \text{Solvent Balance per Substance}_i - \text{Non Solvent Use of Substance}_i$$

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:

$$\text{Overall solvent use in Austria} = \sum_i \text{Solvent Use per Substance}_i + \sum p \text{ Solvents in Product}_p$$

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99 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

100 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

101 Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)

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 175).

Table 175: 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, antifreeze, 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, up until 2015. See Chapter "Recalculations" for an in depth description of the approach for the years after 2000.

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)[102] 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

[102] VOC-Anlagen-Verordnung (VAV), BGBl. II Nr. 301/2002 vom 26.7.2002

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

4.6.2.2 Activity data

Table 176: Activity data for solvent and other product use [t] 1990–2014.

NFR	2.D.3.d							
SNAP	Total	060101	060102	060103	060104[103]	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	4116	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

**Due to methodological reasons 060104 emissions from 2000 onwards are included in 060103*

[103] 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				
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
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

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	1199	235	815	608	4	51	1 991
2001	**12 806**	507	7 455	1199	236	755	604	4	48	1 999
2002	**12 608**	482	7 341	1199	237	695	599	4	44	2 007
2003	**12 408**	457	7 225	1199	238	635	595	4	41	2 015

NFR					2.D.3.g					
SNAP	Total	060305	060306	060307	060308	060309	060310	060311	060312	060314
Unit					t Solvent					
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
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

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

Table 177: Implied NMVOC Emission factors for Category 3 Solvent and Other Product Use 1990–2014.

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	7084 87	288 001

* *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
2001	442 449	848 808	426 636	678 723

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]			
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

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	1175225	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
2014	152 588	146 860	274 438	972 178	1 215 388	9 975	927 168	1 022 481	972 214

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

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 2014, 41% of all CO emissions in this category originated from this category.

4.6.2.3 Recalculations

On the one hand, for the years 2003 onwards new data and methods were applied, mainly data available from reports under directive 1999/13/EC (VOC Solvents Directive)[104] were implemented in the model (see above).

[104] VOC-Anlagen-Verordnung (VAV), BGBl. II Nr. 301/2002 vom 26.7.2002

On the other hand, the 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 time-line (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).

4.6.2.4 Planned improvements

Further investigations concerning emission factors for full implementation of the data obtained from the VOC installations ordinance are required.

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.[105] $Emission_{(TSP, PM10, PM2,5)}$ = activity * emission $factor_{(TSP, PM10, PM2,5)}$	
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 178: PM_{10} emission of Category 2.G Other Product Manufacture and Use 1990–2014.

NFR	**PM_{10} emission of**		
	2.G	**2.G Use of fireworks**	**2.G Use of tobacco**
SNAP	**0604**	**0604**	**0604**

[105] Winiwarter, W.; Schmidt-Stejskal, H.& Windsperger, A. (2007): Aktualisierung und methodische Verbesserung der österreichischen Luftschadstoffinventur für Schwebstaub Endbericht. Dezember 2007. ARC—sys-0149.

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

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 179: 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

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:

- Bread ....4 200 g_{NMVOC}/t_{bread}
- Wine ....65 g_{NMVOC}/hl_{wine}
- Beer ....20 g_{NMVOC}/hl_{beer}
- Spirits ....2 000 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
- PM_{10}........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 2001b[106]) 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

[106] according to MEISTERHOFER (1986)

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 180.

Table 180: POP emissions and activity data from smokehouses 1990–2014.

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
⇣	⇣	⇣	⇣	⇣
2014	19 533	37	0.1	26

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; PM_{10}: 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 181: 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 2007, 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 182: 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	58 632	128.37	51.35	20.54
2010	110 370	241.66	96.66	38.66
2011	107 321	234.98	93.99	37.60
2012	113 825	249.22	99.69	39.88
2013	113 407	248.30	99.32	39.73
2014	104 012	227.73	91.09	36.44

4.8.3 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 C*ombustion 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.

4.9 Recalculations

Summary of Recalculations made since submission 2015:

- The activity for 2013 of the following categories provided by the Austrian mining handbook have changed (BMWFW 2015)
  - NFR 2.A.5.a, SNAP 04 06 16 Extraction of mineral ores – X4B
  - NFR 2.A.5.a, SNAP 04 06 16 Extraction of mineral ores – X4A
  - NFR 2.A.5.a, SNAP 04 06 17 Other – X4F
  - NFR 2.A.5.a, SNAP 040617 Other – X4G
  - NFR 2.A.5.a, SNAP 040617 Other – X4H

- NFR 2.H.1, SNAP 04 06 17 Other – Boards of wood chips: Activity in the chipboard production form 2008 on increased, due to an adaption of the calculation
- NFR 2.I- Wood chips-boilers: Emissions from 2005 on changed, due to changes in the energy balances
- NFR 2.C.1 Iron and Steel Production. Input of coke oven gas was updated in the IEA questionnaire for the years from 2005 onwards
- NFR 2.A.5.b, SNAP 040617 Other – Construction and demolition: Emissions from 2002 on changed, due to changes of the building-cost index

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, 3.F Field Burning of Agricultural Residues* and *3.I Other.*

For the other pollutants the agricultural sector is only a minor source: emissions of SO_2, CO, heavy metals and POPs arise from category *3.F Field Burning of Agricultural Wastes*; the contribution to the national total for SO_2, CO, dioxin, HCBs and heavy metals was below 0.3% 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 2000-2015): 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 NFR 3.B Manure Management

The Austrian sectorial inventory model follows the N-flow concept. Based on (AMON & HÖRTENHUBER 2014) Austria revised its inventory model for sector agriculture according to the EMEP/EEA GB 2013 and to the 2006 IPCC GL in submission 2015. Revised N flow amounts directly fed into both, NEC/CLRTAP and GHG inventory.

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). The inventory revision 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.

5.2.1 Methodological Issues

NH_3 emissions from Sector 3 Agriculture are estimated according to the EMEP/EEA Air Pollutant Emission Inventory Guidebook (EEA 2013). 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. NH_3 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 2013. 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 2013 (EEA 2013).

Animal numbers

The Austrian official statistics (STATISTIK AUSTRIA 2015b) provides national data of annual livestock numbers on a very detailed level. These data are based on livestock counts held in December each year[107].

In Table 183 and Table 184 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.

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[107] For cattle livestock counts are also held in June, but seasonal changes are very small (between 0% and 2%). Livestock 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).

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.

Table 183: Domestic livestock population and its trend 1990–2014 (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
Trend 90–14	***-40.6%***	***-15.2%***	***389.1%***	***-32.0%***	***-25.2%***	***-20.9%***	***-10.0%***

* *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 184: Domestic livestock population and its trend 1990–2014 (II).

Year	Livestock category – Population size [heads] *							
	Swine	Young & Fattening Pigs > 20 kg	Breeding Sows > 50 kg	Young Swine < 20 kg	Sheep	Goats	Horses**	Other (furred game)***
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	86 296	42 102
2005	3 169 541	2 091 225	315 731	762 585	325 728	55 100	85 519	43 014
2006	3 139 438	2 038 170	321 828	779 440	312 375	53 108	84 743	43 926
2007	3 286 292	2 171 519	318 349	796 424	351 329	60 487	83 966	44 839
2008	3 064 231	2 023 536	297 830	742 865	333 181	62 490	83 190	45 751
2009	3 136 967	2 083 459	293 901	759 607	344 709	68 188	82 413	46 663
2010	3 134 156	2 084 923	284 691	764 542	358 415	71 768	81 637	47 575
2011	3 004 907	2 011 138	275 874	717 895	361 183	72 358	81 054	45 654
2012	2 983 158	2 001 150	263 200	718 808	364 645	73 212	80 470	43 733
2013	2 895 841	1 956 862	254 373	684 606	357 440	72 068	79 887	41 812
2014	2 868 191	1 928 596	246 870	692 725	349 087	70 705	79 887	41 812
Trend 90–14	***-22.2%***	***-17.8%***	***-35.4%***	***-27.7%***	***12.6%***	***89.3%***	***62.4%***	***12.7%***

* *from 1990 to 1992 adjusted age class split for swine as recommended in the UNFCCC centralized review (October 2003)*

** *interpolated values for the years 2000–2002, 2004–2009 and 2011–2012*

*** *interpolated values for the years 1991–1993, 2000–2002, 2004–2009 and 2011–2012*

Table 185: Domestic livestock population and its trend 1990–2014 (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
Trend 90–14	***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*

5.2.2 NH_3 emissions from cattle (3.B.1) and swine (3.B.3)

Key Sources: NH_3

5.2.2.1 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. 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 186: 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 187: 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 188: Share of N in animal waste management systems 2014 (cattle and swine).

Cattle category	**Animal Waste Management Systems 2014**					
	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 2013, Table 3.5, 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 189: 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 190: 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 2013, Table 3.5).

Manure storage – cattle and swine

Table 191 describes the share of composted and not composted solid manure for the years 1990, 2005 and 2014. 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 the share of composted and untreated solid manure is held constant in order to prevent implausible trends.

Table 191: Share of composted and untreated solid manure for cattle and swine in Austria in 1990, 2005 and 2014.

	1990		2005		2014	
	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 192: Slurry storage and treatment for cattle and swine in 1990, 2005 and 2014.

	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
2014								
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.

5.2.2.2 Animal excretion – cattle and swine

N excretion

N excretion values as shown in Table 193 and Table 194 are based on the following literature: (GRUBER & PÖTSCH 2006, PÖTSCH et al. 2005, STEINWIDDER & GUGGENBERGER 2003, UNTERARBEITSGRUPPE N-ADHOC 2004 and ZAR 2004).

Table 193: Austria specific N excretion values of dairy cows for the period 1990–2014.

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			

[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 194: 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)] (2014)	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 195: 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

5.2.2.3 Calculation of NH_3 emissions – cattle and swine

NH_3 emissions from were calculated using a country specific methodology following the N-flow model.

Emissions of Ammonia (NH_3) 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, NH_3 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.

NH_3 emissions from Category *3.B.1 Cattle* and *3.B.3 Swine* are calculated as follows:

$$NH_{3\ (3.B)} = NH_{3\ (housing)} + NH_{3\ (storage)}$$

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.

NH_3 emissions from housing – cattle and swine

Table 196 gives NH_3 emission factors for emissions from animal housing. As far as possible, Swiss default values as given in the EMEP/CORINAIR atmospheric emission inventory guidebook have been chosen. Due to similar management strategies and geographic structures, Swiss animal husbandry is closest to Austrian animal husbandry. If no CORINAIR emission factors from Switzerland were available, the CORINAIR German default values were used.

Table 196: Emission factors for NH_3 emissions from animal housing.

Manure management system	CORINAIR 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 197: NH_3 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 183, Table 184 and Table 185)*
$Nex_{(T)}$	=	*N excretion of animals of type T in the country [kg N animal^{-1} yr^{-1}] (see Table 193, Table 194 and Table 201)*
$AWMS_{(T)}$	=	*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*

NH_3 emissions from manure storage – cattle and swine

NH_3 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 NH_3-N losses from housing (see above) are subtracted. The remaining N enters the store.

Solid manure

According to the EMEP/EEA GB 2013 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 kg^{-1} for f_{imm} has been applied (EEA 2013).

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 2013. The default value of 0.1 for f_{min} has been applied (EEA 2013).

NH_3 emission factors – cattle and swine

NH_3-N losses are estimated with CORINAIR default emission factors given in *Table 198*.

Table 198: NH_3 emission factors for manure storage.

Manure storage system	CORINAIR 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 199 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 EAGER[108] group and published in (REIDY et al. 2008, 2009).

Table 199: Correction factors (CF) for NH_3 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

[108] European Agricultural Gaseous Emissions Inventory Researchers Network (EAGER)

5.2.3 NH_3 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 2013).

5.2.3.1 Agricultural practice – non-key livestock categories

Solid systems and pasture are the relevant AWMS for these animal categories in Austria.

Table 200: 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 2013, Table 3.5, 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 190.

5.2.3.2 Animal excretion – non-key livestock categories

Country specific N excretion values are presented in the following table:

Table 201: 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*

5.2.3.3 Calculation of NH_3 emissions – non-key livestock categories

Table 202 presents the default EMEP/EEA Tier 2 NH_3-N emission factors and associated parameters used in the calculations for Austria's non-key livestock categories (EEA 2013, Table 3.7).

Table 202: Default Tier 2 NH_3-N EF and associated parameters for the Tier 2 methodology.

NFR	Livestock category	proportion of TAN	Housing period [days][*)]	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	0.34[(**)]	0.21[(**)]	0.51[(**)]
3.B.4.h	Other animals	0.50	73	0.22	0.28	0.90

[*)] *values of housing period are country specific (ALFRED PÖLLINGER 2008)*

[**)] *EF = weighted mean of ducks & geese 2003-2013*

The EMEP/EEA Guidebook does not give default values for NH_3 emissions from the livestock category 'other animals'. In Austria furred game, mainly deer, dominates this livestock category. As sheep is the most similar livestock category to deer, for 'other animals' the NH_3 emission factors of sheep have been used.

NH_3 emissions from housing and storage – non-key livestock categories

Country specific NH_3-N emission factors for the housing of non-key animals are calculated by using the following formula:

$$\text{kg N excreted [animal}^{-1}\text{ year}^{-1}] * \text{TAN proportion} * \text{housing period}/365 * EF_{housing}$$

The CS emission factors for the storage of animal manure take into account the NH_3-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 2013).

Table 203 presents the resulting country-specific NH_3-N emission factors for housing and storage of sheep, goats, horses, poultry and other animals.

Table 203: NH_3-N emissions per head from housing and storage (non-key animals).

NFR	Livestock category	EF Housing [kg NH_3-N year^{-1}]	EF Storage [kg NH_3-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	0.11	0.05
3.B.4.h	Other animals	0.29	0.28

5.2.4 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 2013 (EEA 2013, Table 3-2).

5.2.5 Recalculations

Update of activity data

For the animal categories horses, poultry and other animals updated livestock data became available for the year 2013. Livestock numbers of the years 2011 and 2012 were interpolated, resulting in higher NH_3 and NO_x emissions from *3.B Manure Management.*

Improvement of methodologies and emission factors

The conversion of NO to NO_x resulted in higher emissions for the whole time series (+135 t for 2013).

5.3 NFR 3.D Agricultural Soils

NFR sector *3.D Agricultural Soils* includes emissions of ammonia (NH_3), nitric oxide (NO_x) and particulate matter (TSP, PM). The methodology for estimating PM emissions is presented in a separate chapter (Chapter 5.5).

5.3.1 Methodological Issues

In the Austrian inventory source category *3.D Agricultural Soils* comprises NH_3 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 NH_3 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 NH_3 emissions from:

- Urine and dung deposited by grazing animals (3.D.a.3) and
- Cultivated crops (3.D.e)

5.3.2 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"). Mineral fertilizer sales data are annually collected by Austria's agricultural marketing association (Agrarmarkt Austria, AMA) and yearly published by the BMLFUW ("Green Reports"). Annual urea fertilizer sales figures for the years 1994 to 2012 are based on information from Austria's leading fertilizer trading firm (RWA). Urea fertilizer data for 2013 and 2014 were provided by the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management.

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 204.

Table 204: Mineral fertilizer N consumption in Austria 1990–2014 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, RWA	120 550	5 328

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]
2001	117 100	3 329	GB, RWA	119 350	3 589
2002	127 600	4 470	GB, RWA	122 350	3 900
2003	94 400	6 506	GB, RWA	111 000	5 488
2004	100 800	7 293	GB, RWA	97 600	6 900
2005	99 700	7 673	GB, RWA	100 250	7 483
2006	103 700	11 310	GB, RWA	101 700	9 491
2007	103 300	11 500	GB, RWA	103 500	11 405
2008	134 400	9 568	GB, RWA	118 850	10 534
2009	86 300	18 400	GB, RWA	110 350	13 984
2010	90 629	6 500	GB, RWA	88 465	12 450
2011	116 751	16 867	GB, RWA	103 690	11 683
2012	97 721	10 733	GB, RWA	107 236	13 800
2013	112 005	16 638	GB,BMLFUW	104 863	13 685
2014	111 615	15 741	GB,BMLFUW	111 810	16 189

GB: (BMLFUW 2000–2015): www.gruenerbericht.at

RWA: Raiffeisen Ware Austria, sales company

BMLFUW:Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft

Emissions of ammonia (NH_3)

For the calculation of NH_3 emissions from synthetic fertilizers the CORINAIR detailed methodology was applied. This method uses specific NH_3 emission factors for different types of synthetic fertilizers and for different climatic conditions. According to CORINAIR, Austria belongs to Group III '*temperate and cool temperate countries*' with largely acidic soils.

In Austria, full time-series data only for urea and non-urea synthetic N fertilizers (see Table 204), but with no further specifications, are available. For urea the CORINAIR default value of 0.15 t NH_3-N per ton of fertilizer-N (EEA 2007, Table 5.1) was 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 t NH_3-N per ton of fertilizer-N is applied for fertilizers other than urea (STREBL et al. 2003).

Emissions of nitric oxide (NO_x)

The CORINAIR simple methodology 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 CORINAIR recommended emission factor of 0.3% (i.e. 0.003 t NO_x-N per ton applied fertilizer-N) is used.

5.3.3 Organic N-fertilizers applied to soils (NFR 3.D.a.2.a)

Key source: NH_3

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).

5.3.3.1 Animal manure applied to soils (NFR 3.D.a.2.a)

Emissions of ammonia (NH_3) 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 5.2.

Nitrogen left for spreading

After housing and storage, manure is applied to agricultural soils. Manure application is connected with NH_3-N, NO_x-N and N_2O-N losses that depend on the amount of manure N. With regard to a comprehensive treatment of the nitrogen budged, Austria established a link between the ammonia and nitrous oxide emissions inventory. A detailed description of the methods applied for the calculation of N_2O emissions is given in the report "Austria's National Inventory Report 2016 – Submission under the United Nations Framework Convention on Climate Change and the Kyoto Protocol" (UMWELTBUNDESAMT 2016a).

From total N excretion the following losses were subtracted:

- N excreted during grazing
- NH_3-N losses from housing
- NH_3-N losses during manure storage
- NO_x-N losses from manure management
- N_2O-N losses from manure management
- The remaining N is applied to agricultural soils.

NH_3 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 NH_3 emissions are highly dependent on the quality of waste and organic matter content in slurry. According to the EEA/EMEP Guidebook 2013 the N input from straw use in manure management systems is taken into account.

NH_3 emissions from manure nitrogen applied to soils have been calculated using the following formula:

$$NH_3\text{-}N_{spread} = N_{exLFS} * (Frac_{SS} * F_{TAN\ SS} * EF\text{-}NH_3\text{-}N_{spread\ SS} + Frac_{LS\text{-}bc} * F_{TAN\ LS} * EF\text{-}NH_3\text{-}N_{spread\ LS} + Frac_{LS\text{-}bs} * F_{TAN\ LS} * EF\text{-}NH_3\text{-}N_{spread\ LS} * CF_{bs})$$

$NH_3\text{-}N_{spread}$	=	*NH_3-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*

$Frac_{LS\text{-}bc}$	=	*Fraction of nitrogen left for spreading produced as liquid slurry in a liquid waste management system (broadcast spreading)*
$Frac_{LS\text{-}bs}$	=	*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*
$EF\text{-}NH_3\text{-}N_{spread\ SS}$	=	*NH_3-N Emission factor of animal waste from a solid manure system (farmyard manure) spread on agricultural soils (broadcast spreading)*
$EF\text{-}NH_3\text{-}N_{spread\ LS}$	=	*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 205 gives information on slurry application for the years 1990, 2005 and 2014. 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 205: Cattle and pig slurry application in Austria 1990, 2005 and 2014.

Animal category:	**1990**		**2005**		**2014**	
	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.

NH_3 emission factors

The following default NH_3 emission factors for spreading of slurry and farmyard manure (expressed as share of TAN) have been used (EEA 2009):

Table 206: Emission factors for NH_3 emissions from animal waste application.

Application technique	CORINAIR 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 207 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 207: Correction factors for NH_3 emissions from animal waste application.

Application technique	[CF]
Broadcast spreading	1
Band spreading	0.7

NH_3 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 NH_3-N emission factors and the default TAN values have been used (EEA 2013, Table 3.7). All N-losses (NH_3-N, NO_x-N, N_2 and N_2O-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 2013 the N input from straw use in manure management systems has been taken into account.

Table 208 presents the resulting NH_3-N emission factors for manure application of sheep, goats, horses, poultry and other animals.

Table 208: Country specific emission factors for NH_3 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

NO_x emissions from animal manure spreading are not addressed explicitly in the EMEP/EEA Guidebook 2013. Thus, a conservative emission factor of 0.01 t NO_x-N per ton of organic fertilizer-N spread on agricultural soils is used (FREIBAUER & KALTSCHMITT 2001).

5.3.3.2 Sewage sludge applied to soils (NFR 3.D.a.2.b)

Ammonia emissions (NH_3)

The CORINAIR emission factor of urea (EEA 2007, Table 5.1) has been taken (0.15 kg NH_3-N/kg fertilizer N).

Emissions of nitric oxide (NO_x)

NO_x emissions were estimated using a conservative emission factor of 1% of manure and sewage sludge nitrogen (FREIBAUER & KALTSCHMITT 2001).

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 209: Amount of sewage sludge (dry matter) produced in Austria, 1990–2014.

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

Year	Total [t dm]	agriculturally applied [t dm]	agriculturally applied [%]
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

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).

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 209)*

5.3.3.3 Other organic fertilizers applied to soils (NFR 3.D.a.2.c)

In addition to N from digested manure, which has been already accounted for in previous submissions, additional N inputs from energy crops applied to soils as fertilizer after the digestion process in biogas plants have been implemented in submission 2015.

Activity Data

The calculation of N from anaerobically digested energy crops 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, 2013 and 2014 proportions of the 2011 balance were used.

Table 210: N from biogas slurry (vegetable part).

Year	manure anaerobically digested [kg N $year^{-1}$]	N from biogas slurry [kg N $year^{-1}$]
1990	49 840	175 293
1991	67 837	238 589
1992	75 303	264 850
1993	100 154	352 251
1994	283 275	996 309
1995	327 613	1 152 251
1996	359 014	1 262 692
1997	460 707	1 620 357
1998	546 005	1 920 361
1999	752 947	2 648 198
2000	871 032	3 063 517
2001	996 191	3 503 715
2002	1 108 080	3 897 238
2003	1 209 113	4 252 582
2004	1 296 492	4 559 906
2005	1 365 534	4 802 732
2006	1 429 936	5 029 242
2007	1 577 004	5 546 496
2008	1 610 693	6 478 924
2009	1 635 722	7 614 425
2010	1 660 440	7 102 316
2011	1 694 441	6 687 875
2012	1 713 829	6 764 400
2013	1 726 782	6 815 522
2014	1 704 280	6 726 710

Ammonia emissions (NH_3)

No default emission factor is available In the EMEP/EEA guidebook. The CORINAIR emission factor of urea (0.15 kg NH_3-N/kg fertilizer N following EEA 2007, Table 5.1) has been used as a conservative approach.

Emissions of nitric oxide (NO_x)

NO_x emissions were estimated using a conservative emission factor of 1% of manure and sewage sludge nitrogen (FREIBAUER & KALTSCHMITT 2001).

5.3.4 Urine and dung deposited by grazing animals (NFR 3.D.a.3)

Key source: NH_3

Cattle and Swine

The CORINAIR emission factor of 0.05 kg NH_3-N/ kg N excreted has been used (Eidgenössische Forschungsanstalt 1997).

The share of N excreted on pastures is presented in Table 186 to

Table 188. 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 194.

Sheeps, goats, horses, poultry and other animals

Tier 2 default NH_3-N EFs have been taken (EEA 2013, Table 3.7). For other animals (furred game) the EF of sheep has been used. N-excretion values and TAN proportion are described under chapter 5.2.3.

