

Switzerland's Informative Inventory Report 2026 (IIR)

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

Submission of March 2026
to the United Nations ECE Secretariat



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Table of contents

Table of contents	5
Glossary	8
Executive Summary	12
1 Introduction	19
1.1 National inventory background	19
1.2 Institutional arrangements	19
1.3 Inventory preparation process	19
1.4 Methods and data sources	21
1.5 Key categories	25
1.6 QA/QC and verification methods	35
1.7 General uncertainty evaluation	36
1.8 General assessment of completeness.....	40
2 Emission trends 1980-2024	42
2.1 Comments on trends	42
2.2 Overall trends of total emissions.....	45
2.3 Trends of main pollutants per gas and sectors	54
2.4 Trends of particulate matter per pollutant	60
2.5 Trends of other pollutants	65
2.6 Trends of priority heavy metals per pollutant	65
2.7 Trends of persistent organic pollutants per pollutant.....	68
2.8 Compliance with the Gothenburg Protocol.....	71
3 Energy	73
3.1 Overview of emissions.....	73
3.2 Source category 1A - Fuel combustion activities	101
3.3 Source category 1B - Fugitive emissions from fuels	189
4 Industrial processes and product use	198
4.1 Overview of emissions.....	198
4.2 Source category 2A – Mineral products	205
4.3 Source category 2B – Chemical industry	209
4.4 Source category 2C – Metal production.....	215
4.5 Source category 2D3 – Other solvent use	220
4.6 Source category 2G – Other product use	232
4.7 Source categories 2H – Other industry production	236
4.8 Source categories 2I – Wood processing, 2K – Consumption of POPs and heavy metals and 2L – Other production, consumption, storage, transportation or handling of bulk products	240

5	Agriculture	244
5.1	Overview of emissions.....	244
5.2	Source category 3B – Manure management	247
5.3	Source category 3D – Agricultural soils	257
5.4	Source category 3F – Field burning of agricultural residuals	266
6	Waste 267	
6.1	Overview of emissions.....	267
6.2	Source category 5A – Biological treatment of waste - Solid waste disposal on land	270
6.3	Source category 5B - Biological treatment of waste - Composting and anaerobic digestion at biogas facilities	272
6.4	Source category 5C – Waste incineration and open burning of waste	277
6.5	Source category 5D – Wastewater handling.....	280
6.6	Source category 5E – Other waste, shredding	284
7	Other and natural emissions	286
7.1	Overview of emissions.....	286
7.2	Source category 6A - Other emissions	291
7.3	Source category 11B - Forest fires	297
7.4	Category 11C – Other natural emissions	299
8	Recalculations and planned improvements	303
8.1	Recalculations	303
8.2	Planned improvements.....	317
9	Emission projections 2030–2050	319
9.1	Comments on projections	319
9.2	Assumptions for projections for the WM scenario	319
9.3	Main pollutants and CO	327
9.4	Suspended particulate matter.....	332
9.5	Priority heavy metals	338
9.6	Persistent organic pollutants	342
10	Reporting of gridded emissions and LPS	347
10.1	EMEP grid.....	347
10.2	Gridding of emissions.....	349
10.3	EMEP grid results (visualizations)	354
10.4	Large point sources (LPS).....	357
11	Adjustments	359
12	References and assignments to EMIS categories	360
12.1	References.....	360
12.2	Assignment of EMIS categories to NFR codes	379

Annexes	380
Annex 1 Key category analysis (KCA)	380
Annex 2 Other detailed methodological descriptions for individual source categories	393
Annex 3 Additional information and explanations concerning the NFR tables	404
Annex 4 National energy balance	406
Annex 5 Additional information concerning uncertainties	409
Annex 6 Summary information on condensables in PM	438
Annex 7 Emission time series of main air pollutants, PM2.5 and BC for 1990–2024 at aggregated sector levels	439
Annex 8 Corrigendum to NH₃ emissions in source category 3Da4 Crop residues applied to soils	445

Glossary

AD	Activity data
Avenergy	Avenergy Suisse (Swiss Petroleum Association, formerly Erdöl-Vereinigung (EV))
BaP	Benzo(a)pyrene (CLRTAP: POP)
BbF	Benzo(b)fluoranthene (CLRTAP: POP)
BC	Black Carbon
BkF	Benzo(k)fluoranthene (CLRTAP: POP)
Carbura	Swiss organisation for the compulsory stockpiling of oil products
CCGT	Combined cycle gas turbine
CEIP	EMEP Centre on Emission Inventories and Projections
Cd	Cadmium (CLRTAP: priority heavy metal)
Cemsuisse	Association of the Swiss cement industry
CHP	Combined heat and power
CLRTAP	UNECE Convention on Long-Range Transboundary Air Pollution
CO	Carbon monoxide
CO ₂	Carbon dioxide
CR	Cruise
CRT	Common Reporting Tables (used for the reporting under the UNFCCC)
DDPS	Federal Department of Defense, Civil Protection and Sport
DETEC	Department of the Environment, Transport, Energy and Communications
DIY	Do it yourself markets
EF	Emission Factor
EMIS	Swiss Emission Information System
EMEP	European Monitoring and Evaluation Programme: Co-operative programme for monitoring and evaluation of the long-range transmissions of air pollutants in Europe (under the CLRTAP)
EMPA	Swiss Federal Laboratories for Material Testing and Research
EPA	Federal Act on the Protection of the Environment
EV	Erdöl-Vereinigung (petroleum association), since 2019: Avenergy Suisse
ex	In combination with pollutant (PM _{2.5} ex, PM ₁₀ ex, TSP ex, BC ex or Cd ex)) exhaust fraction of this pollutant emissions
FAL	Swiss Federal Research Station for Agroecology and Agriculture (since 2013 Agroscope)
FCA	Federal Customs Administration, since 03.01.2022: Federal Office for Customs and Border Security (FOCBS)

FEDRO	Swiss Federal Roads Office
FOCA	Federal Office of Civil Aviation
FOEN	Federal Office for the Environment (former name SAEFL until 2005)
FOCBS	Federal Office for Customs and Border Security, formerly Federal Customs Administration (FCA)
FSKB	Fachverband der Schweizerischen Kies- und Betonindustrie
FSO	Federal Statistical Office (formerly SFSO)
fu	fuel used, principle for calculating activity data and the resulting emissions in the road transportation model (instead of the fuel sold principle)
Gas oil	Light fuel oil
GHG	Greenhouse Gas
GVS	Giesserei Verband der Schweiz / Swiss Foundry Association
ha	Hectare
HAFL	School of Agricultural, Forest and Food Sciences at Bern University of Applied Sciences
HCB	Hexachlorobenzene
Hg	Mercury (CLRTAP: priority heavy metal)
HM	Heavy Metals
IcdP	Indeno(1,2,3-cd)pyrene (CLRTAP: POP)
IIR	Informative Inventory Report (CLRTAP)
INFRAS	Research and consulting company, Zurich/Berne
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
ICAO	International Civil Aviation Organization
I-Teq	International Toxic Equivalent (unit of toxic equivalent factors for PCB's, PCDDs, PCDFs for Human and Wildlife by WHO)
IVZ	Swiss information system traffic admission (Informationssystem Verkehrszulassung IVZ) run by FEDRO, formerly MOFIS
kt	Kilo tonne (1000 tonnes)
L1, L2	Key category according to level assessment with approach 1, approach 2
LTO	Landing/Take-off
LUBW	Baden-Württemberg State Institute for Environmental Protection (Landesanstalt für Umweltschutz Baden-Württemberg), Germany
LULUCF	Land Use, Land-Use Change and Forestry
MOFIS	Swiss federal vehicle registration database run by FEDRO (since 2022: IVZ)
MSW	Municipal Solid Waste
NCV	Net Calorific Value
NFR	Nomenclature For Reporting

NH ₃	Ammonia
NID	National Inventory Document
NIS	National Inventory System
NMVOC	Non-Methane Volatile Organic Compounds
NO _x , NO ₂ , NO	Nitrogen oxides, nitrogen dioxide, nitrogen monoxide
NA, NE, IE, NO, NR	(official notation keys) Not Applicable, Not Estimated, Included Elsewhere, Not Occuring, Not Relevant
nx	In combination with pollutant (PM _{2.5} nx, PM ₁₀ nx, TSP nx, BC nx or Cd nx)) non-exhaust fraction of this pollutant emissions
OAPC	Ordinance on Air Pollution Control
PAH	Polycyclic aromatic hydrocarbons (CLRTAP: POP)
PCDD/PCDF	Polychlorinated Dibenzodioxins and -Furanes (CLRTAP: POP)
Pb	Lead (CLRTAP: priority heavy metal)
PCB	Polychlorinated Biphenyls
PM, PM _{2.5} , PM ₁₀	Suspended Particulate Matter (PM) with an aerodynamic diameter of less than 2.5 µm or 10 µm, respectively.
POPs	Persistent Organic Pollutants
QA/QC	Quality Assurance/Quality Control: QA includes a system of review procedures conducted by persons not directly involved in the inventory development process. QC is a system of routine technical activities to control the quality of the inventory.
QMS	Quality Management System
SAEFL	Swiss Agency for the Environment, Forests and Landscape (since 2006: Federal Office for the Environment FOEN)
SBV	Swiss farmer's union ("Schweizer Bauernverband") or Swiss association of builders ("Schweizerischer Baumeisterverband")
SCGT	Simple cycle gas turbine
SFOE	Swiss Federal Office of Energy
SFSO	Swiss Federal Statistical Office, now: Federal Statistical Office (FSO)
SO _x , SO ₂	Sulphur oxides, sulphur dioxide
SGWA	Swiss Gas and Water Industry Association
SPA	"Schwerpunktaktion", measurement project by the Federal Office for Customs and Border Security (FOCBS) to estimate the sulphur content for diesel oil, gasoline, gas oil Euro and Eco and residual fuel oil
swissmem	Swiss Mechanical and Electrical Engineering Industries (Schweizer Maschinen-, Elektro- und Metallindustrie)
T1, T2	Key category according to trend assessment with approach 1, approach 2
TAN	Total Ammonia Nitrogen
TFEIP	Task Force on Emission Inventory and Projections
TSP	Total Suspended Particulate matter

TSS	“Tankstellensurvey”, measurement project by the Federal Office for Customs and Border Security (FOCBS) to estimate the sulphur content for diesel oil and gasoline
UNFCCC	United Nations Framework Convention on Climate Change
VKTS	Swiss supervising association of textile cleaning
VOC	Volatile Organic Compounds
VSG/SGIA	Swiss Gas Industry Association
VSLF	Swiss association for coating and paint applications
VSTB	Swiss association of grass drying plants
VTG	Swiss Armed Forces – Defence (“Die Gruppe Verteidigung“)
WaM	Scenario “With additional Measures”
WM	Scenario “With Measures”
ZPK	Swiss association of pulp, paper and paperboard industry

Executive Summary

Swiss CLRTAP inventory system

The Swiss inventory system has been developed and is managed by the Federal Office for the Environment (FOEN) under the auspices of the Federal Department of the Environment, Transport, Energy and Communications (DETEC).

FOEN's Air Pollution Control and Chemicals Division maintains a database called EMIS (**EMissionsInformationssystem Schweiz**, Swiss Emission Information System) containing all basic data needed to prepare the CLRTAP inventory. Background information on data sources, activity data, emission factors and methods used for emission estimation are documented in EMIS.

A number of data suppliers provide input data that is fed into EMIS. The inventory's most relevant data sources are the Swiss overall energy statistics, existing models for road transportation and non-road vehicles and machines, data from industry associations and agricultural statistics and models.

Typically, emissions are calculated according to standard methods and procedures as described in the revised UNECE Guidelines 2023 for Estimating and Reporting Emission Data under the Convention on Long Range Transboundary Air Pollution (ECE 2023) and in the EMEP/EEA Air Pollutant Emission Inventory Guidebook, editions 2016, 2019 and 2023 (EMEP/EEA 2016, 2019, 2023).

With a few exceptions, calculations of emissions are consistent with methodological approaches in the greenhouse gas (GHG) inventory under the UNFCCC. However, some relevant differences exist. For example, the Swiss CLRTAP Inventory system applies the "fuel used" (fu) principle for road traffic emissions for estimating compliance with the emission reduction ceilings, while for the GHG inventory, the "fuel sold" principle applies. This means that the so called "fuel tourism" and statistical differences is accounted for in the emissions of the GHG inventory, but not in the CLRTAP Inventory. Note that in the official emission reporting templates the Swiss "National total for the entire territory" (row 141 in the reporting tables) is reported as "fuel sold" in order to be comparable to other countries. **But the Swiss "national total for compliance" with Gothenburg Protocol commitments (row 152 in the reporting tables) is the national total based on the "fuel used"** as mentioned before. The difference between the two approaches can amount to several percent, but deviations varied considerably in the period 1990–2024 due to fluctuating fuel price differences between Switzerland and its neighbouring countries. Also, methodological approaches to determine emissions from aviation under the CLRTAP deviate from the GHG inventory: for the national total CLRTAP, so-called landing and take-off (LTO) emissions of domestic and international flights are taken into account while emissions of international and domestic cruise flights are reported under memo items only (see also chp. 3.1.6.1).

Switzerland and CLRTAP

Switzerland is a Party to the 1979 Geneva Convention on Long-range Transboundary Air Pollution (CLRTAP). The aim of the Convention is to protect the population and the environment against air pollution and to limit and gradually reduce and prevent air pollution including long-range transboundary air pollution. The seven CLRTAP Protocols including the Gothenburg Protocol, require an annual emission reporting. The 1999 Gothenburg Protocol is a multi-pollutant protocol designed to reduce acidification, eutrophication and ground-level ozone by setting national emissions ceilings for sulphur dioxide, nitrogen oxides, volatile organic compounds and ammonia, which were to be met by 2010 and maintained afterwards. A revision of the Protocol including emission reduction commitments for 2020

and beyond expressed as a percentage reduction from the 2005 emission level was adopted in 2012 and entered into force on 7 October 2019. It includes newly also PM_{2.5} commitments. This amended protocol entered into force for Switzerland on 22 October 2019.

Following its obligations under the CLRTAP, Switzerland annually submits its air pollution emission inventory ("CLRTAP Inventory") as well as an Informative Inventory Report (IIR) according to the revised emission reporting guidelines under the CLRTAP. The emission inventory exists since the mid 80's while the very first IIR as a report was submitted in 2008 (FOEN 2008) in accordance with the Guidelines for Reporting Emission Data under the Convention. The report on hand is now the nineteenth IIR of Switzerland.

The report has substantially improved over the years due to recurring external and internal reviews. Stage 1 and stage 2 centralised reviews took place annually, centralised stage 3 reviews in 2010 (UNECE 2010), 2016 (UNECE 2016), 2020 (UNECE 2020a), 2022 (UNECE 2022a), 2023 (UNECE 2023a), 2024 (UNECE 2024a) and 2025 (UNECE 2025a). For the latest submission and driven by this last centralised stage 3 review, specific improvements have been implemented. For a list of the most important improvements, see chapter 1.4.1. Additional information on specific improvements is given in the chapters of the respective sectors and source categories.

Key categories, uncertainties and completeness

In order to identify the most relevant source categories, key category analyses were conducted according to approaches 1 and 2. For both approaches, level assessments were conducted for the years 2024 and 1990 and a trend assessment for 1990-2024. The key category analysis highlights that for the year 2024, Sector 1 Energy is responsible for the majority of emissions of NO_x, SO_x, PM_{2.5} and PM₁₀. Sector 2 IPPU and Sector 3 Agriculture contribute most to NMVOC emissions. The large majority of NH₃ emissions are caused by livestock production within Sector 3 Agriculture.

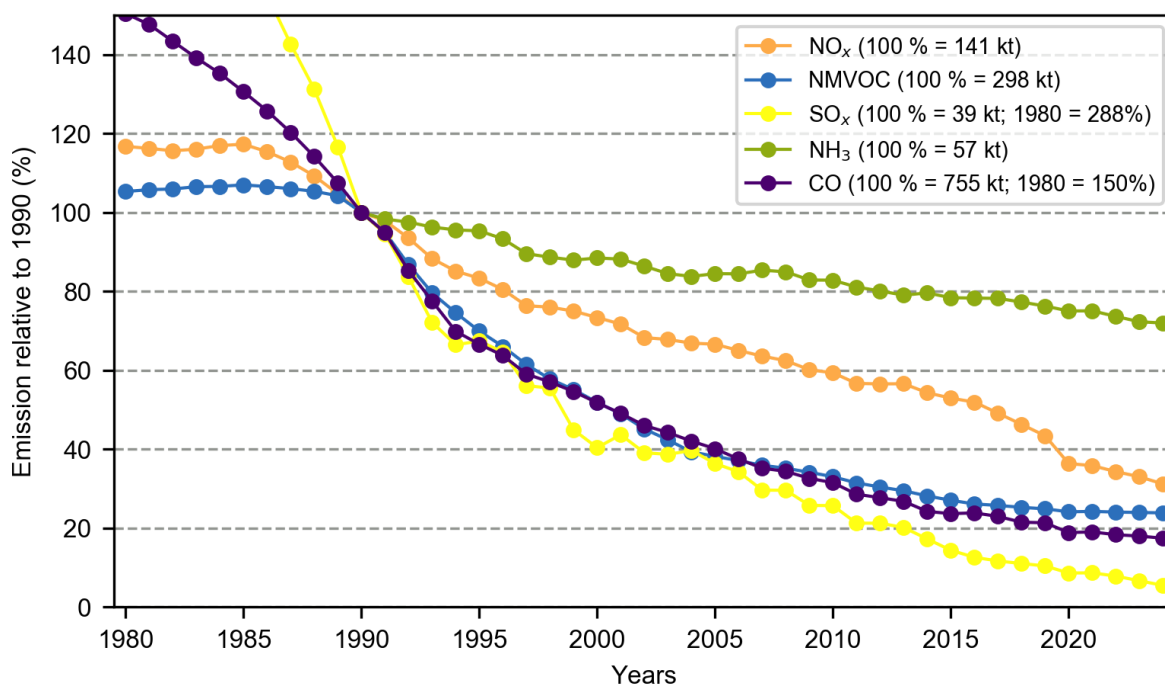
For the main pollutants (NO_x, NMVOC, SO_x, NH₃) as well as for PM_{2.5} and PM₁₀, the uncertainty of the inventory, resulting from uncertainties from each category, is evaluated according to two methods: uncertainty propagation (approach 1) and Monte Carlo simulations (approach 2). In addition, a Tier 2 approach uncertainty estimation was conducted for agricultural NH₃ emissions in 2021. The uncertainty analysis has been carried out for level emissions for the years 1990 and 2024 and for the trend 1990-2024.

Complete emission estimates are accomplished for all known sources and air pollutants. According to current knowledge, the Swiss CLRTAP inventory is complete.

Quality assurance and quality control (QA/QC)

A QA/QC system for the GHG inventory is in place that also covers most of the preparation process of the CLRTAP Inventory. The National GHG Inventory, which is also derived from the Swiss Emission Information System (EMIS), complies with the ISO 9001:2015 standard (Swiss Safety Center 2025). It was certified by the Swiss Association for Quality and Management Systems in December 2007 and has been re-audited annually. A separate and formalized CLRTAP Inventory quality system is not foreseen. However, a centralised plausibility check for emissions was established that compares emissions of the previous and the latest submission.

Emission trends 1980-2024



ES Figure 1.1 Relative trends for the total emissions of main pollutants and CO in Switzerland.

Overall, ES Figure 1.1 shows a decreasing trend of all main air pollutants and CO between 1990 and 2024. The significant decline of NO_x, NMVOC and CO emissions is caused by effective reduction measures: abatement of exhaust emissions from road vehicles and stationary installations, taxation of solvents and voluntary agreements with industry sectors. As a result of the legal restriction of sulphur content in liquid fuels and the decrease of coal consumption, SO_x emissions decreased significantly as well. In contrast to the other main pollutants, NH₃ emissions show a smaller reduction mainly due to the decrease of animal numbers and changes in agricultural production techniques. Due to a recent methodological change in the NH₃-Model (AGRAMMON) and corresponding recalculation, data for 1980-1989 are not available for this submission.

The drop of emissions in 2020/2021, especially visible for NO_x and CO, is due to reduced traffic volumes during the COVID-19 pandemic.

Emission trends for PM_{2.5} (not included in ES Figure 1.1, see Figure 2-3) reveal a significant decline between 1980 and 2024 mainly as a result of the abatement of exhaust emissions from road vehicles and also - to a minor extent - from non-road machinery and from improved residential heating equipment.

Characteristics of the sectors

- 1 Energy: the energy sector encompasses stationary and mobile fuel combustion activities and fugitive emissions from handling of fuels, such as losses in the gas network or refining and storage of gasoline and coal. Compared to the other sectors, fuel combustion activities are the main emission source of all air pollutants reported in the IIR except for NMVOC, NH₃, TSP and PCB. Within sector 1 Energy, source category 1A3 Transport is the predominant source of all main pollutants except for SO_x and PM_{2.5}, where 1A2 Manufacturing industries and construction and 1A4 Other sectors, respectively, are the most important sources. The emissions of all pollutants from the sector decreased compared to 1990. Note that regarding Pb emissions, sector 1 Energy was the dominant source in 1990 (mainly due to 1A3b Road transportation) but has

become less relevant over time due to the fact that only unleaded gasoline is sold in Switzerland since 2000.

- **2 Industrial processes and product use:** this sector comprises process emissions from the mineral, chemical and metal industry. Included are also other production industries such as pulp and paper industry and food and beverages industry as well as other solvent and product use, e.g. emissions from paint applications and domestic solvent use. Emissions from industrial processes and product use are the main emission source of NMVOC and PCB and an important source of particulate matter (mainly PM_{2.5}, but also PM₁₀ and TSP), SO_x as well as heavy metals (particularly Cd) emissions. NMVOC emissions originate mainly from source category 2D3 Other solvent use. 2A1 Cement production, 2A5a Quarrying and mining other than coal, 2G Other product use (i.e. use of fireworks) and 2H1 Pulp and paper industry are responsible for considerable amounts of PM_{2.5} emissions, whereas 2C1 Iron and steel production is a crucial source of heavy metal emissions. SO_x is generated mainly by 2B5 Carbide production as well as 2C3 Aluminium production (until 2006). In source category 2K Consumption of POPs and heavy metals, considerable emissions of PCB are reported. Since 1990, the emissions of all pollutants decreased more or less continuously, although in the past few years, the decrease has been less pronounced for most of the pollutants.
- **3 Agriculture:** this sector encompasses emissions from livestock production and agricultural soils. Overall, sector 3 Agriculture is the most important contributor to total Swiss NH₃ and NMVOC emissions, also contributing to a relevant share of NO_x, PM₁₀ and TSP emissions. Within the sector, the NH₃ emissions are attributed to the source categories 3B Manure management and 3D Agricultural soils. Most NH₃ emission reductions in agriculture occurred between 1990 and 2004, followed by an increase until 2007 and then showed a slight but rather constant decrease again. Emissions of NO_x reveal a decreasing trend since 1990 with slight fluctuations. NMVOC emissions mainly stem from 3B Manure management (silage feeding of cattle).
- **4 Land Use, Land-Use Change and Forestry (LULUCF):** The emissions of this sector are not accounted for in the commitments of the Gothenburg Protocol. Only forest fires (under 11B) and other natural emissions (under 11C) are reported under memo items in the official emission reporting templates and are described in chapter 7 Other and natural emissions.
- **5 Waste:** This sector encompasses solid waste disposal on land, biological treatment of solid waste, waste incineration and open burning of waste, wastewater handling and other waste. Overall, emissions of the main pollutants are minor when compared to the other sectors. The heat generated in waste incineration plants has to be recovered in Switzerland, and in accordance with the EMEP/EEA guidebook (EMEP/EEA 2023), emissions from the combustion of waste-to-energy activities are therefore dealt within 1A Fuel combustion. Relevant pollutants within sector 5 Waste are NMVOC, PM_{2.5}, heavy metals (especially Pb) and POPs. NMVOC emissions are mainly caused by 5B Biological treatment of solid waste. PM_{2.5}, heavy metals, PCDD/PCDF and PAH emissions mainly originate from source category 5C waste incineration. Emissions in sector 5 Waste have declined since 1990, with the exception of NMVOC (increase).
- **6 Other:** In this sector, mainly emissions from human and pet ammonia, private application of synthetic fertiliser as well as fire damages in buildings and in motor vehicles are reported. It is an important source of Pb, PCDD/PCDF, PAH and PCB, mainly due to 6A4 fire damage. Regarding the main pollutants, emissions from sector 6 Other are minor when compared to sectors 1 to 5. Overall, emissions are fluctuating without any significant trends.

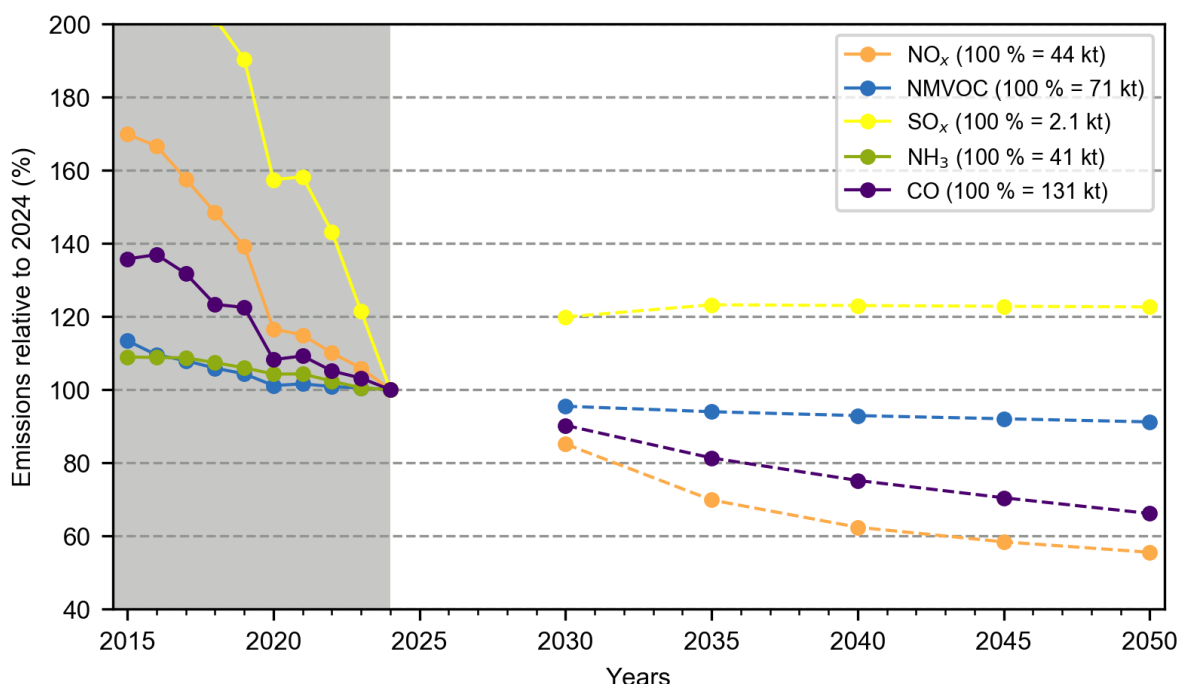
Projections for emissions until 2035

The emission projections of air pollutants in Switzerland have been fully revised for the submission 2021 and a new “With Measures” (WM) scenario was elaborated.

The projected data for the energy consumption and resulting production quantities in industrial processes are mainly in accordance with the scenarios of the Swiss Energy Perspectives 2050+ (Prognos/INFRAS/TEP/Ecoplan 2020).

For all activities depending on population size the latest perspectives for Switzerland’s inhabitants are integrated (SFSO 2020p), and for the agricultural sector an independent scenario was developed (Swiss Confederation 2017, FOAG 2011, Mack and Möhring 2021).

ES Figure 1.2 shows the past emissions from 2015-2024 and the projected emissions between 2030 and 2050 for main air pollutants under the WM scenario.



ES Figure 1.2 Relative trends for the total emissions from 2015-2024 (grey area) and the projected emissions between 2030 and 2050 for main pollutants and CO in the WM scenario. 100 % corresponds to levels of the latest reporting year.

According to the projections 2030-2050, the main pollutants will develop differently. Total NO_x and CO emissions will continue to decrease significantly, while total emissions of NMVOC and SO_x will remain at more or less constant levels. Due to a recent methodological change in the NH₃-Model (AGRAMMON) and corresponding recalculation, projections for NH₃ are not available for this submission.

For suspended particulate matter emissions, the smaller fractions of suspended particulate matter (PM_{2.5}) and Black Carbon (BC) are expected to continue to decrease, whereas the larger fractions (PM₁₀, TSP) are expected to remain at more or less constant levels because the ratio of the amount of non-exhaust particles to exhaust particles is considerably higher for PM₁₀ and TSP than it is for PM_{2.5}, and will be even higher in the future as the number of vehicles and mileage will increase.

Pb emissions are projected to slightly decrease between 2030 and 2050, whereas total Cd and Hg emissions are remaining about constant.

Total emissions of all persistent organic pollutants (POP) will decrease.

Gothenburg Protocol

Under the CLRTAP, the 1999 Gothenburg Protocol requires that parties shall reduce and maintain the reduction in annual emission in accordance with national emission targets set for 2010. The following table shows the emission ceilings, the reported emissions for 2010 and the respective compliance. Accordingly, Switzerland is compliant with the Gothenburg Protocol emission ceilings for all pollutants except for NO_x in 2010. All emissions 2024 are in compliance with the emission ceilings 2010.

ES Table 1.1 Emission ceilings of the Gothenburg Protocol for 2010 and beyond compared to the reported emissions for 2010 and 2024 of the latest submission (2026).

Pollutants	National emission ceilings for 2010	Emissions 2010 (Subm. 2026)	Compliance with emission ceilings 2010 in 2010	Emissions 2024 (Subm. 2026)	Compliance with emission ceilings 2010 in 2024
	kt	kt		kt	
SO _x (as SO ₂)	26	10	yes	2.1	yes
NO _x (as NO ₂)	79	84	no	44	yes
NMVOC	144	98	yes	71	yes
NH ₃	63	47	yes	41	yes

The 2012 revised Gothenburg Protocol included emission reduction commitments for 2020 and beyond expressed as a percentage reduction from the 2005 emission level. On 22 October 2019, the amended protocol including the new reduction commitments for 2020, including newly PM2.5, has entered into force for Switzerland. ES Table 1.2 shows the emission reduction commitments for 2020 and the corresponding level of the emissions 2024. The emission reduction commitments 2020 are achieved for all pollutants.

ES Table 1.2 Reported emission reductions 2020 and 2024 versus level of 2005 and reduction commitments per 2020. The emission reduction commitments for 2020 are defined as reductions in percentages from 2005.

Pollutant	Emission reduction commitments 2020	Reduction achieved in 2020	Compliance with reduction commitments 2020 in 2020	Reduction achieved in 2024	Compliance with reduction commitments 2020 in 2024
	%-reduction of 2005 level	%-reduction of 2005 level		%-reduction of 2005 level	
SO _x (as SO ₂)	21%	76%	yes	85%	yes
NO _x (as NO ₂)	41%	45%	yes	53%	yes
NMVOC	30%	37%	yes	38%	yes
NH ₃	8%	11%	yes	15%	yes
PM2.5	26%	52%	yes	57%	yes

Recalculations and improvements

In 2023, recalculations have a significant impact on emission levels of NH₃ (-22 %) and SO_x (-8.2 %). For all other pollutants, the impact of recalculations is minor; the difference in emission levels does not exceed 1 %.

Also in 1990, recalculations have significant impact on NH₃ emission levels (-17 %). For all other pollutants, the difference in emission levels amounts 1.0 % or less.

In the latest submission 2026, several improvements were conducted and a number of further planned improvements are identified. The following improvements had a relevant impact on the inventory in submission 2026:

- 3 Agriculture: The AGRAMMON model for the calculation of NH₃ emissions was revised based on a new representative questionnaire on farm and manure management and new scientific data. Particularly ALFAM2 for calculating emissions during manure spreading has been integrated in AGRAMMON. The model revision has a significant impact on total NH₃ emissions, as 3B and 3D are key categories for NH₃.
- 1A3b Road transportation: The entire traffic statistics have been renewed, which lead to reduced mileage especially in the years 2020-2023. In addition, activity data and emission factors were updated for the whole time series because the underlying fleet development data was updated to the new version of the Handbook of Emission Factors for Road Transport (HBEFA, version 5.1; INFRAS 2025, 2025a).

Switzerland prioritizes inventory improvements according to the key category analysis (KCA) and the uncertainty analysis where appropriate. The results of the uncertainty analysis are used to prioritize improvements through the results of the key category analysis, approach 2, in which source categories are sorted by decreasing order of contribution to the inventory uncertainty.

1 Introduction

1.1 National inventory background

Switzerland has signed and ratified the 1979 Geneva Convention on Long-range Transboundary Air Pollution (CLRTAP) and its Protocols (Swiss Confederation 2004):

- The 1985 Helsinki Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 %.
- The 1988 Sofia Protocol concerning the Control of Emissions of Nitrogen Oxides or their Transboundary Fluxes.
- The 1991 Geneva Protocol on the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes.
- The 1994 Oslo Protocol on Further Reduction of Sulphur Emissions.
- The 1998 Aarhus Protocol on Heavy Metals and its amendment 2012.
- The 1998 Aarhus Protocol on Persistent Organic Pollutants and its both amendments adopted in 2009.
- The 1999 Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone and its amendment 2012 (national emission reduction commitments for 2020 for SO_x (as SO₂), NO_x (as NO₂), NH₃, NMVOC and for PM_{2.5}).

According to the obligations of the CLRTAP, Switzerland is annually submitting its emission inventory (CLRTAP Inventory). For the present submission in March 2026, Switzerland provides for the nineteenth time an Informative Inventory Report (IIR) with the documentation on hand.

1.2 Institutional arrangements

The Swiss inventory system for the CLRTAP is developed and managed under the auspices of the Federal Office for the Environment (FOEN). As stipulated in the Ordinance on Air Pollution Control of 16 December 1985 (Swiss Confederation 1985), this Office has the lead within the Federal administration regarding air pollution policy and its implementation.

The FOEN publishes overviews of emissions and air quality levels. It has also built up and maintains the Swiss Emission Information System (EMIS) that contains all basic data needed to prepare the CLRTAP Inventory (and which contains also all greenhouse gas emissions as required for the preparation of the UNFCCC Greenhouse Gas Inventory).

1.3 Inventory preparation process

Various data suppliers collect the data needed for the preparation of the CLRTAP Inventory. The individual data suppliers are in charge for the quality of the data provided, so they are also responsible for the collection of activity data and for the selection of emission factors and methods. Thereby, the relevant guidelines including the Guidelines for Reporting Emissions and Projections data under the Convention on Long-range Transboundary Air Pollution (ECE 2023, ECE 2023a), the EMEP/EEA guidebook (EMEP/EEA 2019 and EMEP/EEA 2023) and the 2006 IPCC Guidelines for National Greenhouse Gas Inventories as well as the 2019 Refinement (IPCC 2006, 2019) are also required to be considered.

Various QA/QC activities (see chp. 1.6) provide provisions for maintaining and successively improving the quality of inventory data.

As mentioned above, the Air Pollution Control and Chemicals Division at FOEN maintains the EMIS database, which contains all basic data needed for the preparation of the CLRTAP Inventory. Simultaneously, background information on data sources, activity data, emission factors and methods used for emission estimation is also documented and cited in the subsequent chapters as EMIS 2026/(NFR-Code).

Figure 1-1 illustrates in a simplified manner the data collection and processing steps leading to the EMIS database and its main outputs into the CLRTAP air pollution emission inventory and into the IPCC/UNFCCC greenhouse gas inventory.

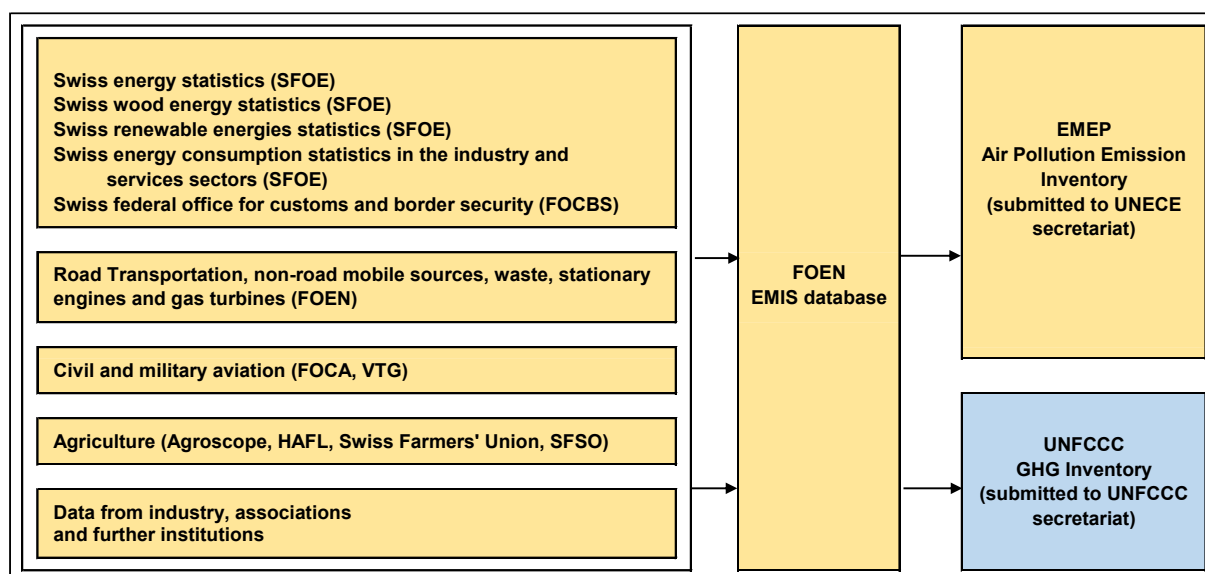


Figure 1-1 Data collection for EMIS database and CLRTAP air pollution emission inventory (GHG: Greenhouse Gas).

The preparation of the CLRTAP Inventory is closely connected to the preparation of the GHG inventory. Therefore, there are several parallel working steps. Also, the compilation of the Informative Inventory Report (IIR, the document on hand) and of the National Inventory Document (NID, see FOEN 2026) are going on simultaneously and are, partly, updated by the same persons. Therefore, both reports are structured similarly.

Annual Stage 1 and 2 reviews were carried out by the EMEP Centre on Emission Inventories and Projections (CEIP) and documented on the EMEP Website (UNECE 2025). Additionally, in-depth Stage 3 reviews took place in 2010, 2016, 2020 and 2022-2025 documented in UNECE (2010, 2016, 2020a, 2022a – 2025a). The recommendations of the latest Stage 1, 2 and 3 reviews were implemented in the latest emission inventory and in the IIR as far as possible.

Archiving of the database and related internal documentation is carried out by the inventory compiler, while any other material is archived on the internal data management system by the QA/QC officer.

1.4 Methods and data sources

1.4.1 Improvements conducted for this submission

The following issues were mentioned as planned improvements in chp. 8.2 of the IIR of the previous submission and were (at least partially) implemented in the latest submission. Switzerland prioritises inventory improvements according to the key category analysis (KCA) and the uncertainty analysis where appropriate. The list shows the current state of realisation:

- 2D3 Other solvent use and 2G Other product use: A comprehensive update of all NMVOC emissions from solvent and product use is on-going. Several sub-categories within 2D3 as well as source category 2G are key categories for NMVOCs.
Current state: In progress.
- 3B and 3D: AGRAMMON model for calculation NH₃ emission was revised based on a new representative questionnaire on farm and manure management and new scientific data. Particularly ALFAM2 for calculating emissions during manure spreading has been integrated in AGRAMMON. The model revision has a significant impact on total NH₃ emissions, as 3B and 3D are key categories for NH₃.
Current state: Done (1990-2024), open (1980-1989, 2025-2050).
- 3Da4: Crop residues applied to soils according to the Guidebook (EMEP/EEA 2023) were reported in the latest submission.
Current state: Done.

Additional improvements have been implemented for this submission 2026 as follows:

- 1A3: The entire traffic statistics have been renewed, which lead to reduced mileage in source category 1A3b Road transportation especially in the years 2020-2023. In addition, activity data and emission factors were updated for the whole time series because the underlying fleet development data was updated to the new version of the Handbook of Emission Factors for Road Transport (HBEFA, version 5.1; INFRAS 2025, 2025a). In the course of the update of the fleet development data, assumptions were adjusted which leads to a shift from mileage shares from gasoline to diesel vehicles (in particular for passenger cars and light duty vehicles). Furthermore, there were changes in the distribution of heavy-duty vehicles between rigid trucks (RT) and articulated or tractor-trailer combinations (AT/TT). In addition, a change was made regarding the fleet of buses, where gasoline-powered buses were replaced by diesel-powered buses.
- 1A2f Cement production: The emission factors for NO_x, NMVOC, SO_x, NH₃, TSP, PM_{2.5}, and PM₁₀ were revised based on continuous measurements conducted by the factories. The updated emission factors have been applied for the years 2018-2023.

1.4.2 General description

Emission key categories and uncertainties are calculated on the basis of the standard methods and procedures as described in:

- UNECE: Guidelines for Reporting Emissions and Projections Data under the Convention on Long-range Transboundary Air Pollution (ECE 2023).
- EMEP/EEA air pollutant emission inventory guidebook — version 2023 (EMEP/EEA 2023), including:
 - Chp. 2. Key category analysis and methodological choice
 - Chp. 5. Uncertainties

Note that there is an important statement regarding the system boundaries for emission modelling in chapter V “Methods”, section A “Emission estimation methods and principles” of the Guidelines for Reporting Emissions and Projections Data under the Convention on Long-range Transboundary Air Pollution. Paragraph 23 states:

“For Parties for which emission ceilings or emission reduction commitments are derived from national energy projections based on the amount of fuels sold, compliance checking will be based on fuels sold in the geographic area of the Party. Other Parties within the EMEP region (i.e., Austria, Belgium, Ireland, Lithuania, Luxembourg, the Netherlands, Switzerland and the United Kingdom of Great Britain and Northern Ireland) may choose to use the national emission total calculated on the basis of fuels used in the geographic area of the Party as a basis for compliance with their respective emission ceilings or emission reduction commitments.” (ECE 2023)

This means that the national totals of the emissions as reported in the NFR tables as “National total for the entire territory (based on fuel sold)” (row 141 in the corresponding template) deviate from “National total for compliance assessment) as reported in row 152 of the template because Switzerland’s compliance assessment refers to “fuel used” (fu) and not to “fuel sold”. Differences exclusively occur in sector 1A3b Road transportation (see Table 3-6 and description of system boundaries in chapter 3.1.6.1). When comparing numbers from the IIR with the NFR tables, please refer to the blue coloured line in the NFR table reporting the national compliance assessment. The KCA and the uncertainty analysis were carried out with emission values based on fuel used.

The methods used for the NFR sectors are given in the following Table 1-1. The classification follows the EMEP/EEA guidebook (EMEP/EEA 2023) in the respective chapters for the source categories.

Table 1-1 Overview of applied methods, emission factors and activity by NFR category. CS = country-specific, D default, T1 = Tier 1, T2 = Tier 2, T3 = Tier 3. Default emission factors mainly stem from EMEP/EEA 2023. In Sector 1A Fuel Combustion source categories with a higher tier method are listed specifically. The methods described for sectors marked with a * apply only to the specific source category description.

Sector	Source category	Method applied	Emission factors	Activity data
1	Energy			
1A	Fuel Combustion activities (excluding source categories marked with a * below)	T2	CS, D	CS
1A2gvii* 1A3a* 1A3c* 1A3d* 1A4aii* 1A4bii* 1A4cii* 1A5b*	Mobile combustion in manufacturing industries and construction Civil Aviation Railways Domestic navigation Commercial/Institutional: Mobile Residential: Household and gardening (mobile) Agriculture/Forestry/Fishing: Off-road vehicles and other machinery Other (Military non-road)	T3	CS, D	CS
1A3b*	Road Transportation	T3 (exhaust pol.), T2 (non-exhaust pol.)	CS, D	CS
1B	Fugitive emissions from fuels	T1, T2, T3	CS, D	CS
2	Industrial processes and product use			
2A	Mineral products	T2	CS, D	CS
2B	Chemical industry	T2	CS	CS
2C	Metal production	T2	CS, D	CS
2D	Other solvent and product use	T1, T2	CS, D	CS
2G	Other product use	T2	CS, D	CS
2H	Other	T2	CS	CS
2I	Wood processing	T2	CS	CS
2K	Consumption of POPs and heavy metals	T2	CS	CS
2L	Other production, consumption, storage, transportation or handling of bulk products	T2	CS	CS
3	Agriculture			
3B	Manure management	T1, T2, T3	CS, D	CS
3D	Crop production and agricultural soils	T1, T2, T3	CS, D	CS
5	Waste			
5A	Biological treatment of waste - Solid waste disposal on land	T2	CS	CS
5B	Biological treatment of waste - Composting and anaerobic digestion at biogas facilities	T2	CS	CS
5C	Waste incineration and open burning of waste	T2	CS, D	CS
5D	Wastewater handling	T2	CS	CS
5E	Other waste	T2	CS	CS
6	Other			
6A	Other sources	T1, T2, T3	CS, D	CS
11	Natural emissions			
11B	Forest fires	T2	CS	CS
11C	Other natural emissions	T2	CS	CS

1.4.3 Swiss emission inventory system

Emission data is extracted from the Swiss emission information system (EMIS), which is on one hand a database for storage of all required numeric values (EMIS database), and on the other hand a documentation compiling all relevant information for emission modelling (EMIS documentation), operated by FOEN (see FOEN 2006). EMIS was established at SAEFL (former name of FOEN) in the late 1980s. Its initial purpose was to record and monitor emissions of air pollutants. Since then, it has been extended to cover greenhouse gases, too. All input data is imported into the database at a level of detail that allows further aggregation according to multiple nomenclatures, to produce the data required for international reporting. Emissions and activity data are aggregated in accordance with the EMEP/EEA system or Nomenclature For Reporting (“NFR Code”, ECE 2023) and, in addition, aggregated in accordance with the UNFCCC system or Common Reporting Table (CRT) nomenclature.

The EMIS-team of the FOEN maintains the database where emissions for various pollutants and greenhouse gases are calculated using emission factors and activity data according to the EMEP/EEA methodology, respectively IPCC Guidelines. Pollutants included are NO_x, NMVOC, SO_x, NH₃, particulate matter (PM2.5, PM10, TSP and BC), CO, priority heavy metals (Pb, Cd and Hg), POPs (PCDD/PCDF and PAHs, HCB and PCB) as well as the greenhouse gases CO₂ (fossil/geogenic origin and CO₂ from biomass), CH₄, N₂O and F-gases. The input data originates from a variety of sources such as various emission measurements, production data and emission factors from the industry, industry associations and research institutions and from Swiss statistics concerning population size, employment, waste and agriculture. Amongst others, these are the SFOE Swiss overall energy statistics, the SFOE Swiss wood energy statistics, FOEN statistics and models for emissions from road transportation, statistics and models of non-road activities, waste statistics and agricultural models and statistics (see Figure 1-1).

EMIS is continuously updated and extended to incorporate additional data sources. Activity data and emission factors are regularly reviewed and updated. Therefore, the data used in this submission are referenced to the specific EMIS data source.

As far as possible, all tables and figures in the IIR contain numerical values that are stored in and can be directly traced back to the EMIS database. All displayed units are (multiples of) existing units according to the international system of units. By default, two significant figures are presented for each value in all tables, independently of the uncertainty associated with the value. For a few tables representing trends, three significant figures are used to make the trend visible. In graphs, axis units are presented in accordance with the guidelines of the Bureau International des Poids et Mesures (BIPM 2019), i.e. the symbol "/" is used before the unit.

1.4.4 Data suppliers

Table 1-2 Primary and secondary data suppliers: 1–13 provide annual updates, 14–21 provide sporadic updates.

No.	Institution	Subject	Data supplied for inventory category											
			1A1	1A2	1A3	1A4	1A5	1B	2	3	5	6	11	
Data suppliers (annual updates)														
1	FOEN, Air Pollution Control	EMIS database	x	x		x	x	x	x	x	x	x	x	x
2	FOEN, Climate	Swiss ETS monitoring reports	x	x		x		x	x					
3	FOEN, Waste and Raw Materials	Waste statistics	x	x								x		
4	SFOE	Swiss overall energy statistics	x	x	x	x		x				x		
5	SFOE	Swiss wood energy statistics	x	x		x								
6	SFOE	Swiss renewable energy statistics	x	x	x	x						x		
7	SFOE	Energy consumption statistics in the industry and services sectors		x										
8	FOCA	Civil aviation			x									
9	DDPS/VTG	Military machinery and aviation					x							
10	SFSO	Transport, Solvents, Agriculture, Waste, Other			x				x	x	x	x		
11	HAFL	Agriculture								x				
12	Industry and Industry Associations	Ind. processes and solvents	x					x	x					
13	Avernergy Suisse / Swiss Petroleum Association	Oil statistics						x	x					
Data suppliers (sporadic updates)														
14	FOEN, Air Pollution Control	Non-road database		x	x	x	x							
15	SGWA	Gas distribution losses						x						
16	Empa	Various emission factors	x	x	x	x								
17	INFRAS	On-road emission model			x									
18	INFRAS	Non-road emission model		x	x	x	x							
19	INFRAS	Model of stationary engines and gas turbines	x	x	x	x								
20	ecolot	Solvents and product use							x					
21	Verenum	Wood energy, emission factor model	x	x		x								

1.5 Key categories

In order to identify the source categories which are the main contributors to the emissions of each pollutant (“level assessment”), or to the emission trend between the base year 1990 and the reporting year (“trend assessment”), and/or to the associated uncertainties, a Key Category Analysis (KCA) is performed according to the methodology described in the EMEP/EEA guidebook (EMEP/EEA 2023). Note that to compute the trend assessment, we use the formula from the 2019 Refinement to the 2006 IPCC Guidelines (IPCC 2019). The KCA can be performed based on two approaches: in approach 1, categories are set out in decreasing order of contribution to the inventory emissions or trend. In approach 2, this ranking is weighted by the uncertainty assigned to each category. Approach 1 therefore highlights categories which mostly contribute to emissions or to emission changes, while approach 2 identifies categories mostly contributing to the inventory uncertainty. A key category is prioritised within the inventory system because its estimate has a significant influence on the national total.

Note that for this submission, the key category analysis is performed based on the approach “fuels used”, (in contrast to “fuels sold”; for differentiation of the two approaches see chapter 3.1.6.1). For approach 2 of the KCA, the emission uncertainty of each category is taken from the results of the Monte Carlo simulations (see details in chp. 1.7).

For the pollutants for which uncertainty estimates are available (NO_x, NMVOC, SO_x, NH₃, PM_{2.5} and PM₁₀), key category analyses were conducted according to approach 1 and 2, for the base year, the reporting year and the trend. A KCA according to approach 1 was also conducted for TSP, BC, CO, Pb, Cd, Hg, PCDD/PCDF, PAHs, HCB and PCBs. All level and trend assessments were performed for all emission sources accounting for 80 % of the total national emissions (or total national trend).

1.5.1 Summary of KCA results, approaches 1 and 2

By comparison to the previous submission, the major sources of pollutants remain very similar:

- For NO_x, a large fraction of emissions for the year 2024 are caused by category 1A3 Transport. The three source categories 1A3bi Passenger cars, 1A3bii Light duty-vehicles and 1A3biii Heavy-duty vehicles and buses represent almost half of the inventory emissions. Each of these categories has a pronounced decreasing trend between 1990 and 2024 (see also chp. 2.3.1 and Annex A1.2).
- For NMVOCs, the major contributors are categories 2D3 Other solvent use and 3B1 Manure management.
- For SO_x, category 1A2f Non-metallic minerals represents about one third of emissions. Its trend for 1990-2024 is decreasing.
- Almost all NH₃ emissions originate from livestock production within Sector 3 Agriculture, particularly from 3Da2a Animal manure applied to soils and 3B Manure management.
- For PM_{2.5} the main source is category 1A4bi Residential: stationary plants, with approx. one third of emissions, followed by 1A3bvi Road transportation: automobile tyre and brake wear (15 %, note that this category contains only non-exhaust emissions). The trend 1990-2024 for category 1A3bvi is positive whereas it is negative for 1A4bi.
- The main source of PM₁₀ emissions is category 1A3bvi Road transportation: automobile tyre and brake wear, representing 18 % of emissions, followed by categories 1A2gvii Mobile combustion in manufacturing industries and construction (17 %). As for PM_{2.5}, the trend 1990-2024 for category 1A3bvi is positive.

There is no outstanding change in the list of key categories to report compared to the previous submission. The detailed results of the key category analysis, approaches 1 and 2, level and trend assessments, are reported in Table 1-3 to Table 1-11, where numeric values represent the percentage contributions to the assessment total, for each pollutant. In each table, the source categories are set out in order according to their NFR code.

1.5.2 KCA approach 1 results

1.5.2.1 Level key category analysis (approach 1)

The results of the key category analysis according to approach 1, level, are summarised in Table 1-3 for the year 1990 and in Table 1-4 for the year 2024 for NO_x, NMVOC, SO_x, NH₃, PM_{2.5} and PM₁₀. See Table 1-5 and Table 1-6 for TSP, BC, CO, Pb, Cd, Hg, PCDD/PCDF, PAHs, HCB and PCBs.

Table 1-3 List of Switzerland's approach 1 level key categories for 1990, for the main pollutants, PM_{2.5} and PM₁₀. Contributions are given in percentage of the total assessment per pollutant and depicted using a colour scale, a darker colour indicating a larger contribution. The bottom line reports the cumulative total over all key source categories per pollutant, which amounts to more than 80 % according to the KCA procedure. The column to the right reports the sum of contributions from all pollutants per category.

NFR Code	Source category	Key categories approach 1: % level contribution to totals 1990						% sum of category
		NO _x	NMVOC	SO _x	NH ₃	PM _{2.5}	PM ₁₀	
1A1a	Public electricity and heat production	4.5		9.4		2.9	2.9	20
1A2d	Stationary combustion in manufacturing industries and construction: pulp paper and print			8.3				8.3
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	7.5		9.0			2.3	19
1A2gvii	Mobile combustion in manufacturing industries and construction	4.5				2.7	6.0	13
1A2gviii	Stationary combustion in manufacturing industries and construction: other			9.0		3.2	2.5	15
1A3bi(fu)	Road transportation: passenger cars (fuel used)	31	19	4.1				54
1A3bii(fu)	Road transportation: light duty vehicles (fuel used)	4.3						4.3
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	21		4.6		5.9	4.4	36
1A3bv(fu)	Road transportation: gasoline evaporation (fuel used)		6.7					6.7
1A3bvi(fu)	Road transportation: automobile tyre and brake wear (fuel used)					2.5	5.6	8.1
1A3c	Railways						2.7	2.7
1A4ai	Commercial/institutional: stationary			9.9		5.0	3.9	19
1A4bi	Residential: stationary plants	8.3	3.4	26		53	42	134
1A4ci	Agriculture/forestry/fishing: stationary					2.6		2.6
1B2av	Distribution of oil products		6.4					6.4
2C1	Iron and steel production					3.0	4.1	7.1
2D3a	Domestic solvent use including fungicides		3.0					3.0
2D3d	Coating applications		14					14
2D3e	Degreasing		3.9					3.9
2D3g	Chemical products		9.2					9.2
2D3h	Printing		6.8					6.8
2G	Other product use		7.5					7.5
2I	Wood processing						2.4	2.4
3B1a	Manure management - Dairy cattle		2.2		14			17
3B1b	Manure management - Non-dairy cattle				8.5			8.5
3B3	Manure management - Swine				12			12
3Da1	Inorganic N-fertilizers (includes also urea application)				7.5			7.5
3Da2a	Animal manure applied to soils				42			42
3De	Cultivated crops						2.9	2.9
Total contribution from key categories, %		81	82	81	84	81	81	

Table 1-4 List of Switzerland's approach 1 level key categories 2024, for the main pollutants, PM2.5 and PM10. Contributions are given in percentage of the total assessment per pollutant and depicted using a colour scale, a darker colour indicating a larger contribution. The bottom line reports the cumulative total over all key source categories per pollutant, which amounts to more than 80 % according to the KCA procedure. The column to the right reports the sum of contributions from all pollutants per category.

NFR Code	Source category	Key categories approach 1: % level contribution to totals 2024					% sum of category	
		NOx	NMVOc	SOx	NH3	PM2.5		PM10
1A1a	Public electricity and heat production	6.0		13				19
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	5.8		31				37
1A2gvii	Mobile combustion in manufacturing industries and construction					6.3	17	23
1A2gviii	Stationary combustion in manufacturing industries and construction: other			7.8		2.7		11
1A3ai(i)	Civil aviation (domestic landing/take-off (LTO))	4.9		7.0				12
1A3bi(fu)	Road transportation: passenger cars (fuel used)	29	4.9					33
1A3bii(fu)	Road transportation: light duty vehicles (fuel used)	6.9						6.9
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	7.7						7.7
1A3bv(fu)	Road transportation: gasoline evaporation (fuel used)		3.1					3.1
1A3bvi(fu)	Road transportation: automobile tyre and brake wear (fuel used)					15	18	33
1A3c	Railways					4.1	12	16
1A4ai	Commercial/institutional: stationary	6.1		3.5		6.8	3.1	20
1A4bi	Residential: stationary plants	8.0	3.1	9.9		29	13	63
1A4ci	Agriculture/forestry/fishing: stationary					3.3		3.3
1A4cii	Agriculture/forestry/fishing: off-road vehicles and other machinery	3.4						3.4
1A5b	Other mobile (including military land-based and recreational boats)						1.9	1.9
1B2av	Distribution of oil products		2.7					2.7
2A5a	Quarrying and mining of minerals other than coal						2.3	2.3
2B5	Carbide production			9.2				9.2
2D3a	Domestic solvent use including fungicides		9.3					9.3
2D3b	Road paving with asphalt		3.7					3.7
2D3d	Coating applications		12					12
2D3e	Degreasing		2.2					2.2
2D3g	Chemical products		4.5					4.5
2D3h	Printing		5.0					5.0
2D3i	Other solvent use		2.7					2.7
2G	Other product use		8.9			6.2	3.6	19
2H1	Pulp and paper industry					2.9		2.9
2H2	Food and beverages industry					2.8	2.2	5.0
3B1a	Manure management - Dairy cattle		9.2		20			29
3B1b	Manure management - Non-dairy cattle		11		16			27
3B3	Manure management - Swine				8.3			8.3
3Da1	Inorganic N-fertilizers (includes also urea application)				6.3			6.3
3Da2a	Animal manure applied to soils	3.4			30			33
3De	Cultivated crops						7.2	7.2
5C1a	Municipal waste incineration					3.6	1.7	5.3
Total contribution from key categories, %		81	82	82	80	82	82	

Table 1-5 List of Switzerland's approach 1 level key categories 1990, for TSP, BC, CO, priority heavy metals, PCDD/PCDF, PAHs total, HCB and PCBs. Contributions are given in percentage of the total assessment per pollutant and depicted using a colour scale, a darker colour indicating a larger contribution. The bottom line reports the cumulative total over all key source categories per pollutant, which amounts to more than 80 % according to the KCA procedure. The column to the right reports the sum of contributions from all pollutants per category.

NFR Code	Source category	Key categories approach 1: % level contribution to totals 1990										% sum of category
		TSP	BC	CO	Pb	Cd	Hg	PCDD/PCDF	PAHs total	HCB	PCB	
1A1a	Public electricity and heat production	1.9			8.5	55	62	68				195
1A2b	Stationary combustion in manufacturing industries and construction: non-ferrous metals									100		100
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	2.2				21						23
1A2gvii	Mobile combustion in manufacturing industries and construction	5.4	4.4									9.8
1A3bi(fu)	Road transportation: passenger cars (fuel used)		4.3	56	59							120
1A3bii(fu)	Road transportation: light duty vehicles (fuel used)			9.3								9.3
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	2.8	14									17
1A3bvi(fu)	Road transportation: automobile tyre and brake wear (fuel used)	3.6										3.6
1A3c	Railways	2.3										2.3
1A4ai	Commercial/institutional: stationary	2.7	5.2									7.9
1A4bi	Residential: stationary plants	29	56	15				9.2	71			180
2B10a	Chemical industry: other						6.1					6.1
2C1	Iron and steel production	4.8			17	14	18	6.5				60
2C3	Aluminium production								12			12
2I	Wood processing	7.7										7.7
2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)										65	65
3De	Cultivated crops	19										19
5E	Other waste										9.2	9.2
6A	Other sources										12	12
Total contribution from key categories, %		81	84	81	85	90	86	83	83	100	87	

Table 1-6 List of Switzerland's approach 1 level key categories 2024, for TSP, BC, CO, priority heavy metals, PCDD/PCDF, PAHs total, HCB and PCBs. Contributions are given in percentage of the total assessment per pollutant and depicted using a colour scale, a darker colour indicating a larger contribution. The bottom line reports the cumulative total over all key source categories per pollutant, which amounts to more than 80 % according to the KCA procedure. The column to the right reports the sum of contributions from all pollutants per category.

NFR Code	Source category	Key categories approach 1: % level contribution to totals 2024										% sum of category
		TSP	BC	CO	Pb	Cd	Hg	PCDD/PCDF	PAHs total	HCB	PCB	
1A1a	Public electricity and heat production				24	39	54	9.8		56		183
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals			5.9		5.8	9.3					21
1A2gvii	Mobile combustion in manufacturing industries and construction	13		3.1		4.8						21
1A2gviii	Stationary combustion in manufacturing industries and construction: other				6.7		4.6					11
1A3aii(i)	Civil aviation (domestic cruise)				8.4							8.4
1A3bi(fu)	Road transportation: passenger cars (fuel used)			33					8.1			41
1A3bvi(fu)	Road transportation: automobile tyre and brake wear (fuel used)	8.9	12			22						42
1A3c	Railways	7.7										7.7
1A3dii	National navigation (shipping)			3.8								3.8
1A4ai	Commercial/institutional: stationary		9.3	4.6				9.1	11			34
1A4aii	Commercial/institutional: mobile			4.9								4.9
1A4bi	Residential: stationary plants	6.8	50	18		6.1	8.5	34	57	25		205
1A4cii	Agriculture/forestry/fishing: off-road vehicles and other machinery		8.9	9.1								18
2A5a	Quarrying and mining of minerals other than coal	2.7										2.7
2C1	Iron and steel production						6.8					6.8
2G	Other product use	1.8			5.0	6.9						14
2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)										89	89
3B3	Manure management - Swine	2.1										2.1
3B4gi	Manure management - Laying hens	2.6										2.6
3De	Cultivated crops	36										36
5C1a	Municipal waste incineration				19			20				39
5C2	Open burning of waste								8.4			8.4
6A	Other sources				20			8.0				28
Total contribution from key categories, %		81	80	82	84	84	83	81	85	81	89	

1.5.2.2 Trend key category analysis (approach 1)

The results of the KCA according to approach 1, trend, for 1990-2024 are summarised in Table 1-7 and Table 1-8.

Table 1-7 List of Switzerland's approach 1 key categories for the trend 1990-2024, for the main pollutants, PM2.5 and PM10. Contributions are given in percentage of the total assessment per pollutant and depicted using a colour scale, a darker colour indicating a larger contribution. The bottom line reports the cumulative total over all key source categories per pollutant, which amounts to more than 80 % according to the KCA procedure. The column to the right reports the sum of contributions from all pollutants per category.

NFR Code	Source category	Key categories approach 1: % contribution to trend 1990 - 2024						% sum of category
		NOx	NM VOC	SOx	NH3	PM2.5	PM10	
1A1a	Public electricity and heat production	3.6		4.3			2.4	10
1A2d	Stationary combustion in manufacturing industries and construction: pulp paper and print			8.6				8.6
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	3.9		23				27
1A2gvii	Mobile combustion in manufacturing industries and construction					4.7	11	16
1A2gviii	Stationary combustion in manufacturing industries and construction: other	4.5						4.5
1A3ai(i)	Civil aviation (domestic landing/take-off (LTO))	9.7		7.0				17
1A3bi(fu)	Road transportation: passenger cars (fuel used)	6.1	19	2.7				28
1A3bii(fu)	Road transportation: light duty vehicles (fuel used)	6.2						6.2
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	33		4.4		6.8	4.3	48
1A3bv(fu)	Road transportation: gasoline evaporation (fuel used)		4.8					4.8
1A3bvi(fu)	Road transportation: automobile tyre and brake wear (fuel used)					16	13	29
1A3c	Railways					4.5	9.2	14
1A3dii	National navigation (shipping)	3.0						3.0
1A4ai	Commercial/institutional: stationary	5.9		6.7				13
1A4bi	Residential: stationary plants			17		32	30	79
1B2av	Distribution of oil products		5.0					5.0
2B5	Carbide production			8.0				8.0
2C1	Iron and steel production					3.7	4.1	7.8
2D3a	Domestic solvent use including fungicides		8.5					8.5
2D3b	Road paving with asphalt		2.8					2.8
2D3d	Coating applications		2.7					2.7
2D3e	Degreasing		2.3					2.3
2D3g	Chemical products		6.4					6.4
2D3h	Printing		2.4					2.4
2G	Other product use					5.5	2.0	7.6
2H1	Pulp and paper industry					2.5		2.5
2H2	Food and beverages industry		2.0			2.7		4.7
3B1a	Manure management - Dairy cattle		9.5		12			22
3B1b	Manure management - Non-dairy cattle		12		18			30
3B3	Manure management - Swine				8.5			8.5
3B4gii	Manure management - Broilers		2.1					2.1
3Da2a	Animal manure applied to soils	4.7			29			34
3Da2b	Sewage sludge applied to soils				4.9			4.9
3Da2c	Other organic fertilisers applied to soils (including compost)				3.6			3.6
3Da3	Urine and dung deposited by grazing animals				4.6			4.6
3De	Cultivated crops						4.5	4.5
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities		2.2					2.2
5C1a	Municipal waste incineration					2.4		2.4
Total contribution from key categories, %		80	82	82	81	81	81	

Table 1-8 List of Switzerland's approach 1 key categories for the trend 1990-2024, for TSP, BC, CO, priority heavy metals, PCDD/PCDF, PAHs total, HCB and PCBs. Contributions are given in percentage of the total assessment per pollutant and depicted using a colour scale, a darker colour indicating a larger contribution. The bottom line reports the cumulative total over all key source categories per pollutant, which amounts to more than 80 % according to the KCA procedure. The column to the right reports the sum of contributions from all pollutants per category.

NFR Code	Source category	Key categories approach 1: % contribution to trend 1990 - 2024										% sum of category
		TSP	BC	CO	Pb	Cd	Hg	PCDD/PCDF	PAHs total	HCB	PCB	
1A1a	Public electricity and heat production				9.9	17	14	41		28	15	125
1A2b	Stationary combustion in manufacturing industries and construction: non-ferrous metals									50		50
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	2.2		6.5		17	9.9					35
1A2gvii	Mobile combustion in manufacturing industries and construction	8.2	5.8			4.8						19
1A2gviii	Stationary combustion in manufacturing industries and construction: other						7.6					7.6
1A3aii(i)	Civil aviation (domestic cruise)				5.0							5.0
1A3bi(fu)	Road transportation: passenger cars (fuel used)			36	37				13			86
1A3bii(fu)	Road transportation: light duty vehicles (fuel used)			11								11
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	3.1	27									30
1A3bvi(fu)	Road transportation: automobile tyre and brake wear (fuel used)	5.8	22			21						49
1A3c	Railways	6.0										6.0
1A4ai	Commercial/institutional: stationary		8.7	4.8			7.2	5.6	8.9			35
1A4aii	Commercial/institutional: mobile			6.7								6.7
1A4bi	Residential: stationary plants	24	12	4.3			13	18	26	12		110
1A4bii	Residential: household and gardening (mobile)			3.9								3.9
1A4cii	Agriculture/forestry/fishing: off-road vehicles and other machinery		10	8.2								18
2B10a	Chemical industry: other						11					11
2C1	Iron and steel production	5.3			9.1	14	19					47
2C3	Aluminium production								22			22
2G	Other product use					6.6						6.6
2I	Wood processing	6.7										6.7
2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)										49	49
3De	Cultivated crops	19										19
5C1a	Municipal waste incineration				12			12				24
5C2	Open burning of waste								9.4			9.4
5E	Other waste										18	18
6A	Other sources				12			5.0				17
Total contribution from key categories, %		81	85	82	84	81	80	82	80	90	82	

1.5.3 KCA approach 2 results

1.5.3.1 Level key category analysis (approach 2)

The results of the KCA according to approach 2, level assessment, are summarised in Table 1-9 for the year 1990 and in Table 1-10 for the year 2024.

Table 1-9 List of Switzerland's approach 2 level key categories 1990, for the main pollutants, PM2.5 and PM10. Contributions are given in percentage of the total assessment per pollutant and depicted using a colour scale, a darker colour indicating a larger contribution. The bottom line reports the cumulative total over all key source categories per pollutant, which amounts to more than 80 % according to the KCA procedure. The column to the right reports the sum of contributions from all pollutants per category.

NFR Code	Source category	Key categories approach 2: % level contribution to totals 1990						% sum of category
		NOx	NMVOc	SOx	NH3	PM2.5	PM10	
1A1a	Public electricity and heat production	3.6		13		2.7	2.5	21
1A2d	Stationary combustion in manufacturing industries and construction: pulp paper and print			6.5				6.5
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	4.9		9.6				14
1A2gvii	Mobile combustion in manufacturing industries and construction						3.6	3.6
1A2gviii	Stationary combustion in manufacturing industries and construction: other			9.6		2.8	2.0	14
1A3bi(fu)	Road transportation: passenger cars (fuel used)	45	14		3.3			63
1A3bii(fu)	Road transportation: light duty vehicles (fuel used)	5.3						5.3
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	14		2.6		2.1		19
1A3biv(fu)	Road transportation: mopeds and motorcycles (fuel used)		6.4					6.4
1A3bv(fu)	Road transportation: gasoline evaporation (fuel used)		3.8					3.8
1A3bvi(fu)	Road transportation: automobile tyre and brake wear (fuel used)						3.4	3.4
1A4ai	Commercial/institutional: stationary			5.6		5.1	3.7	14
1A4bi	Residential: stationary plants	4.2	3.3	16		54	38	115
1B2aiv	Fugitive emissions oil: refining / storage			3.3				3.3
1B2av	Distribution of oil products		3.6					3.6
2A1	Cement production					1.8	1.9	3.6
2A5a	Quarrying and mining of minerals other than coal						2.7	2.7
2C1	Iron and steel production					4.4	5.4	9.7
2C3	Aluminium production			15				15
2D3d	Coating applications		8.8					8.8
2D3e	Degreasing		3.6					3.6
2D3g	Chemical products		13					13
2D3h	Printing		4.4					4.4
2D3i	Other solvent use		3.8					3.8
2G	Other product use		17			2.4	1.8	21
2H2	Food and beverages industry					2.5	2.8	5.3
2I	Wood processing					2.9	7.8	11
3B1a	Manure management - Dairy cattle				12			12
3B1b	Manure management - Non-dairy cattle				6.7			6.7
3B3	Manure management - Swine				14			14
3B4gi	Manure management - Laying hens				4.0			4.0
3Da1	Inorganic N-fertilizers (includes also urea application)	3.3			11			14
3Da2a	Animal manure applied to soils				26			26
3De	Cultivated crops						5.3	5.3
6A	Other sources				4.5			4.5
Total contribution from key categories, %		81	81	81	82	80	81	

Table 1-10 List of Switzerland's approach 2 level key categories 2024, for the main pollutants, PM2.5 and PM10. Contributions are given in percentage of the total assessment per pollutant and depicted using a colour scale, a darker colour indicating a larger contribution. The bottom line reports the cumulative total over all key source categories per pollutant, which amounts to more than 80 % according to the KCA procedure. The column to the right reports the sum of contributions from all pollutants per category.

NFR Code	Source category	Key categories approach 2: % level contribution to totals 2024					% sum of category	
		NOx	NMVOc	SOx	NH3	PM2.5		PM10
1A1a	Public electricity and heat production	4.4		17				21
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	3.5		30				34
1A2gvii	Mobile combustion in manufacturing industries and construction					3.7	9.6	13
1A2gviii	Stationary combustion in manufacturing industries and construction: other			7.6				7.6
1A3ai(i)	Civil aviation (domestic landing/take-off (LTO))	3.4		3.6				7.0
1A3bi(fu)	Road transportation: passenger cars (fuel used)	38	3.4					41
1A3bii(fu)	Road transportation: light duty vehicles (fuel used)	7.7						7.7
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	4.8						4.8
1A3bvi(fu)	Road transportation: automobile tyre and brake wear (fuel used)					8.9	9.9	19
1A3c	Railways					2.4	6.5	8.9
1A4ai	Commercial/institutional: stationary	3.4				6.3	2.7	12
1A4bi	Residential: stationary plants	3.7	2.8	5.4		26	11	49
1A4ci	Agriculture/forestry/fishing: stationary			3.3				3.3
2A1	Cement production					4.1	2.6	6.7
2A5a	Quarrying and mining of minerals other than coal					4.8	7.0	12
2B5	Carbide production			9.4				9.4
2B10a	Chemical industry: other			4.2				4.2
2D3a	Domestic solvent use including fungicides		6.1					6.1
2D3b	Road paving with asphalt		4.5					4.5
2D3d	Coating applications		6.9					6.9
2D3g	Chemical products		5.6					5.6
2D3h	Printing		3.0					3.0
2D3i	Other solvent use		5.1					5.1
2G	Other product use		18			6.9	3.8	29
2H1	Pulp and paper industry					5.2		5.2
2H2	Food and beverages industry		2.4			9.0	6.8	18
2I	Wood processing					2.5	4.1	6.7
3B1a	Manure management - Dairy cattle		7.3		16			23
3B1b	Manure management - Non-dairy cattle		9.9		12			22
3B3	Manure management - Swine		2.1		9.0			11
3B4gi	Manure management - Laying hens						2.5	2.5
3B4gii	Manure management - Broilers		3.4		4.1		3.6	11
3Da1	Inorganic N-fertilizers (includes also urea application)	5.7			8.4			14
3Da2a	Animal manure applied to soils	6.0			18			24
3Da2c	Other organic fertilisers applied to soils (including compost)				4.2			4.2
3Da3	Urine and dung deposited by grazing animals				5.4			5.4
3De	Cultivated crops						12	12
5C1a	Municipal waste incineration					2.5		2.5
6A	Other sources				6.5			6.5
Total contribution from key categories, %		81	80	81	83	82	82	

1.5.3.2 Trend key category analysis (approach 2)

The results of the KCA according to approach 2, trend assessment, for 1990-2024 are summarised in Table 1-11.

Table 1-11 List of Switzerland's approach 2 key categories for the trend 1990-2024, for the main pollutants, PM2.5 and PM10. Contributions are given in percentage of the total assessment per pollutant and depicted using a colour scale, a darker colour indicating a larger contribution. The bottom line reports the cumulative total over all key source categories per pollutant, which amounts to more than 80 % according to the KCA procedure. The column to the right reports the sum of contributions from all pollutants per category.

NFR Code	Source category	Key categories approach 2: % contribution to trend 1990 - 2024						% sum of category
		NOx	NM VOC	SOx	NH3	PM2.5	PM10	
1A1a	Public electricity and heat production	2.9		6.3				9.2
1A2d	Stationary combustion in manufacturing industries and construction: pulp paper and print			7.4				7.4
1A2e	Stationary combustion in manufacturing industries and construction: food processing beverages and tobacco			1.9				1.9
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	2.5		27				30
1A2gvii	Mobile combustion in manufacturing industries and construction					2.9	7.0	9.9
1A2gviii	Stationary combustion in manufacturing industries and construction: other	2.9						2.9
1A3ai(i)	Civil aviation (domestic landing/take-off (LTO))	7.2		4.3				12
1A3bi(fu)	Road transportation: passenger cars (fuel used)	8.7	14					23
1A3bii(fu)	Road transportation: light duty vehicles (fuel used)	7.4						7.4
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	22		2.7		2.3		27
1A3biv(fu)	Road transportation: mopeds and motorcycles (fuel used)		5.9					5.9
1A3bv(fu)	Road transportation: gasoline evaporation (fuel used)		2.7					2.7
1A3bvi(fu)	Road transportation: automobile tyre and brake wear (fuel used)					10.0	7.7	18
1A3c	Railways					2.8	5.6	8.4
1A4ai	Commercial/institutional: stationary	3.6		4.1				7.7
1A4bi	Residential: stationary plants			11		30	28	69
1A4ci	Agriculture/forestry/fishing: stationary			2.7				2.7
1B2av	Distribution of oil products		2.8					2.8
2A1	Cement production					3.3		3.3
2A5a	Quarrying and mining of minerals other than coal					4.8	5.0	9.8
2B5	Carbide production			9.7				9.7
2B10a	Chemical industry: other			4.2				4.2
2C1	Iron and steel production					5.0	5.5	11
2D3a	Domestic solvent use including fungicides		6.1					6.1
2D3b	Road paving with asphalt		3.7					3.7
2D3e	Degreasing		2.1					2.1
2D3g	Chemical products		8.8					8.8
2D3i	Other solvent use		2.4					2.4
2G	Other product use		4.0			6.5	2.3	13
2H1	Pulp and paper industry					4.8		4.8
2H2	Food and beverages industry		2.7			9.0	4.8	16
2I	Wood processing						3.5	3.5
3B1a	Manure management - Dairy cattle		8.2		10			18
3B1b	Manure management - Non-dairy cattle		12		13			26
3B3	Manure management - Swine				9.4			9.4
3B4gii	Manure management - Broilers		4.6		6.9		3.6	15
3Da1	Inorganic N-fertilizers (includes also urea application)	7.1			4.0			11
3Da2a	Animal manure applied to soils	8.8			18			26
3Da2c	Other organic fertilisers applied to soils (including compost)	2.5			5.4			7.9
3Da3	Urine and dung deposited by grazing animals	7.0			7.9			15
3De	Cultivated crops						8.3	8.3
6A	Other sources				5.5			5.5
Total contribution from key categories, %		82	80	82	80	81	81	

1.6 QA/QC and verification methods

The national inventory system (NIS), which covers air pollutant as well as greenhouse gases, has an established quality management system (QMS) that complies with the requirements of ISO 9001:2015 standard. Certification was obtained in 2007 and has been maintained through annual audits since then. The latest audit according to ISO 9001:2015 was on 27th June 2025 and the current certificate is valid until 2028 (Swiss Safety Center 2025). The QMS is designed to comply with the UNFCCC reporting guidelines (UNFCCC 2019, 2022a) to ensure and continuously improve transparency, consistency, comparability, completeness, accuracy, and confidence in national GHG emission and removal estimates. Since the inventory system also covers air pollutants, the same quality requirements as ensured for GHG also hold for air pollutants. The quality manual (FOEN 2026a) contains all relevant information regarding the QMS. It is updated annually and made available to everyone contributing to the GHG inventories.

The NIS quality management system covers data compilation and inventory preparation based on the EMIS database. As mentioned above, EMIS is not only the tool used to model GHG emissions but is also used simultaneously to model air pollution emissions. This means that the process of modelling air pollution emissions is also part of the quality management system.

The integrity of the database is ensured by creating a new copy for each submission and comparing the results from the new database with those from the previous version. Consistency of data across categories is largely ensured by the design of the database: specific emission factors and activity data that apply to multiple categories are used jointly by all relevant categories to calculate emissions.

Checks to ensure correct aggregation are carried out during the initial setup of the various aggregations. Routine checks are also implemented in the database to identify incorrect internal aggregation processes.

Recalculations are compiled in a document and made available to the data compilers and the IIR authors. The recalculations file is of great importance in the QC procedures regarding the reporting tables (NFR) and in the preparation of the IIR. QC procedures regarding the reporting tables (NFR) comprise a detailed comparison of the reporting tables (NFR) of the previous submission with those of the latest submission for the base year and the latest common year. In addition, the time-series consistency is incrementally checked by comparing the latest inventory year with the preceding year. Any exceptional deviations are investigated by the sectoral or the EMIS database experts. These checks are performed in an iterative process: a first check is done by collaborators of the Air Pollution Control and Chemicals division and sectoral experts, providing feedback and comments to the EMIS database experts. Based on the comments, changes to the reporting tables or database are made as required. The process is repeated twice before producing the final reporting tables.

The QA/QC process can therefore be summarised as follows: The preparation steps for the production of the CLRTAP Inventory including data collection, compilation, emissions modelling within the EMIS database and generating the official emission reporting templates are part of the existing quality management system. So far, informal QC activities have been performed by the FOEN experts involved in the CLRTAP Inventory preparation and by the external authors of the Informative Inventory Report on hand. A separate and formalised CLRTAP Inventory quality system as it exists for the GHG emission inventory is not foreseen, however, a centralised plausibility check is in place.

Diverse QC procedures are implemented in the process of data-collection and generation of reporting tables and tables for the IIR. For example:

- Checks of consistency of activity data and emission factors in the individual sectors and subsectors while collecting data every year.
- Crosschecks of input and output (in particular within the energy model)

- Crosschecks between EMIS database and reporting tables
- Crosschecks with the greenhouse gas inventory concerning activity data and precursors (NO_x, CO, NMVOC and SO_x)
- Selective checks of emission factors of the inventory. For example, for submission 2026 a general comparison of emission factors with the newly published EMEP/EEA guidebook (EMEP/EEA 2023) has been conducted. In some source categories (e.g. 1A3b road transportation or 3D Agricultural soils) emission factors from guidebook version 2019 (EMEP/EEA 2019) are still used. The emission factors are progressively updated through methodological updates.
- Every year specific projects are implemented to improve the inventory in particular sections.

In addition to the QA/QC measures mentioned above, Switzerland regularly performs verification checks with data outside of the air pollutant inventory:

- The air pollutant inventory is intertwined with the GHG inventory, so any verification checks regarding precursor emissions or activity data in the GHG inventory are also applied to the air pollutant inventory.
- Switzerland systematically compares the emission factors with other European countries, especially if new emission factors are introduced to the inventory or if the accuracy of an emission factor or of a data source is questioned in an internal or external review process.
- Switzerland carries out sector-specific verification processes for individual source categories or processes.
- Switzerland regularly compares the emissions from the air pollutant inventory with the results of the national ambient concentration modelling “PolluMap” (NO₂, PM2.5 and PM10).

The continuous improvement of the inventory also includes the recommendations and encouragements from the latest stage 3 review of Switzerland’s emission inventory (UNECE 2025a). Switzerland prioritizes inventory improvements based on the findings from the stage 3 reviews and according to the key category analysis (KCA) and the uncertainty analysis, where appropriate.

1.7 General uncertainty evaluation

1.7.1 Data sources and data used

The uncertainty analysis is conducted using activity data and emission factors at the same level of aggregation as used for the NFR reporting tables (classification according to EMEP/EEA 2023). As for the key category analysis, emissions based on fuel used are considered.

Several sources of uncertainties are listed below. Uncertainty values for activity data and emission factors were updated where appropriate.

- Uncertainties of activity data are taken from the uncertainty analysis of Switzerland’s GHG Inventory (FOEN 2025).

- Uncertainties for the emission factors and emissions of mobile sources are from the study IFEU/INFRAS (2010), in which uncertainties are evaluated for road and non-road categories.
- Uncertainties of emission factors for sector 2 Industrial processes and product use are based on default uncertainty values from the EMEP/EEA guidebook (EMEP/EEA 2023, part A, chp. 5, Table 2-2).
- To estimate the uncertainties associated with NH₃ emissions from sector 3 Agriculture, a model essentially based on the nitrogen-flow model AGRAMMON was previously developed by INFRAS (2015c, 2017b). Since then, the AGRAMMON model has been revised and in addition, a new survey on production techniques in Swiss agriculture has been performed in 2019. Based on these updates, INFRAS made a new uncertainty analysis for the year 2019 (INFRAS 2021). The new uncertainty estimate for ammonia emissions from Swiss agriculture is 12.6 %, which is slightly lower than the 13.6 % estimated in the previous study. Numeric values can be found in Annex A5.1.
- Detailed numeric values and references for the uncertainties are reported in Annex 5.

1.7.2 Methodology

The uncertainty aggregation for the main pollutants and particulate matter is carried out for the latest submission according to approach 1 (uncertainty propagation) and approach 2 (Monte Carlo simulations).

Input uncertainty values for activity data and emission factors at the same aggregation level as required for the key category analysis are used for the computation. For the main pollutants, PM_{2.5} and PM₁₀, a total of 127 categories were considered, as in the NFR tables used to report emissions.

Uncertainties are assessed in accordance with the EMEP/EEA guidebook (EMEP/EEA 2023: Part A, chapter 5) and with the 2006 IPCC Guidelines (IPCC 2006), and, where applicable, the 2019 Refinement to the 2006 IPCC Guidelines (IPCC 2019). The Monte Carlo simulations follow the recommendations by JCGM (2008, Supplement 1).

The following assumptions were applied to both approaches:

- Full correlation or no correlation can be set between the base year and the reporting year for the same input variable.
- The following statistical distributions can be used: normal, triangular, gamma. If a variable cannot physically have negative values and has an uncertainty > 100 %, a gamma distribution is preferred in order to not generate negative values during Monte Carlo simulations. This is particularly relevant for emission factors.
- Asymmetric distribution: in approach 1, this is taken into account by computing the uncertainty propagation separately for each side of the mean. In approach 2, each distribution can be simulated, and asymmetric distributions are not an issue.

The following factors are not accounted for:

- Partial correlation between the base year and the reporting year for the same input variable.
- Correlations between categories (for different input variables).

For both approaches, all uncertainty results represent a 95 % confidence interval. For a symmetrical distribution, this interval is centred on the mean. For non-symmetrical

distributions obtained by Monte Carlo simulations, the reported uncertainties represent the narrowest 95 % interval, in agreement with JCGM (2008, S1). Uncertainties are given for the lower range (from the lower edge to the mean) and the upper range (from the mean to the upper edge), expressed as a percentage of the mean.

1.7.2.1 Aggregation of uncertainties using approach 1: uncertainty propagation

The uncertainty propagation is computed using the open source software Python (version 3.6.1, <https://www.python.org/>), in which the equations given in the guidelines are programmed. Results of approach 1 for the reporting year and for the trend for each considered pollutant are summarised in Table 1-12.

1.7.2.2 Aggregation of uncertainties using approach 2: Monte Carlo simulations

The Monte Carlo simulations were performed for the base year 1990, the reporting year 2024 and the trend at the aggregation level required for the KCA. All input variables can be found in Annex 5. Results for each pollutant are summarised in Table 1-12.

The main strategy in Monte Carlo analysis is to simulate a probability distribution for each input variable (distribution type, mean and standard deviation) and propagate these probability distributions to the final value of the model, in order to obtain a realistic uncertainty envelope for the final quantity. In practice, this is achieved by generating a large set of random numbers for each input quantity according to its distribution probability and by computing the intermediate (if any) and final values according to the equations of the model. The strength of this method is to propagate uncertainties accurately even if the equations of the model are non-linear and even if the final uncertainty envelope is non-symmetric. Another advantage is that a distribution is produced to represent the final quantity, while this information is not available from approach 1.

In our settings, each input quantity is an activity data associated with an emission factor or if applicable a direct emission. The final quantity is the emission at the inventory level and the mathematical model is the sum of emissions from each process.

Modelling framework

The Monte Carlo simulations are programmed using the open-source software Python (version 3.6.1, <https://www.python.org/>). Python is run through the Anaconda installation (<https://www.anaconda.com/>, version 4.4.0 (64 bit)) on a Windows PC.

To generate random numbers corresponding to the selected distributions, mean and variances, the Python function `random` is used. In practice, for each input emission factor and activity data (or direct emission, if applicable), random numbers are generated according to the input parameters. The final uncertainty envelope is obtained by computing the emissions as the product of activity data and emission factors and by then adding up all emissions. Intermediate sums can also be obtained, for example the sum for a given sector.

For each input quantity, 500'000 random values were generated resulting in equal numbers of values for the base year, the reporting year and the trend.

The average offset between the obtained mean for each process and the input mean is less than 0.1 % for each pollutant. This reflects the uncertainty introduced by the Monte Carlo method itself. This computational uncertainty remains small compared to the uncertainty introduced by activity data and emission factors.

Correlation

If two variables representing the base year (BY) and the reporting year (RY) for the same process are fully correlated, a random number is generated for the base year only, written BY_{random} . The random value for the reporting year RY_{random} is then computed as:

$$RY_{\text{random}} = BY_{\text{random}} * RY_{\text{input, mean}}/BY_{\text{input, mean}},$$

where $RY_{\text{input, mean}}$ and $BY_{\text{input, mean}}$ are the input mean values for the variables in the reporting year and the base year, respectively.

This method implicitly assumes that the uncertainty for the base year and the reporting year, expressed in percentage of the mean value, stays the same.

No correlation between activity data (or emission factors) resulting from different processes for the same year is programmed.

Sensitivity analysis

The sensitivity analysis investigates how sensitive the total emission is to each input emission. This analysis was conducted for the base year and the reporting year.

The sensitivity of a total value (total base year emission, total reporting year emission) to the variability of input quantities is computed as the correlation coefficient between total and input values, using in Python the function `corrcoef` from the `numpy` package. Each sensitivity value is computed on 500'000 pairs of points.

The sensitivity therefore has a value between -1 and +1, where a negative value indicates a negative correlation, and a positive value a positive correlation. For emissions, since the total values are a sum of input values, we expect only positive correlations.

Intuitively, the variability in the total value will be very sensitive to a process with also a high variability, compared to other processes with a smaller variability. In other words, the inventory total is expected to be mostly sensitive to processes with a high uncertainty (expressed in absolute values or in the same unit as the emissions).

Source code availability

The Python source code is available on the Github public platform with the repository name <inventory_uncertainty_UNFCCC_CLRTAP>.

1.7.3 Results of approach 1 and 2 uncertainty evaluation

Table 1-12 shows the results of the uncertainty evaluation using approaches 1 and 2 for the base year, the reporting year and the trend. Due to the availability of uncertainty data, the analysis was restricted to the main pollutants (NO_x , NMVOC, SO_x , NH_3) as well as PM2.5 and PM10. The total emissions in the base year and the reporting year as well as the emission trends 1990-2024 of these pollutants are also shown in Table 1-12. Since emission factors are generally the major sources of uncertainty (compared to activity data) and since they are considered correlated across years this may result in smaller uncertainties for the trends than for the emission levels.

Table 1-12 For each pollutant, emission levels for 1990 and 2024, trend and associated relative uncertainties obtained from the uncertainty propagation (approach 1) and from Monte Carlo simulations (approach 2), for the main pollutants, PM2.5 and PM10. Note that the trend and its associated uncertainties are expressed in the same unit, in percent. As an example, for a trend of -10 % with uncertainties of 2 %, the trend is comprised between -12 % and -8 %.

Pollutant	Emissions 1990			Emissions 2024			Trend 1990-2024		
	Value t	U(-)%	U(+)%	Value t	U(-)%	U(+)%	Value %	U(-)%	U(+)%
Uncertainty propagation (approach 1)									
NOx	140'959	13	13	43'927	12	12	-68.8	1.1	1.1
NMVOG	298'049	17	30	71'044	17	30	-76.2	3.5	4.4
SOx	39'185	5.1	6.9	2'139	7.5	7.5	-94.5	0.31	0.31
NH3	56'816	13	13	40'882	12	12	-28.0	4.3	4.3
PM2.5	27'191	41	42	6'011	25	37	-77.9	4.7	6.4
PM10	36'490	33	40	13'895	19	39	-61.9	9.5	13
Monte Carlo simulations (approach 2)									
NOx	140'959	13	13	43'927	12	12	-68.8	1.1	1.1
NMVOG	298'049	22	25	71'044	22	25	-76.2	3.8	4.0
SOx	39'185	5.8	6.1	2'139	7.5	7.5	-94.5	0.37	0.36
NH3	56'816	13	13	40'882	12	12	-28.0	4.5	4.5
PM2.5	27'191	42	42	6'011	30	31	-77.9	5.2	6.3
PM10	36'490	36	36	13'895	28	31	-61.9	11	12

In general, uncertainties resulting from approaches 1 and 2 are in concordance, especially for the upper range uncertainty. For the lower range uncertainty, approach 1 may result in a smaller estimate in cases where the inventory probability distribution is asymmetric. We therefore recommend taking into consideration the uncertainty estimate provided by approach 2 (Monte Carlo simulations).

The level and trend uncertainty estimations for the latest submission remained similar for all pollutants compared to the values of the previous submission.

The detailed information on the uncertainties of activity data and the emission factors are provided in Annex 5.

For the other air pollutants such as heavy metals, the uncertainties are assumed to be in the range of 50 % to 100 %. For POPs, uncertainties might be even higher.

The Monte Carlo simulations provide data to conduct a sensitivity analysis between emissions from each category and the inventory (total) emission for NO_x, NMVOG, NH₃, SO_x, PM2.5 and PM10. This analysis quantifies the influence of a change in the emission of a given category on the inventory total. The results of the sensitivity analysis for the base year and the reporting year are shown in Annex 5. The processes ranked in descending order of importance according to the sensitivity analysis follow almost the same order as the processes ranked according to approach 2 of the key category analysis. Both methods highlight categories with large uncertainties, expressed in absolute values. The sensitivity analysis therefore confirms the results obtained by approach 2 of the KCA.

1.8 General assessment of completeness

Complete estimates were accomplished for all known sources for all gases. Compared with the obligations of the EMEP/EEA guidebook (EMEP/EEA 2023), the Swiss CLRTAP Inventory is complete.

1.8.1 Sources not estimated (NE)

Due to time constraints, it was only possible to perform a consistent calculation of NH₃ emissions for sector 3 Agriculture using the new AGRAMMON model version for the years 1990–2024. Accordingly, NH₃ emissions of sector 3 Agriculture and the National totals for the

years 1980–1989 and 2025–2050 are reported as “not estimated”. They will be reported again in the next submission.

Emissions of additional (non-priority) heavy metals in all sectors are not estimated. There are no large sources of non-priority heavy metals in Switzerland. For the most important processes (e.g. wood waste furnaces, waste incineration plants, steelworks), measured emission values for non-priority heavy metals are not available. Due to limited resources, the focus of Switzerland’s inventory is on priority heavy.

In few other source categories, specific pollutants were reported as “not estimated” (NE). For further details, see the respective list in Annex 3.

1.8.2 Sources included elsewhere (IE)

Emissions from a number of source categories are specified as “included elsewhere” (IE). For further information on the allocation of emissions from these source categories, please refer to the respective list in Annex 3.

1.8.3 Other notation keys

Not occurring (NO)

Various pollutants or emissions do not occur in Switzerland because the related processes either do not exist or did not exist during the reporting period. Therefore, the corresponding activity data are not available, and specific emissions are reported as “not occurring” (NO).

Not applicable (NA)

A number of source categories are included in the Swiss inventory but do not result in emissions of one or more specific pollutants. These pollutants are reported as “not applicable” (NA).

2 Emission trends 1980-2024

General remark concerning emission results presented in this chapter:

Note that all the values for emissions in this chapter refer to the “national total for compliance assessment” based on “fuel used” (fu), which deviates from the “national total for the entire territory” based on “fuel sold”. Be aware that the reporting tables contain information on both, “national total emissions for the entire territory” (based on “fuel sold”) as well as “national total for compliance assessment” (based on “fuel used”). When comparing numbers from this chapter with the reporting tables, the reader shall refer to the blue coloured lines in the reporting tables, which relate to the “national total for compliance calculations and checks (CLRTAP)”. For further information concerning this differentiation, see chapter 3.1.6.1.

2.1 Comments on trends

2.1.1 General trend

Switzerland’s emissions of air pollutants are generally decreasing in the period 1980-2024 (see Table 2-1). Only the emissions of non-exhaust particulate matter (PM2.5, PM10, TSP, BC) are increasing. Note that there is a methodological difference between data before 1990 and data from 1990 onward due to lower data availability before 1990. This can lead to interpolation-based edges in the time series.

Table 2-1 Total emissions of main pollutants, particulate matter, CO, priority heavy metals and POPs (including trends). Note that numbers refer to the national total for compliance assessment (based on fuel used), which deviate from the national total for the entire territory (based on fuel sold).

Pollutant	Unit	1980	1990	2005	2024	1980-2024, %	1990-2024, %	2005-2024, %
NOx	kt	165	141	94	44	-73	-69	-53
NMVOC	kt	314	298	114	71	-77	-76	-38
SOx	kt	113	39	14	2.1	-98	-95	-85
NH3	kt	NE	57	48	41	-	-28	-15
PM2.5	kt	26	27	14	6.0	-77	-78	-57
PM2.5 ex	kt	24	25	12	3.7	-84	-85	-68
PM2.5 nx	kt	2.2	2.4	2.2	2.3	3.5	-2.4	6.1
PM10	kt	36	36	22	14	-62	-62	-36
PM10 ex	kt	27	27	13	4.1	-85	-85	-67
PM10 nx	kt	9.4	9.4	8.9	9.8	3.6	4.0	10
TSP	kt	61	56	36	28	-54	-50	-22
TSP ex	kt	33	30	13	4.5	-87	-85	-67
TSP nx	kt	28	27	22	23	-15	-12	4.7
BC	kt	4.9	5.7	3.6	0.79	-84	-86	-78
BC ex	kt	4.9	5.7	3.5	0.70	-86	-88	-80
BC nx	kt	0.026	0.071	0.078	0.092	257	31	19
CO	kt	1'135	755	303	131	-88	-83	-57
Pb	t	1'326	352	18	7.8	-99	-98	-57
Cd	t	5.2	3.2	0.48	0.41	-92	-87	-16
Hg	t	7.5	6.3	0.73	0.57	-92	-91	-22
PCDD/ PCDF	g I-Teq	443	192	31	12	-97	-94	-62
BaP	t	2.3	2.3	1.4	0.67	-71	-71	-53
BbF	t	2.6	2.6	1.6	0.72	-72	-73	-55
BkF	t	1.6	1.7	1.0	0.46	-71	-73	-56
IcdP	t	1.2	1.4	0.82	0.40	-67	-71	-52
PAHs total	t	7.6	8.0	4.9	2.2	-71	-72	-54
HCB	kg	97	173	0.44	0.35	-100	-100	-22
PCB	kg	3'607	2'332	1'270	280	-92	-88	-78

2.1.2 Legal basis for the implementation of reduction measures

The mainly decreasing trend is the result of the implementation of a consistent clean air policy of the Swiss government. It is based on the Federal Environmental Protection Act (EPA) and the Ordinance on Air Pollution Control (OAPC), which were introduced in 1983 and 1985, respectively. The EPA contains the fundamental principles whereas the OAPC contains the detailed prescriptions on air pollution control, e.g. specific emission limit values for stationary sources, ambient air quality standards, prescriptions on enforcement, etc. Main goal of the OAPC is to protect human beings, animals, plants, their biological communities and habitats and the soil against harmful effects or nuisances of air pollution. In addition, the OAPC exclusively contains a limit value for particle number emissions for construction machinery operating on construction sites. For other non-road machinery, in general, the same legislation holds as in the European Union with Regulation (EU) 2016/1628. Requirements for road vehicles are integrated into the Swiss road traffic legislation and are all in accordance with the European Union (Euro standards).

The air pollution control policy is based on:

- Federal Constitution of the Swiss Confederation: Article 74 “Protection of the environment” (Swiss Confederation 1999).
- Federal Act on the Protection of the Environment (EPA) (Swiss Confederation 1983).
- Ordinance on Air Pollution Control (OAPC) (Swiss Confederation 1985, see Figure 2-1 for an overview of the revisions).
- Federal Council’s “Concept on Air Pollution Control”: On behalf of the Swiss Parliament, the Federal Council has adopted a strategy containing national emission reduction targets, actions and measures at the national level, which will allow for reaching the air quality standards and an improved air quality in general. The strategy is regularly updated, the last version dates from 2009 and is still currently applicable (Swiss Confederation 2009).
- Ordinance on the Technical Standards for Motor Vehicles and their Trailers (Swiss Confederation 1995).
- Ordinance on the incentive tax on volatile organic compounds (VOC) since 2000 (Swiss Confederation 1997).
- Federal Act on the reduction of CO₂ emissions (Swiss Confederation 2011).
- Ratification of the seven additional protocols containing emission reduction commitments to the 1979 CLRTAP (Swiss Confederation 2004), including the 1985 Sulphur Protocol (ratified in 1987), the 1988 NO_x Protocol (ratified in 1990), the 1991 VOC Protocol (ratified in 1994), the 1994 Sulphur Protocol (ratified in 1998), the 1998 POP Protocol and 1998 Heavy Metals Protocol (both ratified in 2000) as well as the 1999 (2012) Gothenburg Protocol (ratified in 2005), and the revised 2012 Gothenburg Protocol (ratified in 2019).

Generally, revisions and amendments of the Air Pollution Control Strategy and the Ordinance on Air Pollution Control (OAPC) in Switzerland are driven by scientific findings or advancements in state-of-the-art abatement technologies. In addition, the harmonization of specific regulations (e.g. placing on the market of combustion installations, placing on the market of machinery) with the European Union leads to revisions and amendments. Main steps of revisions and amendments of the OAPC and its driving facts are outlined in Figure 2-1 below.

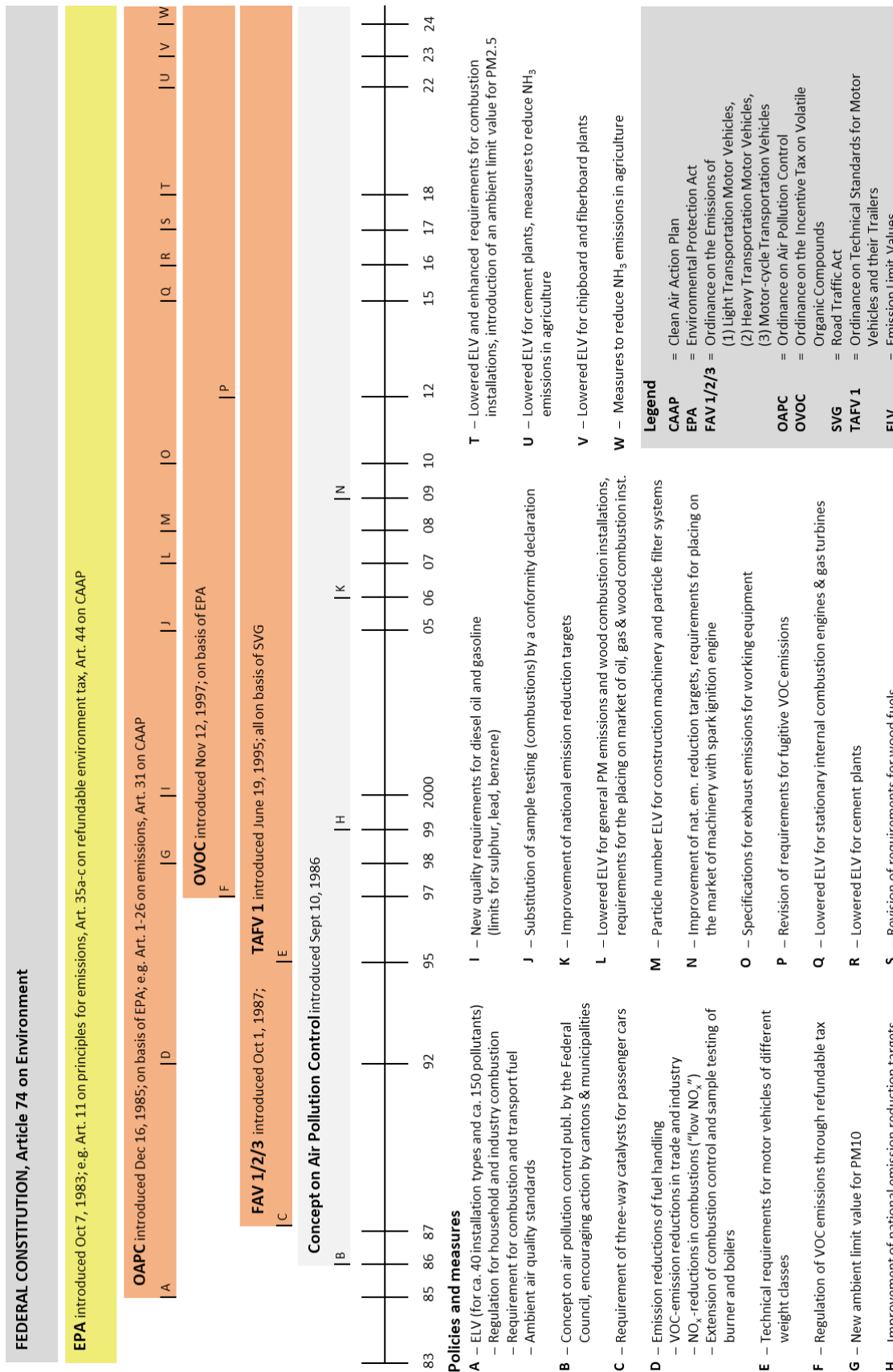


Figure 2-1 Overview of the OAPC Revisions in Switzerland. The Concept on Air Pollution Control is also referred to as the Air Pollution Control Strategy.

For further information on legislation on the abatement of air pollution, see <https://www.bafu.admin.ch/bafu/en/home/topics/air/law.html> [22.01.2026].

2.2 Overall trends of total emissions

2.2.1 Main air pollutants and CO

Emission trends of the main air pollutants and CO show a decline over the past 40 years as a result of the strict air pollution control policy and the implementation of a large number of emission reduction measures (see Figure 2-2 and Table 2-2).

Overall, the most effective reduction measures were the abatement of exhaust emissions from road vehicles and stationary installations and the incentive taxes on VOC (since 2000) and on fossil combustible fuels (since 2008). The latter measure was (jointly) responsible for the significant shift in the fuel mix of standard fossil fuels in industry from solid and liquid fuels to natural gas and the disappearance of residual fuel oil. As a result, NO_x, NMVOC and CO emissions clearly declined between 1980 and 2024.

In addition, the legal restrictions of the sulphur content in liquid fuels and the switch from gas oil to natural gas in residential heating are important for the significant decrease in SO_x emissions observed. The lowering of the sulphur content in liquid fuels is shown in Table 3-29. Annual fluctuations of SO_x emissions occur mainly due to annual variations of heating degree days, which affects the consumption of gas oil.

The reduction of NH₃ emissions since 1990 is not as pronounced as for the other pollutants mentioned above. This trend results from a combination of reduced livestock numbers, changes in animal husbandry, a decrease of N fertiliser use and the growing importance of grazing due to animal welfare incentives.

In the year 2020, a drop of NO_x emissions happened mainly due to the COVID-19 pandemic measures and the resulting reduction of traffic in Switzerland. The reduced traffic volumes affected all pollutants which are emitted by a large share from the source category 1A3 Transport (in particular 1A3b Road transportation).

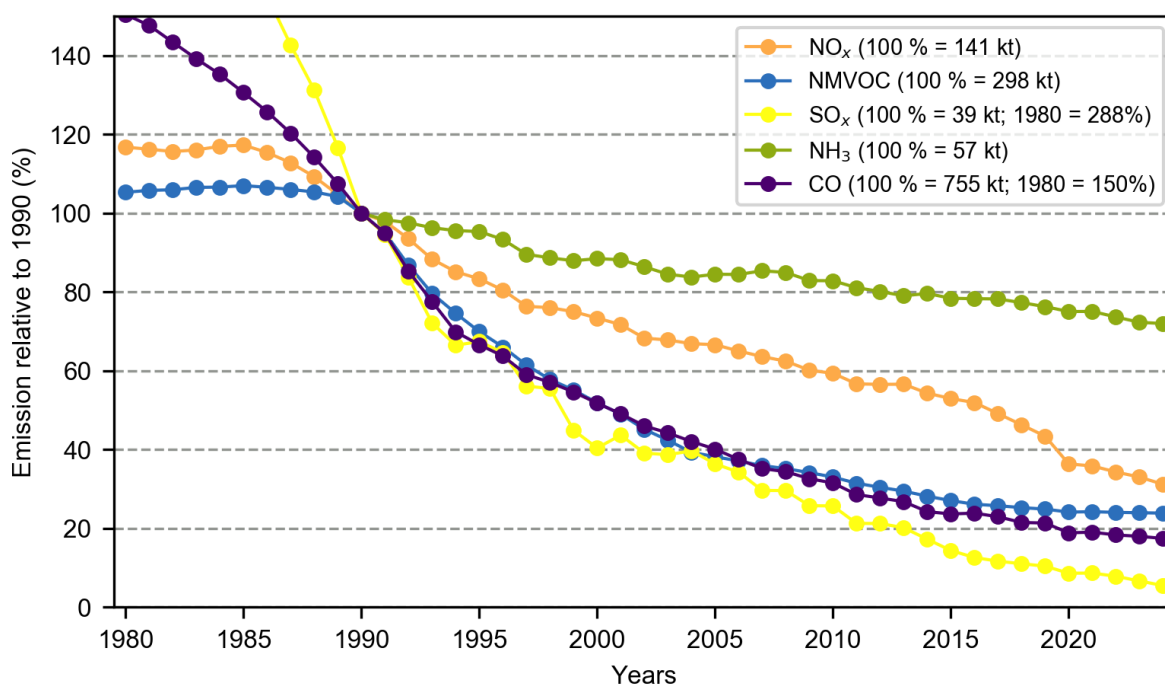


Figure 2-2 Relative trends for the total emissions of main air pollutants and CO in Switzerland 1980–2024 (in percentage of 1990). Potential discrepancies between the values before 1990 and those afterwards result from higher data availability after 1990.

Table 2-2 Main pollutants: Total emissions in kt. Note that numbers refer to the national total for compliance assessment (based on fuel used), which deviate from the national total for the entire territory (based on fuel sold).

Year	NOx	NMVOc	SOx	NH3	CO
	kt	kt	kt	kt	kt
1980	165	314	113	NE	1'135
1985	165	319	68	NE	985
1990	141	298	39	57	755
1995	117	208	26	54	502
2000	103	155	16	50	390
2005	94	114	14	48	303
2010	84	98	10	47	238
2015	75	81	5.6	45	178
2016	73	78	4.9	44	180
2017	69	77	4.6	44	173
2018	65	75	4.3	44	162
2019	61	74	4.1	43	161
2020	51	72	3.4	43	142
2021	50	72	3.4	43	143
2022	48	72	3.1	42	138
2023	47	71	2.6	41	136
2024	44	71	2.1	41	131
2024 vs 2005 (%)	-53	-38	-85	-15	-57

2.2.2 Suspended particulate matter

Emissions for suspended particulate matter (PM_{2.5}, PM₁₀, TSP and BC) show a significant decline since 1990 (see Figure 2-3 and Table 2-3). This decline can be mainly attributed to a reduction of exhaust particulate matter emissions (see Figure 2-4 and Table 2-4). The following measures were important for the reductions:

- The abatement of exhaust emissions from road vehicles and from residential heating systems, mainly affecting the fractions of fine particles (PM_{2.5}, BC).
- An action plan to reduce particulate matter emissions was initiated by the Federal Council in 2006, including 14 measures on the national level. Some of these measures led to a revision of the Ordinance of Air Pollution Control (OAPC) in 2007 and in 2018 (see Figure 2-1) with more stringent emission limit values for general dust emissions and total solids emission limit values for wood combustion installations.
- Another OAPC revision in 2008 introduced a particle number emission limit value for construction machines and particle filter systems. With the OAPC revision in 2018, the particle number emission limit value became mandatory for new machines in all sectors in accordance with new EU regulations. It aims at reducing the fine fraction of particulate matter (PM_{2.5}) and soot (see also Figure 2-1).

In contrast to exhaust particulate matter emissions, non-exhaust emissions show an increasing trend since about 2003 (see Figure 2-5, Table 2-5). This increase is mainly due to growing activity data (annual mileage and machine hours) of mobile sources, and in absolute terms it is more distinctive for TSP and PM₁₀ than for PM_{2.5} (see chp. 2.4.4). Since annual mileage dropped in 2020 and 2021 due to the COVID-19 pandemic measures, non-exhaust particulate matter emissions have decreased in 2020 and 2021 compared to 2019 as well (see Figure 2-5).

Note that in the years 1980 to 1990, BC exhaust emissions increased due to a large increase in the consumption of wood energy mainly in households (1A4bi), and to a lower extent also in the commercial sector (1A4ai) and in agriculture and forestry (1A4ci).

Condensable fractions are included in TSP, PM10 and PM2.5 emissions of wood energy combustion (1A1a, 1A2gviii, 1A4ai/bi/ci; see respective sections in chp. 3.2.1.1.2), road transportation (1A3b), non-road vehicles and machinery (1A2gvii, 1A3c/d, 1A4aii/bii/cii and 1A5b), bonfires (1A4bi) and charcoal use (1A4bi).

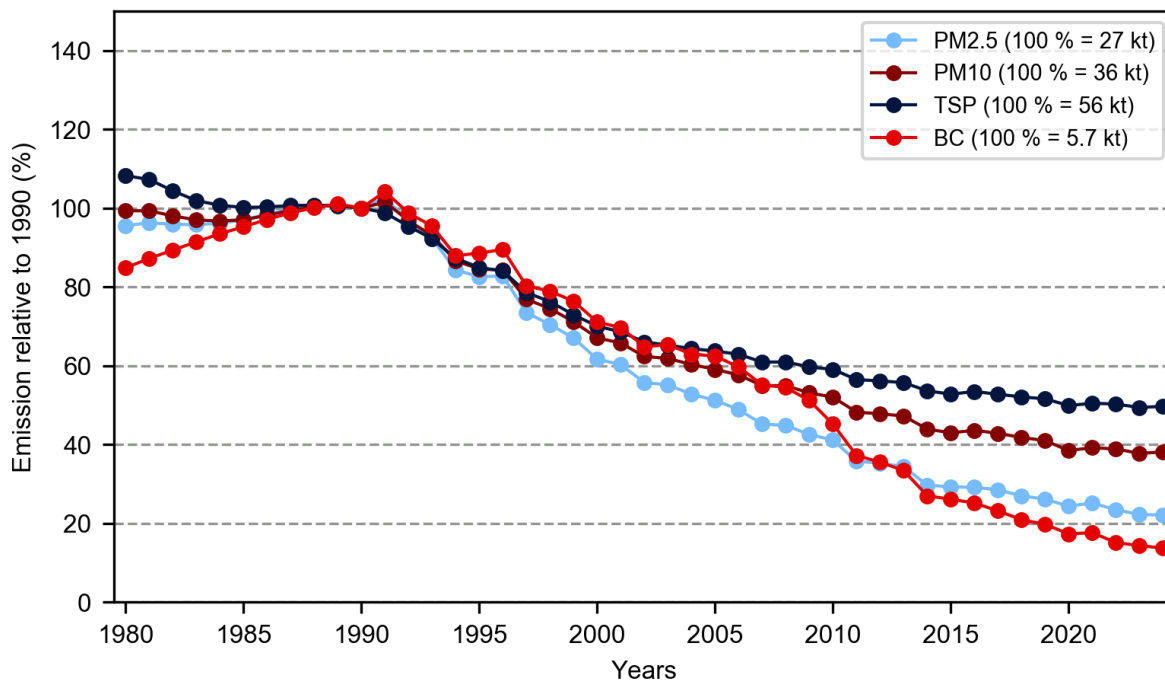


Figure 2-3 Total emissions of suspended particulate matter TSP, PM10, PM2.5 and BC in Switzerland 1980–2024 (in percentage of 1990). Potential discrepancies between the values before 1990 and those afterwards result from higher data availability after 1990.

Table 2-3 Total emissions of particulate matter in kt. Note that numbers refer to the national total for compliance assessment (based on fuel used), which deviate from the national total for the entire territory (based on fuel sold).

Year	PM2.5	PM10	TSP	BC
	kt	kt	kt	kt
1980	26	36	61	4.9
1985	26	35	56	5.5
1990	27	36	56	5.7
1995	22	31	48	5.1
2000	17	24	39	4.1
2005	14	22	36	3.6
2010	11	19	33	2.6
2015	7.9	16	30	1.5
2016	7.9	16	30	1.4
2017	7.7	16	30	1.3
2018	7.3	15	29	1.2
2019	7.1	15	29	1.1
2020	6.6	14	28	1.00
2021	6.8	14	28	1.0
2022	6.4	14	28	0.87
2023	6.0	14	28	0.82
2024	6.0	14	28	0.79
2024 vs 2005 (%)	-57	-36	-22	-78

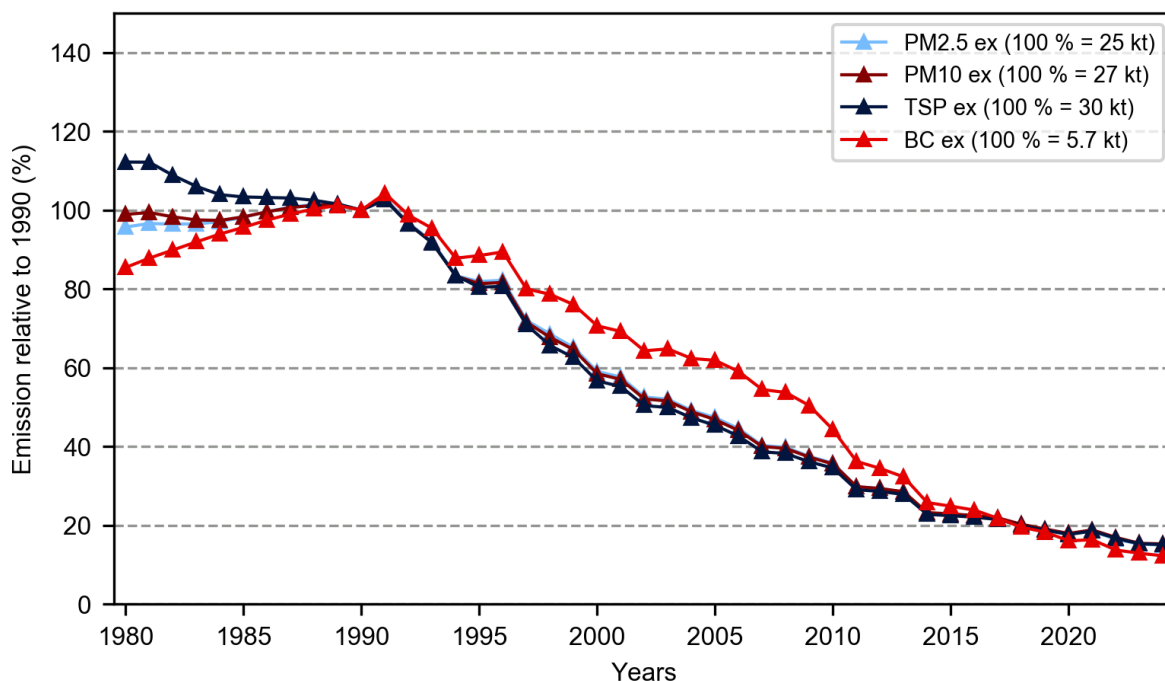


Figure 2-4 Exhaust emissions of suspended particulate matter TSP, PM10, PM2.5 and BC in Switzerland 1980–2024 (in percentage of 1990). Potential discrepancies between the values before 1990 and those afterwards result from higher data availability after 1990.

Table 2-4 Exhaust emissions of particulate matter in kt. Note that numbers refer to the national total for compliance assessment (based on fuel used), which deviate from the national total for the entire territory (based on fuel sold).

Year	PM2.5 ex	PM10 ex	TSP ex	BC ex
	kt	kt	kt	kt
1980	24	27	33	4.9
1985	24	27	31	5.4
1990	25	27	30	5.7
1995	20	22	24	5.0
2000	15	16	17	4.0
2005	12	13	13	3.5
2010	8.9	9.6	10	2.5
2015	5.7	6.2	6.6	1.4
2016	5.6	6.1	6.5	1.4
2017	5.4	5.9	6.3	1.2
2018	4.9	5.5	5.9	1.1
2019	4.7	5.2	5.5	1.0
2020	4.4	4.9	5.2	0.91
2021	4.6	5.1	5.5	0.93
2022	4.1	4.6	4.9	0.78
2023	3.8	4.2	4.5	0.73
2024	3.7	4.1	4.5	0.70
2024 vs 2005 (%)	-68	-67	-67	-80

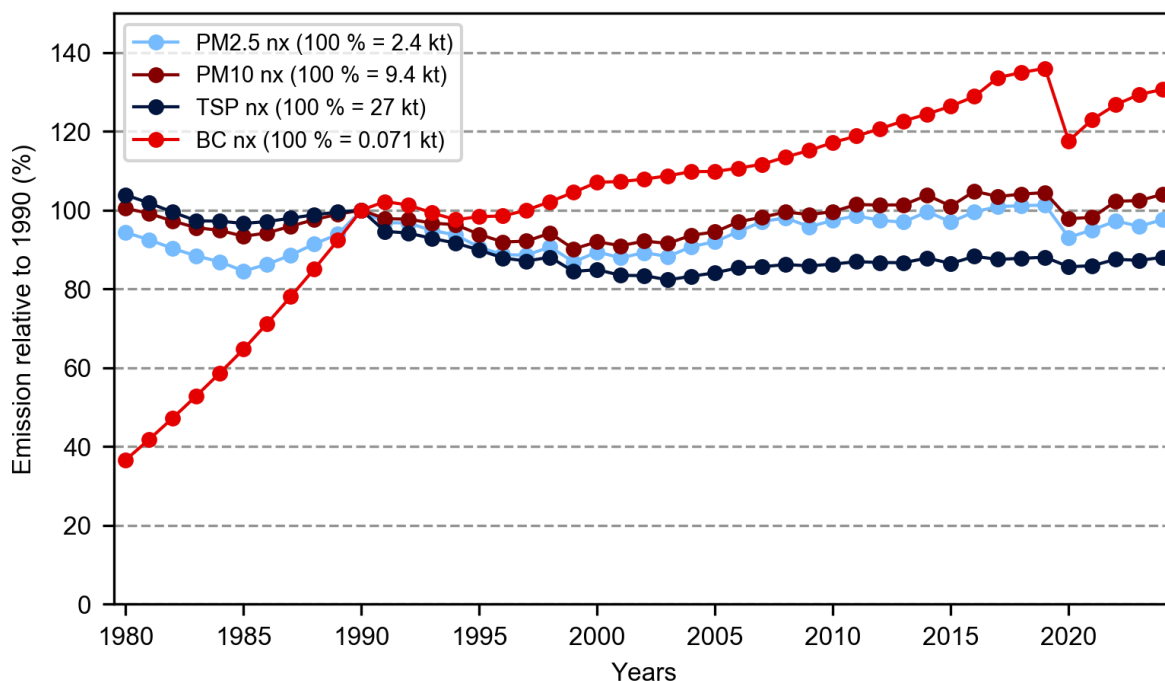


Figure 2-5 Non-exhaust emissions of suspended particulate matter TSP, PM10, PM2.5 and BC in Switzerland 1980–2024 (in percentage of 1990). Potential discrepancies between the values before 1990 and those afterwards result from higher data availability after 1990.

Table 2-5 Non-exhaust emissions of particulate matter in kt. Note that numbers refer to the national total for compliance assessment (based on fuel used), which deviate from the national total for the entire territory (based on fuel sold).

Year	PM2.5 nx	PM10 nx	TSP nx	BC nx
	kt	kt	kt	kt
1980	2.2	9.4	28	0.026
1985	2.0	8.8	26	0.046
1990	2.4	9.4	27	0.071
1995	2.1	8.8	24	0.069
2000	2.1	8.6	23	0.076
2005	2.2	8.9	22	0.078
2010	2.3	9.3	23	0.083
2015	2.3	9.5	23	0.089
2016	2.3	9.8	23	0.091
2017	2.4	9.7	23	0.094
2018	2.4	9.8	23	0.095
2019	2.4	9.8	23	0.096
2020	2.2	9.2	23	0.083
2021	2.2	9.2	23	0.087
2022	2.3	9.6	23	0.090
2023	2.3	9.6	23	0.091
2024	2.3	9.8	23	0.092
2024 vs 2005 (%)	6.1	10	4.7	19

2.2.3 Priority heavy metals

Between 1980 and 2003, emissions of priority heavy metals (Pb, Cd and Hg) show a pronounced decline (see Figure 2-6 and Table 2-6). The continuous decrease of the lead content in gasoline and the final ban on leaded gasoline in 2000 resulted in an important decrease of Pb emissions. The decrease of Cd and Hg emissions is mainly due to the strict emission limit values for waste incineration plants. Since 2003, the decreasing trend of heavy metals emissions is less pronounced. In the case of Cd and Hg, it has even stopped in recent years, with emissions fluctuating from year to year.

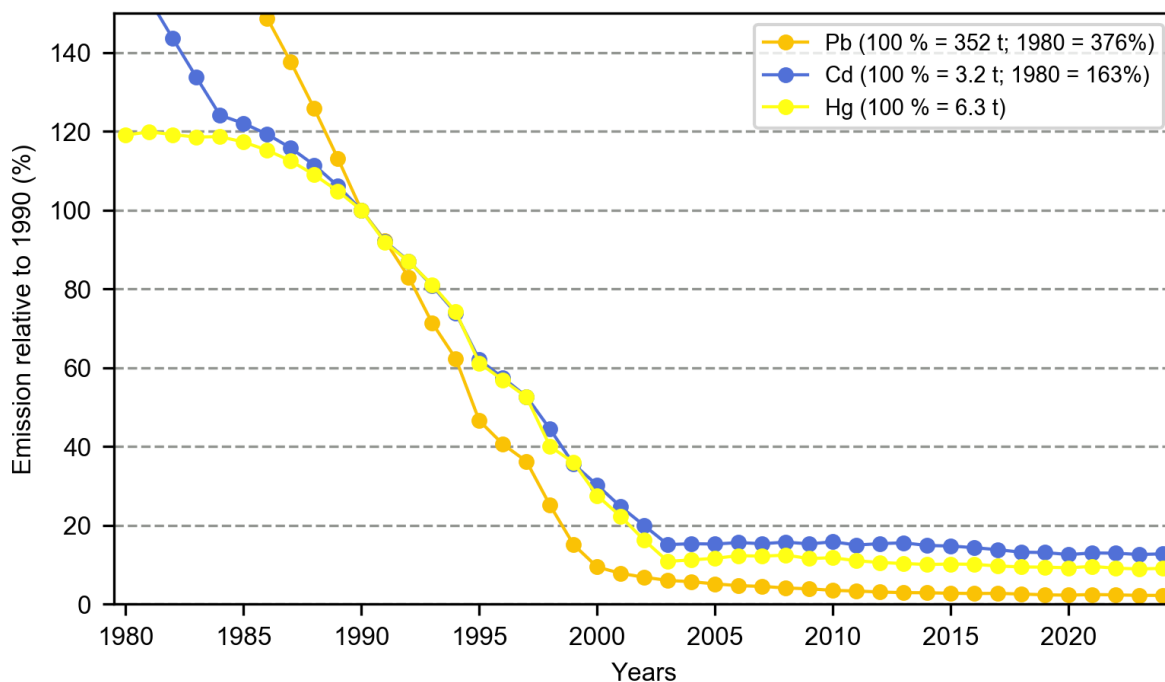


Figure 2-6 Emissions of priority heavy metals in Switzerland 1980–2024 (in percentage of 1990). Potential discrepancies between the values before 1990 and those afterwards result from higher data availability after 1990.

Table 2-6 Total emissions of priority heavy metal in tons. Note that numbers refer to the national total for compliance assessment (based on fuel used), which deviate from the national total for the entire territory (based on fuel sold).

Year	Pb	Cd	Hg
	t	t	t
1980	1'326	5.2	7.5
1985	559	3.9	7.4
1990	352	3.2	6.3
1995	164	2.0	3.9
2000	33	0.96	1.7
2005	18	0.48	0.73
2010	12	0.50	0.74
2015	9.6	0.47	0.64
2016	9.4	0.46	0.64
2017	9.5	0.44	0.61
2018	9.0	0.42	0.59
2019	8.2	0.42	0.59
2020	8.0	0.40	0.58
2021	8.5	0.41	0.60
2022	8.2	0.41	0.57
2023	7.8	0.40	0.56
2024	7.8	0.41	0.57
2024 vs 2005 (%)	-57	-16	-22

2.2.4 Persistent organic pollutants (POPs)

The emissions of persistent organic pollutants have generally declined since 1980 (see Figure 2-7 and Table 2-7).

Between 1980 and 2003, PCDD/PCDF emissions decreased as a result of an indirect effect of the equipment of waste incineration plants with DeNO_x techniques. From 2003 onward, emissions continue to decrease, albeit with a reduced rate.

Emissions of (total) PAH increased slightly in the period 1980-1991, but since then strongly decreased due to reduction measures for waste incineration plants and technological improvements of wood combustion installations in 1A Fuel combustion. In addition, the wood energy consumption decreased by more than half in manually operated furnaces and increased by about a factor of eight in automatic combustion installations since 1990.

HCB emissions are strongly influenced by activity data of the secondary aluminium production. The trend shown in Figure 2-7 is primarily a reflection of the activity of the single plant for secondary aluminium production in Switzerland which ceased in 1993. Since then, total HCB emissions remain on a generally low level with a slight further decrease. The remaining sources of HCB emissions are waste incineration plants in source category 1A1 Energy industries, all wood combustion installations and with a smaller share the use of coal (other bituminous coal and lignite) in 1A Fuel combustion. The annual fluctuations in HCB emissions are due to the wood consumption in 1A4bi Residential: Stationary, which is strongly influenced by climate variabilities, in particular by the winter mean temperatures (heating degree days).

Except for a sudden sharp increase in 1999, PCB emissions decreased continuously since 1980. Although the use of PCBs in anti-corrosive paints and joint sealants (so-called open applications) is prohibited since 1972, they are the predominant PCB emission sources for most of the time. In 1986, a total ban was placed on any form of PCB use in Switzerland. Between 1975 and 1985 and around 2000, burning of PCB contaminated waste oil in outdoor fires (ceased in 1999) and shredding of electronic waste containing PCBs in small capacitors, respectively, were the dominant PCB sources. The latter was also the cause for the sudden sharp emission increase in 1999. Mainly in the seventies and eighties, accidental release by fire, small and large capacitors and waste incineration were important emission sources as well.

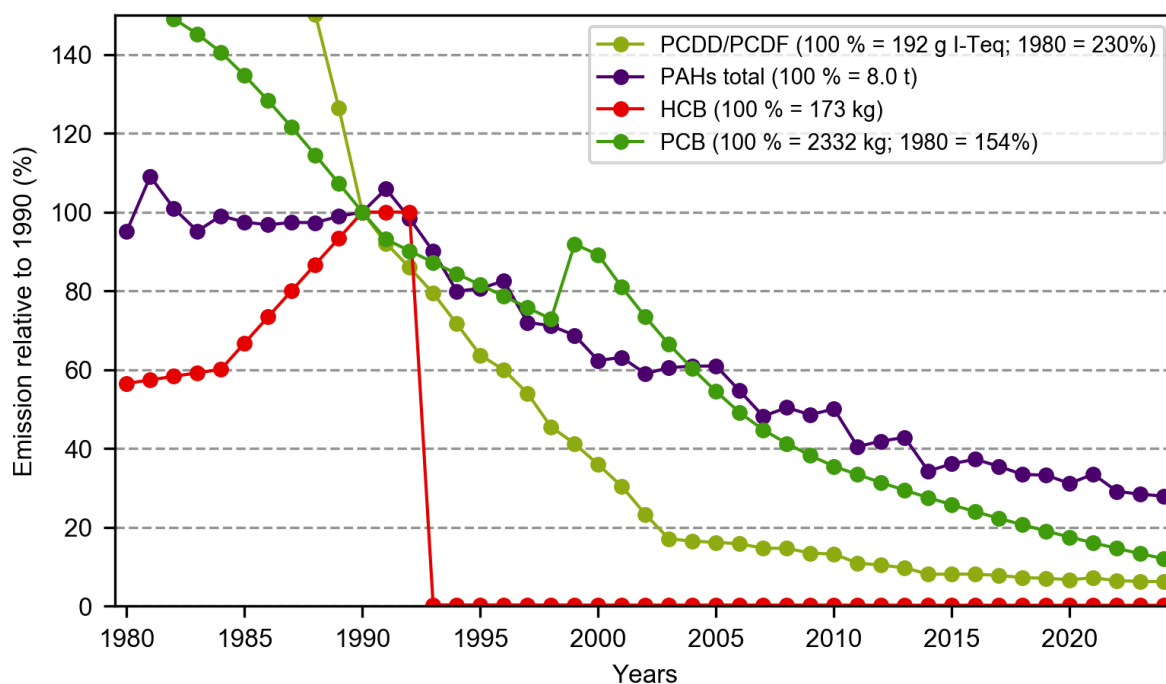


Figure 2-7 Emissions of POPs Annex III¹: PAH – as the sum of benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene – PCDD/PCDF, HCB and PCB in Switzerland 1980–2024. Note that values for PCDD/PCDF before 1989 are not displayed here but illustrated in the table below. Potential discrepancies between the values before 1990 and those afterwards result from higher data availability after 1990.

Table 2-7 Total emissions of POPs Annex III (see footnote 1, p. 53). Please consider the different units. Note that numbers refer to the national total for compliance assessment (based on fuel used), which deviate from the national total for the entire territory (based on fuel sold).

Year	PCDD/ PCDF	BaP	BbF	BkF	IcdP	PAHs total	HCB	PCB
	g I-Teq	t	t	t	t	t	kg	kg
1980	443	2.3	2.6	1.6	1.2	7.6	97	3'607
1985	397	2.3	2.6	1.6	1.3	7.8	115	3'140
1990	192	2.3	2.6	1.7	1.4	8.0	173	2'332
1995	123	2.0	2.1	1.3	1.2	6.5	0.49	1'901
2000	69	1.5	1.6	1.1	0.87	5.0	0.43	2'079
2005	31	1.4	1.6	1.0	0.82	4.9	0.44	1'270
2010	25	1.3	1.3	0.77	0.71	4.0	0.45	827
2015	16	0.89	0.93	0.57	0.51	2.9	0.36	600
2016	16	0.91	0.96	0.59	0.53	3.0	0.38	559
2017	15	0.86	0.91	0.57	0.51	2.9	0.37	519
2018	14	0.81	0.86	0.54	0.48	2.7	0.36	481
2019	14	0.81	0.85	0.54	0.48	2.7	0.36	444
2020	13	0.76	0.80	0.50	0.44	2.5	0.35	408
2021	14	0.81	0.86	0.54	0.48	2.7	0.37	374
2022	12	0.70	0.75	0.47	0.42	2.3	0.34	341
2023	12	0.68	0.73	0.47	0.40	2.3	0.34	310
2024	12	0.67	0.72	0.46	0.40	2.2	0.35	280
2024 vs 2005 (%)	-62	-53	-55	-56	-52	-54	-22	-78

¹ Annex III of the 1998 Aarhus Protocol on Persistent Organic Pollutants (POPs)

2.3 Trends of main pollutants per gas and sectors

2.3.1 Trends for NO_x

Switzerland's emissions of NO_x (sum of NO and NO₂, expressed as NO₂ equivalents) mainly stem from sector 1 Energy. The trend of NO_x emissions per sector is given in Table 2-8 and Figure 2-8. Overall, NO_x emissions in Switzerland constantly declined between 1990 and 2024.

The decline has mainly occurred due to emission reductions in the energy sector. Within the energy sector, in particular categories 1A3 Transport, 1A4 Other sectors and 1A2 Manufacturing industries are relevant for NO_x emissions in 2024. The decrease of NO_x emissions in sector 1 Energy was primarily due to the abatement of exhaust emissions from road vehicles (in category 1A3 Transport) and from production of process heat in manufacturing industries (1A2) and in residential, commercial and institutional heating (1A4).

- The reductions in 1A3b Road transportation were triggered by the implementation of new strict emission standards for road vehicles. The first step happened in the late 80's when Switzerland reduced the standards to a level that required the equipment of three-way catalysts for new passenger cars. Later, when the European Union introduced the first Euro standards in 1993, Switzerland adopted the subsequent reduction path (Euro 2/II in 1995, Euro 3/III in 2000, Euro 4/IV in 2005, Euro V in 2008, Euro 5 in 2009, Euro VI in 2013 and Euro 6 in 2014). However, the reduction of NO_x emissions due to emission standards has not been as pronounced as expected in the years before 2015 because of an increasing share of diesel-powered passenger cars and a higher emission factor than expected (the "dieselgate" scandal², detected in the year 2015).
- In the years 2020 and 2021, the COVID-19 pandemic led to measures that resulted in a massive reduction in transport activities (1A3). The lower traffic volume led to a strong decrease in NO_x emissions from 1A3b Road transportation and a sharp drop in emissions from 1A3a Aviation, especially international aviation. However, the share of NO_x emissions from 1A3a Aviation in 1A3 Transport is smaller than that from 1A3b Road transportation, in particular due to the system boundaries (only LTO emissions from air traffic are taken into account in the national total, see chapter 3.1.6.1).
- The reductions in 1A2 Manufacturing industries and construction were a result of three main factors: First, there has been a fuel switch from residual fuel oil, coal and gas oil towards natural gas and a reduction in total fuel use since 2008. Second, a reduction has been reached due to an on-going sectoral agreement (from 1998) targeting NO_x emissions of the cement industry. Third, manufacturing plants reduced NO_x emissions through technical improvements (e.g. DeNO_x technology, selective non-catalytic reduction technology SNCR).
- In the past, the number of buildings and apartments increased, as well as the average floor space per person and workplace. Both effects resulted in an increase of the total heated area. On the other hand, higher standards were specified for insulation and for combustion equipment efficiency for new or renovated buildings including low-NO_x standards. Furthermore, a substantial substitution of gas oil by natural gas under 1A4 Other sectors resulted in further reductions of NO_x emissions (i.e. natural gas consumption increased by half from 1990 to 2024). These emission reductions compensate for the expected increase in emissions due to higher demand for heating energy because of more heating surface, and lead to a total reduction of NO_x emissions under category 1A4 Other sectors.

² Dieselgate: «The EPA had found that Volkswagen had intentionally programmed turbocharged direct injection diesel engines to activate certain emissions controls only during laboratory emissions testing. Volkswagen deployed this programming in about eleven million cars worldwide» Source: https://en.wikipedia.org/wiki/Volkswagen_emissions_scandal [02.02.2026]

NO_x emissions from Agriculture decrease on a rather low absolute emission level. Main source is category 3D Agricultural soils. The development of NO_x emissions in category 3D depends on the development of livestock numbers and thus N excretions (Kupper et al. 2026) with a similar pattern as overall NO_x emissions from the agriculture sector. The decrease in inorganic N-fertiliser use (3Da1) additionally contributed to the reduction of NO_x emissions (Kupper et al. 2026).

Table 2-8 NO_x emissions, trends and share per sector as well as emission ceiling for 2010 from the Gothenburg Protocol (national total for compliance; fuel used (fu)).

NO _x emissions	1990	2005	2010	2024	1990-2010	2005-2024	2005-2024	share in 2024
	kt	kt	kt	kt	kt	kt	%	%
1(fu) Energy	135	89	79	40	-56	-49	-55	91
1A(fu) Combustion	135	89	79	40	-56	-49	-55	91
1A1 Energy industries	6.8	3.0	3.1	2.9	-3.7	-0.052	-1.7	6.6
1A2 Manufacturing industries and construction	23	14	12	6.1	-10	-8.3	-58	14
1A3(fu) Transport	83	54	48	22	-35	-32	-59	51
1A4 Other sectors	22	17	15	8.1	-6.7	-8.5	-51	18
1A5 Other	0.88	0.60	0.54	0.32	-0.34	-0.28	-47	0.72
1B Fugitive emissions from fuels	0.21	0.29	0.11	0.0010	-0.098	-0.28	-100	0.0024
2 Industrial processes and product use	0.52	0.34	0.40	0.21	-0.11	-0.13	-37	0.48
3 Agriculture	5.0	3.9	4.1	3.6	-0.95	-0.28	-7.1	8.3
5 Waste	0.29	0.16	0.15	0.12	-0.14	-0.037	-23	0.28
6 Other sources	0.092	0.096	0.099	0.088	0.0067	-0.0082	-8.6	0.20
National total (fu)	141	94	84	44	-57	-50	-53	100
Gothenburg Protocol, target emission ceiling 2010			79					
Gothenburg Protocol revised, target emission reduction 2005-2020							-41	

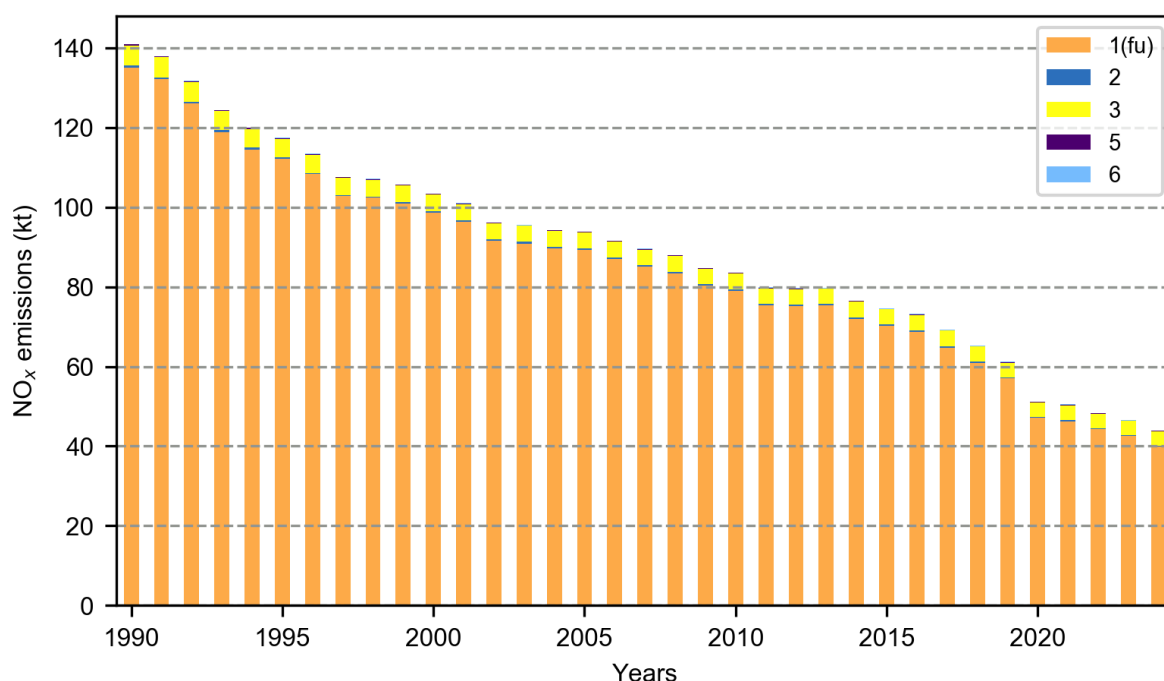


Figure 2-8 Trend of NO_x emissions (kt) in Switzerland by sector ((fu) means fuel used approach).

2.3.2 Trends for NMVOC

Switzerland’s emissions of NMVOC mainly stem from the sectors 2 IPPU, 3 Agriculture and 1 Energy. The trend of NMVOC emissions per sector is given in Table 2-9 and Figure 2-9. The NMVOC emissions have decreased in the time span 1990-2024.