5.3.5 Cultivated crops (3.D.e)

Key source: No

5.3.5.1 Legume cropland

Ammonia emissions (NH_3)

The CORINAIR detailed methodology using the CORINAIR default emission factor of 0.01 t of NH_3-N per ton of N was applied. The amount of N-input to soils via N-fixation of legumes (F_{BN}) was estimated on the basis of the cropping areas and specific consideration of nitrogen fixation rates of all relevant N-fixing crops:

$$F_{BN} = LCA * B_{Fix}/1000$$

F_{BN} = Annual amount of nitrogen input to agricultural soils from N-fixation by legume crops [t]

LCA = Legume cropping area [ha]

B_{Fix} = Annual biological nitrogen fixation rate of legumes [kg/ha]

Activity values (LCA) can be found in Table 212.

Values for biological nitrogen fixation (120 kg N/ha for peas, soja beans and horse/field beans and 160 kg N/ha for clover-hey, respectively) were taken from (UMWELTBUNDESAMT 1998a); the values are constant over the time series.

(UMWELTBUNDESAMT 1998a) represents average data for Austria, which were used for calculating the Austrian Nitrogen Surface balance according to the OECD method. In the study available Austrian data and coefficients were put together, including literature and expert opinions from the Austrian "Fachbeirat für Bodenfruchtbarkeit und Bodenschutz" (advisory board for soil fertility and soil protection of the Federal Ministry for Agriculture and Forestry, Environment and Water Management). This advisory board is a platform of agricultural experts, which publishes regularly the "Richtlinien für die sachgerechte Düngung" (Austrian fertilizer recommendations).

5.3.5.2 NMVOC emissions from vegetation

CORINAIR simple methodology was applied. Biogenic emissions from vegetation canopies of natural grasslands are derived as described in the following equation (CORINAIR 1999, p. B 1104–7, Table 4.1). This method is also suggested to be applied for fertilized cultures.

$$\textbf{E-NMVOC} = \textbf{CA} * \varepsilon\textbf{-NMVOC} * \textbf{D} * \Gamma$$

E-NMVOC = *Annual NMVOC emissions from vegetation [t]*

CA = *Cropping area of vegetation [ha]*

ε–NMVOC = *NMVOC potential emission rate per unit of dry matter and time unit [mg/dry matter.hours]*

D = *Foliar biomass density [t dry matter/ha]*

Γ = *Time integral (over 6 or 12 months) of emission hours. This value includes a correction variable that represents the effect of short-term temperature and solar radiation changes [hours].*

Table 211: Parameters for calculation of NMVOC emissions from vegetation canopies of agriculturally used land.

	Effective emission hours(1) (12 mon)			Biomass Density D(2) [t/ha]	Emission Potential(3)		
	Γ-mts	Γ-ovoc [hours]	Γ–iso		ε–iso	ε-mts	ε-ovoc [µg/g dry matter. hour]
Grassland	734	734	540	0.4	0	0.1	1.5
Alpine grassland	734	734	540	0.2	0	0.1	1.5
Agricultural crops	734	734	540	0.617(4)	0.09	0.13	1.5

Abbreviations: iso = isopren; mts = terpene; ovoc = other VOC's

(1) *Γ = integrated effective emission hours, corrected to represent the effects of short term temperature and solar radiation changes on emissions*

(2) *D = foliar biomass density (in t dry matter per ha)*

(3) *ε = average emission potential*

(4) *based on cereal harvest data (2005-value see Table 213)*

The results are highly dependent on the assumptions about biomass density.

Aboveground biomass of agricultural crops was calculated using official cropping area (see Table 212) and expansion factors for leaves. For simplification, wheat was considered to be representative for the vegetation cover of agricultural crop land (see Table 213).

Activity data

The yearly numbers of the legume cropping areas were taken from official statistics (BMLFUW 2000–2015). Data of agricultural land use are taken from (STATISTIK AUSTRIA, 1990-2015) and (BMLFUW 2000–2015). Land use areas (cropland, grassland, alpine grassland) 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 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. Alpine 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 2016, chapters *6.3 Cropland (Category 4.B)* and *6.4 Grassland (Category 4.C)* (UMWELTBUNDESAMT 2016a).

Table 212: Legume cropping areas and agricultural land use 1990–2014.

Year	Legume Areas [ha]				Land Use Areas [1000 ha]		
	peas	soja beans	horse/field beans	clover hey, lucerne, …	Cropland (total)	Grassland (total)	Grassland (extensive)
1990	40 619	9 271	13 131	57 875	1 405	1 715	456
1991	37 880	14 733	14 377	65 467	1 423	1 713	450
1992	43 706	52 795	14 014	64 379	1 415	1 712	443
1993	44 028	54 064	1 064	68 124	1 399	1 710	437
1994	38 839	46 632	10 081	72 388	1 403	1 690	431
1995	19 133	13 669	6 886	71 024	1 404	1 669	425
1996	30 782	13 315	4 574	72 052	1 403	1 670	419
1997	50 913	15 217	2 783	75 976	1 397	1 671	413
1998	58 637	20 031	2 043	76 245	1 396	1 661	407
1999	46 007	18 541	2 333	75 028	1 395	1 651	401
2000	41 114	15 537	2 952	74 266	1 378	1 652	398
2001	38 567	16 336	2 789	72 196	1 376	1 654	396
2002	41 605	13 995	3 415	75 429	1 375	1 655	393
2003	42 097	15 463	3 465	78 813	1 376	1 657	390
2004	39 320	17 864	2 835	83 349	1 404	1 633	387
2005	36 037	21 429	3 549	88 974	1 405	1 609	385
2006	32 652	25 013	4 555	97 549	1 390	1 581	382
2007	28 111	20 183	4 479	101 861	1 389	1 554	379
2008	22 306	18 419	3 695	98 966	1 377	1 539	376
2009	15 168	25 321	2 819	101 073	1 375	1 524	373
2010	13 562	34 378	4 154	106 080	1 373	1 509	371
2011	11 715	38 123	6 028	104 800	1 370	1 494	368
2012	10 704	37 126	6 852	104 808	1 365	1 479	365
2013	7 248	42 027	6 194	101 861	1 364	1 463	363
2014	6 863	43 832	7 661	102 369	1 352	1 463	363

Table 213: Cereal production in Austria [t/ha].

Year	harvest per area	Year	harvest per area
	[t/ha]		[t/ha]
1990	5.58	2003	5.27
1991	5.46	2004	6.53
1992	5.16	2005	6.17
1993	5.10	2006	5.75
1994	5.40	2007	5.88
1995	5.51	2008	6.86
1996	5.40	2009	6.19
1997	5.92	2010	5.95
1998	5.70	2011	7.09
1999	5.95	2012	6.03
2000	5.42	2013	5.88
2001	5.87	2014	7.10
2002	5.85		

5.3.6 Recalculations

Update of activity data

Manure Management (3.B) and Agricultural Soils (3.D)

For the year 2013 updated livestock data for the animal categories horses, poultry and other animals became available. Livestock numbers of the years 2011 and 2012 for the respective animal categories were interpolated, resulting in higher NH_3 and NO_x emissions from *3.D Agricultural Soils.*

Cultivated Crops (3.D.e)

NMVOC emissions for the whole time series were recalculated due to harmonization of land use data (cropland, grassland) with sector LULUCF. The revision results in slightly higher NMVOC emissions from *3.D.e Cultivated Crops.*

Improvement of methodologies and emission factors

The Austrian agricultural inventory model follows the N-flow concept. Revised N_2O EFs for poultry in sector manure management resulted in slightly increased NH_3 and NO_x emissions from *3.D.a.2.a Animal manure applied to soils.*

5.4 NFR 3.F Field Burning of Agricultural Waste

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.

5.4.1 Methodological Issues

Activity Data

According to the Austrian Chamber of Agriculture (personal communication to Mag. Längauer), in Austria about 570 ha were burnt in 2014. This value corresponds to about 0.1% of the relevant cereal area in 2014. 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 1990-2015) 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 2014) has been calculated.

Further details are given in "Austria's National Inventory Report 2016, chapter *6.3 Cropland (Category 4.B)* (UMWELTBUNDESAMT 2016a).

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 214: Activity data for field burning of agricultural residues 1990–2014.

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

Year	Viniculture Area [ha]	Burnt Residual Wood [t]
2007	49 842	3 738
2008	47 688	3 577
2009	45 533	3 415
2010	45 480	3 411
2011	45 427	3 407
2012	45 373	3 403
2013	45 320	3 399
2014	45 320	3 399

The amount of agricultural waste burned is multiplied with a default or a country specific emission factor.

5.4.1.1 Cereals

NH_3, NO_x, CO

The EMEP/EEA Tier 1 default approach (EEA 2013) 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 an Austrian specific value of 0.86 was used (LÖHR 1990). Residue/crop product ratio was obtained from (UMWELTBUNDESAMT 1998a). For NH3 the default emission factor of 2.4 mg NH_3 per gram straw (EEA 2013, table 3-3) was used. For NO_x the IPCC default emission factor of 2.5 g/kg dm burnt and for CO the IPCC default emission factor of 92 g/kg dm burnt was used (IPCC 2006, Table 2.5).

SO_2

The CORINAIR detailed method and a national emission factor of 78 g per ton straw (dm) was applied. The emission factor corresponds to burning wood logs in poor operation furnace systems (JOANNEUM RESEARCH 1995). For dry matter fraction the Austrian specific value of 0.86 was used (LÖHR 1990). Residue/crop product ratio for wheat, barley, oats, rye and other cereals was obtained from (UMWELTBUNDESAMT 1998a).

NMVOC

A simple national method with a national emission factor of 28 520 g NMVOC per ha burnt was applied (ÖFZS 1991).

Heavy metals (Cd, Hg, Pb)

The CORINAIR detailed method with national emission factors has been applied. The Hg, Cd, and Pb emission factors were taken from (HÜBNER 2001a):

- Cd .... 0.09 mg/kg dm_{straw}, 20% remaining in ash
- Pb .... 0.48 mg/kg dm_{straw}, 20% remaining in ash
- Hg .... 0.013 mg/kg dm_{straw}, 0% remaining in ash

The fraction of dry matter burned was estimated by applying the residue/crop product ratio of wheat, barley, oats, rye and other cereals taken from (UMWELTBUNDESAMT 1998a). For the dry matter content of cereals an Austrian specific value of 0.86 was used (LÖHR 1990).

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.

Particulate Matter (TSP, PM_{10}, $PM_{2.5}$)

Emission factors related to the dry matter (dm) mass of residue burnt have been taken (JENKINS et al. 1996):

- TSP.........0.0058 kg/kg dm_{burnt}
- PM_{10}.......0.0057 kg/kg dm_{burnt}
- $PM_{2.5}$.... ..0.0054 kg/kg dm_{burnt}

5.4.1.2 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 NH_3 the Corinair emission factor of 1.9 kg per ton burnt wood was taken. Table 215 presents the resulting emission factors.

Table 215: 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, PM_{10}, $PM_{2.5}$)

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

5.4.2 Recalculations

Update of activity data

Revisions in viniculture area and cereal harvest data resulted in slightly revised emissions of all air pollutants 1990-2013.

Improvement of methodologies and emission factors

The updated EMEP/EEA Tier 1 default approach (EEA 2013) referring to the IPCC default methodology (IPCC 2006) resulted in slightly higher NO_x emissions (+0.5 t in 2013) and higher CO emissions (+52 t in 2013).

5.5 NFR 3.D Particle Emissions from Agricultural Soils

- Particle emissions reported under source category 3.D result from
  - certain steps of farm work such as soil cultivation and harvesting (field operations). The calculations are based on (WINIWARTER et al. 2007).
  - agricultural bulk material handling. These emissions are estimated under source category *2.A Mineral Products* (see Chapter 4.3).

5.5.1 Methodological Issues

5.5.1.1 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 1990-2015) and (BMLFUW 2000-2015). 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 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.

Further details are given in "Austria's National Inventory Report 2016, chapters *6.3 Cropland (Category 4.B)* (UMWELTBUNDESAMT 2016a).

Table 216: Agricultural land use data 1990–2014.

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	1 403	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			

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 PM_{10} has been applied (OETTL & FUNK 2007). PM emissions occuring from harvesting have been calculated using an emission factor of 5kg/ha PM_{10} (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 hectar:

Table 217: 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%

PM_{10} TSP*45%

5.5.1.2 PM emissions from bulk material handling

The CORINAIR simple methodology was applied. Emissions were estimated multiplying the amount of bulk material by an emission factor. Activity data was taken from national statistics.

5.5.1.3 Recalculations

Recalculations have been carried out due to harmonization of the cropland area with the sector LULUCF leading to slightly revised emissions of PM emissions in several years from 1991 to 2012.

5.6 NFR 3.I Agriculture – Other

Key Source: No

In NRF category **3.I Particle emissions from Animal Husbandry** are included.

5.6.1 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 2015b) 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 218 the applied emission factors are listed.

Table 218: 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 PM_{10} in TSP is assumed to be 45% and the share of $PM_{2.5}$ in TSP is assumed to be 10%.

5.6.2 Recalculations

For the year 2013 updated livestock data for the animal categories horses, poultry and other animals became available. Livestock numbers of the years 2011 and 2012 for the respective animal categories were interpolated, resulting in higher PM emissions.

5.7 Recalculations

Summary of recalculations made since submission 2015 (for details refer to sub-chapters):

NFR 3.B Manure Management

Update of activity data

For the year 2013 updated livestock data for the animal categories horses, poultry and other animals became available. Livestock numbers of the years 2011 and 2012 for the respective animal categories were interpolated, resulting in higher NH_3 and NO_x emissions from *3.B Manure Management.*

Improvement of methodologies and emission factors

The conversion of NO to NO_x resulted in higher emissions for the whole time series (+135 t for 2013).

NFR 3.D Agricultural Soils

Update of activity data

Agricultural Soils (3.D)

For the year 2013 updated livestock data for the animal categories horses, poultry and other animals became available. Livestock numbers of the years 2011 and 2012 for the respective animal categories were interpolated, resulting in higher NH_3 and NO_x emissions from *3.D Agricultural Soils.*

Cultivated Crops (3.D.e)

NMVOC emissions for the whole time series were recalculated due to harmonization of land use data (cropland. grassland) with sector LULUCF. The revision results in slightly higher NMVOC emissions from *3.D.e Cultivated Crops.*

Particle emissions from agricultural soils (3.D.a.1)

Recalculations have been carried out due to harmonization of the cropland area with the sector LULUCF leading to slightly revised emissions of PM emissions in several years from 1991 to 2012.

Improvement of methodologies and emission factors

The Austrian agricultural inventory model follows the N-flow concept. Revised N_2O EFs for poultry in sector manure management resulted in slightly increased NH_3 and NO_x emissions from *3.D.a.2.a Animal manure applied to soils.*

NFR 3.F Field Burning of Agricultural Waste

Update of activity data

Revisions in viniculture area and cereal harvest data resulted in slightly revised emissions of all air pollutants 1990-2013.

Improvement of methodologies and emission factors

The updated EMEP/EEA Tier 1 default approach (EEA 2013) referring to the IPCC default methodology (IPCC 2006) resulted in slightly higher NO_x emissions (+0.5 t in 2013) and higher CO emissions (+52 t in 2013).

NFR 3.I Agriculture Other

Update of activity data

For the year 2013 updated livestock data for the animal categories horses, poultry and other animals became available. Livestock numbers of the years 2011 and 2012 for the respective animal categories were interpolated, resulting in higher PM 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 2014.

Emissions addressed in this chapter include emissions from the sub categories

- *Solid Waste Disposal on Land* (NFR Sector 5.A);
- *Composting* (NRF 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.

NH_3 emissions of this source have been identified as key category. The following Table 219 presents the results of the Key Category Analysis of the Austrian inventory with regard to the contribution to national total emissions (for details of the Key Category Analysis see Chapter 1.5).

Table 219: Contribution to National Total Emissions from NFR sector 5 Waste in 2014.

Pollutant	Source Category: 5 Waste	Pollutant	Source Category: 5 Waste
SO_2	0.06%	PAH	< 0.01%
NO_x	0.01%	Diox	0.52%
NMVOC	0.05%	HCB	0.02%
NH_3	1.80%	TSP	0.66%
CO	0.74%	PM_{10}	0.55%
Cd	0.05%	$PM_{2.5}$	0.33%
Hg	2.07%		
Pb	0.01%		

The overall emission trend reflects changes in waste management policies as well as waste treatment facilities. According to the Landfill Ordinance[109] waste has to be treated before being deposited in order to reduce the organic carbon content. Decreasing amounts of deposited waste result in decreasing NH_3 emissions. Although an increasing amount of waste is incinerated, NO_x, NMVOC and NH_3 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. NH_3 emissions arising from category 5.B Composting show an increasing trend due to increasing amounts of biologically treated waste, a result of the sepa-

[109] 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).

rate collection of organic waste (regulated in an Austrian act on collection of biogenic waste[110]) and the since 2009 obligatory pre-treatment of waste[111] before deposition (regulated in Austrian Landfill Ordinance[112]).

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 waste[113]) and to demonstrate that all relevant activity data are taken into account in the inventory.

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[110] Verordnung über die getrennte Sammlung biogener Abfälle (BGBl. Nr. 68/1992)

[111] 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)

[112] 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

[113] In fact non-residual waste also comprises waste from other (industrial) sources.

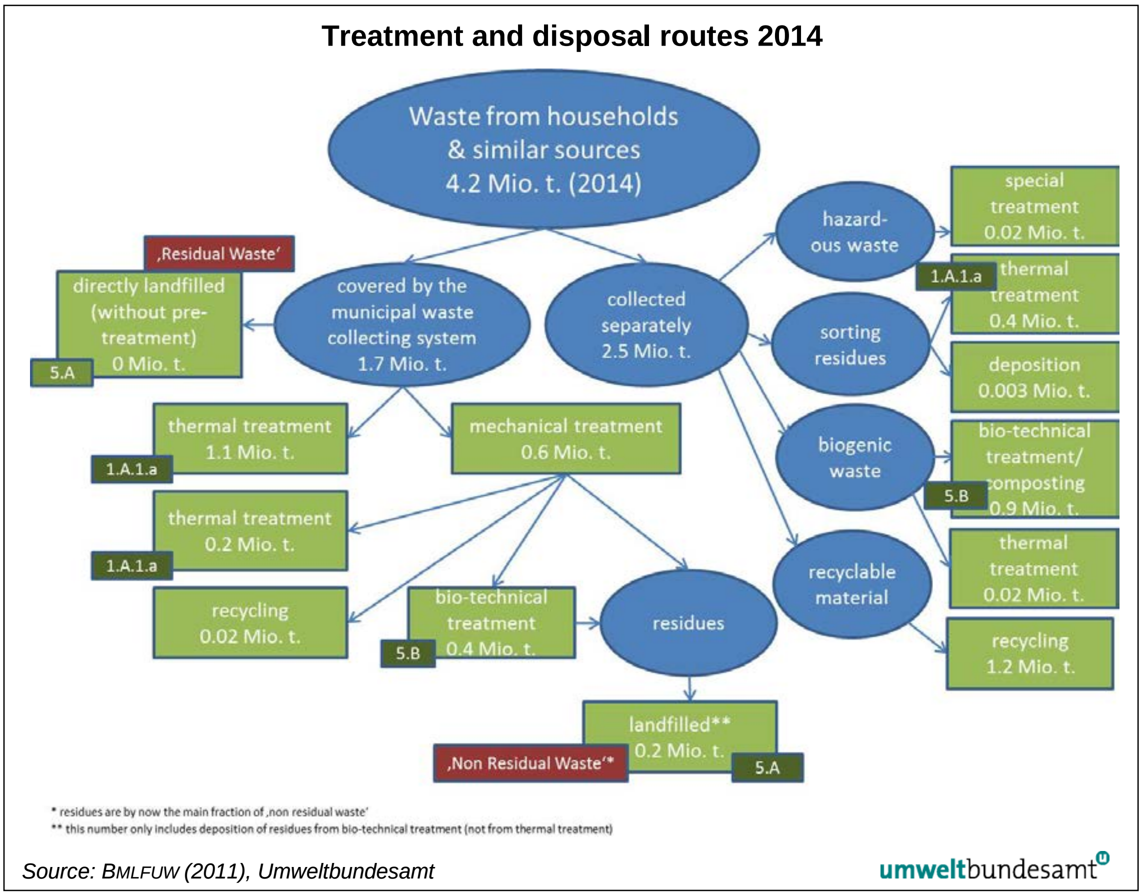

Figure 26: Main streams of treatment and disposal of waste from households and similar sources.

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 220: 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)]
bio-technical treatment	16.7%[2)]	6.3%	11.2%	17.9%	8.8%	10.4%	8.5%	11.0%	10.9%	10.4%
thermal treatment (incineration)	5.9%	14.7%	28.3%	23.7%	34.7%	36.4%	40.2%	38.2%	38.8%	38.6%
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%
recycling	12.9%	34.3%	35.6%	34.8%	32.3%	31.7%	30.7%	26.8%	27.2%	26.9%
bio-technical treatment/composting	1.0%	15.4%	16.0%	17.9%	18.2%	18.7%	17.7%	21.6%	20.9%	22.0%
direct deposition at landfills	63.1%	28.5%	7.7%	3.8%	3.7%	0.4%[*)]	0.4%[*)]	<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)
**) deposition of (sorting-, processing-) residues from separately collected waste*

6.2 General description

6.2.1 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.

6.2.2 Completeness

Table 221 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 221: 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	NMVOC	CO	TSP	PM_{10}	$PM_{2.5}$	Cd	Hg	Pb	Dioxin	PAK	HCB	PCB
5.A	Solid Waste Disposal on Land	NA	NA	✓	✓	✓	✓	✓	✓	✓	✓	✓	NA	NA	NA	NA
5.B	Composting	NA	NA	✓	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5.C	Waste Incineration	✓	✓	✓	✓	✓	NE	NE	NE	✓	✓	✓	✓	✓	✓	NA
5.D	Wastewater Handling	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

6.3 NFR 5.A Waste Disposal on Land

6.3.1 NMVOC, NH_3, CO and heavy metals emissions

Source Category Description

NFR 5.A.1 *Managed waste disposal on land* accounts for the main source of NH_3 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 waste[114] 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.

[114] 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).

'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 Ordinance[115]), 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 (95%). Other fractions deposited are sludges (4.8%) and construction waste (0.3%). 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.

Methodological Issues

The anaerobic degradation of land filled organic substances results in the formation of landfill gas.

NMVOC and NH_3 emissions are calculated based on their respective content in the emitted landfill gas (after consideration of gas recovery). For NMVOC a concentration of 300 mg per m³ landfill gas, for NH_3 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 recovery[116].

[115] 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

[116] Most active landfills in Austria have gas collection systems – regulated in §31 Landfill Ordinance (Federal Law Gazette BGBl. Nr 39/2008.

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 222: Activity data for "Residual waste" and "Non-Residual Waste" 1990–2014.

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	1 995 747	2 289 067
1993	688 407	1 799 718	2 333 126
1994	702 175	1 614 157	1 844 242
1995	716 219	1 644 718	1 765 928
1996	730 543	1 142 067	1 854 713
1997	745 154	1 049 709	1 827 788
1998	760 057	1 124 169	1 841 171
1999	822 179	1 082 634	1 906 804
2000	826 874	1 081 114	1 878 935
2001	772 786	1 084 625	1 838 378
2002	792 753	1 052 061	1 967 296
2003	890 640	1 065 592	2 276 584
2004	344 747	1 174 543	627 403
2005	389 660	1 385 944	631 393
2006	425 091	282 656	685 159
2007	464 109	241 733	618 626
2008	319 927	260 068	449 251
2009	256 340	154 517	256 340
2010	244 786	129 324	244 786
2011	273 313	0	273 313
2012	166 263	0	166 263
2013	185 156	0	185 156
2014	174 500	0	174 500
1990–2014	**-71%**	**-100%**	**-93%**

In 1990 the Austrian Waste Management Law[117] 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

[117] Waste Management Act of 2002 , Federal Law Gazette I No 102/2002 as amended by Federal Law Gazette I No 9/2011

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.[118] 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 waste[119] is allowed to be deposited any more.