The relevant reductions were achieved in sectors 2 IPPU and 1 Energy:

- In sector 2 IPPU, the emission reduction was more pronounced for the years 1990-2004 than from 2004 onwards. The reduction of 1990-2004 can be mainly attributed to category 2D3d Coating applications, where the paint composition changed from solvent based to water-based paints. In addition, paint consumption in 2D3d decreased for construction (1990-1998) as well as for industrial paint application (2001-2004) which is partly due to substitution of conventional paints by powder coatings. Despite population growth and the associated increase in product use (e.g. cosmetics, toiletries, cleaning agents and care products), the general trend of NMVOC emissions from sector 2 IPPU was still decreasing from 2004-2016 (and rather constant values afterwards). This was mainly a result of reduced emissions caused by the ordinance on the VOC incentive tax (enactment of the tax in 2000 and revision in 2012).
- In sector 1 Energy, the emission reduction was mainly influenced from category 1A3b Road transportation, in particular resulting from the higher Euro standards for passenger cars (Euro 1 in 1993, Euro 2 in 1995, Euro 3 in 2000, Euro 4 in 2005, Euro 5 in 2009 and Euro 6 in 2014). Furthermore, the share of diesel oil in fuels used under 1A3b has increased compared to gasoline between 1990 and 2024, which leads to a decrease of NMVOC emissions. In 2020 and 2021, the COVID-19 pandemic led to a reduction of NMVOC emissions from road transportation due to reduced traffic volumes. The measures against the pandemic also led to a sharp drop in emissions from 1A3a Aviation in 2020 and 2021, especially international aviation. However, the share of NMVOC emissions from 1A3a Aviation in 1A3 Transport is smaller than that from 1A3b Road transportation, in particular due to the different fuel types (most NMVOC emissions stem from gasoline engines) and the system boundaries (only LTO emissions from air traffic are taken into account in the national total, see chapter 3.1.6.1).
- NMVOC emissions of source category 1A4 Other sectors declined in the same period as well due to technical improvements of wood combustion installations and a reduction in the number and energy consumption of emission intensive types of log wood furnaces.

NMVOC emissions from sector 3 Agriculture show a significant increase between 2000 and 2008 and have remained at about constant level since 2014. They depend on the number of livestock, in particular the number of cattle receiving silage feeding. Thus, the emission increase is mainly due to the increase in non-dairy cattle which predominately are fed by silage.

Table 2-9 NMVOC emissions, trends and share per sector as well as the emission ceiling for 2010 from the Gothenburg Protocol (national total for compliance; fuel used).

NMVOC emissions	1990	2005	2010	2024	1990-2010	2005-2024	2005-2024	share in 2024
	kt	kt	kt	kt	kt	kt	%	%
1(fu) Energy	133	46	32	15	-101	-31	-68	21
1A(fu) Combustion	112	38	27	13	-85	-26	-67	18
1A1 Energy industries	0.33	0.32	0.26	0.21	-0.067	-0.11	-34	0.30
1A2 Manufacturing industries and construction	2.4	2.1	1.6	0.86	-0.78	-1.2	-58	1.2
1A3(fu) Transport	92	24	16	6.9	-76	-17	-72	9.7
1A4 Other sectors	17	12	9.3	4.5	-8.2	-7.1	-61	6.4
1A5 Other	0.16	0.11	0.090	0.053	-0.070	-0.057	-52	0.074
1B Fugitive emissions from fuels	21	7.2	5.2	2.2	-16	-5.0	-69	3.2
2 Industrial processes and product use	149	51	47	36	-102	-15	-29	51
3 Agriculture	14	16	17	18	2.8	2.1	13	25
5 Waste	1.1	1.0	1.2	1.8	0.048	0.78	76	2.6
6 Other sources	0.20	0.20	0.18	0.17	-0.024	-0.038	-19	0.23
National total (fu)	298	114	98	71	-200	-43	-38	100
Gothenburg Protocol, target emission ceiling 2010			144					
Gothenburg Protocol revised, target emission reduction 2005-2020							-30	

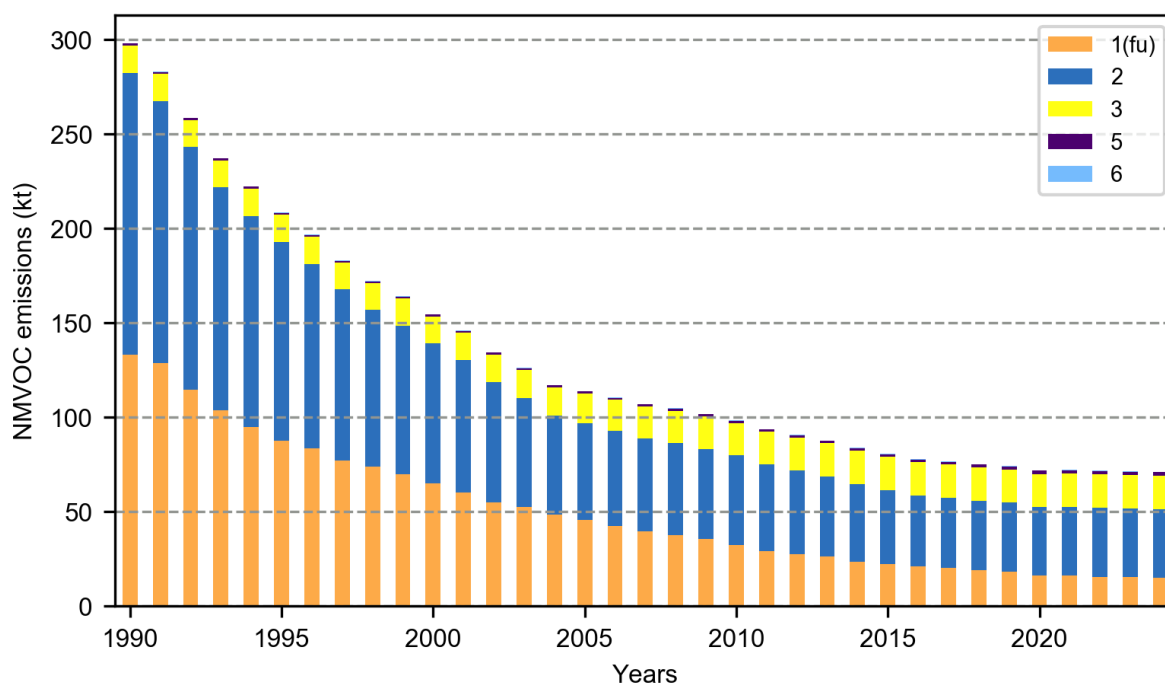


Figure 2-9 Trend of NMVOC emissions (kt) in Switzerland by sector ((fu) means fuel used approach).

2.3.3 Trends for SO_x

Switzerland's emissions of SO_x (sum of SO₂ and SO₃, expressed as SO₂ equivalents) mainly stem from sector 1 Energy. The trend of SO_x emissions per sector is given in Table 2-10 and Figure 2-10. SO_x emissions show a decreasing trend with some fluctuations between 1990 and 2024.

The decrease can be mainly attributed to three measures in Switzerland in the sector Energy:

- First, the Ordinance on Air Pollution Control (Swiss Confederation 1985) introduced a limitation of the sulphur content in liquid fuels, with further stepwise lowering in 1991, 2000, 2005, 2008 and 2009 for liquid fuels (Table 3-28). These stringent measures resulted in a significant decrease of the sulphur oxide emissions from fuel combustion under 1A3 Transport and 1A4 Other sectors (gas oil, diesel oil and gasoline, see Table 3-28).
- Second, a substantial substitution of gas oil with natural gas and eco-grade gas oil (with low sulphur and nitrogen content, from 2006 onwards) under 1A4 Other sectors resulted in further reductions of sulphur emissions (natural gas consumption increased by half from 1990 to 2024).
- Third, a similar substitution of residual fuel oil, coal and gas oil by natural gas has reduced sulphur emissions as well in 1A2 Manufacturing industries (i.e. coal and residual fuel oil from 1990, gas oil from about 2005 onwards).

In addition, SO_x emissions from 2C Metal production declined between 1990 and 2007, mainly following the decrease in aluminium production volume, which was ceased in 2006. SO_x emissions of sector 2B Chemical industry show no clear trend in the period 1990–2024. They stem predominately from the sulphur content of the raw materials of the graphite and

silicon carbide production (petroleum coke and other bituminous coal) and reflect, thus, the production volumes.

Table 2-10 SO_x emissions, trends and share per sector as well as the emission ceiling for 2010 from the Gothenburg Protocol (national total for compliance; fuel used).

SO _x emissions	1990	2005	2010	2024	1990-2010	2005-2024	2005-2024	share in 2024
	kt	kt	kt	kt	kt	kt	%	%
1(fu) Energy	37	13	9.2	1.8	-28	-11	-86	86
1A(fu) Combustion	37	13	9.0	1.8	-28	-11	-86	85
1A1 Energy industries	4.3	1.6	1.7	0.34	-2.6	-1.3	-80	16
1A2 Manufacturing industries and construction	13	4.2	2.9	0.92	-10	-3.2	-78	43
1A3(fu) Transport	4.0	0.18	0.20	0.20	-3.8	0.021	12	9.5
1A4 Other sectors	15	6.6	4.1	0.34	-11	-6.3	-95	16
1A5 Other	0.078	0.037	0.037	0.025	-0.041	-0.012	-32	1.2
1B Fugitive emissions from fuels	0.72	0.51	0.22	0.014	-0.50	-0.50	-97	0.67
2 Industrial processes and product use	1.6	1.0	0.80	0.26	-0.84	-0.77	-75	12
3 Agriculture	NA	NA	NA	NA	-	-	-	-
5 Waste	0.16	0.063	0.063	0.030	-0.10	-0.034	-53	1.4
6 Other sources	0.0092	0.0094	0.0074	0.0070	-0.0017	-0.0024	-25	0.33
National total (fu)	39	14	10	2.1	-29	-12	-85	100
Gothenburg Protocol, target emission ceiling 2010			26					
Gothenburg Protocol revised, target emission reduction 2005-2020							-21	

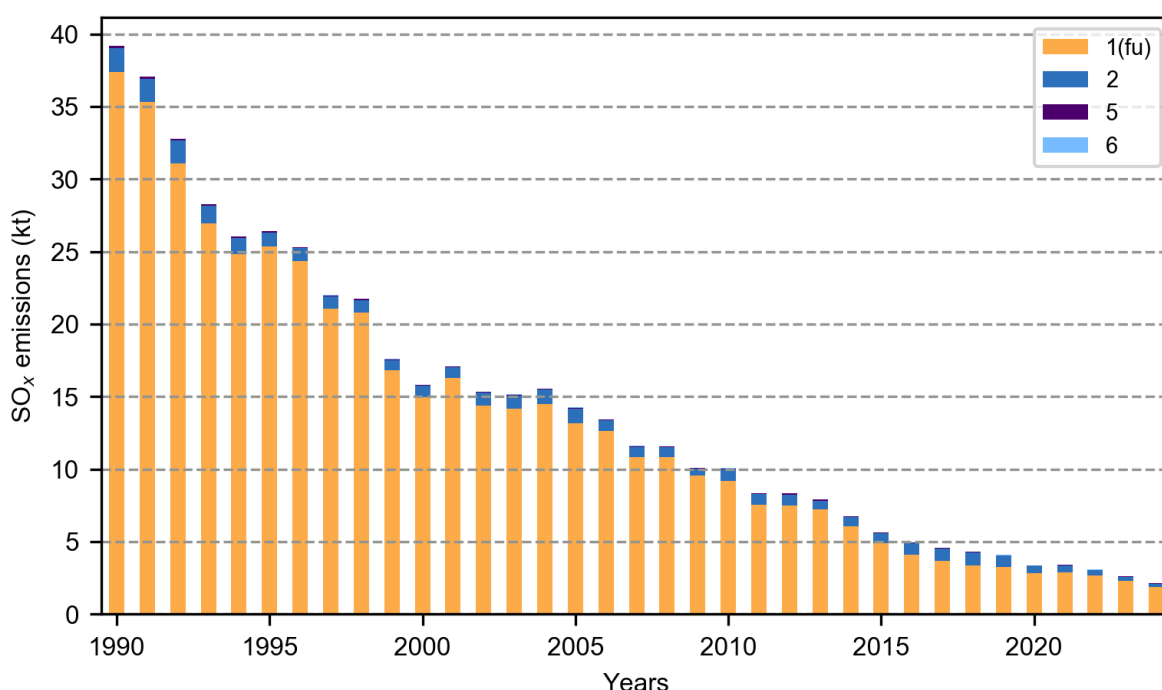


Figure 2-10 Trend of SO_x emissions (kt) in Switzerland by sector (SO_x as sum of SO₂ and SO₃, expressed as SO₂ equivalents) ((fu) means fuel used approach).

2.3.4 Trends for NH₃

Switzerland's emissions of NH₃ mainly stem from sector 3 Agriculture. The trend of NH₃ emissions per sector is given in Table 2-11 and Figure 2-11. NH₃ emissions show a decreasing trend between 1990 and 2024.

Emission reductions (with fluctuations) occurred mainly in source category 3D Agricultural soils, especially in 3Da2a Animal manure applied to soils, while emissions from source category 3B Manure management decreased only slightly. In 2024, both categories are

about equally important. Agricultural ammonia emissions decreased between 1990 and 2004, followed by a slight increase until 2007 and another decrease since then. This non-monotonic trend results from a combination of changes in animal numbers, introduction of nutrient balance regulations for nitrogen, introduction of new housing systems and more grazing due to developments in animal welfare regulations, increase of animal productivity, changes in production techniques and a considerable decrease of N fertiliser use due to nutrient balance restrictions (Kupper et al. 2015, 2018, 2022, 2026).

Table 2-11 NH₃ emissions, trends and share per sector as well as the emission ceiling for 2010 from the Gothenburg Protocol (national total for compliance; fuel used).

NH ₃ emissions	1990	2005	2010	2024	1990-2010	2005-2024	2005-2024	share in 2024
	kt	kt	kt	kt	kt	kt	%	%
1(fu) Energy	1.7	3.9	2.7	1.2	1.0	-2.6	-69	3.0
1A(fu) Combustion	1.7	3.9	2.7	1.2	1.0	-2.6	-69	3.0
1A1 Energy industries	0.0049	0.029	0.036	0.052	0.032	0.023	80	0.13
1A2 Manufacturing industries and construction	0.17	0.19	0.24	0.22	0.077	0.028	14	0.54
1A3(fu) Transport	1.3	3.5	2.3	0.84	0.95	-2.7	-76	2.1
1A4 Other sectors	0.18	0.14	0.14	0.10	-0.038	-0.044	-30	0.25
1A5 Other	0.00004	0.00004	0.00004	0.00004	0.000005	0.000001	3.2	0.00010
1B Fugitive emissions from fuels	NA	NA	NA	NA	-	-	-	-
2 Industrial processes and product use	0.37	0.35	0.21	0.12	-0.16	-0.23	-65	0.30
3 Agriculture	53	42	42	38	-11	-4.3	-10	92
5 Waste	0.91	0.93	0.89	0.88	-0.020	-0.051	-5.5	2.1
6 Other sources	0.85	0.87	0.91	0.93	0.067	0.064	7.4	2.3
National total (fu)	57	48	47	41	-9.8	-7.1	-15	100
Gothenburg Protocol, target emission ceiling 2010			63					
Gothenburg Protocol revised, target emission reduction 2005-2020							-8.0	

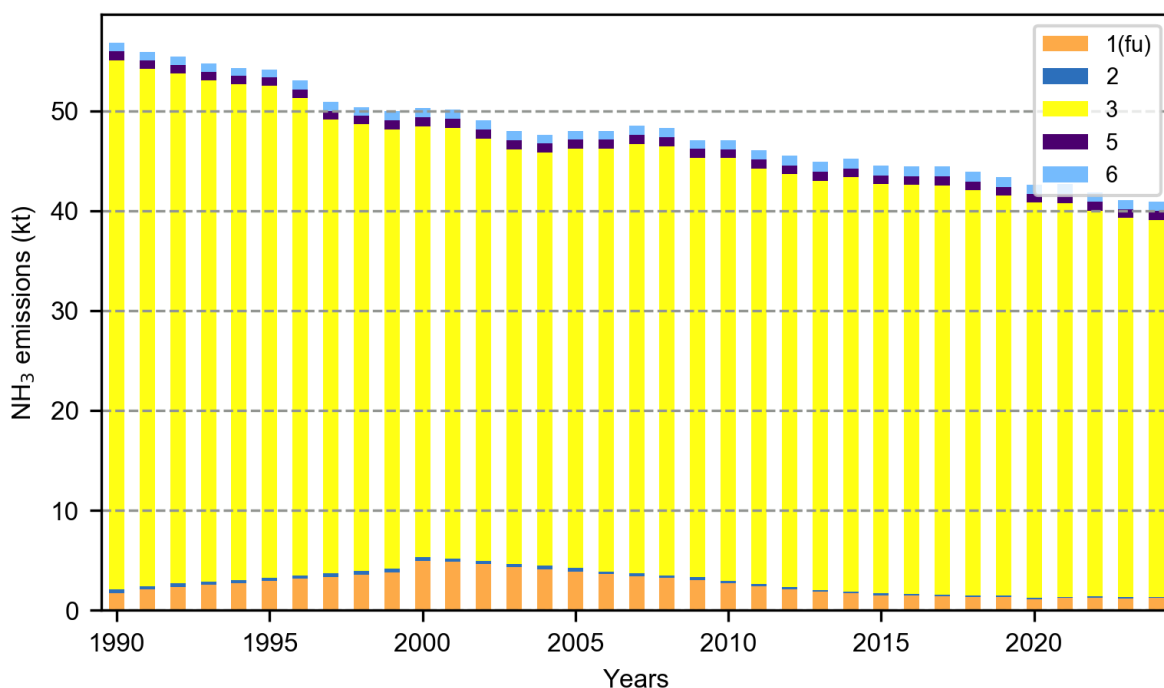


Figure 2-11 Trend of NH₃ emissions (kt) in Switzerland by sector. ((fu) means fuel used approach).

2.4 Trends of particulate matter per pollutant

2.4.1 Features commonly holding for all particulate matter fractions PM2.5, PM10, TSP and BC

Switzerland's emissions of particulate matter (PM2.5, PM10, TSP and BC) mainly stem from sector 1 Energy. For TSP, due to the considerable emission reductions in sector 1 Energy, the emissions from sector 3 Agriculture have gained in importance and have been at a comparable level in recent years.

Particulate matter emissions per sector are given in Table 2-12 and Figure 2-12 for PM2.5, in Table 2-13 for PM10, in Table 2-14 to Table 2-16 and Figure 2-13 for TSP and in Table 2-17 for BC. Total particulate matter emissions generally show decreasing trends from 1990 on. The observed reduction of emissions in PM2.5, PM10, TSP and BC were achieved in sectors 1 Energy and 2 IPPU.

In the sector 1 Energy, the decline can be mainly attributed to a reduction of exhaust particulate matter emissions:

- The large reduction of exhaust particulate matter emissions is primarily due to the development of emissions from wood combustion, especially in single-room furnaces and building heating systems (1A4). The reduction was achieved through technological improvements of the combustion installations and a reduction in the number of emission intensive types of wood furnaces (e.g. cooking stoves). In addition, wood energy consumption in manually operated furnaces decreased by more than half since 1990. Furthermore, the revision of the Ordinance of Air Pollution (Swiss Confederation 1985) in 2007 introduced more stringent emission limits (2007, 2008 and 2012) for mainly automatic wood combustion installations, which also led to a reduction in emissions from these installations (mainly in 1A1 and 1A2), although their wood energy consumption increased by about a factor of eight since 1990.
- A further reduction of exhaust emissions under 1A3 Transport was caused by the abatement of exhaust emissions from road vehicles. Throughout the years, a continuous reduction of these emissions has been achieved with the stepwise adoption of the Euro standards. New diesel cars must be equipped with diesel particle filters.
- Under category 1A2 Manufacturing industries and construction, a reduction of exhaust emissions resulted from technological improvements in construction machineries (an installation of particle filters for new construction machineries with diesel engines is required by the Ordinance on Air Pollution Control (OAPC) since 2009) and from a fuel switch in stationary combustion (i.e. from coal, residual fuel oil and gas oil to natural gas).
- There is an underlying increasing trend in non-exhaust particulate matter emissions from growing activity data (annual mileage and machine hours) of mobile sources 1A3 Transport and 1A2gvii Mobile combustion in manufacturing industries and construction which affects larger particle emissions (TSP and PM10) more than PM2.5. This is due to a larger share of non-exhaust emissions with a particle diameter of 10 micrometres and larger. Therefore, the overall decreasing trend in TSP emissions is less pronounced as compared to the decrease in PM2.5 emissions. Note: In 2020 and 2021, despite this underlying increasing trend, the measures against the COVID-19 pandemic led to a reduction of non-exhaust PM10 emissions from road transportation due to reduced traffic volumes.

In sector 2 IPPU, particulate matter emissions strongly decrease in the period 1990-2001 and fluctuate only slightly since then. In 1990, the source categories 2A Mineral products (PM2.5, PM10, TSP), 2C Metal production (PM2.5, PM10, TSP), 2G Other product use (PM2.5), 2H Other (PM2.5) and 2I Wood processing (PM10, TSP) contributed the most to the particulate matter emissions. After 1999, IPPU emissions (e.g. from cement production,

gravel plants and use of fireworks and tobacco, wood processing) became a smaller source of total particulate matter emissions. The following measures contribute to the decreasing trend:

- Significant emission reductions up to 1999 occurred in category 2C1 Iron and steel production in two steps. In 1995, two steel production sites were closed in Switzerland, whereas the drastic drop in emission in 1998/1999 was due to the installation of new filters in the remaining two steel plants.
- For TSP emissions, also the emission reduction in 2I Wood processing between 1990 and 2003 was relevant. On the one hand, this was achieved by refurbishments due to the enforcement of the OAPC (Swiss Confederation 1985), but also by the area-wide introduction of filter systems due to occupational safety regulations (carcinogenic effect of beech wood dust).

2.4.2 Trends for PM2.5

Switzerland’s emissions of PM2.5 per sector are given in Table 2-12 and Figure 2-12. For explanations regarding the trends, see chp. 2.4.1 for features commonly holding for all particulate matter emissions.

Table 2-12 PM2.5 emissions, trends and share per sector (national total for compliance; fuel used).

PM2.5 emissions	1990	2005	2010	2024	1990-2010	2005-2024	2005-2024	share in 2024
	kt	kt	kt	kt	kt	kt	%	%
1(fu) Energy	24	12	9.3	4.6	-15	-7.5	-62	76
1A(fu) Combustion	24	12	9.3	4.6	-15	-7.5	-62	76
1A1 Energy industries	0.83	0.19	0.20	0.082	-0.64	-0.11	-58	1.4
1A2 Manufacturing industries and construction	2.3	1.7	1.2	0.59	-1.1	-1.1	-65	9.7
1A3(fu) Transport	3.8	2.9	2.3	1.4	-1.5	-1.5	-52	23
1A4 Other sectors	17	7.2	5.6	2.4	-11	-4.8	-66	41
1A5 Other	0.087	0.057	0.050	0.044	-0.037	-0.013	-23	0.73
1B Fugitive emissions from fuels	0.00060	0.00066	0.00031	0.00003	-0.00029	-0.00063	-95	0.00056
2 Industrial processes and product use	2.5	1.3	1.4	1.0	-1.1	-0.31	-23	17
3 Agriculture	0.12	0.13	0.13	0.15	0.013	0.017	14	2.4
5 Waste	0.57	0.38	0.36	0.26	-0.20	-0.11	-30	4.4
6 Other sources	0.0044	0.0043	0.0044	0.0047	0.00001	0.00044	10	0.079
National total (fu)	27	14	11	6.0	-16	-7.9	-57	100
Gothenburg Protocol, target emission ceiling 2010			-					
Gothenburg Protocol revised, target emission reduction 2005-2020							-26	

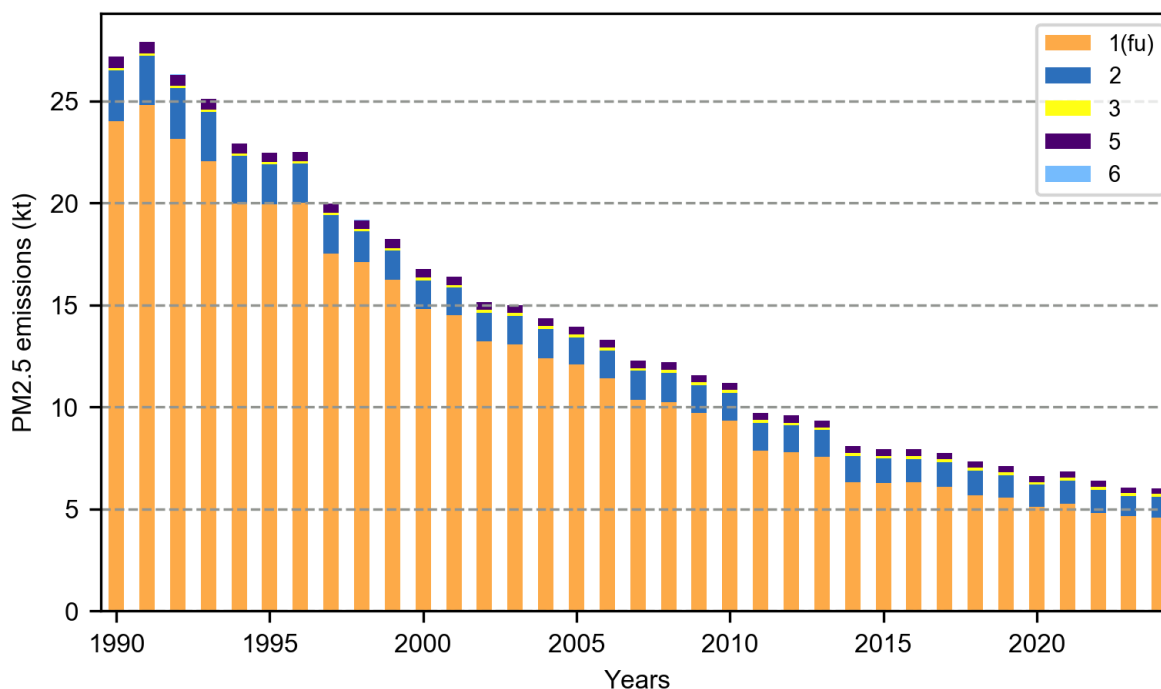


Figure 2-12 Trend of PM2.5 emissions (kt) in Switzerland by sector ((fu) means fuel used approach).

2.4.3 Trends for PM10

Switzerland’s emissions of PM10 per sector are given in Table 2-13. For explanations regarding the trends, see chp. 2.4.1 for features commonly holding for all particulate matter emissions.

Table 2-13 PM10 emissions, trends and share per sector (national total for compliance; fuel used).

PM10 emissions	1990	2005	2010	2024	1990-2010	2005-2024	2005-2024	share in 2024
	kt	kt	kt	kt	kt	kt	%	%
1(fu) Energy	29	17	14	9.9	-15	-7.2	-42	71
1A(fu) Combustion	29	17	14	9.9	-15	-7.2	-42	71
1A1 Energy industries	1.1	0.20	0.20	0.084	-0.90	-0.12	-58	0.60
1A2 Manufacturing industries and construction	4.2	3.6	3.1	2.6	-1.1	-0.95	-27	19
1A3(fu) Transport	5.9	5.4	4.9	4.3	-0.98	-1.0	-19	31
1A4 Other sectors	18	7.7	6.0	2.6	-12	-5.1	-66	19
1A5 Other	0.29	0.27	0.27	0.26	-0.018	-0.0053	-2.0	1.9
1B Fugitive emissions from fuels	0.0020	0.0013	0.00098	0.00032	-0.0011	-0.00097	-75	0.0023
2 Industrial processes and product use	4.5	2.2	2.3	1.8	-2.2	-0.40	-18	13
3 Agriculture	1.7	1.7	1.7	1.8	0.015	0.13	7.6	13
5 Waste	0.64	0.42	0.41	0.29	-0.24	-0.12	-29	2.1
6 Other sources	0.23	0.21	0.14	0.11	-0.086	-0.11	-50	0.77
National total (fu)	36	22	19	14	-18	-7.7	-36	100

2.4.4 Trends for TSP

Switzerland’s emissions of TSP per sector are given in Table 2-14 to Table 2-16 and Figure 2-13. In addition to the features commonly holding for all particulate matter emissions mentioned in chp. 2.4.1, the contribution of sector 3 Agriculture to non-exhaust TSP emissions is significant (see Table 2-16). Its dominant emission sources are soil cultivation and crop harvesting reported in 3De Cultivated crops. These emissions remained on a rather constant level since 1990 and account for a high share of TSP emissions. In recent years,

the TSP emission shares of the sectors 1 Energy and 3 Agriculture are at a comparable level. In comparison, non-exhaust PM10 and PM2.5 emissions from the agriculture sector contribute less. Accordingly, the (relative) decreasing trend of TSP is less pronounced than the ones of PM10 and PM2.5.

Table 2-14 Total TSP emissions (sum of exhaust and non-exhaust), trends and share per sector (national total for compliance; fuel used).

TSP emissions	1990	2005	2010	2024	1990-2010	2005-2024	2005-2024	share in 2024
	kt	kt	kt	kt	kt	kt	%	%
1(fu) Energy	32	19	16	12	-16	-7.2	-38	43
1A(fu) Combustion	32	19	16	12	-16	-7.2	-38	43
1A1 Energy industries	1.1	0.22	0.22	0.088	-0.90	-0.13	-60	0.31
1A2 Manufacturing industries and construction	5.5	4.7	4.2	3.8	-1.3	-0.85	-18	14
1A3(fu) Transport	6.2	5.7	5.4	4.9	-0.87	-0.87	-15	17
1A4 Other sectors	19	8.1	6.3	2.8	-13	-5.3	-66	9.9
1A5 Other	0.40	0.39	0.40	0.39	-0.0054	-0.00045	-0.12	1.4
1B Fugitive emissions from fuels	0.0045	0.0023	0.0021	0.00080	-0.0024	-0.0015	-66	0.0029
2 Industrial processes and product use	9.9	3.4	3.4	2.8	-6.5	-0.54	-16	10
3 Agriculture	13	13	13	13	-0.33	0.097	0.78	45
5 Waste	0.79	0.51	0.49	0.36	-0.29	-0.15	-30	1.3
6 Other sources	0.31	0.31	0.23	0.20	-0.083	-0.11	-36	0.70
National total (fu)	56	36	33	28	-23	-7.9	-22	100

Table 2-15 Exhaust TSP emissions, trends and share per sector (national total for compliance; fuel used).

TSP ex emissions	1990	2005	2010	2024	1990-2010	2005-2024	2005-2024	share in 2024
	kt	kt	kt	kt	kt	kt	%	%
1(fu) Energy	26	12	8.7	3.3	-17	-8.5	-72	73
1A(fu) Combustion	26	12	8.7	3.3	-17	-8.5	-72	73
1A1 Energy industries	1.1	0.22	0.22	0.088	-0.90	-0.13	-60	2.0
1A2 Manufacturing industries and construction	2.9	1.6	1.0	0.28	-1.9	-1.3	-82	6.4
1A3(fu) Transport	2.9	2.0	1.3	0.24	-1.7	-1.7	-88	5.4
1A4 Other sectors	19	8.0	6.2	2.7	-13	-5.3	-67	60
1A5 Other	0.057	0.020	0.012	0.0055	-0.044	-0.015	-73	0.12
1B Fugitive emissions from fuels	0.00044	0.00059	0.00024	0.000002	-0.00021	-0.00059	-100	0.00004
2 Industrial processes and product use	2.6	0.83	0.81	0.66	-1.8	-0.18	-22	15
3 Agriculture	NA	NA	NA	NA	-	-	-	-
5 Waste	0.78	0.50	0.49	0.35	-0.29	-0.15	-30	7.9
6 Other sources	0.30	0.29	0.21	0.17	-0.096	-0.12	-40	3.9
National total (fu)	30	13	10	4.5	-19	-8.9	-67	100

Table 2-16 Non-exhaust TSP emissions, trends and share per sector (national total for compliance; fuel used).

TSP nx emissions	1990	2005	2010	2024	1990-2010	2005-2024	2005-2024	share in 2024
	kt	kt	kt	kt	kt	kt	%	%
1(fu) Energy	6.4	7.3	7.8	8.6	1.4	1.3	18	37
1A(fu) Combustion	6.4	7.3	7.8	8.6	1.4	1.3	18	37
1A1 Energy industries	NA	NA	NA	NA	-	-	-	-
1A2 Manufacturing industries and construction	2.6	3.0	3.2	3.5	0.61	0.47	15	15
1A3(fu) Transport	3.3	3.8	4.1	4.6	0.78	0.84	22	20
1A4 Other sectors	0.13	0.12	0.11	0.10	-0.021	-0.019	-16	0.43
1A5 Other	0.34	0.37	0.38	0.38	0.039	0.015	3.9	1.6
1B Fugitive emissions from fuels	0.0040	0.0017	0.0019	0.00080	-0.0022	-0.00095	-54	0.0034
2 Industrial processes and product use	7.4	2.5	2.6	2.2	-4.7	-0.36	-14	9.2
3 Agriculture	13	13	13	13	-0.33	0.097	0.78	54
5 Waste	0.0034	0.0036	0.0036	0.0036	0.00024	0.00000	0.000	0.015
6 Other sources	0.0072	0.017	0.020	0.022	0.013	0.0049	29	0.094
National total (fu)	27	22	23	23	-3.6	1.1	4.7	100

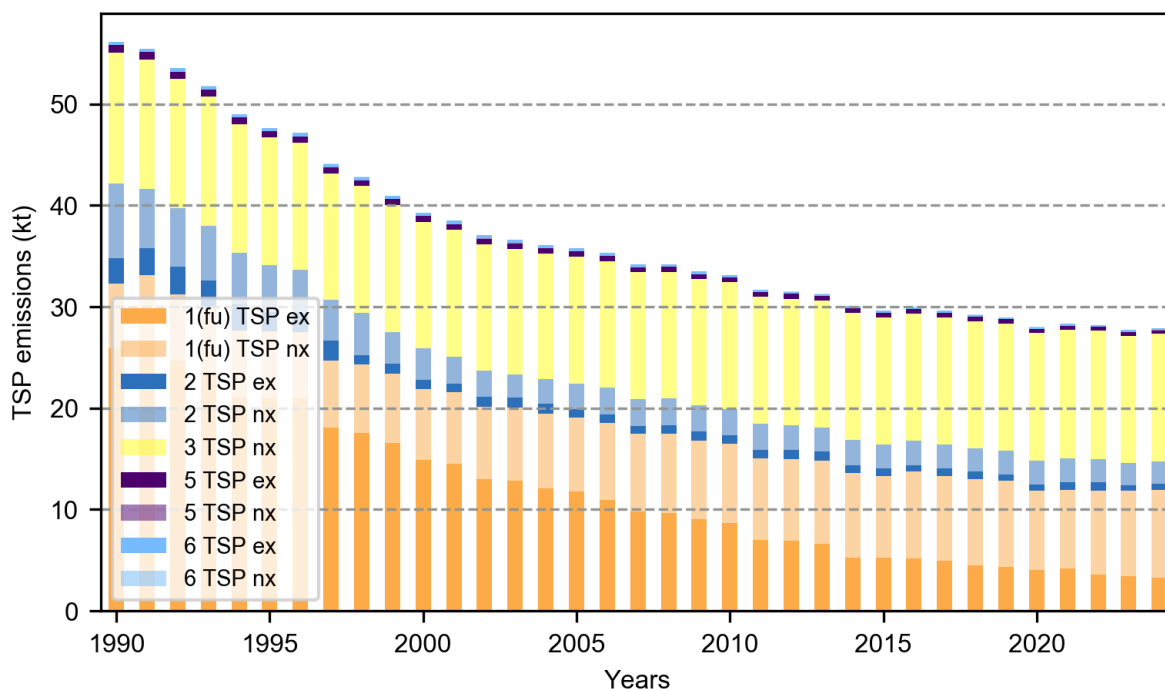


Figure 2-13 Trend of TSP emissions (kt) in Switzerland for sectors 1-6 split in exhaust (ex) and non-exhaust (nx) fraction. Non-exhaust emissions cross-hatched ((fu) means fuel used approach).

2.4.5 Trends for BC

Switzerland’s emissions of BC mainly stem from sector 1 Energy, especially from stationary combustion in category 1A4bi Residential. The trend of BC emissions per sector is given in Table 2-17. BC emissions have decreased throughout the time period 1990-2024.

Table 2-17 BC emissions, trends and share per sector (national total for compliance; fuel used).

BC emissions	1990	2005	2010	2024	1990-2010	2005-2024	2005-2024	share in 2024	
	kt	kt	kt	kt	kt	kt	%	%	
1(fu) Energy	5.7	3.6	2.6	0.77	-3.1	-2.8	-78	97	
1A(fu) Combustion	5.7	3.6	2.6	0.77	-3.1	-2.8	-78	97	
1A1 Energy industries	0.038	0.016	0.016	0.0067	-0.022	-0.0092	-58	0.85	
1A2 Manufacturing industries and construction	0.42	0.32	0.14	0.024	-0.28	-0.29	-92	3.1	
1A3(fu) Transport	1.4	1.3	0.90	0.18	-0.51	-1.1	-86	23	
1A4 Other sectors	3.8	1.9	1.5	0.55	-2.3	-1.4	-71	70	
1A5 Other	0.026	0.0099	0.0058	0.0026	-0.020	-0.0072	-73	0.34	
1B Fugitive emissions from fuels	0.00020	0.00018	0.00010	0.00002	-0.00010	-0.00016	-89	0.0025	
2 Industrial processes and product use	0.0063	0.0026	0.0016	0.0012	-0.0047	-0.0014	-55	0.15	
3 Agriculture	NA	NA	NA	NA	-	-	-	-	
5 Waste	0.040	0.027	0.026	0.019	-0.014	-0.0076	-29	2.4	
6 Other sources	0.00016	0.00015	0.00010	0.00007	-0.00006	-0.00007	-50	0.0094	
National total (fu)	5.7	3.6	2.6	0.79	-3.2	-2.8	-78	100	

2.5 Trends of other pollutants

2.5.1 Trends for CO

Switzerland’s emissions of CO mainly stem from sector 1 Energy. The trend of CO emissions per sector is given in Table 2-18. The CO emissions have decreased between 1990 and 2024.

The relevant reductions were achieved in sector 1 Energy:

- Reductions of CO emissions in road transportation (1A3b) through the abatement of exhaust emissions from road vehicles (similar as for NMVOC emissions, see chp. 2.3.2). In 2020 and 2021, the COVID-19 pandemic led to a strong reduction of CO emissions from road transportation due to reduced traffic volumes.
- A reduction of CO emissions under 1A4 Other sectors due to technological improvements of wood combustion installations, a reduction in the number of emission intensive types of wood furnaces (e.g. cooking stoves) and a decrease in wood energy consumption in manually operated furnaces by more than half.

Table 2-18 CO emissions, trends and share per sector (national total for compliance; fuel used).

CO emissions	1990	2005	2010	2024	1990-2010	2005-2024	2005-2024	share in 2024
	kt	kt	kt	kt	kt	kt	%	%
1(fu) Energy	740	292	228	126	-512	-166	-57	96
1A(fu) Combustion	740	292	228	126	-512	-166	-57	96
1A1 Energy industries	1.2	1.1	1.0	0.89	-0.19	-0.19	-17	0.68
1A2 Manufacturing industries and construction	27	21	20	14	-7.2	-7.0	-34	11
1A3(fu) Transport	549	163	114	58	-434	-104	-64	44
1A4 Other sectors	162	106	92	52	-70	-54	-51	40
1A5 Other	1.2	0.92	0.87	0.68	-0.34	-0.24	-26	0.52
1B Fugitive emissions from fuels	0.048	0.063	0.025	0.00021	-0.022	-0.063	-100	0.00016
2 Industrial processes and product use	11	8.1	7.2	3.5	-3.9	-4.6	-57	2.7
3 Agriculture	NA	NA	NA	NA	-	-	-	-
5 Waste	2.6	1.8	1.7	1.3	-0.83	-0.50	-27	1.0
6 Other sources	0.93	0.86	0.57	0.43	-0.35	-0.42	-50	0.33
National total (fu)	755	303	238	131	-517	-171	-57	100

2.6 Trends of priority heavy metals per pollutant

2.6.1 Trends for Pb

Switzerland’s emissions of Pb mainly stem from sector 1 Energy. Due to significant reductions of Pb emissions in sector 1 Energy, also sectors 6 Other and 5 Waste contribute significantly to the emissions since around 2000 and 2010, respectively. The trend of Pb emissions per sector is given in Table 2-19. Pb emissions have strongly declined between 1990 and 2000 and from then on continued a slightly decreasing trend.

The most relevant reductions were achieved in sectors 1 Energy and 2 IPPU:

- A pronounced decrease of Pb emissions in the energy sector (in particular 1A3b Road transportation) was achieved due to a stepwise reduction of lead content in gasoline, and finally due to the introduction of unleaded gasoline in the OAPC revision of the year 2000 (see Figure 2-1).
- Further measures that resulted in a significant decrease of the emissions under 2C1 Iron and steel production were the closing down of two production sites in 1995 and the installation of new filters in the electric arc furnaces of the remaining secondary steel production plants in 1998/1999.

- Furthermore, a significant reduction was achieved under category 1A1 Energy industries in the period 1990–2003 by equipping municipal solid waste incineration plants with flue gas treatment or by improving the already installed technology.

Since 2000, the emissions further decrease on a lower level. The main reductions in this time period were achieved in the sectors, 1 Energy, 6 Other and 2 IPPU:

- In sector 1 Energy, specifically source category 1A2f Non-metallic minerals (dominated by the emission reduction in container glass production due to reduced lead contamination of the glass cullet and installation of electro filters in 2011) as well as 1A3b Road transportation due to a higher share of diesel oil in comparison to gasoline (diesel oil has a much lower lead content than gasoline).
- The Pb emissions in sector 6 Other originate from fire damages (6Ad) and their reduction is mainly caused by a decrease in the number of building fires per year.
- In sector 2 IPPU, the ban of Pb in fireworks (2G) in 2003 lead to Pb emission reductions.

Table 2-19 Pb emissions, trends and share per sector (national total for compliance; fuel used).

Pb emissions	1990	2005	2010	2024	1990-2010	2005-2024	2005-2024	share in 2024
	t	t	t	t	t	t	%	%
1(fu) Energy	273	6.7	5.4	4.0	-267	-2.7	-40	52
1A(fu) Combustion	269	6.7	5.4	4.0	-264	-2.7	-40	52
1A1 Energy industries	30	1.9	1.8	1.9	-28	-0.065	-3.3	24
1A2 Manufacturing industries and construction	6.3	2.7	1.8	0.80	-4.5	-1.9	-70	10
1A3(fu) Transport	229	1.2	1.00	0.83	-228	-0.37	-31	11
1A4 Other sectors	3.8	0.94	0.90	0.53	-2.9	-0.40	-43	6.9
1A5 Other	0.033	0.00023	0.00024	0.00024	-0.032	0.00001	4.7	0.0031
1B Fugitive emissions from fuels	3.5	0.0011	0.00043	0.000004	-3.5	-0.0011	-100	0.00005
2 Industrial processes and product use	67	2.1	0.70	0.59	-66	-1.5	-72	7.6
3 Agriculture	NA	NA	NA	NA	-	-	-	-
5 Waste	4.3	2.3	2.3	1.5	-2.0	-0.78	-34	20
6 Other sources	7.6	6.8	3.8	1.6	-3.8	-5.2	-77	20
National total (fu)	352	18	12	7.8	-339	-10	-57	100

2.6.2 Trends for Cd

Switzerland’s emissions of Cd mainly stem from sector 1 Energy. The trend of Cd emissions per sector is given in Table 2-20. Cd emissions showed a decreasing trend between 1990 and 2003 and remained about constant since then until 2013. After that, emissions decreased slightly until 2020 and have since fluctuated at rather constant level.

The decrease 1990-2003 was mainly achieved with the following measures within sectors 1 Energy and 2 IPPU:

- By equipping municipal solid waste incineration plants with flue gas treatment or by improving the already installed technologies, a significant reduction has been achieved in the period 1990–2003 under category 1A1a Public electricity and heat production.
- A significant reduction occurred also in source category 1A2 Manufacturing industries dominated by an emission decrease in the production of mixed goods (1A2f). (Please note that Cd emission measurements are extremely limited and thus these emissions are associated with a high uncertainty.)
- Further measures, resulting in a significant decrease of emissions under 2C1 Iron and steel production, were the closing down of two production sites in 1995 and the installation of new filters in the electric arc furnaces of the remaining secondary steel production plants in 1998/1999.

The slight decrease since 2013 is mainly due to continuous technical improvement in municipal solid waste incineration plants (source category 1A1a Public electricity and heat production), but also in sewage sludge incineration plants (source category 5C1). After 2020, the decrease stopped due to the increase in Cd emissions from brake wear caused by the increase in traffic volume.

Table 2-20 Cd emissions, trends and share per sector (national total for compliance; fuel used).

Cd emissions	1990	2005	2010	2024	1990-2010	2005-2024	2005-2024	share in 2024
	t	t	t	t	t	t	%	%
1(fu) Energy	2.6	0.43	0.44	0.36	-2.2	-0.066	-15	89
1A(fu) Combustion	2.6	0.43	0.44	0.36	-2.2	-0.064	-15	89
1A1 Energy industries	1.8	0.18	0.20	0.16	-1.6	-0.019	-11	39
1A2 Manufacturing industries and construction	0.74	0.10	0.091	0.063	-0.65	-0.040	-39	15
1A3(fu) Transport	0.069	0.077	0.083	0.092	0.013	0.015	19	23
1A4 Other sectors	0.084	0.068	0.068	0.048	-0.017	-0.020	-29	12
1A5 Other	0.00048	0.00051	0.00054	0.00053	0.00006	0.00001	2.8	0.13
1B Fugitive emissions from fuels	0.0011	0.0015	0.00058	0.000005	-0.00056	-0.0015	-100	0.0012
2 Industrial processes and product use	0.49	0.033	0.032	0.033	-0.45	-0.00052	-1.6	8.1
3 Agriculture	NA	NA	NA	NA	-	-	-	-
5 Waste	0.046	0.021	0.027	0.0087	-0.020	-0.012	-58	2.1
6 Other sources	0.0023	0.0023	0.0017	0.0016	-0.00054	-0.00070	-31	0.39
National total (fu)	3.2	0.48	0.50	0.41	-2.7	-0.079	-16	100

2.6.3 Trends for Hg

Switzerland's emissions of Hg mainly stem from sector 1 Energy. The trend of Hg emissions per sector is shown in Table 2-21. Hg emissions showed a decreasing trend between 1990 and 2003, followed by a further slightly decreasing trend until 2020. Since then, they have fluctuated at a relatively constant level.

The decrease 1990-2003 was mainly achieved with the following measures within the sectors 1 Energy and 2 IPPU:

- A significant reduction under category 1A1 Energy industries has been achieved in the period 1990–2003 by equipping municipal solid waste incineration plants with flue gas treatment or by improving the already installed technology.
- The closing down of two steel production sites in 1995 and the installation of new filters in the two remaining secondary steel production plants in 1998/1999 were the leading measures in reducing emissions under 2C1.

Since 2003, the decreasing trend continued on a lower level mainly due to continuous technical improvements in waste and special waste incineration plants (1A1a) as well as crematoria (5C1). After 2020, the decrease stopped mainly due to the increase in wood and wood waste as well as waste combustion (1A1).

Table 2-21 Hg emissions, trends and share per sector (national total for compliance; fuel used).

Hg emissions	1990	2005	2010	2024	1990-2010	2005-2024	2005-2024	share in 2024
	t	t	t	t	t	t	%	%
1(fu) Energy	4.3	0.59	0.59	0.50	-3.7	-0.087	-15	88
1A(fu) Combustion	4.3	0.59	0.59	0.50	-3.7	-0.087	-15	88
1A1 Energy industries	3.9	0.34	0.32	0.31	-3.6	-0.034	-9.8	54
1A2 Manufacturing industries and construction	0.25	0.12	0.14	0.083	-0.11	-0.039	-32	15
1A3(fu) Transport	0.034	0.037	0.036	0.032	0.0022	-0.0046	-13	5.6
1A4 Other sectors	0.089	0.086	0.094	0.076	0.0048	-0.0094	-11	13
1A5 Other	0.00003	0.00003	0.00003	0.00003	0.000003	0.000001	2.3	0.0051
1B Fugitive emissions from fuels	0.00020	0.00025	0.00010	0.000001	-0.00010	-0.00025	-100	0.00014
2 Industrial processes and product use	1.5	0.067	0.066	0.041	-1.4	-0.025	-38	7.3
3 Agriculture	NA	NA	NA	NA	-	-	-	-
5 Waste	0.52	0.077	0.081	0.029	-0.44	-0.048	-63	5.0
6 Other sources	0.0011	0.0011	0.00080	0.00070	-0.00029	-0.00036	-34	0.12
National total (fu)	6.3	0.73	0.74	0.57	-5.6	-0.16	-22	100

2.7 Trends of persistent organic pollutants per pollutant

2.7.1 Trends for PCDD/PCDF

Switzerland’s emissions of PCDD/PCDF mainly stem from sector 1 Energy. The trend of PCDD/PCDF emissions per sector is given in Table 2-22. PCDD/PCDF emissions were significantly reduced between 1990 and 2003. From then on, the decrease continues on a lower level. Due to the significant reductions in PCDD/PCDF emissions, particularly in sector 1 Energy, sector 5 Waste has also become an important PCDD/PCDF emission source.

The significant decrease between 1990 and 2003 was mainly achieved in category 1A1a Public electricity and heat production by retrofitting municipal solid waste incineration plants with flue gas treatment or by improving the already installed technology. Further reductions between 1990 and 2003 were achieved in source categories 2C1 Iron and steel production (i.e. closing down of two production sites in 1995 and installation of new filters in the electric arc furnaces of the remaining two secondary steel production plants in 1998/1999) and 5C1 Waste incineration (i.e. a continuous reduction of clinical waste incinerated at the hospital sites themselves which ceased in 2002 completely).

In source category 1A4bi Residential: Stationary, a continuous emission reduction occurred over the entire time series (technological improvements of wood combustion installations, reduction in the number of emission intensive types of wood furnaces (e.g. cooking stoves) and wood energy consumption in manually operated furnaces decreased by more than half).

Since 2003, the slightly decreasing trend is mainly shaped through reductions in categories 1A4bi Residential: Stationary and 1A1a Public electricity and heat production (mainly due to further technical improvements in municipal solid waste incineration plants).

Table 2-22 PCDD/PCDF emissions, trends and share per sector (national total for compliance; fuel used).

PCDD/ PCDF emissions	1990	2005	2010	2024	1990-2010	2005-2024	2005-2024	share in 2024
	g I-Teq	g I-Teq	g I-Teq	g I-Teq	g I-Teq	g I-Teq	%	%
1(fu) Energy	161	23	19	7.6	-142	-16	-67	64
1A(fu) Combustion	161	23	19	7.6	-142	-16	-67	64
1A1 Energy industries	130	5.2	3.4	1.2	-127	-4.1	-78	9.8
1A2 Manufacturing industries and construction	8.4	2.8	2.1	0.81	-6.3	-2.0	-71	6.8
1A3(fu) Transport	1.6	1.7	1.6	0.39	0.066	-1.3	-77	3.3
1A4 Other sectors	20	13	12	5.2	-8.3	-8.2	-61	44
1A5 Other	0.00036	0.00038	0.00040	0.00039	0.00004	0.00001	2.3	0.0033
1B Fugitive emissions from fuels	0.00001	NA	NA	NA	-0.00001	-	-	-
2 Industrial processes and product use	17	2.1	1.2	0.69	-16	-1.4	-68	5.8
3 Agriculture	NA	NA	NA	NA	-	-	-	-
5 Waste	13	4.3	4.0	2.7	-9.1	-1.6	-37	22
6 Other sources	1.6	1.6	1.1	0.95	-0.51	-0.62	-40	8.0
National total (fu)	192	31	25	12	-167	-19	-62	100

2.7.2 Trends for PAHs

Switzerland’s emissions of PAH mainly stem from sector 1 Energy. The trend of PAH emissions per sector is given in Table 2-23. PAH emissions have been reduced continuously between 1990 and 2024, except for 1A3b Road transportation, where PAH emissions increased in parallel with the increase of traffic volumes (except for 2020/2021, where traffic volumes shrank due to the COVID-19 pandemic).

The PAH emissions are dominated by wood energy combustion in single-room furnaces and building heating installations. Their reduction has mainly been achieved in the dominant source category 1A4 Other sectors through technological improvements of wood furnaces and a reduction in the number of emission intensive types of wood furnaces (e.g. cooking stoves) as well as a decrease of wood energy consumption by more than half in manually operated furnaces. The superimposed fluctuations in the emission trend reflect the climate variabilities (i.e. warmer or colder winters).

Table 2-23 PAH emissions, trends and share per sector (national total for compliance; fuel used).

PAHs total emissions	1990	2005	2010	2024	1990-2010	2005-2024	2005-2024	share in
	t	t	t	t	t	t	%	2024
1(fu) Energy	6.7	4.1	3.7	1.9	-3.0	-2.2	-53	86
1A(fu) Combustion	6.7	4.1	3.7	1.9	-3.0	-2.2	-53	86
1A1 Energy industries	0.0076	0.0085	0.011	0.018	0.0030	0.0097	114	0.81
1A2 Manufacturing industries and construction	0.23	0.18	0.16	0.090	-0.075	-0.088	-50	4.0
1A3(fu) Transport	0.15	0.17	0.21	0.26	0.061	0.092	55	11
1A4 Other sectors	6.3	3.7	3.3	1.6	-3.0	-2.2	-58	70
1A5 Other	0.00071	0.00073	0.00076	0.00068	0.00005	-0.00006	-7.6	0.030
1B Fugitive emissions from fuels	0.000002	0.000002	0.000001	0.00000001	-0.000001	-0.000002	-100	0.0000003
2 Industrial processes and product use	0.96	0.51	0.023	0.018	-0.94	-0.49	-96	0.80
3 Agriculture	NA	NA	NA	NA	-	-	-	-
5 Waste	0.28	0.23	0.21	0.19	-0.075	-0.037	-16	8.4
6 Other sources	0.065	0.086	0.092	0.11	0.027	0.024	28	4.9
National total (fu)	8.0	4.9	4.0	2.2	-4.0	-2.7	-54	100

2.7.3 Trends for HCB

Switzerland’s emissions of HCB exclusively stem from sector 1 Energy. The trend of HCB emissions per sector is shown in Table 2-24. HCB emissions have significantly dropped in 1993 and then slightly decreased until 2024.

The decrease of HCB emissions in 1993 occurred in category 1A2b Non-ferrous metals due to the shutdown of the single secondary aluminium production plant. Since then, emissions continue to slightly decrease, in particular in category 1A4 Other sectors due to changes in wood energy combustion (i.e. technological improvements of wood combustion installations, reduction in the number of emission intensive types of wood furnaces and decrease in wood energy consumption in manually operated furnaces by more than half). In contrast, the amount of municipal solid waste incinerated has increased, which leads to an increase in HCB emissions in source category 1A1a Public electricity and heat production.

Table 2-24 HCB emissions, trends and share per sector (national total for compliance; fuel used).

HCB emissions	1990	2005	2010	2024	1990-2010	2005-2024	2005-2024	share in 2024
	kg	kg	kg	kg	kg	kg	%	%
1(fu) Energy	173	0.44	0.45	0.35	-172	-0.099	-22	100
1A(fu) Combustion	173	0.44	0.45	0.35	-172	-0.099	-22	100
1A1 Energy industries	0.11	0.15	0.17	0.19	0.060	0.041	27	56
1A2 Manufacturing industries and construction	172	0.051	0.051	0.031	-172	-0.020	-39	9.1
1A3(fu) Transport	NE	NE	NE	NE	-	-	-	-
1A4 Other sectors	0.38	0.24	0.22	0.12	-0.16	-0.12	-50	35
1A5 Other	NE	NE	NE	NE	-	-	-	-
1B Fugitive emissions from fuels	NA	NA	NA	NA	-	-	-	-
2 Industrial processes and product use	NA	NA	NA	NA	-	-	-	-
3 Agriculture	NA	NA	NA	NA	-	-	-	-
5 Waste	NA	NA	NA	NA	-	-	-	-
6 Other sources	NA	NA	NA	NA	-	-	-	-
National total (fu)	173	0.44	0.45	0.35	-172	-0.099	-22	100

2.7.4 Trends for PCBs

Switzerland's emissions of PCBs mainly stem from sector 2 IPPU, i.e. from source category 2K Usage of PCBs. To a lesser extent, also sectors 5 Waste and 6 Other contribute to PCB emissions. The trend of PCB emissions per sector is shown in Table 2-25. PCB emissions have decreased continuously between 1990 and 2024 except for a sudden sharp increase in 1999.

PCBs were used in Switzerland in transformers, large and small capacitors, anti-corrosive paints and joint sealants between 1946 and 1986, before a total ban was placed on any form of PCB use. The use in so-called open applications, i.e. anti-corrosive paints and joint sealants, was already forbidden in 1972. The emissions from source category 2K Usage of PCBs are dominated by the two open applications and are decreasing since 1975, while still remaining the major source until now (see also Table 1-6 and Figure A - 2).

At the end of the PCB containing products' life cycle, they are disposed of. Some of them undergo priorly a treatment process. Shredding of electronic waste containing PCBs in small capacitors (5E) is the dominant emission source in sector 5 Waste from 1990 onwards and is the cause for the sudden sharp increase in 1999. Because of the legal ban of disposal of combustible waste in landfills a sharp increase in shredding of small capacitors occurred in 1999 although they should have been treated as special waste from 1998 onwards. Between 1999 and 2002, shredding was even the largest emission source of all. Before 1990, 5C1bii Open burning, i. e. burning of PCB contaminated waste oil in outdoor fires (ceased in 1999) dominated the emissions from 5 Waste.

From all PCB usages, PCBs can also be accidentally released by fire or by spilling to soil. Accidental release by fire is dominating the emissions from sector 6 Other which has decreased continuously since 1980.

PCB emissions from 1A1a Municipal solid waste incineration were of somewhat lower importance reaching a maximum in the early 1980s. From 1998 onwards, all PCB containing waste has to be incinerated in special waste incineration plants only.

PCB emissions arise also from combustion of solid and liquid fuels. Like PCDD/PCDF, PCBs are synthesized in the combustion process as by-products involving chloride and organic carbon or are due to incomplete combustion of PCB impurities in the fuel. Please note that these emissions are orders of magnitude smaller than the emissions from former use and subsequent disposal of PCBs.

Table 2-25 PCB emissions, trends and share per sector (national total for compliance; fuel used).

PCB emissions	1990	2005	2010	2024	1990-2010	2005-2024	2005-2024	share in 2024
	kg	kg	kg	kg	kg	kg	%	%
1(fu) Energy	165	1.4	0.55	0.34	-164	-1.1	-76	0.12
1A(fu) Combustion	165	1.4	0.55	0.34	-164	-1.1	-76	0.12
1A1 Energy industries	164	1.1	0.18	0.057	-164	-1.0	-95	0.020
1A2 Manufacturing industries and construction	0.50	0.35	0.38	0.28	-0.12	-0.073	-21	0.10
1A3(fu) Transport	0.00037	0.00037	0.00034	0.00008	-0.00003	-0.00029	-78	0.00003
1A4 Other sectors	0.0022	0.0015	0.0013	0.00067	-0.00093	-0.00082	-55	0.00024
1A5 Other	NE	NE	NE	NE	-	-	-	-
1B Fugitive emissions from fuels	NA	NA	NA	NA	-	-	-	-
2 Industrial processes and product use	1'537	922	708	252	-829	-670	-73	90
3 Agriculture	NA	NA	NA	NA	-	-	-	-
5 Waste	347	254	56	4.4	-291	-250	-98	1.6
6 Other sources	282	93	62	24	-220	-69	-74	8.6
National total (fu)	2'332	1'270	827	280	-1'505	-990	-78	100

2.8 Compliance with the Gothenburg Protocol

2.8.1 Emission ceilings 2010

Under the CLRTAP, the 1999 Gothenburg Protocol requires that parties shall reduce and maintain the reduction in annual emissions in accordance with emission ceilings set for 2010 and beyond. Table 2-26 shows the emission ceilings, the reported emissions for 2010 and the respective compliance. Accordingly, Switzerland is in compliance with the Gothenburg Protocol emission ceilings for all pollutants except for NO_x in 2010. All emissions 2024 are in compliance with the emission ceilings for 2010.

Table 2-26 Emission ceilings of the Gothenburg Protocol for 2010 and beyond compared to the emissions reported in the latest submission (2026) for 2010 and 2024.

Pollutants	National emission ceilings for 2010	Emissions 2010 (Subm. 2026)	Compliance with emission ceilings 2010 in 2010	Emissions 2024 (Subm. 2026)	Compliance with emission ceilings 2010 in 2024
	kt	kt		kt	
SO _x (as SO ₂)	26	10	yes	2.1	yes
NO _x (as NO ₂)	79	84	no	44	yes
NM VOC	144	98	yes	71	yes
NH ₃	63	47	yes	41	yes

2.8.2 Emission reduction commitments 2020

After five years of negotiations, a revised Gothenburg Protocol was successfully finalised on 4 May 2012 at a meeting of the parties to the Convention on Long-range Transboundary Air Pollution (CLRTAP) in Geneva.

The revised protocol specifies emission reduction commitments in terms of percentage reductions from the reference year 2005 to 2020. It has also been extended to cover one additional air pollutant, namely particulate matter (PM_{2.5}), and thereby also black carbon as a component of PM_{2.5}. On 7 October 2019, the amended protocol including the new reduction commitments for 2020 has entered into force.

Table 2-27 shows the emission reduction commitments under the revised Gothenburg protocol and the corresponding percentage emission reductions in 2024 compared to the reference year 2005. The emission reduction commitments 2020 are achieved for all pollutants (SO_x, NO_x, NM VOC, NH₃ and PM_{2.5}).

Table 2-27 Emission reduction commitments for 2020 and reported emission reductions for 2020 and 2024 compared to 2005. The emission commitments for 2020 are defined as reductions in percentages compared to the reference year 2005.

Pollutant	Emission reduction commitments 2020	Reduction achieved in 2020	Compliance with reduction commitments 2020 in 2020	Reduction achieved in 2024	Compliance with reduction commitments 2020 in 2024
	<i>%-reduction of 2005 level</i>	<i>%-reduction of 2005 level</i>		<i>%-reduction of 2005 level</i>	
SO _x (as SO ₂)	21%	76%	yes	85%	yes
NO _x (as NO ₂)	41%	45%	yes	53%	yes
NMVOG	30%	37%	yes	38%	yes
NH ₃	8%	11%	yes	15%	yes
PM2.5	26%	52%	yes	57%	yes

3 Energy

3.1 Overview of emissions

In this introductory chapter, an overview of emissions separated by most relevant pollutants in sector 1 Energy is presented. In the sector 1 Energy the substances NO_x, NMVOC, PM2.5 and SO_x are the main contributors to air pollution. The following source categories are reported:

- 1A Fuel combustion
- 1B Fugitive emissions from fuels

3.1.1 Overview and trend for NO_x

According to Figure 3-1, emissions from 1A3 Transport contribute most to NO_x emissions in the energy sector for all years. The largest share of 1A3 Transport since 1990 was reached in the year 2015, afterwards the share decreases. Emissions from 1A2 Manufacturing industries and construction and 1A4 Other sectors (commercial/institutional, residential, agriculture/forestry/fishing) are also contributing a noticeable amount. As a consequence of the air pollution ordinance endorsed in 1985 (Swiss Confederation 1985), NO_x emissions steadily decreased ever since. The legislation prescribes clear reduction targets that are mirrored in the trends of most energy related sectors. Various measures led to a total NO_x reduction between 1990 and 2024:

- The reductions in 1A3b Road transportation were triggered by the implementation of new strict emission standards for road vehicles. The first step happened in the late 80's when Switzerland reduced the standards to a level that required the equipment of three-way catalysts for new passenger cars. Later, when the European Union introduced the first Euro standards in 1993, Switzerland adopted the subsequent reduction path (Euro 2/II in 1995, Euro 3/III in 2000, Euro 4/IV in 2005, Euro V in 2008, Euro 5 in 2009, Euro VI in 2013 and Euro 6 in 2014). However, the reduction of NO_x emissions due to emission standards has not been as pronounced as expected in the years before 2015 because of an increasing share of diesel-powered passenger cars and a higher emission factor than expected (the "dieselgate" scandal³, detected in the year 2015).
- In the years 2020 and 2021, the COVID-19 pandemic led to measures that resulted in a massive reduction in transport activities (1A3). The lower traffic volume led to a strong decrease in NO_x emissions from 1A3b Road transportation and a sharp drop in emissions from 1A3a Aviation, especially international aviation. However, the share of NO_x emissions from 1A3a Aviation in 1A3 Transport is smaller than that from 1A3b Road transportation, in particular due to the system boundaries (only LTO emissions from air traffic are taken into account in the national total, see chapter 3.1.6.1).
- The reductions in 1A2 Manufacturing industries and construction were a result of three main factors: First, there has been a fuel switch from residual fuel oil, coal and gas oil towards natural gas and a reduction in total fuel use since 2008. Second, a reduction has been reached due to an on-going sectoral agreement (from 1998) targeting NO_x emissions of the cement industry. Third, manufacturing plants reduced NO_x emissions through technical improvements (e.g. DeNO_x technology, selective non-catalytic reduction technology SNCR).

³ Dieselgate: «The EPA had found that Volkswagen had intentionally programmed turbocharged direct injection diesel engines to activate certain emissions controls only during laboratory emissions testing. Volkswagen deployed this programming in about eleven million cars worldwide» Source: https://en.wikipedia.org/wiki/Volkswagen_emissions_scandal [02.02.2026]

- In the past, the number of buildings and apartments increased, as well as the average floor space per person and workplace. Both phenomena resulted in an increase of the total heated area. On contrary, higher standards were specified for insulation and for combustion equipment efficiency for both new and renovated buildings including low-NO_x standards. Furthermore, a substantial substitution of gas oil by natural gas under 1A4 Other sectors resulted in further reductions of NO_x emissions (i.e. natural gas consumption increased by half from 1990 to 2024). These two effects compensated for the additional heated area, and lead to a reduction of NO_x emissions under category 1A4 Other sectors.

Emissions from 1A1 Energy industries are minor with a decreasing trend until 2015 and a slight increase in the recent years due to increasing use of wood waste. 1A5 Other (Military) and 1B Fugitive emissions are minor.

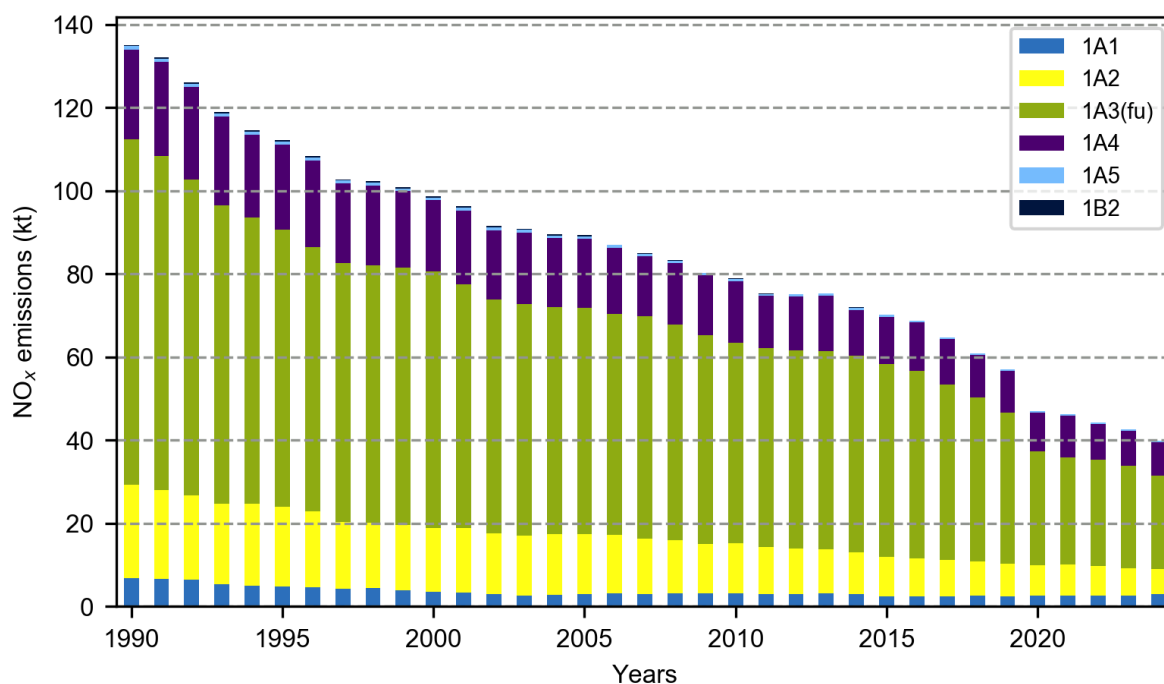


Figure 3-1 Switzerland's NO_x emissions from the energy sector by source categories 1A1-1A5 and 1B2 between 1990 and 2024 ((fu) means fuel used approach). The corresponding data can be found in Table 3-1.

Table 3-1 NO_x emissions from sector 1 Energy by source categories 1A1-1A5 and 1B2 ((fu) means fuel used approach). The last column in the third part of the table indicates the relative trend.

NO _x		1990	1995	2000	2005	2010
1A1	kt	6.8	4.7	3.5	3.0	3.1
1A2	kt	23	19	15	14	12
1A3(fu)	kt	83	67	62	54	48
1A4	kt	22	20	17	17	15
1A5	kt	0.88	0.71	0.67	0.60	0.54
1B1	kt	NA	NA	NA	NA	NA
1B2	kt	0.21	0.31	0.31	0.29	0.11
Sum	kt	135	112	99	89	79

NO _x		2015	2016	2017	2018	2019
1A1	kt	2.5	2.5	2.5	2.5	2.5
1A2	kt	9.3	9.1	8.7	8.2	7.8
1A3(fu)	kt	46	45	42	40	36
1A4	kt	11	12	11	10	9.9
1A5	kt	0.49	0.49	0.45	0.43	0.39
1B1	kt	NA	NA	NA	NA	NA
1B2	kt	0.050	0.0031	0.0024	0.0024	0.0016
Sum	kt	70	69	65	61	57

NO _x		2020	2021	2022	2023	2024	2005-2024 (%)
1A1	kt	2.5	2.5	2.5	2.6	2.9	-1.7
1A2	kt	7.4	7.6	7.3	6.6	6.1	-58
1A3(fu)	kt	28	26	26	24	22	-59
1A4	kt	9.3	9.9	8.5	8.4	8.1	-51
1A5	kt	0.40	0.38	0.40	0.40	0.32	-47
1B1	kt	NA	NA	NA	NA	NA	-
1B2	kt	0.0018	0.0013	0.00059	0.00057	0.0010	-100
Sum	kt	47	46	44	43	40	-55

3.1.2 Overview and trend for NMVOC

Figure 3-2 depicts the NMVOC emissions in energy related sectors since 1990. 1A3 Transport contributes the largest share of total emissions in the period between 1990 and 2024. Due to the decrease of NMVOC emissions from 1A3 Transport, the relative importance of NMVOC emissions from 1A4 Other sectors is increasing.

- In sector 1 Energy, the emission reduction was mainly influenced from category 1A3b Road transportation, in particular resulting from the higher Euro standards for passenger cars (Euro 1 in 1993, Euro 2 in 1995, Euro 3 in 2000, Euro 4 in 2005, Euro 5 in 2009 and Euro 6 in 2014). Furthermore, the share of diesel oil in fuels used under 1A3b has increased compared to gasoline between 1990 and 2024, which leads to a decrease of NMVOC emissions. In 2020 and 2021, the COVID-19 pandemic led to a reduction of NMVOC emissions from road transportation due to reduced traffic volumes. The measures against the pandemic also led to a sharp drop in emissions from 1A3a Aviation in 2020 and 2021, especially international aviation. However, the share of NMVOC emissions from 1A3a Aviation in 1A3 Transport is smaller than that from 1A3b Road transportation, in particular due to the different fuel types (most NMVOC emissions stem from gasoline engines and the system boundaries (only LTO emissions from air traffic are taken into account in the national total, see chapter 3.1.6.1).
- NMVOC emissions of source category 1A4 Other sectors declined in the same period as well due to technical improvements of wood combustion installations and a reduction in the number and energy consumption of emission intensive types of log wood furnaces.

- The decline of NMVOC emissions in 1B2 Fugitive emissions from oil and gas is due to technical improvement to reduce fugitive emissions caused by distribution and storage of gasoline.

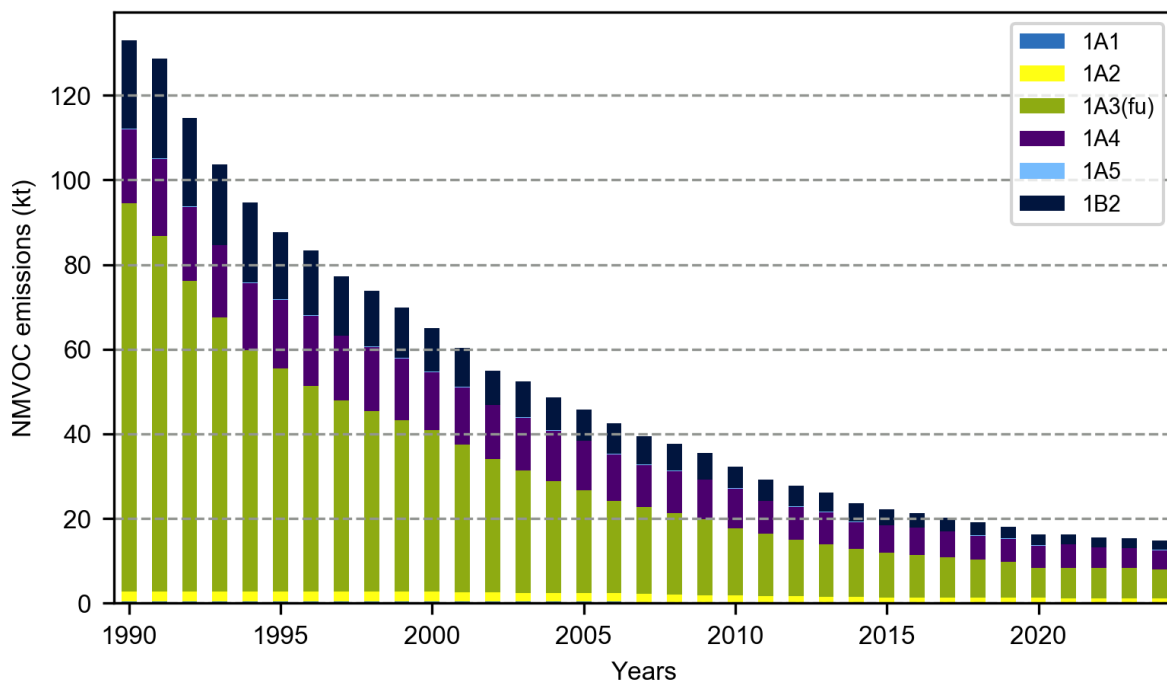


Figure 3-2 Switzerland's NMVOC emissions from the energy sector by source categories 1A1-1A5 and 1B2 between 1990 and 2024 ((fu) means fuel used approach). The corresponding data can be found in Table 3-2.

Table 3-2 NMVOC emissions from sector 1 Energy by source categories 1A1-1A5 and 1B2 ((fu) means fuel used approach). The last column in the third part of the table indicates the relative trend.

NMVOC		1990	1995	2000	2005	2010
1A1	kt	0.33	0.33	0.35	0.32	0.26
1A2	kt	2.4	2.4	2.3	2.1	1.6
1A3(fu)	kt	92	53	38	24	16
1A4	kt	17	16	14	12	9.3
1A5	kt	0.16	0.14	0.13	0.11	0.090
1B1	kt	NA	NA	NA	NA	NA
1B2	kt	21	16	10	7.2	5.2
Sum	kt	133	88	65	46	32

NMVOC		2015	2016	2017	2018	2019
1A1	kt	0.21	0.21	0.21	0.21	0.21
1A2	kt	1.1	1.1	1.1	1.1	1.0
1A3(fu)	kt	11	10	9.5	9.0	8.4
1A4	kt	6.3	6.4	6.1	5.7	5.5
1A5	kt	0.075	0.076	0.070	0.068	0.062
1B1	kt	NA	NA	NA	NA	NA
1B2	kt	3.8	3.3	3.1	3.0	2.8
Sum	kt	22	21	20	19	18

NMVOC		2020	2021	2022	2023	2024	2005-2024 (%)
1A1	kt	0.21	0.21	0.20	0.20	0.21	-34
1A2	kt	1.0	0.98	0.92	0.90	0.86	-58
1A3(fu)	kt	7.1	7.1	7.2	7.2	6.9	-72
1A4	kt	5.2	5.5	4.8	4.6	4.5	-61
1A5	kt	0.063	0.061	0.064	0.064	0.053	-52
1B1	kt	NA	NA	NA	NA	NA	-
1B2	kt	2.5	2.3	2.3	2.3	2.2	-69
Sum	kt	16	16	16	15	15	-68

3.1.3 Overview and trend for SO_x

Figure 3-3 depicts the SO_x emissions in energy related sectors since 1990. In 2024, the main contribution from the sector 1 Energy are SO_x emissions from source category 1A2 Manufacturing industries and construction. Other relevant sources are categories 1A1 Energy industries, 1A3 Transport and 1A4 Other sectors. SO_x emissions from the other source categories (1A5 and 1B2) are negligible in the meantime. Overall, there is a decreasing trend since 1990, which is more pronounced between 1990 and 2000. The time series also show some year-to-year fluctuations. These fluctuations are mainly due to annual variations in the number of heating degree days, which causes fluctuations in the SO_x emissions from fossil fuel-based heating systems in sector 1A4 Other sectors.

- First, the Ordinance on Air Pollution Control (Swiss Confederation 1985) introduced a limitation of the sulphur content in fuels, with further stepwise lowering in 1991, 2000, 2005, 2008 and 2009 for liquid fuels (Table 3-28). These stringent measures resulted in a significant decrease of the sulphur oxide emissions from fuel combustion under 1A3 Transport and 1A4 Other sectors (gas oil, diesel oil and gasoline, see Table 3-28).
- Second, a substantial substitution of gas oil with natural gas and eco-grade gas oil (with low sulphur and nitrogen content, from 2006 onwards) under 1A4 Other sectors resulted in further reductions of sulphur emissions (natural gas consumption increased by half from 1990 to 2024).

- Third, a similar substitution of residual fuel oil, coal and gas oil by natural gas has reduced sulphur emissions as well in 1A2 Manufacturing industries (i.e. coal and residual fuel oil from 1990, gas oil from about 2005 onwards).

Additionally, emissions of 1A1 are decreasing caused by substitution of emission intensive fuels (e.g. no more consumption of residual fuel oil since 2011 and no more bituminous coal since 1996) and by the closing of a refinery plant in 2015. The SO_x emissions from 1B2 Fugitive emissions from oil and gas are due to Claus units and flaring in refineries. The decrease between 1990 and 1995 can be explained by the retrofitting of the claus units due to the enactment of the Ordinance on Air Pollution Control in 1985. Further, the emission factors from claus units and flaring decreased over time.

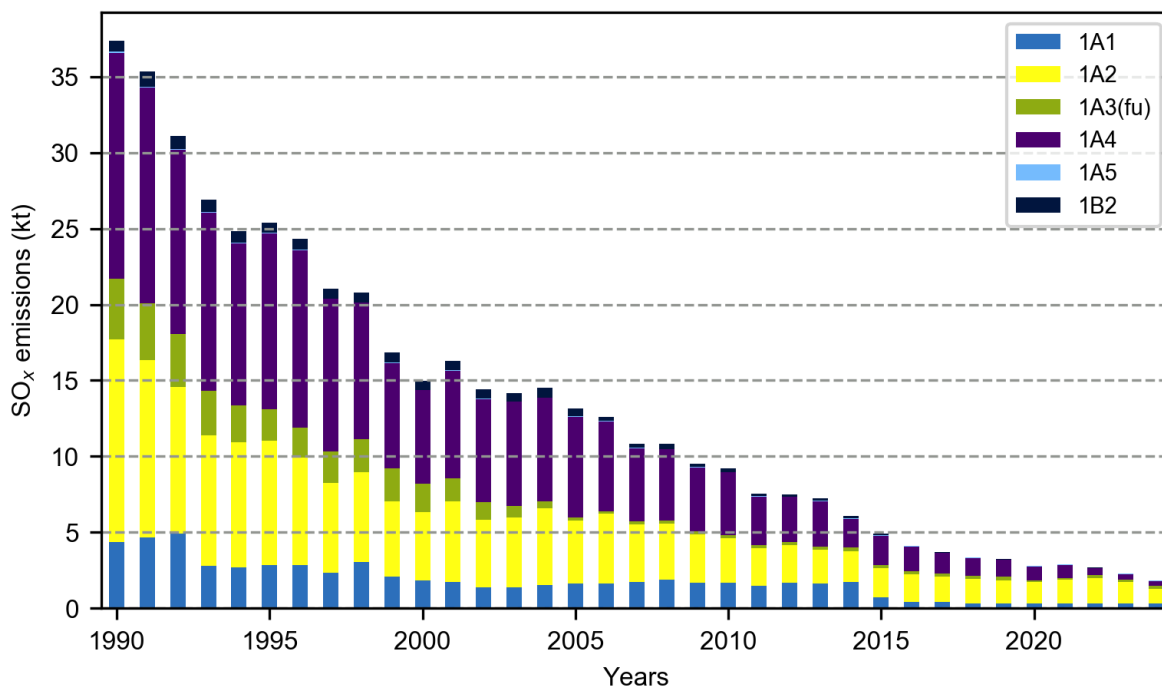


Figure 3-3 Switzerland's SO_x emissions from the energy sector by source category 1A1-1A5 and 1B2 between 1990 and 2024 ((fu) means fuel used approach). The corresponding data can be found in Table 3-3.

Table 3-3 SO_x emissions from sector 1 Energy by source categories 1A1-1A5 and 1B2 ((fu) means fuel used approach). The last column in the third part of the table indicates the relative trend.

SO _x		1990	1995	2000	2005	2010
1A1	kt	4.3	2.8	1.8	1.6	1.7
1A2	kt	13	8.2	4.5	4.2	2.9
1A3(fu)	kt	4.0	2.0	1.9	0.18	0.20
1A4	kt	15	12	6.1	6.6	4.1
1A5	kt	0.078	0.049	0.045	0.037	0.037
1B1	kt	NA	NA	NA	NA	NA
1B2	kt	0.72	0.63	0.59	0.51	0.22
Sum	kt	37	25	15	13	9.2

SO _x		2015	2016	2017	2018	2019
1A1	kt	0.73	0.39	0.39	0.31	0.29
1A2	kt	1.9	1.8	1.7	1.6	1.6
1A3(fu)	kt	0.22	0.22	0.22	0.23	0.23
1A4	kt	1.9	1.6	1.3	1.2	1.1
1A5	kt	0.036	0.038	0.034	0.034	0.030
1B1	kt	NA	NA	NA	NA	NA
1B2	kt	0.085	0.019	0.018	0.019	0.016
Sum	kt	4.9	4.1	3.7	3.4	3.2

SO _x		2020	2021	2022	2023	2024	2005-2024 (%)
1A1	kt	0.29	0.33	0.30	0.32	0.34	-80
1A2	kt	1.4	1.6	1.7	1.4	0.92	-78
1A3(fu)	kt	0.11	0.12	0.17	0.19	0.20	12
1A4	kt	0.92	0.83	0.45	0.36	0.34	-95
1A5	kt	0.031	0.030	0.033	0.033	0.025	-32
1B1	kt	NA	NA	NA	NA	NA	-
1B2	kt	0.017	0.014	0.016	0.015	0.014	-97
Sum	kt	2.8	2.9	2.7	2.3	1.8	-86

3.1.4 Overview and trend for NH₃

Figure 3-4 depicts the NH₃ emissions in energy related sectors since 1990. Note: The contribution of the energy sector is small in comparison to the national total. Therefore, there are no source categories from the energy sector that are key categories for NH₃ (except for 1A3, which is a key category with approach 2, level assessment, for 1990 only). For all years, the main contributor among categories of sector 1 Energy is 1A3 Transport. Since 1990, total emissions underwent a twofold trend: Overall emissions increased continuously until 2000. This is mainly attributable to changes of sulphur contents in fuels used in road transportation in combination with three-way catalytic converters: with low sulphur petrol in use, higher NH₃ emissions result (Mejía-Centeno 2007). This effect manifests mainly for car fleets with EURO standards 1, 2 and 3. For cars registered as EURO 2, this effect becomes particularly evident and causes the model to reveal a pronounced jump in emission levels between 1999 and 2000. Afterwards, emissions decreased because the car fleet changes again towards stricter EURO standards, where the sulphur content in fuels has less influence on the NH₃ emissions due to technological improvements in three-way catalytic converters.

In 2020, the COVID-19 pandemic led to measures that resulted in a massive reduction in traffic. The lower traffic volume led to a small but visible decrease in NH₃ emissions from 1A3b Road transportation.

Emissions from the other source categories are comparably small. The NH₃ emissions in 1A2 Manufacturing industries and construction are mainly due to source category 1A2f Manufacturing industries and construction: Non-metallic minerals (especially cement and

rock wool production). NH₃ emissions in 1A4 Other sectors stem mainly from residential wood combustions.

There are no NH₃ emissions from source category 1B Fugitive emissions from fuels.

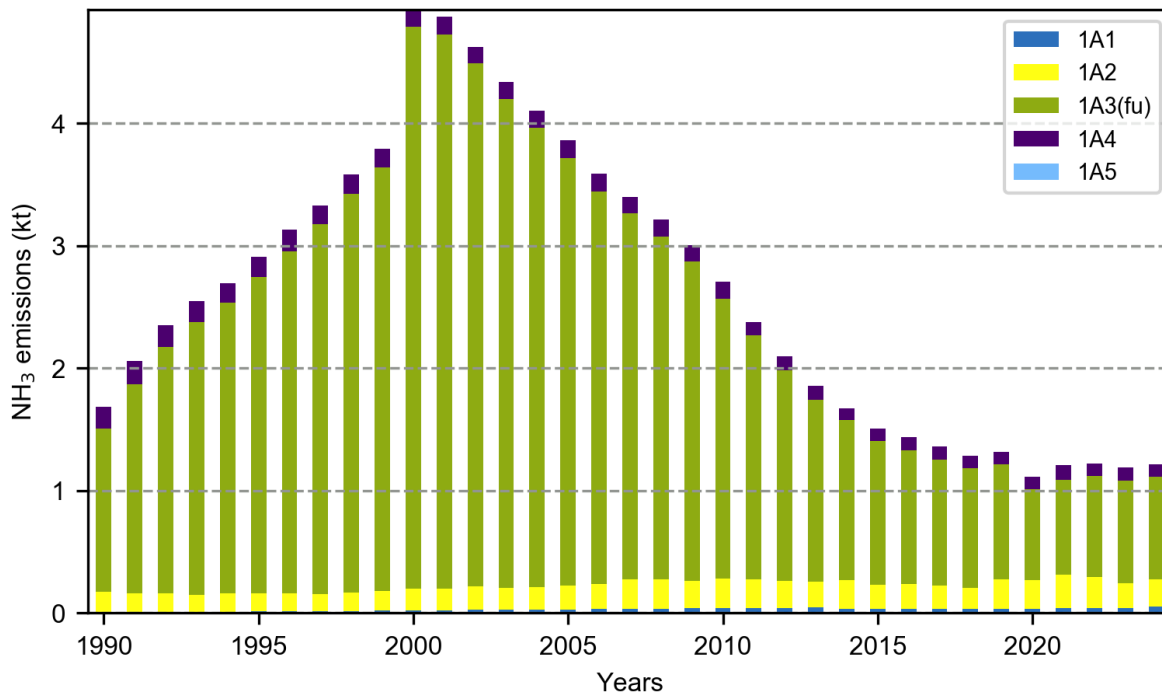


Figure 3-4 Switzerland's NH₃ emissions from the energy sector by source category 1A1-1A5 between 1990 and 2024 ((fu) means fuel used approach). There are no emissions from 1B. The corresponding data can be found in Table 3-4.

Table 3-4 NH₃ emissions from sector 1 Energy by source categories 1A1-1A5 ((fu) means fuel used approach). The last column in the third part of the table indicates the relative trend.

NH ₃		1990	1995	2000	2005	2010
1A1	kt	0.0049	0.011	0.021	0.029	0.036
1A2	kt	0.17	0.15	0.18	0.19	0.24
1A3(fu)	kt	1.3	2.6	4.6	3.5	2.3
1A4	kt	0.18	0.17	0.14	0.14	0.14
1A5	kt	0.000037	0.000038	0.000039	0.000039	0.000042
1B1	kt	NA	NA	NA	NA	NA
1B2	kt	NA	NA	NA	NA	NA
Sum	kt	1.7	2.9	4.9	3.9	2.7

NH ₃		2015	2016	2017	2018	2019
1A1	kt	0.032	0.032	0.034	0.033	0.033
1A2	kt	0.20	0.21	0.19	0.17	0.24
1A3(fu)	kt	1.2	1.1	1.0	0.98	0.94
1A4	kt	0.098	0.11	0.10	0.10	0.10
1A5	kt	0.000041	0.000041	0.000041	0.000041	0.000041
1B1	kt	NA	NA	NA	NA	NA
1B2	kt	NA	NA	NA	NA	NA
Sum	kt	1.5	1.4	1.4	1.3	1.3

NH ₃		2020	2021	2022	2023	2024	2005-2024 (%)
1A1	kt	0.034	0.037	0.037	0.042	0.052	80
1A2	kt	0.23	0.28	0.26	0.20	0.22	14
1A3(fu)	kt	0.74	0.78	0.83	0.84	0.84	-76
1A4	kt	0.10	0.12	0.10	0.10	0.10	-30
1A5	kt	0.000041	0.000041	0.000041	0.000041	0.000041	3.2
1B1	kt	NA	NA	NA	NA	NA	-
1B2	kt	NA	NA	NA	NA	NA	-
Sum	kt	1.1	1.2	1.2	1.2	1.2	-69

3.1.5 Overview and trend for PM_{2.5}

Figure 3-5 depicts the PM_{2.5} emissions in energy related sectors since 1990. The main contributor is source category 1A4 Other sectors, followed by 1A3 Transport and 1A2 Manufacturing industries and construction. Within source category 1A4 Other sectors, mainly wood combustion in small and mid-sized wood furnaces contribute to PM_{2.5} emissions. Overall emissions declined since 1990. The following effects mainly attributed to the reduction of particulate matter emissions:

- The large reduction of exhaust particulate matter emissions is primarily due to the development of emissions from wood combustion, especially in single-room furnaces and building heating systems (1A4; not only filterable fractions, but also condensable fractions which are particularly relevant for single-room furnaces and building heating). The reduction was achieved through technological improvements of the combustion installations and a reduction in the number of emission intensive types of wood furnaces (e.g. cooking stoves). In addition, wood energy consumption in manually operated furnaces decreased by more than half since 1990. Furthermore, the revision of the Ordinance of Air Pollution (Swiss Confederation 1985) in 2007 introduced more stringent emission limits (2007, 2008 and 2012) for mainly automatic wood combustion installations, which also led to a reduction in emissions from these installations (mainly in 1A1 and 1A2), although their wood energy consumption increased by about a factor of eight since 1990.

- A further reduction of exhaust emissions under 1A3 Transport was caused by the abatement of exhaust emissions from road vehicles. Throughout the years, a continuous reduction of these emissions has been achieved with the stepwise adoption of the Euro standards. New diesel cars must be equipped with diesel particle filters.
- Under category 1A2 Manufacturing industries and construction, a reduction of exhaust emissions resulted from technological improvements in construction machineries (an installation of particle filters for new construction machineries with diesel engines is required by the Ordinance on Air Pollution Control (OAPC) since 2009) and from a fuel switch in stationary combustion (i.e. from coal, residual fuel oil and gas oil to natural gas).
- There is an underlying increasing trend in non-exhaust particulate matter emissions from growing activity data (annual mileage and machine hours) of mobile sources 1A3 Transport and 1A2gvii Mobile combustion in manufacturing industries and construction which affects larger particle emissions (TSP and PM10) more than PM2.5 (see Table 2-16 and Figure 2-13). This is due to a larger share of non-exhaust emissions with a particle diameter of 10 micrometres and larger. Therefore, the overall decreasing trend in TSP emissions is less pronounced as compared to the decrease in PM2.5 emissions. Note: In 2020 and 2021, despite this underlying increasing trend, the measures against the COVID-19 pandemic led to a reduction of non-exhaust PM10 emissions from road transportation due to reduced traffic volumes.

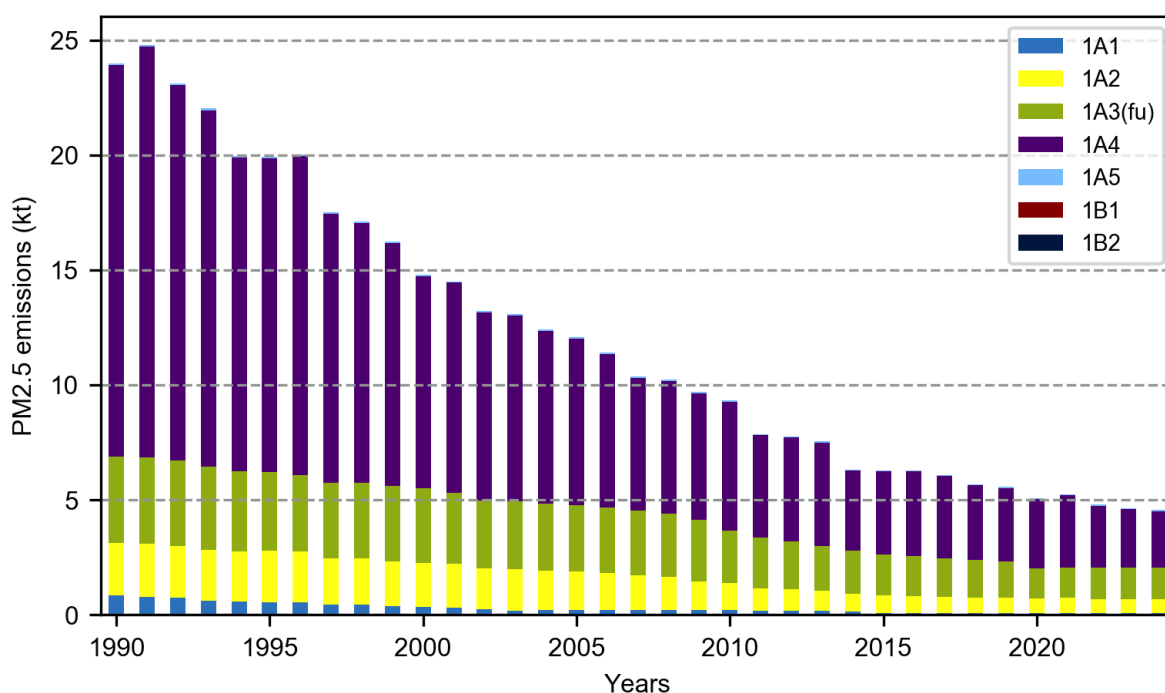


Figure 3-5 Switzerland's PM2.5 emissions from the energy sector by source categories 1A1-1A5 and 1B1 between 1990 and 2024 ((fu) means fuel used approach). The corresponding data can be found in Table 3-5.

Table 3-5 PM2.5 emissions from sector 1 Energy by source categories 1A1-1A5 and 1B1-1B2 ((fu) means fuel used approach). The last column in the third part of the table indicates the relative trend.

PM2.5		1990	1995	2000	2005	2010	
1A1	kt	0.83	0.55	0.35	0.19	0.20	
1A2	kt	2.3	2.2	1.9	1.7	1.2	
1A3(fu)	kt	3.8	3.4	3.3	2.9	2.3	
1A4	kt	17	14	9.2	7.2	5.6	
1A5	kt	0.087	0.063	0.062	0.057	0.050	
1B1	kt	0.00016	0.000086	0.000063	0.000070	0.000074	
1B2	kt	0.00044	0.00065	0.00065	0.00059	0.00024	
Sum	kt	24	20	15	12	9.3	

PM2.5		2015	2016	2017	2018	2019	
1A1	kt	0.089	0.069	0.069	0.065	0.067	
1A2	kt	0.75	0.73	0.71	0.68	0.67	
1A3(fu)	kt	1.8	1.7	1.7	1.6	1.6	
1A4	kt	3.6	3.7	3.6	3.3	3.2	
1A5	kt	0.046	0.046	0.046	0.045	0.045	
1B1	kt	0.000064	0.000059	0.000057	0.000053	0.000047	
1B2	kt	0.00010	0.000006	0.000005	0.000005	0.000003	
Sum	kt	6.3	6.3	6.1	5.7	5.6	

PM2.5		2020	2021	2022	2023	2024	2005-2024 (%)
1A1	kt	0.062	0.065	0.060	0.060	0.082	-58
1A2	kt	0.65	0.66	0.63	0.62	0.59	-65
1A3(fu)	kt	1.3	1.3	1.4	1.4	1.4	-52
1A4	kt	3.0	3.2	2.7	2.5	2.4	-66
1A5	kt	0.045	0.045	0.045	0.045	0.044	-23
1B1	kt	0.000046	0.000046	0.000048	0.000038	0.000032	-54
1B2	kt	0.000004	0.000003	0.000001	0.000001	0.000002	-100
Sum	kt	5.1	5.2	4.8	4.6	4.6	-62

3.1.6 General method and disaggregation of energy consumption

3.1.6.1 System boundaries: Differences between CLRTAP and UNFCCC reporting

Switzerland uses the same database for the Swiss greenhouse gas inventory as for the Swiss air pollution inventory. It reports its greenhouse gas emissions according to the requirements of the UNFCCC, as well as air pollutants according to the requirements of the CLRTAP. The nomenclature for both reporting systems is (almost) the same (NFR), but there are differences concerning the system boundaries.

Fuel used or fuel sold approach in 1A3b Road transportation

There are two different approaches for calculating emissions in source category 1A3b Road transportation. One is the fuel used approach, which is based on the road transportation model, that calculates the fuel consumption using kilometres driven per vehicle category in the Swiss territory as described in chapter 3.2.6. The other one is the fuel sold approach, which bases on the total amount of fuel sold as reported in the Swiss energy statistics. The difference between the calculated fuel consumption of diesel oil, gasoline, biodiesel, bioethanol and natural gas in the road transportation model and the Swiss energy statistics is called "statistical difference and fuel tourism". "Fuel tourism" refers to the amount of fuel sold in Switzerland but consumed abroad or vice versa. To calculate the emissions for the fuel sold approach, this difference in fuel consumption per fuel type is distributed proportionally

across each vehicle category, whereby the activity data in GJ, driven kilometres and the number of vehicles is adjusted proportionally in each category.

As Switzerland is a small country, the difference between these two approaches amounts to several percent, with considerable variation from year to year due to fluctuating fuel price differences between Switzerland and its neighboring countries.

Only domestic flights or only LTO cycles in 1A3a Civil aviation

Another difference concerns emissions from 1A3a Civil aviation: International flights are flights from a Swiss airport to a destination abroad. International flights with landing in Switzerland are not accounted for because they buy their fuel at the departure airport abroad. Domestic flights are flights with departure and destination in Switzerland. For the GHG inventory, only emissions from domestic flights are accounted for, while emissions from international flights are reported as aviation bunkers, i.e., as a memo item (1D1 International aviation). For the reporting of air pollutants under the CLRTAP, Landing/Take-off (LTO) cycle emissions of domestic and international flights are accounted for, while emissions of domestic and international cruise flights are reported as memo items only (see Table 3-6). Note that emissions from overflights without landing in Switzerland are not considered in either approach.

National totals for compliance with emission ceilings

Under the UNFCCC, there is no difference between the reported national total and the national total for assessing compliance as it is based on fuel sold within the national territory. Under the CLRTAP, the national total is based on fuel sold but for assessing compliance it is based on fuel used (fu) in 1A3b Road transportation within the Swiss boundaries.

Table 3-6 Accounting rules for emissions from 1A3a Civil aviation and 1A3b Road transportation for CLRTAP and UNFCCC.

Differences between reporting under CLRTAP and UNFCCC concerning the accounting to the national total			CLRTAP / NFR tables			UNFCCC / CRT tables	
			National total	accounted to		National total	Bunker (1D)
National total for compliance	Separated information / Memo items	National total					
1A3b - Road transportation	1A3bi-v (fu) Fuel used - approach	Based on statistics of driven km and vehicle categories	No	Yes	Yes	No	No
	1A3bi-v Fuels sold - approach	The activity data of the fuel used-approach are adapted to reflect the total of fuel sold as reported in statistics.	Yes	No	No	Yes	No
1A3a - Aviation	Civil and domestic aviation	Landing and Take-Off (LTO)	Yes	Yes	No	Yes	No
		Cruise	No	No	Yes	Yes	No
	International aviation	Landing and Take-Off (LTO)	Yes	Yes	No	No	Yes
		Cruise	No	No	Yes	No	Yes
		Fuel Dumping	No	No	Yes	No	Yes
		Overflights	No	No	No	No	No

Emissions generated by road transportation considering fuel used in Switzerland as modelled in the road transportation model described in chp. 3.2.6.2.2 are reported in lines 143-149 in the NFR tables. Emissions generated by road transportation considering the amount of fuel sold in Switzerland are reported in lines 27-33 in the NFR tables.

The following memo items are reported for Switzerland in lines 157-164 in the NFR tables:

- 1A3ai(ii) International aviation cruise (civil) Emission modelling see chp. 3.2.6.2
- 1A3aii(ii) Domestic aviation cruise (civil) Emission modelling see chp. 3.2.6.2
- 1A3di(i) International maritime navigation Emission modelling see chp. 3.2.6.2
- 11B Forest fires Emission modelling see chp. 7.3
- 11C Other natural emissions Emission modelling see chp. 7.4

Recalculations concerning emission estimates of source categories in 1A3 are described in chp. 3.2.6.3, recalculations for 11B in chp. 7.3.3 and for 11C in chp. 7.4.3.

3.1.6.2 Net calorific values (NCV)

Table 3-7 summarizes the net calorific values (NCV) which are used to convert from energy amounts in tonnes into energy quantities in gigajoules (GJ). More detailed explanations including information about the origin of the NCVs of the different fuels are given below.

Table 3-7 Net calorific values (NCVs) of various fuels. Where values for two years are indicated, the NCV is interpolated between these two years and constant NCVs are used before the first and after the second year (corresponding to the two indicated values). For the NCV of wood, a range covering all facility categories and years is provided. For the NCVs of natural gas and biogas see Table 3-8.

Fuel	Year	NCV	Unit	Data sources
Fossil fuel				
Gasoline	until 1998	42.5	GJ/t	EMPA (1999)
	from 2013	42.6	GJ/t	SFOE/FOEN (2014)
Jet kerosene	until 1998	43.0	GJ/t	EMPA (1999)
	from 2013	43.2	GJ/t	SFOE/FOEN (2014)
Diesel oil	until 1998	42.8	GJ/t	EMPA (1999)
	from 2013	43.0	GJ/t	SFOE/FOEN (2014)
Gas oil	until 1998	42.6	GJ/t	EMPA (1999)
	from 2013	42.9	GJ/t	SFOE/FOEN (2014)
Residual fuel oil	from 1990	41.2	GJ/t	EMPA (1999)
Liquefied petroleum gas	from 1990	46.0	GJ/t	SFOE (2025)
Petroleum coke	until 1998	35.0	GJ/t	SFOE (2025)
	from 2010	31.8	GJ/t	SFOE (2025)
Other bituminous coal	until 1998	28.052	GJ/t	SFOE (2025)
	from 2010	25.5	GJ/t	SFOE (2024)
Lignite	until 1998	20.097	GJ/t	SFOE (2025)
	from 2010	23.6	GJ/t	SFOE (2024)
Biofuel				
Biodiesel	from 1990	32.7	GJ/m3	SFOE (2025)
Bioethanol	from 1990	21.1	GJ/m3	SFOE (2025)
Wood	from 1990	8.6-14.6	GJ/t	SFOE (2025b)

Gasoline, jet kerosene, diesel oil and gas oil

For gasoline, jet kerosene, diesel oil and gas oil, the NCVs for 1998 and 2013 are based on national measurement campaigns and are the same as those used by the Swiss Federal Office of Energy (SFOE 2025). A first campaign was conducted by the Swiss Federal Laboratories for Materials Science and Technology (EMPA) in 1998 (EMPA 1999). Since

earlier data are not available, the values for 1990–1998 are assumed to be constant at the 1998 levels. A second campaign, commissioned by the Swiss Federal Office of Energy (SFOE) and the Swiss Federal Office for the Environment (FOEN), was conducted in 2013 (SFOE/FOEN 2014). This study was based on representative samples covering summer and winter fuel qualities from the main import streams. Sampling started in July 2013 and lasted six months. Samples were taken fortnightly from nine different sites (large-scale storage facilities and the two refineries operating at that time in Switzerland) and analysed for carbon content and NCVs, among other parameters. These updated values are used from 2013 onwards, while the NCVs for 1999–2012 are linearly interpolated between the measured values of 1998 and 2013.

Residual fuel oil

Residual fuel oil plays only a minor role in the Swiss energy supply. Therefore, this fuel was not analysed in the most recent measurement campaign in 2013 (SFOE/FOEN 2014). Thus, the respective NCV refers to the 1998 measurement campaign (EMPA 1999). The NCV for residual fuel oil, which is the same as the one used by the Swiss Federal Office of Energy (SFOE 2025), is assumed to be constant over the entire reporting period.

Liquefied petroleum gas

The NCV of liquefied petroleum gas is the same as the one used by the Swiss Federal Office of Energy (SFOE 2025) and is, as in the Swiss overall energy statistics, constant over the entire reporting period. It is assumed that liquefied petroleum gas is a mixture of propane and butane in equal proportions.

Petroleum coke, other bituminous coal, lignite

For the entire reporting period, the NCVs of petroleum coke, other bituminous coal and lignite are the same as those used by the Swiss Federal Office of Energy (SFOE 2025). For these fuels, the Swiss overall energy statistics contain NCVs for the years 1998 and 2010. Values in between are interpolated, with values before the first and after the last year of available data held constant. The NCVs for 2010 are based on measured samples taken from Switzerland's cement plants, as they are the largest consumers of these fuels in Switzerland. Samples from the individual plants were taken from January to September 2010 and analysed for NCVs by an independent analytical laboratory (Cemsuisse 2010a). For each fuel, the measurements from the individual plants were weighted according to the relative consumption of each plant.

Natural gas, biogas

The NCV of natural gas (see Table 3-8) and also the CO₂ emission factor used in the GHG inventory of natural gas are calculated based on measurements of gas properties and corresponding import shares of individual gas import stations. Measurements of gas properties are available from the Swiss Gas and Water Industry Association (SGWA) on an annual basis since 2009 and for selected years before. The latest report is SGWA (2025). Import shares are available for 1991, 1995, 2000, 2005, 2007 and from 2009 onwards on an annual basis. Estimated import shares for the years 1991, 1995 and 2000 are taken from Quantis (2014). Values for the years in between are interpolated. The calculation procedure is documented in FOEN (2025i). The NCV of biogas is assumed to be equal to the NCV of natural gas since the raw biogas is treated to fulfil the same quality level, including its energetic properties, as natural gas.

Table 3-8 Net calorific values of natural gas and biogas for selected years. Years in-between are linearly interpolated. Data source: annual reports of the Swiss Gas and Water Industry Association SGWA, the latest report is SGWA (2025). Spreadsheet to determine national averages: FOEN 2025i.

Year	NCV of natural gas and biogas [GJ/t]
1990	46.5
1991	46.5
1995	47.5
2000	47.2
2005	46.6
2007	46.3
2009	46.4
2010	46.3
2011	46.1
2012	45.8
2013	45.7
2014	45.7
2015	46.6
2016	47.1
2017	47.4
2018	47.6
2019	47.5
2020	47.6
2021	48.2
2022	48.0
2023	48.4
2024	48.3

Wood

The net calorific value of wood depends on the type of wood fuel (e.g., log wood, wood chips, pellets) and is based on the Swiss wood energy statistics (SFOE 2025b).

Table 3-7 illustrates the range of the NCV for all wood fuel types.

Bioethanol and biodiesel

The NCVs of bioethanol and biodiesel are the same as those used by the Swiss Federal Office of Energy (SFOE 2025) and are, as in the Swiss overall energy statistics, constant over the entire reporting period.

3.1.6.3 Swiss energy model and final Swiss energy consumption

3.1.6.3.1 Swiss overall energy statistics

The fundamental data on final energy consumption is provided by the Swiss overall energy statistics (SFOE 2025). However, since Switzerland and Liechtenstein form a customs and monetary union governed by a customs treaty, data regarding liquid fuels in the Swiss overall energy statistics also cover liquid fuel consumption in Liechtenstein. To calculate the correct Swiss fuel consumption, Liechtenstein's liquid fossil fuel consumption, given by Liechtenstein's energy statistics (OS 2025), is subtracted from the figures provided by the Swiss overall energy statistics. In all years of the reporting period, the sum of liquid fossil fuels used in Liechtenstein was less than half a percent of the Swiss consumption.

The energy-related activity data correspond to the energy balance provided in the Swiss overall energy statistics (SFOE 2025). The energy statistics are updated annually and contain all relevant information about primary and final energy consumption. This includes annual aggregated consumption data for various fuels and main consumers such as households, transport, energy industries, industry, and services (see energy balance in Annex 4).

The main data sources of the Swiss overall energy statistics are:

- The Swiss organisation for the compulsory stockpiling of oil products (Carbura) and Avenegy Suisse (formerly Swiss petroleum association, EV) for data on import, export, sales, stocks of oil products and processing of crude oil in refineries.
- Annual import data for natural gas from the Swiss gas industry association (VSG).
- Annual import data for petroleum products and coal from the Federal Office for Customs and Border Security (FOCBS).
- Data provided by industry associations (GVS, SGWA, Cemsuisse, VSG, VSTB, etc.).
- Swiss electricity statistics (SFOE 2025g).
- Swiss renewable energies statistics (SFOE 2025a).
- Swiss wood energy statistics (SFOE 2025b).
- Swiss statistics on combined heat and power generation (SFOE 2025c).

As can be seen in Figure 3-6, fossil fuels amount to slightly less than half of primary energy consumption. The main end-users of fossil fuels are the transport and housing sectors, as electricity generation is predominantly based on hydro- and nuclear power stations. The most recent energy balance is provided in Annex 4.

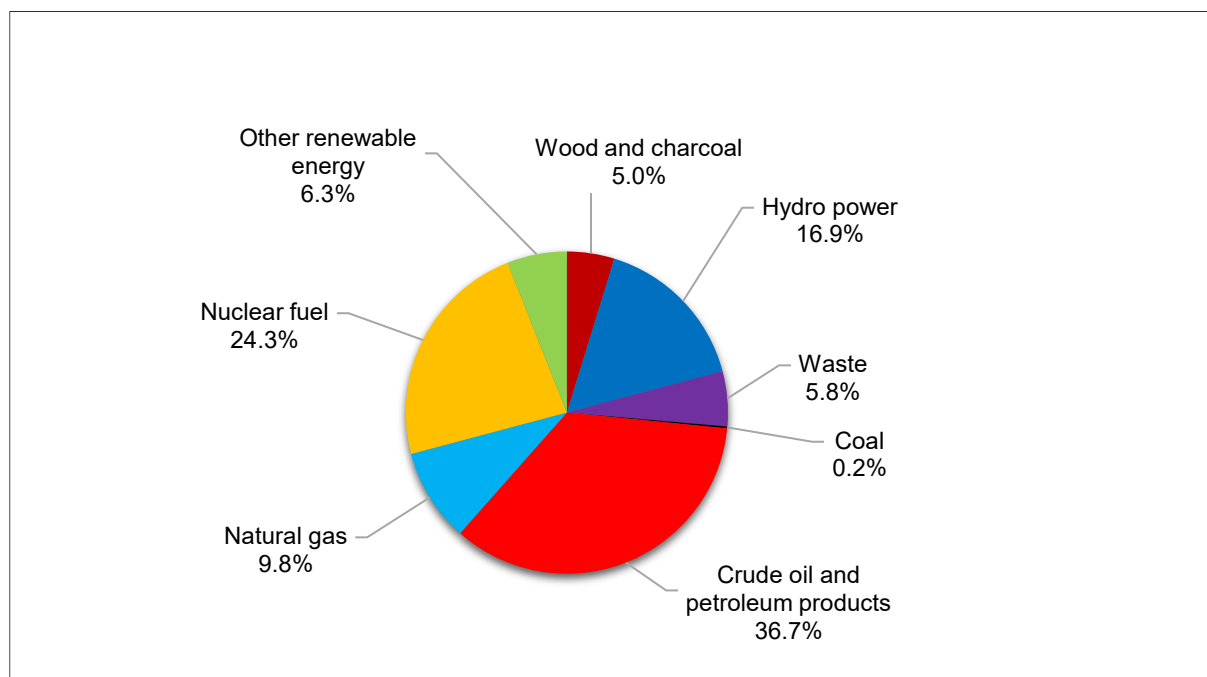


Figure 3-6 Switzerland's primary energy consumption in 2024 by fuel type (see corresponding data and additional information on energy consumption over time in SFOE 2025).

Table 3-9 shows primary energy consumption excluding nuclear fuel and hydro power. On the one hand, the combined effect of decreasing consumption of gasoline and increasing consumption of jet kerosene and diesel oil led to an increasing trend until about 2010 and a stabilization thereafter in the transport sector. On the other hand, consumption in the residential and industrial sector (mainly gas oil) substantially decreased. Overall, liquid fossil fuel consumption changed only little between 1990 and about 2010, but started to decrease thereafter. Natural gas consumption has increased since 1990, compensating to some extent the decreasing use of gas oil and residual fuel oil in the various sectors. Due to the restrictions related to the COVID-19 pandemic, the years 2020 and 2021 are exceptional, with lower fossil fuel consumption than in the years before. Particularly, in the transport sector the consumption of gasoline, jet kerosene and diesel oil did not reach the level of 2019 anymore. Compared to 2021, total fuel consumption declined in 2022. In particular gas oil and natural gas consumption were lower compared to the previous years due to the warm winter and energy saving measures in response to the looming energy shortage. In 2024 total fuel consumption was on a similar level as in 2022 and 2023.

Table 3-9 Switzerland's energy consumption by fuel type. Only those fuels are shown that are implemented in the EMIS database (no hydro or nuclear power). The numbers are based on the fuels sold principle; thus, they include gasoline, diesel and biofuels consumption from fuel tourism, as well as all jet kerosene sold for domestic and international aviation. Natural gas and gasoline losses due to fugitive emissions (reported in sector 1B) are not included.

Year	Gasoline	Jet kerosene used for LTO	Jet kerosene used for cruise (memo item)	Diesel oil (incl. fossil fraction of biodiesel)	Diesel oil used for intern. Navigation (memo item)	Gas oil	Residual fuel oil	Refinery gas & Liquefied petroleum gas	Petroleum coke	Solid fuels	Gaseous fuels excl. losses	Other fossil fuels	Biomass (incl. Bio fuels)	National Total as reported in NFR tables	Total incl. memo items
	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ
1990	155'703	8'059	40'008	46'736	821	218'510	23'342	8'890	1'400	14'901	68'426	19'074	46'825	611'864	652'694
1991	162'063	7'640	38'922	47'417	737	238'602	23'590	12'437	980	12'162	76'724	18'503	48'826	648'944	688'602
1992	168'037	7'803	41'297	45'926	780	236'809	24'170	11'492	315	8'758	80'627	18'935	47'747	650'619	692'696
1993	155'808	7'861	42'915	44'197	781	225'920	17'165	12'388	1'120	7'442	84'574	19'041	48'091	623'605	667'301
1994	155'797	7'911	44'198	46'924	824	207'141	17'860	13'455	1'470	7'632	83'402	19'051	46'052	606'695	651'718
1995	151'094	7'987	46'960	47'865	739	217'523	17'278	12'756	1'260	7'962	91'942	19'586	48'094	623'345	671'045
1996	155'033	8'017	48'736	44'946	651	226'289	15'097	13'939	1'015	5'456	99'530	20'430	51'679	641'431	690'818
1997	161'031	8'320	50'454	46'731	657	212'223	12'581	14'236	280	4'590	96'083	21'501	48'539	626'114	677'225
1998	162'315	8'540	52'728	48'684	528	222'407	15'882	15'259	455	3'960	98'890	23'575	50'159	650'127	703'383
1999	167'815	8'762	56'482	51'629	558	212'349	11'058	15'805	521	4'105	102'415	24'197	50'916	649'573	706'613
2000	168'009	9'074	58'987	55'149	531	196'137	7'923	13'649	551	6'120	101'800	26'288	50'601	635'302	694'820
2001	163'442	8'598	55'610	56'266	447	213'089	9'942	14'069	410	6'233	105'966	26'775	53'894	658'684	714'741
2002	160'276	8'128	51'278	58'392	333	196'655	6'446	15'584	679	5'565	104'007	27'624	53'435	636'792	688'403
2003	159'512	7'327	46'110	61'812	443	208'040	7'061	13'642	202	5'663	109'957	27'369	56'019	656'605	703'158
2004	156'708	6'885	43'555	66'453	446	203'370	7'561	16'429	1'819	5'420	113'459	28'495	56'995	663'594	707'594
2005	151'966	7'020	44'081	72'583	493	205'729	5'805	16'432	2'906	5'940	116'493	28'833	59'157	672'865	717'439
2006	147'344	7'291	46'280	78'622	457	195'926	6'419	18'578	3'324	6'467	113'264	30'837	62'269	670'341	717'078
2007	145'923	7'538	49'627	84'437	465	171'313	5'179	15'587	2'730	7'196	110'252	29'617	61'319	641'091	691'183
2008	142'713	7'773	53'378	92'691	473	178'833	4'581	16'288	3'616	6'562	117'451	30'393	65'504	666'405	720'256
2009	138'883	7'496	51'169	94'157	425	173'219	3'530	16'301	3'254	6'193	112'674	29'313	65'684	650'703	702'298
2010	133'953	7'699	53'921	97'793	471	182'295	2'967	15'463	3'498	6'208	125'846	30'610	70'537	676'869	731'261
2011	128'775	7'970	57'726	100'467	428	143'760	2'292	14'856	2'957	5'792	111'617	30'261	66'252	614'999	673'154
2012	124'229	8'257	59'048	106'633	385	154'448	2'780	12'247	3'148	5'269	122'398	30'555	72'140	642'105	701'538
2013	118'572	8'243	59'825	111'502	342	162'532	1'959	15'053	2'735	5'567	128'912	30'355	75'748	661'178	721'345
2014	113'820	8'282	60'259	114'422	299	122'694	1'581	14'473	3'148	5'704	111'660	30'827	70'023	596'633	657'192
2015	105'540	8'414	62'374	112'888	342	129'349	862	9'822	1'145	5'205	119'314	31'735	73'332	597'605	660'321
2016	102'250	8'577	65'584	114'207	299	132'325	378	9'136	890	4'795	125'355	33'303	79'411	610'629	676'512
2017	99'112	8'581	67'352	113'954	256	123'726	350	8'770	763	4'609	125'602	33'104	82'592	601'164	668'772
2018	97'545	8'756	71'494	115'562	200	111'225	87	8'890	781	4'285	118'931	34'318	82'277	582'656	654'351
2019	96'748	8'587	72'482	115'642	197	108'625	111	8'108	777	3'842	121'941	34'881	84'670	583'932	656'611
2020	85'681	3'930	26'685	109'599	189	97'256	76	7'627	700	3'696	118'835	34'691	84'066	546'157	573'031
2021	87'541	4'203	29'756	110'742	228	108'151	139	7'543	604	3'726	129'419	33'884	90'993	576'944	606'928
2022	85'025	6'779	53'086	110'591	207	87'140	0	9'646	731	3'880	106'398	33'765	85'132	529'088	582'380
2023	87'805	7'584	63'617	108'365	200	84'506	41	9'087	733	3'065	98'608	32'478	87'926	520'199	584'016
2024	86'956	7'783	69'914	105'240	233	80'859	0	7'583	507	2'563	100'306	32'975	91'617	516'388	586'535

3.1.6.3.2 Energy model – Conceptual overview

For the elaboration of the greenhouse gas and air pollutant inventories, information about energy consumption is needed at a much more detailed level than provided by the Swiss overall energy statistics (SFOE 2025). Activity data in sector 1 Energy are therefore calculated and disaggregated by the Swiss energy model, which is an integral part of the emission database EMIS. The model is developed and updated annually by the Swiss Federal Office for the Environment (FOEN). It relies on the Swiss overall energy statistics and is complemented with further data sources, e.g., Liechtenstein's liquid fuel sales (OS 2025), the Swiss renewable energy statistics (SFOE 2025a), the energy consumption statistics in the industry and services sectors (SFOE 2025d), as well as additional information from the industry. As wood energy consumption is not based on the Swiss overall energy statistics but directly on the figures from the Swiss wood energy statistics (SFOE 2025b), its activity data are derived in a separate but analogous model.

The Swiss overall energy statistics are not only the main data input into the energy model but also serve as a calibration and quality control instrument: The total energy consumption given by the Swiss overall energy statistics has to be equal to the sum of the disaggregated activity data of all source categories within the energy sector (including memo items/bunker). Differences are explicitly taken into account as “statistical differences” (see chp. 3.2.6.2.2 Road transportation).

As shown in Figure 3-7, the energy model consists of several sub-models, such as the industry model, the civil aviation model, the road transportation model, the non-road transportation model, and the model of stationary engines and gas turbines. A brief overview of each of these models is given below. However, depending on the scope of these sub-models, they are either described in the corresponding source category chapter or in an overarching chapter preceding the detailed description of the individual source categories. In chapter 3.1.6.3.3, the resulting sectoral disaggregation is shown separately for each fuel type (including the disaggregation of the separate model for wood energy combustion).

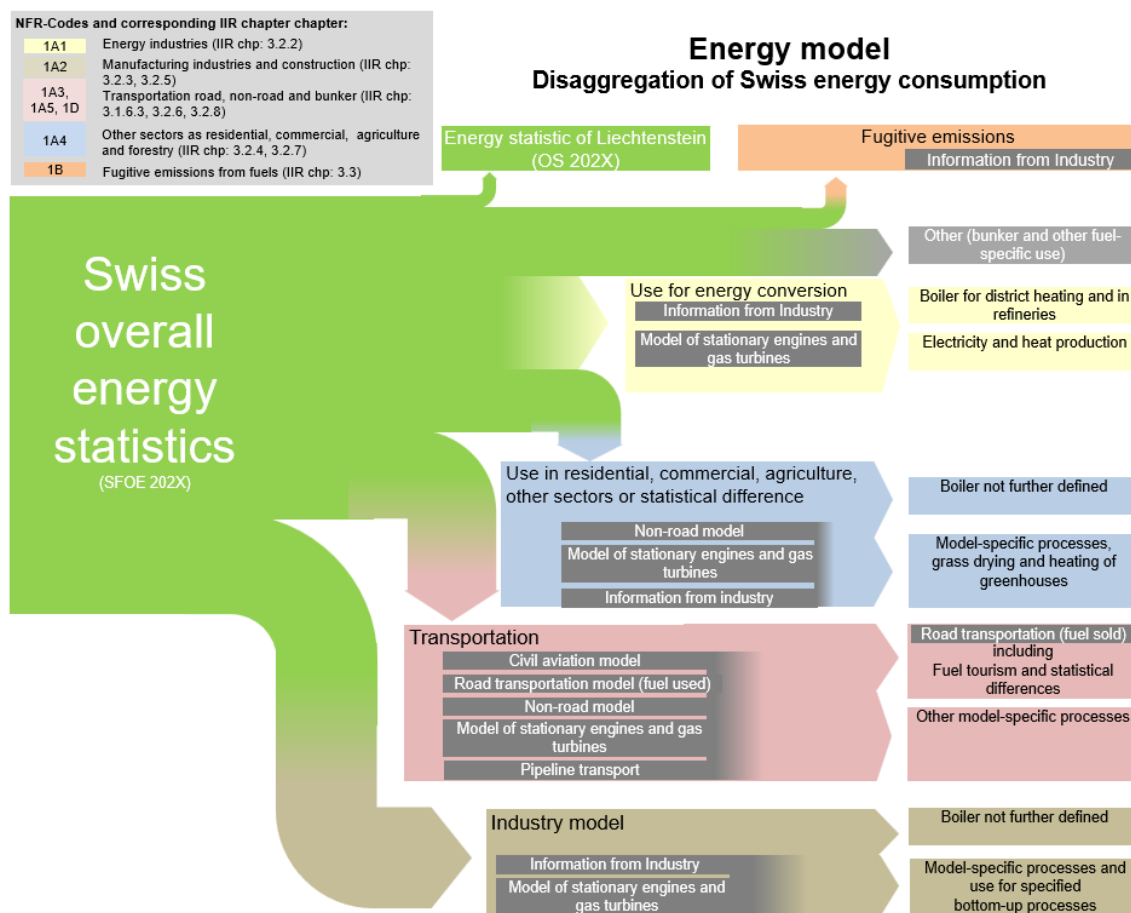


Figure 3-7 Overview of Switzerland's energy model. In the abbreviations SFOE 202X and OS 202X the "X" refers to the latest edition of the respective statistics.

Industry model (Details are given in chp. 3.2.3.2)

The industry model disaggregates the total fuel consumption in the industry sector (SFOE 2025) by source category and fuel type. It is based on the following two pillars. First, the energy consumption statistics in the industry and services sectors (SFOE 2025d) provide a comprehensive annual survey of fuel consumption for all years since 1999 or 2002 (depending on the fuel type). These statistics are consistently extended back to 1990 based on a bottom-up industry model (Prognos 2013). Second, further disaggregation is achieved by using plant-level industry data for specific processes, where available.

Civil aviation model (Details are given in chp. 3.2.6.2.1)

The civil aviation model is developed and updated by the Federal Office for Civil Aviation (FOCA). It aggregates individual aircraft movements according to detailed movement statistics of the Swiss airports. Differentiation between domestic and international aviation is based on the information on the departure and destination of each flight in the movement database.

Road transportation model (Details are given in chp. 3.2.6.2.2)

The road transportation model is a territorial model, accounting for traffic on Swiss territory only. The model is based on detailed vehicle stock data (from the vehicle registration database of the Federal Roads Office FEDRO), mileage per vehicle category differentiated into different driving patterns and specific consumption and emission factors.

Non-road transportation model (Details are given in chp. 3.2.1.1.1)

The non-road transportation model covers all remaining mobile sources, i.e., industrial vehicles, construction machinery, agricultural and forestry machinery, gardening machinery as well as railways, navigation and military vehicles (except for military aviation, which is considered separately, see chp. 3.2.8). The model combines vehicle numbers, their operation hours, engine power, and load factors to derive specific fuel consumption, emission factors and resulting emissions. Data stem from surveys among producers, various user associations, and the national database of non-road vehicles run by FEDRO.

Model of stationary engines and gas turbines (Details are given in chp. 3.2.1.1.2)

The model of stationary engines and gas turbines in 1A Fuel combustion activities is based on an inventory of installed capacities, technologies and operating hours of engines and gas turbines throughout Switzerland (INFRAS 2022a). The inventory is based on a survey with the cantonal authorities, information from websites, annual reports from industry, as well as from direct enquiries with the operators. The fuel consumption per engine and turbine type was derived from the inventory and the emissions are calculated using corresponding emission factors from different references.

Model for wood energy combustion (Details are given in chp. 3.2.1.1.3)

Based on the Swiss wood energy statistics (SFOE 2025b), total wood consumption is disaggregated into source categories (public electricity and heat production, industry, commercial/institutional, residential, agriculture/forestry/fisheries) and into 24 different combustion installations (ranging from open fireplaces to large-scale automatic boiler or heat and power plants). Where available, industry data on wood combustion is taken into account to allocate parts of the wood consumption, as given by the Swiss wood energy statistics, to a specific source category.

3.1.6.3.3 Disaggregation of the energy consumption by source category and fuel types

The energy model, as outlined above, disaggregates total energy consumption as provided by the Swiss overall energy statistics (SFOE 2025) into the relevant source categories 1A1-1A5 (Figure 3-8). For each fuel type, the disaggregation process of the energy model, as shown schematically in Figure 3-7, the interaction between the different sub-models, and additional data sources are visualized separately in Figure 3-9 to Figure 3-18.

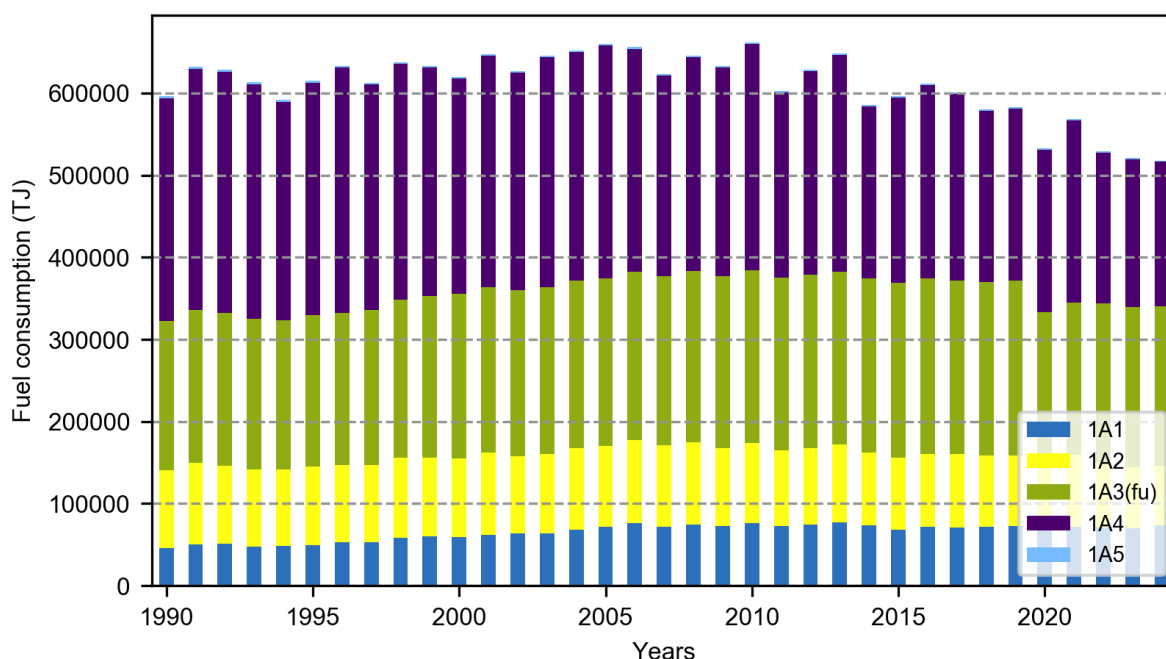


Figure 3-8 Switzerland's energy consumption in the source categories 1A1–1A5 based on the Swiss energy model ("fu" means fuel used approach). Since 1990 population has increased by about one third, industrial production by more than three quarters and the motor vehicle fleet by almost three quarters (SFOE 2025, table 43a).

Starting from the total energy consumption reported in the Swiss overall energy statistics, for each fuel type, the energy is assigned to the relevant source categories based on the various sub-models of the energy model, mentioned above in chp. 3.1.6.3.2. In addition, the following assignments are considered:

- For source category 1A4ci Other sectors – Agriculture/forestry/fishing, specific bottom-up industry information is available for grass drying and the heating of greenhouses. The fuel consumption for grass drying is determined by the Swiss association of grass drying plants (VSTB). Further, based on annual energy consumption data from the Energy Agency of the Swiss Private Sector (EnAW) regarding agricultural greenhouses exempt from the CO₂ levy, total energy consumption of all greenhouses within Switzerland is extrapolated. The respective fuel consumption for grass drying and greenhouses is subtracted from the total fuel consumption of commercial, agriculture and statistical differences (see Figure 3-7).
- In order to report all energy consumption, the statistical differences, as reported in the Swiss overall energy statistics, are allocated to source category 1A4ai Other sectors – Commercial/institutional (stationary combustion) and 1A3bi-iii Road transportation.

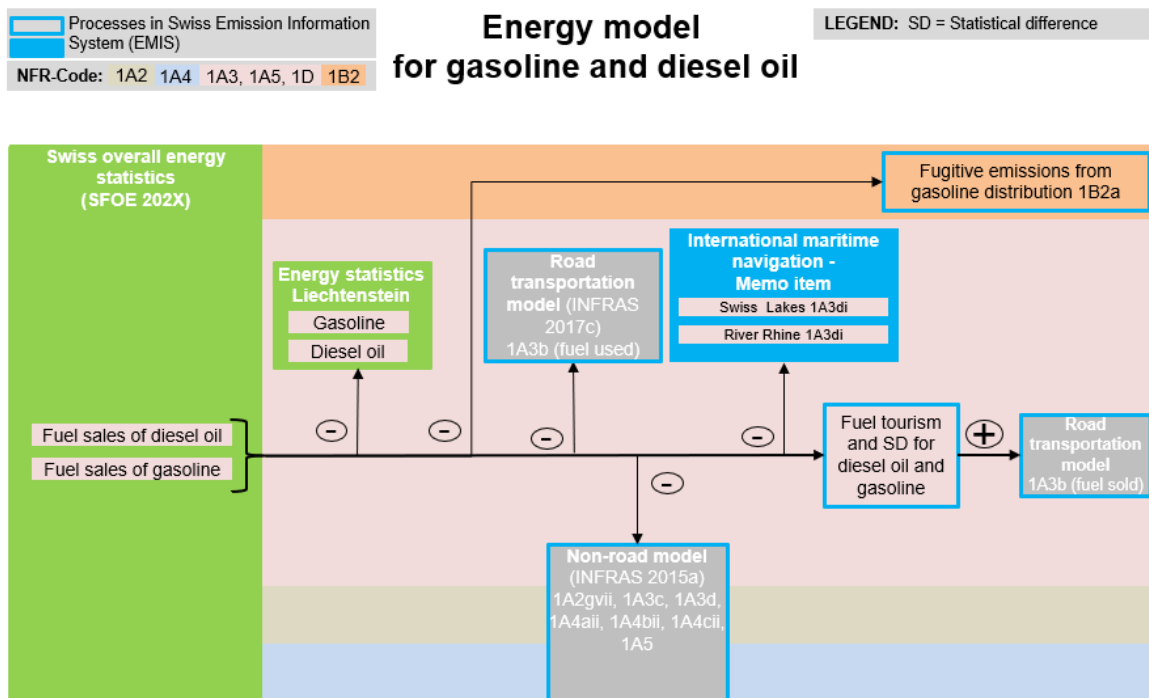


Figure 3-9 Schematic disaggregation of 1A Fuel consumption for gasoline and diesel oil. Marine bunker fuel consumption is based on the national customs statistics (see chapter 3.1.6.1 on memo items).

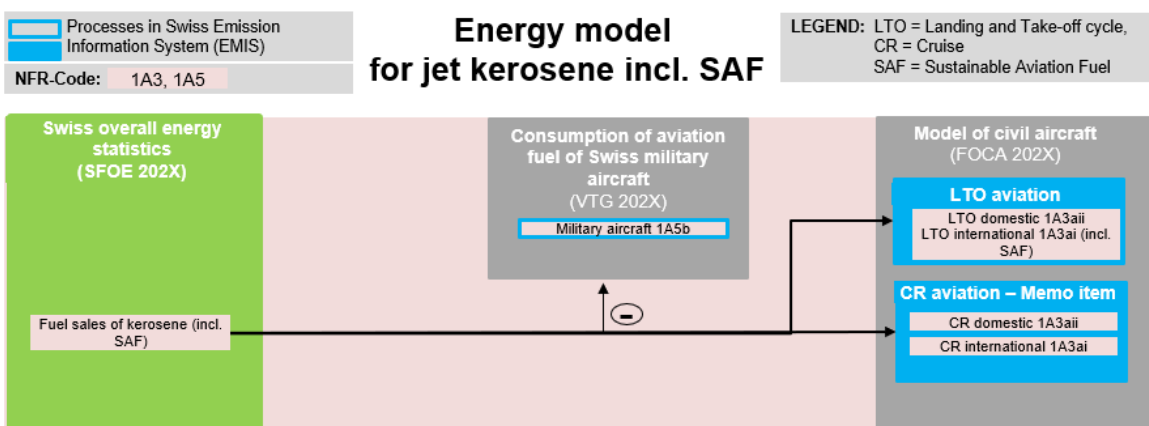


Figure 3-10 Schematic disaggregation of 1A Fuel consumption for jet kerosene. Fuel consumption for military aircraft is provided by the Swiss Air Force (part of the Swiss Armed Forces, VTG). The differentiation between domestic and international aviation as well as between CR and LTO is provided by the civil aviation model (see chp. 3.2.6.2.1).

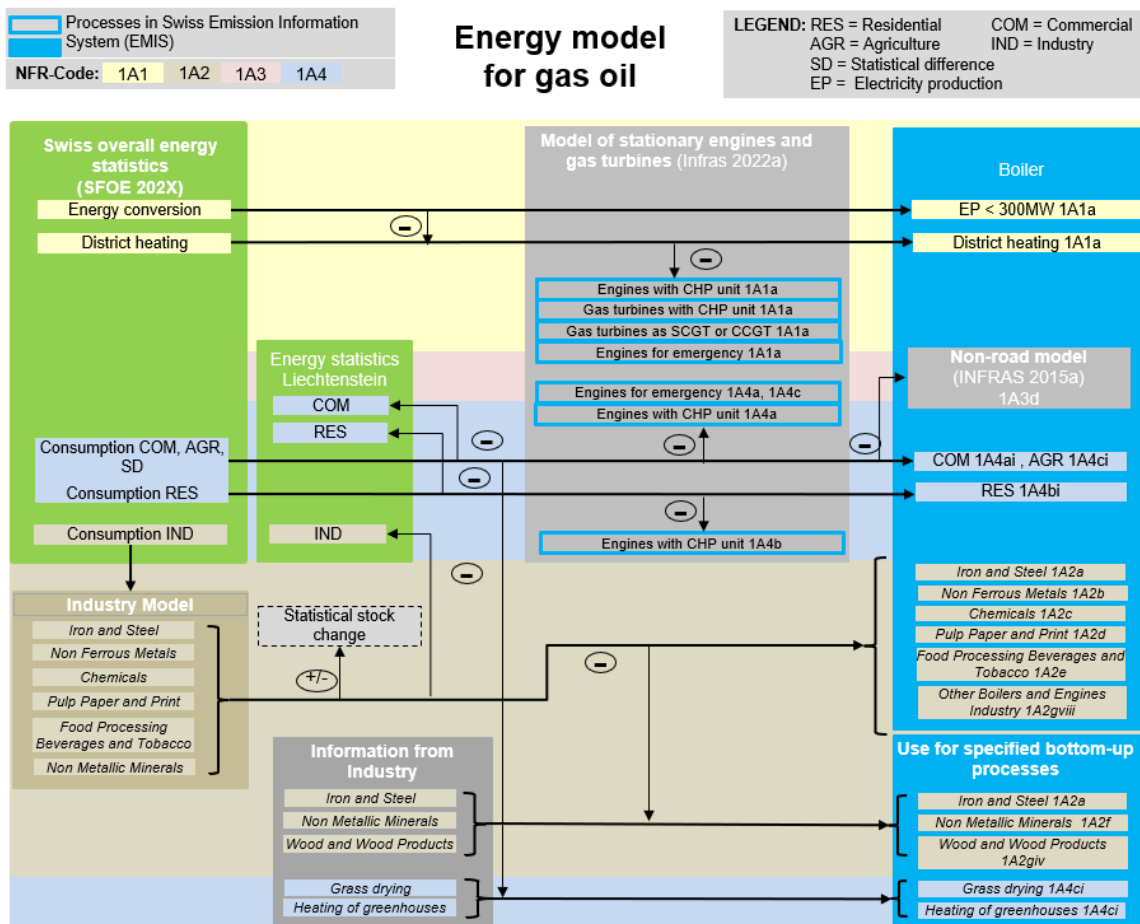


Figure 3-11 Schematic disaggregation of 1A Fuel consumption for gas oil. The Swiss overall energy statistics provide gas oil use for energy conversion and the amount thereof being used for district heating. Based on this information, gas oil use is split into 1A1ai Electricity generation and 1A1aiii Heat plants. According to the non-road model, a small amount of gas oil is consumed in source category 1A3d navigation (steam-powered vessels).

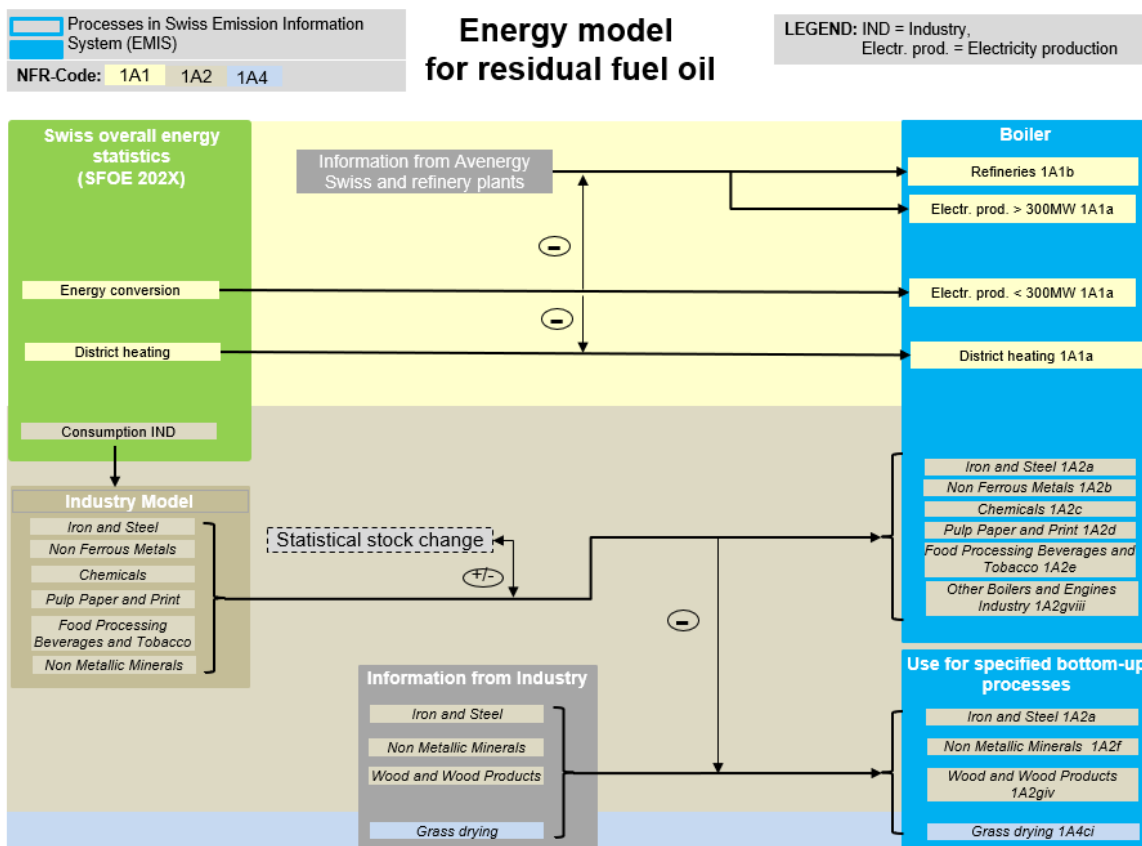


Figure 3-12 Schematic disaggregation of 1A Fuel consumption for residual fuel oil. The Swiss overall energy statistics report residual fuel oil use in energy conversion and the amount thereof consumed in electricity production (one single fossil fuel power station, operational from 1985 to 1994), district heating, and in petroleum refineries. Based on this information, residual fuel oil use in Energy industries is split into 1A1ai Electricity generation, 1A1aiii Heat plants and 1A1b Petroleum refining.