Figure 27: Deposited waste (residual and non-residual waste) 1990–2014.

The quantities of "residual waste" have been taken from the following sources:

- Data for 2008–2014 have been taken from the EDM[120], 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**[122].
- 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

[118] Regulated in § 76.Abs. 7 AWG 2002

[119] as defined at the beginning of this sub-chapter

[120] Electronic Data Management

[121] According to § 41 (1) Landfill Ordinance, Federal Law Gazette BGBl. Nr 39/2008

[122] According to §41 (1) Landfill Ordinance, Federal Law Gazette BGBl. Nr 39/2008

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 years[123] (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 EDM[124] (Electronic Data Management). Only the amounts of waste with biodegradable lots were considered. Table 223 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.

Table 223: Considered types of waste (list of waste[125]).

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

[123] Data available from the Federal Waste Management Plan (Bundesabfallwirtschaftsplan - BAWP) as well as from the Austrian landfill database.

[124] 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

[125] 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.

Waste Identification No	Type of Waste	Waste Identification No	Type of Waste
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 224 summarises the parameters used and the corresponding references.

Table 224: Parameters for calculating landfill gas from SWDS.

Waste category/ Parameters	residual waste	wood	paper	sludges	Sorting residues/ output MBT[126]/ 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
	IPCC default taking into account national waste expertise (UMWELTBUNDESAMT 2005b)								
DOC (kt C/kt waste)	see Table 226	0.45	0.3	0.11	0.16	0.16	0.5	0.09	0.2
	(HACKL & MAUSCHITZ 1999) (UMWELTBUNDESAMT 2003c) (BAWP 2006a)					(BAUMELER 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 CH_4 in Landfill Gas (F)	0.55 Mean value cited in the literature, also within the IPCC range.								
Methane Oxidation in the upper layer (OX)	10% IPCC default								
Landfill gas recovery (R)	see Figure 30 (UMWELTBUNDESAMT 2004c, 2008a, 2014b)								
Process start (M)	13 Delay time of 6 months, with an average residence time of 6 months (IPCC default)								

[126] MBT: **M**echanical-**b**iological **t**reatment

DOC

The DOCs of the different waste categories under **'non-residual waste'** are constant for the entire time series and are shown in Table 224. 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.

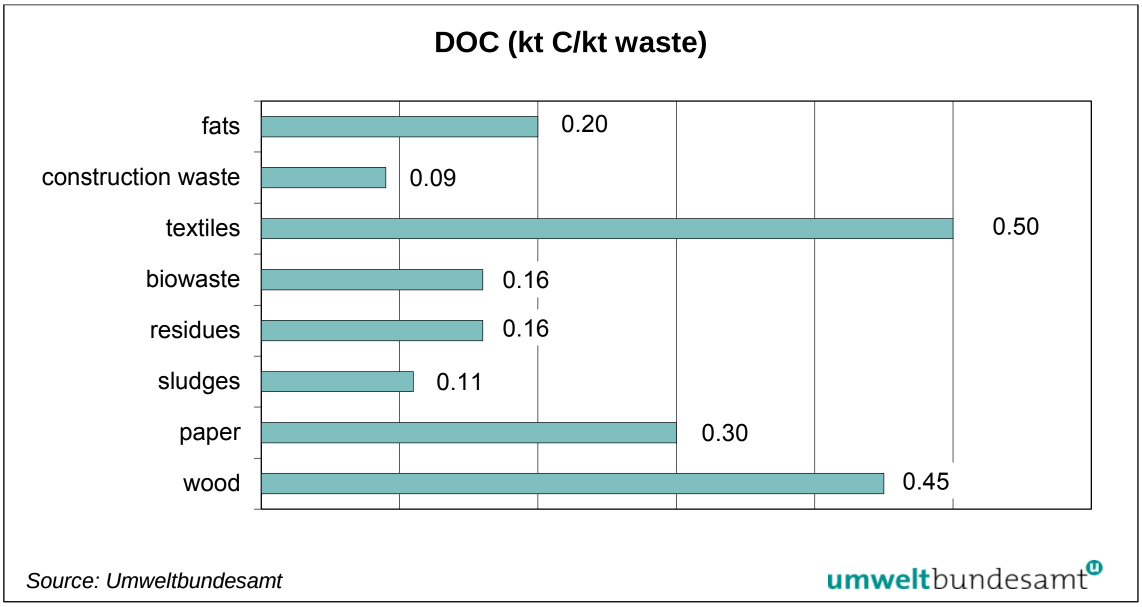

Figure 28: DOC of non-residual waste fractions.

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.

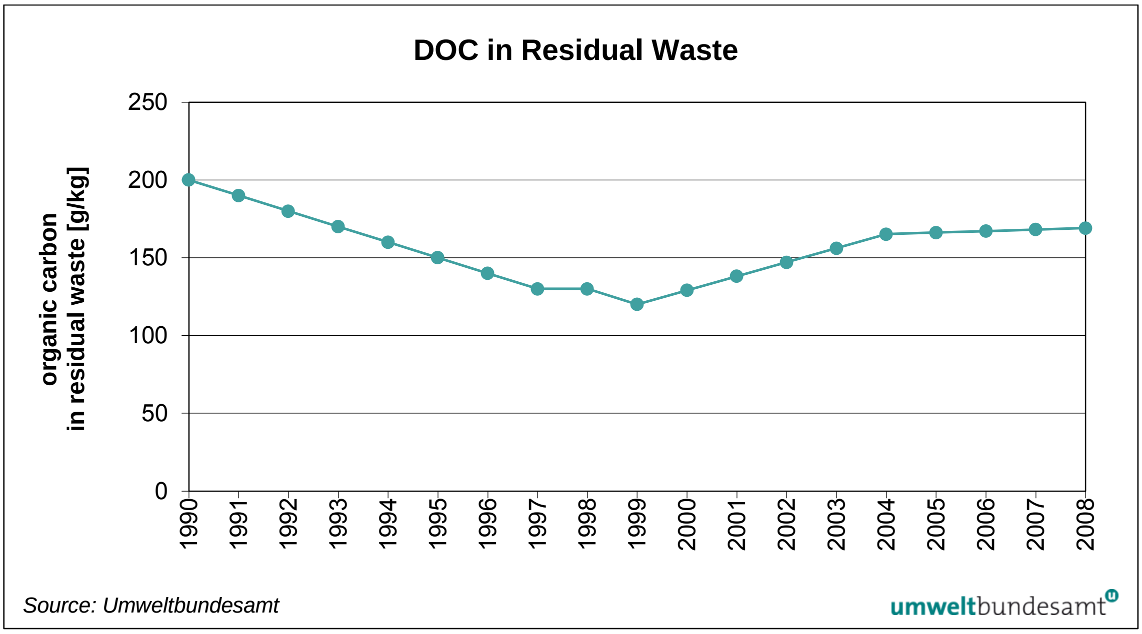

Figure 29: Development of DOC in residual waste.

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 225 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 226). For the years before 1990, quantities according to a national study (HACKL & MAUSCHITZ 1999) were used.

Table 225: Composition of residual wast.

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 226: Time series of bio-degradable organic carbon content of residual waste (mixed MSW, directly deposited)

Year	kt C/kt Residual Waste	Year	kt C/kt Residual Waste
1950–1959	0.24 1)	1998	0.13 2)
1960–1969	0.23 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)	2009–2014	n.r.**)

1) (HACKL & MAUSCHITZ 1999)

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*

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 gas[127] – 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 67% by 2014.

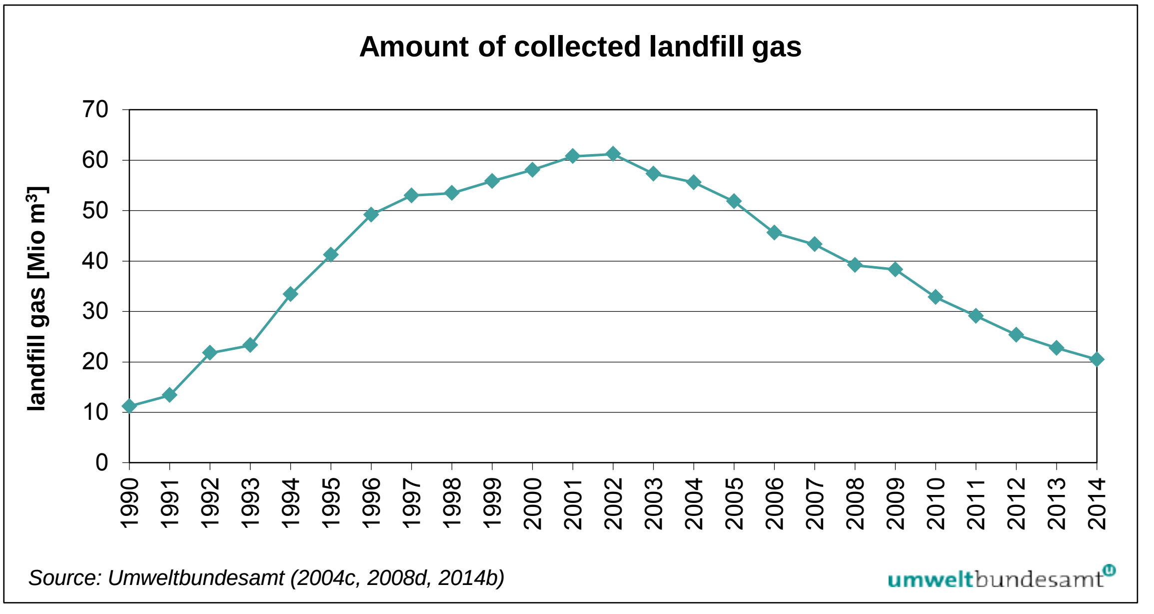

Figure 30: Amount of collected landfill gas 1990 to 2014

Emission Factors

NMVOC, CO, NH_3 and heavy metal emissions are calculated according to their content in the emitted landfill gas (after consideration of gas recovery). [128]

Table 227: Emission factors for CO, NMVOC, NH_3 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

Recalculations

The Austrian FOD model has been newly set up in accordance with the simplified approach of the IPCC 2006 GL. In the course of this, the number of considered years for the annual calculation has been extended to 65 for OLI 2015 (i.e. unlimited consideration) slightly affecting the amount of landfill gas generated. In previous submissions this was limited to 5 half lives (41 years at least[129]) for some waste fractions.

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[127] a methane concentration of 55 % (default) is used for the estimation of the landfill gas **produced** ('F') over the whole time-series.

[128] according to UMWELTBUNDESAMT (2001b)

[129] to be in accordance with the base year calculation, in the calculation for the base year 1990, waste deposited since 1950 has been considered.

Furthermore, delay time and average residence time have been considered in the calculation for the first time. In the previous submission, no delay time and no average residence time was considered, i.e. reaction start was originally set in the 1st month after deposition (M=1). This was changed to 6 months time delay (M=13) for this years' submission, leading to a slight shift of emissions.

6.3.2 PM emissions

PM emissions reported here are from waste handling at landfill sites.

Methodological Issues

PM emissions are calculated by multiplying the waste amounts with the respective emission factors for TSP, PM_{10} and $PM_{2,5}$. For the calculation 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.

Activity Data and Emission Factors

Activity data have been taken from a database for landfill disposal and – since 2008 – the EDM[130]. 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].

Table 228: Activity data for PM.

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	578 913	10 156 901	471

[130] Electronic Data Management

Year	residues from iron and steel production (slags, dusts)	clinker, dust and ashes	mineral waste	construction waste
	[t]	[t]	[t]	[t]
2011	69 075	596 097	11 805 373	628
2012	71 987	558 869	14 728 289	229
2013	167 390	765 275	14 775 275	619
2014	213 676	962 200	19 011 447	486
1998–2014	**224%**	**217%**	**378%**	**-99%**

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 229: 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

6.4 NFR 5.B Composting

Source Category Description

In this category NH_3 emissions from mechanical-biological treatment and composting of waste is addressed. NH_3 emissions arising from this subcategory increased over the time period as a result of the increasing amount of biologically treated waste.

Methodological Issues

Emissions were estimated using a simple methodology based on EMEP/EEA 2013. Two different fractions were considered:

- waste from households and similar sources covered by the municipal waste collecting system, undergoing a mechanical-biological treatment. To a smaller extent also waste from industrial sources (e.g. residues from processing of recovered paper) are included (UMWELTBUNDESAMT 2008b).
- biogenic waste composted, which in turn comprises green/bio waste collected and treated in composting plants[131] (centralised composting) and bio waste composted at the place it is generated (home composting).

[131] A certain part of this waste undergoes an anaerobic treatment (digestion), but currently all bio waste generated is assumed to be treated aerobically (composted).

NH_3 emissions were calculated by multiplying an emission factor with the quantity of waste.

$$NH_3\ Emissions = M_i * EF_i$$

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 230.

In most recent years the 'Electronic Data Management' (EDM) is the primary data basis[132], providing data for the 'Federal Waste Management Plan' 'BAWP' (BMLFUW 2006a, BMLFUW 2011), 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).

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.

[132] In subcategory *5.A Solid Waste Disposal* waste amounts have been taken from EDM reports already since 2008.

Table 230: Activity data for NFR Category 5.B Composting.

	Total waste	Mechanical-Biological Treatment (MBT)		Composting			
				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)	370	AMLINGER 2003
1991	**798**	345		78		375	
1992	**942**	345		137		460	
1993	**1 161**	345		306		510	
1994	**1 373**	345		444		585	
1995	**1 446**	295	ANGERER 1997	551		600	
1996	**1 515**	281	interpolated	617		616	
1997	**1 488**	244	UMWELT-BUNDESAMT 1998b	582		663	
1998	**1 541**	240	UMWELT-BUNDESAMT 2000c	604		696	
1999	**1 621**	266	UMWELT-BUNDESAMT 2001e	623		732	
2000	**1 721**	254	Interpolated	695	interpolated	772	AMLINGER et al 2005
2001	**1 953**	242		767		944	interpolated
2002	**2 186**	230		834		1 117	
2003	**2 418**	218	UMWELT-BUNDESAMT 2008d	871		1 290	
2004	**2 932**	488		899		1 462	calculated based on BMLFUW 2008
2005	**3 150**	623		903		1 472	
2006	**3 266**	660		874		1 480	
2007	**3 367**	684		884		1 485	BMLFUW 2008
2008	**3 387**	619	interpolated	919		1 498	BMLFUW 2011
2009	**3 401**	555	EDM	977		1 505	
2010	**3 452**	551		1 035		1 488	calculated on basis of BMLFUW 2011
2011	**3 495**	519		1 118	EDM + EJ (2015)	1 491	
2012	**3 573**	453		1 239		1 496	
2013	**3 416**	379		1 168		1 502	
2014	**3 538**	413		1 215		1 511	

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 231: 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)

6.4.1 Recalculations

NH_3 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 Management[133] 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 applied for the Federal Waste Management Plan (BMLFUW 2011).

6.5 NFR 5.C Incineration and open burning of waste

Source Description

In this category emissions are included from

- incineration of corpses,
- hospital waste,
- waste oil,
- incineration of domestic or municipal solid waste without energy recovery.

Additionally heavy metal and POPs emissions of a single plant without emission control 1990 to 1991 are included here. From 1992 the plant was equiped 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.

In Austria waste oil is incinerated in especially designed so called "USK-facilities" (**U**mwelt**s**chutz**k**omponenten). 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.

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[133] 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.

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.

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 t/year. Activity data for the years 2006–2009 has been interpolated.

Table 232: Activity data for IPCC Category 5.C Waste Incineration.

Year	Municipal Waste [t]	Clinical Waste [t]	Waste Oil [t]
1990	22 000	9 000	2 200
1991	22 000	7 525	1 500
1992	0	6 050	1 800
1993	0	4 575	2 100
1994	0	3 100	2 500

Year	Municipal Waste [t]	Clinical Waste [t]	Waste Oil [t]
1995	0	3 100	2 600
1996	0	3 100	2 700
1997	0	3 100	2 800
1998	0	3 100	2 900
1999–2005	0	3 100	3 000
2006	0	2 500	2 500
2007	0	2 000	2 000
2008	0	1 500	1 500
2009	0	1 000	1 000
2010	0	500	500
2011	0	500	500
2012	0	500	500
2013	0	500	500
2014	0	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). Table 233 shows emission factors of the air pollutants.

Table 233: NFR 5.C Waste Incineration: emission factors by type of waste.

Type of waste	NO_x	CO	NMVOC	SO_2	NH_3
	[kg/kt]				
Waste oil	8 060.0	604.5	403.0	18 135.0	110.0
Municipal waste	870.0	1 740.0	330.6	1 131.0	0.2
Clinical waste	7 000.0	840.0	330.0	700.0	0.2

Municipal waste	Cd	Hg	Pb	PAH	DIOX	HCB
	[kg/kt]					
1985	2 580.0	1 800.0	30 000.0	0.7	250.0	850.0
1986	2 078.2	1 499.8	24 234.0	0.7	250.0	850.0
1987	1 576.4	1 199.6	18 468.0	0.7	250.0	850.0
1988	1 074.6	899.4	12 702.0	0.7	250.0	850.0
1989	572.8	599.2	6 936.0	0.7	250.0	850.0
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
	[kg/kt]					
1985	720.0	100.0	8 300.0	1.6	160.0	970.0
1986	678.0	102.4	7 120.0	1.6	160.0	970.0
1987	636.0	104.8	5 940.0	1.6	160.0	970.0
1988	594.0	107.2	4 760.0	1.6	160.0	970.0
1989	552.0	109.6	3 580.0	1.6	160.0	970.0
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
	[kg/kt]					
1985	6.0	3.0	280.0	1.6	1.5	300.0
1986	51.8	13.4	370.0	1.6	1.5	300.0
1987	97.6	23.8	460.0	1.6	1.5	300.0
1988	143.4	34.2	550.0	1.6	1.5	300.0
1989	189.2	44.6	640.0	1.6	1.5	300.0
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
	[kg/kt]					
1985–1990	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
2010–2014	0.10	0.12	1.25	0.00	0.00	0.03

Waste oil	Cd	Hg	Pb	PAH	DIOX	HCB
			[kg/kt]			
1985	1 800.0	150.0	200 000.0	6.7	37.0	37 000.0
1986	1 512.0	126.0	181 260.0		37.0	37 000.0
1987	1 224.0	102.0	162 520.0		37.0	37 000.0
1988	936.0	78.0	143 780.0		35.6	35 591.2
1989	648.0	54.0	125 040.0		31.9	31 947.6
1990	360.0	30.0	106 300.0		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			
1995–2014	13.0		60.0			

Table 234: NFR 5.C Waste Incineration of corps: emission factors.

Hg	Pb	PAH	Dioxin	HCB
[kg/kt]		[kg/kt]	[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)
2 500(6)				
1 000(7)				

(1) for 1985–2008
(2) for 1980–1992
(3) for 1993–2008
(4) for 1985–1990
(5) for 1991
(6) for 1992–1995
(7) for 2000–2014

6.5.1 Recalculations

No recalculations have been made in this years' submission.

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 2013 submitted this year might differ from data reported previously.

The last stage 3 in-depth review took place in 2010; findings were commented in the IIR 2011 (UMWELTBUNDESAMT 2011b). The last stage 1 and 2 review took place in 2015. The next stage 3 in-depth review for Austria will be in 2017.

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

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 section describes the methodological changes made to the inventory since the previous submission (for each sector).

ENERGY (1)

Revision of the energy balance

The energy balance was revised for the years 2005 to 2013.

The most important revisions were made for natural gas consumption from 2009 onwards, which was revised upwards by 7.6 PJ in 2009 and by 2 PJ in the year 2013. Natural gas consumption was shifted from households to the commercial sector from the year 2005 onwards. In the year 2013 the revision shows a 8 PJ higher consumption for the commercial sector (1.A.4.a.i) and a 2 PJ lower consumption for households (1.A.4.b.i).

The most important reason of the shift was a revision of the household census data evaluation which also induces a shift of gasoil (2005: 8 PJ. 2013: 7 PJ) from households to the commercial sector. Solid biomass consumption of households was revised downwards for 2005 to 2012 with the highest decrease in 2012 (-7 PJ) while 2013 biomass consumption was revised upwards by 0.4 PJ.

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

Consideration of emission declarations of public waste incineration plants since the year 1998 shows lower emissions for NO_x (2013: -0.2 kt), SO_2 (2013: -0.7 kt). The revision of the NMVOC emission factor for municipal and industrial waste leads to -0.5 kt lower emissions in 2013.

Manufacturing Industries and Construction (1.A.2)

The changes in this subsector mainly resulted from the revisions of the energy balance. Elimination of coal consumption double counting of iron and steel industries (1.A.2.a) shows 0.2 kt lower NO_x and 0.5 kt lower SO_2 emissions in the year 2013.

Housholds and Institutional/Commercial sector (1.A.4.a.i, 1.A.4.b.i)

Revisions are following the the revisions of the energy balance and the improved evaluation of housholds census data which shows a shift single oven fuel consumption to central heatings. For the year 2013,NO_x emissions of the commercial sector (1.A.4.a.i) were revised by +0.4 kt and those of the housholds sector were revised by -0.2 kt. NMVOC emissions of housholds were revised by +0.8 kt in the year 2013.

Civil Aviation (1.A.3.a)

Revisions of the amount of aviation gasoline for the years 2012 and 2013 according to the national energy balance resulted in minor adjustments of the total sectorial domestic fuel consumption data (-1.7% in 2013).

Road transport (1.A.3.b)

By using the latest version of NEMO (3.7.4 Version Nov. 2015) minor changes of all emission components occur. In the energy balance, LPG fuel amounts were slightly revised for 2013. There was a strong upward revision for CNG fuel amounts from 2009 onwards. The most important changes in emissions for 2013 are: +0.1 kt NO_x, +0.07 t NMVOC.

PAH emission factors in the model NEMO (HAUSBERGER/SCHWINGSHACKL/REXEIS, M. 2015c) were updated according to the EMEP/EEA 2013 Guidebook (EEA 2013), which lead to a reduction of PAH emissions over the whole time series. In 2013 PAH emissions have been revised by -1.3 kt.

Rail transport (1.A.3.c)

The revision of emissions follows the changes in the off-road model by reorganizing the fleet composition in the course of the integration of the future emission class "Stage V". In addition, the year 2013 was revised in accordance with current statistical traffic performance data.

The most important changes in emissions for 2013 are: -0.2 kt NO_x, -0.1 kt NMVOC, -0.3 kt CO, +0.04 kt PM.

Navigation (1.A.3.d)

The revision of emissions follows the changes in the off-road model by reorganizing the fleet composition in the course of the integration of the future emission class "Stage V". In addition, the year 2013 was revised in accordance with current statistical traffic performance data for the Danube. The most important changes in emissions for 2013 are: +0.1 kt NMVOC, -0.2 kt CO, -0.05 kt PM.

Off-road – mobile sources (1.A.2.f, 1.A.4.a, b, c)

Emissions of mobile off-road sources were changed for forestry only. Due to changes in the implementation periods for chainsaws and other mobile equipment, emissions were revised downwards for the whole time series. The most important changes in emissions for 2013 are: -1.1 kt NMVOC, -8.1 kt CO.

Fugitive Emissions (1.B)

Revision of the energy balance

Recalculations for the storage of solid fuels in TSP, PM2.5 and PM10 are due to revisions in the Energy Balance.

Reallocation of emission source

Reporting of oil and natural gas exploration, production and transport is now under 1.B.2.b (previously reported under 1.B.2.a.i) due to the fact, that emissions from these activities are dominated of those from natural gas exploration, production and transport.

INDUSTRIAL PROCESSES AND PRODUCT USE (2)

Mining, Construction/Demolition (2.A.5)

Activity data of NFR subsector *Quarrying and mining of minerals other than coal* for the year 2013 were updated. Furthermore, the building-cost index was changed. Therefore recalculations of PM emissions from 2002 onwards have been carried out.