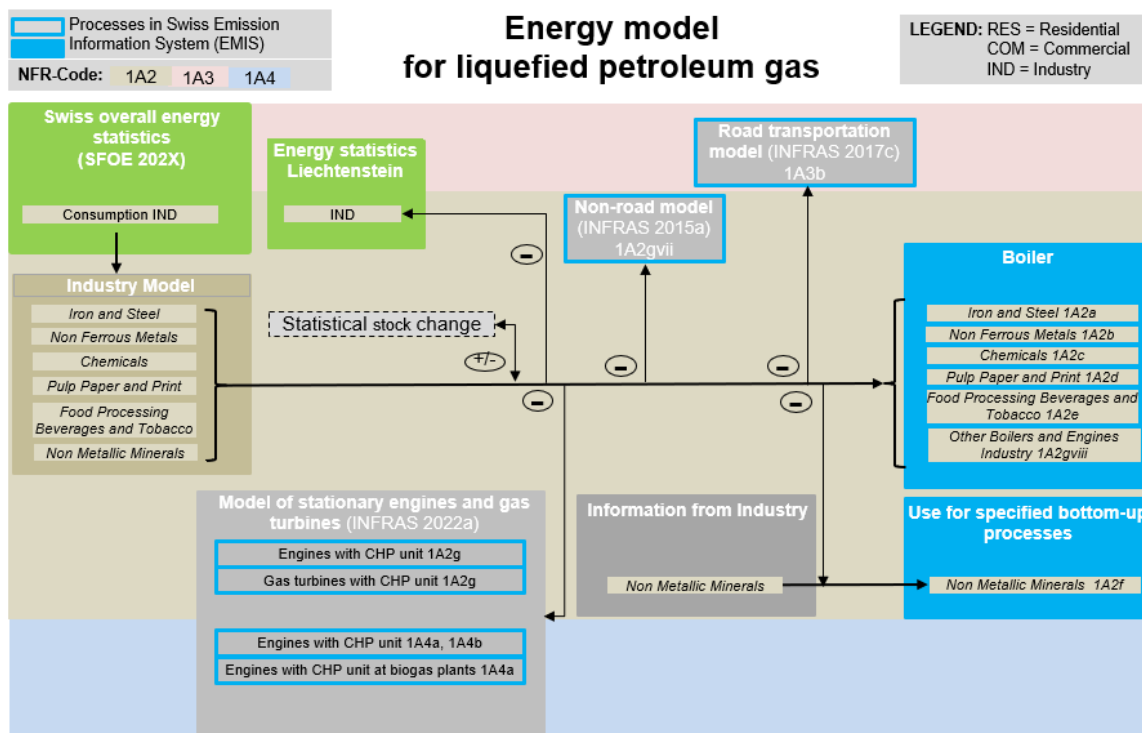


Figure 3-13 Schematic disaggregation of 1A Fuel consumption for liquefied petroleum gas.

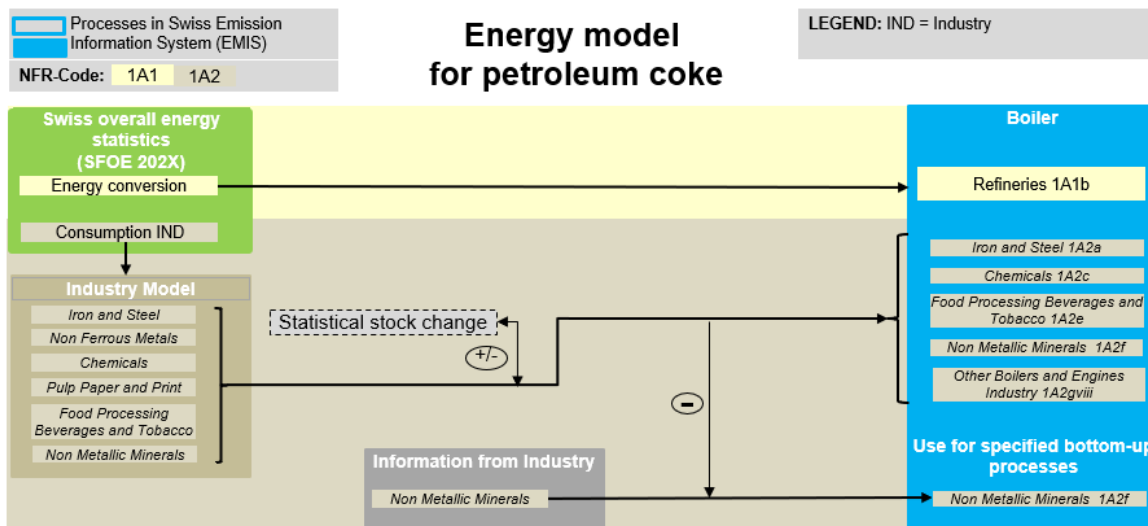


Figure 3-14 Schematic disaggregation of 1A Fuel consumption for petroleum coke.

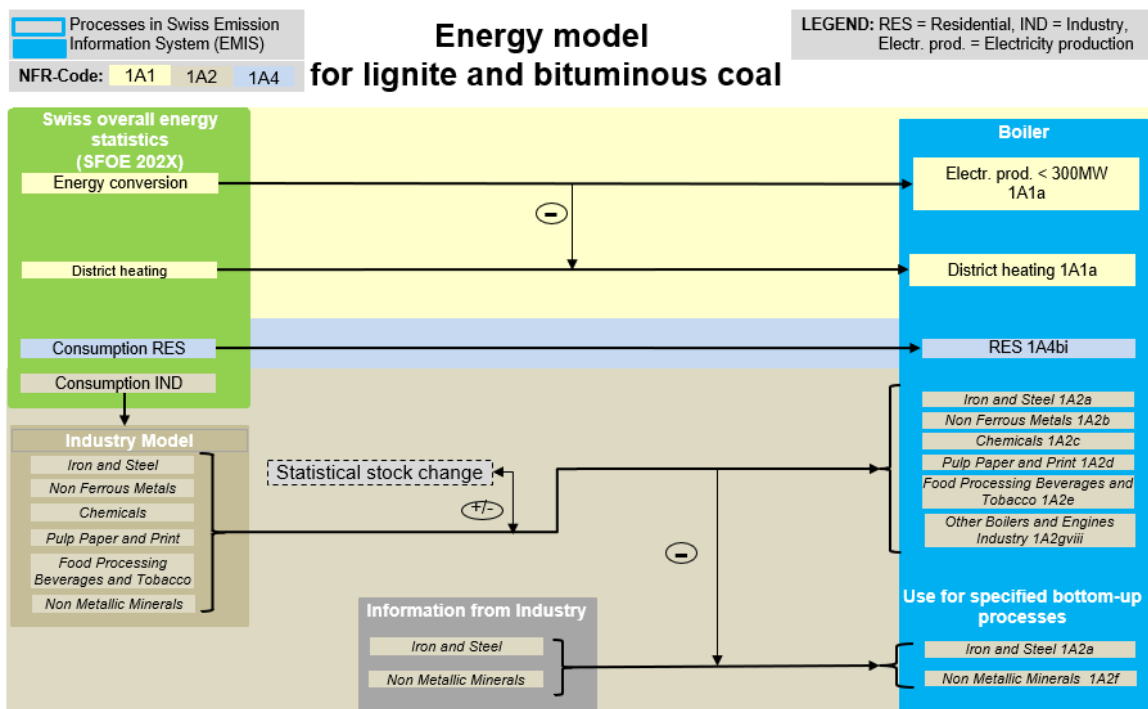


Figure 3-15 Schematic disaggregation of 1A Fuel consumption for lignite and bituminous coal. The Swiss overall energy statistics provide bituminous coal use for energy conversion and the amount thereof being used for district heating. Based on this information, use of bituminous coal in energy industries is split into 1A1ai Electricity generation and 1A1aiii Heat plants up to 1995. Coal consumption for public electricity and heat production ceased thereafter.

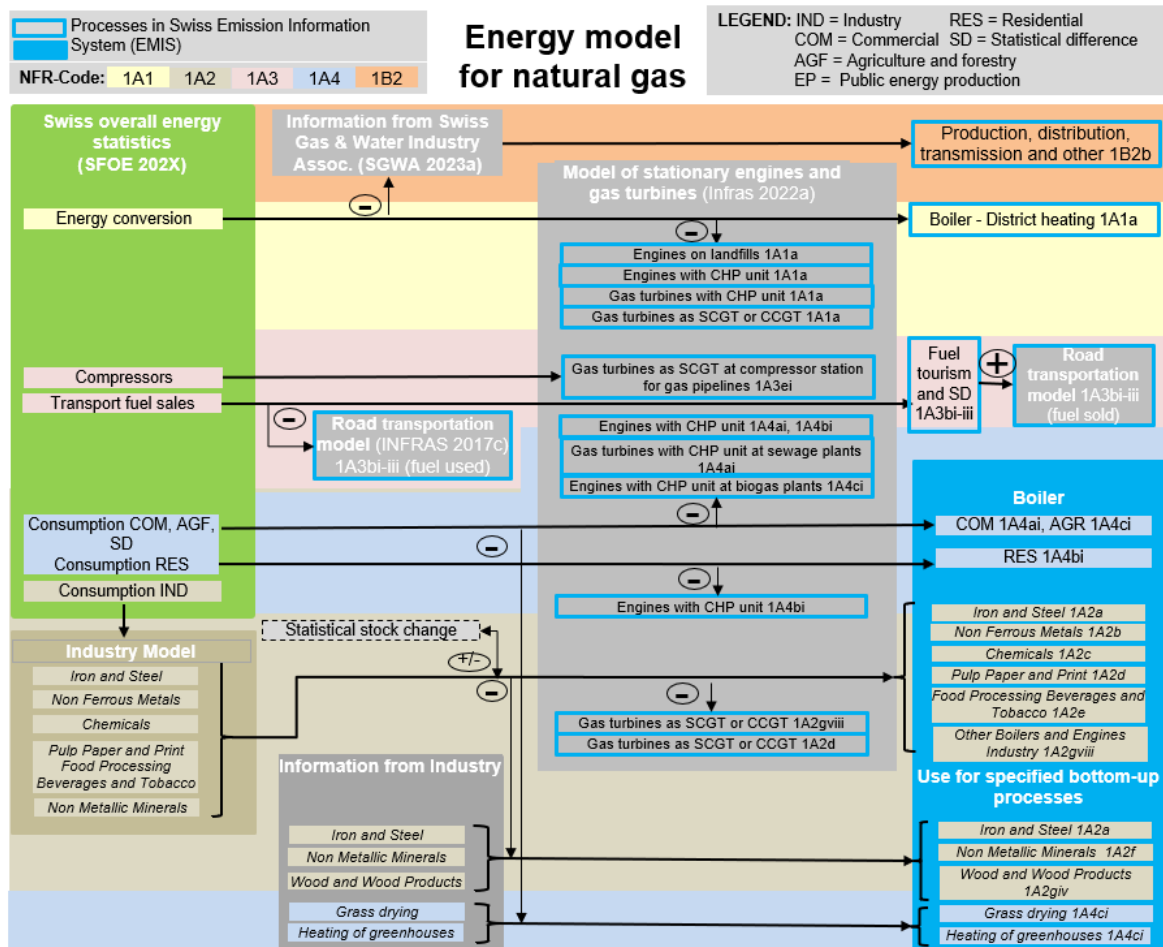


Figure 3-16 Schematic disaggregation of 1A Fuel consumption (and 1B Fugitive emissions from fuels) for natural gas. The Swiss overall energy statistics (SFOE 2025) provide gas use in the transformation sector (energy conversion and distribution losses). Distribution losses as estimated by the Swiss Gas and Water Industry Association SGWA are subtracted and reported under source category 1B2 Fugitive emissions from fuels. The remaining fuel consumption for natural gas is reported under 1A1a Public electricity and heat production.

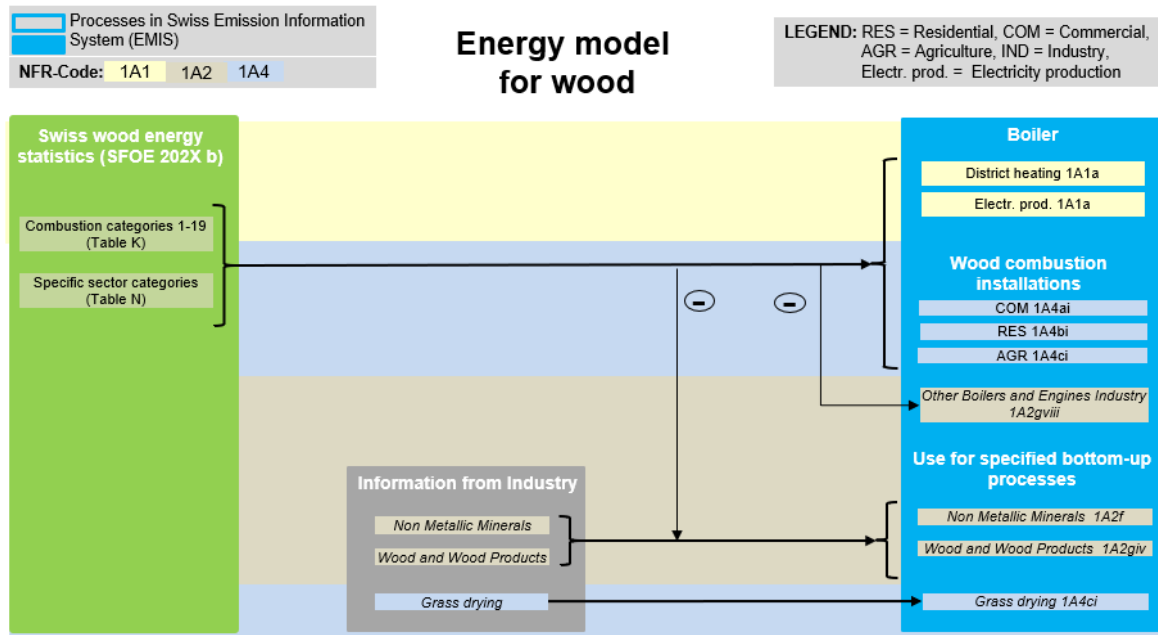


Figure 3-17 Schematic disaggregation of 1A Fuel consumption for wood. For a detailed description of the Energy model for wood combustion, see chapter 3.2.1.1.2.

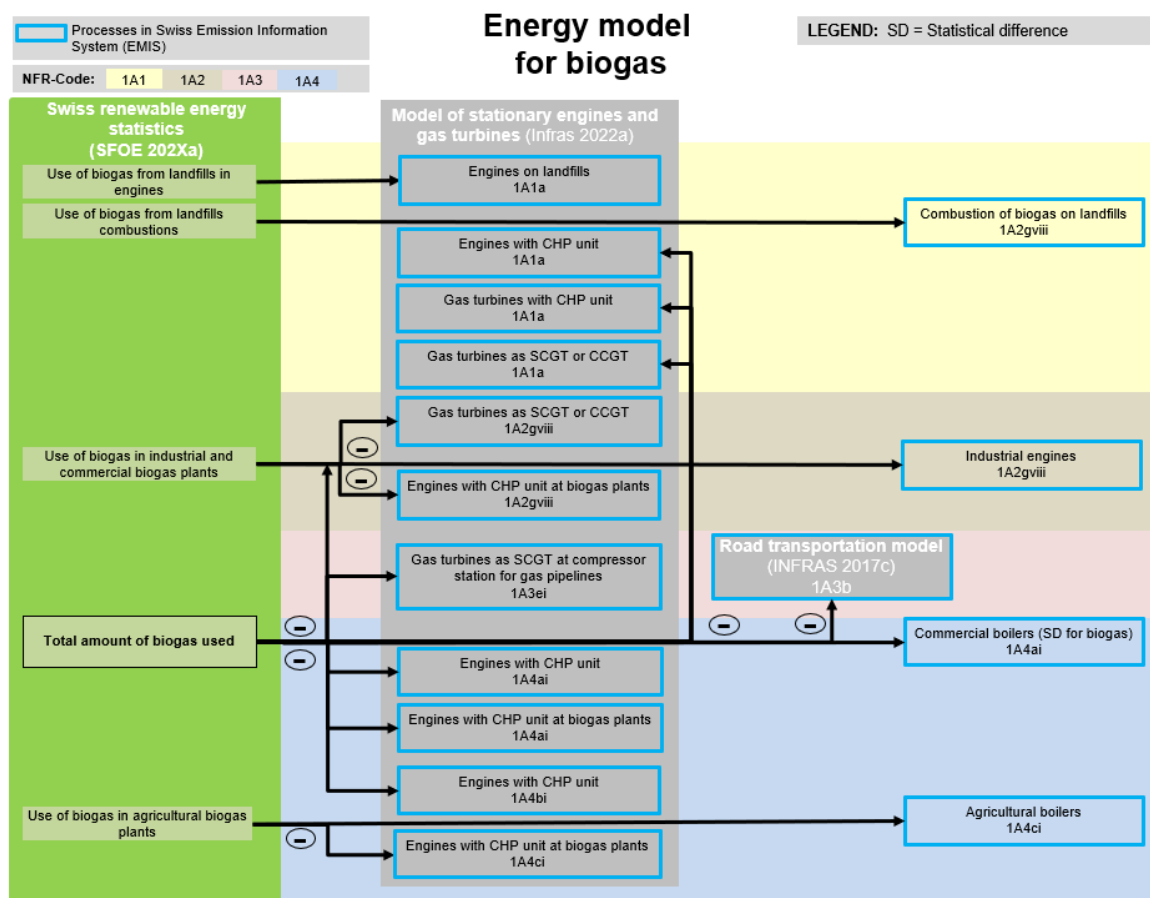


Figure 3-18 Schematic disaggregation of 1A Fuel consumption for biogas.

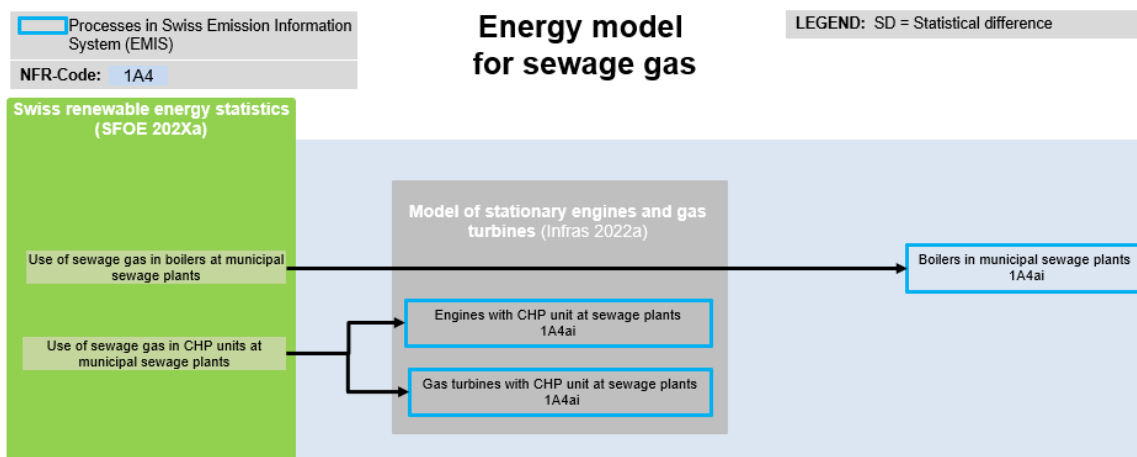


Figure 3-19 Schematic disaggregation of 1A Fuel consumption for sewage gas.

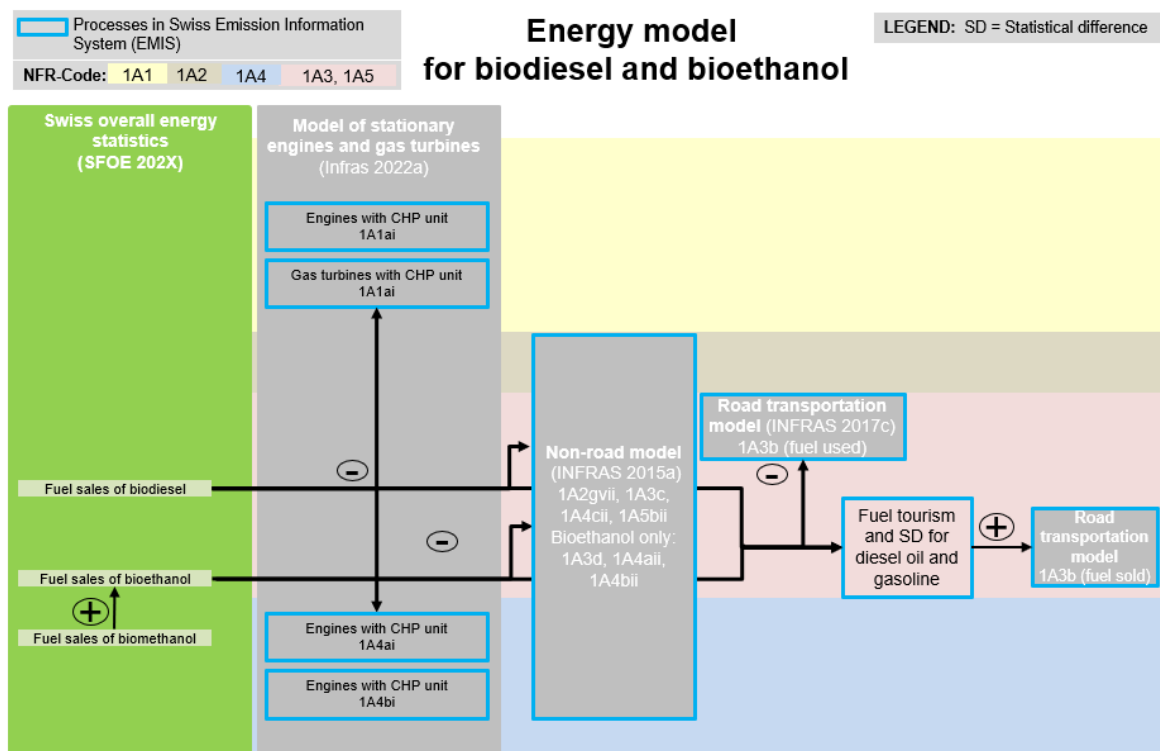


Figure 3-20 Schematic disaggregation of 1A Fuel consumption for biodiesel and bioethanol.

Statistical stock change

For some years, the amount of a fuel reported as sold in the total energy statistics may be less - or more - than the amount actually consumed in the same year, as indicated by bottom-up data. The reason for such deviations is further stocks, which are not taken into consideration at the level of the Swiss energy statistics and are managed at the individual plant level. Some plants manage their own intermediate fuel stocks, which they may carry over for use in later years. To mitigate the difference between less fuel sold (according to the total energy statistics) and fuel used (according to bottom-up information) in one year, so-called “stock shifts” are assumed in the energy model. Stockpiling can only be performed in the years in which more fuel was sold according to total energy statistics than was used based on bottom-up information. Stock which accumulated in such years can be used in later

years to level out the deviations between the total energy statistics and bottom-up data. Currently, stocks are formed in different years for residual fuel oil, petroleum coke and other bituminous coal:

- For residual fuel oil stock was built up in the years 2008-2010, 2014, 2015 and consumed in the years 2011, 2012, 2016-2021.
- For petroleum coke stock was built up in the years 2007, 2018, 2023 and consumed in the years 2008, 2019, 2024.
- For other bituminous coal stock was built up in the years 1991, 1996, 2003, 2005-2007 and consumed in the years 1993, 1994, 1998-2001, 2011, 2012.

3.2 Source category 1A - Fuel combustion activities

3.2.1 Country-specific issues of 1A Fuel combustion

In the following chapter, the general country-specific approach of determining activity data and emission factors is presented. Specific information about each source category is included in the respective chapters 3.2.2 to 3.2.8.

3.2.1.1 Models overlapping more than one source category

3.2.1.1.1 Non-road transportation model (excl. aviation)

Choice of method

For all source categories, for which the non-road transportation model is applied (Table 3-10), the air pollutant emissions are calculated by a Tier 3 method based on the corresponding decision trees given in EMEP/EEA guidebook (EMEP/EEA 2023). The detailed references to the related chapters of the Guidebook are shown in the chps. 3.2.5.2, 3.2.6.2, 3.2.7.2, and 3.2.8.2.

Methodology

The emissions of the non-road sector underwent an extensive revision in 2014/2015. Results are documented in FOEN (2015j). The following non-road categories are considered, all of them including several fuels, technologies, and emission standards.

Table 3-10 Non-road categories (FOEN 2015j) and the corresponding NFR nomenclature (reporting tables).

Non-road categories (by Corinair)	Nomenclature NFR
Construction machinery	1A2gvii Mobile Combustion in manufacturing industries and construction
Industrial machinery	1A2gvii Mobile Combustion in manufacturing industries and construction
Railway machinery	1A3c Railways
Navigation machinery	1A3dii National navigation (shipping)
Garden-care/professional appliances	1A4aii Commercial/institutional: Mobile
Garden-care/hobby appliances	1A4bii Residential: Household and gardening (mobile)
Agricultural machinery	1A4cii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery
Forestry machinery	1A4cii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery
Military machinery (excl. aviation)	1A5b Other, Mobile (including military, land based)

Within each non-road category, the non-road database (INFRAS 2015a) uses the following classification structure:

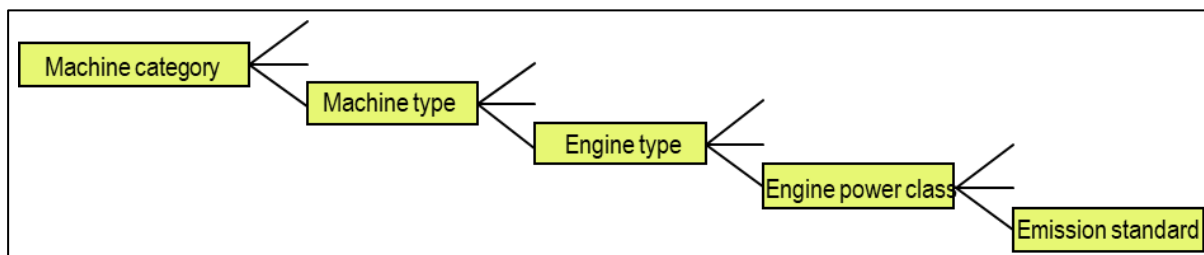


Figure 3-21 Each non-road vehicle is classified by its engine-power class, engine type, machine type, machine category, and emission standard.

The emission modelling is based on activity data and emission factors by means of the following equation, which is implemented at the most disaggregated level (Figure 3-21):

$$Em = N \cdot H \cdot P \cdot \lambda \cdot \varepsilon \cdot CF_1 \cdot CF_2 \cdot CF_3 \dots$$

with

- Em = emission by engine type, pollutant or GHG (in g/a)
- N = number of vehicles (--)
- H = number of operation hours per year (h/a)
- P = engine power output (kW)
- λ = effective load factor (--)
- ε = emission factor (g/kWh), fuel consumption factor (g/kWh)
- CF_1 = correction factor for the effective load (--)
- CF_2 = correction factor for dynamical engine use (--)
- CF_3 = degradation factor due to aging (--)

The same equation also holds for the calculation of the fuel consumption, where ε is the consumption instead of emission factor (in g/kWh) and Em the consumption (in g/a). A more detailed description of the analytical details is given in the Annex of FOEN (2015j).

The total emission and consumption per non-road family is calculated by summing over all classes of the categories included in the families.

The method holds for CO, VOC, NO_x and exhaust particulate matter (PM). For the calculation of emissions of non-regulated air pollutants, the following approaches are applied:

- NMVOC is calculated as a share of VOC dependent on fuel and engine type.
- Further pollutants follow the methodology documented in IFEU (2010) and references therein.

Note that the emissions are only calculated in steps of 5 years from 1980 to 2050. Emissions for the years in between are interpolated linearly.

Emission factors

Emission factors are taken from various sources based on measurements, modelling and literature. SO_x is country-specific, see Table 3-28. For other air pollutants, the main data sources are USEPA (2010), IFEU (2010), EMEP/EEA (2019) and Integer (2013). In general, the following sources are used for the emission factors (if not stated differently in the respective chapters 3.2.5.2, 3.2.6.2, 3.2.7.2 or 3.2.8.2):

- Emission factors for NO_x, VOC/CH₄, CO and exhaust particulate matter (PM) are generally given in FOEN (2015j) and INFRAS (2015a). BC exhaust emission factors stem from Neosys (2013). Considering the measuring procedure and the maximum temperature of 52°C, it can be assumed that PM condensable are also included in the measurements. The installed technology also plays a role in this context (petrol engines with/without catalytic converter, diesel engines with/without particulate filter, etc.).
- Non-exhaust particulate matter (PM) and non-exhaust BC emission factors are based on Carbotech (2000), with some modifications by BUWAL (2001). It should be noted that "PM" in BUWAL (2001) corresponds to total PM, including particles larger than 10 µm. For all non-road mobile machinery sources except rail abrasion, PM10 amounts to 67 % of total PM according to in BUWAL (2001). For rail abrasion, PM10 amounts to 90 % to 100 % of total PM according to in BUWAL (2001). The corresponding factors have been applied in PM10 emission calculation.
- NMVOC is not modelled bottom-up; the NMVOC emissions are calculated as the difference of VOC and CH₄ emissions given in FOEN (2015j) and INFRAS (2015a).
- SO_x emission factors are based upon the sulphur content of fuels (see chp. 3.2.1.2). These are country- and fuel-specific, see implied emission factors in Table 3-28 (column diesel oil, gasoline, natural gas) and in specific tables in the non-road chapters.
- Emission factors for NH₃, priority heavy metals and POPs are generally taken from the EMEP/EEA guidebook (EMEP/EEA 2019). Pb emission factors are estimated based on the Pb content of fuels (according to EMEP/EEA 2023). PCDD/PCDF emissions are taken from Rentz et al. (2008).

Note that all emission factors (in kg/hr) of NO_x, NMVOC, PM (exhaust only; PM2.5 assumed equal to PM10 for combustion particles) and CO can be visualised and downloaded (tables in CSV format) by a query from the online non-road database INFRAS (2015a)⁴. For a detailed description of emission factors and their origin, see tables in the Annex of FOEN (2015j). They can be queried by vehicle type, fuel type, power class and emission standard either at aggregated or disaggregated levels. In Annex A2.1.1 an excerpt of a query is shown to illustrate the results that can be downloaded from the database.

Activity data

Activity data were collected by surveys among producers and several user associations in Switzerland (FOEN 2015j), and by evaluating information from the national database of non-road vehicles (IVZ, formerly MOFIS) run by the Federal Roads Office (FEDRO 2013). In addition, several publications serve as further data source:

- SBV (2013) for construction machinery
- SFSO (2013a) for agricultural machinery
- Jardin Suisse (2012) for garden care /hobby and professional appliances
- KWF (2012) for forestry machinery

⁴ <https://www.bafu.admin.ch/bafu/en/home/topics/air/state/non-road-datenbank.html> [06.02.2025]

- The national statistics on imports/exports of non-road vehicles was assessed by FCA (2015c)
- Off-Highway Research (2005, 2008, 2012) provided information on the number of non-road vehicles.
- Federal Department of Defence, Civil Protection and Sport: List of military machinery with vehicle stock, engine-power classes and operating hours (DDPS 2014a).

From these data sources, all necessary information like size distributions, modelling of the fleets, annual operating hours (age-dependent), load factors, year of placing on the market, and age distribution was derived. Details are documented in FOEN (2015j). All activity data (vehicle stocks, operating hours, consumption factors) can be downloaded by query from the online non-road database INFRAS (2015a), which is the data pool of FOEN (2015j). They can be queried by vehicle type, fuel type, power class and emission standard either at aggregated or disaggregated levels.

In Annex A2.1.2 (Table A - 13) the stock numbers and the operating hours of non-road vehicles are summarised for each non-road category.

For the greenhouse gas inventory under UNFCCC the fossil carbon fraction of biodiesel is estimated based on the method described in Sebos (2022). While all carbon in HVO (Hydrotreated Vegetable Oil) is of biogenic origin, FAME (Fatty Acid Methyl Esters) contains a fossil fraction due to the use of methanol from fossil sources in its production. The shares of FAME and HVO in biodiesel are available from the Swiss overall energy statistics (SFOE 2025). The fossil fraction of FAME depends on the feedstock it is derived from (e.g. rapeseed, soy, palm oil); since the feedstock shares are not captured in the Swiss energy statistics, they are based on European average values from HBEFA 4.1. The resulting overall fossil fraction of biodiesel varies over time – around 4.0 to 5.4 % of total biodiesel are reported under “fossil liquid fuels” as “biodiesel fossil”. For technical reasons in our database, there is a split of the whole biodiesel amount in fossil and biogenic biodiesel and not only for the carbon fraction and CO₂.

3.2.1.1.2 Model of stationary engines and gas turbines

Choice of method

The emissions from stationary engines and gas turbines in 1A Fuel combustion activities are calculated by a Tier 2 method based on chapter 1A1 Energy industries in the EMEP/EEA guidebook (EMEP/EEA 2023).

Methodology

The model for calculating emissions from stationary engines and gas turbines underwent an extensive revision during the years 2021 to 2022 and were finally implemented for the data submission 2024. To calculate the final fuel consumption for each category of stationary engines and gas turbines an inventory of power output values, distribution of exhaust gas technologies, average load factors and operating hours was elaborated. For large installations including engines and gas turbines with combined heat and power generation (CHP) along with gas turbines in simple cycle (SCGT) and combined cycle (CCGT) configuration, the available information was compiled individually for each unit. Most of the information was obtained from the cantonal air pollution control authorities, from publicly accessible websites and annual reports from industry, as well as from direct enquiries to the operators. Further details and results are documented in INFRAS (2022a). Emissions are

calculated using the resulting fuel consumption for each category of stationary engines and gas turbines within 1A – Fuel consumption activities and multiplied with the respective emission factors.

Emission factors

Emission factors are taken from various sources based on measurements, modelling and literature and described in INFRAS (2022a). SO_x is country-specific, see chp. 3.2.1.2, Table 3-30. For other air pollutants, the main data sources are EMEP/EEA (2023), UBA (2020), Norwegian Environment Agency (2020), Ecoinvent (2021), Ebertsch (2021) and Aschmann et al. (2019). The following sources are used for the emission factors of stationary engines and gas turbines, depending on the fuel used:

- Emission factors for NO_x and CO are primarily based on measurements and given in INFRAS 2022a. Exhaust particulate matter (PM) including TSP, PM₁₀ and PM_{2.5} as well as BC exhaust emission factors stem from tables 3-29, 3-30 and 3-31 (Tier 2) of chapter 1A4 Small combustion of the EMEP/EEA guidebook (EMEP/EEA 2023). Considering the measuring procedure and the recommended sample temperature of 160°C, it can be assumed that PM condensable are not included in the measurements.
- NMVOC emissions are calculated as the difference of VOC and CH₄ emissions given in INFRAS (2022a).
- VOC emission factors stem from tables 3-28, 3-29, 3-30 and 3-31 (Tier 2) of chapter 1A4 Small combustion of the EMEP/EEA guidebook (EMEP/EEA 2023).
- CH₄ emission factors originate from table 87 of the National Inventory Report for the German Greenhouse Gas Inventory 1990 – 2018, UBA (2020).
- SO_x emission factors are based upon the sulphur content of fuels (see chp. 3.2.1.2). These are country- and fuel-specific, see implied emission factors in Table 3-30 (column diesel oil, gas oil, natural gas) and in specific tables below.
- Emission factors for NH₃ are generally taken from Ecoinvent (2021) and the Norwegian Environment Agency (2020) for all categories, except for installations with SCR catalysts, where the corresponding limit values were taken as defined in the Federal Ordinance on Air Pollution Control OAPC (Swiss Confederation 1985).
- Emission factors for priority heavy metals, PCDD/PCDF, PAHs as well as HCB and PCB stem from tables 3-28, 3-29, 3-30 and 3-31 (Tier 2) of chapter 1A4 Small combustion of the EMEP/EEA guidebook (EMEP/EEA 2019).

Table 3-11 Emission factors of engines and gas turbines in 1A1 Energy industries.

1A1 Energy industries (Engines and gas turbines)		Unit	NOx	NMVOc	SOx	NH3	PM2.5 ex	PM10 ex	TSP ex	BC ex	CO
			g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
1A1a Gas turbines as SCGT or CCGT	Gas oil	GJ	83	0.18	0.77	0.10	9.5	9.5	9.5	0.32	2.6
1A1a Gas turbines as SCGT or CCGT	Natural gas	GJ	28	1.6	0.43	NA	0.20	0.20	0.20	0.00050	14
1A1a Gas turbines as SCGT or CCGT	Biogas	GJ	48	1.6	0.50	NA	0.20	0.20	0.20	0.00050	14
1A1a Gas turbines with CHP unit	Gas oil	GJ	83	0.18	0.77	0.10	9.5	9.5	9.5	0.32	2.6
1A1a Gas turbines with CHP unit	Natural gas	GJ	31	1.6	0.43	NA	0.23	0.23	0.23	0.00050	10
1A1a Gas turbines with CHP unit	Biodiesel fossil	GJ	83	0.18	0.30	0.10	9.5	9.5	9.5	0.32	2.6
1A1a Gas turbines with CHP unit	Biodiesel biogenic	GJ	83	0.18	0.30	0.10	9.5	9.5	9.5	0.32	2.6
1A1a Gas turbines with CHP unit	Biogas	GJ	48	1.6	0.50	NA	0.23	0.23	0.23	0.00050	10
1A1a Engines with CHP unit	Gas oil	GJ	138	50	0.77	8.9	30	30	30	2.3	136
1A1a Engines with CHP unit	Natural gas	GJ	70	89	0.43	2.7	2.0	2.0	2.0	0.0040	53
1A1a Engines with CHP unit	Biodiesel fossil	GJ	408	50	0.30	3.5	30	30	30	2.3	132
1A1a Engines with CHP unit	Biodiesel biogenic	GJ	408	50	0.30	3.5	30	30	30	2.3	132
1A1a Engines with CHP unit	Biogas	GJ	94	89	0.50	2.7	2.0	2.0	2.0	0.0040	85
1A1a Engines used as emergency generators	Gas oil	GJ	942	50	0.77	0.10	25	25	25	2.3	137
1A1a Engines on landfills	Natural gas	GJ	NO	NO	NO	NO	NO	NO	NO	NO	NO
1A1a Engines on landfills	Biogas	GJ	96	89	0.50	3.2	2.0	2.0	2.0	0.0038	121
1A1b Gas turbines as SCGT at refineries	Refinery gas	GJ	NO	NO	NO	NO	NO	NO	NO	NO	NO

1A1 Energy industries (Engines and gas turbines)		Unit	Pb	Cd	Hg	PCDD/PCDF	BaP	BbF	BkF	IcdP	HCB	PCB
			mg/...	mg/...	mg/...	ng I-Teq/...	mg/...	mg/...	mg/...	mg/...	ng/...	ng/...
1A1a Gas turbines as SCGT or CCGT	Gas oil	GJ	0.012	0.0010	0.12	1.8	NA	NA	NA	NA	NA	NA
1A1a Gas turbines as SCGT or CCGT	Natural gas	GJ	0.0015	0.00025	0.10	0.50	0.00056	0.00084	0.00084	0.00084	NA	NA
1A1a Gas turbines as SCGT or CCGT	Biogas	GJ	0.0015	0.00025	0.10	0.50	0.00056	0.00084	0.00084	0.00084	NA	NA
1A1a Gas turbines with CHP unit	Gas oil	GJ	0.012	0.0010	0.12	1.8	NA	NA	NA	NA	NA	NA
1A1a Gas turbines with CHP unit	Natural gas	GJ	0.0015	0.00025	0.10	0.50	0.00056	0.00084	0.00084	0.00084	NA	NA
1A1a Gas turbines with CHP unit	Biodiesel fossil	GJ	0.012	0.0010	0.12	1.8	NA	NA	NA	NA	NA	NA
1A1a Gas turbines with CHP unit	Biodiesel biogenic	GJ	0.012	0.0010	0.12	1.8	NA	NA	NA	NA	NA	NA
1A1a Gas turbines with CHP unit	Biogas	GJ	0.0015	0.00025	0.10	0.50	0.00056	0.00084	0.00084	0.00084	NA	NA
1A1a Engines with CHP unit	Gas oil	GJ	0.15	0.010	0.11	0.99	0.0019	0.015	0.0017	0.0015	220	0.11
1A1a Engines with CHP unit	Natural gas	GJ	0.040	0.0030	0.10	0.57	0.0012	0.0090	0.0017	0.0018	NA	NA
1A1a Engines with CHP unit	Biodiesel fossil	GJ	0.15	0.010	0.11	0.99	0.0019	0.015	0.0017	0.0015	220	0.11
1A1a Engines with CHP unit	Biodiesel biogenic	GJ	0.15	0.010	0.11	0.99	0.0019	0.015	0.0017	0.0015	220	0.11
1A1a Engines with CHP unit	Biogas	GJ	0.040	0.0030	0.10	0.57	0.0012	0.0090	0.0017	0.0018	NA	NA
1A1a Engines used as emergency generators	Gas oil	GJ	0.15	0.010	0.11	0.99	0.0019	0.015	0.0017	0.0015	220	0.11
1A1a Engines on landfills	Natural gas	GJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1A1a Engines on landfills	Biogas	GJ	0.040	0.0030	0.10	0.57	0.0012	0.0090	0.0017	0.0018	NA	NA
1A1b Gas turbines as SCGT at refineries	Refinery gas	GJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Table 3-12 Emission factors of engines and gas turbines in 1A2 Manufacturing industry and construction.

1A2 Manufacturing industries and construction (Engines and gas turbines)		Unit	NOx	NMVOc	SOx	NH3	PM2.5 ex	PM10 ex	TSP ex	BC ex	CO
			g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
1A2d Gas turbines as SCGT or CCGT	Natural gas	GJ	NO	NO	NO	NO	NO	NO	NO	NO	NO
1A2gviii Gas turbines as SCGT or CCGT	Natural gas	GJ	75	1.6	0.43	NA	0.20	0.20	0.20	0.00050	12
1A2gviii Gas turbines as SCGT or CCGT	Biogas	GJ	48	1.6	0.50	NA	0.20	0.20	0.20	0.00050	12
1A2gviii Gas turbines with CHP unit	Liquefied petroleum gas	GJ	48	1.6	0.50	NA	0.20	0.20	0.20	0.00050	4.8
1A2gviii Engines with CHP unit	Liquefied petroleum gas	GJ	135	89	0.50	NA	2.0	2.0	2.0	0.0050	56
1A2gviii Engines with CHP unit at biogas plants	Biogas	GJ	97	89	0.50	3.9	2.0	2.0	2.0	0.0038	128

1A2 Manufacturing industries and construction (Engines and gas turbines)		Unit	Pb	Cd	Hg	PCDD/PCDF	BaP	BbF	BkF	IcdP	HCB	PCB
			mg/...	mg/...	mg/...	ng I-Teq/...	mg/...	mg/...	mg/...	mg/...	ng/...	ng/...
1A2d Gas turbines as SCGT or CCGT	Natural gas	GJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1A2gviii Gas turbines as SCGT or CCGT	Natural gas	GJ	0.0015	0.00025	0.10	0.50	0.00056	0.00084	0.00084	0.00084	NA	NA
1A2gviii Gas turbines as SCGT or CCGT	Biogas	GJ	0.0015	0.00025	0.10	0.50	0.00056	0.00084	0.00084	0.00084	NA	NA
1A2gviii Gas turbines with CHP unit	Liquefied petroleum gas	GJ	0.0015	0.00025	0.10	0.50	0.00056	0.00084	0.00084	0.00084	NA	NA
1A2gviii Engines with CHP unit	Liquefied petroleum gas	GJ	0.040	0.0030	0.10	0.57	0.0013	0.0090	0.0017	0.0018	NA	NA
1A2gviii Engines with CHP unit at biogas plants	Biogas	GJ	0.040	0.0030	0.10	0.57	0.0012	0.0090	0.0017	0.0018	NA	NA

Table 3-13 Emission factors of engines and gas turbines in 1A3 Transport.

1A3(fu) Transport (Engines and gas turbines)		Unit	NOx	NMVOc	SOx	NH3	PM2.5 ex	PM10 ex	TSP ex	BC ex	CO
			g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
1A3ei Gas turbines at compressor stations for gas pipelines	Natural gas	GJ	29	1.6	0.43	NA	0.20	0.20	0.20	0.00050	12
1A3ei Gas turbines at compressor stations for gas pipelines	Biogas	GJ	48	1.6	0.50	NA	0.20	0.20	0.20	0.00050	12

1A3(fu) Transport (Engines and gas turbines)		Unit	Pb	Cd	Hg	PCDD/PCDF	BaP	BbF	BkF	IcdP	HCB	PCB
			mg/...	mg/...	mg/...	ng I-Teq/...	mg/...	mg/...	mg/...	mg/...	ng/...	ng/...
1A3ei Gas turbines at compressor stations for gas pipelines	Natural gas	GJ	0.0015	0.00025	0.10	0.50	0.00056	0.00084	0.00084	0.00084	NA	NA
1A3ei Gas turbines at compressor stations for gas pipelines	Biogas	GJ	0.0015	0.00025	0.10	0.50	0.00056	0.00084	0.00084	0.00084	NA	NA

Table 3-14 Emission factors of engines and gas turbines in 1A4ai Other sectors: commercial/institutional.

1A4ai Commercial/Institutional Stationary (Engines and gas turbines)		Unit	NOx	NMVOc	SOx	NH3	PM2.5 ex	PM10 ex	TSP ex	BC ex	CO
			g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
1A4ai Engines with CHP unit	Gas oil	GJ	138	50	0.77	8.9	30	30	30	2.3	136
1A4ai Engines with CHP unit	Liquefied petroleum gas	GJ	135	89	0.50	NA	2.0	2.0	2.0	0.0050	56
1A4ai Engines with CHP unit	Natural gas	GJ	70	89	0.43	2.7	2.0	2.0	2.0	0.0040	53
1A4ai Engines with CHP unit	Biodiesel fossil	GJ	408	50	0.30	3.5	30	30	30	2.3	132
1A4ai Engines with CHP unit	Biodiesel biogenic	GJ	408	50	0.30	3.5	30	30	30	2.3	132
1A4ai Engines with CHP unit	Biogas	GJ	94	89	0.50	2.7	2.0	2.0	2.0	0.0040	85
1A4ai Engines with CHP unit at biogas plants	Liquefied petroleum gas	GJ	NO	NO	NO	NO	NO	NO	NO	NO	NO
1A4ai Engines with CHP unit at biogas plants	Biodiesel fossil	GJ	158	50	0.30	8.7	30	30	30	2.3	136
1A4ai Engines with CHP unit at biogas plants	Biodiesel biogenic	GJ	158	50	0.30	8.7	30	30	30	2.3	136
1A4ai Engines with CHP unit at biogas plants	Biogas	GJ	97	89	0.50	3.9	2.0	2.0	2.0	0.0038	128
1A4ai Engines used as emergency generators	Gas oil	GJ	902	50	0.77	0.54	13	13	13	2.3	137
1A4ai Gas turbines at sewage plants	Natural gas	GJ	53	1.6	0.43	NA	0.20	0.20	0.20	0.00050	25
1A4ai Gas turbines at sewage plants	Sewage gas	GJ	48	1.6	0.50	NA	0.23	0.23	0.23	0.00050	10
1A4ai Engines with CHP unit at sewage plants	Natural gas	GJ	310	89	0.43	NA	2.0	2.0	2.0	0.0050	76
1A4ai Engines with CHP unit at sewage plants	Sewage gas	GJ	100	89	0.50	2.1	2.0	2.0	2.0	0.0041	138

1A4ai Commercial/Institutional Stationary (Engines and gas turbines)		Unit	Pb	Cd	Hg	PCDD/PCDF	BaP	BbF	BkF	IcdP	HCB	PCB
			mg/...	mg/...	mg/...	ng I-Teq/...	mg/...	mg/...	mg/...	mg/...	ng/...	ng/...
1A4ai Engines with CHP unit	Gas oil	GJ	0.15	0.010	0.11	0.99	0.0019	0.015	0.0017	0.0015	220	0.11
1A4ai Engines with CHP unit	Liquefied petroleum gas	GJ	0.040	0.0030	0.10	0.57	0.0013	0.0090	0.0017	0.0018	NA	NA
1A4ai Engines with CHP unit	Natural gas	GJ	0.040	0.0030	0.10	0.57	0.0012	0.0090	0.0017	0.0018	NA	NA
1A4ai Engines with CHP unit	Biodiesel fossil	GJ	0.15	0.010	0.11	0.99	0.0019	0.015	0.0017	0.0015	220	0.11
1A4ai Engines with CHP unit	Biodiesel biogenic	GJ	0.15	0.010	0.11	0.99	0.0019	0.015	0.0017	0.0015	220	0.11
1A4ai Engines with CHP unit	Biogas	GJ	0.040	0.0030	0.10	0.57	0.0012	0.0090	0.0017	0.0018	NA	NA
1A4ai Engines with CHP unit at biogas plants	Liquefied petroleum gas	GJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1A4ai Engines with CHP unit at biogas plants	Biodiesel fossil	GJ	0.15	0.010	0.11	0.99	0.0019	0.015	0.0017	0.0015	220	0.11
1A4ai Engines with CHP unit at biogas plants	Biodiesel biogenic	GJ	0.15	0.010	0.11	0.99	0.0019	0.015	0.0017	0.0015	220	0.11
1A4ai Engines with CHP unit at biogas plants	Biogas	GJ	0.040	0.0030	0.10	0.57	0.0012	0.0090	0.0017	0.0018	NA	NA
1A4ai Engines used as emergency generators	Gas oil	GJ	0.15	0.010	0.11	0.99	0.0019	0.015	0.0017	0.0015	220	0.11
1A4ai Gas turbines at sewage plants	Natural gas	GJ	0.0015	0.00025	0.10	0.50	0.00056	0.00084	0.00084	0.00084	NA	NA
1A4ai Gas turbines at sewage plants	Sewage gas	GJ	0.0015	0.00025	0.10	0.50	0.00056	0.00084	0.00084	0.00084	NA	NA
1A4ai Engines with CHP unit at sewage plants	Natural gas	GJ	0.040	0.0030	0.10	0.57	0.0012	0.0090	0.0017	0.0018	NA	NA
1A4ai Engines with CHP unit at sewage plants	Sewage gas	GJ	0.040	0.0030	0.10	0.57	0.0012	0.0090	0.0017	0.0018	NA	NA

Table 3-15 Emission factors of engines and gas turbines in 1A4bi Other sectors: residential.

1A4bi Residential Stationary (Engines and gas turbines)		Unit	NOx	NMVOc	SOx	NH3	PM2.5 ex	PM10 ex	TSP ex	BC ex	CO
			g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
1A4bi Engines with CHP unit	Gas oil	GJ	138	50	0.77	8.9	30	30	30	2.3	136
1A4bi Engines with CHP unit	Liquefied petroleum gas	GJ	135	89	0.50	NA	2.0	2.0	2.0	0.0050	56
1A4bi Engines with CHP unit	Natural gas	GJ	70	89	0.43	2.7	2.0	2.0	2.0	0.0040	53
1A4bi Engines with CHP unit	Biodiesel fossil	GJ	408	50	0.30	3.5	30	30	30	2.3	132
1A4bi Engines with CHP unit	Biodiesel biogenic	GJ	408	50	0.30	3.5	30	30	30	2.3	132
1A4bi Engines with CHP unit	Biogas	GJ	94	89	0.50	2.7	2.0	2.0	2.0	0.0040	85

1A4bi Residential Stationary (Engines and gas turbines)		Unit	Pb	Cd	Hg	PCDD/PCDF	BaP	BbF	BkF	IcdP	HCB	PCB
			mg/...	mg/...	mg/...	ng I-Teq/...	mg/...	mg/...	mg/...	mg/...	ng/...	ng/...
1A4bi Engines with CHP unit	Gas oil	GJ	0.15	0.010	0.11	0.99	0.0019	0.015	0.0017	0.0015	220	0.11
1A4bi Engines with CHP unit	Liquefied petroleum gas	GJ	0.040	0.0030	0.10	0.57	0.0013	0.0090	0.0017	0.0018	NA	NA
1A4bi Engines with CHP unit	Natural gas	GJ	0.040	0.0030	0.10	0.57	0.0012	0.0090	0.0017	0.0018	NA	NA
1A4bi Engines with CHP unit	Biodiesel fossil	GJ	0.15	0.010	0.11	0.99	0.0019	0.015	0.0017	0.0015	220	0.11
1A4bi Engines with CHP unit	Biodiesel biogenic	GJ	0.15	0.010	0.11	0.99	0.0019	0.015	0.0017	0.0015	220	0.11
1A4bi Engines with CHP unit	Biogas	GJ	0.040	0.0030	0.10	0.57	0.0012	0.0090	0.0017	0.0018	NA	NA

Table 3-16 Emission factors of engines and gas turbines in 1A4ci Other sectors: agriculture/forestry/fishing.

1A4ci Agriculture/Forestry/Fishing Stationary (Engines and gas turbines)		Unit	NOx	NMVOc	SOx	NH3	PM2.5 ex	PM10 ex	TSP ex	BC ex	CO
			g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
1A4ci Engines used as emergency generators	Gas oil	GJ	942	50	0.77	0.10	27	27	27	2.3	137
1A4ci Engines with CHP unit at biogas plants	Natural gas	GJ	NO	NO	NO	NO	NO	NO	NO	NO	NO
1A4ci Engines with CHP unit at biogas plants	Biogas	GJ	95	89	0.50	3.4	2.0	2.0	2.0	0.0037	104

1A4ci Agriculture/Forestry/Fishing Stationary (Engines and gas turbines)		Unit	Pb	Cd	Hg	PCDD/PCDF	BaP	BbF	BkF	IcdP	HCB	PCB
			mg/...	mg/...	mg/...	ng I-Teq/...	mg/...	mg/...	mg/...	mg/...	ng/...	ng/...
1A4ci Engines used as emergency generators	Gas oil	GJ	0.15	0.010	0.11	0.99	0.0019	0.015	0.0017	0.0015	220	0.11
1A4ci Engines with CHP unit at biogas plants	Natural gas	GJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1A4ci Engines with CHP unit at biogas plants	Biogas	GJ	0.040	0.0030	0.10	0.57	0.0012	0.0090	0.0017	0.0018	NA	NA

Activity data

Activity data were collected by surveys among the cantonal air pollution control authorities. For engines used as emergency generators, their proof of gas oil use, which is deposited with the Federal Office for Customs and Border Security (FOCBS), were the most important source of data. Furthermore, the statistics by the SFOE about the thermal electricity production including combined heat and power generation (CHP) in Switzerland (SFOE 2021c) served as the basis for activity data modelling. For large installations including engines as well as simple cycle gas turbines (SCGT) and combined cycle gas turbines (CCGT), the websites and annual reports of the operators provided informative information on technical data, operating hours or fuel consumption. From these data sources, all necessary information like modelling of the quantity of installations, annual operating hours, load factors and rated thermal input were derived. Details are documented in INFRAS (2022a).

The activity data of engines using landfill gas in 1A1a Public electricity and heat production, engines using biogas in 1A2gviii Other - Manufacturing industries, 1A4ai Other – Commercial/institutional and 1A4ci Other – Agriculture/forestry /fishing, as well as gas turbines at the compressor station in 1A3ei Pipeline transport using natural gas are updated annually with newest available information concerning fuel consumption from SFOE 2025a and SFOE 2025, respectively.

For the greenhouse gas inventory under UNFCCC the fossil carbon fraction of biodiesel is estimated based on the method described in Sebos (2022). While all carbon in HVO (Hydrotreated Vegetable Oil) is of biogenic origin, FAME (Fatty Acid Methyl Esters) contains a fossil fraction due to the use of methanol from fossil sources in its production. The shares of FAME and HVO in biodiesel are available from the Swiss overall energy statistics (SFOE 2025). The fossil fraction of FAME depends on the feedstock it is derived from (e.g. rapeseed, soy, palm oil); since the feedstock shares are not captured in the Swiss energy statistics, they are based on European average values from HBEFA 4.1. The resulting overall fossil fraction of biodiesel varies over time – around 4.0 to 5.4 % of total biodiesel are reported under “fossil liquid fuels” as “biodiesel fossil”. For technical reasons in our database, there is a split of the whole biodiesel amount in fossil and biogenic biodiesel and not only for the carbon fraction and CO₂.

Natural gas also includes the consumed amount of liquefied natural gas (LNG) as supplied by the Swiss overall energy statistics (SFOE 2025).

Table 3-17 Activity data of engines and gas turbines in 1A1 Energy industries.

1A1 Energy industries (Engines and gas turbines)		Unit	1990	1995	2000	2005	2010						
Total fuel consumption		TJ	421	1'907	4'851	4'647	5'088						
1A1a Gas turbines as SCGT or CCGT	Gas oil	TJ	24	33	33	33	33						
1A1a Gas turbines as SCGT or CCGT	Natural gas	TJ	3.5	779	840	1'110	2'410						
1A1a Gas turbines as SCGT or CCGT	Biogas	TJ	NO	NO	NO	NO	NO						
1A1a Gas turbines with CHP unit	Gas oil	TJ	6.7	3.6	NO	8.1	3.6						
1A1a Gas turbines with CHP unit	Natural gas	TJ	66	31	NO	39	42						
1A1a Gas turbines with CHP unit	Biodiesel fossil	TJ	NO	NO	NO	0.0049	0.028						
1A1a Gas turbines with CHP unit	Biodiesel biogenic	TJ	NO	NO	NO	0.096	0.61						
1A1a Gas turbines with CHP unit	Biogas	TJ	NO	NO	NO	NO	NO						
1A1a Engines with CHP unit	Gas oil	TJ	7.5	47	179	167	55						
1A1a Engines with CHP unit	Natural gas	TJ	73	405	655	799	661						
1A1a Engines with CHP unit	Biodiesel fossil	TJ	NO	NO	NO	0.10	0.44						
1A1a Engines with CHP unit	Biodiesel biogenic	TJ	NO	NO	NO	2.0	9.5						
1A1a Engines with CHP unit	Biogas	TJ	NO	NO	NO	NO	NO						
1A1a Engines used as emergency generators	Gas oil	TJ	1.4	1.4	1.5	1.5	1.6						
1A1a Engines on landfills	Natural gas	TJ	NO	NO	NO	14	14						
1A1a Engines on landfills	Biogas	TJ	238	609	568	204	49						
1A1b Gas turbines as SCGT at refineries	Refinery gas	TJ	NO	NO	2'575	2'270	1'808						
1A1 Energy industries (Engines and gas turbines)		Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
Total fuel consumption		TJ	3'213	4'709	3'748	3'643	3'649	3'566	3'668	3'834	3'846	4'053	
1A1a Gas turbines as SCGT or CCGT	Gas oil	TJ	33	33	33	33	33	7.2	7.4	7.7	7.8	8.2	
1A1a Gas turbines as SCGT or CCGT	Natural gas	TJ	2'306	4'154	3'245	3'208	3'260	3'208	3'192	3'331	3'337	3'515	
1A1a Gas turbines as SCGT or CCGT	Biogas	TJ	NO	NO	NO	NO	NO	NO	110	121	130	144	
1A1a Gas turbines with CHP unit	Gas oil	TJ	0.59	0.29	0.20	0.12	0.16	0.16	0.16	0.16	0.15	0.15	
1A1a Gas turbines with CHP unit	Natural gas	TJ	12	6.5	3.5	3.2	2.8	2.7	2.8	2.9	2.9	3.0	
1A1a Gas turbines with CHP unit	Biodiesel fossil	TJ	0.010	0.0048	0.0028	0.0024	0.0025	0.0026	0.0029	0.0030	0.0029	0.0030	
1A1a Gas turbines with CHP unit	Biodiesel biogenic	TJ	0.18	0.100	0.062	0.055	0.054	0.053	0.053	0.054	0.053	0.054	
1A1a Gas turbines with CHP unit	Biogas	TJ	NO	NO	NO	NO	NO	0.089	0.096	0.11	0.11	0.12	
1A1a Engines with CHP unit	Gas oil	TJ	25	21	24	14	18	18	18	18	17	17	
1A1a Engines with CHP unit	Natural gas	TJ	513	473	426	370	319	307	315	327	325	338	
1A1a Engines with CHP unit	Biodiesel fossil	TJ	0.42	0.35	0.35	0.28	0.28	0.29	0.32	0.34	0.33	0.34	
1A1a Engines with CHP unit	Biodiesel biogenic	TJ	7.5	7.3	7.6	6.4	6.1	6.0	6.0	6.1	5.9	6.1	
1A1a Engines with CHP unit	Biogas	TJ	NO	NO	NO	NO	NO	10	11	12	13	14	
1A1a Engines used as emergency generators	Gas oil	TJ	1.7	1.7	1.7	1.8	1.8	1.7	1.8	1.8	1.8	1.9	
1A1a Engines on landfills	Natural gas	TJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
1A1a Engines on landfills	Biogas	TJ	21	12	6.5	6.0	8.4	4.0	4.0	5.0	4.4	4.5	
1A1b Gas turbines as SCGT at refineries	Refinery gas	TJ	293	NO	NO	NO	NO	NO	NO	NO	NO	NO	

Table 3-18 Activity data of engines and gas turbines in 1A2 Manufacturing industry and construction.

1A2 Manufacturing industries and construction (Engines and gas turbines)		Unit	1990	1995	2000	2005	2010						
Total fuel consumption		TJ	655	1'298	1'777	1'478	1'799						
1A2d Gas turbines as SCGT or CCGT	Natural gas	TJ	NO	477	808	245	211						
1A2gviii Gas turbines as SCGT or CCGT	Natural gas	TJ	613	721	810	1073	1'355						
1A2gviii Gas turbines as SCGT or CCGT	Biogas	TJ	NO	NO	NO	NO	NO						
1A2gviii Gas turbines with CHP unit	Liquefied petroleum gas	TJ	0.68	0.87	NO	1.5	2.3						
1A2gviii Engines with CHP unit	Liquefied petroleum gas	TJ	0.75	11	33	30	35						
1A2gviii Engines with CHP unit at biogas plants	Biogas	TJ	41	87	126	128	195						
1A2 Manufacturing industries and construction (Engines and gas turbines)		Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
Total fuel consumption		TJ	770	451	415	353	354	346	363	398	372	389	
1A2d Gas turbines as SCGT or CCGT	Natural gas	TJ	341	NO	NO	NO	NO	NO	NO	NO	NO	NO	
1A2gviii Gas turbines as SCGT or CCGT	Natural gas	TJ	145	145	145	145	145	145	144	150	151	159	
1A2gviii Gas turbines as SCGT or CCGT	Biogas	TJ	NO	NO	NO	NO	NO	NO	5.0	5.5	5.9	6.5	
1A2gviii Gas turbines with CHP unit	Liquefied petroleum gas	TJ	0.66	0.54	0.12	0.081	0.066	0.064	0.063	0.064	0.064	0.063	
1A2gviii Engines with CHP unit	Liquefied petroleum gas	TJ	28	39	14	9.4	7.4	7.3	7.3	7.5	7.3	7.4	
1A2gviii Engines with CHP unit at biogas plants	Biogas	TJ	256	267	256	199	201	194	206	235	208	217	

Table 3-19 Activity data of engines and gas turbines in 1A3 Transport.

1A3(fu) Transport (Engines and gas turbines)		Unit	1990	1995	2000	2005	2010						
Total fuel consumption		TJ	560	310	340	1'070	830						
1A3ei Gas turbines at compressor stations for gas pipelines	Natural gas	TJ	560	310	340	1'070	830						
1A3ei Gas turbines at compressor stations for gas pipelines	Biogas	TJ	NO	NO	NO	NO	NO						
1A3(fu) Transport (Engines and gas turbines)		Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
Total fuel consumption		TJ	760	340	470	490	600	540	138	420	192	34	
1A3ei Gas turbines at compressor stations for gas pipelines	Natural gas	TJ	760	340	470	490	600	540	120	400	170	10	
1A3ei Gas turbines at compressor stations for gas pipelines	Biogas	TJ	NO	NO	NO	NO	NO	NO	18	20	22	24	

Table 3-20 Activity data of engines and gas turbines in 1A4a Other sectors: commercial/institutional.

1A4ai Commercial/Institutional Stationary (Engines and gas turbines)		Unit	1990	1995	2000	2005	2010					
Total fuel consumption		TJ	1'572	2'973	4'524	5'062	4'603					
1A4ai Engines with CHP unit	Gas oil	TJ	44	171	580	539	178					
1A4ai Engines with CHP unit	Liquefied petroleum gas	TJ	2.4	36	103	95	109					
1A4ai Engines with CHP unit	Natural gas	TJ	355	1'407	2'169	2'596	2'089					
1A4ai Engines with CHP unit	Biodiesel fossil	TJ	NO	NO	NO	0.32	1.4					
1A4ai Engines with CHP unit	Biodiesel biogenic	TJ	NO	NO	NO	6.2	30					
1A4ai Engines with CHP unit	Biogas	TJ	NO	NO	NO	NO	NO					
1A4ai Engines with CHP unit at biogas plants	Liquefied petroleum gas	TJ	NO	2.9	5.6	NO	NO					
1A4ai Engines with CHP unit at biogas plants	Biodiesel fossil	TJ	NO	NO	1.3	0.068	1.1					
1A4ai Engines with CHP unit at biogas plants	Biodiesel biogenic	TJ	NO	NO	25	1.3	24					
1A4ai Engines with CHP unit at biogas plants	Biogas	TJ	NO	29	82	143	394					
1A4ai Engines used as emergency generators	Gas oil	TJ	383	383	391	396	405					
1A4ai Gas turbines at sewage plants	Natural gas	TJ	NO	0.23	0.073	NO	0.019					
1A4ai Gas turbines at sewage plants	Sewage gas	TJ	179	169	66	NO	18					
1A4ai Engines with CHP unit at sewage plants	Natural gas	TJ	NO	1.0	1.2	1.4	1.4					
1A4ai Engines with CHP unit at sewage plants	Sewage gas	TJ	610	775	1'100	1'284	1'351					
1A4ai Commercial/Institutional Stationary (Engines and gas turbines)		Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total fuel consumption		TJ	4'264	4'185	4'009	3'810	3'638	3'932	3'936	3'964	4'000	4'026
1A4ai Engines with CHP unit	Gas oil	TJ	77	66	76	44	57	55	55	56	54	54
1A4ai Engines with CHP unit	Liquefied petroleum gas	TJ	87	121	44	29	23	23	23	23	23	23
1A4ai Engines with CHP unit	Natural gas	TJ	1'596	1'469	1'325	1'151	991	956	979	1'018	1'010	1'050
1A4ai Engines with CHP unit	Biodiesel fossil	TJ	1.3	1.1	1.1	0.88	0.88	0.91	1.0	1.1	1.0	1.1
1A4ai Engines with CHP unit	Biodiesel biogenic	TJ	23	23	24	20	19	19	19	19	18	19
1A4ai Engines with CHP unit	Biogas	TJ	NO	NO	NO	NO	NO	31	34	37	39	43
1A4ai Engines with CHP unit at biogas plants	Liquefied petroleum gas	TJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1A4ai Engines with CHP unit at biogas plants	Biodiesel fossil	TJ	1.3	1.2	0.88	1.0	0.75	0.78	0.84	0.85	0.83	0.82
1A4ai Engines with CHP unit at biogas plants	Biodiesel biogenic	TJ	23	24	19	23	16	16	16	15	15	15
1A4ai Engines with CHP unit at biogas plants	Biogas	TJ	738	780	807	818	813	807	787	784	827	818
1A4ai Engines used as emergency generators	Gas oil	TJ	413	415	417	420	421	413	411	409	405	402
1A4ai Gas turbines at sewage plants	Natural gas	TJ	0.029	0.25	0.23	0.24	0.23	0.21	0.20	0.20	0.19	0.18
1A4ai Gas turbines at sewage plants	Sewage gas	TJ	25	26	26	34	33	41	41	41	41	41
1A4ai Engines with CHP unit at sewage plants	Natural gas	TJ	1.5	12	11	8.8	8.6	8.0	7.7	7.4	7.2	6.9
1A4ai Engines with CHP unit at sewage plants	Sewage gas	TJ	1'278	1'245	1'258	1'261	1'254	1'562	1'562	1'553	1'559	1'552

Table 3-21 Activity data of engines and gas turbines in 1A4b Other sectors: residential.

1A4bi Residential Stationary (Engines and gas turbines)		Unit	1990	1995	2000	2005	2010					
Total fuel consumption		TJ	45	179	317	360	267					
1A4bi Engines with CHP unit	Gas oil	TJ	4.9	19	64	60	20					
1A4bi Engines with CHP unit	Liquefied petroleum gas	TJ	0.26	4.0	11	11	12					
1A4bi Engines with CHP unit	Natural gas	TJ	39	156	241	288	232					
1A4bi Engines with CHP unit	Biodiesel fossil	TJ	NO	NO	NO	0.035	0.15					
1A4bi Engines with CHP unit	Biodiesel biogenic	TJ	NO	NO	NO	0.69	3.3					
1A4bi Engines with CHP unit	Biogas	TJ	NO	NO	NO	NO	NO					
1A4bi Residential Stationary (Engines and gas turbines)		Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total fuel consumption		TJ	198	187	163	138	121	121	123	128	127	132
1A4bi Engines with CHP unit	Gas oil	TJ	8.5	7.4	8.4	4.8	6.4	6.2	6.1	6.2	6.0	6.0
1A4bi Engines with CHP unit	Liquefied petroleum gas	TJ	9.6	14	4.9	3.3	2.6	2.5	2.5	2.6	2.5	2.6
1A4bi Engines with CHP unit	Natural gas	TJ	177	163	147	128	110	106	109	113	112	117
1A4bi Engines with CHP unit	Biodiesel fossil	TJ	0.15	0.12	0.12	0.097	0.098	0.10	0.11	0.12	0.11	0.12
1A4bi Engines with CHP unit	Biodiesel biogenic	TJ	2.6	2.5	2.6	2.2	2.1	2.1	2.1	2.1	2.1	2.1
1A4bi Engines with CHP unit	Biogas	TJ	NO	NO	NO	NO	NO	3.5	3.7	4.1	4.4	4.8

Table 3-22 Activity data of engines and gas turbines in 1A4c Other sectors: agriculture/forestry/fishing.

1A4ci Agriculture/Forestry/Fishing Stationary (Engines and gas turbines)		Unit	1990	1995	2000	2005	2010					
Total fuel consumption		TJ	64	53	67	133	499					
1A4ci Engines used as emergency generators	Gas oil	TJ	2.1	2.1	2.1	2.1	2.1					
1A4ci Engines with CHP unit at biogas plants	Natural gas	TJ	2.7	1.3	2.5	2.3	NO					
1A4ci Engines with CHP unit at biogas plants	Biogas	TJ	59	49	62	128	497					
1A4ci Agriculture/Forestry/Fishing Stationary (Engines and gas turbines)		Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total fuel consumption		TJ	1'043	1'194	1'274	1'405	1'614	1'764	1'911	1'948	2'005	2'047
1A4ci Engines used as emergency generators	Gas oil	TJ	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
1A4ci Engines with CHP unit at biogas plants	Natural gas	TJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1A4ci Engines with CHP unit at biogas plants	Biogas	TJ	1'041	1'192	1'272	1'403	1'612	1'762	1'909	1'946	2'003	2'045

3.2.1.1.3 Model for wood energy combustion

Choice of method

The emissions from wood combustion in 1A Fuel combustion activities are calculated by a Tier 2 method based on chapter 1A4 Small combustion in the EMEP/EEA guidebook (EMEP/EEA 2023).

Methodology

The Swiss wood energy statistics (SFOE 2025b) distinguish 24 wood combustion installation types (exclusive municipal solid waste plants) that are fired with logwood, pellets, chips or so-called renewable waste from wood products, see Table 3-23. The statistics provide both the annual wood consumption for the individual categories of combustion installation types (table 4.1, categories 1-19) and the allocations of the installation types to the sectoral consumer categories (table 6.1, household, agriculture/forestry, industry, services, electricity and district heating). This allows for assigning the annual wood consumption at the level of combustion installation categories to the source categories 1A1a Public Electricity and Heat Production, 1A2gviii Other, 1A4ai Commercial/Institutional, 1A4bi Residential and 1A4ci Agriculture/Forestry/Fishing. Installation types of the wood energy statistics with the same emission behaviour are grouped into one category in the emission factor model of Zotter and Nussbaumer 2022 (Table 3-23).

The combustion of any household waste in wood-burning fireplaces and stoves is prohibited in Switzerland since 1992 (Ordinance on Air Pollution Control, Swiss Confederation 1985). Emissions from illegal domestic incineration of municipal solid waste are reported in source category 5C1a Municipal waste incineration (see chp. 6.4.2)

Table 3-23 Assignment of the categories of wood combustion installations from the Swiss wood energy statistics (SFOE 2025b) to the categories of the emission factor model (Zotter and Nussbaumer 2022).

Categories of wood combustion installations		
Swiss wood energy statistics		Emission factor model
1	Open fireplaces	Open fireplaces
2	Closed fireplaces	Closed fireplaces, log wood stoves
3	Log wood stoves	
4a	Heating stoves (living area)	
4b	Pellet stoves	Pellet stoves
5	Tiled stoves	Closed fireplaces, log wood stoves
6	Log wood hearths	Log wood hearths
7	Central heating hearths	
8	Log wood boilers <50 kW	Log wood boilers
9	Log wood boilers >50 kW	
10	Log wood dual chamber boilers	Log wood dual chamber boilers
11a	Automatic chip boilers < 50 kW	Automatic chip boilers < 50 kW
11b	Automatic pellet boilers < 50 kW	Automatic pellet boilers < 50 kW
12a	Automatic chip boilers 50–300 kW w/o wood processing companies	Automatic chip boilers 50–300 kW w/o wood processing companies
12b	Automatic pellet boilers 50–300 kW	Automatic pellet boilers 50–300 kW
13	Automatic chip boilers 50–300 kW within wood processing companies	Automatic chip boilers 50–300 kW within wood processing companies
14a	Automatic chip boilers 300–500 kW w/o wood processing companies	Automatic chip boilers 300–500 kW w/o wood processing companies
14b	Automatic pellet boilers 300–500 kW	Automatic pellet boilers 300–500 kW
15	Automatic chip boilers 300–500 kW within wood processing companies	Automatic chip boilers 300–500 kW within wood processing companies
16a	Automatic chip boilers > 500 kW w/o wood processing companies	Automatic chip boilers > 500 kW w/o wood processing companies
16b	Automatic pellet boilers > 500 kW	Automatic pellet boilers > 500 kW
17	Automatic chip boilers > 500 kW within wood processing companies	Automatic chip boilers > 500 kW within wood processing companies
18	Combined chip heat and power plants	Combined chip heat and power plants
19	Plants for renewable waste from wood products	Plants for renewable waste from wood products

Emission factors

All emission factors are based on a country-specific emission factor model for wood energy that has been completely revised for the entire time series (including projections) by Zotter and Nussbaumer (2022). Emission factor values are modelled for the years 1990, 2008, 2014, 2020 and 2035, i.e. 2008 and 2014 being the update years of the previous models. Years in between are linearly interpolated.

The model is based on a large number of air pollution control measurements, laboratory and field measurements, literature data (e.g. beReal, emission factors in the Nordic countries) and the EMEP/EEA guidebook (EMEP/EEA 2019) and takes into account both various technology standards of combustion installations and operating influences.

For single-room furnaces, i.e. open/closed fireplaces and log wood stoves (categories 1-4a, 5) the emission factors of NO_x, VOC, PM exhaust (filterable fraction) and CO are modelled based on literature emission data covering the entire combustion process including the start-up phase and burn-out. A distinction was made between furnaces of conventional and modern technology. In a first step, average emission factors were derived under optimal operating conditions. Optimal operation means that no wet wood is used, the wood is lit from above and the combustion process is not negatively influenced by non-optimal operation. However, in order to be able to represent the emissions as realistically as possible, user impacts such as lighting from below, lighting with newspaper, using wet wood, overloading the combustion chamber as well as reducing the air supply were taken into account by factors. Also based on literature data, factors for the ratio of the emission factors of each disadvantageous operation mode compared to optimal operation were determined. As no literature data on the shares of the respective (disadvantageous) operating modes could be found they were estimated. Shares of 35 % optimal operation, 25 % lighting from below, 10 % lighting with newspaper, 10 % wet wood, 10 % overloaded combustion chamber and 10 % reduced air supply were assumed for a representative mean furnace operation in 2020. By varying these operation shares (user impacts) and the shares of furnace technology (conventional, modern), the emission factors for the past (1990, 2008, 2014) and the future (2035) were modelled as well. As there is no information on the technology of the appliances in the Swiss wood energy statistics (SFOE 2025b), assumptions had to be made. Only a classification into so-called conventional and modern furnaces was made. Conventional includes furnaces with single-stage combustion and those described as old in the literature, while modern comprises multi-stage furnaces and those designated as new or with the eco-label. Assumptions on technology distribution were made for three commissioning periods (1990-1998: 100 % conventional, 1999-2008: 50 % conventional/50 % modern, 2009-2019: 25 % conventional/75 % modern) yielding a fleet of 56 % conventional and 44 % modern single-room furnaces in 2020. Compared to other countries (Austria, Denmark, Germany, Norway and Sweden) with values in the range of 20 % to 50 % this share of conventional furnaces is rather high.

For log boilers (<50 kW, >50 kW, categories 8-9), limited literature data were available for the derivation of emission factors. Only studies that reflect real operation as far as possible were considered, i.e. that cover the entire combustion process or large parts of it (at least including start or burn-out), and for which data on full and partial load were available. It was also not possible to differentiate between different technologies (conventional, modern).

For automatic boilers >50 kW (categories 12-17), combined heat and power plants (category 18) and plants for renewable waste from wood products (category 19), the emission factors of NO_x, VOC, PM exhaust and CO are derived based on the factors of the different operating phases (start, stop, full load, partial load and stand-by) and their effective combustion heat output, taking into account typical shares of the respective phases.

Besides the emission factors for PM exhaust, those for PM condensable were also derived, see Table 3-25. The condensable PM fractions were estimated using the ratio of PM (total particles)/PM exhaust based on literature data, including measurements by Zotter and Nussbaumer (2022) on some installation types relevant for Switzerland. The model

differentiates between manually operated single room stoves / central heating boilers and (larger) automatic combustion installations, see Table 3-26. The latest submission of Switzerland's air pollution emission inventory now also includes the emissions of PM condensable.

A mean constant NMVOC to VOC ratio over time of 0.7 is used for all combustion installation types, based on literature emission data for single-room furnaces and central heating systems of different technology, operating conditions and phases. The shares of PM_{2.5} in TSP and PM₁₀ in TSP are assumed to be 90 % and 95 %, respectively, for all installation types and the entire time series.

For the temporal development of the emission factors of the priority heavy metals Pb and Cd the same relative development was assumed as for PM and for those of the POPs (PCDD/PCDF, PAHs, HCB and PCBs) as for CO. The emission factors of Hg were assumed to be constant over the entire period.

Table 3-24 Emission factors 2024 of pollutants from wood combustion installations in source categories 1A1-1A4 (“w/o wood proc. companies.” stands for “without wood processing companies”). PM2.5, PM10 and TSP correspond to PM total particles, which include both exhaust (filterable) and condensable fractions.

1A Combustion (Wood combustion)	Unit of activity data	NOx	NM VOC	SOx	NH3	PM2.5	PM10	TSP	BC ex	CO
		g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
Open fireplaces	GJ wood	80	245	10	4.7	170	180	189	57	2'867
Closed fireplaces	GJ wood	85	222	10	4.7	140	149	156	50	2'640
Log wood stoves	GJ wood	85	222	10	4.7	140	149	156	50	2'640
Heating stoves (living area)	GJ wood	85	222	10	4.7	140	149	156	50	2'640
Pellet stoves	GJ wood	85	12	10	1.9	62	66	69	12	366
Tiled stoves	GJ wood	85	222	10	4.7	140	149	156	50	2'640
Log wood hearths	GJ wood	70	317	10	4.7	336	355	373	119	3'787
Central heating hearths	GJ wood	70	317	10	4.7	336	355	373	119	3'787
Log wood boilers <50 kW	GJ wood	100	62	10	1.9	94	99	104	14	1'540
Log wood boilers >50 kW	GJ wood	100	62	10	1.9	94	99	104	14	1'540
Log wood dual chamber boilers	GJ wood	70	331	10	4.7	336	355	373	130	4'000
Automatic chip boilers < 50 kW	GJ wood	120	37	10	1.9	148	157	164	15	820
Automatic pellet boilers < 50 kW	GJ wood	70	11	10	1.9	29	30	32	6.5	298
Automatic chip boilers 50-300 kW w/o wood proc. companies	GJ wood	127	18	3.0	1.9	49	52	54	2.4	415
Automatic pellet boilers 50-300 kW	GJ wood	75	6.7	3.0	1.9	27	29	30	0.97	154
Automatic chip boilers 50-300 kW within wood proc. companies	GJ wood	137	18	3.0	1.9	50	53	56	2.5	425
Automatic chip boilers 300-500 kW w/o wood proc. companies	GJ wood	127	18	3.0	1.9	49	52	54	2.4	415
Automatic pellet boilers 300-500 kW	GJ wood	75	6.7	3.0	1.9	27	29	30	0.97	154
Automatic chip boilers 300-500 kW within wood proc. companies	GJ wood	137	18	3.0	1.9	50	53	56	2.5	425
Automatic chip boilers > 500 kW w/o wood proc. companies	GJ wood	117	6.5	3.0	2.0	8.7	9.5	9.5	0.17	129
Automatic pellet boilers > 500 kW	GJ wood	71	2.0	3.0	2.0	4.9	4.9	4.9	0.10	47
Automatic chip boilers > 500 kW within wood proc. companies	GJ wood	117	6.7	3.0	2.0	18	19	20	0.42	142
Combined chip heat and power plants	GJ wood	39	0.27	1.0	2.0	0.33	0.33	0.33	0.0030	8.9
Plants for renewable waste from wood products	GJ wood waste	127	1.1	19	5.0	1.4	1.4	1.5	0.030	55

1A Combustion (Wood combustion)	Unit of activity data	Pb	Cd	Hg	PCDD/PCDF	BaP	BbF	BkF	IcdP	HCB	PCB
		mg/...	mg/...	mg/...	ng I-Teq/...	mg/...	mg/...	mg/...	mg/...	ng/...	ng/...
Open fireplaces	GJ wood	19	1.0	2.0	473	47	47	27	27	4'733	57
Closed fireplaces	GJ wood	19	1.0	2.0	473	47	47	27	27	4'733	57
Log wood stoves	GJ wood	19	1.0	2.0	473	47	47	27	27	4'733	57
Heating stoves (living area)	GJ wood	19	1.0	2.0	473	47	47	27	27	4'733	57
Pellet stoves	GJ wood	19	1.0	2.0	47	9.2	9.2	3.7	3.7	4'733	10
Tiled stoves	GJ wood	19	1.0	2.0	473	47	47	27	27	4'733	57
Log wood hearths	GJ wood	19	1.0	2.0	473	47	47	27	27	4'733	57
Central heating hearths	GJ wood	19	1.0	2.0	473	47	47	27	27	4'733	57
Log wood boilers <50 kW	GJ wood	19	1.0	2.0	237	27	27	14	14	4'733	17
Log wood boilers >50 kW	GJ wood	19	1.0	2.0	237	27	27	14	14	4'733	17
Log wood dual chamber boilers	GJ wood	20	1.0	2.0	500	100	100	60	60	5'000	60
Automatic chip boilers < 50 kW	GJ wood	19	1.0	2.0	92	9.2	9.2	3.7	3.7	4'733	10
Automatic pellet boilers < 50 kW	GJ wood	19	1.0	2.0	45	9.2	9.2	3.7	3.7	4'733	10
Automatic chip boilers 50-300 kW w/o wood proc. companies	GJ wood	13	1.0	2.0	47	4.5	4.5	2.4	2.4	4'467	10
Automatic pellet boilers 50-300 kW	GJ wood	13	1.0	2.0	47	4.5	4.5	2.4	2.4	4'467	10
Automatic chip boilers 50-300 kW within wood proc. companies	GJ wood	13	1.0	2.0	95	4.5	4.5	2.4	2.4	4'467	10
Automatic chip boilers 300-500 kW w/o wood proc. companies	GJ wood	8.7	1.0	2.0	47	0.92	0.92	0.92	0.92	4'467	10
Automatic pellet boilers 300-500 kW	GJ wood	8.7	1.0	2.0	47	0.92	0.92	0.92	0.92	4'467	10
Automatic chip boilers 300-500 kW within wood proc. companies	GJ wood	8.7	1.0	2.0	95	0.92	0.92	0.92	0.92	4'467	10
Automatic chip boilers > 500 kW w/o wood proc. companies	GJ wood	8.7	1.0	2.0	47	0.92	0.92	0.92	0.92	920	10
Automatic pellet boilers > 500 kW	GJ wood	8.7	1.0	2.0	47	0.92	0.92	0.92	0.92	920	10
Automatic chip boilers > 500 kW within wood proc. companies	GJ wood	8.7	1.0	2.0	95	0.92	0.92	0.92	0.92	920	10
Combined chip heat and power plants	GJ wood	8.7	1.0	2.0	10	0.089	0.089	0.089	0.089	920	10
Plants for renewable waste from wood products	GJ wood waste	100	2.0	2.0	45	0.92	0.92	0.92	0.92	920	10

Table 3-25 Emission factors 2024 of PM exhaust (filterable) and PM condensable from wood combustion installations in source categories 1A1-1A4 (“w/o wood proc. companies.” stands for “without wood processing companies”).

1A Combustion (Wood combustion)	Unit of activity data	PM2.5 ex	PM2.5 cond	PM10 ex	PM10 cond	TSP ex	TSP cond
		g/...	g/...	g/...	g/...	g/...	g/...
Open fireplaces	GJ wood	85	85	90	90	95	95
Closed fireplaces	GJ wood	74	67	78	71	82	74
Log wood stoves	GJ wood	74	67	78	71	82	74
Heating stoves (living area)	GJ wood	74	67	78	71	82	74
Pellet stoves	GJ wood	34	29	36	30	37	32
Tiled stoves	GJ wood	74	67	78	71	82	74
Log wood hearths	GJ wood	168	168	177	177	187	187
Central heating hearths	GJ wood	168	168	177	177	187	187
Log wood boilers <50 kW	GJ wood	49	44	52	47	55	49
Log wood boilers >50 kW	GJ wood	49	44	52	47	55	49
Log wood dual chamber boilers	GJ wood	180	156	190	165	200	173
Automatic chip boilers < 50 kW	GJ wood	79	69	83	73	87	77
Automatic pellet boilers < 50 kW	GJ wood	26	2.7	28	2.7	29	2.9
Automatic chip boilers 50-300 kW w/o wood proc. companies	GJ wood	44	4.2	47	4.9	49	4.9
Automatic pellet boilers 50-300 kW	GJ wood	25	2.7	26	2.7	27	2.7
Automatic chip boilers 50-300 kW within wood proc. companies	GJ wood	46	4.2	48	4.9	51	5.1
Automatic chip boilers 300-500 kW w/o wood proc. companies	GJ wood	44	4.2	47	4.9	49	4.9
Automatic pellet boilers 300-500 kW	GJ wood	25	2.7	26	2.7	27	2.7
Automatic chip boilers 300-500 kW within wood proc. companies	GJ wood	46	4.2	48	4.9	51	5.1
Automatic chip boilers > 500 kW w/o wood proc. companies	GJ wood	7.9	0.79	8.7	0.87	8.7	0.87
Automatic pellet boilers > 500 kW	GJ wood	4.5	0.45	4.5	0.45	4.5	0.45
Automatic chip boilers > 500 kW within wood proc. companies	GJ wood	16	2.4	17	2.5	17	2.5
Combined chip heat and power plants	GJ wood	0.30	0.030	0.30	0.030	0.30	0.030
Plants for renewable waste from wood products	GJ wood waste	1.3	0.13	1.3	0.13	1.4	0.14

Table 3-26 Ratios of PM(total particles)/PMexhaust for wood combustion installations (model values, Zotter and Nussbaumer (2022))

1A Wood combustion	1990	2008	2014	2020	2035
	PM(total particles)/PMexhaust				
Open fireplaces	3		2		2
Closed fireplaces, log wood stoves					1.5
Pellet stoves					1.3
Log wood hearths					2
Log wood boilers					1.5
Log wood dual chamber boilers					2
Automatic chip boilers < 50 kW					1.5
Automatic pellet boilers < 50 kW	1.5		1.1		
Automatic chip boilers 50–300 kW w/o wood proc. companies					
Automatic pellet boilers 50–300 kW					
Automatic chip boilers 50–300 kW within wood proc. companies					
Automatic chip boilers 300–500 kW w/o wood proc. companies					
Automatic pellet boilers 300–500 kW					
Automatic chip boilers 300–500 kW within wood proc. companies					
Automatic chip boilers > 500 kW w/o wood proc. companies					
Automatic pellet boilers > 500 kW					
Automatic chip boilers > 500 kW within wood proc. companies					
Combined chip heat and power plants					
Plants for renewable waste from wood products					

Activity data

Categories of wood combustion installations and their respective wood energy consumption (see Table 3-27) are based on the Swiss wood energy statistics (SFOE 2025b, table 4.1) as well as the disaggregation into the individual source categories 1A1a Public electricity and heat production, 1A2gviii Manufacturing industries: Other, 1A4ai Commercial/Institutional, 1A4bi Residential and 1A4ci Agriculture/Forestry/Fishing (SFOE 2025b, table 6.1).

In the statistics, the wood energy consumption of single-room furnaces and central heating systems (fireplaces, stoves and boilers <50 kW, categories 1-11b) is not based on sales figures (and estimated amounts of collected wood) but modelled based on the stock of appliances of the individual installation types and their average type-specific wood consumption. The number of new appliances that are annually commissioned are collected based on sales statistics of the associations of manufacturers and importers of wood furnaces and large DIY markets. The stock of appliances is calculated based on the annual number of new appliances commissioned and their respective average service life assuming that they are all decommissioned when they reach the average service life. The average service life is installation type-specific and varies between 15 years for pellets stoves and automatic boilers and 30 years for tiled stoves. The installation-specific wood consumption is derived from the average rated thermal input and the average number of operating hours, also taking into account whether the installations are operated only to a small extent or not at all since the main heating of the building is provided by another heating system (e.g. gas oil, natural gas). The wood energy consumption of automatic boilers >50 kW (categories 12-17) is based on the actual number of these boilers, which is updated annually based on information from the cantons and manufacturing companies, and their installed capacities. The fuel consumption of combined heat and power plants (category 18) and plants for renewable waste from wood products (category 19) are collected individually due to their small number and large outputs.

As additional data source, specific bottom-up information from the industry is used in order to allocate wood combustion emissions directly. Thus, activity data of wood combustion of 1A2f, 1A2gviii and 1A4ci are allocated based on industry information. The information on the specific processes is documented in the respective EMIS documentation (EMIS 2026/1A Holzfeuerungen). Note that this specific industry data is subtracted from the activity data of the respective combustion installation category in order to avoid double counting within source category 1A2 and 1A4 (see Figure 3-17):

- 1A2: The wood energy consumption of 1A2f Brick and tile production (2000-2012) was subtracted from the activity data of 1A2gviii Automatic chip boiler >500 kW without wood processing companies, while that of wood waste in 1A2f Cement production (1994-1997 and from 2009 onwards) and 1A2gviii Fibreboard is subtracted from the activity data of 1A2gviii Plants for renewable waste from wood products.
- 1A4: From 2013 onwards, also the wood energy consumption in 1A4ci Grass drying has been subtracted from the activity data in 1A4ci Automatic chip boiler >500 kW without wood processing companies.

Table 3-27 Wood energy consumption in 1A Fuel combustion (“w/o wood proc. companies.” stands for “without wood processing companies”).

1A Combustion (Wood combustion)	Unit	1990	1995	2000	2005	2010					
Total fuel consumption	TJ	28'219	29'649	27'426	31'413	40'136					
Open fireplaces	TJ wood	226	270	195	181	124					
Closed fireplaces	TJ wood	258	545	766	953	1'211					
Log wood stoves	TJ wood	1'144	1'769	2'148	2'789	3'879					
Heating stoves (living area)	TJ wood	1'830	1'552	1'012	584	254					
Pellet stoves	TJ wood	NO	NO	7.0	48	151					
Tiled stoves	TJ wood	4'041	3'300	2'561	2'710	3'175					
Log wood hearths	TJ wood	3'877	2'840	1'611	1'427	854					
Central heating hearths	TJ wood	4'643	4'177	3'126	2'593	1'494					
Log wood boilers <50 kW	TJ wood	5'219	5'391	4'861	4'995	4'488					
Log wood boilers >50 kW	TJ wood	88	173	244	362	421					
Log wood dual chamber boilers	TJ wood	1'964	1'777	977	480	273					
Automatic chip boilers < 50 kW	TJ wood	239	433	550	753	1'008					
Automatic pellet boilers < 50 kW	TJ wood	NO	NO	56	804	2'106					
Automatic chip boilers 50-300 kW w/o wood proc. companies	TJ wood	464	858	1'161	1'862	2'735					
Automatic pellet boilers 50-300 kW	TJ wood	NO	NO	3.0	114	600					
Automatic chip boilers 50-300 kW within wood proc. companies	TJ wood	895	1'186	1'216	1'365	1'533					
Automatic chip boilers 300-500 kW w/o wood proc. companies	TJ wood	237	521	713	1'000	1'503					
Automatic pellet boilers 300-500 kW	TJ wood	NO	NO	NO	19	195					
Automatic chip boilers 300-500 kW within wood proc. companies	TJ wood	412	570	588	632	674					
Automatic chip boilers > 500 kW w/o wood proc. companies	TJ wood	314	1'096	1'732	2'400	4'481					
Automatic pellet boilers > 500 kW	TJ wood	NO	NO	NO	9.0	186					
Automatic chip boilers > 500 kW within wood proc. companies	TJ wood	1'389	2'128	2'368	2'768	2'964					
Combined chip heat and power plants	TJ wood	NO	3.0	186	127	2'756					
Plants for renewable waste from wood products	TJ wood waste	979	1'060	1'345	2'439	3'070					
1A Combustion (Wood combustion)	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total fuel consumption	TJ	38'920	42'572	43'570	41'156	43'332	42'653	49'908	45'181	47'411	48'553
Open fireplaces	TJ wood	64	68	67	62	62	58	59	42	35	27
Closed fireplaces	TJ wood	933	941	865	759	735	649	721	582	569	547
Log wood stoves	TJ wood	3'370	3'572	3'429	3'131	3'103	2'829	3'170	2'594	2'567	2'526
Heating stoves (living area)	TJ wood	113	103	81	74	74	64	74	67	72	76
Pellet stoves	TJ wood	181	199	196	186	187	175	198	166	170	174
Tiled stoves	TJ wood	3'030	3'246	3'165	2'962	3'031	2'833	3'315	2'813	2'918	3'001
Log wood hearths	TJ wood	533	520	468	408	392	344	383	316	293	286
Central heating hearths	TJ wood	473	472	432	384	371	331	365	301	296	290
Log wood boilers <50 kW	TJ wood	2'637	2'695	2'532	2'300	2'306	2'060	2'253	1'823	1'822	1'784
Log wood boilers >50 kW	TJ wood	333	337	320	297	290	260	270	216	213	202
Log wood dual chamber boilers	TJ wood	119	112	88	67	57	42	38	27	21	17
Automatic chip boilers < 50 kW	TJ wood	786	798	742	667	644	559	582	455	450	424
Automatic pellet boilers < 50 kW	TJ wood	2'376	2'610	2'619	2'538	2'676	2'489	2'909	2'719	2'825	2'904
Automatic chip boilers 50-300 kW w/o wood proc. companies	TJ wood	3'030	3'348	3'370	3'247	3'372	3'230	3'862	3'344	3'534	3'642
Automatic pellet boilers 50-300 kW	TJ wood	1'090	1'309	1'450	1'497	1'642	1'674	2'143	2'008	2'229	2'380
Automatic chip boilers 50-300 kW within wood proc. companies	TJ wood	1'400	1'488	1'486	1'426	1'421	1'367	1'533	1'341	1'390	1'402
Automatic chip boilers 300-500 kW w/o wood proc. companies	TJ wood	1'644	1'816	1'820	1'741	1'818	1'746	2'053	1'797	1'919	1'919
Automatic pellet boilers 300-500 kW	TJ wood	279	338	355	354	366	353	449	394	437	446
Automatic chip boilers 300-500 kW within wood proc. companies	TJ wood	600	632	622	616	589	568	624	539	562	561
Automatic chip boilers > 500 kW w/o wood proc. companies	TJ wood	5'851	6'583	6'788	6'554	6'938	7'100	8'432	7'327	7'905	7'299
Automatic pellet boilers > 500 kW	TJ wood	317	364	362	346	370	373	449	402	428	485
Automatic chip boilers > 500 kW within wood proc. companies	TJ wood	2'563	2'647	2'540	2'381	2'452	2'324	2'578	2'237	2'410	2'904
Combined chip heat and power plants	TJ wood	3'830	3'970	4'887	4'696	5'922	6'319	6'795	7'294	7'730	8'227
Plants for renewable waste from wood products	TJ wood waste	3'367	4'404	4'887	4'463	4'513	4'906	6'653	6'375	6'615	7'030

3.2.1.2 Country-specific and fuel-specific default emission factors for 1A Fuel combustion

Methodology

For fossil standard fuels in source category 1A Fuel combustion, we use country-specific and fuel-specific default emission factors, whose values are applicable to several source categories, for SO₂ only. This is appropriate for SO₂ because in many cases, the amount of SO₂ emitted per amount of fuel burned directly depends on the sulphur content of the fuel. For a given fuel, the sulphur content for the whole country is considered homogenous. For other pollutants, the emission factors depend on the combustion process as well and are reported in their specific chapters.

The country-specific default emission factors for SO₂ are estimated as follow:

- Where available, we use sulphur content measured annually in fuels in Switzerland, usually expressed as a mass of sulphur per mass of fuel. For liquid fuels, due to yearly fluctuating average values probably caused by a low number of samples per year, we use as annual sulphur content the average value from all samples available from the given year as well as the previous and subsequent year. In case no data are available for a given year, we use a linear interpolation between existing 3-year-average data points. An overview of the available measured data is presented in Table 3-29. These data are available for diesel oil, gasoline, gas oil and residual fuel oil.
- In case no measurement is available, we assume that the legal emission limits are respected and use these legal limits as emission factors. An overview of applicable maximal emission limits as defined in the Federal Ordinance on Air Pollution Control OAPC (Swiss Confederation 1985) is given in Table 3-28. This approach is used in particular for bituminous coal and lignite.

The SO₂ emission factor expressed as mass per energy amount of a given fuel *i* is computed as:

$$EF_{SO_2,i} = \frac{M_{SO_2}}{M_S} * \frac{C_{S,i}}{NCV_i}$$

Where:

EF_{SO₂,i} is the emission factor for SO₂ for a given fuel *i* (g/GJ)

M_{SO₂} is the molar mass of SO₂ (g/mol)

M_S is the molar mass of sulphur (g/mol)

C_{S,i} is the measured sulphur content of the given fuel *i* if applicable, otherwise the maximum legal limit for sulphur content (g/t)

NCV_i is the net calorific value for the given fuel *i* (GJ/t)

The obtained country-specific and fuel-specific SO₂ emission factors are reported in Table 3-30.

Ongoing measurement surveys

“Schwerpunktaktion, SPA”: The data produced by the Federal Office for Customs and Border Security (FOCBS) through its measurement project “Schwerpunktaktion Brenn und Treibstoffe” (“SPA”) are used from 2004 onwards. This project aims at estimating the sulphur content for diesel oil, gasoline, gas oil Euro and Eco and residual fuel oil.

“Tankstellensurvey, TSS”: For diesel oil and gasoline, the measurement project “Tankstellensurvey” (“TSS”), piloted by the FOEN, started in 2009 and is conducted annually. Samples are taken from a representative set of fueling stations in Switzerland and analysed for sulphur content.

Details per fuel type

Gas oil, heating gas: 2006 saw the introduction to the market of low-sulphur eco-grade gas oil with a maximum legal sulphur limit of 50 g/t. From 2009 onwards, FOCBS measurements (“SPA” campaign) include both standard Euro- and eco-grade gas oil. For eco-grade gas oil for the years before 2009, values are assumed equal to those from 2009. For each year, the sulphur content for the sum of gas oil is the measured sulphur content for each grade, weighted by the respective total annual fuel consumption. From 2014 onwards, the detailed

annual fuel consumption for the two grades is available from the activity report of Carbura (latest report with reported data for the two grades: Carbura 2023b). The fraction of used eco-grade is interpolated linearly between 2006 and 2013. Measurements from both the SPA (from 2004 onwards) and the TSS (from 2009 onwards) campaigns are used. Before 2004, we use data as published in SAEFL (2000). From 1st June 2023 onwards, the use of Euro-grade heating oil is banned by the OAPC.

The emission factor for heating gas (used as fuel in source category 1A2c Chemicals) is assumed equal to the one for gas oil.

Diesel oil, Biodiesel: Measurements from both the SPA (from 2004 onwards) and the TSS (from 2009 onwards) campaigns are used. Before 1994, data are assumed equal to the measured values for Gas oil (Euro grade). Between 1994 and 2004, data are used as published in SAEFL 2000.

The emission factor for biodiesel is assumed equal to the one for diesel oil.

Gasoline, Bioethanol: Measurements from both the SPA (from 2004 onwards) and the TSS (from 2009 onwards) campaigns are used. Due to the absence of data for 1990-2000 included, the sulphur content in gasoline is assumed to be 10% less than the legal maximum limit of 200 g/t, producing a value of 180 g/t. Values are linearly interpolated between 2000 and 2004.

The emission factor for bioethanol is assumed equal to the one for gasoline.

Residual fuel oil, Gasolio: Measurements from the SPA campaign are used from 2004 onwards. For previous years, we use data as published in SAEFL (2000).

The emission factor for gasolio (used as fuel in source category 1A2c Chemicals) is assumed equal to the one for residual fuel oil.

Liquefied petroleum gas: No data is available for liquefied petroleum gas. We assume that the sulphur content is near the legal limit of 190 g/t for natural gas and therefore use a value of 0.5 g/GJ.

Natural gas: The sulphur content of natural gas is determined by two legal limits. The minimum content is prescribed by safety regulations requiring the addition of the odorant Tetrahydrothiophene (C₄H₈S). This substance is the main source of sulphur in gas and results in a sulphur content of approximately 8 mg/m³. Depending on the gas density and calorific value, this corresponds to approx. 0.43 g/GJ. The upper limit is set by the OAPC legal limit of 190 g/t, corresponding to approx. 0.5 g/GJ. For all years before 2003, we assume that the sulphur content in natural gas is near the legal limit of 190 g/t and therefore use a value of 0.5 g/GJ. For the years 2003, 2006, 2009 and then annually from 2011 onwards, we use the sulphur content in the odoured gas as published by the SGWA. This value has been stable at 8 mg/m³ since 2006 (latest report: SGWA 2025). We also use a linear interpolation in case of missing data.

Gaseous fuels of biogenic origin: For biogas, sewage gas and landfill gas, no data are available. We assume that the sulphur content is near the legal limit of 190 g/t and therefore use a value of 0.5 g/GJ.

Other bituminous coal: There are no measured data and we assume that the sulphur content is 20% below the legal limit. The legal limit of sulphur content depends on the size of the heat capacity of the combustion system. The value of 1 % sulphur content (350 g SO₂/GJ) shown in Table 3-28 holds for heat capacity below 1 MW (see OAPC Annex 3, §513 (Swiss Confederation 1985)). For larger capacities, the value is 3 % (OAPC Annex 5, §2, Swiss Confederation 1985). For industrial combustion plants, the limit for the exhaust emissions actually sets the corresponding maximum sulphur content to 1.4 % (500 g SO₂/GJ).

Lignite: There are no measured data and we assume that the sulphur content is 10% below the legal limit, which is the same as for bituminous coal.

Jet kerosene: There is no default, country-specific emission factor for SO₂ for jet kerosene. Category-specific emission factors are reported in their respective chapters.

Table 3-28 Legal limits for sulphur content per fuel type. From 1st June 2023 onwards, the use of Euro-grade gas oil is banned by the OAPC.

Maximum legal limit of sulphur content									
Fuel	Diesel oil	Gasoline	Gas oil (Euro extra-light)	Gas oil (eco extra-light)	Natural gas	Res. fuel oil Class A	Res. fuel oil Class B	Coal, thermal input < 1MW	Coal, thermal input > 1MW
Ref. OAPC 2022	OAPC Annex 5 §6	OAPC Annex 5 §5	OAPC Annex 5 §11bis a	OAPC Annex 5 §11bis b	OAPC Annex 5 §42	OAPC Annex 3, §421, lit.2	OAPC Annex 5 §11bis c	OAPC Annex 3 §513	OAPC Annex 5 §2
Unit	g/t	g/t	g/t	g/t	g/t	g/t	g/t	g/t	g/t
1990	2'000	200	2'000	NO	190	15'000	28'000	10'000	30'000
1991	2'000	200	2'000	NO	190	10'000	28'000	10'000	30'000
1992	2'000	200	2'000	NO	190	10'000	28'000	10'000	30'000
1993	2'000	200	2'000	NO	190	10'000	28'000	10'000	30'000
1994	2'000	200	2'000	NO	190	10'000	28'000	10'000	30'000
2000	350	150	2'000	NO	190	10'000	28'000	10'000	30'000
2005	50	50	2'000	NO	190	10'000	28'000	10'000	30'000
2008	50	50	2'000	NO	190	10'000	28'000	10'000	30'000
2009	10	10	1'000	NO	190	10'000	28'000	10'000	30'000
2018	10	10	1'000	50	190	10'000	28'000	10'000	30'000
2024	10	10	NO	50	190	10'000	28'000	10'000	30'000

Table 3-29 Measured sulphur content per fuel type. Values for the years 2024 are not evaluated yet and assumed equal as for the year 2023.

Fuel	Measured sulphur content in fuels				
	Diesel oil	Gasoline	Gas oil (Euro)	Gas oil (Eco)	Res. fuel oil Class A
Unit	g/t	g/t	g/t	g/t	g/t
1990	NE	NE	1'600	NO	9'747
1991	NE	NE	1'300	NO	8'900
1992	NE	NE	1'200	NO	8'600
1993	NE	NE	1'000	NO	8'700
1994	434	NE	1'350	NO	7'710
1995	341	NE	1'170	NO	7'770
1996	372	NE	1'160	NO	7'770
1997	353	NE	1'250	NO	7'000
1998	402	NE	926	NO	8'300
1999	443	NE	650	NO	6'200
2000	272	NE	680	NO	6'600
2001	250	NE	830	NO	8'200
2002	235	NE	798	NO	8'200
2003	200	NE	NE	NO	7'900
2004	5.2	3.8	730	NO	7'600
2005	6.4	5.6	808	NO	7'800
2006	NE	NE	NE	NE	NE
2007	NE	NE	NE	NE	NE
2008	NE	NE	NE	NE	NE
2009	7.6	5.3	641	25	9'217
2010	6.7	4.3	631	34	8'825
2011	6.6	4.7	531	21	8'967
2012	6.5	4.8	672	26	9'100
2013	7.1	4.5	308	25	8'967
2014	6.8	4.4	502	27	7'800
2015	7.7	4.2	516	14	8'233
2016	7.0	4.2	246	10	8'450
2017	7.7	5.0	248	19	9'833
2018	7.5	5.2	486	5	9'133
2019	NE	NE	NE	NE	NE
2020	6.2	NE	319	18	5'533
2021	7.1	NE	337	19	5'600
2022	6.6	4.8	551	17	6'567
2023	6.4	3.7	NE	14	5'500

Table 3-30 Country-specific and fuel-specific default emissions factors for SO_x used within source category 1A Fuel combustion activities, 1990-2024.

SOx emission factors		Unit	1990	1995	2000	2005	2010					
Fuel combustion	Gasoline	g/GJ	8.46	8.46	6.80	0.233	0.219					
Fuel combustion	Diesel oil	g/GJ	69.1	17.8	15.0	0.280	0.319					
Fuel combustion	Gas oil	g/GJ	72.4	57.5	33.7	34.6	23.0					
Fuel combustion	Residual fuel oil	g/GJ	466	376	339	381	438					
Fuel combustion	Liquefied petroleum gas	g/GJ	0.500	0.500	0.500	0.500	0.500					
Fuel combustion	Lignite	g/GJ	500	500	500	500	500					
Fuel combustion	Natural gas	g/GJ	0.500	0.500	0.500	0.451	0.425					
Fuel combustion	Biodiesel fossil	g/GJ	69.1	17.8	15.0	0.280	0.319					
Fuel combustion	Biodiesel biogenic	g/GJ	69.1	17.8	15.0	0.280	0.319					
Fuel combustion	Bioethanol	g/GJ	8.46	8.46	6.80	0.233	0.219					
Fuel combustion	Biogas	g/GJ	0.500	0.500	0.500	0.500	0.500					
Fuel combustion	Sewage gas	g/GJ	0.500	0.500	0.500	0.500	0.500					
Fuel combustion: Boilers manufacturing industry	Other bituminous coal	g/GJ	500	500	500	500	500					
Fuel combustion: Boilers residential	Other bituminous coal	g/GJ	350	350	350	350	350					

SOx emission factors		Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Fuel combustion	Gasoline	g/GJ	0.200	0.209	0.218	0.236	0.240	0.217	0.222	0.190	0.194	0.194
Fuel combustion	Diesel oil	g/GJ	0.333	0.347	0.342	0.333	0.325	0.316	0.307	0.309	0.305	0.305
Fuel combustion	Gas oil	g/GJ	13.8	10.6	8.85	8.38	7.84	6.79	4.88	1.94	0.841	0.766
Fuel combustion	Residual fuel oil	g/GJ	396	448	453	460	356	269	290	290	283	283
Fuel combustion	Liquefied petroleum gas	g/GJ	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
Fuel combustion	Lignite	g/GJ	500	500	500	500	500	500	500	500	500	500
Fuel combustion	Natural gas	g/GJ	0.434	0.431	0.431	0.433	0.430	0.430	0.433	0.429	0.428	0.428
Fuel combustion	Biodiesel fossil	g/GJ	0.333	0.347	0.342	0.333	0.325	0.316	0.307	0.309	0.305	0.305
Fuel combustion	Biodiesel biogenic	g/GJ	0.333	0.347	0.342	0.333	0.325	0.316	0.307	0.309	0.305	0.305
Fuel combustion	Bioethanol	g/GJ	0.200	0.209	0.218	0.236	0.240	0.217	0.222	0.190	0.194	0.194
Fuel combustion	Biogas	g/GJ	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
Fuel combustion	Sewage gas	g/GJ	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
Fuel combustion: Boilers manufacturing industry	Other bituminous coal	g/GJ	500	500	500	500	500	500	500	500	500	500
Fuel combustion: Boilers residential	Other bituminous coal	g/GJ	350	350	350	350	350	350	350	350	350	350

3.2.2 Source category 1A1 - Energy industries (stationary)

3.2.2.1 Source category description for 1A1 Energy industries (stationary)

The most important source category in Energy industries is 1A1a Public electricity and heat production, followed by 1A1b Petroleum refining. Activities in source category 1A1c Manufacture of solid fuels and other energy industries, are virtually nonexistent in Switzerland, apart from a very small charcoal production activity in traditional and historic trade.

Table 3-31 Specification of source category 1A1 Energy industries.

1A1	Source category	Specification
1A1a	Public electricity and heat production	Main sources are waste incineration plants with heat and power generation (Other fossil and biogenic fuels) and public district heating systems including boilers, and boilers with combined heat and power generation not further defined, as well as engines and gas turbines with fossil fuels and biogas, and engines on landfill sites or emergency generators. The only fossil fuelled public electricity generation unit "Vouvry" (300 MW _e ; no public heat production) ceased operation in 1999.
1A1b	Petroleum refining	Combustion activities supporting the refining of petroleum products, excluding evaporative emissions. Use of refinery gas in gas turbines with SCGT at refineries.
1A1c	Manufacture of solid fuels and other energy industries	Emissions from charcoal production

Table 3-32 Key categories, approaches 1 and 2, level assessment 2024 (L1, L2) and trend assessment 1990-2024 (T1, T2) for source category 1A1, Energy Industries.

NFR code	Source category	Pollutant	Identification criteria
1A1a	Public electricity and heat production	NOx	L1, L2, T1, T2
1A1a	Public electricity and heat production	SOx	L1, L2, T1, T2
1A1a	Public electricity and heat production	PM10	T1

3.2.2.2 Methodological issues for 1A1 Energy industries (stationary)

3.2.2.2.1 Public electricity and heat production (1A1a)

Methodology (1A1a)

Within source category 1A1a Energy industries, heat and electricity production in waste incineration plants cause the largest emissions, as electricity production in Switzerland is dominated by hydroelectric power plants (almost 60 %) and nuclear power stations (more than 30 %). Emissions from industries producing heat and/or power for their own use are included in category 1A2 Manufacturing industries and construction.

Energy recovery from municipal solid waste incineration is mandatory in Switzerland and plants are equipped with energy recovery systems (Schwager 2005). The emissions from municipal solid waste and special waste incineration plants are therefore reported under category 1A1a.

Emissions from fuel combustion in 1A1a Public electricity and heat production are estimated using a Tier 2 method, see decision tree in chapter 1A1 Energy industries in EMEP/EEA guidebook (EMEP/EEA 2023).

Emission factors (1A1a)

Municipal solid waste incineration plants and special waste incineration plants with heat and power generation (reported under "Other fuels"):

Emission factors are expressed in pollutant per energy content of municipal solid waste incinerated. They are all country-specific and based on extensive and repeated emission control measurements according to the Ordinance on Air Pollution Control on municipal solid waste incineration and special waste incineration plants (TBF 2005, TBF 2015, TBF 2021), as well as on expert estimates. The sources are documented in the EMIS documentation (EMIS 2026/1A1a Kehrichtverbrennungsanlagen and EMIS 2026/1A1a Sonderabfallverbrennungsanlagen). Emission factors take into account flue gas cleaning standards in incineration plants. In addition, the burn-out efficiency in modern municipal solid and special waste incineration plants is very high. The PCB emission factors from municipal solid waste and special waste incineration are based on the mass flow and emission model of former use and disposal of PCBs in Switzerland (Glüge et al. 2017), see Annex A2.2.

Until 2003 the same emission factors have been applied for special waste and municipal solid waste incineration plants (TBF 2005). The emission factors have been reevaluated and revised for the two types of installations separately for the years 2013 and 2018 (TBF 2015, TBF 2021). In general, emission factors for sewage sludge incineration plants are considerably higher compared to those for municipal solid waste incineration plants. Regardless, special waste incineration plants meet equal Ordinance on Air Pollution Control emission limit values as municipal solid waste incineration plants.

Table 3-33 Implied emission factors for 1A1a Public electricity and heat production of energy industries for Other fuels (municipal solid waste and special waste) in 2024.

1A1a Public electricity and heat production	Unit	NOx	NM VOC	SOx	NH3	PM2.5 _{ex}	PM10 _{ex}	TSP _{ex}	BC _{ex}
		g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
Waste	t	376	28	52	4.6	8.2	8.2	8.2	0.074
Hazardous waste	t	745	150	24	16	33	33	33	0.30
PCB	g	NA	NA	NA	NA	NA	NA	NA	NA

1A1a Public electricity and heat production	Unit	CO	Pb	Cd	Hg	PCDD/ PCDF	HCb	PCB
		g/...	mg/...	mg/...	mg/...	ng I- Teq/...	mg/...	mg/...
Waste	t	72	300	30	69	200	0.045	NA
Hazardous waste	t	229	1'383	124	42	250	NA	NA
PCB	g	NA	NA	NA	NA	NA	NA	0.0059

Wood combustion for combined heat and power generation as well as for heat production:

The wood combustion installation categories used in 1A1 are plants for renewable waste from wood products since 1990, combined chip heat and power generation plants since 1995 as well as automatic chip boilers (>300 kW, w/o wood processing companies, >500 kW, within wood processing companies) and automatic pellet boilers (>300 kW) since 2024. All emission factors are based on an emission factor model for wood energy by Zotter and Nussbaumer (2022) as described in chapter 3.2.1.1.3.

Fossil fuels for heat production and for power generation with boilers not further defined:

Emission factors for NO_x, CO, NM VOC and PM2.5/PM10/TSP are country-specific and are documented in SAEFL 2000 (pp. 14 – 27). For NO_x emission factors, expert judgement has been used to estimate the fraction of low-NO_x burners. The emission factors for NO_x and CO for natural gas and gas oil are based on Leupro (2012) and Zotter and Nussbaumer (2026). The particulate matter emission factors for natural gas and gas oil from 2020 onwards are also based on Zotter and Nussbaumer (2026).

The emission factors for SO_x are based on the estimated sulphur content for each combustible, see detailed description in chp. 3.2.1.2.

Emission factors for Hg, Pb, Cd, PCDD/PCDF and PAH are taken from the EMEP/EEA guidebook (EMEP/EEA 2019) as follows:

- Gas oil; PAH: chp. 1A4, Tier 1, Table 3.9 liquid fuels
- Gas oil; Pb, Hg, Cd, PCDD/PCDF: chp. 1A4, Table 3.18
- Natural gas; Pb, Hg, Cd, PAH: chp. 1A4, Tier 2, Table 3.13
- Natural gas; PCDD/PCDF: chp. 1A4, Tier 2 Table 3.26

The emission factors of HCB and PCBs are taken from the Danish emission inventory for HCB and PCBs (Nielsen et al. 2013).

Engines and gas turbines

The use of fossil and biogenic fuels in engines and gas turbines is described in the specific model description chp. 3.2.1.1.2. For the greenhouse gas inventory under the UNFCCC reporting the fossil carbon fraction in biodiesel is estimated based on the method described in chp. 3.2.1.1.2. For technical reasons in our database, there is a split of the whole biodiesel amount in fossil and biogenic biodiesel and not only for the carbon fraction and CO₂. Therefore, there are two lines with biodiesel, one with “biodiesel fossil” and one with “biodiesel biogenic”.

Table 3-34 Implied emission factors for 1A1a Public electricity and heat production of energy industries for fossil fuels, biogenic fuels and wood in 2024.

1A1a Public electricity and heat production	Unit	NOx	NM VOC	SOx	NH3	PM2.5 _{ex}	PM10 _{ex}	TSP _{ex}	BC _{ex}	CO
		g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
Gas oil	GJ	38	4.3	0.77	0.40	1.8	1.8	1.8	0.13	10
Residual fuel oil	GJ	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other bituminous coal	GJ	NO	NO	NO	NO	NO	NO	NO	NO	NO
Natural gas	GJ	25	6.2	0.43	0.14	0.24	0.24	0.24	0.0024	14
Biodiesel fossil	GJ	405	50	0.30	3.5	30	30	30	2.3	131
Biodiesel biogenic	GJ	405	50	0.30	3.5	30	30	30	2.3	131
Biogas	GJ	53	11	0.50	0.32	0.40	0.40	0.40	0.00089	23
Wood and wood waste	GJ	78	1.3	7.3	3.0	2.5	2.6	2.7	0.064	41

1A1a Public electricity and heat production	Unit	Pb	Cd	Hg	PCDD/ PCDF	BaP	BbF	BkF	IcdP	HCB	PCB
		mg/...	mg/...	mg/...	ng l- Teg/...	mg/...	mg/...	mg/...	mg/...	ng/...	ng/...
Gas oil	GJ	0.019	0.0014	0.12	1.8	0.0019	0.015	0.0017	0.0015	215	0.11
Residual fuel oil	GJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other bituminous coal	GJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Natural gas	GJ	0.0034	0.00039	0.10	0.50	0.00059	0.0013	0.00088	0.00089	NA	NA
Biodiesel fossil	GJ	0.15	0.0099	0.11	1.00	0.0019	0.015	0.0017	0.0015	218	0.11
Biodiesel biogenic	GJ	0.15	0.0099	0.11	1.00	0.0019	0.015	0.0017	0.0015	218	0.11
Biogas	GJ	0.0058	0.00056	0.10	0.51	0.00063	0.0018	0.00094	0.00095	NA	NA
Wood and wood waste	GJ	40	1.3	2.0	32	0.48	0.48	0.48	0.48	930	10

Activity data (1A1a)

Municipal solid waste incineration

Activity data for municipal solid waste and special waste incineration are based on annual waste statistics (FOEN 2025j) and provided in the table below.

Table 3-35 Activity data for 1A1a Other fuels: municipal solid waste and special waste incineration plants (with heat and/or power generation).

1A1a Public electricity and heat production	Unit	1990	1995	2000	2005	2010
Waste	kt	2'470	2'270	2'801	3'297	3'717
Hazardous waste	kt	133	163	239	230	252
PCB	t	60	44	73	49	31

1A1a Public electricity and heat production	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Waste	kt	3'889	4'010	4'011	4'042	4'059	4'072	4'027	3'853	3'921	4'070
Hazardous waste	kt	261	254	236	255	262	241	218	261	209	199
PCB	t	20	18	17	16	14	13	12	11	10	9.7

Engines and gas turbines

The use of fossil and biogenic fuels in engines and gas turbines is described in the specific model description chp. 3.2.1.1.2.

Other public electricity and heat production

Apart from fossil or biogenic municipal solid waste, hazardous waste, wood waste and wood, fuel consumption (TJ) for Public electricity and heat production (1A1a) as activity data are extracted from the Swiss overall energy statistics (SFOE 2025; Tables 21, 26, and 28).

Activity data for wood as fuel for combined heat and power generation and for plants for renewable waste from wood products are taken from the Swiss wood energy statistics (SFOE 2025b) as described in chapter 3.2.1.1.3 Model for wood energy combustion.

Table 3-36 Fuel consumption of 1A1a Public electricity and heat production.

1A1a Public electricity and heat production	Unit	1990	1995	2000	2005	2010					
Total fuel consumption	TJ	40'379	39'179	49'913	56'978	61'751					
Gas oil	TJ	980	554	790	1'300	490					
Residual fuel oil	TJ	3'214	1'813	340	290	40					
Other bituminous coal	TJ	530	46	NO	NO	NO					
Natural gas	TJ	4'339	5'422	8'292	9'827	9'926					
Waste fossil	TJ	13'995	13'662	17'784	20'181	21'044					
Hazardous waste fossil	TJ	2'610	3'206	4'692	4'514	4'941					
Biodiesel fossil	TJ	NO	NO	NO	0.11	0.47					
Biodiesel biogenic	TJ	NO	NO	NO	2.1	10					
Biogas	TJ	247	614	573	207	49					
Waste biogenic	TJ	14'163	13'396	16'894	19'813	22'292					
Wood and wood waste	TJ	301	466	547	844	2'958					

1A1a Public electricity and heat production	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total fuel consumption	TJ	61'386	65'017	64'752	65'311	66'483	66'402	66'988	64'124	64'072	67'825
Gas oil	TJ	660	430	490	380	450	350	580	590	610	390
Residual fuel oil	TJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other bituminous coal	TJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Natural gas	TJ	7'050	8'926	7'907	8'111	8'444	8'341	9'271	7'198	6'571	6'672
Waste fossil	TJ	22'054	23'146	23'377	23'697	23'974	24'154	23'802	22'972	23'070	23'694
Hazardous waste fossil	TJ	5'115	4'979	4'641	5'013	5'148	4'722	4'276	5'127	4'101	3'974
Biodiesel fossil	TJ	0.43	0.35	0.35	0.28	0.28	0.30	0.32	0.34	0.33	0.34
Biodiesel biogenic	TJ	7.7	7.4	7.7	6.4	6.2	6.0	6.0	6.1	6.0	6.1
Biogas	TJ	21	13	6.5	6.0	8.4	14	125	138	147	162
Waste biogenic	TJ	23'379	24'296	24'298	24'387	24'430	24'372	23'781	22'725	22'823	23'440
Wood and wood waste	TJ	3'098	3'218	4'024	3'710	4'022	4'443	5'147	5'366	6'743	9'486

3.2.2.2 Petroleum refining (1A1b)

Switzerland originally had two petroleum refining plants. One refinery operated at reduced capacity in 1990 but resumed full production in subsequent years. In 2012, one refinery was shut down for six months due to insolvency and the search for a new buyer (EV 2014). After one refinery permanently ceased operations in 2015, the data have been considered confidential and are available to reviewers upon request. In addition, operations were interrupted several times in 2014.

Methodology (1A1b)

Based on the decision tree in Fig. 4-1 in chapter 4 1A1b Petroleum refining of the EMEP/EEA guidebook (EMEP/EEA 2023), emissions from fuel combustion are calculated using a Tier 2 bottom-up approach. The calculations are generally based on measurements and data from individual point sources in the refining industry.

Since 2013, refineries in Switzerland have participated in the Swiss Emissions Trading Scheme (ETS). From 2013 onwards, fuel consumption data are available from annual monitoring reports, which provide plant-specific activity data, as well as from an allocation report, which provides plant-specific information for the period 2005-2011.

Emission factors (1A1b)

Emission factors for fuel combustion are confidential, but are available to reviewers upon request.

Emission factors for gas turbines with SCGT are described in chp. 3.2.1.1.2.

Activity data (1A1b)

Activity data on fuel combustion for 1A1b Petroleum refining, are provided by the Swiss overall energy statistics (SFOE 2025) and by the refining industry (bottom-up data). Industry data are collected by Carbura and forwarded to the Swiss Federal Office of Energy for inclusion in the Swiss overall energy statistics (SFOE 2025). As one of the refineries ceased operation in 2015, the data have been considered confidential since 2014 and are available to reviewers upon request. The use of refinery gas in gas turbines with SCGT is described in chp. 3.2.1.1.2.

Refinery gas is the most important fuel used in source category 1A1b. Energy consumption, in particular the use of refinery gas, has increased substantially since 1990 because one of the two Swiss refineries operated at reduced capacity in 1990 and resumed full production in subsequent years. In 2012, one of the refineries was shut down for six months due to insolvency and the search for a new buyer (EV 2014). Between 2004 and 2015, one of the Swiss refineries also used petroleum coke as a fuel. Natural gas has been used in addition to residual fuel oil and refinery gas since 2017. In 2019 and 2020 as well as 2022-2024, the use of residual fuel oil was halted.

Net calorific values (NCVs) are provided by annual monitoring reports of the refining industry for the years 2005-2011 and 2013-2024, as required under the Swiss Federal Act and Ordinance on the Reduction of CO₂ Emissions (Swiss Confederation 2011, Swiss Confederation 2012). For years with missing data (1990-2004 and 2012), weighted mean net calorific values are applied for residual fuel oil and petroleum coke. The net calorific value of refinery gas is based on an estimate provided by one of the two refining plants for the years 1990-2004 and is assumed to be constant. The use of a plant-specific net calorific value leads to a slight difference from the energy consumption data provided by the Swiss overall energy statistics (SFOE 2025).

Table 3-37 Activity data of 1A1b Petroleum Refining.

1A1b Petroleum refining	Unit	1990	1995	2000	2005	2010														
Total fuel consumption	TJ	5'629	9'836	9'636	14'548	14'176														
Petroleum coke	TJ	NO	NO	NO	1'813	2'003														
Refinery residual fuel oil	TJ	1'259	1'786	1'908	902	891														
Refinery gas	TJ	4'370	8'050	7'728	11'833	11'282														
Natural gas	TJ	NO	NO	NO	NO	NO														
1A1b Petroleum refining	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024									
Total fuel consumption	TJ	7'232	6'355	6'298	6'627	5'911	5'987	5'160	6'575	6'198	5'617									
Petroleum coke	TJ	C	NO	NO	NO	NO	NO	NO	NO	NO	NO									
Refinery residual fuel oil	TJ	C	C	C	C	NO	NO	C	NO	NO	NO									
Refinery gas	TJ	C	C	C	C	C	C	C	C	C	C									
Natural gas	TJ	NO	NO	C	C	C	C	C	C	C	C									

3.2.2.2.3 Manufacture of solid fuels and other energy industries (1A1c)

Methodology (1A1c)

Based on the decision tree Figure 5.1 in chapter 1A1c Manufacture of solid fuels and other energy industries of the EMEP/EEA guidebook (EMEP/EEA 2023), the emissions are calculated by a Tier 2 approach. The only activity in this source category is charcoal production and is only of minor importance in Switzerland.

Emission factors (1A1c)

Emission factors for NO_x, NMVOC, CO are based on the revised 1996 IPCC Guidelines (IPCC 1996) and for PM10 exhaust and TSP exhaust based on USEPA (1995, Chapter 10.7 Charcoal). PM2.5 exhaust is supposed to be 95 % from PM10 exhaust (EMIS 2026/1A1c). Since there is no information available on BC emissions from source category 1A1c Charcoal production (artisanal) its BC factor (%PM2.5) is set to the default Tier 2 value (48 %) of coke manufacture provided in the EMEP/EEA guidebook (EMEP/EEA 2023, chp. 1A1c Manufacture of solid fuels and other energy industries, Tab. 5-2/5-3). Neither the 1996 IPCC Guidelines nor the EMEP/EEA guidebook provide a SO_x emission factor for charcoal production. The latter one contains data on coke manufacture only which we did not consider as applicable for artisanal charcoal production as the sulphur content of coal is more than one order of magnitude higher than that of wood.

Table 3-38 Emission factors of 1A1c charcoal production in 2024.

1A1c Manufacture of solid fuels and other energy industries	Unit	NO _x	NMVOC	SO _x	NH ₃	PM2.5 ex	PM10 ex	TSP ex	BC ex	CO
		g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
Charcoal	GJ	10	1'700	NE	NE	3'700	3'900	4'800	1'776	7'000

1A1c Manufacture of solid fuels and other energy industries	Unit	Pb	Cd	Hg	PCDD/ PCDF	BaP	BbF	BkF	lcdP	HCB	PCB
		mg/...	mg/...	mg/...	ng l- Teq/...	mg/...	mg/...	mg/...	mg/...	ng/...	ng/...
Charcoal	GJ	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

Activity data (1A1c)

Activity data on annual charcoal production are provided by the Swiss association of charcoal producers (Köhlerverband Romoos) and individual producers as documented in the EMIS documentation (EMIS 2026/1A1c).

Table 3-39 Activity data of 1A1c charcoal production.

1A1c Manufacture of solid fuels and other energy industries	Unit	1990	1995	2000	2005	2010
Charcoal	TJ	1.3	1.4	2.2	3.4	3.6

1A1c Manufacture of solid fuels and other energy industries	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Charcoal	TJ	3.8	4.1	3.9	4.3	5.1	3.9	4.0	3.4	3.4	3.1

3.2.2.3 Category-specific recalculations in 1A1 Energy industries (stationary)

The following recalculations were implemented in submission 2026:

- 1A1a: The SO_x emission factor for natural gas has been updated in the period 2016-2023 to reflect the sulphur content of the gas after the odorant addition, rather than before.
- 1A1a: Based on recalculations in the Swiss overall energy statistics, yearly amounts of around 630 to 840 TJ of natural gas have been reallocated from 1A4 Other Sectors commercial/institutional to 1A1a Public electricity and heat production for the years 2020-2023.
- 1A1a: The activity data of 1A1a Public electricity and heat production, for landfill gas production, was revised due to an update in the underlying national statistics.
- 1A1a: In source category 1A2gviii, the activity data of combined chip heat and power plants were revised for 2019 and 2023 as well as of plants for renewable waste from wood products for 2023 due to recalculations in the Swiss wood energy statistics (SFOE 2025b).
- 1A1a: The fuel consumption of gas oil in 1A1a electricity generation was revised for the year 2023 due to an update in the underlying statistics of the national energy balance.

- 1A1aii Combined heat and power generation: Due to an error in the aggregation in the EMIS database, emissions were wrongly attributed to source category 1A1aii instead of 1A2gviii, for liquified petroleum gas. This correction affects all years from 1990 to 2023.
- 1A1b: The SO_x emission factor of natural gas for the period 2016-2023 has been updated to reflect the sulphur content of the gas after the odorant addition, rather than before.
- 1A1b Petroleum refining refinery residual fuel oil: The computational steps were reorganized to streamline the model, resulting in minor rounding changes for the years 1990-2019 and 2021.
- 1A1b Petroleum refining refinery gas: The computational steps were reorganized to streamline the model, resulting in minor rounding changes for the years 1990-2023.
- 1A1b Petroleum refining petroleum coke: The computational steps were reorganized to streamline the model, resulting in minor rounding changes for the years 2004-2015.
- 1A1c: The activity data of 1A1c Charcoal production was updated for 2023 based on information provided by individual charcoal producers.

3.2.3 Source category 1A2 - Stationary combustion in manufacturing industries and construction

3.2.3.1 Source category description for 1A2 Stationary combustion in manufacturing industries and construction

The source category 1A2 Stationary combustion in manufacturing industries and construction comprises all emissions from the combustion of fuels in stationary boilers and cogeneration facilities within manufacturing industries and construction. This includes use of conventional fossil fuels as well as waste derived fuels and biomass. Within this category, only activities involving fuel combustion are taken into account. Note that information regarding vehicles and machinery of source category 1A2gvii Mobile combustion in manufacturing industries and construction are provided in chapter 3.2.5.

Table 3-40 Specification of source category 1A2 Stationary combustion in manufacturing industries and construction (stationary without 1A2gvii) in Switzerland.

1A2	Source category	Specification
1A2a	Iron and steel	Fuel combustion in iron and steel industry (cupola furnaces of iron foundries, reheating furnaces in steel plants, boilers)
1A2b	Non-ferrous metals	Fuel combustion in non-ferrous metals industry (non-ferrous metals foundries, aluminium production (ceased in 2006), boilers)
1A2c	Chemicals	Fuel combustion in chemical industry (steam production from cracker by-products, boilers)
1A2d	Pulp, paper and print	Fuel combustion in pulp, paper and print industry (furnaces of cellulose production (ceased in 2008), boilers and gas turbines)
1A2e	Food processing, beverages and tobacco	Fuel combustion in food processing, beverages and tobacco industry (boilers)
1A2f	Non-metallic minerals	Fine ceramics, container glass, tableware glass, glass wool, lime, mineral wool, mixed goods, cement, brick and tile
1A2gviii	Other	Fibreboard production, use of fossil fuel and biomass (wood and biogas) in industrial boilers, engines and gas turbines

Table 3-41 Key categories, approaches 1 and 2, level assessment 2024 (L1, L2) and trend assessment 1990-2024 (T1, T2) for source category 1A2 Combustion in manufacturing industries and construction (stationary only).

NFR code	Source category	Pollutant	Identification criteria
1A2d	Stationary combustion in manufacturing industries and construction: pulp paper and print	SOx	T1, T2
1A2e	Stationary combustion in manufacturing industries and construction: food processing beverages and tobacco	SOx	T2
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	NOx	L1, L2, T1, T2
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	SOx	L1, L2, T1, T2
1A2gviii	Stationary combustion in manufacturing industries and construction: other	NOx	T1, T2
1A2gviii	Stationary combustion in manufacturing industries and construction: other	SOx	L1, L2
1A2gviii	Stationary combustion in manufacturing industries and construction: other	PM2.5	L1

3.2.3.2 Methodological issues for 1A2 Stationary combustion in manufacturing industries and construction

3.2.3.2.1 Methodology (1A2) and industry model

Based on the decision tree Fig. 3.1 in chapter 1A2 Combustion in manufacturing industries and construction of the EMEP/EEA guidebook (EMEP/EEA 2023), the emissions are calculated according to a Tier 2 approach based on country-specific emission factors.

Overview industry model

As a sub-model of the Swiss energy model (see chp. 3.1.6.3.2), the industry model disaggregates for each fuel type, the total fuel consumption in the industry sector provided by the Swiss overall energy statistics (SFOE 2025, see also description in chp. 3.1.6.3) into the source categories and processes under 1A2 Manufacturing industries and construction. As visualized in Figure 3-22, the industry model is based on two pillars. First, the energy consumption statistics in the industry and services sectors (SFOE 2025d) provide a comprehensive annual survey of fuel consumptions for all years since 1999 or 2002 (depending on the fuel type, see paragraph “Energy consumption statistics in the industry and services sectors” below). These statistics are consistently extended back to 1990 based on a bottom-up industry model (Prognos 2013, see paragraph “Modelling of industry categories” below). Second, further disaggregation is achieved by using plant-level industry data for specific processes, as far as available (see paragraph “Bottom-up industry data” below).

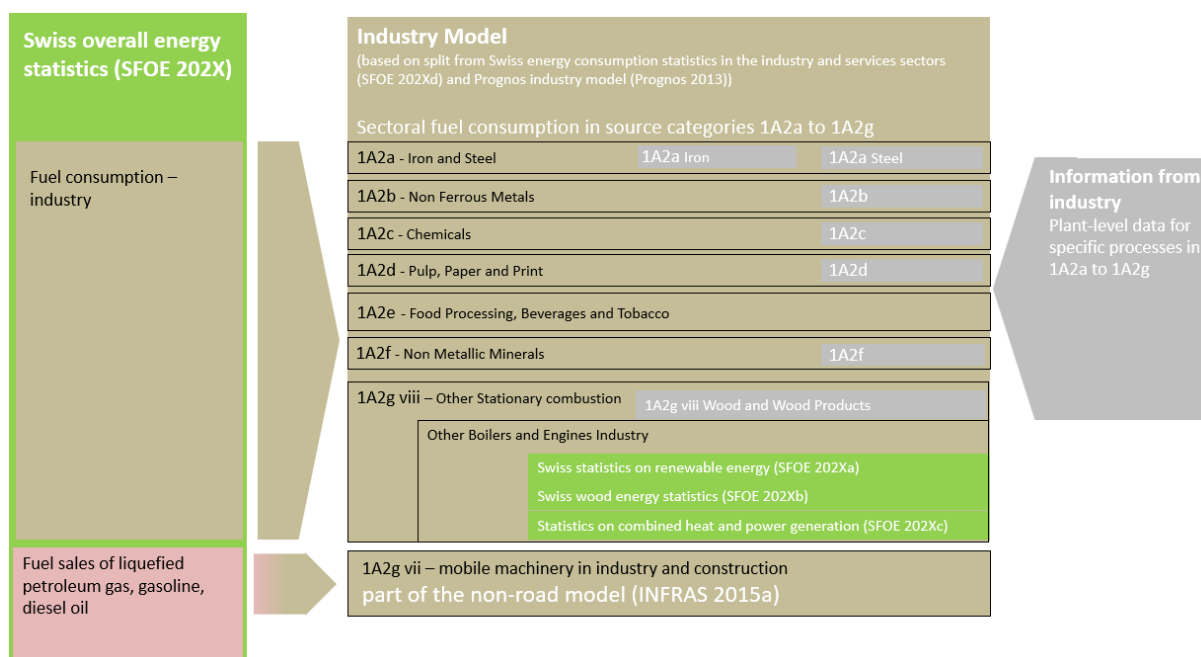


Figure 3-22 Schematic presentation of the data sources used for the industrial sectors 1A2a – 1A2g. The references SFOE 202X, SFOE 202Xa, 202Xb and 202Xc refer to the 2025 edition of the corresponding energy statistics. For each fuel type, the Swiss overall energy statistics provide the total fuel consumption in the industry sector (SFOE 2025). The total fuel consumption is then distributed to the different source categories based on the energy consumption statistics in the industry and services sectors (SFOE 2025d) for all years since 1999 or 2002 (depending on the fuel type), consistently extended back to 1990 based on a bottom-up industry model (Prognos 2013). The grey boxes on the right show the further disaggregation achieved by using plant-level industry data for specific processes.

Energy consumption statistics in the industry and services sectors

The energy consumption statistics in the industry and services sectors (SFOE 2025d) refer to representative annual surveys with about 13'000 workplaces in the industry and services sectors that are then grossed up or extrapolated to the entire industry branch. For certain sectors and fuel types (i.e. industrial waste, residual fuel oil, other bituminous coal and lignite) the surveys represent a census covering all fuel consumed. The surveys are available since 1999 for gas oil and natural gas. For all other standard fossil fuels (i.e. residual fuel oil, liquefied petroleum gas, petroleum coke, other bituminous coal and lignite) data are available since 2002.

In 2015, a change in the survey method of the energy consumption statistics in the industry and services sectors was implemented (SFOE 2015d). In brief, the business and enterprise register, which forms the basis for the samples of the surveys, was revised. While previously the business and enterprise register was based on direct surveys with workplaces, it is now based on annual investigations of registry data (e.g. from the old-age and life insurance). During this revision, a comparative assessment was conducted for the year 2013. This comparison showed that the energy consumption in the source categories of 1A2 stationary are modified by less than 1 percent, but also that the differences between the new and the old results for 2013 are not statistically significant (SFOE 2015d). As these statistics are only used for allocation of total energy consumption to different source categories, the impact on the different source categories consists only of a reallocation of the energy consumption and does not affect the total of the sector. Moreover, only consumption of gas oil and natural gas is affected. For all these reasons, the time series consisting of data based on the old (1990-2012) and new (since 2013) survey method are therefore considered consistent.

Modelling of industry categories

As mentioned above, the energy consumption statistics in the industry and services sectors (SFOE 2025d) are available since 1999 or 2002. In order to get consistent time series starting in 1990, a bottom-up industry model (Prognos 2013) is used. The model is based on 164 individual industrial processes and further 64 processes related to infrastructure in industry. Fuel consumption of a specific process is calculated by multiplication of the process activity data with the process-specific fuel consumption factor.

The model provides data on the disaggregation of total energy consumption according to different industries and services between 1990 and 2012. For the time period where the two disaggregation methods (i.e. surveys and model) overlap, systematic differences between the two time series can be detected. These two data sets have been combined in order to obtain consistent time series of the shares of each source category 1A2a-1A2g for each fuel type. For this purpose, the approach to “generate consistent time series from overlapping time series” is used according to the 2019 Refinement to the 2006 IPCC Guidelines (IPCC 2019, Volume 1, chp. 5.3.3.1, overlap). To illustrate the approach, an example for gas oil attributed to source category 1A2c is provided in Figure 3-23. A detailed description for all fuel types and source categories (1A2a-1A2g), including further assumptions, is provided in the underlying EMIS documentation (EMIS 2026/1A2_Sektorgliederung Industrie).