Iron and Steel Production (2.C.1)

Recalculations have been carried out for all relevant gases as the input of coke oven gas was updated in the IEA questionnaire for the years from 2005 onwards.

Solvent Use (2.D.3)

The calculation model of sector 2.D.3. was updated, and non-solvent uses, like that of methanol (which is used for the production of Biodiesel), excluded. Wherever possible, emissions were based on data obtained via reports for the VOC Solvent Emissions Directive, and extrapolated using other data (number of employees in that sector, etc.).

Pulp and Paper Industry (2.H.1)

Activity data of chipboard production were updated for the years 2008-2013. Total technical production in cubic meters (m^3), taken from the Austrian trade statistics, was used consistently for these years. This resulted in increased NMVOC emissions (+ 131 t) for the year 2013.

Wood processing (2.I)

PM emissions from 2005 onwards have been recalculated due to changes in the energy balances.

AGRICULTURE (3)

Methodological changes

Manure Management (3.B)

The conversion of NO to NO_x resulted in higher emissions (+135 t for 2013).

Agricultural Soils (3.D)

The Austrian agricultural inventory model follows the N-flow concept. Revised N_2O EFs for poultry in sector manure management resulted in slightly increased NH_3 and NO_x emissions from *3.D.a.2.a Animal manure applied to soils.*

Field burning of agricultural residues (3.F)

The updated EMEP/EEA Tier 1 default approach (EEA 2013) referring to the IPCC default methodology (IPCC 2006) resulted in slightly higher NO_x emissions (+0.5 t in 2013) and higher CO emissions (+52 t in 2013).

Update of activity data

Manure Management (3.B), Agricultural Soils (3.D) and Agriculture – Other (3.I)

For the year 2013 updated livestock data for the animal categories horses, poultry (chicken and other poultry), and deer became available. Livestock numbers of the years 2011 and 2012 for the respective animal categories were interpolated, resulting in higher NH_3 and NO_x emissions from *3.B Manure Management* and *3.D Agricultural Soils.*

Cultivated Crops (3.D.e)

NMVOC emissions for the whole time series were recalculated due to harmonization of land use data (cropland, grassland) with sector LULUCF. The revision results in slightly higher NMVOC emissions from *3.D.e Cultivated Crops.*

Particle emissions from agricultural soils (3.D.a.1)

Recalculations have been carried out due to harmonization of the cropland area with the sector LULUCF leading to slightly revised emissions of PM emissions in several years from 1991 to 2012.

Field burning of agricultural residues (3.F)

Revisions in viniculture area and cereal harvest data resulted in slightly revised emissions of all relevant gases 1990-2013.

WASTE (5)

Solid Waste disposal (5.A)

In 2015 the practical implementation of the First Order Decay Model was redesigned in accordance with the IPCC 2006 Guidelines affecting the amount of landfill gas generated and CH_4 emitted. In this context delay time and average residence time were considered in the calculation for the first time. Therefore, recalculations have been carried out for all relevant gases and the whole time series.

Compost Production (5.B)

NH_3 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 by Umweltbundesamt in 2015, showing significant lower amounts of green waste compared to estimates for the years before. Therefore, waste amounts treated in composting plants had to be revised, in particular the assumptions made on biologically treated waste not covered by the Electronic Data Management on activity data 2011-2013.

7.3 Recalculations per Pollutant

The following tables present the changes in emissions[134] for all relevant pollutants compared to the previous submission (IIR 2015). Detailed explanations are provided in the sectoral chapters.

Table 235: Recalculation difference of SO_2 emissions [kt] with respect to submission 2015.

		1990			2013			Absolute Diff.	
SO_2 emissions [kt]		**Δ%**	**Subm. 2015**	**Subm. 2016**	**Δ%**	**Subm. 2015**	**Subm. 2016**	**1990**	**2013**
1.A.1	Energy Industries	=	14.04	14.04	*-26.5%*	2.40	1.76	-	-0.63
1.A.2	Manufacturing Industries & Construction	*<0.1%*	17.97	17.97	*-4.5%*	11.34	10.83	<0.01	-0.51
1.A.3	Transport	*<0.1%*	5.19	5.19	*-0.9%*	0.30	0.30	<0.01	<0.01
1.A.4	Other Sectors	*<0.1%*	32.94	32.94	*-11.3%*	1.92	1.71	<0.01	-0.22
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	=	1.22	1.22	-	-
3	Agriculture	*-0.2%*	<0.01	<0.01	*0.2%*	<0.01	<0.01	<0.01	<0.01
5	Waste	=	0.07	0.07	=	0.01	0.01	-	-
	Total Emissions	***<0.1%***	**74.45**	**74.45**	***-7.9%***	**17.25**	**15.88**	**<0.01**	**-1.37**

Table 236: Recalculation difference of NO_x emissions [kt] with respect to submission 2015.

		1990			2013			Absolute Diff.	
NO_x emissions [kt]		**Δ%**	**Subm. 2015**	**Subm. 2016**	**Δ%**	**Subm. 2015**	**Subm. 2016**	**1990**	**2013**
1.A.1	Energy Industries	=	17.74	17.74	*-2.1%*	13.07	12.79	-	-0.28
1.A.2	Manufacturing Industries & Construction	*<0.1%*	32.97	32.98	*-0.7%*	31.41	31.21	0.01	-0.21
1.A.3	Transport	*<0.1%*	125.49	125.49	*-0.3%*	90.46	90.15	<0.01	-0.31
1.A.4	Other Sectors	=	27.73	27.73	*1.3%*	20.16	20.42	-	0.26
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	*14.1%*	1.27	1.45	-	0.18
3	Agriculture	*2.8%*	6.57	6.75	*2.6%*	5.85	6.00	0.18	0.15
5	Waste	=	0.10	0.10	=	0.01	0.01	-	-
	Total Emissions	***0.1%***	**215.47**	**215.66**	***-0.1%***	**162.32**	**162.11**	**0.19**	**-0.21**

[134] 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 237: Recalculation difference of NMVOC emissions [kt] with respect to submission 2015.

		1990			2013			Absolute Diff.	
NMVOC emissions [kt]		**Δ%**	**Subm. 2015**	**Subm. 2016**	**Δ%**	**Subm. 2015**	**Subm. 2016**	**1990**	**2013**
1.A.1	Energy Industries	*-21.5%*	0.42	0.33	*-54.2%*	0.85	0.39	-0.09	-0.46
1.A.2	Manufacturing Industries & Construction	*-4.1%*	1.76	1.69	*-10.9%*	2.04	1.81	-0.07	-0.22
1.A.3	Transport	*0.1%*	74.64	74.72	*1.2%*	8.85	8.95	0.08	0.10
1.A.4	Other Sectors	*-0.5%*	61.27	60.94	*-0.7%*	31.72	31.49	-0.33	-0.23
1.A.5	Other	=	0.01	0.01	=	0.02	0.02	-	-
1.B	Fugitive Emissions	=	15.49	15.49	=	2.30	2.30	-	-
2	Industrial Processes and Product Use	=	125.53	125.53	*-12.7%*	78.86	68.85	-	-10.01
3	Agriculture	*4.0%*	1.74	1.81	*<0.1%*	1.66	1.66	0.07	-
5	Waste	*-1.5%*	0.16	0.16	*12.0%*	0.05	0.06	<0.01	0.01
	Total Emissions	***-0.1%***	**281.02**	**280.68**	***-8.6%***	**126.34**	**115.53**	**-0.34**	**-10.82**

Table 238: Recalculation difference of NH_3 emissions [kt] with respect to submission 2015.

		1990			2013			Absolute Diff.	
NH_3 emissions [kt]		**Δ%**	**Subm. 2015**	**Subm. 2016**	**Δ%**	**Subm. 2015**	**Subm. 2016**	**1990**	**2013**
1.A.1	Energy Industries	=	0.19	0.19	*-0.6%*	0.40	0.40	-	<0.01
1.A.2	Manufacturing Industries & Construction	*0.1%*	0.33	0.33	*0.1%*	0.42	0.42	<0.01	<0.01
1.A.3	Transport	*<0.1%*	1.13	1.13	*0.3%*	1.42	1.43	<0.01	<0.01
1.A.4	Other Sectors	*<0.1%*	0.63	0.63	*1.3%*	0.63	0.64	<0.01	0.01
1.A.5	Other	=	<0.01	<0.01	=	<0.01	<0.01	-	-
1.B	Fugitive Emissions	=	IE	IE	=	IE	IE	-	-
2	Industrial Processes and Product Use	=	0.27	0.27	=	0.10	0.10	-	-
3	Agriculture	*<0.1%*	63.55	63.58	*0.7%*	61.99	62.39	0.03	0.41
5	Waste	*<0.1%*	0.36	0.36	*-9.9%*	1.29	1.16	<0.01	-0.13
	Total Emissions	***<0.1%***	**66.47**	**66.50**	***0.4%***	**66.25**	**66.54**	**0.03**	**0.29**

Table 239: Recalculation difference of CO emissions [kt] with respect to submission 2015.

		1990			2013			Absolute Diff.	
CO emissions [kt]		**Δ%**	**Subm. 2015**	**Subm. 2016**	**Δ%**	**Subm. 2015**	**Subm. 2016**	**1990**	**2013**
1.A.1	Energy Industries	=	6.07	6.07	*-18.9%*	5.65	4.59	-	-1.07
1.A.2	Manufacturing Industries & Construction	*<0.1%*	231.58	231.58	*<0.1%*	155.55	155.56	<0.01	0.01
1.A.3	Transport	*<0.1%*	508.87	508.90	*-0.9%*	95.21	94.34	0.03	-0.88
1.A.4	Other Sectors	*-0.3%*	482.08	480.87	*0.3%*	297.77	298.74	-1.21	0.96
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	*0.5%*	23.82	23.95	-	0.13
3	Agriculture	*28.7%*	0.99	1.28	*15.7%*	0.33	0.38	0.29	0.05
5	Waste	*-1.7%*	11.16	10.98	*12.2%*	3.78	4.24	-0.18	0.46
	Total Emissions	***-0.1%***	**1,287.3**	**1,286.3**	***-0.1%***	**582.40**	**582.07**	**-1.08**	**-0.32**

Table 240: Recalculation difference of Cd emissions [t] with respect to submission 2015.

		1990			2013			Absolute Diff.	
Cd emissions [t]		**Δ%**	**Subm. 2015**	**Subm. 2016**	**Δ%**	**Subm. 2015**	**Subm. 2016**	**1990**	**2013**
1.A.1	Energy Industries	=	0.19	0.19	*-4.4%*	0.32	0.30	-	-0.01
1.A.2	Manufacturing Industries & Construction	=	0.32	0.32	*0.4%*	0.23	0.23	-	<0.01
1.A.3	Transport	*<0.1%*	0.06	0.06	*<0.1%*	0.10	0.10	<0.01	<0.01
1.A.4	Other Sectors	*<0.1%*	0.42	0.42	*-0.8%*	0.32	0.32	<0.01	<0.01
1.A.5	Other	=	<0.01	<0.01	=	<0.01	<0.01	-	-
1.B	Fugitive Emissions	=	NA	NA	=	NA	NA	-	-
2	Industrial Processes and Product Use	=	0.53	0.53	=	0.25	0.25	-	-
3	Agriculture	*-0.3%*	<0.01	<0.01	*0.4%*	<0.01	<0.01	<0.01	<0.01
5	Waste	*<0.1%*	0.06	0.06	*10.1%*	<0.01	<0.01	<0.01	<0.01
	Total Emissions	***<0.1%***	**1.58**	**1.58**	***-1.3%***	**1.23**	**1.21**	**<0.01**	**-0.02**

Table 241: Recalculation difference of Hg emissions [t] with respect to submission 2015.

		1990			2013			Absolute Diff.	
Hg emissions [t]		**Δ%**	**Subm. 2015**	**Subm. 2016**	**Δ%**	**Subm. 2015**	**Subm. 2016**	**1990**	**2013**
1.A.1	Energy Industries	=	0.33	0.33	*-1.7%*	0.19	0.19	-	<0.01
1.A.2	Manufacturing Industries & Construction	=	0.80	0.80	*0.1%*	0.29	0.29	-	<0.01
1.A.3	Transport	*<0.1%*	<0.01	<0.01	*<0.1%*	<0.01	<0.01	<0.01	<0.01
1.A.4	Other Sectors	*<0.1%*	0.43	0.43	*-1.9%*	0.18	0.18	<0.01	<0.01
1.A.5	Other	=	<0.01	<0.01	=	<0.01	<0.01	-	-
1.B	Fugitive Emissions	=	NA	NA	=	NA	NA	-	-
2	Industrial Processes and Product Use	=	0.53	0.53	=	0.34	0.34	-	-
3	Agriculture	*0.5%*	<0.01	<0.01	*-0.3%*	<0.01	<0.01	<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**	***-0.6%***	**1.02**	**1.02**	**<0.01**	**-0.01**

Table 242: Recalculation difference of Pb emissions [t] with respect to submission 2015.

		1990			2013			Absolute Diff.	
Pb emissions [t]		**Δ%**	**Subm. 2015**	**Subm. 2016**	**Δ%**	**Subm. 2015**	**Subm. 2016**	**1990**	**2013**
1.A.1	Energy Industries	=	1.08	1.08	*-3.5%*	2.40	2.32	-	-0.08
1.A.2	Manufacturing Industries & Construction	=	6.14	6.14	*0.6%*	2.94	2.96	-	0.02
1.A.3	Transport	*<0.1%*	163.68	163.70	*<0.1%*	0.01	0.01	0.01	<0.01
1.A.4	Other Sectors	*-0.2%*	7.49	7.48	*-1.8%*	2.26	2.22	-0.01	-0.04
1.A.5	Other	=	<0.01	<0.01	=	<0.01	<0.01	-	-
1.B	Fugitive Emissions	=	NA	NA	=	NA	NA	-	-
2	Industrial Processes and Product Use	=	35.65	35.65	=	8.27	8.27	-	-
3	Agriculture	*-0.2%*	0.01	0.01	*0.1%*	0.01	0.01	<0.01	<0.01
5	Waste	*<0.1%*	1.02	1.02	*3.4%*	<0.01	<0.01	<0.01	<0.01
	Total Emissions	***<0.1%***	**215.08**	**215.07**	***-0.7%***	**15.90**	**15.79**	**<0.01**	**-0.10**

Table 243: Recalculation difference of PAH emissions [t] with respect to submission 2015.

		1990			2013			Absolute Diff.	
PAH emissions [t]		**Δ%**	**Subm. 2015**	**Subm. 2016**	**Δ%**	**Subm. 2015**	**Subm. 2016**	**1990**	**2013**
1.A.1	Energy Industries	=	<0.01	<0.01	*-4.4%*	0.02	0.02	-	<0.01
1.A.2	Manufacturing Industries & Construction	*<0.1%*	0.07	0.07	*0.5%*	0.25	0.25	<0.01	<0.01
1.A.3	Transport	*-69.1%*	0.93	0.29	*-79.0%*	1.67	0.35	-0.64	-1.32
1.A.4	Other Sectors	*<0.1%*	8.53	8.53	*0.3%*	5.25	5.26	<0.01	0.02
1.A.5	Other	*<0.1%*	<0.01	<0.01	*<0.1%*	<0.01	<0.01	-	-
1.B	Fugitive Emissions	=	NA	NA	=	NA	NA	-	-
2	Industrial Processes and Product Use	=	7.13	7.13	=	0.24	0.24	-	-
3	Agriculture	=	0.25	0.25	=	0.08	0.08	-	-
5	Waste	=	<0.01	<0.01	=	<0.01	<0.01	-	-
	Total Emissions	***-3.8%***	**16.91**	**16.27**	***-17.4%***	**7.52**	**6.21**	**-0.64**	**-1.31**

Table 244: Recalculation difference of Dioxin/Furan (PCDD/F) emissions [g] with respect to submission 2015.

		1990			2013			Absolute Diff.	
Dioxin/Furan emissions [g]		**Δ%**	**Subm. 2015**	**Subm. 2016**	**Δ%**	**Subm. 2015**	**Subm. 2016**	**1990**	**2013**
1.A.1	Energy Industries	=	0.82	0.82	*-4.3%*	1.49	1.43	-	-0.06
1.A.2	Manufacturing Industries & Construction	*<0.1%*	49.62	49.62	*0.9%*	4.77	4.81	<0.01	0.04
1.A.3	Transport	*<0.1%*	3.88	3.88	*0.4%*	1.85	1.86	<0.01	0.01
1.A.4	Other Sectors	*<0.1%*	45.46	45.46	*-0.1%*	24.55	24.52	<0.01	-0.03
1.A.5	Other	*<0.1%*	<0.01	<0.01	*<0.1%*	<0.01	<0.01	-	-
1.B	Fugitive Emissions	=	NA	NA	=	NA	NA	-	-
2	Industrial Processes and Product Use	=	42.53	42.53	=	4.87	4.87	-	-
3	Agriculture	=	0.18	0.18	=	0.06	0.06	-	-
5	Waste	=	18.19	18.19	=	0.16	0.16	-	-
	Total Emissions	***<0.1%***	**160.69**	**160.69**	***-0.1%***	**37.76**	**37.72**	**<0.01**	**-0.04**

Table 245: Recalculation difference of HCB emissions [kg] with respect to submission 2015.

		1990			2013			Absolute Diff.	
HCB emissions [kg]		**Δ%**	**Subm. 2015**	**Subm. 2016**	**Δ%**	**Subm. 2015**	**Subm. 2016**	**1990**	**2013**
1.A.1	Energy Industries	=	0.21	0.21	*-18.8%*	0.57	0.47	-	-0.11
1.A.2	Manufacturing Industries & Construction	*<0.1%*	16.25	16.25	*12 528.2%*	0.82	103.21	<0.01	102.39
1.A.3	Transport	*<0.1%*	0.78	0.78	*0.4%*	0.37	0.37	<0.01	<0.01
1.A.4	Other Sectors	*<0.1%*	54.30	54.30	*2.0%*	34.62	35.32	<0.01	0.71
1.A.5	Other	*<0.1%*	<0.01	<0.01	=	<0.01	<0.01	-	-
1.B	Fugitive Emissions	=	NA	NA	=	NA	NA	-	-
2	Industrial Processes and Product Use	=	19.96	19.96	=	4.79	4.79	-	-
3	Agriculture	=	0.04	0.04	=	0.01	0.01	-	-
5	Waste	=	0.39	0.39	=	0.03	0.03	-	-
	Total Emissions	***<0.1%***	**91.93**	**91.93**	***249.9%***	**41.21**	**144.20**	**<0.01**	**102.99**

Table 246: Recalculation difference of TSP emissions [kt] with respect to submission 2015.

TSP emissions [kt]		1990 Δ%	1990 Subm. 2015	1990 Subm. 2016	2013 Δ%	2013 Subm. 2015	2013 Subm. 2016	Absolute Diff. 1990	Absolute Diff. 2013
1.A.1	Energy Industries	=	1.03	1.03	*-2.8%*	1.43	1.39	-	-0.04
1.A.2	Manufacturing Industries & Construction	*<0.1%*	2.90	2.90	*-0.9%*	4.97	4.92	<0.01	-0.04
1.A.3	Transport	*<0.1%*	12.26	12.26	*<0.1%*	13.29	13.29	<0.01	<0.01
1.A.4	Other Sectors	=	14.12	14.12	*-1.1%*	9.72	9.61	-	-0.11
1.A.5	Other	*<0.1%*	0.02	0.02	=	0.02	0.02	-	-
1.B	Fugitive Emissions	*32.0%*	0.65	0.85	*-0.9%*	0.45	0.45	0.21	<0.01
2	Industrial Processes and Product Use	=	18.94	18.94	*-0.1%*	15.58	15.56	-	-0.02
3	Agriculture	*<0.1%*	11.53	11.53	*0.2%*	10.90	10.92	<0.01	0.02
5	Waste	=	0.15	0.15	=	0.28	0.28	-	-
	Total Emissions	***0.3%***	**61.59**	**61.80**	***-0.3%***	**56.64**	**56.45**	**0.21**	**-0.20**

Table 247: Recalculation difference of PM_{10} emissions [kt] with respect to submission 2015.

PM_{10} emissions [kt]		1990 Δ%	1990 Subm. 2015	1990 Subm. 2016	2013 Δ%	2013 Subm. 2015	2013 Subm. 2016	Absolute Diff. 1990	Absolute Diff. 2013
1.A.1	Energy Industries	=	0.98	0.98	*-2.9%*	1.31	1.27	-	-0.04
1.A.2	Manufacturing Industries & Construction	*<0.1%*	2.50	2.50	*-1.1%*	3.69	3.65	<0.01	-0.04
1.A.3	Transport	*<0.1%*	7.32	7.32	*-0.2%*	6.07	6.06	<0.01	-0.01
1.A.4	Other Sectors	=	12.84	12.84	*-1.1%*	8.73	8.63	-	-0.10
1.A.5	Other	=	0.02	0.02	=	0.02	0.02	-	-
1.B	Fugitive Emissions	*32.2%*	0.30	0.40	*-0.9%*	0.22	0.21	0.10	<0.01
2	Industrial Processes and Product Use	=	10.86	10.86	*-0.1%*	7.86	7.85	-	-0.01
3	Agriculture	*<0.1%*	5.26	5.26	*0.2%*	4.94	4.95	<0.01	0.01
5	Waste	=	0.07	0.07	=	0.13	0.13	-	-
	Total Emissions	***0.2%***	**40.14**	**40.24**	***-0.6%***	**32.96**	**32.77**	**0.10**	**-0.19**

Table 248: Recalculation difference of $PM_{2.5}$ emissions [kt] with respect to submission 2015.

$PM_{2.5}$ emissions [kt]		1990 Δ%	1990 Subm. 2015	1990 Subm. 2016	2013 Δ%	2013 Subm. 2015	2013 Subm. 2016	Absolute Diff. 1990	Absolute Diff. 2013
1.A.1	Energy Industries	=	0.83	0.83	*-2.8%*	1.11	1.08	-	-0.03
1.A.2	Manufacturing Industries & Construction	*<0.1%*	2.07	2.07	*-1.2%*	2.67	2.63	<0.01	-0.03
1.A.3	Transport	*<0.1%*	5.59	5.59	*-0.4%*	3.55	3.53	<0.01	-0.01
1.A.4	Other Sectors	=	11.64	11.64	*-1.1%*	7.83	7.75	-	-0.09
1.A.5	Other	=	0.02	0.02	=	0.02	0.02	-	-
1.B	Fugitive Emissions	*14.5%*	0.09	0.11	*-0.9%*	0.07	0.07	0.01	<0.01
2	Industrial Processes and Product Use	=	3.65	3.65	*<0.1%*	1.80	1.80	-	<0.01
3	Agriculture	*-0.1%*	1.27	1.27	*0.1%*	1.15	1.15	<0.01	<0.01
5	Waste	=	0.02	0.02	=	0.04	0.04	-	-
	Total Emissions	***0.1%***	**25.18**	**25.20**	***-0.9%***	**18.23**	**18.06**	**0.01**	**-0.16**

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 (SO_2), nitrogen oxides (NO_x), ammonia (NH_3), $PM_{2.5}$ 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 scenarios "with existing measures" und "with additional measures" for the year 2015, 2020 and 2030 are published in the report "Austria's National Air Emission Projections 2013 for 2015, 2020 and 2030" (UMWELTBUNDESAMT 2015c). The report includes background information to enable a quantitative understanding of the key socio-economic assumptions used in the preparation of the projections. It updates previous projections for air pollutants published in 2014 (UMWELTBUNDESAMT 2014c).

The WEM scenario leads to significant reductions in emissions by 2030 for all pollutants but NH_3. The most substantial reduction with about 63% from 2005 until 2030 is projected for the pollutant NO_x. Emission reductions for the other pollutants are in the range from 36% to 46%; NH_3 emissions, however, increase by 11–12%.

The WAM scenario shows some percentage points more reduction for most of the pollutants and NH_3 emissions slightly higher than nowadays.

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10 ABBREVIATIONS

AMA .... Agrarmarkt Austria

AWMS.................. Animal Waste Management System

BAWP .... Bundes-Abfallwirtschaftsplan (Federal Waste Management Plan)

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)

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

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 Transboundary 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

CH_4 ....Methane
CO_2 ....Carbon Dioxide
N_2O ....Nitrous Oxide
HFCs ....Hydroflurocarbons
PFCs...................Perfluorocarbons
SF_6 ....Sulphur hexafluoride
NF_3.................Nitrogen Trifluoride

Further chemical compounds

CO ....Carbon Monoxide
Cd ....Cadmium
NH_3 ....Ammonia
Hg ....Mercury
NO_x ....Nitrogen Oxides (NO plus NO_2)
NO_2 ....Nitrogen Dioxide
NMVOC ....Non-Methane Volatile Organic Compounds
PAH ....Polycyclic Aromatic Hydrocarbons
Pb ....Lead
POP ....Persistent Organic Pollutants
SO_2 ....Sulfur Dioxide
SO_X.....................Sulfur 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}

11 ANNEX

1. NFR for 2014
2. Footnotes to NFR
3. Emission trends per sector – submission under UNECE/LRTAP
4. Austria's emissions for SO_2, NO_x, NMVOC and NH_3 according to the submission under NEC directive
5. Extracts from Austrian Legislation

11.1 Nomenclature for Reporting (NFR) – Format of Reporting under the UNECE/LRTAP Convention

11.1.1 NFR for 2014

(a) For example, fugitive emissions from the production of geothermal power could be reported here.

(b) Only NH_3 and NMVOC emissions from crops should be reported here.

(c) Excludes waste incineration for energy (this is included in 1.A.1) and in industry (if used as fuel).

(d) Includes accidental fires.

"(e) The 'National Total for Compliance' includes any aggregated combination of i) adjustments to national totals; ii) national totals based on transport fuel used; iii) territory declared upon ratification of the relevant Protocol of the Convention.

Member States of the European Union may also use this line for reporting national totals for compliance purposes under the National Emission Ceilings Directive (NECD) if these differ from the main National Total. MS should consult the definitions of geographical coverage in the NECD to determine what should be included within the NECD National Total."

AT: 05.02.2016: 2014	NFR sectors to be reported			Main Pollutants (from 1990)				Particulate Matter (from 2000)				Other (from 1990)	Priority Heavy Metals (from 1990)			Additional Heavy Metals (from 1990, voluntary reporting)					
				NOx (as NO_2)	NMVOC	SOx (as SO_2)	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
NFR Aggregation for Gridding and LPS (GNFR)	NFR Code	Longname	Notes	kt	kt	kt	kt	kt	kt	kt	kt	kt	t	t	t	t	t	t	t	t	t
A_PublicPower	1A1a	Public electricity and heat production		10.02	0.36	1.31	0.29	0.86	1.03	1.13	NR	3.81	1.82	0.13	0.15	NR	NR	NR	NR	NR	NR
B_Industry	1A1b	Petroleum refining		1.02	IE	0.52	0.08	0.05	0.06	0.06	NR	0.38	0.36	0.17	0.01	NR	NR	NR	NR	NR	NR
B_Industry	1A1c	Manufacture of solid fuels and other energy industries		0.67	0.00	NA	0.00	0.08	0.08	0.08	NR	0.04	NA	NA	NA	NR	NR	NR	NR	NR	NR
B_Industry	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel		3.71	0.18	5.34	0.02	0.01	0.01	0.01	NR	134.64	0.16	0.00	0.00	NR	NR	NR	NR	NR	NR
B_Industry	1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals		0.23	0.00	0.10	0.00	0.01	0.01	0.01	NR	0.05	0.48	0.01	0.01	NR	NR	NR	NR	NR	NR
B_Industry	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals		1.84	0.05	0.55	0.04	0.31	0.37	0.41	NR	1.11	0.27	0.01	0.01	NR	NR	NR	NR	NR	NR
B_Industry	1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print		4.59	0.24	1.10	0.05	0.17	0.21	0.24	NR	1.88	0.84	0.10	0.07	NR	NR	NR	NR	NR	NR
B_Industry	1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco		0.83	0.01	0.21	0.02	0.02	0.02	0.03	NR	0.13	0.00	0.00	0.00	NR	NR	NR	NR	NR	NR
B_Industry	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals		6.21	0.26	1.19	0.11	0.09	0.10	0.12	NR	16.92	0.34	0.02	0.15	NR	NR	NR	NR	NR	NR
I_Offroad	1A2gvii	Mobile Combustion in manufacturing industries and construction: (please specify in the IIR)		6.77	0.72	0.01	0.00	0.52	1.11	2.09	NR	6.99	0.00	0.00	0.00	NR	NR	NR	NR	NR	NR
B_Industry	1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)		6.07	0.18	2.70	0.18	1.43	1.72	1.91	NR	3.07	0.88	0.08	0.04	NR	NR	NR	NR	NR	NR
H_Aviation	1A3ai(i)	International aviation LTO (civil)		1.22	0.41	0.09	0.00	0.10	0.10	0.10	NR	1.72	0.00	0.00	0.00	NR	NR	NR	NR	NR	NR
H_Aviation	1A3aii(i)	Domestic aviation LTO (civil)		0.06	0.08	0.01	0.00	0.01	0.01	0.01	NR	1.96	0.00	0.00	0.00	NR	NR	NR	NR	NR	NR
F_RoadTransport	1A3bi	Road transport: Passenger cars		32.38	4.13	0.06	1.29	0.88	0.88	0.88	NR	48.51	0.00	0.00	0.00	NR	NR	NR	NR	NR	NR
F_RoadTransport	1A3bii	Road transport: Light duty vehicles		6.56	0.18	0.01	0.02	0.28	0.28	0.28	NR	1.97	0.00	0.00	0.00	NR	NR	NR	NR	NR	NR
F_RoadTransport	1A3biii	Road transport: Heavy duty vehicles and buses		40.26	1.08	0.05	0.04	0.69	0.69	0.69	NR	14.06	0.00	0.00	0.00	NR	NR	NR	NR	NR	NR
F_RoadTransport	1A3biv	Road transport: Mopeds & motorcycles		0.48	1.85	0.00	0.00	IE	IE	IE	NR	17.59	NE	0.00	0.00	NR	NR	NR	NR	NR	NR
F_RoadTransport	1A3bv	Road transport: Gasoline evaporation		NA	0.24	NA	NA	NA	NA	NA	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
F_RoadTransport	1A3bvi	Road transport: Automobile tyre and brake wear		NA	NA	NA	NA	NA	NA	NA	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
F_RoadTransport	1A3bvii	Road transport: Automobile road abrasion		NA	NA	NA	NA	0.95	3.17	9.52	NR	NA	NA	0.10	NA	NR	NR	NR	NR	NR	NR
I_Offroad	1A3c	Railways		1.07	0.11	0.05	0.00	0.24	0.60	1.64	NR	0.72	0.00	0.00	0.00	NR	NR	NR	NR	NR	NR
G_Shipping	1A3di(ii)	International inland waterways		0.63	0.10	0.02	0.00	0.05	0.05	0.05	NR	0.42	0.00	0.00	0.00	NR	NR	NR	NR	NR	NR
G_Shipping	1A3dii	National navigation (shipping)		0.06	0.22	0.00	0.00	0.00	0.00	0.00	NR	1.80	0.00	0.00	0.00	NR	NR	NR	NR	NR	NR
I_Offroad	1A3ei	Pipeline transport		0.48	0.00	NA	0.01	0.00	0.00	0.00	NR	0.09	NA	NA	NA	NR	NR	NR	NR	NR	NR
I_Offroad	1A3eii	Other (please specify in the IIR)		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
C_OtherStationaryComb	1A4ai	Commercial/institutional: Stationary		1.30	0.39	0.12	0.06	0.29	0.30	0.32	NR	5.09	0.13	0.02	0.01	NR	NR	NR	NR	NR	NR
I_Offroad	1A4aii	Commercial/institutional: Mobile		IE	IE	IE	IE	IE	IE	IE	NR	IE	IE	IE	IE	NR	NR	NR	NR	NR	NR
C_OtherStationaryComb	1A4bi	Residential: Stationary		8.82	21.07	1.19	0.44	5.13	5.68	6.23	NR	202.96	1.52	0.19	0.12	NR	NR	NR	NR	NR	NR
I_Offroad	1A4bii	Residential: Household and gardening (mobile)		0.53	1.34	0.00	0.00	0.02	0.02	0.02	NR	17.14	0.00	0.00	0.00	NR	NR	NR	NR	NR	NR
C_OtherStationaryComb	1A4ci	Agriculture/Forestry/Fishing: Stationary		0.96	1.58	0.11	0.04	0.45	0.51	0.57	NR	14.83	0.20	0.06	0.02	NR	NR	NR	NR	NR	NR
I_Offroad	1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery		6.59	2.00	0.01	0.00	0.84	0.99	1.23	NR	10.86	0.00	0.00	0.00	NR	NR	NR	NR	NR	NR
I_Offroad	1A4ciii	Agriculture/Forestry/Fishing: National fishing		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR

Nomenclature for Reporting for the provision of inventory information to the UNECE/CLRTAP

AT: 05.02.2016: 2014	NFR sectors to be reported			POPs [1] (from 1990)								Activity Data (from 1990)						
				PCDD/ PCDF (dioxins/ furans)	PAHs					HCB	PCBs	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels	*Other activity (specified)*	*Other Activity Units*
					benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno (1,2,3-cd) pyrene	Total 1-4									
NFR Aggregation for Gridding and LPS (GNFR)	**NFR Code**	**Longname**	**Notes**	**g I-TEQ**	**t**	**t**	**t**	**t**	**t**	**kg**	**kg**	**TJ NCV**	**TJ NCV**	**TJ NCV**	**TJ NCV**	**TJ NCV**		
A_PublicPower	1A1a	Public electricity and heat production		1.44	NR	NR	NR	NR	0.02	0.48	0.10	1,998	24,739	50,747	57,189	22,313	NA	*TJ NCV*
B_Industry	1A1b	Petroleum refining		0.02	NR	NR	NR	NR	0.00	0.00	0.00	28,466	0	10,870	0	0	NA	*TJ NCV*
B_Industry	1A1c	Manufacture of solid fuels and other energy industries		0.00	NR	NR	NR	NR	NA	0.00	NA	0	0	4,438	36	0	NA	*TJ NCV*
B_Industry	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel		0.02	NR	NR	NR	NR	0.00	0.00	0.02	83	3,718	24,465	4	0	NA	*TJ NCV*
B_Industry	1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals		0.35	NR	NR	NR	NR	0.00	0.09	0.03	250	152	4,152	39	10	NA	*TJ NCV*
B_Industry	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals		0.55	NR	NR	NR	NR	0.02	0.08	0.25	1,081	1,287	26,138	3,525	2,769	NA	*TJ NCV*
B_Industry	1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print		0.54	NR	NR	NR	NR	0.00	0.11	0.75	548	4,186	16,885	37,853	180	NA	*TJ NCV*
B_Industry	1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco		0.02	NR	NR	NR	NR	0.00	0.00	0.03	2,086	172	13,269	337	0	NA	*TJ NCV*
B_Industry	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals		0.45	NR	NR	NR	NR	0.01	107.91	0.49	1,687	2,879	11,477	1,211	6,507	NA	*TJ NCV*
I_Offroad	1A2gvii	Mobile Combustion in manufacturing industries and construction: (please specify in the IIR)		0.13	NR	NR	NR	NR	0.10	0.03	0.00	14,771	0	0	1,066	0	NA	*TJ NCV*
B_Industry	1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)		2.78	NR	NR	NR	NR	0.11	0.44	0.07	5,237	15	20,703	30,652	2,993	NA	*TJ NCV*
H_Aviation	1A3ai(i)	International aviation LTO (civil)		NE	NR	NR	NR	NR	NE	NE	NE	4,080	NO	NO	NO	NO	NA	*TJ NCV*
H_Aviation	1A3aii(i)	Domestic aviation LTO (civil)		NE	NR	NR	NR	NR	NE	NE	NE	310	NO	NO	NO	NO	NA	*TJ NCV*
F_RoadTransport	1A3bi	Road transport: Passenger cars		0.71	NR	NR	NR	NR	0.14	0.14	0.00	151,578	NO	693	9,692	NO	NA	*TJ NCV*
F_RoadTransport	1A3bii	Road transport: Light duty vehicles		0.10	NR	NR	NR	NR	0.02	0.02	0.00	18,124	NO	8	1,295	NO	NA	*TJ NCV*
F_RoadTransport	1A3biii	Road transport: Heavy duty vehicles and buses		1.01	NR	NR	NR	NR	0.16	0.20	0.00	112,998	NO	0	8,473	NO	NA	*TJ NCV*
F_RoadTransport	1A3biv	Road transport: Mopeds & motorcycles		0.01	NR	NR	NR	NR	0.00	0.00	0.00	2,139	NO	0	111	NO	NA	*TJ NCV*
F_RoadTransport	1A3bv	Road transport: Gasoline evaporation		NA	NR	NR	NR	NR	NA	NA	NA	NO	NO	NO	NO	NO	1,444	*kt gasoline*
F_RoadTransport	1A3bvi	Road transport: Automobile tyre and brake wear		NA	NR	NR	NR	NR	NA	NA	NA	NO	NO	NO	NO	NO	66,229	*10^6 km*
F_RoadTransport	1A3bvii	Road transport: Automobile road abrasion		NA	NR	NR	NR	NR	0.01	NA	NA	NO	NO	NO	NO	NO	66,229	*10^6 km*
I_Offroad	1A3c	Railways		0.02	NR	NR	NR	NR	0.01	0.00	0.00	1,582	5	0	114	0	NA	*TJ NCV*
G_Shipping	1A3di(ii)	International inland waterways		0.00	NR	NR	NR	NR	0.01	0.00	0.00	860	0	0	0	0	NA	*TJ NCV*
G_Shipping	1A3dii	National navigation (shipping)		0.00	NR	NR	NR	NR	0.00	0.00	0.00	152	0	0	7	0	NA	*TJ NCV*
I_Offroad	1A3ei	Pipeline transport		0.00	NR	NR	NR	NR	NA	0.00	NA	0	0	9,079	0	0	NA	*TJ NCV*
I_Offroad	1A3eii	Other (please specify in the IIR)		NO	NR	NR	NR	NR	NO	NO	NO	NO	NO	NO	NO	NO	NA	*TJ NCV*
C_OtherStationaryComb	1A4ai	Commercial/institutional: Stationary		0.93	NR	NR	NR	NR	0.06	0.56	0.02	10,314	115	22,146	3,035	83	NA	*TJ NCV*
I_Offroad	1A4aii	Commercial/institutional: Mobile		IE	NR	NR	NR	NR	IE	IE	IE	0	0	0	0	0	NA	*TJ NCV*
C_OtherStationaryComb	1A4bi	Residential: Stationary		14.57	NR	NR	NR	NR	3.20	21.79	0.17	37,017	971	41,897	60,363	0	NA	*TJ NCV*
I_Offroad	1A4bii	Residential: Household and gardening (mobile)		0.05	NR	NR	NR	NR	0.02	0.01	0.00	1,640	0	0	101	0	NA	*TJ NCV*
C_OtherStationaryComb	1A4ci	Agriculture/Forestry/Fishing: Stationary		2.64	NR	NR	NR	NR	0.59	4.31	0.01	135	31	541	8,760	0	NA	*TJ NCV*
I_Offroad	1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery		0.11	NR	NR	NR	NR	0.07	0.02	0.00	10,402	NO	NO	744	NO	NA	*TJ NCV*
I_Offroad	1A4ciii	Agriculture/Forestry/Fishing: National fishing		NO	NR	NR	NR	NR	NO	NO	NO	0	NO	0	NO	NO	NA	*TJ NCV*

Nomenclature for Reporting for the provision of inventory information to the UNECE/CLRTAP

AT: 05.02.2016: 2014	NFR sectors to be reported			Main Pollutants (from 1990)				Particulate Matter (from 2000)				Other (from 1990)	Priority Heavy Metals (from 1990)			Additional Heavy Metals (from 1990, voluntary reporting)					
				NOx (as NO_2)	NMVOC	SOx (as SO_2)	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
NFR Aggregation for Gridding and LPS (GNFR)	**NFR Code**	**Longname**	**Notes**	**kt**	**kt**	**kt**	**kt**	**kt**	**kt**	**kt**	**kt**	**kt**	**t**	**t**	**t**	**t**	**t**	**t**	**t**	**t**	**t**
C_OtherStationaryComb	1A5a	Other stationary (including military)		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
I_Offroad	1A5b	Other, Mobile (including military, land based and recreational boats)		0.08	0.02	0.01	0.00	0.02	0.02	0.02	NR	0.29	0.00	0.00	0.00	NR	NR	NR	NR	NR	NR
D_Fugitive	1B1a	Fugitive emission from solid fuels: Coal mining and handling		NA	NA	NA	NA	0.06	0.20	0.41	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
D_Fugitive	1B1b	Fugitive emission from solid fuels: Solid fuel transformation		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
D_Fugitive	1B1c	Other fugitive emissions from solid fuels		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
D_Fugitive	1B2ai	Fugitive emissions oil: Exploration, production, transport		NA	0.50	NA	NA	NA	NA	NA	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
D_Fugitive	1B2aiv	Fugitive emissions oil: Refining / storage		NA	0.70	NA	NA	NA	NA	NA	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
D_Fugitive	1B2av	Distribution of oil products		NA	0.70	NA	NA	NA	NA	NA	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
D_Fugitive	1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)		NA	0.51	0.04	NA	NA	NA	NA	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
D_Fugitive	1B2c	Venting and flaring (oil, gas, combined oil and gas)		IE	IE	IE	IE	NA	NA	NA	NR	IE	NA	NA	NA	NR	NR	NR	NR	NR	NR
D_Fugitive	1B2d	Other fugitive emissions from energy production	(a)	NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
B_Industry	2A1	Cement production		NA	NA	NA	NA	0.04	0.05	0.05	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
B_Industry	2A2	Lime production		NA	NA	NA	NA	0.06	0.09	0.10	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
B_Industry	2A3	Glass production		IE	IE	IE	IE	IE	IE	IE	NR	IE	IE	IE	IE	NR	NR	NR	NR	NR	NR
B_Industry	2A5a	Quarrying and mining of minerals other than coal		NA	NA	NA	NA	0.56	4.93	10.53	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
B_Industry	2A5b	Construction and demolition		NA	NA	NA	NA	0.12	1.22	2.44	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
B_Industry	2A5c	Storage, handling and transport of mineral products		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
B_Industry	2A6	Other mineral products (please specify in the IIR)		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
B_Industry	2B1	Ammonia production		0.16	IE	IE	0.02	NA	NA	NA	NR	0.02	NA	NA	NA	NR	NR	NR	NR	NR	NR
B_Industry	2B2	Nitric acid production		0.09	NA	NA	0.00	NA	NA	NA	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
B_Industry	2B3	Adipic acid production		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
B_Industry	2B5	Carbide production		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
B_Industry	2B6	Titanium dioxide production		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
B_Industry	2B7	Soda ash production		NE	NE	NE	NE	NE	NE	NE	NR	NE	NE	NE	NE	NR	NR	NR	NR	NR	NR
B_Industry	2B10a	Chemical industry: Other (please specify in the IIR)		0.08	1.32	0.77	0.07	0.14	0.27	0.46	NR	11.07	0.00	0.00	0.00	NR	NR	NR	NR	NR	NR
B_Industry	2B10b	Storage, handling and transport of chemical products (please specify in the IIR)		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
B_Industry	2C1	Iron and steel production		0.08	0.25	0.05	IE	0.25	0.56	0.80	NR	1.91	7.15	0.24	0.34	NR	NR	NR	NR	NR	NR
B_Industry	2C2	Ferroalloys production		NA	NA	NA	NA	0.01	0.01	0.01	NR	NA	NE	NE	NE	NR	NR	NR	NR	NR	NR
B_Industry	2C3	Aluminium production		NA	NA	NA	NA	NA	NA	NA	NR	NA	0.04	NA	NA	NR	NR	NR	NR	NR	NR
B_Industry	2C4	Magnesium production		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
B_Industry	2C5	Lead production		NA	NA	NA	NA	NA	NA	NA	NR	NA	0.89	0.01	NE	NR	NR	NR	NR	NR	NR
B_Industry	2C6	Zinc production		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR

Nomenclature for Reporting for the provision of inventory information to the UNECE/CLRTAP

AT: 05.02.2016: 2014	NFR sectors to be reported			POPs [1] (from 1990) PCDD/ PCDF (dioxins/ furans)	PAHs benzo(a) pyrene	PAHs benzo(b) fluoranthene	PAHs benzo(k) fluoranthene	PAHs Indeno (1,2,3-cd) pyrene	PAHs Total 1-4	HCB	PCBs	Activity Data (from 1990) Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels	*Other activity (specified)*	*Other Activity Units*
NFR Aggregation for Gridding and LPS (GNFR)	**NFR Code**	**Longname**	**Notes**	**g I-TEQ**	**t**	**t**	**t**	**t**	**t**	**kg**	**kg**	**TJ NCV**	**TJ NCV**	**TJ NCV**	**TJ NCV**	**TJ NCV**		
C_OtherStationaryComb	1A5a	Other stationary (including military)		NO	NR	NR	NR	NR	NO	NO	NO	0	0	0	0	0	NA	*TJ NCV*
I_Offroad	1A5b	Other, Mobile (including military, land based and recreational boats)		0.00	NR	NR	NR	NR	0.00	0.00	0.00	667	0	0	2	0	NA	*TJ NCV*
D_Fugitive	1B1a	Fugitive emission from solid fuels: Coal mining and handling		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	NO	*Coal produced [Mt]*
D_Fugitive	1B1b	Fugitive emission from solid fuels: Solid fuel transformation		NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	1	*Coal used for transformation [Mt]*
D_Fugitive	1B1c	Other fugitive emissions from solid fuels		NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NA	*Please specify*
D_Fugitive	1B2ai	Fugitive emissions oil: Exploration, production, transport		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	1	*Crude oil produced [Mt]*
D_Fugitive	1B2aiv	Fugitive emissions oil: Refining / storage		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	8	*Crude oil refined [Mt]*
D_Fugitive	1B2av	Distribution of oil products		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	2	*Oil consumed [Mt]*
D_Fugitive	1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	1,247	*Gas throughput [Mn3]*
D_Fugitive	1B2c	Venting and flaring (oil, gas, combined oil and gas)		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	NA	*Gas vented flared [TJ]*
D_Fugitive	1B2d	Other fugitive emissions from energy production	(a)	NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NA	
B_Industry	2A1	Cement production		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	3,143	*Clinker produced [kt]*
B_Industry	2A2	Lime production		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	787	*Lime produced [kt]*
B_Industry	2A3	Glass production		IE	NR	NR	NR	NR	IE	IE	IE	NA	NA	NA	NA	NA	497	*Glass produced [t]*
B_Industry	2A5a	Quarrying and mining of minerals other than coal		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	NA	*Material quarried [Mt]*
B_Industry	2A5b	Construction and demolition		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	14,075,536	*Area covered with new buildings [m2]*
B_Industry	2A5c	Storage, handling and transport of mineral products		NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NA	*Amount [Mt]*
B_Industry	2A6	Other mineral products (please specify in the IIR)		NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NA	*Please specify*
B_Industry	2B1	Ammonia production		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	537	*Ammonia produced [kt]*
B_Industry	2B2	Nitric acid production		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	552	*Nitric acid produced [kt]*
B_Industry	2B3	Adipic acid production		NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NO	*Adipic acid produced [kt]*
B_Industry	2B5	Carbide production		NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NA	*Carbide produced [kt]*
B_Industry	2B6	Titanium dioxide production		NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NO	*Titanium dioxide produced [kt]*
B_Industry	2B7	Soda ash production		NE	NR	NR	NR	NR	NE	NE	NE	NA	NA	NA	NA	NA	NO	*Soda ash produced [kt]*
B_Industry	2B10a	Chemical industry: Other (please specify in the IIR)		NA	NR	NR	NR	NR	NE	NA	NA	NA	NA	NA	NA	NA	NA	*Please specify*
B_Industry	2B10b	Storage, handling and transport of chemical products (please specify in the IIR)		NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NA	*Please specify*
B_Industry	2C1	Iron and steel production		3.42	NR	NR	NR	NR	0.20	4.05	34.73	NA	NA	NA	NA	NA	7,185	*Steel produced [kt]*
B_Industry	2C2	Ferroalloys production		NE	NR	NR	NR	NR	NE	NE	NA	NA	NA	NA	NA	NA	15	*Ferroalloys produced [kt]*
B_Industry	2C3	Aluminium production		1.26	NR	NR	NR	NR	NE	0.63	NA	NA	NA	NA	NA	NA	C	*Aluminium produced [kt]*
B_Industry	2C4	Magnesium production		NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NA	*Magnesium produced [kt]*
B_Industry	2C5	Lead production		0.11	NR	NR	NR	NR	NA	NA	118.79	NA	NA	NA	NA	NA	37	*Lead produced [kt]*
B_Industry	2C6	Zinc production		NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NA	*Zinc produced [kt]*