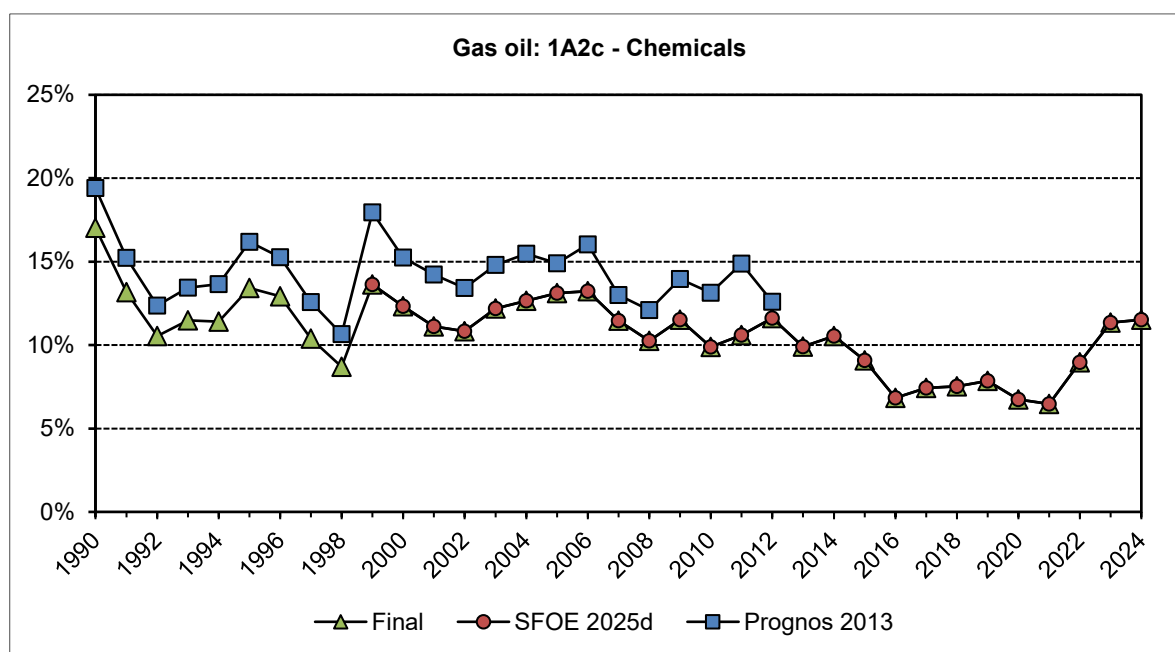


Figure 3-23 Illustrative example for combining time series with consistent overlap according to the 2019 Refinement (IPCC 2019, Volume 1, chp. 5.3.3.1, overlap). The y-axis indicates the share of source category 1A2c in total gas oil consumption in the industry sector. The green triangles correspond to the share finally used to calculate the fuel consumption in 1A2c, based on the combination of the shares from the energy consumption statistics in the industry and services sectors (SFOE 2025d, orange dots, since 1999) and the bottom-up industry model (Prognos 2013, blue squares, from 1990 to 2012). Similar calculations are performed for each source category and fuel type.

Bottom-up industry data

Grey colored boxes in Figure 3-22 represent source categories (i.e. 1A2a-d, 1A2f and 1A2gviii) for which bottom-up data from the industry are used in order to further disaggregate the fuel consumption within a particular source category. These data consist of validated and verified monitoring data from the Swiss emissions trading scheme implemented under the Ordinance for the Reduction of CO₂ Emissions (Swiss Confederation 2012) and are discussed in depth in the following chapters 3.2.3.2.2 to 3.2.3.2.8.

The bottom-up information provides activity data for specific industrial production processes and forms a subset of the total fuel consumption allocated to each source category by the approach described above. Therefore, the fuel consumptions of the bottom-up industry processes are subtracted from the total fuel consumption of the respective source category and the remaining fuel consumptions are considered as fuels used in boilers of each source category (exclusion principle). This method ensures that the sum of fuel consumptions over all processes of a source category corresponds to the total fuel consumption assigned based on the energy consumption statistics in the industry and services sectors (SFOE 2025d) and the bottom-up industry model (Prognos 2013).

There is a difference in calculating the emissions from boilers and bottom-up industry processes. For boilers, fuel consumption is used as activity data whereas for bottom-up processes production data is used.

Further specific statistical data

The share of fuel used for co-generation in turbines and engines within 1A2 is derived from a model of stationary engines and gas turbines developed by INFRAS (2022a) as described in chapter 3.2.1.1.2.

Fuel consumption of wood, wood waste and biogas in manufacturing industries is based on the Swiss wood energy statistics (SFOE 2025b) as well as on data from the Swiss renewable energy statistics (SFOE 2025a) and the Statistics on combined heat and power generation in Switzerland (SFOE 2025c), respectively. Emissions from these sources are reported under 1A2gviii Other due to insufficient information regarding sectoral disaggregation.

Emission factors (1A2)

This chapter describes the emission factors of fossil fuel consumption in boilers. Emission factors are identical for all source categories. Emission factors of bottom-up industry processes and other relevant processes are described in the following chapters for each source category. Emission factors for engines and gas turbines are described in chapter 3.2.1.1.2.

For liquefied petroleum gas and petroleum coke, the same emission factors are assumed for all air pollutants as for natural gas and residual fuel oil, respectively, except for SO_x of liquefied petroleum gas (see chp. 3.2.1.2).

The emission factors of NO_x and CO for natural gas and gas oil are derived from a large number of air pollution control measurements of combustion installations in several Swiss cantons in 1990, 2000 and 2010 (Leupro 2012) and 2022 (Zotter and Nussbaumer 2026). The emission factors for residual fuel oil, other bituminous coal and lignite are country-specific and documented in the Handbook on emission factors for stationary sources (SAEFL 2000). The emission factors for NMVOC and NH₃ as well as PM_{2.5}, PM₁₀ and TSP (until 2020) are country-specific and documented in the Handbook on emission factors for stationary sources (SAEFL 2000). The particulate matter emission factors for natural gas and gas oil from 2020 onwards are also based on Zotter and Nussbaumer (2026).

The SO_x emission factors for gas oil, residual fuel oil, liquefied petroleum gas, other bituminous coal, lignite and natural gas are described in chp. 3.2.1.2 and Table 3-30.

Emission factors of BC (% PM_{2.5}), Pb (except natural gas), Cd (except natural gas), Hg, PCDD/PCDF (except natural gas) and PAH (except natural gas) are taken from the EMEP/EEA guidebook (EMEP/EEA 2023). For natural gas, emission factors of Pb, Cd, PCDD/PCDF and PAH are still based on EMEP/EEA (2019). The emission factors of HCB and PCBs are taken from the Danish emission inventory for HCB and PCBs (Nielsen et al. 2013). There is a difficulty with industrial gas oil burners, as there is a lack of data for non-residential medium-

sized boiler in the EMEP/EEA guidebook. Therefore, the emission factors available for the different combustion installations burning gas oil were compared and then the most reasonable and most current data were chosen. The emission factors of BC (% PM2.5), Pb, Cd, Hg and PCDD/PCDF are taken from table 3-18 (EMEP/EEA 2023, Tier 2 Residential plants, boilers burning liquid fuels, chp. 1A4). While the emission factors of PAHs are taken from table 3-9 (EMEP/EEA 2023, Tier 1 emission factors for NFR source category 1.A.4.a/c, 1.A.5.a, using liquid fuels) as they represent an average of Tier 2 emission factors for liquid fuel combustion for all technologies.

Table 3-42 Emission factors for fossil fuel boilers of 1A2 Stationary combustion in manufacturing industries and construction in 2024.

1A2 Manufacturing industries and construction (boilers)	Unit	NOx	NM VOC	SOx	NH3	PM2.5 ex	PM10 ex	TSP ex	BC ex	CO
		g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
Gas oil	GJ	28	2.0	0.77	0.0020	0.19	0.19	0.19	0.0073	3.7
Residual fuel oil	GJ	NO	NO	NO	NO	NO	NO	NO	NO	NO
Liquefied petroleum gas	GJ	17	2.0	0.50	0.00100	0.087	0.087	0.087	0.0047	8.0
Petroleum coke	GJ	125	4.0	283	0.0020	20	20	23	2.0	10
Other bituminous coal	GJ	200	10	500	0.0030	45	45	50	2.9	100
Lignite	GJ	200	10	500	0.0030	45	45	50	2.9	100
Natural gas	GJ	17	2.0	0.43	0.0010	0.087	0.087	0.087	0.0047	8.0

1A2 Manufacturing industries and construction (boilers)	Unit	Pb	Cd	Hg	PCDD/PCDF	BaP	BbF	BkF	IcdP	HCB	PCB
		mg/...	mg/...	mg/...	ng I- Teg/...	mg/...	mg/...	mg/...	mg/...	ng/...	ng/...
Gas oil	GJ	0.012	0.0010	0.12	1.8	0.0019	0.015	0.0017	0.0015	220	0.11
Residual fuel oil	GJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Liquefied petroleum gas	GJ	0.0015	0.00025	0.10	0.50	0.00056	0.00084	0.00084	0.00084	NA	NA
Petroleum coke	GJ	4.6	1.2	0.34	2.5	0.0045	0.0045	0.0045	0.0069	220	3.2
Other bituminous coal	GJ	167	1.0	16	40	0.079	1.2	0.85	0.62	620	53
Lignite	GJ	167	1.0	16	40	0.079	1.2	0.85	0.62	620	53
Natural gas	GJ	0.0015	0.00025	0.10	0.50	0.00056	0.00084	0.00084	0.00084	NA	NA

Activity data (1A2)

Table 3-43 shows the total fuel consumption in 1A2. Table 3-44 to Table 3-49 show fuel consumption in boilers of each source category 1A2a-1A2gviii as described above in the industry model (chp. 3.2.3.2.1). Consumption of other fossil fuels occurs mainly in source category 1A2f, where it refers to fossil waste fuels in cement production. But also, the cracker by-products, i.e. gasolio, heating gas and synthesis gas (from 2018 onwards) used for steam production in a chemical plant in source category 1A2c are included. There is no fuel consumption in boilers of source category 1A2f Non-metallic minerals since this source category consists of specific bottom-up industry processes only.

Table 3-43 Total fuel consumption of 1A2 Stationary combustion in manufacturing industries and construction.

1A2 Manufacturing industries and construction (stationary, i.e. without 1A2gvii)	Unit	1990	1995	2000	2005	2010
Total fuel consumption	TJ	88'851	89'268	87'445	90'720	89'388
Gas oil	TJ	22'910	24'471	25'892	25'317	21'137
Residual fuel oil	TJ	18'870	13'678	5'675	4'613	2'036
Liquefied petroleum gas	TJ	4'352	4'415	5'508	4'203	3'788
Petroleum coke	TJ	1'400	1'260	551	1'093	1'495
Other bituminous coal	TJ	13'476	7'303	5'866	4'799	4'348
Lignite	TJ	265	153	124	742	1'460
Natural gas	TJ	19'610	28'700	32'000	34'870	38'420
Other fossil fuels	TJ	2'469	2'718	3'812	4'138	4'625
Biomass	TJ	5'500	6'570	8'018	10'944	12'080

1A2 Manufacturing industries and construction (stationary, i.e. without 1A2gvii)	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total fuel consumption	TJ	78'751	79'820	80'250	77'430	77'083	73'959	78'119	70'406	64'575	63'325
Gas oil	TJ	12'725	12'812	11'489	10'871	10'071	8'854	9'074	8'725	7'679	6'773
Residual fuel oil	TJ	196	155	123	34	111	76	55	NO	41	NO
Liquefied petroleum gas	TJ	3'245	2'619	3'085	3'022	2'904	2'781	2'925	2'930	3'022	2'703
Petroleum coke	TJ	795	890	763	781	777	700	604	731	733	507
Other bituminous coal	TJ	1'946	1'517	1'634	1'665	1'481	1'186	1'184	1'364	1'070	670
Lignite	TJ	3'060	3'078	2'876	2'520	2'262	2'410	2'442	2'466	1'945	1'854
Natural gas	TJ	39'450	39'960	41'000	39'320	39'560	37'890	39'470	32'910	29'610	30'910
Other fossil fuels	TJ	4'566	5'178	5'085	5'608	5'759	5'815	5'806	5'665	5'307	5'306
Biomass	TJ	12'770	13'610	14'195	13'610	14'158	14'248	16'560	15'614	15'167	14'602

Energy: Source category 1A - Fuel combustion activities - Source category 1A2 - Stationary combustion in manufacturing industries and construction

Table 3-44 Fuel consumption in boilers of 1A2a Stationary combustion in manufacturing industries and construction: Iron and steel.

1A2a Iron and steel (boilers)	Unit	1990	1995	2000	2005	2010					
Total fuel consumption	TJ	1'045	1'017	978	1'094	1'657					
Gas oil	TJ	480	262	338	401	315					
Residual fuel oil	TJ	26	131	20	39	51					
Liquefied petroleum gas	TJ	408	193	286	217	219					
Natural gas	TJ	131	431	334	437	1'072					
1A2a Iron and steel (boilers)	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total fuel consumption	TJ	1'920	1'892	2'159	2'292	2'143	2'113	1'914	1'800	1'708	1'543
Gas oil	TJ	136	134	123	127	97	81	80	57	59	60
Residual fuel oil	TJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Liquefied petroleum gas	TJ	393	327	368	358	342	327	342	342	352	317
Natural gas	TJ	1'391	1'431	1'669	1'808	1'704	1'704	1'491	1'401	1'296	1'166

Table 3-45 Fuel consumption in boilers of 1A2b Stationary combustion in manufacturing industries and construction: Non-ferrous metals.

1A2b Non-ferrous metals (boilers)	Unit	1990	1995	2000	2005	2010					
Total fuel consumption	TJ	2'256	1'969	1'555	973	1'217					
Gas oil	TJ	451	336	225	119	108					
Residual fuel oil	TJ	NO	NO	NO	NO	0.024					
Liquefied petroleum gas	TJ	27	17	15	7.1	7.7					
Natural gas	TJ	1'779	1'616	1'315	848	1'101					
1A2b Non-ferrous metals (boilers)	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total fuel consumption	TJ	1'794	1'684	1'642	1'748	1'965	1'801	2'006	1'828	1'653	1'459
Gas oil	TJ	76	74	77	53	60	48	64	68	69	83
Residual fuel oil	TJ	44	NO	3.7	NO	NO	NO	NO	NO	NO	NO
Liquefied petroleum gas	TJ	9.9	8.3	9.3	9.0	8.6	8.3	8.6	8.6	8.9	8.0
Natural gas	TJ	1'664	1'602	1'552	1'686	1'897	1'745	1'933	1'751	1'575	1'368

Table 3-46 Fuel consumption in boilers of 1A2c Stationary combustion in manufacturing industries and construction: Chemicals.

1A2c Chemicals (boilers)	Unit	1990	1995	2000	2005	2010					
Total fuel consumption	TJ	14'511	15'236	13'544	15'515	11'836					
Gas oil	TJ	3'942	3'313	3'215	3'345	2'103					
Residual fuel oil	TJ	1'434	693	252	36	66					
Liquefied petroleum gas	TJ	15	13	12	10	7.5					
Natural gas	TJ	9'119	11'217	10'065	12'124	9'660					
1A2c Chemicals (boilers)	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total fuel consumption	TJ	12'551	14'401	13'834	13'312	11'834	10'878	10'674	9'149	8'037	8'373
Gas oil	TJ	1'167	881	860	825	799	602	593	790	881	789
Residual fuel oil	TJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Liquefied petroleum gas	TJ	9.0	7.5	8.4	8.2	7.9	7.5	7.9	7.9	8.1	7.3
Natural gas	TJ	11'375	13'512	12'966	12'479	11'026	10'268	10'073	8'351	7'148	7'577

Table 3-47 Fuel consumption in boilers of 1A2d Stationary combustion in manufacturing industries and construction: Pulp, paper and print.

1A2d Pulp paper and print (boilers)	Unit	1990	1995	2000	2005	2010					
Total fuel consumption	TJ	9'701	11'917	9'108	9'099	6'575					
Gas oil	TJ	1'188	1'751	1'403	1'456	852					
Residual fuel oil	TJ	5'250	3'061	1'417	2'092	279					
Liquefied petroleum gas	TJ	86	141	148	100	61					
Natural gas	TJ	3'177	6'963	6'141	5'451	5'383					
1A2d Pulp paper and print (boilers)	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total fuel consumption	TJ	3'321	2'988	2'857	2'077	2'155	2'058	2'256	1'940	1'669	1'931
Gas oil	TJ	383	410	288	293	345	284	247	363	270	177
Residual fuel oil	TJ	19	9.0	8.8	NO	NO	NO	NO	NO	NO	NO
Liquefied petroleum gas	TJ	60	50	57	55	53	50	53	53	54	49
Natural gas	TJ	2'859	2'518	2'504	1'729	1'757	1'724	1'957	1'524	1'345	1'705

Table 3-48 Fuel consumption in boilers of 1A2e Stationary combustion in manufacturing industries and construction; Food processing, beverages and tobacco.

1A2e Food processing beverages and tobacco (boilers)	Unit	1990	1995	2000	2005	2010					
Total fuel consumption	TJ	9'867	8'802	10'457	10'256	13'181					
Gas oil	TJ	7'410	5'511	5'515	4'070	3'778					
Residual fuel oil	TJ	1'160	466	137	NO	NO					
Liquefied petroleum gas	TJ	204	308	535	534	659					
Natural gas	TJ	1'094	2'517	4'270	5'653	8'744					

1A2e Food processing beverages and tobacco (boilers)	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total fuel consumption	TJ	11'591	10'992	11'231	10'843	11'851	11'858	12'215	10'064	10'037	10'224
Gas oil	TJ	2'522	2'503	2'110	1'925	2'119	2'009	2'298	2'246	2'063	1'822
Residual fuel oil	TJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Liquefied petroleum gas	TJ	838	699	785	763	731	699	731	731	752	677
Natural gas	TJ	8'230	7'790	8'337	8'155	9'001	9'150	9'186	7'087	7'222	7'725

Table 3-49 Fuel consumption in boilers of 1A2gviii Stationary combustion in manufacturing industries and construction: Other.

1A2gviii Stationary combustion Other (boilers)	Unit	1990	1995	2000	2005	2010					
Total fuel consumption	TJ	16'898	20'913	21'380	22'190	22'219					
Gas oil	TJ	7'418	11'626	13'484	14'497	12'705					
Residual fuel oil	TJ	5'237	3'605	47	4.9	9.3					
Liquefied petroleum gas	TJ	3'087	3'233	4'011	2'979	2'694					
Petroleum coke	TJ	765	914	15	383	318					
Other bituminous coal	TJ	205	140	12	88	11					
Lignite	TJ	NO	NO	NO	4.7	111					
Natural gas	TJ	186	1'396	3'811	4'233	6'371					

1A2gviii Stationary combustion Other (boilers)	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total fuel consumption	TJ	17'838	17'668	17'731	16'849	16'640	15'096	16'223	13'768	11'948	11'690
Gas oil	TJ	7'341	7'784	6'912	6'568	5'597	4'831	4'794	4'141	3'319	2'844
Residual fuel oil	TJ	2.8	7.9	4.3	2.2	2.4	3.7	2.8	NO	41	NO
Liquefied petroleum gas	TJ	1'854	1'443	1'801	1'775	1'709	1'642	1'734	1'717	1'692	1'564
Petroleum coke	TJ	104	155	113	168	169	65	21	193	165	5.6
Other bituminous coal	TJ	134	125	102	91	89	133	47	43	5.6	22
Lignite	TJ	204	197	182	153	141	144	138	135	122	102
Natural gas	TJ	8'198	7'955	8'617	8'092	8'934	8'275	9'487	7'539	6'603	7'152

3.2.3.2.2 Iron and steel (1A2a)

Methodology (1A2a)

Emission factors and activity data of fuel consumption in boilers of this source category are documented in Table 3-42 and Table 3-44, respectively. In the following chapters, only those source categories are described, that are directly based on bottom-up industry data as outlined above in chapter 3.2.3.2.1. In addition, the chapter on activity data provides an overview on the fuel consumption within 1A2a.

Reheating furnaces in steel production

There is no primary iron and steel production in Switzerland. Only secondary steel production using recycled steel scrap occurs. Today, steel is produced in two steel production plants only, after two plants closed in 1994. The remaining plants use electric arc furnaces (EAF) with carbon electrodes for melting the steel scrap. Therefore, only emissions from the reheating furnaces are reported in source category 1A2a. Since 1995, these furnaces have been using only natural gas for reheating the ingot moulds before the rolling mills. Process emissions from steel production are included in source category 2C1 Iron and steel production.

Electric arc furnaces in steel production:

In the electric arc furnaces of secondary steel production also so-called injection coal and petroleum coke for slag formation as well as natural gas are used. The emissions from the electric arc furnaces reported under source category 2C1 Steel production are based on air

pollution control measurements at the chimney and thus also include emissions from injection coal, coke and natural gas. Therefore, in order to avoid double counting, these fuel consumptions are subtracted from the respective boilers in source categories 1A2gviii Other (petroleum coke, other bituminous coal) and 1A2a Iron and steel (natural gas) based on plant-specific data from monitoring reports of the Swiss ETS for the years 2005-2011 and from 2013 onwards.

Cupola furnaces in iron foundries

Iron is produced in 14 iron foundries. About 75 % of the iron is processed in induction furnaces and 25 % in cupola furnaces. The share of induction furnaces increased since 1990 with a sharp increase in 2009 based on the closure of at least one cupola furnace. Induction furnaces use electricity for the melting process and therefore only process emissions occur, which are reported in source category 2C1 Iron and steel production.

Emission factors (1A2a)

Reheating furnaces in steel production

For NO_x, PM2.5/PM10, TSP and CO production weighted emission factors are derived from data that are based on various air pollution control measurements under the Ordinance on Air Pollution Control (Swiss Confederation 1985). In years with missing data, emission factors are estimated by interpolation. For NMVOC, SO_x and Hg country-specific emission factors are used. Emission factors for Pb and Cd are available for selected years. Since 1995, emission factors are assumed to be constant. The emission factors of BC (% PM2.5) are taken from EMEP/EEA guidebook (EMEP/EEA 2023, chp. 1A4, table Liquid fuels (rounded mean value), Appendix E for residual fuel oil and table 3-26 for natural gas), see EMIS 2026/1A2a Stahl-Produktion Wärmeöfen.

Cupola furnaces in iron foundries

Emission factors of NO_x, NMVOC, SO_x, PM2.5/PM10, TSP, CO, Pb, Cd and PCDD/PCDF are provided by the Swiss foundry association (Schweizerischer Giessereiverband GVS) and are assumed constant. The emission factors of BC (% PM2.5) is taken from EMEP/EEA guidebook (EMEP/EEA 2023, chp.1A4, Table 3-23). Emission factors of PAH are based on data from literature, see USEPA (1998) and EMIS 2026/1A2a Eisengiessereien Kupolöfen). The Hg emission factor is based on the default value for other bituminous coal of Table 3-23 (chp. 1A4) of EMEP/EEA (2023).

Table 3-50 Emission factors of 1A2a Iron and Steel in 2024.

1A2a Iron and steel		Unit	NOx	NMVOC	SOx	NH3	PM2.5 ex	PM10 ex	TSP ex	BC ex	CO
			g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
Iron foundries, cupola	Iron	t	67	40	1'500	NE	60	110	120	3.8	11'000
Steel plants, reheating furnaces	Steel	t	75	2.8	0.71	NE	2.1	2.1	4.1	0.11	0.50

1A2a Iron and steel		Unit	Pb	Cd	Hg	PCDD/PCDF	BaP	BbF	BkF	IcdP	HCb	PCB
			mg/...	mg/...	mg/...	ng I- Teq/...	mg/...	mg/...	mg/...	mg/...	mg/...	mg/...
Iron foundries, cupola	Iron	t	4'800	24	80	1'300	0.13	1.4	1.2	1.6	NE	NE
Steel plants, reheating furnaces	Steel	t	32	3.4	0.071	NE	NE	NE	NE	NE	NA	NA

Activity data (1A2a)

Activity data of iron and steel production that is used to calculate emissions from cupola ovens in iron foundries and reheating furnaces in steel plants is provided by the industry as documented in the EMIS documentation (EMIS 2026/1A2a).

Energy: Source category 1A - Fuel combustion activities - Source category 1A2 - Stationary combustion in manufacturing industries and construction

Reheating furnaces in steel production

Since 1995, steel production increased continuously until 2004 to reach the same production level as 1990. Up to 2022 the steel production remained about constant. In 2009, the production was significantly lower due to the financial crisis. Due to the economic situation, including the strong rise in electricity prices because of the war in Ukraine, production fell sharply from 2022 to 2023. One steel producer switched its production to high quality steel and therefore the specific energy use per tonne of steel produced increased between 1995 and 2000. This led to higher natural gas consumption. Data on annual steel production is provided by the steel production plant. Since 2009, activity data refer to monitoring reports of the Swiss ETS.

In steel production, mainly natural gas is used as fuel. Until 1994, the Swiss steel industry also used residual fuel oil in one steel production plant. Due to the closure of two steel production plants in 1994, the amount of fuel used in Swiss steel plants decreased significantly. Fuel consumption is derived from specific energy consumption per tonne of steel or iron and the annual production of steel or iron respectively.

Cupola furnaces in iron foundries

Annual production data are provided by the Swiss foundry association (Schweizerischer Giessereiverband GVS). The use of other bituminous coal decreased significantly due to a switch from cupola furnaces to induction furnaces. Bituminous coal used in cupola furnaces primarily acts as fuel, but also as carburization material and reductant. Therefore, emissions are accounted for in source category 1A2a. This allows to be consistent with the allocation of bituminous coal in the Swiss overall energy statistics (SFOE 2025).

Table 3-51 Activity data from production of iron and steel that is used to calculate bottom-up emissions from sources of 1A2a.

1A2a Iron and steel		Unit	1990	1995	2000	2005	2010					
Iron foundries, cupola	Iron	kt	90	60	55	32	13					
Steel plants, reheating furnaces	Steel	kt	1'108	716	1'022	1'082	1'082					
1A2a Iron and steel		Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Iron foundries, cupola	Iron	kt	9.2	8.6	8.8	8.6	6.0	5.1	5.4	5.8	5.4	4.5
Steel plants, reheating furnaces	Steel	kt	1'144	1'085	1'138	1'160	1'037	1'031	1'104	1'121	884	906

3.2.3.2.3 Non-ferrous metals (1A2b)

Methodology (1A2b)

Emission factors and activity data of fuel consumption in boilers of this source category are documented in Table 3-42 and Table 3-45, respectively. In the following chapters, only those source categories are described, that are directly based on bottom-up industry data as outlined above in chapter 3.2.3.2.1. In addition, the chapter on activity data provides an overview on the fuel consumption within 1A2b.

Source category 1A2b Non-ferrous metals includes secondary aluminium production plants as well as non-ferrous metal foundries, producing mainly copper alloys.

Secondary aluminium production plants:

Until 1993, secondary aluminium production plants have been in operation using gas oil. On the other hand, emissions from primary aluminium production in Switzerland are reported in

source category 2C3 as induction furnaces have been used. Its last production site closed in April 2006.

Non-ferrous metals smelters and furnaces

Regarding non-ferrous metal industry in Switzerland, only casting and no production of non-ferrous metals occur. There is one large company and several small foundries, which are organized within the Swiss foundry association (GVS).

Emission factors (1A2b)

Emissions from non-ferrous metals smelters and furnaces are derived from the emission factors per tonne of metal as shown in the following table as documented in the EMIS documentation (EMIS 2026/1A2b Buntmetallgiessereien übriger Betrieb). The emission factors are based on information of the Swiss foundry association (GVS).

Table 3-52 Emission factors of 1A2b Non-ferrous metals in 2024.

1A2b Non-ferrous metals		Unit	NOx	NM VOC	SOx	NH3	PM2.5 ex	PM2.5 nx	PM10 ex	PM10 nx
			g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
Aluminium production remelting plant	Aluminium	t	NO	NO	NO	NO	NO	NO	NO	NO
Foundries	Metal	t	7.0	420	4.0	NE	160	NA	170	NA

1A2b Non-ferrous metals		Unit	TSP ex	TSP nx	BC ex	CO	Pb	Cd	Hg	PCDD/PCDF
			g/...	g/...	g/...	g/...	mg/...	mg/...	mg/...	ng I-Teq/...
Aluminium production remelting plant	Aluminium	t	NO	NO	NO	NO	NO	NO	NO	NO
Foundries	Metal	t	170	NA	6.2	2'100	510	85	NE	4'900

1A2b Non-ferrous metals		Unit	BaP	BbF	BkF	IcdP	HCB	PCB
			mg/...	mg/...	mg/...	mg/...	mg/...	mg/...
Aluminium production remelting plant	Aluminium	t	NO	NO	NO	NO	NO	NO
Foundries	Metal	t	NE	NE	NE	NE	NE	NE

Activity data (1A2b)

The production data for the non-ferrous metal industry is provided by the largest company (Swissmetal, monitoring reports of the Swiss ETS from 2006 onwards) and the annual statistics of the Swiss Foundry Association (GVS). The non-ferrous metal foundries continuously increased their production from 1990 to 2000. Since 2000, the production has strongly decreased. The decrease in production is also reflected in its fuel consumption (Table 3-45).

Activity data of the secondary aluminium production plant (ceased in 1993) were based on data from the Swiss aluminium association (www.alu.ch).

Table 3-53 Activity data from production of Non-ferrous metals that are used to calculate bottom-up emissions from sources of 1A2b.

1A2b Non-ferrous metals		Unit	1990	1995	2000	2005	2010
Aluminium production remelting plant	Aluminium	kt	34	NO	NO	NO	NO
Foundries	Metal	kt	60	56	53	33	20

1A2b Non-ferrous metals		Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Aluminium production remelting plant	Aluminium	kt	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Foundries	Metal	kt	8.9	9.0	8.0	6.8	6.4	5.1	7.5	7.9	5.3	4.8

3.2.3.2.4 Chemicals (1A2c)

Methodology (1A2c)

In Switzerland, there are more than thirty chemical companies mainly producing fine chemicals and pharmaceuticals. Fossil fuels are mostly used for steam production.

Emission factors and activity data of fuel consumption in boilers of this source category are documented in Table 3-42 and Table 3-46, respectively. In the following chapters, only those source categories are described, that are directly based on bottom-up industry data as outlined above in chapter 3.2.3.2.1. In addition, the chapter on activity data provides an overview on the fuel consumption within 1A2c.

Steam production from cracker by-products

There is one large company producing ammonia and ethylene by thermal cracking of liquefied petroleum gas and light virgin naphtha. In addition, thermal cracking also produces so-called heating gas and gasolio as by-products. In 2018 the cracking process and the subsequent integrated production chain were modified yielding synthesis gas as additional by-product. These cracker by-products are used thermally for steam production within the same plant and are accounted for within source category 1A2c as other fossil fuels. Process emissions from ammonia and ethylene production are reported in source category 2B10a Ethylene production.

Emission factors (1A2c)

Since the fuel quality of gasolio and heating gas are of similar quality as residual fuel oil and gas oil, respectively, the same emission factors as of those boilers are assumed for all air pollutants, see Table 3-42. For synthesis gas (about 23 % vol. CO, 77 % vol. H₂) emissions of NO_x and NH₃ are assumed only. Thus, for NO_x and NH₃, the same emission factors as of boilers, natural gas are applied, see Table 3-42.

Activity data (1A2c)

Activity data on gasolio, heating gas and synthesis gas (from 2018 onwards) are provided by the industry. Since 2013, they are based on monitoring reports of the Swiss ETS as documented in the EMIS documentation (EMIS 2026/1A2c ethylene production). The activity data are confidential but available to reviewers on request.

3.2.3.2.5 Pulp, paper and print (1A2d)

Methodology (1A2d)

Around half a dozen paper producers and several printing facilities exist in Switzerland. The only cellulose production plant was closed in 2008. Thermal energy is mainly used for provision of steam used in the drying process within paper production.

Emission factors and activity data of fuel consumption in boilers of this source category are documented in Table 3-42 and Table 3-47, respectively. In the following chapters, only those source categories are described, that are directly based on bottom-up industry data as outlined above in chapter 3.2.3.2.1. In addition, the chapter on activity data provides an overview on the fuel consumption within 1A2d.

Emission factors (1A2d)

For the cellulose production plant, NO_x and SO_x emission factors were derived from air pollution control measurements. The emission factor of BC (% PM_{2.5}) was taken according to the EMEP/EEA guidebook (EMEP/EEA 2023, chp. 1A4, table Liquid fuels (rounded mean value), Appendix E) as documented in the EMIS database (EMIS 2026/1A2d Zellulose-Produktion Feuerung). Emission factors for natural gas used in gas turbines as SCGT or CCGT are described in chapter 3.2.1.1.2.

Activity data (1A2d)

Activity data on annual cellulose production are provided by the industry as documented in the EMIS database (EMIS 2026/1A2d Zellulose-Produktion Feuerung). The only plant closed in 2008.

In 2024, natural gas is the most important fuel in this category (see Table 3-47). The use of natural gas in gas turbines as SCGT or CCGT is described in chapter 3.2.1.1.2. Biomass used in paper production is reported in source category 1A2gviii, because no comprehensive data exist to distribute biomass consumption to the specific industries within 1A2.

The overall fuel consumption within the Swiss pulp and paper industry has decreased significantly due to the closure of the cellulose production plant in 2008 and the closure of several paper producers in the last years.

3.2.3.2.6 Food processing, beverages and tobacco (1A2e)

Methodology (1A2e)

In Switzerland, the source category 1A2e Food, beverages and tobacco includes around 200 companies. According to the national food industry association, a major part of revenues is provided by meat production, milk products and convenience food. Further productions comprise chocolate, sugar or baby food (Fial 2013). Fossil fuels are used for steam production and drying processes.

Emission factors and activity data of fuel consumption in boilers of this source category are documented in Table 3-42 and Table 3-48, respectively.

In 2024, the fuels used in this category were mainly natural gas as well as gas oil and small amounts of liquefied petroleum gas (Table 3-48). All fuel is consumed in boilers.

3.2.3.2.7 Non-metallic minerals (1A2f)

Source category 1A2f Non-metallic minerals includes several large fuel consumers from mineral industry as for example cement, lime or brick and tile, glass and rock wool production (EMIS 2026/1A2f). Emission factors and activity data of some source categories reported under 1A2f Non-metallic minerals are considered confidential and are available to reviewers on request.

Emission factors (1A2f)

The following table provides an overview of the emission factors applied for source category 1A2f. Data sources are described for each process in the following chapters and are documented in the EMIS database (EMIS 2026/1A2f).

Table 3-54 Emission factors for 1A2f Non-metallic minerals in 2024.

1A2f Non-metallic minerals		Unit	NOx	NM VOC	SOx	NH3	PM2.5 ex	PM2.5 nx	PM10 ex	PM10 nx
			g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
Brick and tile	Bricks	t	530	140	80	NE	19	NA	29	NA
Cement	Clinker	t	753	81	127	60	2.1	NA	3.6	NA
Container glass	Glass	t	C	NA	C	NE	C	NA	C	NA
Fine ceramics	Ceramics	t	C	C	C	NE	C	NA	C	NA
Glass wool	Glass wool	t	5'000	14	3.4	NE	342	NA	611	NA
Lime	Lime	t	C	C	C	NE	C	NA	C	NA
Mixed goods	Mixed goods	t	10	32	17	NE	1.0	NA	2.9	NA
Rock wool	Rock wool	t	C	IE	C	C	C	C	C	C
Tableware glass	Glass	t	C	C	C	NE	C	NA	C	NA

1A2f Non-metallic minerals		Unit	TSP ex	TSP nx	BC ex	CO	Pb	Cd	Hg	PCDD/PCDF
			g/...	g/...	g/...	g/...	mg/...	mg/...	mg/...	ng I-Teq/...
Brick and tile	Bricks	t	32	NA	1.0	560	45	0.70	7.0	18
Cement	Clinker	t	4.3	NA	0.18	2'600	20	2.0	10	40
Container glass	Glass	t	C	NA	C	C	C	C	NE	NE
Fine ceramics	Ceramics	t	C	NA	C	C	C	C	C	C
Glass wool	Glass wool	t	630	NA	18	80	860	90	0.34	NE
Lime	Lime	t	C	NA	C	C	C	C	C	C
Mixed goods	Mixed goods	t	3.0	NA	0.044	85	20	2.0	2.0	5.0
Rock wool	Rock wool	t	C	C	C	C	C	C	C	NE
Tableware glass	Glass	t	C	NA	C	C	C	C	C	NE

1A2f Non-metallic minerals		Unit	BaP	BbF	BkF	lcdP	HCb	PCB
			mg/...	mg/...	mg/...	mg/...	mg/...	mg/...
Brick and tile	Bricks	t	NE	NE	NE	NE	NE	NE
Cement	Clinker	t	0.060	1.0	0.040	0.30	0.0040	0.10
Container glass	Glass	t	NE	NE	NE	NE	NA	NA
Fine ceramics	Ceramics	t	NE	NE	NE	NE	NA	NA
Glass wool	Glass wool	t	NE	NE	NE	NE	NA	NA
Lime	Lime	t	NE	NE	NE	NE	NA	NA
Mixed goods	Mixed goods	t	0.040	0.060	0.040	0.040	NE	NE
Rock wool	Rock wool	t	NE	NE	NE	NE	NE	NE
Tableware glass	Glass	t	NE	NE	NE	NE	NA	NA

Activity data (1A2f)

Table 3-55 provides an overview of activity data in source category 1A2f. Data sources are described for each process in the following chapters and are documented in the EMIS database (EMIS 2026/1A2f).

Table 3-55 Activity data for 1A2f Non-metallic minerals.

1A2f Non-metallic minerals		Unit	1990	1995	2000	2005	2010
Brick and tile	Bricks	kt	1'271	1'115	959	1'086	879
Cement	Clinker	kt	4'808	3'706	3'214	3'442	3'642
Container glass	Glass	kt	C	C	C	C	C
Fine ceramics	Ceramics	kt	C	C	C	C	C
Glass wool	Glass wool	kt	24	24	31	37	36
Lime	Lime	kt	C	C	C	C	C
Mixed goods	Mixed goods	kt	5'500	4'800	5'170	4'780	5'250
Rock wool	Rock wool	kt	C	C	C	C	C
Tableware glass	Glass	kt	C	C	C	C	C

1A2f Non-metallic minerals		Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Brick and tile	Bricks	kt	726	660	622	581	554	531	484	521	449	417
Cement	Clinker	kt	3'195	3'296	3'279	3'239	3'227	3'129	3'227	3'155	2'855	2'735
Container glass	Glass	kt	C	C	C	C	C	C	C	C	C	C
Fine ceramics	Ceramics	kt	C	C	C	C	C	C	C	C	C	C
Glass wool	Glass wool	kt	31	32	36	40	47	40	47	45	37	31
Lime	Lime	kt	C	C	C	C	C	C	C	C	C	C
Mixed goods	Mixed goods	kt	4'850	4'710	5'260	5'180	5'210	4'910	4'960	4'970	4'940	4'930
Rock wool	Rock wool	kt	C	C	C	C	C	C	C	C	C	C
Tableware glass	Glass	kt	C	C	C	C	C	C	C	C	C	C

Cement (1A2f)

Methodology

In Switzerland, there are six plants producing clinker and cement. The Swiss plants are rather small and do not exceed a capacity of 3'000 tonnes of clinker per day. All of them use modern dry process technology.

Cement industry emissions stem from incineration of fossil and waste derived fuels used to generate high temperatures needed for the clinker production process. Fossil fuels used in cement industry are coal (lignite and other bituminous coal), petroleum coke and, to a lesser extent, gas oil, residual fuel oil and natural gas. Waste derived fuels can be of fossil or biogenic origin and include for example plastics, waste oil, solvents and residues from distillation or wood waste. The fuels consumed in this category are very diverse and depend on the fuel use within the specific plant (see detailed documentation below).

Emission factors

Table 3-54 shows product-specific emission factors for cement production (EMIS 2026/1A2f Zementwerke Feuerung). Since 2008, emission factors have been based on various air pollution control measurements under the Ordinance on Air Pollution Control (Swiss Confederation 1985). For this submission, a reassessment of annual emission measurement reports from 2018 to 2024 led to changes in emission factors for 2018-2023. Regarding NO_x, industry agreements define an emission reduction pathway 2022-2032. Emission data used for monitoring compliance with this agreement were evaluated, and the corresponding emission factor for NO_x was computed. The value for PCB is based on the Tier 2 emission factor in the EMEP/EEA guidebook (EMEP/EEA 2023, chp.1A2, Table 3-25).

Activity data

Activity data of annual clinker production of each cement production plant in Switzerland are provided by the association of the Swiss cement industry (see Table 3-55). Since 2008, activity data are available from monitoring reports of the Swiss ETS.

For information purposes, the annual fuel consumption of cement production plants in Switzerland are shown in Table 3-56. Waste-derived fuels can be of fossil or biogenic origin and are therefore differentiated into so-called other fossil fuels and biomass.

The amount of fuels consumed in the Swiss cement production plants is also provided in the annual monitoring reports of the cement production plants as documented in the respective EMIS 2026/1A2f Zementwerke Feuerung.

Table 3-56 Fuel consumption of cement industry (fossil without waste, fossil waste derived, and biomass waste derived).

1A2f Non-metallic minerals (Cement industry)	Unit	1990	1995	2000	2005	2010					
Total fuel consumption	TJ	17'194	12'774	11'017	11'623	12'388					
Gas oil	TJ	NO	NO	NO		72					
Residual fuel oil	TJ	1'907	2'825	1'530	637	112					
Petroleum coke	TJ	550	300	480	638	1'130					
Other bituminous coal	TJ	12'235	6'547	5'176	4'120	3'662					
Lignite	TJ	265	153	124	737	1'348					
Natural gas	TJ	362	168	22	3.9	21					
CSS, fossil	TJ	5.0	29	34	29	26					
Mixed industrial waste	TJ	NO	NO	NO	NO	NO					
Other fossil waste fuels	TJ	NO	NO	NO	NO	45					
Plastics, fossil	TJ	NO	40	413	608	905					
Solvents and residues from distillation, fossil	TJ	281	180	422	967	1'178					
Waste coke from coke filters	TJ	59	59	59	58	NO					
Waste oil, fossil	TJ	1'170	1'485	1'520	1'411	1'253					
Waste tyres and rubber, fossil	TJ	241	303	307	471	614					
Wood waste	TJ	NO	322	NO	NO	292					
CSS, biogenic	TJ	18	106	124	105	97					
Agricultural waste	TJ	NO	NO	NO	NO	7.3					
Animal meal	TJ	NO	NO	198	856	624					
Dry sewage sludge	TJ	9.4	128	333	494	477					
Other biomass	TJ	NO	NO	NO	NO	5.7					
Plastics, biogenic	TJ	NO	15	158	233	347					
Solvents biogenic	TJ	2.5	1.6	3.8	8.8	11					
Waste oil, biogenic	TJ	NO	NO	NO	NO	NO					
Waste tyres and rubber, biogenic	TJ	89	112	114	174	227					
1A2f Non-metallic minerals (Cement industry)	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total fuel consumption	TJ	11'348	11'583	11'476	11'524	11'416	11'248	11'609	11'606	10'488	10'094
Gas oil	TJ	87	50	56	63	43	54	61	93	81	75
Residual fuel oil	TJ	45	90	59	NO	63	35	52	NO	NO	NO
Petroleum coke	TJ	622	658	574	542	552	591	583	538	568	501
Other bituminous coal	TJ	1'267	826	938	987	831	528	587	788	605	438
Lignite	TJ	2'856	2'881	2'694	2'367	2'120	2'266	2'304	2'331	1'824	1'752
Natural gas	TJ	41	39	34	56	65	26	28	82	71	141
CSS, fossil	TJ	20	26	21	20	16	0.043	0.58	0.67	0.42	NO
Mixed industrial waste	TJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other fossil waste fuels	TJ	12	11	5.7	5.4	NO	NO	13	NO	NO	NO
Plastics, fossil	TJ	887	890	1'071	1'319	1'246	1'558	1'688	1'692	1'704	1'714
Solvents and residues from distillation, fossil	TJ	1'194	1'397	1'254	1'238	1'456	1'155	1'107	1'265	1'121	941
Waste coke from coke filters	TJ	NO	NO	66	61	48	52	48	30	24	41
Waste oil, fossil	TJ	1'083	1'469	1'215	1'239	1'359	1'353	1'253	1'009	974	922
Waste tyres and rubber, fossil	TJ	699	694	760	763	760	743	726	730	607	668
Wood waste	TJ	896	811	840	840	861	867	973	962	989	995
CSS, biogenic	TJ	60	72	57	53	43	0.12	1.6	1.8	1.1	NO
Agricultural waste	TJ	NO	NO	9.2	NO	NO	NO	NO	NO	NO	NO
Animal meal	TJ	412	409	470	522	475	441	454	317	246	265
Dry sewage sludge	TJ	420	479	499	519	512	553	572	578	526	534
Other biomass	TJ	42	7.9	5.6	5.4	31	36	147	175	197	155
Plastics, biogenic	TJ	290	281	327	403	381	476	516	517	520	524
Solvents biogenic	TJ	98	137	144	142	167	133	127	145	129	108
Waste oil, biogenic	TJ	60	98	96	98	107	107	99	79	77	73
Waste tyres and rubber, biogenic	TJ	259	257	281	282	281	275	269	270	224	247

In 2024, the Swiss cement industry used about 70 % of waste-derived fuels (fossil and biogenic) and 30 % of standard fossil fuels. Today, fossil fuels used in cement industry are mainly lignite, plastics, solvents and residues from distillation, waste oil, whereas waste tyres, petroleum coke and other bituminous coal are less important. Biogenic wastes contain mainly wood waste, sewage sludge, (bio)plastics and animal residues (animal meal). The main fossil fuel used in 1990 was other bituminous coal, but residual fuel oil and waste oil were also of importance.

Fuel consumption in cement plants has decreased between 1990 and 2015 and remained rather constant until 2022. This is partly due to a decrease in production since 1990 and an increase in energy efficiency. In 2023 and 2024 there was a decrease again. In the period 1990-2019, the fuel mix has changed significantly from mainly standard fossil fuels to the above-mentioned mix of fuels.

Please note that all fossil waste-derived fuels are reported as “Other fuels” in the emission reporting templates, whereas the biogenic waste derived fuels belong to “Biomass”.

Container glass (1A2f)

Methodology

The last remaining production plant for container glass in Switzerland was closed in June 2024. The emission factors and activity data are considered confidential and are available to reviewers on request.

Emission factors

For container glass production, emission factors of NO_x and PM_{2.5}/PM₁₀/TSP are based on various air pollution control measurements under the Ordinance on Air Pollution Control (EMIS 2026/1A2f Hohlglas Produktion) and partly on information from industry. The SO_x emission factor is based on air pollution control measurements from 2011. The emission factor of BC (% PM_{2.5}) are taken from EMEP/EEA guidebook (EMEP/EEA 2023 chp. 1A4, table Liquid fuels (rounded mean value), Appendix E for residual fuel oil and Table 3-26 for natural gas).

Emission factors are derived based on air pollution control measurements at the production plants and therefore emission factors include both emission from fuel combustion as well as process emissions. Therefore, emissions from glass production are reported only in source category non-metallic minerals (1A2f). The same holds for tableware glass and glass wool.

Activity data

Activity data consist of annual production data provided by the industry (Table 3-55). Since 2008, activity data are available from monitoring reports of the Swiss ETS.

Since 1990, fuel consumption for container glass has drastically decreased due to reduction in production. Until 2003, only residual fuel oil was used. Since 2004, the share of natural gas has increased to reach a stable share between 2006 and 2012. In autumn 2013, the plant has switched its glass kiln completely to natural gas.

Tableware glass (1A2f)

Methodology

Today, there exists only one production plant for tableware glass in Switzerland after the other one ceased production in 2006. Therefore, emission factors and activity data are considered confidential and are available to reviewers on request.

Emission factors

For tableware glass production, emission factors of NO_x and PM_{2.5}/PM₁₀/TSP are based on various air pollution control measurements under the Ordinance on Air Pollution Control whereas those of SO_x, NMVOC, CO are based on information from industry (EMIS 2026/1A2f Glas übrige Produktion). Emission factors of Pb and Cd are assumed proportional to the emissions of TSP. The emission factor of Hg is calculated proportional to the composition of fuels consumed in the production process (liquefied petroleum gas and residual fuel oil until 1995). The emission factors of BC (% PM_{2.5}) are taken from EMEP/EEA guidebook (EMEP/EEA 2023, chp. 1A4, table Liquid fuels (rounded mean value), Appendix E for residual fuel oil and table 3-26 for liquefied petroleum gas).

Activity data

For tableware glass production, activity data are provided by monitoring reports of the Swiss ETS (Table 3-55). Activity data of tableware glass are considered confidential and are available to reviewers on request.

Fuel consumption for tableware glass currently includes only liquefied petroleum gas. Since 1990, fuel consumption for tableware glass strongly decreased because of the closure of one production plant in 2006. In addition, the consumption of residual fuel oil was eliminated in 1995.

Glass wool (1A2f)

Methodology

In Switzerland, glass wool is produced in two plants.

Emission factors

Table 3-54 shows product-specific emission factors for glass wool production. For glass wool, emission factors of NO_x and PM_{2.5}/PM₁₀/TSP are based on various air pollution control measurements under the Ordinance on Air Pollution Control (EMIS 2026/1A2f Glaswolle Produktion) and partly on information from industry. The emission factor for SO_x is based on measurements and analysis of fuel samples carried out by the Swiss Federal Laboratories for Materials Testing and Research (EMPA 1999). The emission factor of BC (% PM_{2.5}) is taken from EMEP/EEA guidebook (EMEP/EEA 20123 chp. 1A4, table 3-26).

Activity data

Activity data consist of annual production data provided by monitoring reports from the industry (Table 3-55). Currently, fuel consumption for glass wool production includes only natural gas. Production of glass wool has increased since 1990, but the natural gas consumption decreased. This can be explained by an increase in energy efficiency in the production process.

Lime (1A2f)

Methodology

In Switzerland there is only one plant producing lime. Therefore, emission factors and activity data are considered confidential and are available to reviewers upon request. Fossil fuels are used for the burning process (calcination) of limestone. The fuel consumption of two sugar plants that auto produce lime is reported in category 1A2e.

Emission factors

For lime production, emission factors of NO_x, SO_x, PM_{2.5}/PM₁₀/TSP and CO are based on various air pollution control measurements under the Ordinance on Air Pollution Control (Swiss Confederation 1985) between 1990 and 2011. Air pollution control measurements in 2017 led to revised emission factors of these pollutants for the natural gas operation of the kiln from 2014 onwards (EMIS 2026/1A2f). The emission factor of BC (% PM_{2.5}) is taken from EMEP/EEA guidebook (EMEP/EEA 2023 chp. 1A4, table 3-18 for gas oil, table Liquid fuels (rounded mean value), Appendix E for residual fuel oil, table 3-23 for other bituminous coal and table 3-26 for natural gas), see EMIS 2026/1A2f Kalkproduktion Feuerung.

Activity data

Activity data consist of annual production data provided by the industry. Since 2008, activity data are available from monitoring reports of the Swiss ETS.

Between 1994 and 2012, fuel consumption in lime production was mainly based on residual fuel oil; gas oil was only used to start up the kilns. Up to 1995, also other bituminous coal was used and was the most important fuel (up to 1993). However, in 2013, the kiln was switched to natural gas.

Brick and Tile (1A2f)

Methodology

In Switzerland there are about 15 plants producing bricks and tiles. Mainly fossil fuels but also wood, paper pulp and animal fat are used for drying and burning of the clay blanks.

Emission factors

Table 3-54 shows emission factors for brick and tile production. Emission factors of NO_x, NMVOC, SO_x, PM2.5/PM10/TSP, CO, Pb, Cd und Hg are derived from air pollution control measurements as described in the EMIS database (EMIS 2026/1A2f Ziegeleien). The emission factors of BC (% PM2.5) are taken from EMEP/EEA guidebook (EMEP/EEA 2023, chp. 1A4, table 3-18 for gas oil, table Liquid fuels (rounded mean value), Appendix E for residual fuel oil, paper pulp and animal fat and table 3-26 for liquefied petroleum gas and natural gas).

Activity data

Activity data consist of annual production data provided by the industry (Table 3-55). Since 2013, for one large plant activity data are available from monitoring reports of the Swiss ETS.

Fuels used in the brick and tile production in 2024 are mainly natural gas as well as small amounts of liquefied petroleum gas and gas oil. Apart from a production recovery in the years around 2004, the production has gradually decreased since 1990, which is also represented in the overall fuel consumption decrease. Regarding the fuels used, there has been a considerable shift from residual fuel oil to natural gas from 1990 onwards as well as a minor shift from gas oil and liquefied petroleum gas to natural gas from 2004 onwards. Paper production residues, wood and animal fat are used since 2000. But the consumption of wood, paper production residues and animal fat is no longer reported in the monitoring reports since 2013, 2018 and 2021, respectively.

Fine Ceramics (1A2f)

Methodology

In Switzerland, the main production of fine ceramics is sanitary ware produced by one big and some small companies. In earlier years, also other ceramics were produced as for example glazed ceramics tiles, electrical porcelain and earthenware. Since 2001, only sanitary ware has been produced.

Emission factors

Emission factors of NO_x, NMVOC, SO_x and CO are based on air pollution control measurements from 2001, 2005, 2009 and 2012. The emission factor of PM is based on production weighted air pollution control measurements from 2005 and 2009 and the share of PM_{2.5}/PM₁₀ is assumed 95 % and 60 % of total PM emissions, respectively. Emission factors of Pb and Cd are calculated based on the assumption that they are proportional to the TSP emissions. The emission factor of Hg and SO_x is assumed to be constant. The emission factors of BC (% PM_{2.5}) are taken from EMEP/EEA guidebook (EMEP/EEA 2023 chp. 1A4, table 3-18 for gas oil and table 3-26 for natural gas), see EMIS 2026/1A2f Feinkeramik Produktion.

Activity data

Activity data consist of annual production data provided by monitoring reports of the industry. Activity data are considered confidential and are available to reviewers on request.

Since 2010, fuel consumption within fine ceramics production is natural gas only. In 2001 the fuel-mix consisted of natural gas and gas oil. Since then, fuel mix has continuously shifted to natural gas. Compared to the production of other fine ceramics, the production of sanitary ware is more energy intensive. Therefore, the specific energy use per tonne of produced fine ceramics has increased since 1990. This results in a lower reduction of fuel consumption compared to the reduction in production since 1990.

Rock Wool (1A2f)

Methodology

In Switzerland, there is one single producer of rock wool. Therefore, emission factors and activity data are considered confidential and are available to reviewers on request. Fossil fuels are used for the melting of rocks at a temperature of 1500°C in cupola furnaces. The cupola furnaces were shut down at the end of 2023 and replaced by electric furnaces in spring 2024. The air pollutant emissions control measurements could only be carried out in 2025. Accordingly, no new emission factors for electric furnace operation could be determined for 2024.

Emission factors

All emission factors (e.g. NO_x, NH₃, SO_x) for rock wool production are based on annual flux analysis from industry – except for the emission factors of BC (% PM_{2.5}), which are taken from EMEP/EEA guidebook (EMEP/EEA 2023 chp. 1A4, table 3-18 for gas oil, table 3-23 for other bituminous coal and table 3-26 for liquefied petroleum gas and natural gas), see EMIS 2026/1A2f Steinwolle Produktion.

Activity data

Activity data consist of annual production data provided by the industry (monitoring reports of the Swiss ETS).

Currently, other bituminous coal and natural gas are used in the production process. But with the switch from cupola furnaces to electric furnaces in 2023 to 2024, other bituminous coal is now only used for the start-up process. Until 2004 also gas oil and liquefied petroleum gas were used. In 2005, these fuels were substituted by natural gas. Since 1990, there was a decrease in the specific energy consumption of rock wool production.

Mixed Goods (1A2f)

Methodology

The production of mixed goods mainly includes the production of bitumen for road paving. A total of 110 production sites is producing the mixed goods at stationary production sites.

Emission factors

Table 3-54 shows product-specific emission factors for production of mixed goods. Emission factors of NO_x, NMVOC, CO, PM2.5/PM10/TSP, Pb and Cd are based on air pollution control measurements from the time period between 2001 and 2015. This includes about 150 measurements from 55 out of 110 Swiss producers. As these measurements show no clear trend in the emission factors, a constant country-specific, average emission factor is used from 2001 onwards. Emission factors of SO_x, Hg and PCCD/PCDF are based on data from the industry association (Schweizerische Mischgut-Industrie) (EMIS 2026/1A2f Mischgut Produktion).

Activity data

Activity data consist of annual production data provided by the industry association (Schweizerische Mischgut-Industrie) (Table 3-55).

The main fuel types used are gas oil and natural gas. There has been a fuel switch from gas oil to natural gas in the period 2000 to 2019.

3.2.3.2.8 Other (1A2gviii)

Methodology (1A2gviii)

Source category 1A2gviii Other covers fossil fuel combustion in boilers of manufacturing industries and construction mainly within non-metallic mineral industries as well as combustion of wood, wood waste and biogas in all manufacturing industries.

In addition, also the emissions from fibreboard production are reported in 1A2gviii. Please note that they are calculated based on fuel consumption and not on production data as for all other bottom-up industry processes. Fibreboard was produced in two plants in Switzerland until 2019, where thermal energy is used for heating and drying processes. Since 2020 only one plant is left.

Methodologically, the fossil fuel consumption in boilers comprises also all the residual entities of the industry installations that could not be allocated to any other industrial source categories 1A2a-f.

Emission factors (1A2gviii)

The emission factors for fossil fuel consumption in 1A2gviii in boilers and in fibreboard production are described in chp. 3.2.3.2.1 (see Table 3-42). For animal fat which was used as fuel in the fibreboard production (2001 – 2013) the same emission factors as of residual fuel are assumed for all air pollutants. Emission factors of consumption of wood waste in fibreboard production are documented in Table 3-24.

The emission factors of the individual wood and wood waste combustion installations are described in chp. 3.2.1.1.3 and listed in Table 3-24. The resulting weighted emission factors

of wood and wood waste combustion in manufacturing industries and construction are given in Table 3-57.

Table 3-57 Emission factors (weighted average) for 1A2gviii Wood and wood waste combustion in manufacturing industries and construction in 2024.

1A2gviii Stationary combustion Other	Unit	NOx	NMVOC	SOx	NH3	PM2.5 ex	PM10 ex	TSP ex	BC ex	CO
		g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
Wood and wood waste	GJ	105	5.8	8.5	3.1	12	12	13	0.70	142

1A2gviii Stationary combustion Other	Unit	Pb	Cd	Hg	PCDD/PCDF	BaP	BbF	BkF	IcdP	HCB	PCB
		mg/...	mg/...	mg/...	ng I-Teq/...	mg/...	mg/...	mg/...	mg/...	ng/...	ng/...
Wood and wood waste	GJ	43	1.4	2.0	51	1.5	1.5	1.1	1.1	1'638	10

Emission factors for stationary engines and gas turbines are based on INFRAS (2022a) as described in chp. 3.2.1.1.2.

Activity data (1A2gviii)

Activity data of fossil fuels is derived from the industry model and given in Table 3-44. Fuel consumption of wood and wood waste in manufacturing industries and construction is based on the Swiss wood energy statistics (SFOE 2025b) (see also chp. 3.2.1.1.3) and is given in Table 3-58. Fuel consumption in stationary engines and gas turbines is as described in chapter 3.2.1.1.2.

Table 3-58 Fuel consumption of 1A2gviii Wood and wood waste combustion in manufacturing industries and construction.

1A2gviii Stationary combustion Other	Unit	1990	1995	2000	2005	2010
Wood and wood waste	TJ	3'254	4'440	5'228	6'652	9'639

1A2gviii Stationary combustion Other	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Wood and wood waste	TJ	9'972	10'786	11'204	10'543	11'097	11'165	13'191	12'327	12'043	11'478

In source category fibreboard production, the fuels currently used are wood waste and natural gas (EMIS 2026/1A2giv). From 1990 to 2008, the production of fibreboard and thus the fuel consumption have increased significantly. The fuel mix has strongly shifted between 1990 and 2024 from fossil fuels to biomass (wood waste). Between 2001 and 2013, also animal fat was used

In 2024, fuel consumption of 1A2gviii Other comprises mainly wood/wood waste and natural gas. Overall, there has been a shift in fuel consumption between 1990 and 2024 from liquid and solid fuels to wood/wood waste and natural gas.

3.2.3.3 Category-specific recalculations for 1A2 Stationary combustion in manufacturing industries and construction

The following recalculations were implemented in submission 2026:

- 1A2: The SO_x emission factor of natural gas has been updated for the period 2016-2023 to reflect the sulphur content of the gas after the odorant addition, rather than before.
- 1A2: There are recalculations in all source categories 1A2a to 1A2g in the years 2020-2023 due to reallocations of natural gas and gas oil within these categories of 1A2 Manufacturing industries and construction. The reason is that during the surveys for the energy consumption statistics in the industry and services sectors for the most recent year, the reports from the previous year are reviewed again and, if necessary, adjusted

retroactively. Generally, this only affects the disaggregation and not the total amount of fuels used in 1A2 Manufacturing industries and construction for that year. However, additional recalculations were introduced in the overall energy statistics with regard to the total fuel consumption in the industry sector for natural gas (2020–2023).

- 1A2d: Due to an error in the model calculation, there was a double counting of natural gas consumption from gas turbines in 1A2d - Manufacturing industries Pulp, paper and print, for the years 1993-2015.
- 1A2f Cement production: The emission factors for NO_x, NMVOC, SO_x, NH₃, PM2.5, PM10 and TSP have been updated based on measurement reports at the factory level, for each year 2018-2023. Minimum and maximum changes in percentage per pollutant are: NO_x: [+0.3; +5]; NMVOC: [40; 10]; SO_x: [-40; -15]; NH₃: [-23; 23]; PM2.5: [-50; -8]; PM10: [-37; -3]; TSP: [40; 8].
- 1A2f: In the model to compute fuel consumption for cement production, the number of significant digits was harmonized. This caused minor value changes from 1990 until 2023 of less than 1 %.
- 1A2f: Due to updates in the underlying data reported by the factories, the fuel consumption for cement production was updated causing changes of less than 2 % for the following fuels and years. Year 2022: other bituminous coal, petroleum coke; year 2023: waste oil, waste tyres, plastics, solvents and residues from distillation, wood waste, animal meal.
- 1A2f: As the activity data (gas oil) of 1A2f Fine ceramics production was revised for the years 2010-2019, the BC emission factor, which is calculated based on the fuel mix, has also changed.
- 1A2f: The last year's extrapolated production volume of mixed goods for 2023 was replaced by the actual production figure reported by the industry association yielding revised activity data for 1A2f Mixed goods production in 2023.
- 1A2g: The fuel use of petroleum coke 2022-2023 assigned to boilers in 1A2g has been reassessed because of an update in the underlying statistics of the national energy balance.
- 1A2g: The activity data of 1A2gviii Boiler, gas oil for the years 2010-2029 and 2023 and of 1A2gviii Boiler, natural gas for 2023 were revised due to recalculations in the activity data of source category 1A2f Fine ceramics production (gas oil) in the years 2010-2019 and of source category 1A2f Mixed goods production (natural gas, gas oil) in 2023. Also, the activity data of 1A2gviii Boiler, other bituminous coal for 2022-2023 were revised due to recalculations in the fuel consumption (other bituminous coal) of source category 1A2a Secondary steel production, electric arc furnace in the years 2022-2023.
- 1A2gviii: The activity data of 1A2gviii Boilers, liquefied petroleum gas were revised for the years 2021 to 2023 due changes in the activity data of 1A2gvii Industrial machinery, liquefied petroleum gas for the years 2021 to 2023.
- 1A2gviii: Due to an error in the aggregation in the EMIS database, a part of the emissions for source category 1A2gviii, for liquified petroleum gas, was missing. This correction affects all years from 1990 to 2023.
- 1A2gviii: The activity data of automatic wood combustion installations (≥ 50 kW) in source category 1A2gviii were revised for 2010-2023 due to recalculations in the Swiss wood energy statistics (SFOE 2025b), with the largest changes occurring in 2023.

3.2.4 Source category 1A4 - Stationary combustion in other sectors (commercial, residential, agriculture and forestry)

3.2.4.1 Source category description for 1A4 Stationary combustion in other sectors (commercial, residential, agriculture and forestry)

The source category 1A4 Stationary combustion in other sectors comprises all emissions from the combustion of fuels in stationary boilers and cogeneration in facilities within processes in commerce and institutions, households, agriculture and forestry. This includes use of conventional fossil fuels as well as biomass. Within this category, only activities involving fuel combustion are taken into account. Note that information regarding fuel combustion in source category 1A4 Non-road and machinery in other sectors are provided in chapter 3.2.7.

Table 3-59 Specification of source category 1A4 Stationary combustion in other sectors.

1A4	Source category	Specification
1A4ai	Commercial/institutional: Stationary	Stationary fuel combustion in commercial and institutional buildings as different wood combustions, boilers and engines with combined heat and power generation unit, engines and gas turbines at biogas and sewage plants, emergency generators
1A4bi	Residential: Stationary	Stationary fuel combustion in households, including different wood combustion installations, boilers and engines
1A4ci	Agriculture/Forestry/Fishing: Stationary	Stationary fuel combustion in agriculture, including different wood combustion installations, engines at biogas plants, emergency generators, heating of greenhouses and grass drying

Table 3-60 Key categories, approaches 1 and 2, level assessment 2024 (L1, L2) and trend assessment 1990-2024 (T1, T2) for source category 1A4 Stationary combustion in other sectors.

NFR code	Source category	Pollutant	Identification criteria
1A4ai	Commercial/institutional: stationary	NOx	L1, L2, T1, T2
1A4ai	Commercial/institutional: stationary	SOx	L1, T1, T2
1A4ai	Commercial/institutional: stationary	PM2.5	L1, L2
1A4ai	Commercial/institutional: stationary	PM10	L1, L2
1A4bi	Residential: stationary plants	NOx	L1, L2
1A4bi	Residential: stationary plants	NMVOG	L1, L2
1A4bi	Residential: stationary plants	SOx	L1, L2, T1, T2
1A4bi	Residential: stationary plants	PM2.5	L1, L2, T1, T2
1A4bi	Residential: stationary plants	PM10	L1, L2, T1, T2
1A4ci	Agriculture/forestry/fishing: stationary	SOx	L2, T2
1A4ci	Agriculture/forestry/fishing: stationary	PM2.5	L1

3.2.4.2 Methodological issues for 1A4 Stationary combustion in other sectors (commercial, residential, agriculture and forestry)

Methodology (1A4 ai/bi/ci stationary)

For the calculation of the emissions from the use of gas oil and natural gas, the following sources are differentiated: (a) heat only boilers, (b) combined heat and power production in turbines and (c) combined heat and power production in engines. A considerable part (10-20 %) of the fuel consumption consists of wood and wood wastes. Source category 1A4ai also includes emissions from mobile pellet combustion installations (from 2017 onwards) that are used for temporary applications such as construction drying, events in large marquees or as emergency solutions in the event of heating failures. Besides the main energy sources, also the use of other bituminous coal, charcoal use and bonfires are considered in source

category 1A4bi. Emissions from 1A4ci originate from fuel combustion for the heating of greenhouses and grass drying, as well as for heating in agriculture and forestry.

The methodology to estimate emissions from stationary combustion in source categories 1A4ai, 1A4bi and 1A4ci, follows a Tier 2 approach according to the decision tree for small combustion, Figure 3-1 in chapter 1A4 small combustion in the EMEP/EEA guidebook (EMEP/EEA 2023). Emission factors and activity data are specified for different technologies. Direct emission measurements are not available.

Emission factors (1A4 ai/bi/ci stationary)

Table 3-61, Table 3-62 and Table 3-63 present the emission factors applied for source categories 1A4ai, 1A4bi and 1A4ci, respectively. Please note the following additional information:

- For boilers, the emission factors of NO_x and CO for natural gas, biogas and gas oil are based on a study by Leupro (2012) for the years 1990-2010, and Zotter and Nussbaumer (2026) for 2022 (and the projections). Within those studies, measurements from the control of combustion installations in eight and eleven Swiss cantons and the city of Zurich, respectively, were analysed. Emission factors are thus country specific.
- For boilers, the emission factors for PM₁₀, PM_{2.5} and TSP for natural gas, biogas and gas oil are based on a study by Leupro (2012).
- For boilers, the emission factors for NMVOC are documented in SAEFL (2000).
- For boilers with natural gas or biogas, the emission factors for Pb, Cd, Hg and PAH are taken from the EMEP/EEA guidebook (EMEP/EEA 2019, chp. 1.A.4 Small combustion) as follows. 1A4ai: natural gas/biogas boilers table 3-26, 1A4bi: natural gas boilers table 3-16, 1A4ci: natural gas/biogas boilers table 3-26.
- For boilers with gas oil, the emission factors for Pb, Cd and Hg are taken from table 3-18 in the EMEP/EEA guidebook (EMEP/EEA 2023), PAHs are from table 3-31 and 3-9 (Tier 1 emission factors for NFR source category 1.A.4.a/c, 1.A.5.a, using liquid fuels), respectively, as stated in the EMEP/EEA guidebook representing average of Tier 2 emission factors for commercial/institutional liquid fuel combustion for all technologies. These PAH emission factor values have been taken since the proposed values in table 3-18 are based on a relatively old reference from 1995 and are rather high compared to other PAH values within the guidebook.
- For boilers with other bituminous coal in 1A4bi, Hg emission factors stem from table 3-23 in the EMEP/EEA guidebook (EMEP/EEA 2019, chp. 1A4) allocated to non-residential sources (automatic boilers) burning coal fuels and not from table 3-15 in the EMEP/EEA guidebook (EMEP/EEA 2019) allocated to residential boilers burning solid fuels. This choice was made because table 3-15 provides a lower value for Hg with 6 g/TJ than table 3-23 with 16 g/TJ for advanced technology.
- For boilers using gaseous and liquid fuels, the HCB emission factors are based on the approach of the Danish Emission Inventory for hexachlorobenzene and polychlorinated biphenyls (Nielsen et al. 2013).
- For boilers with solid and liquid fossil fuels as well as of wood and wood waste combustion, the emission factors of PCB are taken from the Danish emission inventory for HCB and PCBs (Nielsen et al. 2013).
- Emission factors for SO_x are described in chp. 3.2.1.2.
- Wood combustion in 1A4ai/bi/ci: The country-specific emission factor model for wood energy is described in chp. 3.2.1.1.3. For mobile pellet combustion installations in source

category 1A4ai, the same emission factors are assumed as for the installation category (stationary) automatic pellet boilers 50-300 kW.

- Emission factors for combined heat and power generation in turbines and engines are based on INFRAS (2022a) as described in chapter 3.2.1.1.2.
- Bonfires and use of charcoal (within 1A4bi): Emission factors of NO_x, NMVOC, SO_x, NH₃, PM2.5/PM10, TSP, CO, Pb, Cd, Hg, PCDD/PCDF, PAH and HCB are taken from EMEP/EEA guidebook, Tier 2 level of source category open fireplaces burning biomass (EMEP/EEA 2023, chp.1A4, Table 3-39) as shown in Table 3-62. According to the EMEP/EEA guidebook (EMEP/EEA 2023, chp.1A4, Table 3-39), the values for particulate matter correspond to total particles including both filterable and condensable particulate matter. More details are described in EMIS 2026/1A4bi Lagerfeuer and EMIS 2026/1A4bi Holzkohle Verbrauch.
- 1A4ci Emission factors for grass drying are based on air pollution control measurements (NO_x since 2002, NMVOC since 1990, TSP and CO since 2000).

Table 3-61 Emission factors for 1A4ai for 2024. All fuels not listed are "NO".