Nomenclature for Reporting for the provision of inventory information to the UNECE/CLRTAP

AT: 05.02.2016: 2014	*NFR sectors to be reported*			Main Pollutants (from 1990)				Particulate Matter (from 2000)				Other (from 1990)	Priority Heavy Metals (from 1990)			Additional Heavy Metals (from 1990, voluntary reporting)					
				NOx (as NO_2)	NMVOC	SOx (as SO_2)	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
NFR Aggregation for Gridding and LPS (GNFR)	**NFR Code**	**Longname**	**Notes**	**kt**	**kt**	**kt**	**kt**	**kt**	**kt**	**kt**	**kt**	**kt**	**t**	**t**	**t**	**t**	**t**	**t**	**t**	**t**	**t**
B_Industry	2C7a	Copper production		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
B_Industry	2C7b	Nickel production		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
B_Industry	2C7c	Other metal production (please specify in the IIR)		0.02	0.20	0.40	NA	NE	NE	NE	NR	0.33	IE	IE	IE	NR	NR	NR	NR	NR	NR
B_Industry	2C7d	Storage, handling and transport of metal products (please specify in the IIR)		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
E_Solvents	2D3a	Domestic solvent use including fungicides		NA	23.30	NA	NA	NA	NA	NA	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
B_Industry	2D3b	Road paving with asphalt		NA	IE	NA	NA	NA	NA	NA	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
B_Industry	2D3c	Asphalt roofing		NA	IE	NA	NA	NA	NA	NA	NR	9.78	NA	NA	NA	NR	NR	NR	NR	NR	NR
E_Solvents	2D3d	Coating applications		NA	17.21	NA	NA	NA	NA	NA	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
E_Solvents	2D3e	Degreasing		NA	7.41	NA	NA	NA	NA	NA	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
E_Solvents	2D3f	Dry cleaning		NA	0.02	NA	NA	NA	NA	NA	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
E_Solvents	2D3g	Chemical products		NA	4.32	NA	NA	NA	NA	NA	NR	NA	0.02	0.00	NA	NR	NR	NR	NR	NR	NR
E_Solvents	2D3h	Printing		NA	4.15	NA	NA	NA	NA	NA	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
E_Solvents	2D3i	Other solvent use (please specify in the IIR)		NA	7.82	NA	NA	NA	NA	NA	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
E_Solvents	2G	Other product use (please specify in the IIR)		NA	NA	NA	0.00	0.45	0.45	0.45	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
B_Industry	2H1	Pulp and paper industry		1.06	0.78	NA	NA	NA	NA	NA	NR	0.77	NA	NA	NA	NR	NR	NR	NR	NR	NR
B_Industry	2H2	Food and beverages industry		NA	2.54	NA	NA	0.00	0.00	0.00	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
B_Industry	2H3	Other industrial processes (please specify in the IIR)		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
B_Industry	2I	Wood processing		NA	NA	NA	NA	0.18	0.46	1.15	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
B_Industry	2J	Production of POPs		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
B_Industry	2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
B_Industry	2L	Other production, consumption, storage, transportation or handling of bulk products (please specify in the IIR)		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
K_AgriLivestock	3B1a	Manure management - Dairy cattle		0.08	NA	NA	7.25	IE	IE	IE	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
K_AgriLivestock	3B1b	Manure management - Non-dairy cattle		0.19	NA	NA	9.53	IE	IE	IE	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
K_AgriLivestock	3B2	Manure management - Sheep		0.00	NA	NA	0.61	IE	IE	IE	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
K_AgriLivestock	3B3	Manure management - Swine		0.04	NA	NA	6.28	IE	IE	IE	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
K_AgriLivestock	3B4a	Manure management - Buffalo		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
K_AgriLivestock	3B4d	Manure management - Goats		0.00	NA	NA	0.12	IE	IE	IE	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
K_AgriLivestock	3B4e	Manure management - Horses		0.02	NA	NA	1.10	IE	IE	IE	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
K_AgriLivestock	3B4f	Manure management - Mules and asses		IE	IE	IE	IE	IE	IE	IE	NR	IE	IE	IE	IE	NR	NR	NR	NR	NR	NR
K_AgriLivestock	3B4gi	Manure mangement - Laying hens		0.04	NA	NA	2.44	IE	IE	IE	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
K_AgriLivestock	3B4gii	Manure mangement - Broilers		0.01	NA	NA	0.68	IE	IE	IE	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
K_AgriLivestock	3B4giii	Manure mangement - Turkeys		0.00	NA	NA	0.30	IE	IE	IE	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
K_AgriLivestock	3B4giv	Manure management - Other poultry		0.00	NA	NA	0.02	IE	IE	IE	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
K_AgriLivestock	3B4h	Manure management - Other animals (please specify in IIR)		0.00	NA	NA	0.03	IE	IE	IE	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR

Nomenclature for Reporting for the provision of inventory information to the UNECE/CLRTAP

AT: 05.02.2016: 2014	NFR sectors to be reported			POPs (1) (from 1990)								Activity Data (from 1990)						
				PCDD/ PCDF (dioxins/ furans)	PAHs benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno (1,2,3-cd) pyrene	Total 1-4	HCB	PCBs	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels	*Other activity (specified)*	*Other Activity Units*
NFR Aggregation for Gridding and LPS (GNFR)	NFR Code	Longname	Notes	g I-TEQ	t	t	t	t	t	kg	kg	TJ NCV	TJ NCV	TJ NCV	TJ NCV	TJ NCV		
B_Industry	2C7a	Copper production		NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NA	*Copper produced [kt]*
B_Industry	2C7b	Nickel production		NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NA	*Nickel produced [kt]*
B_Industry	2C7c	Other metal production (please specify in the IIR)		IE	NR	NR	NR	NR	IE	IE	62.85	NA	NA	NA	NA	NA	NA	*Please specify*
B_Industry	2C7d	Storage, handling and transport of metal products (please specify in the IIR)		NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NA	*Amount (kt)*
E_Solvents	2D3a	Domestic solvent use including fungicides		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	33	*Solvents used [kt]*
B_Industry	2D3b	Road paving with asphalt		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	1,558	*Asphalt used [kt]*
B_Industry	2D3c	Asphalt roofing		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	28	*Roof area [km2]*
E_Solvents	2D3d	Coating applications		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	44	*Solvents used [kt]*
E_Solvents	2D3e	Degreasing		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	17	*Solvents used [kt]*
E_Solvents	2D3f	Dry cleaning		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	0	*Solvents used [kt]*
E_Solvents	2D3g	Chemical products		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	12	*Solvents used [kt]*
E_Solvents	2D3h	Printing		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	9	*Solvents used [kt]*
E_Solvents	2D3i	Other solvent use (please specify in the IIR)		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	14	*Solvents used [kt]*
E_Solvents	2G	Other product use (please specify in the IIR)		NE	NR	NR	NR	NR	NE	NE	NA	NA	NA	NA	NA	NA	NA	*Please specify*
B_Industry	2H1	Pulp and paper industry		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	NA	*Pulp production [kt]*
B_Industry	2H2	Food and beverages industry		0.13	NR	NR	NR	NR	0.04	0.03	NA	NA	NA	NA	NA	NA	NA	*Bread, Wine, Beer, Spirits production [kt]*
B_Industry	2H3	Other industrial processes (please specify in the IIR)		NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NA	
B_Industry	2I	Wood processing		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	NA	*Please specify*
B_Industry	2J	Production of POPs		NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NA	*NA*
B_Industry	2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)		NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NA	*NA*
B_Industry	2L	Other production, consumption, storage, transportation or handling of bulk products (please specify in the IIR)		NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NA	*NA*
K_AgriLivestock	3B1a	Manure management - Dairy cattle		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	538	*Population size (1000 head)*
K_AgriLivestock	3B1b	Manure management - Non-dairy cattle		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	1,423	*Population size (1000 head)*
K_AgriLivestock	3B2	Manure management - Sheep		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	349	*Population size (1000 head)*
K_AgriLivestock	3B3	Manure management - Swine		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	2,868	*Population size (1000 head)*
K_AgriLivestock	3B4a	Manure management - Buffalo		NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NO	*Population size (1000 head)*
K_AgriLivestock	3B4d	Manure management - Goats		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	71	*Population size (1000 head)*
K_AgriLivestock	3B4e	Manure management - Horses		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	80	*Population size (1000 head)*
K_AgriLivestock	3B4f	Manure management - Mules and asses		IE	NR	NR	NR	NR	IE	IE	IE	NA	NA	NA	NA	NA	IE	*Population size (1000 head)*
K_AgriLivestock	3B4gi	Manure mangement - Laying hens		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	7,997	*Population size (1000 head)*
K_AgriLivestock	3B4gii	Manure mangement - Broilers		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	7,082	*Population size (1000 head)*
K_AgriLivestock	3B4giii	Manure mangement - Turkeys		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	600	*Population size (1000 head)*
K_AgriLivestock	3B4giv	Manure management - Other poultry		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	92	*Population size (1000 head)*
K_AgriLivestock	3B4h	Manure management - Other animals (please specify in IIR)		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	42	*Population size (1000 head)*

Nomenclature for Reporting for the provision of inventory information to the UNECE/CLRTAP

AT: 05.02.2016: 2014	*NFR sectors to be reported*			Main Pollutants (from 1990)				Particulate Matter (from 2000)				Other (from 1990)	Priority Heavy Metals (from 1990)			Additional Heavy Metals (from 1990, voluntary reporting)					
				NOx (as NO_2)	NMVOC	SOx (as SO_2)	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
NFR Aggregation for Gridding and LPS (GNFR)	**NFR Code**	**Longname**	**Notes**	**kt**	**kt**	**kt**	**kt**	**kt**	**kt**	**kt**	**kt**	**kt**	**t**	**t**	**t**	**t**	**t**	**t**	**t**	**t**	**t**
L_AgriOther	3Da1	Inorganic N-fertilizers (includes also urea application)		1.10	NA	NA	5.27	0.97	4.36	9.68	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
L_AgriOther	3Da2a	Animal manure applied to soils		4.31	NA	NA	26.91	NA	NA	NA	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
L_AgriOther	3Da2b	Sewage sludge applied to soils		0.05	NA	NA	0.28	NA	NA	NA	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
L_AgriOther	3Da2c	Other organic fertilisers applied to soils (including compost)		0.22	NA	NA	1.23	NA	NA	NA	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
L_AgriOther	3Da3	Urine and dung deposited by grazing animals		IE	NA	NA	0.64	NA	NA	NA	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
L_AgriOther	3Da4	Crop residues applied to soils		NA	NA	NA	NA	NA	NA	NA	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
L_AgriOther	3Db	Indirect emissions from managed soils		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
L_AgriOther	3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
L_AgriOther	3Dd	Off-farm storage, handling and transport of bulk agricultural products		NA	NA	NA	NA	0.01	0.03	0.06	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
L_AgriOther	3De	Cultivated crops	(b)	NA	1.80	NA	0.28	NA	NA	NA	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
L_AgriOther	3Df	Use of pesticides		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
L_AgriOther	3F	Field burning of agricultural residues		0.01	0.06	0.00	0.01	0.07	0.07	0.07	NR	0.45	0.01	0.00	0.00	NR	NR	NR	NR	NR	NR
L_AgriOther	3I	Agriculture other (please specify in the IIR)		NA	NA	NA	NA	0.11	0.47	1.05	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
J_Waste	5A	Biological treatment of waste - Solid waste disposal on land		NA	0.05	NA	0.00	0.05	0.17	0.36	NR	3.95	0.00	0.00	0.00	NR	NR	NR	NR	NR	NR
J_Waste	5B1	Biological treatment of waste - Composting		NA	NA	NA	1.20	NA	NA	NA	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
J_Waste	5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities		NA	NA	NA	NA	NA	NA	NA	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
J_Waste	5C1a	Municipal waste incineration	(c)	NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
J_Waste	5C1bi	Industrial waste incineration	(c)	0.00	0.00	0.01	0.00	0.00	0.00	0.00	NR	0.00	0.00	0.00	0.00	NR	NR	NR	NR	NR	NR
J_Waste	5C1bii	Hazardous waste incineration	(c)	NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
J_Waste	5C1biii	Clinical waste incineration	(c)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NR	0.00	0.00	0.00	0.00	NR	NR	NR	NR	NR	NR
J_Waste	5C1biv	Sewage sludge incineration	(c)	NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
J_Waste	5C1bv	Cremation	(c)	0.01	0.00	NA	NA	0.00	0.00	0.00	NR	0.01	0.00	NA	0.02	NR	NR	NR	NR	NR	NR
J_Waste	5C1bvi	Other waste incineration (please specify in the IIR)	(c)	NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
J_Waste	5C2	Open burning of waste		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
J_Waste	5D1	Domestic wastewater handling		NA	NA	NA	NA	NA	NA	NA	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
J_Waste	5D2	Industrial wastewater handling		NA	NA	NA	NA	NA	NA	NA	NR	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
J_Waste	5D3	Other wastewater handling		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
J_Waste	5E	Other waste (please specify in IIR)	(d)	NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
M_Other	6A	Other (included in national total for entire territory) (please specify in IIR)		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
	NATIONAL TOTAL	**National total for the entire territory (based on fuel sold)**		151.03	110.46	16.02	66.99	16.61	31.39	55.29	NR	537.33	15.11	1.15	0.96	NR	NR	NR	NR	NR	NR

Nomenclature for Reporting for the provision of inventory information to the UNECE/CLRTAP

AT: 05.02.2016: 2014	NFR sectors to be reported			POPs [1] (from 1990)								Activity Data (from 1990)						
				PCDD/ PCDF (dioxins/ furans)	PAHs					HCB	PCBs	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels	*Other activity (specified)*	*Other Activity Units*
					benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno (1,2,3-cd) pyrene	Total 1-4									
NFR Aggregation for Gridding and LPS (GNFR)	**NFR Code**	**Longname**	**Notes**	**g I-TEQ**	**t**	**t**	**t**	**t**	**t**	**kg**	**kg**	**TJ NCV**	**TJ NCV**	**TJ NCV**	**TJ NCV**	**TJ NCV**		
L_AgriOther	3Da1	Inorganic N-fertilizers (includes also urea application)		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	NA	*Use of inorganic fertilizers (kg N/yr)*
L_AgriOther	3Da2a	Animal manure applied to soils		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	NA	
L_AgriOther	3Da2b	Sewage sludge applied to soils		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	NA	
L_AgriOther	3Da2c	Other organic fertilisers applied to soils (including compost)		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	NA	
L_AgriOther	3Da3	Urine and dung deposited by grazing animals		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	NA	
L_AgriOther	3Da4	Crop residues applied to soils		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	NA	
L_AgriOther	3Db	Indirect emissions from managed soils		NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NA	
L_AgriOther	3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products		NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NA	
L_AgriOther	3Dd	Off-farm storage, handling and transport of bulk agricultural products		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	NA	
L_AgriOther	3De	Cultivated crops	(b)	NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	NA	
L_AgriOther	3Df	Use of pesticides		NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NA	
L_AgriOther	3F	Field burning of agricultural residues		0.07	NR	NR	NR	NR	0.09	0.01	NA	NA	NA	NA	NA	NA	NA	*Area burned [k ha/yr]*
L_AgriOther	3I	Agriculture other (please specify in the IIR)		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	NA	*NA*
J_Waste	5A	Biological treatment of waste - Solid waste disposal on land		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	NA	*Annual deposition of MSW at the SWDS [kt]*
J_Waste	5B1	Biological treatment of waste - Composting		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	NA	
J_Waste	5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	NA	
J_Waste	5C1a	Municipal waste incineration	(c)	NO	NR	NR	NR	NR	NO	NO	NA	NA	NA	NA	NA	NA	NO	*MSW incinerated [kt]*
J_Waste	5C1bi	Industrial waste incineration	(c)	0.00	NR	NR	NR	NR	0.00	0.00	NA	NA	NA	NA	NA	NA	1	*Waste incinerated [kt]*
J_Waste	5C1bii	Hazardous waste incineration	(c)	NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NA	*Waste incinerated [kt]*
J_Waste	5C1biii	Clinical waste incineration	(c)	0.00	NR	NR	NR	NR	NA	0.00	NA	NA	NA	NA	NA	NA	1	*Waste incinerated [kt]*
J_Waste	5C1biv	Sewage sludge incineration	(c)	NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NA	
J_Waste	5C1bv	Cremation	(c)	0.16	NR	NR	NR	NR	0.00	0.03	NA	NA	NA	NA	NA	NA	19,800	*Incineration of corpses [Number]*
J_Waste	5C1bvi	Other waste incineration (please specify in the IIR)	(c)	NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NA	
J_Waste	5C2	Open burning of waste		NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NA	
J_Waste	5D1	Domestic wastewater handling		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	NE	*Total organic product [Gg DC/yr]*
J_Waste	5D2	Industrial wastewater handling		NA	NR	NR	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	NE	*Total organic product [Gg DC/yr]*
J_Waste	5D3	Other wastewater handling		NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NE	*Total organic product [Gg DC/yr]*
J_Waste	5E	Other waste (please specify in IIR)	(d)	NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NA	*Please specify*
M_Other	6A	Other (included in national total for entire territory) (please specify in IIR)		NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NA	*NA*
	NATIONAL TOTAL	**National total for the entire territory (based on fuel sold)**		31.61	NR	NR	NR	NR	4.89	140.95	218.30	408,205	38,272	257,509	224,611	34,856	NA	*NA*

Nomenclature for Reporting for the provision of inventory information to the UNECE/CLRTAP

AT: 05.02.2016: 2014	NFR sectors to be reported			Main Pollutants (from 1990)				Particulate Matter (from 2000)				Other (from 1990)	Priority Heavy Metals (from 1990)			Additional Heavy Metals (from 1990, voluntary reporting)					
				NOx (as NO_2)	NMVOC	SOx (as SO_2)	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
NFR Aggregation for Gridding and LPS (GNFR)	**NFR Code**	**Longname**	**Notes**	**kt**	**kt**	**kt**	**kt**	**kt**	**kt**	**kt**	**kt**	**kt**	**t**	**t**	**t**	**t**	**t**	**t**	**t**	**t**	**t**
	ADJUSTMENTS (Net total)	Sum of adjustments (negative value) from Annex VII		0.00	0.00	0.00	0.00	0.00	0.00	0.00	NR	0.00	0.00	0.00	0.00	NR	NR	NR	NR	NR	NR
	NATIONAL TOTAL FOR COMPLIANCE	**National total for compliance assessment (please specify all details in the IIR)**	(e)	151.03	110.46	16.02	66.99	16.61	31.39	55.29	NR	537.33	15.11	1.15	0.96	NR	NR	NR	NR	NR	NR
'MEMO' ITEMS - NOT TO BE INCLUDED IN NATIONAL TOTALS																					
O_AviCruise	1A3ai(ii)	International aviation cruise (civil)		7.36	0.45	0.53	0.00	0.58	0.58	0.58	NR	0.71	0.00	0.00	0.00	NR	NR	NR	NR	NR	NR
O_AviCruise	1A3aii(ii)	Domestic aviation cruise (civil)		0.13	0.01	0.01	0.00	0.01	0.01	0.01	NR	0.03	0.00	0.00	0.00	NR	NR	NR	NR	NR	NR
P_IntShipping	1A3di(i)	International maritime navigation		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
z_Memo	1A5c	Multilateral operations		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
z_Memo	1A3	Transport (fuel used)		62.11	7.78	0.26	1.28	2.84	5.43	12.81	NR	79.12	0.00	0.10	0.00	NR	NR	NR	NR	NR	NR
z_Memo	6B	Other not included in national total of the entire territory (please specify in the IIR)		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
N_Natural	11A	Volcanoes		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
N_Natural	11B	Forest fires		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR
N_Natural	11C	Other natural emissions (please specify in the IIR)		NO	NO	NO	NO	NO	NO	NO	NR	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR

Nomenclature for Reporting for the provision of inventory information to the UNECE/CLRTAP

AT: 05.02.2016: 2014	NFR sectors to be reported			POPs (1) (from 1990)								Activity Data (from 1990)						
				PCDD/ PCDF (dioxins/ furans)	PAHs benzo(a) pyrene	PAHs benzo(b) fluoranthene	PAHs benzo(k) fluoranthene	PAHs Indeno (1,2,3-cd) pyrene	PAHs Total 1-4	HCB	PCBs	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels	*Other activity (specified)*	*Other Activity Units*
NFR Aggregation for Gridding and LPS (GNFR)	**NFR Code**	**Longname**	**Notes**	**g I-TEQ**	**t**	**t**	**t**	**t**	**t**	**kg**	**kg**	**TJ NCV**	**TJ NCV**	**TJ NCV**	**TJ NCV**	**TJ NCV**		
	ADJUSTMENTS (Net total)	Sum of adjustments (negative value) from Annex VII		0.00	NR	NR	NR	NR	0.00	0.00	0.00	NA	NA	NA	NA	NA	NA	*NA*
	NATIONAL TOTAL FOR COMPLIANCE	**National total for compliance assessment (please specify all details in the IIR)**	(e)	31.61	NR	NR	NR	NR	4.89	140.95	218.30	NA	NA	NA	NA	NA	NA	*NA*
'MEMO' ITEMS - NOT TO BE INCLUDED IN NATIONAL TOTALS																		
O_AviCruise	1A3ai(ii)	International aviation cruise (civil)		NE	NR	NR	NR	NR	NE	NE	NE	23,098	NO	NO	NO	NO	NO	*TJ NCV*
O_AviCruise	1A3aii(ii)	Domestic aviation cruise (civil)		NE	NR	NR	NR	NR	NE	NE	NE	371	NO	NO	NO	NO	NO	*TJ NCV*
P_IntShipping	1A3di(i)	International maritime navigation		NO	NR	NR	NR	NR	NO	NO	NO	NO	NO	NO	NO	NO	NO	*TJ NCV*
z_Memo	1A5c	Multilateral operations		NO	NR	NR	NR	NR	NO	NO	NO	NO	NO	NO	NO	NO	NO	
z_Memo	1A3	Transport (fuel used)		1.86	NR	NR	NR	NR	0.25	0.29	0.00	NA	NA	NA	NA	NA	NA	
z_Memo	6B	Other not included in national total of the entire territory (please specify in the IIR)		NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NA	*NA*
N_Natural	11A	Volcanoes		NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NA	*Please specify*
N_Natural	11B	Forest fires		NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NA	*Area of forest burned [ha]*
N_Natural	11C	Other natural emissions (please specify in the IIR)		NO	NR	NR	NR	NR	NO	NO	NO	NA	NA	NA	NA	NA	NA	

Nomenclature for Reporting for the provision of inventory information to the UNECE/CLRTAP

11.2 Emission Trends per Sector - Submission under UNECE/LRTAP

Table A-1: Emission trends for SO_2 [kt] 1990–2014 – Submission under UNECE/LRTAP.

year	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	72.16	70.16	2.00	2.22	0.00	0.07	NO	**74.45**	0.26
1991	69.58	68.28	1.30	1.90	0.00	0.06	NO	**71.54**	0.29
1992	53.46	51.46	2.00	1.67	0.00	0.04	NO	**55.16**	0.31
1993	52.07	49.97	2.10	1.42	0.00	0.04	NO	**53.53**	0.33
1994	46.43	45.15	1.28	1.42	0.00	0.05	NO	**47.90**	0.34
1995	46.07	44.54	1.53	1.37	0.00	0.05	NO	**47.49**	0.38
1996	43.44	42.24	1.20	1.29	0.00	0.05	NO	**44.78**	0.43
1997	38.92	38.85	0.07	1.27	0.00	0.05	NO	**40.24**	0.44
1998	34.37	34.33	0.04	1.18	0.00	0.05	NO	**35.61**	0.46
1999	32.46	32.42	0.04	1.12	0.00	0.06	NO	**33.64**	0.45
2000	30.42	30.38	0.04	1.09	0.00	0.06	NO	**31.57**	0.48
2001	31.41	31.36	0.05	1.21	0.00	0.06	NO	**32.68**	0.47
2002	30.58	30.54	0.04	1.21	0.00	0.06	NO	**31.85**	0.43
2003	30.64	30.59	0.05	1.21	0.00	0.06	NO	**31.91**	0.40
2004	26.11	26.07	0.04	1.22	0.00	0.06	NO	**27.39**	0.47
2005	25.13	25.09	0.04	1.22	0.00	0.06	NO	**26.40**	0.55
2006	25.85	25.80	0.05	1.22	0.00	0.05	NO	**27.12**	0.58
2007	22.89	22.83	0.05	1.22	0.00	0.04	NO	**24.15**	0.61
2008	20.56	20.51	0.04	1.23	0.00	0.03	NO	**21.81**	0.61
2009	15.18	15.12	0.06	1.21	0.00	0.02	NO	**16.41**	0.53
2010	16.68	16.63	0.05	1.21	0.00	0.01	NO	**17.90**	0.57
2011	15.57	15.52	0.05	1.22	0.00	0.01	NO	**16.80**	0.60
2012	14.90	14.85	0.05	1.22	0.00	0.01	NO	**16.12**	0.57
2013	14.65	14.61	0.04	1.22	0.00	0.01	NO	**15.88**	0.54
2014	14.79	14.76	0.04	1.22	0.00	0.01	NO	**16.02**	0.54

Table A-2: Emission trends for NO_x [kt] 1990–2014 – Submission under UNECE/LRTAP.

year	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	204.01	204.01	IE	4.80	6.75	0.10	NO	**215.66**	2.44
1991	211.90	211.90	IE	4.48	6.93	0.09	NO	**223.40**	2.76
1992	199.60	199.60	IE	4.55	6.54	0.06	NO	**210.75**	3.00
1993	193.51	193.51	IE	1.98	6.33	0.05	NO	**201.87**	3.18
1994	186.11	186.11	IE	1.92	6.77	0.04	NO	**194.85**	3.31
1995	185.89	185.89	IE	1.46	6.89	0.05	NO	**194.28**	3.73
1996	204.48	204.48	IE	1.42	6.55	0.05	NO	**212.50**	4.14
1997	192.87	192.87	IE	1.50	6.55	0.05	NO	**200.97**	4.29
1998	205.07	205.07	IE	1.46	6.57	0.05	NO	**213.14**	4.43
1999	197.00	197.00	IE	1.44	6.41	0.05	NO	**204.91**	4.33
2000	202.43	202.43	IE	1.54	6.32	0.05	NO	**210.34**	6.44
2001	212.21	212.21	IE	1.57	6.31	0.05	NO	**220.14**	6.32
2002	218.13	218.13	IE	1.63	6.25	0.05	NO	**226.06**	5.67
2003	227.92	227.92	IE	1.34	6.12	0.05	NO	**235.42**	5.21
2004	226.00	226.00	IE	1.28	5.97	0.05	NO	**233.29**	6.09
2005	227.02	227.02	IE	1.75	5.95	0.05	NO	**234.77**	6.99
2006	212.32	212.32	IE	1.82	5.96	0.04	NO	**220.15**	7.54
2007	203.59	203.59	IE	1.71	6.05	0.04	NO	**211.39**	7.99
2008	186.62	186.62	IE	1.91	6.18	0.03	NO	**194.74**	7.90
2009	170.45	170.45	IE	1.54	6.20	0.02	NO	**178.21**	6.86
2010	171.22	171.22	IE	1.81	5.96	0.01	NO	**179.01**	7.60
2011	161.32	161.32	IE	1.83	6.03	0.01	NO	**169.19**	7.98
2012	155.15	155.15	IE	1.63	6.03	0.01	NO	**162.81**	7.68
2013	154.65	154.65	IE	1.45	6.00	0.01	NO	**162.11**	7.46
2014	143.45	143.45	IE	1.50	6.08	0.01	NO	**151.03**	7.49

Table A-3: Emission trends for NMVOC [kt] 1990–2014 – Submission under UNECE/LRTAP.

year	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	153.17	137.69	15.49	125.53	1.81	0.16	NO	**280.68**	0.18
1991	154.23	139.11	15.12	120.38	1.80	0.16	NO	**276.57**	0.20
1992	138.21	123.02	15.19	114.95	1.75	0.15	NO	**255.05**	0.22
1993	129.23	114.57	14.65	109.59	1.72	0.15	NO	**240.69**	0.24
1994	114.57	103.46	11.12	101.48	1.77	0.14	NO	**217.96**	0.25
1995	109.12	99.63	9.49	93.22	1.78	0.13	NO	**204.25**	0.29
1996	106.22	97.75	8.46	89.82	1.76	0.13	NO	**197.92**	0.34
1997	88.52	80.57	7.95	86.69	1.85	0.12	NO	**177.18**	0.37
1998	83.95	77.51	6.43	83.53	1.80	0.11	NO	**169.39**	0.40
1999	79.70	74.03	5.67	80.03	1.84	0.11	NO	**161.69**	0.39
2000	74.46	68.77	5.69	77.13	1.74	0.11	NO	**153.43**	0.42
2001	71.55	67.71	3.84	76.34	1.82	0.10	NO	**149.80**	0.41
2002	67.87	63.84	4.03	76.35	1.81	0.10	NO	**146.13**	0.37
2003	66.13	62.17	3.96	75.83	1.72	0.10	NO	**143.78**	0.34
2004	62.34	58.77	3.57	75.04	1.97	0.10	NO	**139.46**	0.40
2005	60.17	56.83	3.34	74.44	1.86	0.10	NO	**136.57**	0.47
2006	55.46	52.10	3.36	73.64	1.76	0.09	NO	**130.95**	0.50
2007	52.24	49.25	2.98	72.67	1.77	0.09	NO	**126.76**	0.53
2008	50.28	47.53	2.75	71.81	1.91	0.08	NO	**124.09**	0.52
2009	45.81	43.22	2.59	70.48	1.79	0.07	NO	**118.15**	0.45
2010	47.17	44.71	2.45	69.67	1.74	0.07	NO	**118.64**	0.49
2011	43.74	41.33	2.41	69.25	1.90	0.06	NO	**114.95**	0.51
2012	43.72	41.32	2.40	68.41	1.70	0.06	NO	**113.89**	0.49
2013	44.96	42.65	2.30	68.85	1.66	0.06	NO	**115.53**	0.46
2014	39.23	36.82	2.42	69.31	1.86	0.05	NO	**110.46**	0.46

Table A-4: Emission trends for NH_3 [kt] 1990–2014 – Submission under UNECE/LRTAP.

year	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	2.290	2.290	IE	0.269	63.579	0.358	NO	**66.496**	0.002
1991	2.917	2.917	IE	0.507	64.226	0.371	NO	**68.022**	0.002
1992	3.184	3.184	IE	0.369	62.404	0.421	NO	**66.378**	0.002
1993	3.498	3.498	IE	0.219	62.998	0.498	NO	**67.212**	0.002
1994	3.644	3.644	IE	0.168	64.279	0.572	NO	**68.663**	0.002
1995	3.812	3.812	IE	0.099	65.422	0.584	NO	**69.917**	0.003
1996	3.929	3.929	IE	0.097	63.902	0.605	NO	**68.533**	0.003
1997	3.936	3.936	IE	0.103	64.394	0.586	NO	**69.019**	0.003
1998	4.237	4.237	IE	0.103	64.673	0.603	NO	**69.617**	0.003
1999	4.199	4.199	IE	0.119	63.246	0.638	NO	**68.201**	0.003
2000	4.106	4.106	IE	0.100	61.914	0.669	NO	**66.790**	0.003
2001	4.216	4.216	IE	0.079	61.929	0.748	NO	**66.972**	0.003
2002	4.293	4.293	IE	0.061	61.210	0.824	NO	**66.387**	0.003
2003	4.320	4.320	IE	0.076	61.097	0.891	NO	**66.383**	0.003
2004	4.126	4.126	IE	0.059	60.675	1.123	NO	**65.983**	0.003
2005	4.010	4.010	IE	0.068	60.755	1.209	NO	**66.041**	0.004
2006	3.799	3.799	IE	0.074	61.176	1.223	NO	**66.272**	0.004
2007	3.668	3.668	IE	0.077	62.572	1.243	NO	**67.560**	0.004
2008	3.410	3.410	IE	0.081	62.394	1.221	NO	**67.106**	0.004
2009	3.191	3.191	IE	0.088	63.787	1.204	NO	**68.271**	0.004
2010	3.230	3.230	IE	0.091	62.909	1.216	NO	**67.446**	0.004
2011	3.046	3.046	IE	0.101	62.364	1.227	NO	**66.738**	0.004
2012	2.962	2.962	IE	0.094	62.488	1.231	NO	**66.774**	0.004
2013	2.888	2.888	IE	0.096	62.392	1.164	NO	**66.540**	0.004
2014	2.726	2.726	IE	0.089	62.966	1.204	NO	**66.985**	0.004

Table A-5: Emission trends for CO [kt] 1990–2014 – Submission under UNECE/LRTAP.

year	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	1 227.64	1 227.64	IE	46.37	1.28	10.98	NO	**1 286.26**	0.49
1991	1 231.47	1 231.47	IE	41.67	1.24	11.11	NO	**1 285.48**	0.55
1992	1 158.65	1 158.65	IE	44.97	1.25	10.90	NO	**1 215.78**	0.59
1993	1 090.78	1 090.78	IE	47.15	1.11	10.76	NO	**1 149.80**	0.63
1994	1 024.36	1 024.36	IE	48.65	1.23	10.40	NO	**1 084.63**	0.66
1995	930.85	930.85	IE	45.08	1.22	9.86	NO	**987.00**	0.75
1996	942.83	942.83	IE	39.44	1.13	9.29	NO	**992.70**	0.84
1997	875.02	875.02	IE	38.30	1.22	8.86	NO	**923.41**	0.89
1998	841.49	841.49	IE	34.86	1.20	8.49	NO	**886.04**	0.93
1999	743.91	743.91	IE	30.58	1.24	8.12	NO	**783.85**	0.89
2000	749.05	749.05	IE	27.38	1.06	7.77	NO	**785.25**	0.80
2001	727.86	727.86	IE	24.20	1.21	7.44	NO	**760.71**	0.78
2002	695.81	695.81	IE	23.87	1.14	7.39	NO	**728.20**	0.66
2003	700.13	700.13	IE	23.59	1.06	7.36	NO	**732.14**	0.65
2004	680.16	680.16	IE	23.86	1.74	7.46	NO	**713.22**	0.73
2005	653.11	653.11	IE	24.23	1.01	7.03	NO	**685.38**	0.91
2006	631.75	631.75	IE	24.51	0.92	6.66	NO	**663.85**	0.92
2007	599.29	599.29	IE	24.70	0.96	6.28	NO	**631.23**	0.96
2008	578.42	578.42	IE	24.74	0.94	5.96	NO	**610.06**	0.96
2009	538.10	538.10	IE	23.62	0.86	5.54	NO	**568.12**	0.82
2010	550.04	550.04	IE	24.09	0.82	5.18	NO	**580.12**	0.87
2011	533.86	533.86	IE	24.18	0.61	4.84	NO	**563.49**	0.86
2012	534.46	534.46	IE	23.86	0.42	4.54	NO	**563.29**	0.83
2013	553.51	553.51	IE	23.95	0.38	4.24	NO	**582.07**	0.74
2014	509.04	509.04	IE	23.88	0.45	3.96	NO	**537.33**	0.74

Table A-6: Emission trends for Cd [kg] 1990–2014 – Submission under UNECE/LRTAP.

year	1 ENERGY	1.A FUEL COMBUSTION ACTIVITIES	1.B FUGITIVE EMISSIONS FROM FUELS	2 INDUSTRIAL PROCESSES and PRODUCT USE	3 AGRICULTURE	5 WASTE	6 OTHER EMISSION SOURCES	NATIONAL TOTAL	International Bunkers
1990	992.8	992.8	NA	527.3	1.9	59.1	NO	**1 581.1**	0.0002
1991	1 041.0	1 041.0	NA	439.2	1.9	48.4	NO	**1 530.4**	0.0003
1992	946.8	946.8	NA	296.9	1.9	5.3	NO	**1 250.9**	0.0003
1993	921.2	921.2	NA	237.2	1.8	4.6	NO	**1 164.8**	0.0003
1994	863.8	863.8	NA	199.5	1.9	3.9	NO	**1 069.1**	0.0003
1995	794.4	794.4	NA	177.3	1.8	2.0	NO	**975.5**	0.0003
1996	834.8	834.8	NA	160.2	1.7	1.9	NO	**998.6**	0.0004
1997	791.0	791.0	NA	174.0	1.8	1.8	NO	**968.7**	0.0004
1998	728.0	728.0	NA	169.4	1.8	1.8	NO	**900.9**	0.0004
1999	769.4	769.4	NA	174.5	1.8	1.7	NO	**947.4**	0.0004
2000	731.8	731.8	NA	187.4	1.6	1.7	NO	**922.6**	0.0004
2001	757.9	757.9	NA	184.1	1.7	1.6	NO	**945.4**	0.0004
2002	752.9	752.9	NA	194.1	1.7	1.6	NO	**950.4**	0.0004
2003	792.9	792.9	NA	194.8	1.6	1.6	NO	**991.0**	0.0003
2004	783.5	783.5	NA	202.8	2.2	1.6	NO	**990.2**	0.0004
2005	840.9	840.9	NA	223.2	1.6	1.6	NO	**1 067.2**	0.0005
2006	848.2	848.2	NA	228.0	1.5	1.4	NO	**1 079.1**	0.0005
2007	884.0	884.0	NA	241.1	1.5	1.3	NO	**1 127.9**	0.0005
2008	907.4	907.4	NA	239.9	1.5	1.1	NO	**1 149.9**	0.0005
2009	872.5	872.5	NA	177.9	1.4	0.9	NO	**1 052.7**	0.0005
2010	944.3	944.3	NA	228.4	1.3	0.8	NO	**1 174.8**	0.0005
2011	916.9	916.9	NA	235.7	1.2	0.7	NO	**1 154.5**	0.0005
2012	930.2	930.2	NA	232.7	1.0	0.7	NO	**1 164.5**	0.0005
2013	956.0	956.0	NA	251.9	1.0	0.7	NO	**1 209.6**	0.0005
2014	896.8	896.8	NA	247.1	1.0	0.6	NO	**1 145.6**	0.0005

Table A-7: Emission trends for Hg [kg] 1990–2014 – Submission under UNECE/LRTAP.

year	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	1 561.9	1 561.9	NA	527.6	0.3	53.6	NO	**2 143.4**	0.0001
1991	1 501.7	1 501.7	NA	492.2	0.3	45.5	NO	**2 039.7**	0.0001
1992	1 183.0	1 183.0	NA	435.4	0.3	23.9	NO	**1 642.6**	0.0001
1993	958.6	958.6	NA	412.0	0.3	22.8	NO	**1 393.6**	0.0001
1994	760.7	760.7	NA	398.1	0.3	21.4	NO	**1 180.5**	0.0001
1995	714.8	714.8	NA	466.2	0.3	20.3	NO	**1 201.6**	0.0001
1996	711.2	711.2	NA	430.8	0.3	18.3	NO	**1 160.5**	0.0001
1997	682.9	682.9	NA	433.6	0.3	16.1	NO	**1 132.9**	0.0001
1998	601.6	601.6	NA	333.5	0.3	14.0	NO	**949.3**	0.0001
1999	646.7	646.7	NA	275.9	0.3	12.1	NO	**934.9**	0.0001
2000	640.3	640.3	NA	241.4	0.2	10.0	NO	**892.0**	0.0001
2001	701.6	701.6	NA	244.9	0.3	9.8	NO	**956.5**	0.0001
2002	650.0	650.0	NA	260.9	0.3	9.9	NO	**921.1**	0.0001
2003	687.0	687.0	NA	261.4	0.2	14.6	NO	**963.3**	0.0001
2004	643.7	643.7	NA	271.7	0.4	19.3	NO	**935.1**	0.0001
2005	655.7	655.7	NA	304.8	0.2	20.6	NO	**981.3**	0.0002
2006	663.7	663.7	NA	310.7	0.2	20.5	NO	**995.1**	0.0002
2007	650.6	650.6	NA	328.8	0.2	20.3	NO	**999.9**	0.0002
2008	669.3	669.3	NA	326.5	0.2	20.2	NO	**1 016.2**	0.0002
2009	629.8	629.8	NA	244.4	0.2	20.1	NO	**894.4**	0.0002
2010	660.0	660.0	NA	315.1	0.2	19.9	NO	**995.2**	0.0002
2011	638.8	638.8	NA	325.0	0.2	19.9	NO	**984.0**	0.0002
2012	647.4	647.4	NA	321.1	0.1	19.9	NO	**988.7**	0.0002
2013	654.6	654.6	NA	343.1	0.1	19.9	NO	**1 017.8**	0.0002
2014	605.0	605.0	NA	336.0	0.1	19.9	NO	**961.1**	0.0002

Table A-8: Emission trends for Pb [kg] 1990–2014 – Submission under UNECE/LRTAP.

year	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	178 395.8	178 395.8	NA	35 651.4	11.4	1 015.8	NO	**215 074.4**	0.2
1991	145 150.7	145 150.7	NA	30 390.2	11.1	777.6	NO	**176 329.6**	0.3
1992	99 893.8	99 893.8	NA	21 155.1	11.1	488.3	NO	**121 548.3**	0.3
1993	66 916.8	66 916.8	NA	17 537.8	10.5	381.1	NO	**84 846.2**	0.3
1994	43 719.4	43 719.4	NA	14 817.2	10.9	265.7	NO	**58 813.2**	0.3
1995	8 726.5	8 726.5	NA	7 336.3	10.8	9.2	NO	**16 082.9**	0.3
1996	8 589.9	8 589.9	NA	6 919.6	10.3	9.1	NO	**15 528.9**	0.4
1997	7 496.1	7 496.1	NA	6 953.3	10.5	9.1	NO	**14 469.1**	0.4
1998	6 632.9	6 632.9	NA	6 340.7	10.4	9.0	NO	**12 993.0**	0.4
1999	6 393.7	6 393.7	NA	6 018.7	10.5	9.0	NO	**12 431.9**	0.4
2000	5 822.9	5 822.9	NA	6 066.7	9.6	9.0	NO	**11 908.2**	0.4
2001	6 026.4	6 026.4	NA	5 936.7	10.2	8.9	NO	**11 982.2**	0.4
2002	5 874.2	5 874.2	NA	6 236.0	9.8	8.9	NO	**12 128.8**	0.4
2003	6 138.9	6 138.9	NA	6 262.8	9.3	8.9	NO	**12 419.9**	0.3
2004	6 263.9	6 263.9	NA	6 528.8	12.6	8.9	NO	**12 814.2**	0.4
2005	6 096.1	6 096.1	NA	7 135.4	9.4	8.9	NO	**13 249.8**	0.5
2006	6 142.4	6 142.4	NA	7 340.4	8.9	7.3	NO	**13 499.0**	0.5
2007	6 538.4	6 538.4	NA	7 743.1	9.1	6.0	NO	**14 296.5**	0.5
2008	6 972.2	6 972.2	NA	7 677.9	8.8	4.6	NO	**14 663.5**	0.5
2009	7 010.6	7 010.6	NA	5 746.8	8.2	3.3	NO	**12 768.9**	0.5
2010	7 670.6	7 670.6	NA	7 314.6	8.0	2.0	NO	**14 995.2**	0.5
2011	7 323.7	7 323.7	NA	7 545.2	7.0	1.9	NO	**14 877.9**	0.5
2012	7 382.1	7 382.1	NA	7 429.6	6.2	1.9	NO	**14 819.8**	0.5
2013	7 513.0	7 513.0	NA	8 271.4	6.0	1.8	NO	**15 792.3**	0.5
2014	7 005.8	7 005.8	NA	8 100.3	6.3	1.8	NO	**15 114.1**	0.5

Table A-9: Emission trends for PAH [kg] 1990–2014 – Submission under UNECE/LRTAP.

year	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	8 885.0	8 885.0	NA	7 134.1	249.8	0.2	NO	**16 269.1**	NE
1991	9 714.4	9 714.4	NA	6 932.2	249.3	0.2	NO	**16 896.2**	NE
1992	8 824.9	8 824.9	NA	3 083.5	248.9	0.0	NO	**12 157.2**	NE
1993	8 723.9	8 723.9	NA	515.2	248.5	0.0	NO	**9 487.6**	NE
1994	7 852.5	7 852.5	NA	401.2	247.6	0.0	NO	**8 501.3**	NE
1995	8 314.8	8 314.8	NA	287.9	246.7	0.0	NO	**8 849.4**	NE
1996	8 907.9	8 907.9	NA	250.1	244.9	0.0	NO	**9 403.0**	NE
1997	7 973.9	7 973.9	NA	221.8	243.2	0.0	NO	**8 438.9**	NE
1998	7 608.4	7 608.4	NA	195.3	242.4	0.0	NO	**8 046.1**	NE
1999	7 592.1	7 592.1	NA	197.4	241.7	0.0	NO	**8 031.2**	NE
2000	6 984.5	6 984.5	NA	179.1	240.7	0.0	NO	**7 404.3**	NE
2001	7 083.4	7 083.4	NA	181.1	239.7	0.0	NO	**7 504.1**	NE
2002	6 325.7	6 325.7	NA	190.3	238.6	0.0	NO	**6 754.6**	NE
2003	6 056.6	6 056.6	NA	190.7	237.6	0.0	NO	**6 484.9**	NE
2004	5 894.1	5 894.1	NA	196.9	305.6	0.0	NO	**6 396.5**	NE
2005	6 230.2	6 230.2	NA	216.1	207.6	0.0	NO	**6 653.9**	NE
2006	5 808.7	5 808.7	NA	219.7	196.9	0.0	NO	**6 225.3**	NE
2007	5 637.4	5 637.4	NA	230.4	205.2	0.0	NO	**6 073.0**	NE
2008	5 683.0	5 683.0	NA	229.1	178.9	0.0	NO	**6 091.1**	NE
2009	5 116.6	5 116.6	NA	181.0	178.6	0.0	NO	**5 476.2**	NE
2010	5 649.5	5 649.5	NA	222.1	170.9	0.0	NO	**6 042.4**	NE
2011	5 094.3	5 094.3	NA	228.1	118.2	0.0	NO	**5 440.6**	NE
2012	5 251.7	5 251.7	NA	225.7	98.7	0.0	NO	**5 576.1**	NE
2013	5 887.0	5 887.0	NA	238.3	84.4	0.0	NO	**6 209.7**	NE
2014	4 560.0	4 560.0	NA	234.3	90.9	0.0	NO	**4 885.1**	NE

Table A-10: Emission trends for Dioxin/Furan (PCDD/F) [g] 1990–2014 – Submission under UNECE/LRTAP.

year	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	99.78	99.78	NA	42.53	0.18	18.19	NO	**160.69**	NE
1991	78.80	78.80	NA	38.66	0.18	17.75	NO	**135.39**	NE
1992	51.74	51.74	NA	24.36	0.18	0.53	NO	**76.81**	NE
1993	47.75	47.75	NA	18.88	0.18	0.22	NO	**67.03**	NE
1994	42.87	42.87	NA	13.13	0.18	0.08	NO	**56.26**	NE
1995	44.13	44.13	NA	14.09	0.18	0.08	NO	**58.48**	NE
1996	46.54	46.54	NA	13.03	0.18	0.08	NO	**59.84**	NE
1997	41.14	41.14	NA	17.92	0.18	0.08	NO	**59.32**	NE
1998	38.85	38.85	NA	17.22	0.18	0.08	NO	**56.33**	NE
1999	39.36	39.36	NA	14.00	0.18	0.08	NO	**53.62**	NE
2000	36.34	36.34	NA	15.45	0.18	0.08	NO	**52.04**	NE
2001	36.36	36.36	NA	14.95	0.18	0.08	NO	**51.56**	NE
2002	32.72	32.72	NA	4.62	0.18	0.08	NO	**37.60**	NE
2003	31.71	31.71	NA	4.36	0.17	0.12	NO	**36.36**	NE
2004	31.13	31.13	NA	4.68	0.22	0.16	NO	**36.19**	NE
2005	32.05	32.05	NA	5.40	0.15	0.17	NO	**37.77**	NE
2006	30.44	30.44	NA	6.14	0.15	0.17	NO	**36.89**	NE
2007	30.55	30.55	NA	5.46	0.15	0.17	NO	**36.32**	NE
2008	31.33	31.33	NA	4.91	0.13	0.17	NO	**36.54**	NE
2009	28.76	28.76	NA	4.08	0.13	0.17	NO	**33.14**	NE
2010	31.92	31.92	NA	4.71	0.13	0.16	NO	**36.91**	NE
2011	28.93	28.93	NA	4.50	0.09	0.16	NO	**33.69**	NE
2012	29.72	29.72	NA	4.48	0.07	0.16	NO	**34.44**	NE
2013	32.61	32.61	NA	4.87	0.06	0.16	NO	**37.72**	NE
2014	26.45	26.45	NA	4.92	0.07	0.16	NO	**31.61**	NE

Table A-11: Emission trends for HCB [kg] 1990–2014 – Submission under UNECE/LRTAP.

year	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	**91.93**	NE
1991	68.69	68.69	NA	15.62	0.04	0.28	NO	**84.62**	NE
1992	55.90	55.90	NA	13.63	0.04	0.11	NO	**69.67**	NE
1993	52.86	52.86	NA	11.08	0.04	0.04	NO	**64.02**	NE
1994	47.27	47.27	NA	4.61	0.04	0.02	NO	**51.93**	NE
1995	49.46	49.46	NA	3.57	0.04	0.02	NO	**53.09**	NE
1996	52.41	52.41	NA	3.34	0.04	0.02	NO	**55.80**	NE
1997	46.35	46.35	NA	5.51	0.04	0.02	NO	**51.91**	NE
1998	43.93	43.93	NA	5.35	0.04	0.02	NO	**49.34**	NE
1999	44.10	44.10	NA	3.42	0.04	0.02	NO	**47.57**	NE
2000	40.48	40.48	NA	3.74	0.04	0.02	NO	**44.28**	NE
2001	41.96	41.96	NA	3.64	0.04	0.02	NO	**45.65**	NE
2002	37.93	37.93	NA	3.83	0.04	0.02	NO	**41.81**	NE
2003	36.88	36.88	NA	3.83	0.03	0.02	NO	**40.77**	NE
2004	36.73	36.73	NA	3.95	0.04	0.03	NO	**40.77**	NE
2005	38.36	38.36	NA	4.34	0.03	0.03	NO	**42.77**	NE
2006	35.66	35.66	NA	4.41	0.03	0.03	NO	**40.14**	NE
2007	34.42	34.42	NA	4.63	0.03	0.03	NO	**39.11**	NE
2008	34.70	34.70	NA	4.60	0.03	0.03	NO	**39.35**	NE
2009	31.54	31.54	NA	3.61	0.03	0.03	NO	**35.21**	NE
2010	35.74	35.74	NA	4.45	0.03	0.03	NO	**40.25**	NE
2011	31.94	31.94	NA	4.57	0.02	0.03	NO	**36.56**	NE
2012	57.31	57.31	NA	4.52	0.01	0.03	NO	**61.88**	NE
2013	139.37	139.37	NA	4.79	0.01	0.03	NO	**144.20**	NE
2014	136.21	136.21	NA	4.70	0.01	0.03	NO	**140.95**	NE

Table A-12: Emission trends for PCB [kg] 1990–2014 – Submission under UNECE/LRTAP.

year	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	4.95	4.95	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	3.73	3.73	NA	172.01	NA	NA	NO	**175.74**	NE
2006	3.56	3.56	NA	184.57	NA	NA	NO	**188.13**	NE
2007	2.84	2.84	NA	187.92	NA	NA	NO	**190.75**	NE
2008	2.81	2.81	NA	182.54	NA	NA	NO	**185.35**	NE
2009	2.45	2.45	NA	158.98	NA	NA	NO	**161.43**	NE
2010	2.47	2.47	NA	176.57	NA	NA	NO	**179.04**	NE
2011	2.09	2.09	NA	179.95	NA	NA	NO	**182.04**	NE
2012	1.98	1.98	NA	174.19	NA	NA	NO	**176.17**	NE
2013	1.91	1.91	NA	222.21	NA	NA	NO	**224.12**	NE
2014	1.93	1.93	NA	216.36	NA	NA	NO	**218.30**	NE

Table A-13: Emission trends for TSP [kt] 1990–2014 – Submission under UNECE/LRTAP.

year	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	31.19	30.33	0.85	18.94	11.53	0.15	NO	**61.80**	0.28
1995	31.48	30.83	0.65	19.05	11.70	0.16	NO	**62.39**	0.42
2000	31.89	31.23	0.66	19.20	11.40	0.09	NO	**62.58**	0.52
2001	32.15	31.47	0.68	18.54	11.40	0.09	NO	**62.19**	0.51
2002	31.84	31.12	0.72	17.84	11.37	0.11	NO	**61.15**	0.46
2003	31.98	31.25	0.73	17.55	11.38	0.13	NO	**61.04**	0.43
2004	31.58	30.96	0.62	18.17	11.53	0.17	NO	**61.45**	0.51
2005	31.87	31.27	0.61	17.57	11.49	0.19	NO	**61.12**	0.59
2006	31.62	31.03	0.59	16.35	11.33	0.19	NO	**59.48**	0.63
2007	31.41	30.88	0.53	15.87	11.27	0.22	NO	**58.76**	0.66
2008	31.17	30.66	0.51	16.94	11.17	0.18	NO	**59.46**	0.66
2009	29.59	29.21	0.38	15.78	11.15	0.17	NO	**56.69**	0.57
2010	30.27	29.80	0.46	15.53	11.11	0.19	NO	**57.10**	0.62
2011	29.55	29.08	0.48	15.98	11.04	0.22	NO	**56.79**	0.65
2012	29.26	28.82	0.44	15.64	10.97	0.28	NO	**56.14**	0.62
2013	29.68	29.23	0.45	15.56	10.92	0.28	NO	**56.45**	0.59
2014	28.07	27.65	0.41	15.99	10.87	0.36	NO	**55.29**	0.59

Table A-14: Emission trends for PM_{10} [kt] 1990–2014 – Submission under UNECE/LRTAP.

year	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	24.05	23.65	0.40	10.86	5.26	0.07	NO	**40.24**	0.28
1995	23.80	23.50	0.31	10.38	5.34	0.08	NO	**39.60**	0.42
2000	23.53	23.22	0.31	10.34	5.19	0.04	NO	**39.11**	0.52
2001	23.72	23.39	0.32	10.02	5.20	0.04	NO	**38.98**	0.51
2002	23.33	22.99	0.34	9.34	5.18	0.05	NO	**37.90**	0.46
2003	23.31	22.96	0.35	9.20	5.18	0.06	NO	**37.75**	0.43
2004	22.83	22.54	0.29	9.46	5.28	0.08	NO	**37.65**	0.51
2005	22.83	22.55	0.29	9.13	5.23	0.09	NO	**37.29**	0.59
2006	22.33	22.05	0.28	8.37	5.16	0.09	NO	**35.94**	0.63
2007	21.95	21.70	0.25	8.00	5.13	0.10	NO	**35.18**	0.66
2008	21.53	21.29	0.24	8.55	5.08	0.08	NO	**35.26**	0.66
2009	20.22	20.04	0.18	7.96	5.07	0.08	NO	**33.33**	0.57
2010	20.68	20.46	0.22	7.84	5.05	0.09	NO	**33.66**	0.62
2011	19.87	19.65	0.23	8.07	5.01	0.11	NO	**33.06**	0.65
2012	19.56	19.36	0.21	7.89	4.97	0.13	NO	**32.56**	0.62
2013	19.84	19.63	0.21	7.85	4.95	0.13	NO	**32.77**	0.59
2014	18.24	18.04	0.20	8.05	4.93	0.17	NO	**31.39**	0.59

Table A-15: Emission trends for $PM_{2.5}$ [kt] 1990–2014– Submission under UNECE/LRTAP.

year	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	20.25	20.15	0.11	3.65	1.27	0.02	NO	**25.20**	0.28
1995	20.00	19.91	0.09	3.03	1.29	0.02	NO	**24.34**	0.42
2000	19.53	19.44	0.09	2.82	1.24	0.01	NO	**23.61**	0.52
2001	19.68	19.59	0.09	2.77	1.25	0.01	NO	**23.72**	0.51
2002	19.29	19.19	0.10	2.36	1.24	0.02	NO	**22.90**	0.46
2003	19.18	19.08	0.10	2.33	1.24	0.02	NO	**22.78**	0.43
2004	18.71	18.62	0.09	2.33	1.29	0.03	NO	**22.36**	0.51
2005	18.57	18.48	0.09	2.27	1.25	0.03	NO	**22.12**	0.59
2006	17.93	17.85	0.09	2.01	1.23	0.03	NO	**21.20**	0.63
2007	17.46	17.38	0.08	1.82	1.22	0.03	NO	**20.53**	0.66
2008	16.92	16.84	0.08	1.93	1.21	0.03	NO	**20.09**	0.66
2009	15.74	15.68	0.06	1.81	1.20	0.03	NO	**18.78**	0.57
2010	16.04	15.97	0.07	1.81	1.20	0.03	NO	**19.07**	0.62
2011	15.22	15.15	0.07	1.86	1.18	0.03	NO	**18.29**	0.65
2012	14.90	14.84	0.07	1.81	1.16	0.04	NO	**17.92**	0.62
2013	15.07	15.00	0.07	1.80	1.15	0.04	NO	**18.06**	0.59
2014	13.57	13.51	0.06	1.83	1.15	0.05	NO	**16.61**	0.59

11.3 Austria's emissions for SO_2, NO_x, NMVOC and NH_3 according to the submission under the NEC directive

In the following tables Austria's emissions 1990–2014 are listed according to NEC Directive 2001/81/EC. NEC 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: Austria's emissions 1990–2014 on the basis of fuel used according to Directive 2001/81/EC, Article 8 (1).

	SO_2 [kt]	NO_x [kt]	NMVOC [kt]	NH_3 [kt]
1990	73.54	197.97	277.37	66.44
1991	70.37	198.32	268.83	67.81
1992	53.98	188.48	250.95	66.24
1993	52.21	179.38	238.36	67.13
1994	46.67	175.69	217.30	68.67
1995	46.37	174.32	203.74	69.95
1996	43.97	173.94	197.84	68.70
1997	39.75	176.27	178.04	69.27
1998	34.88	173.98	168.19	69.67
1999	33.10	173.87	161.70	68.43
2000	30.97	172.78	153.01	67.00
2001	31.97	174.69	148.29	67.00
2002	31.09	172.47	142.85	66.04
2003	31.10	175.39	139.51	65.81
2004	27.32	174.34	135.15	65.38
2005	26.35	175.73	132.39	65.45
2006	27.08	174.10	127.71	65.72
2007	24.11	170.21	123.90	67.05
2008	21.78	162.88	122.13	66.76
2009	16.38	148.27	116.38	67.94
2010	17.87	147.44	117.10	67.18
2011	16.77	143.88	113.88	66.57
2012	16.09	139.26	112.95	66.62
2013	15.84	135.72	114.66	66.42
2014	15.99	129.95	109.83	66.91
Ceilings 2010	*39.00*	*103.00*	*159.00*	*66.00*

Table A-17: Austria's SO_2 emissions 1990–2014 on the basis of fuel used according to Directive 2001/81/EC, Article 8 (1).

SO_x	NFR Sectors according to NEC directive								
	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	NATIONAL TOTAL	International Bunkers
	kt								
1990	71.25	69.25	2.00	2.22	0.00	0.07	NO	**73.54**	0.26
1991	68.41	67.11	1.30	1.90	0.00	0.06	NO	**70.37**	0.29
1992	52.27	50.27	2.00	1.67	0.00	0.04	NO	**53.98**	0.31
1993	50.75	48.65	2.10	1.42	0.00	0.04	NO	**52.21**	0.33
1994	45.21	43.93	1.28	1.42	0.00	0.05	NO	**46.67**	0.34
1995	44.95	43.42	1.53	1.37	0.00	0.05	NO	**46.37**	0.38
1996	42.62	41.42	1.20	1.29	0.00	0.05	NO	**43.97**	0.43
1997	38.42	38.36	0.07	1.27	0.00	0.05	NO	**39.75**	0.44
1998	33.64	33.60	0.04	1.18	0.00	0.05	NO	**34.88**	0.46
1999	31.92	31.88	0.04	1.12	0.00	0.06	NO	**33.10**	0.45
2000	29.82	29.78	0.04	1.09	0.00	0.06	NO	**30.97**	0.48
2001	30.70	30.65	0.05	1.21	0.00	0.06	NO	**31.97**	0.47
2002	29.82	29.78	0.04	1.21	0.00	0.06	NO	**31.09**	0.43
2003	29.83	29.78	0.05	1.21	0.00	0.06	NO	**31.10**	0.40
2004	26.05	26.00	0.04	1.22	0.00	0.06	NO	**27.32**	0.47
2005	25.07	25.03	0.04	1.22	0.00	0.06	NO	**26.35**	0.55
2006	25.81	25.76	0.05	1.22	0.00	0.05	NO	**27.08**	0.58
2007	22.85	22.80	0.05	1.22	0.00	0.04	NO	**24.11**	0.61
2008	20.52	20.48	0.04	1.23	0.00	0.03	NO	**21.78**	0.61
2009	15.15	15.09	0.06	1.21	0.00	0.02	NO	**16.38**	0.53
2010	16.64	16.59	0.05	1.21	0.00	0.01	NO	**17.87**	0.57
2011	15.54	15.49	0.05	1.22	0.00	0.01	NO	**16.77**	0.60
2012	14.87	14.82	0.05	1.22	0.00	0.01	NO	**16.09**	0.57
2013	14.61	14.57	0.04	1.22	0.00	0.01	NO	**15.84**	0.54
2014	14.76	14.72	0.04	1.22	0.00	0.01	NO	**15.99**	0.54

Table A-18: Austria's NO_x emissions 1990–2014 on the basis of fuel used according to Directive 2001/81/EC, Article 8 (1).

NO_x	NFR Sectors according to NEC directive								
	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	186.32	186.32	IE	4.80	6.75	0.10	NO	**197.97**	2.44
1991	186.82	186.82	IE	4.48	6.93	0.09	NO	**198.32**	2.76
1992	177.33	177.33	IE	4.55	6.54	0.06	NO	**188.48**	3.00
1993	171.03	171.03	IE	1.98	6.33	0.05	NO	**179.38**	3.18
1994	166.96	166.96	IE	1.92	6.77	0.04	NO	**175.69**	3.31
1995	165.93	165.93	IE	1.46	6.89	0.05	NO	**174.32**	3.73
1996	165.92	165.92	IE	1.42	6.55	0.05	NO	**173.94**	4.14
1997	168.17	168.17	IE	1.50	6.55	0.05	NO	**176.27**	4.29
1998	165.90	165.90	IE	1.46	6.57	0.05	NO	**173.98**	4.43
1999	165.97	165.97	IE	1.44	6.41	0.05	NO	**173.87**	4.33
2000	164.87	164.87	IE	1.54	6.32	0.05	NO	**172.78**	6.44
2001	166.76	166.76	IE	1.57	6.31	0.05	NO	**174.69**	6.32
2002	164.54	164.54	IE	1.63	6.25	0.05	NO	**172.47**	5.67
2003	167.89	167.89	IE	1.34	6.12	0.05	NO	**175.39**	5.21
2004	167.04	167.04	IE	1.28	5.97	0.05	NO	**174.34**	6.09
2005	167.97	167.97	IE	1.75	5.95	0.05	NO	**175.73**	6.99
2006	166.27	166.27	IE	1.82	5.96	0.04	NO	**174.10**	7.54
2007	162.41	162.41	IE	1.71	6.05	0.04	NO	**170.21**	7.99
2008	154.75	154.75	IE	1.91	6.18	0.03	NO	**162.88**	7.90
2009	140.51	140.51	IE	1.54	6.20	0.02	NO	**148.27**	6.86
2010	139.65	139.65	IE	1.81	5.96	0.01	NO	**147.44**	7.60
2011	136.01	136.01	IE	1.83	6.03	0.01	NO	**143.88**	7.98
2012	131.59	131.59	IE	1.63	6.03	0.01	NO	**139.26**	7.68
2013	128.26	128.26	IE	1.45	6.00	0.01	NO	**135.72**	7.46
2014	122.36	122.36	IE	1.50	6.08	0.01	NO	**129.95**	7.49

Table A-19: Austria's NMVOC emissions 1990–2014 on the basis of fuel used according to Directive 2001/81/EC, Article 8 (1).

NMVOC	NFR Sectors according to NEC directive								
	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	149.87	134.38	15.49	125.53	1.81	0.16	NO	**277.37**	0.18
1991	146.49	131.37	15.12	120.38	1.80	0.16	NO	**268.83**	0.20
1992	134.10	118.91	15.19	114.95	1.75	0.15	NO	**250.95**	0.22
1993	126.90	112.25	14.65	109.59	1.72	0.15	NO	**238.36**	0.24
1994	113.91	102.79	11.12	101.48	1.77	0.14	NO	**217.30**	0.25
1995	108.61	99.12	9.49	93.22	1.78	0.13	NO	**203.74**	0.29
1996	106.13	97.67	8.46	89.82	1.76	0.13	NO	**197.84**	0.34
1997	89.37	81.42	7.95	86.69	1.85	0.12	NO	**178.04**	0.37
1998	82.74	76.31	6.43	83.53	1.80	0.11	NO	**168.19**	0.40
1999	79.72	74.04	5.67	80.03	1.84	0.11	NO	**161.70**	0.39
2000	74.04	68.35	5.69	77.13	1.74	0.11	NO	**153.01**	0.42
2001	70.03	66.20	3.84	76.34	1.82	0.10	NO	**148.29**	0.41
2002	64.58	60.55	4.03	76.35	1.81	0.10	NO	**142.85**	0.37
2003	61.86	57.91	3.96	75.83	1.72	0.10	NO	**139.51**	0.34
2004	58.03	54.46	3.57	75.04	1.97	0.10	NO	**135.15**	0.40
2005	56.00	52.65	3.34	74.44	1.86	0.10	NO	**132.39**	0.47
2006	52.22	48.86	3.36	73.64	1.76	0.09	NO	**127.71**	0.50
2007	49.38	46.39	2.98	72.67	1.77	0.09	NO	**123.90**	0.53
2008	48.33	45.57	2.75	71.81	1.91	0.08	NO	**122.13**	0.52
2009	44.04	41.45	2.59	70.48	1.79	0.07	NO	**116.38**	0.45
2010	45.63	43.18	2.45	69.67	1.74	0.07	NO	**117.10**	0.49
2011	42.66	40.25	2.41	69.25	1.90	0.06	NO	**113.88**	0.51
2012	42.78	40.38	2.40	68.41	1.70	0.06	NO	**112.95**	0.49
2013	44.09	41.78	2.30	68.85	1.66	0.06	NO	**114.66**	0.46
2014	38.60	36.18	2.42	69.31	1.86	0.05	NO	**109.83**	0.46

Table A-20: Austria's NH_3 emissions 1990–2014 on the basis of fuel used according to Directive 2001/81/EC, Article 8 (1).

NH_3	NFR Sectors according to NEC directive								
	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	2.236	2.236	IE	0.269	63.579	0.358	NO	66.441	0.002
1991	2.710	2.710	IE	0.507	64.226	0.371	NO	67.815	0.002
1992	3.041	3.041	IE	0.369	62.404	0.421	NO	66.235	0.002
1993	3.411	3.411	IE	0.219	62.998	0.498	NO	67.126	0.002
1994	3.650	3.650	IE	0.168	64.279	0.572	NO	68.669	0.002
1995	3.841	3.841	IE	0.099	65.422	0.584	NO	69.946	0.003
1996	4.101	4.101	IE	0.097	63.902	0.605	NO	68.704	0.003
1997	4.182	4.182	IE	0.103	64.394	0.586	NO	69.265	0.003
1998	4.290	4.290	IE	0.103	64.673	0.603	NO	69.669	0.003
1999	4.424	4.424	IE	0.119	63.246	0.638	NO	68.426	0.003
2000	4.317	4.317	IE	0.100	61.914	0.669	NO	67.001	0.003
2001	4.244	4.244	IE	0.079	61.929	0.748	NO	67.001	0.003
2002	3.941	3.941	IE	0.061	61.210	0.824	NO	66.035	0.003
2003	3.750	3.750	IE	0.076	61.097	0.891	NO	65.813	0.003
2004	3.521	3.521	IE	0.059	60.675	1.123	NO	65.378	0.003
2005	3.420	3.420	IE	0.068	60.755	1.209	NO	65.451	0.004
2006	3.248	3.248	IE	0.074	61.176	1.223	NO	65.721	0.004
2007	3.154	3.154	IE	0.077	62.572	1.243	NO	67.046	0.004
2008	3.066	3.066	IE	0.081	62.394	1.221	NO	66.762	0.004
2009	2.859	2.859	IE	0.088	63.787	1.204	NO	67.939	0.004
2010	2.966	2.966	IE	0.091	62.909	1.216	NO	67.181	0.004
2011	2.873	2.873	IE	0.101	62.364	1.227	NO	66.565	0.004
2012	2.809	2.809	IE	0.094	62.488	1.231	NO	66.622	0.004
2013	2.770	2.770	IE	0.096	62.392	1.164	NO	66.422	0.004
2014	2.649	2.649	IE	0.089	62.966	1.204	NO	66.907	0.004

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The Informative Inventory Report (IIR) 2016 presents a comprehensive and detailed description of trends and methodologies applied in the Austrian Air Emission Inventory (Österreichische Luftschadstoff-Inventur – OLI) for the air pollutants

- sulphur dioxide (SO_2), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOCs), ammonia (NH_3)
- carbon monoxide (CO) and
- particulate matter (TSP, PM_{10}, $PM_{2.5}$)

as well as the air pollutant groups such as

- heavy metals: cadmium (Cd), mercury (Hg), lead (Pb) and
- persistent organic pollutants (POPs): polycyclic aromatic hydrocarbons (PAHs), dioxins and furans (PCDD/Fs), hexachlorobenzene (HCB) as well as polychlorinated biphenyls (PCB).

With the IIR 2016, Austria complies with its reporting obligation under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP).

EMAS
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