1A4ai Commercial/Institutional Stationary		Unit	NO _x	NMVOC	SO _x	NH ₃	PM2.5 _{ex}	PM10 _{ex}	TSP _{ex}	BC _{ex}	CO
			g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
Boilers	Gas oil	GJ	28	6.0	0.77	0.0010	0.19	0.19	0.19	0.0073	5.3
Boilers	Natural gas	GJ	13	2.0	0.43	0.0010	0.087	0.087	0.087	0.0047	8.7
Boilers	Biogas	GJ	13	2.0	0.50	0.0010	0.087	0.087	0.087	0.0047	8.7
Boilers	Sewage gas	GJ	13	2.0	0.50	0.0010	0.087	0.087	0.087	0.0047	8.7
Engines	Gas oil	GJ	812	50	0.77	1.5	15	15	15	2.3	137
Engines	Liquefied petroleum gas	GJ	135	89	0.50	NA	2.0	2.0	2.0	0.0050	56
Engines	Natural gas	GJ	71	89	0.43	2.7	2.0	2.0	2.0	0.0040	53
Engines	Biodiesel fossil	GJ	298	50	0.30	5.8	30	30	30	2.3	134
Engines	Biodiesel biogenic	GJ	298	50	0.30	5.8	30	30	30	2.3	134
Engines	Biogas	GJ	96	89	0.50	3.9	2.0	2.0	2.0	0.0038	126
Engines	Sewage gas	GJ	100	89	0.50	2.1	2.0	2.0	2.0	0.0041	138
Turbines	Natural gas	GJ	53	1.6	0.43	NA	0.20	0.20	0.20	0.00050	25
Turbines	Sewage gas	GJ	48	1.6	0.50	NA	0.23	0.23	0.23	0.00050	10
Wood combustion	Wood and wood waste	GJ	108	36	4.6	2.4	28	30	31	7.2	529

1A4ai Commercial/Institutional Stationary		Unit	Pb	Cd	Hg	PCDD/PCDF	BaP	BbF	BkF	IcdP	HCB	PCB
			mg/...	mg/...	mg/...	ng I- Teq/...	mg/...	mg/...	mg/...	mg/...	ng/...	ng/...
Boilers	Gas oil	GJ	0.012	0.0010	0.12	1.8	0.0019	0.015	0.0017	0.0015	220	0.11
Boilers	Natural gas	GJ	0.0015	0.00025	0.10	0.50	0.00056	0.00084	0.00084	0.00084	NA	NA
Boilers	Biogas	GJ	0.0015	0.00025	0.10	0.50	0.00056	0.00084	0.00084	0.00084	NA	NA
Boilers	Sewage gas	GJ	0.0015	0.00025	0.10	0.50	0.00056	0.00084	0.00084	0.00084	NA	NA
Engines	Gas oil	GJ	0.15	0.0100	0.11	0.99	0.0019	0.015	0.0017	0.0015	220	0.11
Engines	Liquefied petroleum gas	GJ	0.040	0.0030	0.10	0.57	0.0013	0.0090	0.0017	0.0018	NA	NA
Engines	Natural gas	GJ	0.040	0.0030	0.10	0.57	0.0012	0.0090	0.0017	0.0018	NA	NA
Engines	Biodiesel fossil	GJ	0.15	0.010	0.11	0.99	0.0019	0.015	0.0017	0.0015	220	0.11
Engines	Biodiesel biogenic	GJ	0.15	0.010	0.11	0.99	0.0019	0.015	0.0017	0.0015	220	0.11
Engines	Biogas	GJ	0.040	0.0030	0.10	0.57	0.0012	0.0090	0.0017	0.0018	NA	NA
Engines	Sewage gas	GJ	0.040	0.0030	0.10	0.57	0.0012	0.0090	0.0017	0.0018	NA	NA
Turbines	Natural gas	GJ	0.0015	0.00025	0.10	0.50	0.00056	0.00084	0.00084	0.00084	NA	NA
Turbines	Sewage gas	GJ	0.0015	0.00025	0.10	0.50	0.00056	0.00084	0.00084	0.00084	NA	NA
Wood combustion	Wood and wood waste	GJ	15	1.0	2.0	102	7.7	7.7	4.6	4.6	2'801	16

Table 3-62 Emission factors for 1A4bi (including charcoal and bonfires) for 2024. All fuels not listed are "NO".

1A4bi Residential Stationary		Unit	NO _x	NMVO _C	SO _x	NH ₃	PM _{2.5} ex	PM ₁₀ ex	TSP ex	BC ex	CO
			g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
Boilers	Gas oil	GJ	26	6.0	0.77	0.0010	0.19	0.19	0.19	0.0073	7.5
Boilers	Other bituminous coal	GJ	65	100	350	1.6	65	65	95	4.1	1'000
Boilers	Natural gas	GJ	11	4.0	0.43	0.0010	0.087	0.087	0.087	0.0047	10
Engines	Gas oil	GJ	138	50	0.77	8.9	30	30	30	2.3	136
Engines	Liquefied petroleum gas	GJ	135	89	0.50	NA	2.0	2.0	2.0	0.0050	56
Engines	Natural gas	GJ	70	89	0.43	2.7	2.0	2.0	2.0	0.0040	53
Engines	Biodiesel fossil	GJ	408	50	0.30	3.5	30	30	30	2.3	132
Engines	Biodiesel biogenic	GJ	408	50	0.30	3.5	30	30	30	2.3	132
Engines	Biogas	GJ	94	89	0.50	2.7	2.0	2.0	2.0	0.0040	85
Wood combustion	Wood and wood waste	GJ	95	81	7.4	2.8	45	47	49	20	1'106
Use of charcoal	Charcoal	GJ	50	600	11	8.0	820	840	880	57	4'000
Bonfires	Wood (bonfires)	GJ	50	600	11	8.0	820	840	880	57	4'000

1A4bi Residential Stationary		Unit	Pb	Cd	Hg	PCDD/PCDF	BaP	BbF	BkF	IcdP	HCB	PCB
			mg/...	mg/...	mg/...	ng I-TEQ/...	mg/...	mg/...	mg/...	mg/...	ng/...	ng/...
Boilers	Gas oil	GJ	0.012	0.0010	0.12	1.8	0.0019	0.015	0.0017	0.0015	220	0.11
Boilers	Other bituminous coal	GJ	200	3.0	16	500	270	250	100	90	620	66
Boilers	Natural gas	GJ	0.0015	0.00025	0.10	1.5	0.00056	0.00084	0.00084	0.00084	NA	NA
Engines	Gas oil	GJ	0.15	0.010	0.11	0.99	0.0019	0.015	0.0017	0.0015	220	0.11
Engines	Liquefied petroleum gas	GJ	0.040	0.0030	0.10	0.57	0.0013	0.0090	0.0017	0.0018	NA	NA
Engines	Natural gas	GJ	0.040	0.0030	0.10	0.57	0.0012	0.0090	0.0017	0.0018	NA	NA
Engines	Biodiesel fossil	GJ	0.15	0.010	0.11	0.99	0.0019	0.015	0.0017	0.0015	220	0.11
Engines	Biodiesel biogenic	GJ	0.15	0.010	0.11	0.99	0.0019	0.015	0.0017	0.0015	220	0.11
Engines	Biogas	GJ	0.040	0.0030	0.10	0.57	0.0012	0.0090	0.0017	0.0018	NA	NA
Wood combustion	Wood and wood waste	GJ	18	1.0	2.0	191	19	19	11	11	3'895	25
Use of charcoal	Charcoal	GJ	27	13	0.56	800	121	111	42	71	5'000	60
Bonfires	Wood (bonfires)	GJ	27	13	0.56	800	121	111	42	71	5'756	60

Table 3-63 Emission factors for 1A4ci for 2024. All fuels not listed are "NO".

1A4ci Agriculture/forestry/ fishing	Unit of activity data	NO _x	NMVO _C	SO _x	NH ₃	PM _{2.5}	PM ₁₀	TSP	BC	CO
		g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
Drying of grass	GJ	68	92	77	NA	264	264	264	13	527
Heating of greenhouses (weighted average)	GJ	18	2.0	0.54	0.0013	0.12	0.12	0.12	0.0056	7.5
Gas oil	GJ	28	2.0	0.77	0.0020	0.19	0.19	0.19	0.0073	5.3
Natural gas	GJ	13	2.0	0.43	0.0010	0.087	0.087	0.087	0.0047	8.7
Other fossil combustion (weighted average)	GJ	942	50	0.77	0.10	27	27	27	2.3	137
Gas oil (engines)	GJ	942	50	0.77	0.10	27	27	27	2.3	137
Natural gas (engines)	GJ	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other biomass combustion (weighted average)	GJ	100	72	1.8	3.0	11	11	12	1.5	218
Biogas (engines)	GJ	95	89	0.50	3.4	2.0	2.0	2.0	0.0037	104
Wood and wood waste (various furnaces)	GJ	113	23	5.4	2.0	36	38	40	5.8	537

1A4ci Agriculture/forestry/ fishing	Unit of activity data	Pb	Cd	Hg	PCDD/PCDF	BaP	BbF	BkF	IcdP	HCB	PCB
		mg/...	mg/...	mg/...	ng I-TEQ/...	mg/...	mg/...	mg/...	mg/...	ng/...	ng/...
Drying of grass	GJ	5.8	1.2	0.60	NE	NE	NE	NE	NE	NE	NE
Heating of greenhouses (weighted average)	GJ	0.0051	0.00050	0.11	0.94	0.0010	0.0056	0.0011	0.0011	75	0.037
Gas oil	GJ	0.012	0.0010	0.12	1.8	0.0019	0.015	0.0017	0.0015	220	0.11
Natural gas	GJ	0.0015	0.00025	0.10	0.50	0.00056	0.00084	0.00084	0.00084	NA	NA
Other fossil combustion (weighted average)	GJ	0.15	0.010	0.11	0.99	0.0019	0.015	0.0017	0.0015	220	0.11
Gas oil (engines)	GJ	0.15	0.010	0.11	0.99	0.0019	0.015	0.0017	0.0015	220	0.11
Natural gas (engines)	GJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other biomass combustion (weighted average)	GJ	3.7	0.27	0.60	22	1.9	1.9	1.0	1.0	3'125	12
Biogas (engines)	GJ	0.040	0.0030	0.10	0.57	0.0012	0.0090	0.0017	0.0018	NA	NA
Wood and wood waste (various furnaces)	GJ	14	1.0	2.0	82	7.3	7.3	3.7	3.7	3'125	12

Activity data (1A4 ai/bi/ci stationary)

Activity data on consumption of gas oil, residual fuel oil, natural gas and biomass are calculated by the energy model (see chp. 3.1.6.3 for further information) and the Energy model for wood combustion (see chp. 3.2.1.1.3). For other energy sources such as other

bituminous coal, activity data are provided directly by the Swiss overall energy statistics (SFOE 2025).

The activity data on fuel consumption in 1A4ai Mobile pellet combustion installations used for temporary applications are based on information from the Swiss wood energy statistics publication (SFOE 2025b, chp. 1.4). However, this is not part of the wood energy statistics model.

Charcoal is only used for barbecues. The total charcoal consumption under 1A4bi is very small compared to other fuels used for heating purposes. The activity data are the sum of charcoal production under 1A1c, and net imports provided by the Swiss overall energy statistics (SFOE 2025).

As the Swiss wood energy statistics (SFOE 2025b) cover wood used for heating and energy purposes only, no figures are available on wood burnt in source category 1A4bi Bonfires. The activity data of bonfires are thus expert judgements based on a per capita consumption. Two types of bonfires are considered: (public) traditional bonfires such as on national day and (private) bonfires for barbecuing. The number of traditional bonfires has declined, as fewer communities are holding national day bonfires. With the increasing use of gas barbecues, there has also been a decrease in bonfires for barbecuing. Overall, a constant wood consumption was therefore assumed for bonfires due to the declining per capita consumption and increasing population (EMIS 2026/1A4bi Lagerfeuer).

Activity data for grass drying in source category 1A4ci are reported by the Swiss association of grass drying plants VSTB (as standard tonne of dried grass, confidential report), see also illustrations Figure 3-12 and Figure 3-16.

Since submission 2015, data on fuel consumption for grass drying are available and used for emission calculations (see EMIS 2026/1A4ci Grastrocknung). The use of gas oil and natural gas for grass drying in 1A4ci is subtracted from boilers in 1A4ai.

The fuel consumption for the heating of greenhouses is extrapolated from the information provided by the Energy Agency of the Swiss Private Sector (EnAW) as documented in the EMIS database (EMIS 2026/1A4ci Gewächshäuser).

Table 3-64 Activity data of 1A4ai Commercial/institutional. All fuels not listed are "NO".

1A4ai Commercial/Institutional Stationary		Unit	1990	1995	2000	2005	2010					
Total fuel consumption		TJ	73'724	81'712	78'705	85'365	81'749					
Boilers	Gas oil	TJ	52'548	53'823	47'804	50'261	45'940					
Boilers	Natural gas	TJ	16'196	20'597	21'497	24'205	23'281					
Boilers	Biogas	TJ	NO	0.00000	0.019	0.010	0.11					
Boilers	Sewage gas	TJ	468	448	429	410	392					
Engines	Gas oil	TJ	427	554	971	935	583					
Engines	Liquefied petroleum gas	TJ	2.4	39	108	95	109					
Engines	Natural gas	TJ	355	1'408	2'170	2'597	2'090					
Engines	Biodiesel fossil	TJ	NO	NO	1.3	0.39	2.5					
Engines	Biodiesel biogenic	TJ	NO	NO	25	7.5	54					
Engines	Biogas	TJ	NO	29	82	143	394					
Engines	Sewage gas	TJ	610	775	1'100	1'284	1'351					
Turbines	Natural gas	TJ	NO	0.23	0.073	NO	0.019					
Turbines	Sewage gas	TJ	179	169	66	NO	18					
Wood combustion	Wood and wood waste	TJ	2'940	3'870	4'451	5'427	7'533					

1A4ai Commercial/Institutional Stationary		Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total fuel consumption		TJ	69'606	72'971	70'416	63'901	64'342	61'730	70'581	57'673	56'933	54'791
Boilers	Gas oil	TJ	34'661	35'957	33'727	30'414	29'793	27'126	30'881	25'152	24'942	24'482
Boilers	Natural gas	TJ	21'564	22'909	22'680	20'062	20'806	19'935	23'017	17'221	16'007	15'912
Boilers	Biogas	TJ	0.70	0.86	0.96	1.1	1.2	1.2	1.0	1.2	1.2	1.3
Boilers	Sewage gas	TJ	367	360	353	346	338	338	338	338	338	338
Engines	Gas oil	TJ	490	481	493	463	478	468	466	464	459	455
Engines	Liquefied petroleum gas	TJ	87	121	44	29	23	23	23	23	23	23
Engines	Natural gas	TJ	1'597	1'481	1'336	1'159	999	964	986	1'026	1'017	1'057
Engines	Biodiesel fossil	TJ	2.6	2.2	2.0	1.9	1.6	1.7	1.8	1.9	1.9	1.9
Engines	Biodiesel biogenic	TJ	46	47	43	43	35	34	34	34	33	34
Engines	Biogas	TJ	738	780	807	818	813	838	821	821	866	861
Engines	Sewage gas	TJ	1'278	1'245	1'258	1'261	1'254	1'562	1'562	1'553	1'559	1'552
Turbines	Natural gas	TJ	0.029	0.25	0.23	0.24	0.23	0.21	0.20	0.20	0.19	0.18
Turbines	Sewage gas	TJ	25	26	26	34	33	41	41	41	41	41
Wood combustion	Wood and wood waste	TJ	8'749	9'560	9'645	9'268	9'766	10'397	12'407	10'996	11'643	10'031

Table 3-65 Activity data of 1A4bi Residential. All fuels not listed are "NO".

1A4bi Residential Stationary		Unit	1990	1995	2000	2005	2010
Total fuel consumption		TJ	185'560	189'596	170'753	186'291	182'299
Boilers	Gas oil	TJ	136'882	133'529	116'231	123'964	111'712
Boilers	Other bituminous coal	TJ	630	460	130	400	400
Boilers	Natural gas	TJ	26'075	34'234	36'270	42'555	48'195
Engines	Gas oil	TJ	4.9	19	64	60	20
Engines	Liquefied petroleum gas	TJ	0.26	4.0	11	11	12
Engines	Natural gas	TJ	39	156	241	288	232
Engines	Biodiesel fossil	TJ	NO	NO	NO	0.035	0.15
Engines	Biodiesel biogenic	TJ	NO	NO	NO	0.69	3.3
Engines	Biogas	TJ	NO	NO	NO	NO	NO
Wood combustion	Wood and wood waste	TJ	21'457	20'741	17'353	18'540	21'222
Use of charcoal	Charcoal	TJ	311	291	292	313	344
Bonfires	Wood (bonfires)	TJ	160	160	160	160	160

1A4bi Residential Stationary		Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total fuel consumption		TJ	145'009	151'174	145'048	133'304	134'207	124'419	139'741	114'488	110'922	109'562
Boilers	Gas oil	TJ	79'398	81'332	76'104	67'896	66'635	59'369	66'042	51'241	49'794	47'753
Boilers	Other bituminous coal	TJ	200	200	100	100	100	100	100	50	50	40
Boilers	Natural gas	TJ	46'118	48'862	48'380	45'992	47'671	46'948	52'865	45'131	42'663	42'489
Engines	Gas oil	TJ	8.5	7.4	8.4	4.8	6.4	6.2	6.1	6.2	6.0	6.0
Engines	Liquefied petroleum gas	TJ	9.6	14	4.9	3.3	2.6	2.5	2.5	2.6	2.5	2.6
Engines	Natural gas	TJ	177	163	147	128	110	106	109	113	112	117
Engines	Biodiesel fossil	TJ	0.15	0.12	0.12	0.097	0.098	0.10	0.11	0.12	0.11	0.12
Engines	Biodiesel biogenic	TJ	2.6	2.5	2.6	2.2	2.1	2.1	2.1	2.1	2.1	2.1
Engines	Biogas	TJ	NO	NO	NO	NO	NO	3.5	3.7	4.1	4.4	4.8
Wood combustion	Wood and wood waste	TJ	18'582	20'098	19'766	18'664	19'194	17'318	20'086	17'424	17'894	18'755
Use of charcoal	Charcoal	TJ	354	334	374	354	325	404	364	353	233	233
Bonfires	Wood (bonfires)	TJ	160	160	160	160	160	160	160	160	160	160

Table 3-66 Activity data of 1A4ci Agriculture / forestry / fishing. All fuels not listed are "NO".

1A4ci Other sectors (stationary): Agriculture/forestry/fishing		Unit	1990	1995	2000	2005	2010
Total fuel consumption		TJ	6'387	6'110	5'804	5'531	5'656
Grass drying		TJ	1'895	1'544	1'223	994	739
Gas oil		TJ	1'156	942	746	607	451
Residual fuel oil		TJ	NO	NO	NO	NO	NO
Natural gas		TJ	739	602	477	388	288
Biomass (crop residues, fat, wood)		TJ	NO	NO	NO	NO	NO
Heating of greenhouses		TJ	4'000	4'000	4'000	3'735	3'677
Gas oil		TJ	3'490	3'490	3'490	3'133	1'803
Natural gas		TJ	510	510	510	601	1'874
Other fossil combustion		TJ	4.9	3.4	4.6	4.5	2.1
Gas oil (engines)		TJ	2.1	2.1	2.1	2.1	2.1
Natural gas (engines)		TJ	2.7	1.3	2.5	2.3	NO
Other biomass combustion		TJ	487	563	577	797	1'239
Biogas (engines)		TJ	59	49	62	128	497
Wood and wood waste (various furnaces)		TJ	428	514	515	669	741

1A4ci Other sectors (stationary): Agriculture/forestry/fishing		Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total fuel consumption		TJ	4'937	5'442	5'963	5'489	5'825	5'945	6'382	5'549	5'599	5'512
Grass drying		TJ	431	492	610	545	684	721	630	559	495	579
Gas oil		TJ	89	86	118	116	124	148	94	99	150	121
Residual fuel oil		TJ	22	18	25	13	NO	NO	NO	NO	NO	NO
Natural gas		TJ	233	279	338	296	427	435	410	347	221	319
Biomass (crop residues, fat, wood)		TJ	88	109	129	120	132	138	126	113	124	139
Heating of greenhouses		TJ	2'900	2'899	3'238	2'754	2'732	2'537	2'753	2'114	2'125	2'161
Gas oil		TJ	1'165	1'066	1'145	930	916	788	861	717	720	733
Natural gas		TJ	1'735	1'834	2'093	1'824	1'816	1'749	1'892	1'397	1'405	1'429
Other fossil combustion		TJ	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Gas oil (engines)		TJ	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Natural gas (engines)		TJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other biomass combustion		TJ	1'605	2'048	2'112	2'188	2'407	2'684	2'997	2'875	2'977	2'769
Biogas (engines)		TJ	1'041	1'192	1'272	1'403	1'612	1'762	1'909	1'946	2'003	2'045
Wood and wood waste (various furnaces)		TJ	564	856	840	786	795	923	1'088	929	974	725

3.2.4.3 Category-specific recalculations for 1A4 Stationary combustion in other sectors (commercial, residential, agriculture and forestry)

The following recalculations were implemented in submission 2025:

- 1A4: The SO_x emission factor for the period 2016-2023 has been updated to reflect the sulphur content of the gas after the odorant addition, rather than before.
- 1A4/1A1a: Based on recalculations in the Swiss overall energy statistics yearly amounts of around 630 to 840 TJ natural gas has been reallocated from 1A4 Other Sectors commercial/institutional to 1A1a Public electricity and heat production for the years 2020-2023.
- 1A4a, 1A4b: The fuel consumption of gas oil in 1A4ai and 1A4bi was revised for the years 2020-2023 due to an update in the underlying statistics of the national energy balance.
- 1A4: The activity data of automatic wood combustion installations (≥ 50 kW) in source categories 1A4ai, 1A4bi and 1A4ci were revised for 2010-2023 due to recalculations in the Swiss wood energy statistics (SFOE 2025b). There were also recalculations in 2023 for open fireplaces and log wood stoves (1A4ai, 1A4bi).
- 1A4a: The activity data for 1A4ai for biogas (sewage gas) use in wastewater treatment plants have been updated for the years 1990-2019 because of a rounding issue; the activity data for sewage gas and biogas for the years 2020-2023 have been updated according to the latest available statistics.
- 1A4ai: Activity data of mobile pellet combustion installations were revised for the years 2015, 2016, 2021 and 2023 due to recalculations in the Swiss wood energy statistics publication (SFOE 2025b, chp. 1.3).
- 1A4ai: Activity data for biogas consumption in commercial/institutional stationary boilers has been reassessed and strongly reduced because of a previous computation mistake in the national energy balance.
- 1A4bi: The activity data of 1A4bi Charcoal consumption was revised for 2023 based on updated production figures derived from information provided by individual charcoal producers.

3.2.5 Source category 1A2 - Mobile combustion in manufacturing industries and construction

3.2.5.1 Source category description for 1A2 Mobile combustion in manufacturing industries and construction

Table 3-67 Specification of source category 1A2 Mobile combustion in manufacturing industries and construction.

1A2	Source category	Specification
1A2gvii	Mobile combustion in manufacturing industries and construction	Industry sector: forklifts and snow groomers etc. Construction machines: excavators, loaders, dump trucks, mobile compressors etc.

Table 3-68 Key categories, approaches 1 and 2, level assessment 2024 (L1, L2) and trend assessment 1990-2024 (T1, T2) for source category 1A2 Combustion in manufacturing industries and construction (mobile only).

NFR code	Source category	Pollutant	Identification criteria
1A2gvii	Mobile combustion in manufacturing industries and construction	PM2.5	L1, L2, T1, T2
1A2gvii	Mobile combustion in manufacturing industries and construction	PM10	L1, L2, T1, T2

3.2.5.2 Methodological issues for 1A2 Mobile combustion in manufacturing industries and construction

Methodology (1A2gvii)

Based on the decision tree Fig. 3.1 in chapter Non-road mobile sources and machinery of the EMEP/EEA guidebook (EMEP/EEA 2023), the emissions of industry and construction vehicles and machinery are calculated by a Tier 3 method with the non-road transportation model described in chapter 3.2.1.1.1.

Emission factors (1A2gvii)

The general sources for the emission factors of the non-road model are described in chp. 3.2.1.1.1. Power class and emission standard-specific emission factors are shown in Table 3-69 to Table 3-72. Implied emission factors for the reporting year are shown in Table 3-73. For the greenhouse gas inventory under UNFCCC the fossil carbon fraction of biodiesel is estimated based on the method described in chapter 3.2.1.1.1. For technical reasons in our database, there is a split of the whole biodiesel amount in fossil and biogenic biodiesel and not only for the carbon fraction and CO₂. Therefore, there are two lines with biodiesel, one with "biodiesel fossil" and one with "biodiesel biogenic".

Table 3-69 Emission factors for diesel-powered machinery (1A2gvii) per emission standard.

engine power	Pre-EU A	Pre-EU B	EU I	EU II	EU IIIA	EU IIIB	EU IV	EU V
g/kWh								
Carbon monoxide (CO)								
<18 kW	6.71	6.71	2.90	2.90	2.90	2.90	2.90	2.90
18–37 kW	6.71	6.71	2.76	2.42	2.06	1.76	1.50	1.50
37–56 kW	4.68	4.68	1.87	1.63	1.39	1.19	1.01	1.01
56–75 kW	4.68	4.68	1.87	1.63	1.39	1.19	1.01	1.01
75–130 kW	3.62	3.62	1.28	1.01	0.86	0.73	0.62	0.62
130–560 kW	3.62	3.62	1.04	0.91	0.77	0.66	0.50	0.50
>560 kW	3.62	3.62	1.04	0.91	0.77	0.66	0.50	0.50
Hydrocarbons (HC)								
<18 kW	2.28	2.28	1.60	1.00	0.59	0.59	0.59	0.53
18–37 kW	2.41	2.41	0.92	0.56	0.37	0.37	0.37	0.37
37–56 kW	1.33	1.33	0.65	0.46	0.33	0.33	0.33	0.33
56–75 kW	1.33	1.33	0.65	0.46	0.33	0.13	0.13	0.13
75–130 kW	0.91	0.91	0.45	0.35	0.28	0.17	0.17	0.13
130–560 kW	0.91	0.91	0.43	0.30	0.22	0.17	0.17	0.13
>560 kW	0.91	0.91	0.43	0.30	0.22	0.17	0.17	0.13
Nitrogen oxides (NO_x)								
<18 kW	10.31	8.20	5.95	5.95	5.95	5.95	5.95	5.95
18–37 kW	10.31	8.20	6.34	6.34	6.34	6.34	6.34	6.34
37–56 kW	12.40	9.87	8.95	6.56	3.90	3.90	3.90	3.90
56–75 kW	12.40	9.87	8.95	6.56	3.90	3.30	0.40	0.40
75–130 kW	12.52	9.96	8.44	5.67	3.32	3.30	0.40	0.40
130–560 kW	12.52	9.96	8.19	5.66	3.38	2.00	0.40	0.40
>560 kW	12.52	9.96	8.19	5.66	5.66	5.66	5.66	3.50
Particulate matter (PM)								
<18 kW	1.51	1.18	1.00	0.80	0.70	0.60	0.60	0.40
18–37 kW	1.20	0.94	0.74	0.60	0.54	0.54	0.54	0.01
37–56 kW	1.09	0.85	0.47	0.32	0.32	0.03	0.03	0.01
56–75 kW	1.09	0.85	0.47	0.32	0.32	0.03	0.03	0.01
75–130 kW	0.61	0.47	0.35	0.24	0.24	0.03	0.03	0.01
130–560 kW	0.61	0.47	0.22	0.16	0.16	0.03	0.03	0.01
>560 kW	0.61	0.47	0.22	0.16	0.16	0.16	0.16	0.05
Fuel consumption								
<18 kW	248	248	248	248	248	248	248	248
18–37 kW	248	248	248	248	248	248	248	248
37–75 kW	248	248	248	248	248	248	248	248
75–130 kW	223	223	223	223	223	223	223	223
>130 kW	223	223	223	223	223	223	223	223

Table 3-70 Emission factors for gasoline-powered machinery (4-stroke engines) (1A2gvii) per emission standard.
cc: cubic centimetres

Capacity range	Pre-EU A	Pre-EU B	Pre-EU C	EU I	EU II	EU V
Carbon monoxide (CO)						
<66 cc	470	470	470	467	467	467
66–100 cc	470	470	470	467	467	467
100–225 cc	470	470	470	467	467	467
>225 cc	470	470	470	467	467	467
Hydrocarbons (HC)						
<66 cc	60	60	60	41	41	8
66–100 cc	40	40	40	32	32	8
100–225 cc	20	20	20	12	12	8
>225 cc	20	20	20	10	9	6
Nitrogen oxides (NO_x)						
<66 cc	1.5	2.0	3.0	4.5	4.5	0.9
66–100 cc	1.5	2.0	3.0	3.6	3.6	0.9
100–225 cc	3.5	3.5	3.5	2.8	2.8	0.9
>225 cc	3.5	3.5	3.5	2.2	1.9	0.72
Fuel consumption (FC)						
<66 cc	500	500	500	480	480	460
66–100 cc	480	480	480	470	470	460
100–225 cc	460	460	460	450	450	450
>225 cc	460	460	460	450	450	450
Assumptions regarding introduction of emission stages						
<66 cc	<1996	1996	2000	2004	2005	2019
66–100 cc	<1996	1996	2000	2004	2005	2019
100–225 cc	<1996	1996	2000	2004	2009	2019
>225 cc	<1996	1996	2000	2004	2007	2019

Table 3-71 Emission factors for gasoline-powered machinery (2-stroke engines) (1A2gvii) per emission standard.
 cc: cubic centimetres

Capacity range	Pre-EU A	Pre-EU B	Pre-EU C	EU I	EU II	EU V
Carbon monoxide (CO)						
<20 cc	650	640	620	600	600	500
20–50 cc	650	640	620	600	600	500
>50 cc	650	640	620	540	540	500
Hydrocarbons (HC)						
<20 cc	260	250	150	100	41	41
20–50 cc	260	250	150	100	41	41
>50 cc	260	250	150	100	58	58
Nitrogen oxides (NO_x)						
<20 cc	1.5	2.0	3.0	4.8	4.5	4.5
20–50 cc	1.5	2.0	3.0	4.8	4.5	4.5
>50 cc	1.5	2.0	3.0	4.8	6.3	6.3
Fuel consumption						
<20 cc	660	650	550	500	440	410
20–50 cc	660	650	550	500	440	410
>50 cc	660	650	550	500	460	410
Assumptions regarding the introduction of emission stages						
<20 cc	<1996	1996	2000	2004	2009	2019
20–50 cc	<1996	1996	2000	2004	2009	2019
>50 cc	<1996	1996	2000	2004	2011	2019

Table 3-72 Emission factors for gas-operated machinery (1A2gvii).

Pollutant	Without catalyst	With oxidation catalysts	50% with 3-way catalysts	100% with 3-way catalysts
	g/kWh			
CO	10	0.2	0.2	0.2
HC	8	0.5	0.5	0.5
NO _x	10	10	6	2
PM	0.02	0.01	0.01	0.01
Fuel consumption	450	450	455	460
Assumptions regarding introduction of emission stages				
All capacities		1980	1994	2000

Table 3-73 Implied emission factors for 1A2gvii in 2024.

1A2gvii Mobile combustion in manufacturing industries and construction	Unit	NOx	NM VOC	SOx	NH3	PM2.5 ex	PM2.5 nx	PM10 ex	PM10 nx
		g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
Gasoline	GJ	NA	NA	0.19	NA	NA	NA	NA	NA
Diesel oil	GJ	NA	NA	0.30	NA	NA	NA	NA	NA
Biodiesel fossil	GJ	158	17	0.30	0.17	3.3	NA	3.3	NA
Biodiesel biogenic	GJ	158	17	0.30	0.17	3.3	NA	3.3	NA
Bioethanol	GJ	52	287	0.19	0.091	0.30	NA	0.30	NA
Working hours gasoline	h	3.8	26	NA	0.0040	0.058	NA	0.058	NA
Working hours diesel oil	h	45	4.8	NA	0.048	0.94	NA	0.94	NA
Working hours LPG	h	16	1.5	NA	0.037	0.081	NA	0.081	NA
Working hours (for non-exhaust only)	h	NA	NA	NA	NA	NA	2.4	NA	16

1A2gvii Mobile combustion in manufacturing industries and construction	Unit	TSP ex	TSP nx	BC ex	BC nx	CO	Pb	Cd	Hg
		g/...	g/...	g/...	g/...	g/...	mg/...	mg/...	mg/...
Gasoline	GJ	NA	NA	NA	NA	NA	16	NA	NA
Diesel oil	GJ	NA	NA	NA	NA	NA	NA	NA	NA
Biodiesel fossil	GJ	3.3	NA	1.4	NA	81	0.89	2.1	0.11
Biodiesel biogenic	GJ	3.3	NA	1.4	NA	81	0.89	2.1	0.11
Bioethanol	GJ	0.30	NA	0.015	NA	18'490	0.59	2.3	0.20
Working hours gasoline	h	0.058	NA	0.0029	NA	883	0.027	0.10	0.0089
Working hours diesel oil	h	0.94	NA	0.41	NA	23	0.25	0.60	0.032
Working hours LPG	h	0.081	NA	0.0041	NA	4.2	NA	0.040	NA
Working hours (for non-exhaust only)	h	NA	24	NA	0.0030	NA	NA	NA	NA

1A2gvii Mobile combustion in manufacturing industries and construction	Unit	PCDD/PCDF	BaP	BbF	BkF	IcdP
		ng I- -Teq/...	mg/...	mg/...	mg/...	mg/...
Gasoline	GJ	NA	NA	NA	NA	NA
Diesel oil	GJ	NA	NA	NA	NA	NA
Biodiesel fossil	GJ	1.5	0.64	1.1	0.79	0.18
Biodiesel biogenic	GJ	1.5	0.64	1.1	0.79	0.18
Bioethanol	GJ	2.7	1.0	1.0	0.099	0.30
Working hours gasoline	h	0.12	0.045	0.045	0.0044	0.014
Working hours diesel oil	h	0.42	0.18	0.30	0.22	0.051
Working hours LPG	h	NA	0.00075	NA	0.00075	0.00075
Working hours (for non-exhaust only)	h	NA	NA	NA	NA	NA

Activity data (1A2gvii)

Table 3-74 shows the activity data of 1A2gvii taken from FOEN (2015j). Diesel oil is the main fuel type consumed in this category. Data on biofuels are provided by the statistics of renewable energies (SFOE 2025a).

Detailed activity data can be downloaded from the online database INFRAS (2015a).

Table 3-74 Activity data for 1A2gvii.

1A2gvii Mobile combustion in manufacturing industries and construction	Unit	1990	1995	2000	2005	2010
Total fuel consumption	TJ	5'721	6'852	7'636	8'169	8'779
Gasoline	TJ	196	224	227	225	220
Diesel oil	TJ	5'359	6'380	7'108	7'630	8'259
Liquefied petroleum gas	TJ	165	248	294	290	269
Biodiesel fossil	TJ	NO	NO	0.41	1.2	1.4
Biodiesel biogenic	TJ	NO	NO	7.5	23	30
Bioethanol	TJ	NO	NO	NO	NO	0.0029

1A2gvii Mobile combustion in manufacturing industries and construction	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total fuel consumption	TJ	8'938	8'945	8'951	8'958	8'964	8'971	8'995	9'019	9'043	9'068
Gasoline	TJ	184	181	179	176	173	171	170	169	169	168
Diesel oil	TJ	8'416	8'368	8'321	8'273	8'226	8'178	8'225	8'273	8'320	8'367
Liquefied petroleum gas	TJ	226	215	203	192	180	168	163	157	151	145
Biodiesel fossil	TJ	5.9	8.9	12	15	18	21	21	20	20	20
Biodiesel biogenic	TJ	105	170	235	300	365	430	414	397	381	365
Bioethanol	TJ	0.80	1.1	1.4	1.7	1.9	2.2	2.5	2.7	2.9	3.1

Energy: Source category 1A - Fuel combustion activities - Source category 1A2 - Mobile combustion in manufacturing industries and construction

3.2.5.3 Category-specific recalculations for 1A2 Mobile combustion in manufacturing industries and construction

The following recalculations were implemented in submission 2026:

- 1A2gvii: The consumption of biodiesel (fossil and biogenic) has been set to zero for the year 1996 to insure compatibility with the national statistics. Values linearly interpolated until the next data point in 2000 are affected as well.

3.2.6 Source category 1A3 - Transport

3.2.6.1 Source category description for 1A3 Transport

The source category 1A3 Transport includes all emissions from fuel combustion in transport processes by air, on roads, on railways, in water transport, and in pipelines.

Table 3-75 Specification of source category 1A3 Transport.

1A3	Source category	Specification
1A3ai(i)	International aviation LTO (civil)	LTO: Landing/Take-off emissions from international flights
1A3ai(ii)	International aviation CR (civil)	CR: Cruise emissions of international flights Memo item – not to be included in national total
1A3aii(i)	Domestic aviation LTO (civil)	LTO: Landing/Take-off emissions from domestic flights Large (jet, turboprop) & small (piston) aircrafts, helicopters
1A3aii(ii)	Domestic aviation CR (civil)	CR: Cruise emissions from domestic flights Large (jet, turboprop) & small (piston) aircrafts, helicopters Memo item – not to be included in national total
1A3bi	Road transportation: Passenger cars	Emissions from passenger cars
1A3bii	Road transportation: Light duty vehicles	Emissions from light duty vehicles
1A3biii	Road transportation: Heavy duty vehicles and buses	Emissions from heavy duty vehicles, coaches and buses
1A3biv	Road transportation: Mopeds & motorcycles	Emissions from 2-stroke and 4-stroke motorcycles
1A3bv	Road transportation: Gasoline evaporation	NM VOC emissions from gasoline evaporation
1A3bvi	Road transportation: Automobile tyre and brake wear	Non-exhaust emissions from road transportation
1A3bvii	Road transportation: Automobile road abrasion	Not reported separately but included in non-exhaust emissions reported in 1A3bvi
1A3c	Railways	Diesel locomotives, abrasion by merchandise and person traffic
1A3di(ii)	International maritime navigation	Shipping leaving Switzerland on the river Rhine and on Lake Geneva and Lake Constance Memo item - not to be included in national total
1A3dii	National navigation (shipping)	Passenger ships, motor and sailing boats on the Swiss lakes and the river Rhine
1A3ei	Pipeline transport	Gas turbines at the compressor station in Ruswil (canton Lucerne) for the Swiss gas network.

Note that emissions from cruise (CR) in civil aviation (see also Table 3-6; 1A3ai(ii) International aviation CR and 1A3aii(ii) Domestic aviation CR) as well as emissions from international inland waterways are reported under “memo items” and not considered for the national total.

Table 3-76 Key categories, approaches 1 and 2, level assessment 2024 (L1, L2) and trend assessment 1990-2024 (T1, T2) for source category 1A3, Transport.

NFR code	Source category	Pollutant	Identification criteria
1A3ai(i)	Civil aviation (domestic landing/take-off (LTO))	NO _x	L1, L2, T1, T2
1A3ai(i)	Civil aviation (domestic landing/take-off (LTO))	SO _x	L1, L2, T1, T2
1A3bi(fu)	Road transportation: passenger cars (fuel used)	NO _x	L1, L2, T1, T2
1A3bi(fu)	Road transportation: passenger cars (fuel used)	NM VOC	L1, L2, T1, T2
1A3bi(fu)	Road transportation: passenger cars (fuel used)	SO _x	T1
1A3bii(fu)	Road transportation: light duty vehicles (fuel used)	NO _x	L1, L2, T1, T2
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	NO _x	L1, L2, T1, T2
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	SO _x	T1, T2
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	PM _{2.5}	T1, T2
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	PM ₁₀	T1
1A3biv(fu)	Road transportation: mopeds and motorcycles (fuel used)	NM VOC	T2
1A3bv(fu)	Road transportation: gasoline evaporation (fuel used)	NM VOC	L1, T1, T2
1A3bvi(fu)	Road transportation: automobile tyre and brake wear (fuel used)	PM _{2.5}	L1, L2, T1, T2
1A3bvi(fu)	Road transportation: automobile tyre and brake wear (fuel used)	PM ₁₀	L1, L2, T1, T2
1A3c	Railways	PM _{2.5}	L1, L2, T1, T2
1A3c	Railways	PM ₁₀	L1, L2, T1, T2
1A3dii	National navigation (shipping)	NO _x	T1

3.2.6.2 Methodological issues for 1A3 Transport

3.2.6.2.1 Civil aviation (1A3a)

Methodology (1A3a)

According to the decision tree in Figure 3-1 in chapter 1A3a (Aviation) in the EMEP/EEA guidebook (EMEP/EEA 2023), Switzerland uses a Tier 3 approach because data on start and final destinations are available by aircraft type. Emission factors are also applied at a detailed level and are stratified by engine type.

All civil flights to and from Swiss airports are classified as domestic (national, 1A3a(ii)) or international (1A3a(i)) flights. The Landing/Take-off (LTO) emissions from domestic and international flights are reported under category 1A3a. Emissions from domestic and international cruise phases are reported as memo items and are therefore not included in the national total.

A complete emissions modelling (LTO and cruise emissions for domestic and international flights) was carried out by FOCA for the years 1990, 1995, 2000, 2002, 2004, 2005, and 2007-2024. The results of the emissions modelling were transmitted from FOCA to FOEN in aggregated form (FOCA 2006, 2006a, 2007a, 2008-2025). Years in-between are interpolated. Further details of the emissions modelling are described in Switzerland's National Inventory Document (FOEN 2026).

Emission factors (1A3a)

The emission factors used are either country-specific or derived from the ICAO engine emissions database from the EMEP/EEA guidebook (EMEP/EEA 2023), the Swedish Defence Research Agency (FOI), and measurements conducted by the Swiss FOCA. Emission factors are case-sensitive and therefore separated into those relating to the LTO cycle and cruise phase. Values of the emission factors (EF) are provided in Table 3-77.

- NO_x, SO_x, VOC, and CO EF are differentiated by engine type and by flight phase (taxi, take-off etc.)

- NMVOC is calculated as a fraction of VOC. For the LTO cycle $EF_{NMVOC} = 0.47 * EF_{VOC}$, whereas for cruise $EF_{NMVOC} = EF_{VOC}$ i.e, there are no CH₄ emissions during the cruise phase.
- PM10 and PM2.5 EF have been determined by the Federal Office of Civil Aviation (FOCA 2016b). For exhaust emissions, PM10 exhaust = PM2.5 exhaust = PM exhaust is assumed. During high-power engine operating states, PM exhaust is assumed to be equal to BC; during other operating states, PM exhaust also contains volatile compounds. FOCA recommends setting $EF_{PM2.5\ exhaust} = 2 * EF_{BC}$, (see also chapter 1.A.3.a, 1.A.5.b * Aviation of the EMEP/EEA guidebook (EMEP/EEA 2023, notes to Table 3-11 on p. 28).
- For non-exhaust emissions from tyre, brake and airstrip abrasion, FOCA provides a weighted non-exhaust emission factor of 0.1 g per LTO-cycle. This value is based on 0.08 g per landing for short-distance flights and 0.27 g per landing for long-distance flights.
- Emissions of Pb from leaded aviation fuel are assumed to be equal to the maximum allowed Pb content in the fuel, which is 0.794 g Pb per kg of fuel. The Pb emission factors shown in Table 3-77 are implied emission factors, as they are calculated by dividing Pb emissions from leaded aviation fuels by the sum of leaded aviation fuels and unleaded jet kerosene consumption. The share of leaded aviation fuels relative to total kerosene consumption is less than 1%.

LTO

The Swiss FOCA engine emissions database consists of more than 520 individual engine datasets. Jet engine emission factors for engines with a thrust above 26.7 kN (emission-certificated) are identical to those in the ICAO engine emissions database. Emission factors for lower-thrust engines, piston engines, and helicopters are obtained from manufacturers or from FOCA's own measurements. Emission factors for turboprop engines were obtained in collaboration with the Swedish Defence Research Agency (FOI).

Cruise

Aircraft cruise emission factors depend on representative flight distances for each aircraft type. A load factor of 65% is assumed. Some cruise emission factors are taken from former CROSSAIR data (FOCA 1991). The entire Airbus fleet (which accounts for a large share of the Swiss inventory) has been modelled on the basis of real operational aircraft data from flight data recorders (FDR) of Swiss International Airlines.

Some older or missing aircraft cruise emission factors were modelled using the ICAO engine emissions database. For piston-engine aircraft, FOCA has produced its own emission factors, measured under real flight conditions.

Table 3-77 Emission factors for 1A3a Civil aviation, year 2024. (LTO: Landing/Take-off; CR: cruise). Sustainable aviation fuels (SAF) are referred to as jet kerosene biogenic.

1A3a Aviation		Unit	NOx	NM VOC	SOx	NH3	PM2.5 ex	PM2.5 nx	PM10 ex	PM10 nx
			g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
1A3ai(i) International aviation LTO (civil)	Jet kerosene fossil	GJ	334	22	23	NA	2.4	0.00098	2.4	0.00098
1A3ai(i) International aviation LTO (civil)	Jet kerosene biogenic	GJ	349	22	23	NA	2.3	0.00097	2.3	0.00097
1A3aii(i) Domestic aviation LTO (civil)	Jet kerosene fossil	GJ	238	115	20	NA	6.5	0.00078	6.5	0.00078
1A3aii(ii) International aviation cruise (civil)	Jet kerosene fossil	GJ	426	3.9	23	NA	0.74	NA	0.74	NA
1A3aii(ii) International aviation cruise (civil)	Jet kerosene biogenic	GJ	447	4.2	23	NA	0.62	NA	0.62	NA
1A3aii(ii) Domestic aviation cruise (civil)	Jet kerosene fossil	GJ	238	81	22	NA	4.3	NA	4.3	NA

1A3a Aviation		Unit	TSP ex	TSP nx	BC ex	BC nx	CO	Pb	Cd ex	Cd nx	Hg
			g/...	g/...	g/...	g/...	g/...	mg/...	mg/...	mg/...	mg/...
1A3ai(i) International aviation LTO (civil)	Jet kerosene fossil	GJ	2.4	0.00098	0.91	NA	261	4.9	NA	NA	NA
1A3ai(i) International aviation LTO (civil)	Jet kerosene biogenic	GJ	2.3	0.00097	0.80	NA	256	0.45	NA	NA	NA
1A3aii(i) Domestic aviation LTO (civil)	Jet kerosene fossil	GJ	6.5	0.00078	1.6	NA	3'220	2'510	NA	NA	NA
1A3aii(ii) International aviation cruise (civil)	Jet kerosene fossil	GJ	0.74	NA	0.74	NA	43	3.8	NA	NA	NA
1A3aii(ii) International aviation cruise (civil)	Jet kerosene biogenic	GJ	0.62	NA	0.62	NA	41	0.25	NA	NA	NA
1A3aii(ii) Domestic aviation cruise (civil)	Jet kerosene fossil	GJ	4.3	NA	4.3	NA	611	701	NA	NA	NA

1A3a Aviation		Unit	PCDD/ PCDF ng I- Teq/...	BaP	BbF	BkF	IcdP	HCB	PCB
			mg/...	mg/...	mg/...	mg/...	mg/...	ng/...	ng/...
1A3ai(i) International aviation LTO (civil)	Jet kerosene fossil	GJ	NA	NA	NA	NA	NA	NA	NA
1A3ai(i) International aviation LTO (civil)	Jet kerosene biogenic	GJ	NA	NA	NA	NA	NA	NA	NA
1A3aii(i) Domestic aviation LTO (civil)	Jet kerosene fossil	GJ	NA	NA	NA	NA	NA	NA	NA
1A3aii(ii) International aviation cruise (civil)	Jet kerosene fossil	GJ	NA	NA	NA	NA	NA	NA	NA
1A3aii(ii) International aviation cruise (civil)	Jet kerosene biogenic	GJ	NA	NA	NA	NA	NA	NA	NA
1A3aii(ii) Domestic aviation cruise (civil)	Jet kerosene fossil	GJ	NA	NA	NA	NA	NA	NA	NA

Activity data (1A3a)

Activity data are derived from detailed movement statistics provided by FOCA. The statistics distinguish between scheduled and charter aviation, as well as non-scheduled, non-charter and general aviation (including helicopters).

Scheduled and charter aviation

The statistical basis was extended after 1996. Therefore, the modelling details for the years 1990 and 1995 are not exactly the same as those for the subsequent years. The source data for the 1990 and 1995 modelling are the movement statistics, which record, for each movement, information on the airline, number of seats, Swiss airport, arrival/departure, origin/destination, number of passengers, and distance. From 1996 onwards, each movement in the FOCA statistics also includes the individual aircraft tail number (aircraft registration), which is the key variable for linking airport data and aircraft data. All recorded annual aircraft movements are split into domestic and international flights.

Non-scheduled, non-charter and general aviation (including helicopters)

Airports and most airfields report individual aircraft data (aircraft registration). FOCA is therefore able to compute the inventory for small aircraft using a Tier 3 approach. However, for 1990 and 1995, emissions for non-scheduled, non-charter, and general aviation (helicopters etc.) could not be calculated using a Tier 3 approach. Fuel consumption for these activities is estimated at 10% of the domestic fuel consumption. Data were taken from two studies conducted by FOCA (FOCA 1991, FOCA 1991a). Since 2000, all movements at airfields have been registered, allowing more detailed emissions modelling.

Helicopter flights that do not take off from an official airport or airfield such as transport flights, flights for lumbering, animal transport, supply of alpine huts, heli-skiing and flight training in alpine regions, cannot be captured in the airport and airfield movement database. Although these helicopter movements account for only 0.1% of the total domestic aviation

emissions, they are included using the statistics from the Swiss Helicopter Association (Unternehmensstatistik der Schweizer Helikopterunternehmen). These statistics are officially collected by FOCA and updated annually (see FOCA 2004 as illustrative example for subsequent years). Since 2007, these data have been included electronically in the model data warehouse and undergo initial plausibility checks (E-plaus software). To distinguish between single-engine and twin-engine helicopters, a fixed split of 87% single-engine and 13% twin-engine helicopters is applied for the entire commitment period, based on investigations conducted in 2004 (FOCA 2004). Note that all emissions from helicopter flights that do not take off from an official airport or an official airfield are considered domestic emissions. In addition, a helicopter base in the Principality of Liechtenstein consumes a very small amount of fuel that is included in the Swiss statistics. As a result, this fuel consumption is reported as domestic instead of international bunker emissions. FOCA and FOEN decided to report these emissions as Swiss domestic emissions, as it is a very small amount and the effort for a separation would be considerable.

Table 3-78 summarises the activity data for civil aviation. Note that cruise emissions are included in international bunkers and reported as memo items (1A3ai(ii) and 1A3aii(ii)). The increase in energy consumption from 1990 to 2019 is due to the growing number of flights. In 2020 and 2021, the COVID-19 pandemic led to a strong reduction in energy consumption compared with 2019, due to a significantly reduced number of flights. Since 2022, flight activities, and thus energy consumption, has increased again and reached pre-pandemic levels in 2024. Since 2021, sustainable aviation fuels (SAF) have been reported from Zurich Airport and attributed to international flights. The amount is very small compared with the consumption of fossil jet fuel.

Table 3-78 Jet kerosene consumption for domestic and international aviation stated in TJ. Note that domestic and international LTO emissions are reported and included in the national total for the entire territory (based on fuel sold), whereas domestic and international cruise emissions are reported as memo items only. Sustainable aviation fuels (SAF) are referred to as jet kerosene biogenic.

1A3a Aviation		Unit	1990	1995	2000	2005	2010					
Total fuel consumption		TJ	45'334	52'993	66'267	49'477	60'028					
Total, 1990 = 100 %		%	100	117	146	109	132					
1A3ai(i) International aviation LTO (civil)	Jet kerosene fossil	TJ	4'277	5'097	6'507	4'878	5'643					
1A3ai(i) International aviation LTO (civil)	Jet kerosene biogenic	TJ	NO	NO	NO	NO	NO					
1A3aii(i) Domestic aviation LTO (civil)	Jet kerosene fossil	TJ	1'050	935	773	518	464					
1A3ai(ii) International aviation cruise (civil)	Jet kerosene fossil	TJ	37'608	44'821	57'219	42'896	52'691					
1A3aii(ii) International aviation cruise (civil)	Jet kerosene biogenic	TJ	NO	NO	NO	NO	NO					
1A3aii(ii) Domestic aviation cruise (civil)	Jet kerosene fossil	TJ	2'401	2'139	1'768	1'184	1'230					
1A3a Aviation		Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total fuel consumption		TJ	69'220	72'534	74'465	78'793	79'767	29'250	32'683	58'443	69'786	76'635
Total, 1990 = 100 %		%	153	160	164	174	176	65	72	129	154	169
1A3ai(i) International aviation LTO (civil)	Jet kerosene fossil	TJ	6'459	6'529	6'728	6'953	6'963	2'395	2'718	5'129	5'915	6'418
1A3ai(i) International aviation LTO (civil)	Jet kerosene biogenic	TJ	NO	NO	NO	NO	NO	NO	2.0	0.029	1.4	3.3
1A3aii(i) Domestic aviation LTO (civil)	Jet kerosene fossil	TJ	387	421	384	346	321	170	183	227	236	261
1A3aii(ii) International aviation cruise (civil)	Jet kerosene fossil	TJ	60'874	64'073	66'096	70'261	71'233	25'799	29'129	52'369	62'966	68'983
1A3aii(ii) International aviation cruise (civil)	Jet kerosene biogenic	TJ	NO	NO	NO	NO	NO	NO	24	0.33	17	39
1A3aii(ii) Domestic aviation cruise (civil)	Jet kerosene fossil	TJ	1'500	1'511	1'257	1'234	1'250	886	628	717	651	931

3.2.6.2.2 Road transportation (1A3b)

Methodology (1A3b)

- The exhaust air pollutant emissions are calculated by a Tier 3 method based on the decision trees Fig. 3.1 in the chapters 1A3bi-iv Road transport 2025 in the EMEP/EEA guidebook (EMEP/EEA 2023).

- The non-exhaust air pollutant emissions are calculated by a Tier 2 method based on the decision trees Fig. 3.1 in the chapters 1A3bi-iv Road transport 2025 in the EMEP/EEA guidebook (EMEP/EEA 2023).

The total emissions are reported in two versions. The first version is based on fuel used to account to the national total for compliance assessment. The second version is based on fuel sold and shown in the reporting tables, thereby contributing to the national total (but not for compliance assessment). See also chapter 3.1.6.1 on system boundaries.

The emission computation is based on emission factors and activity data. For general methods see INFRAS (2017c), emission factors see INFRAS (2019a), Matzer et al. (2019) and Notter et al. (2022). Emission factors are expressed as specific emissions in grams per unit, where the unit depends on the set of traffic activity data: vehicle kilometres travelled (hot emissions, evaporation running losses), number of starts/stops and vehicle stock (cold start, evaporation soak and diurnal emissions from gasoline passenger cars, light duty vehicles and motorcycles only) or fuel consumption per vehicle category.

For all years up to 2024, statistical data was used for calculating activity data from 1A3b Road transportation (ex-post). Emissions are calculated as follows:

- Hot emissions: $E_{hot} = VKT \cdot EF_{hot}$
- Cold start excess emissions: $E_{start} = N_{start} \cdot EF_{start}$
- Evaporation soak VOC emissions: $E_{evap\ s} = N_{evap\ s} \cdot EF_{evap\ s}$
- Evaporation diurnal VOC emissions: $E_{evap\ d} = N_{evap\ d} \cdot EF_{evap\ d}$
- Evaporation running VOC losses: $E_{evap\ RL} = VKT \cdot EF_{evap\ RL}$

with

- EF_{hot} , EF_{start} , $EF_{evap\ s}$, $EF_{evap\ d}$, $EF_{evap\ RL}$: Emission factors for ordinary driving conditions (hot engine), cold start excess emissions, and evaporative (VOC) emissions (after stops, diurnal losses and running losses)
- VKT : Vehicle km travelled
- N_{start} : Number of starts
- $N_{evap\ s}$: Number of stops
- $N_{evap\ d}$: Number of vehicles multiplied with the number of days in the reporting period

Emission factors are differentiated by fuel types: Gasoline (4-stroke), gasoline (2-stroke), diesel oil, liquefied petroleum gas, bioethanol, biodiesel, (compressed) natural gas, biogas, and by emission standard (in terms of percentage of vehicles with evaporation control, average tank and canister size, canister purge rates, and percentage of vehicles with mono- vs. multi-layered tanks).

Emission factors (1A3b)

Emission factors in 1A3b Road transportation originate from the following sources:

- Emission factors for the exhaust pollutants NO_x , NMVOC, NH_3 , CO, PM2.5, and PM10 are country-specific. These factors have been derived from “emission functions” determined from a compilation of measurements from various European countries with programs using similar driving cycles (legislative as well as standardized real-world cycles, like “Common Artemis Driving Cycle” (CADC). The method has been developed

in 1990-1995 and has been extended and updated in 2000, 2004, 2010, 2017, 2019 and 2022 (INFRAS 2017c, INFRAS 2019a, Notter et al. 2022). These emission factors are compiled in a database called “Handbook of Emission Factors for Road Transport” (INFRAS 2022). Version 4.2 is presented and documented on the website <http://www.hbefa.net/>. The resulting emission factors are differentiated by so-called “traffic situations”, which represent characteristic patterns of driving behaviour (i.e., speed profiles) and which serve as a key to the disaggregation of the activity data. They are defined by spatial characteristics (urban/rural areas, 7 gradient classes (0, +/-2, +/-4, +/-6%), road type, speed limit) and temporal features (levels of service, i.e., traffic density, from free flow to heavy stop-and-go). The underlying database contains a dynamic fleet composition model simulating the release of new exhaust technologies and the fading out of old technologies. Corrective factors are provided to account for future technologies. Considering the measuring procedure and the maximum temperature of 52°C, it can be assumed that the measurements also include PM condensables. The installed technology also plays a role in this context (petrol engines with/without catalytic converter, diesel engines with/without particulate filter, etc.).

- Emission factors for Pb, Cd exhaust, Zn exhaust, Hg, PCDD/PCDF (except for natural gas engines, see below), PAH and PCB are taken from the EMEP/EEA guidebook (EMEP/EEA 2019, chapter 1.A.3.b.i-iv Road transport 2019).
- SO_x emission factors are based upon the sulphur content of fuels and are country- and fuel-specific (see chp. 3.2.1.2).
- Emission factor for PCDD/PCDF emissions from natural gas engines is taken from Rentz et al. (2008).
- Emission factors for BC and Cd stem from the Handbook of Emission Factors for Road Transport as well as non-exhaust emissions of particulate matter (TSP, PM₁₀, PM_{2.5}), which are based on Düring and Schmidt (2016); their integration into the Handbook of Emission Factors for Road Transport is described in INFRAS (2019a). Details to non-exhaust emission factors can be found in EMIS 2026/1A3b-Strassenverkehr.
- Note that there is still no HCB emission factor available in the EMEP/EEA guidebook (EMEP/EEA 2019). Therefore, these emissions are still NE for the years 1990-2024.

For biofuels, the respective air pollutant emission factors of 1A3b Road transportation for fossil fuels are used as follows: for biodiesel and vegetable/waste oil the ones from diesel oil, for bioethanol the ones from gasoline and for biogas the ones from (compressed) natural gas use. Table 3-79 shows a selection of implied emission factors (emissions divided by specific fuel consumption per source category) for 2024.

Table 3-79 Implied emission factors for road transportation in 2024 ((fu) means fuel used approach).

1A3b(fu) Road Transportation (Gasoline, Bioethanol)	NO _x	NM VOC	SO _x	NH ₃	PM2.5 ex	PM2.5 nx	PM10 ex	PM10 nx	TSP ex	TSP nx	BC ex	BC nx
	kg/TJ											
1A3bi(fu) Passenger cars	29	40	0.19	8.1	0.55	NA	0.55	NA	0.55	NA	0.084	NA
1A3bii(fu) Light duty vehicles	52	82	0.19	9	2.1	NA	2.1	NA	2.1	NA	0.35	NA
1A3biii(fu) Heavy duty vehicles	782	476	0.19	0.23	NA	NA	NA	NA	NA	NA	NA	NA
1A3biv(fu) Motorcycles	59	160	0.19	1.3	9	NA	9	NA	9	NA	1.8	NA
1A3bv(fu) Gasoline evaporation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1A3bvi(fu) Automobile tyre and break wear	NA	NA	NA	NA	NA	4.8	NA	13	NA	13	NA	0.49
1A3b(fu) Road Transportation (Gasoline, Bioethanol)	CO	Pb	Cd ex	Cd nx	Hg	PCDD/PCDF	BaP	BbF	BkF	IcdP	HCB	PCB
	kg/TJ		g/TJ			mg I-TEQ/TJ		g/TJ			ng/TJ	
1A3bi(fu) Passenger cars	498	0.59	0.0042	NA	0.20	0.0029	0.13	0.15	0.11	0.16	NE	580
1A3bii(fu) Light duty vehicles	1'786	0.59	0.0037	NA	0.19	0.0028	0.11	0.13	0.09	0.14	NE	559
1A3biii(fu) Heavy duty vehicles	596	0.59	0.0055	NA	NE	NE	NE	NE	NE	NE	NE	NE
1A3biv(fu) Motorcycles	1'426	0.59	0.0045	NA	0.20	0.0079	0.20	0.22	0.16	0.24	NE	2'266
1A3bv(fu) Gasoline evaporation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1A3bvi(fu) Automobile tyre and break wear	NA	NA	NA	0.41	NA	NA	NA	NA	NA	NA	NA	NA
1A3b Road Transportation (Diesel, Biodiesel)	NO _x	NM VOC	SO _x	NH ₃	PM2.5 ex	PM2.5 nx	PM10 ex	PM10 nx	TSP ex	TSP nx	BC ex	BC nx
	kg/TJ											
1A3bi(fu) Passenger cars	191	3.3	0.30	1.9	1.04	NA	1.04	NA	1.04	NA	0.56	NA
1A3bii(fu) Light duty vehicles	173	1.4	0.30	1.5	2.6	NA	2.6	NA	2.6	NA	1.2	NA
1A3biii(fu) Heavy duty vehicles	113	2.4	0.30	1.1	1.1	NA	1.1	NA	1.1	NA	0.35	NA
1A3biv(fu) Motorcycles	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1A3bvi(fu) Automobile tyre and break wear	NA	NA	NA	NA	NA	4.5	NA	13	NA	13	NA	0.45
1A3b Road Transportation (Diesel, Biodiesel)	CO	Pb	Cd ex	Cd nx	Hg	PCDD/PCDF	BaP	BbF	BkF	IcdP	HCB	PCB
	kg/TJ		g/TJ			mg I-TEQ/TJ		g/TJ			ng/TJ	
1A3bi(fu) Passenger cars	45	0.91	0.0011	NA	0.12	0.0019	0.65	0.73	0.57	0.61	NE	371
1A3bii(fu) Light duty vehicles	42	0.91	0.0011	NA	0.12	0.0015	0.47	0.53	0.41	0.44	NE	308
1A3biii(fu) Heavy duty vehicles	33	0.91	0.0009	NA	0.21	0.00009	0.080	0.48	0.54	0.12	NE	18
1A3biv(fu) Motorcycles	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1A3bvi(fu) Automobile tyre and break wear	NA	NA	NA	0.48	NA	NA	NA	NA	NA	NA	NA	NA
1A3b Road Transportation (Gas, Biogas)	NO _x	NM VOC	SO _x	NH ₃	PM2.5 ex	PM2.5 nx	PM10 ex	PM10 nx	TSP ex	TSP nx	BC ex	BC nx
	kg/TJ											
1A3bi(fu) Passenger cars	20	1.1	0.45	8.3	1.5	NA	1.5	NA	1.5	NA	0.22	NA
1A3bii(fu) Light duty vehicles	14	0.58	0.45	8.0	2.4	NA	2.4	NA	2.4	NA	0.36	NA
1A3biii(fu) Heavy duty vehicles	41	1.1	0.45	NE	0.41	NA	0.41	NA	0.41	NA	0.061	NA
1A3biv(fu) Motorcycles	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1A3bvi(fu) Automobile tyre and break wear	NA	NA	NA	NA	NA	4.9	NA	14	NA	14	NA	0.49
1A3b Road Transportation (Gas, Biogas)	CO	Pb	Cd ex	Cd nx	Hg	PCDD/PCDF	BaP	BbF	BkF	IcdP	HCB	PCB
	kg/TJ		g/TJ			mg I-TEQ/TJ		g/TJ			ng/TJ	
1A3bi(fu) Passenger cars	150	NA	NA	NA	0.19	0.0027	0.14	0.16	0.12	0.17	NE	NA
1A3bii(fu) Light duty vehicles	1235	NA	NA	NA	0.19	0.0025	0.13	0.15	0.11	0.16	NE	NA
1A3biii(fu) Heavy duty vehicles	47	NA	NA	NA	NE	0.0015	0.0038	0.0061	0.0031	0.0023	NE	NA
1A3biv(fu) Motorcycles	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1A3bvi(fu) Automobile tyre and break wear	NA	NA	NA	0.52	NA	NA	NA	NA	NA	NA	NA	NA
1A3b Road Transportation (Liquefied petroleum gas)	NO _x	NM VOC	SO _x	NH ₃	PM2.5 ex	PM2.5 nx	PM10 ex	PM10 nx	TSP ex	TSP nx	BC ex	BC nx
	kg/TJ											
1A3bi(fu) Passenger cars	21	1.9	0.50	8.0	NA	NA	NA	NA	NA	NA	NA	NA
1A3bii(fu) Light duty vehicles	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1A3biii(fu) Heavy duty vehicles	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1A3biv(fu) Motorcycles	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1A3bvi(fu) Automobile tyre and break wear	NA	NA	NA	NA	NA	5.3	NA	14	NA	14	NA	0.53
1A3b Road Transportation (Liquefied petroleum gas)	CO	Pb	Cd ex	Cd nx	Hg	PCDD/PCDF	BaP	BbF	BkF	IcdP	HCB	PCB
	kg/TJ		g/TJ			mg I-TEQ/TJ		g/TJ			ng/TJ	
1A3bi(fu) Passenger cars	297	NA	NA	NA	0.19	NA	0.14	0.16	0.114	0.17	NA	NA
1A3bii(fu) Light duty vehicles	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1A3biii(fu) Heavy duty vehicles	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1A3biv(fu) Motorcycles	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1A3bvi(fu) Automobile tyre and break wear	NA	NA	NA	0.44	NA	NA	NA	NA	NA	NA	NA	NA
1A3b Road Transportation (Electricity, Hydrogen)	NO _x	NM VOC	SO _x	NH ₃	PM2.5 ex	PM2.5 nx	PM10 ex	PM10 nx	TSP ex	TSP nx	BC ex	BC nx
	kg/Mio. veh. km											
1A3bi(fu) Passenger cars	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1A3bii(fu) Light duty vehicles	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1A3biii(fu) Heavy duty vehicles	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1A3biv(fu) Motorcycles	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1A3bvi(fu) Automobile tyre and break wear	NA	NA	NA	NA	NA	12.3	NA	33	NA	33	NA	1.2
1A3b Road Transportation (Electricity, Hydrogen)	CO	Pb	Cd ex	Cd nx	Hg	PCDD/PCDF	BaP	BbF	BkF	IcdP	HCB	PCB
	kg/Mio. veh. km		g/Mio. veh. km			mg I-TEQ/Mio. veh. km		g/Mio. veh. km			ng/Mio. veh. km	
1A3bi(fu) Passenger cars	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1A3bii(fu) Light duty vehicles	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1A3biii(fu) Heavy duty vehicles	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1A3biv(fu) Motorcycles	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1A3bvi(fu) Automobile tyre and break wear	NA	NA	NA	1.1	NA	NA	NA	NA	NA	NA	NA	NA

Activity data (1A3b)

The activity data are derived from different data sources:

- Vehicle stock: The federal vehicle registration database IVZ (run by the Federal Roads Office FEDRO) contains vehicle stock data including all parameters needed for the emission modelling (vehicle category, engine capacity, fuel type, total weight, vehicle age and exhaust technology). Aggregated official vehicle stock numbers are published by the Swiss Federal Statistical Office (FSO 2025e). With the help of a fleet turnover model, the vehicle categories are assigned emission standards based on age and thereby split up into “sub-segments”, which are used to link with the specific emission factors of the same categorisation (vehicle category, size class, fuel type, emission standard [“Euro classes”]).
- The specific mileage per vehicle category is an input from Swiss Federal Statistical Office (FSO 2025e, 2025f). It is based on periodical surveys/Mikrozensus (ARE 2002, ARE/SFSO 2005, ARE/SFSO 2012, ARE/SFSO 2017, ARE/SFSO 2023). By means of the vehicle stock data (see paragraph above), the average specific mileage per vehicle category can be derived (SFOE 2025e, INFRAS 2017). The relative differences in specific mileage between vehicles of different technologies and ages within a vehicle category are based on the odometer readings at periodical technical inspections (PTI), which are recorded in the IVZ database (see above).
- Numbers of starts/stops: Derived from vehicles stock and periodical surveys/Mikrozensus (ARE/SFSO 2005, 2012, 2017 and 2023).
- Also, the consumption of biofuels for 1A3b Road transportation is reported. Fuel types involved, emission factors and activity data are summarised in a comment to the EMIS database (EMIS 2026/1A3bi-viii “Strassenverkehr”), Consumption of biofuels is provided by the statistics of renewable energies (SFOE 2025a).
- For the greenhouse gas inventory under UNFCCC the fossil carbon fraction of biodiesel is estimated based on the method described in Sebos (2022). While all carbon in HVO (Hydrotreated Vegetable Oil) is of biogenic origin, FAME (Fatty Acid Methyl Esters) contains a fossil fraction due to the use of methanol from fossil sources in its production. The shares of FAME and HVO in biodiesel are available from the Swiss overall energy statistics (SFOE 2025). The fossil fraction of FAME varies depending on the type of feedstock used to produce it (e.g., rapeseed, soy, palm oil). As these types of feedstock are not included in the Swiss energy statistics, average European values from HBEFA 4.1 are used instead. The resulting overall fossil fraction of biodiesel varies over time, with around 4.0 to 5.4% of total biodiesel reported under “fossil liquid fuels” as “biodiesel fossil”. For technical reasons in our database, there is a split of the whole biodiesel amount in fossil and biogenic biodiesel and not only for the carbon fraction and CO₂.

The total mileage of each vehicle category is differentiated by “traffic situations” (characteristic patterns of driving behaviour) and gradients, which serve as a key to select the appropriate emission factor, and which are also available per traffic situation and gradient (see above). The relative shares of the traffic situations and gradients are derived from a national road traffic model (operated by the Federal Office of Spatial Development, see ARE 2022). The traffic model is based on an origin-destination matrix that is assigned to a detailed network of about 600'000 road segments. The model is calibrated partly bottom-up and partly top-down: bottom-up by the number of traffic counts from the national traffic-counter network, and top-down by the total of the mileage per vehicle category. The assignment of traffic situations and gradients to the modelled mileage is described in INFRAS (2017). The traffic model in combination with consumption factors (per vehicle category, size class, fuel type, emissions standard and per traffic situation) allows to calculate the territorial road traffic consumption of gasoline and diesel oil.

The mileage driven serves as activity data in the national traffic model. Table 3-80 shows the mileage per vehicle category. Numbers hold for the version “fuel used” and represent the vehicle kilometres driven within the Swiss territory.

Table 3-80 Mileages in millions of vehicle kilometres. PC: passenger cars, LDV: light duty vehicles, HDV: heavy duty vehicles.

Veh. category	1990	1995	2000	2005	2010
	million vehicle-km				
PC	47'727	45'089	51'355	52'595	57'030
LDV	2'789	2'787	3'002	3'214	3'572
HDV	1'867	1'816	2'018	1'996	2'202
Coaches and urban buses	264	260	265	315	365
2-Wheelers	2'288	1'729	1'946	2'009	2'098
Sum	54'936	51'681	58'585	60'128	65'266
(1990=100%)	100%	94%	107%	109%	119%

Veh. category	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
	million vehicle-km									
PC	58'053	58'507	60'086	60'879	61'001	52'990	54'758	55'537	57'061	57'167
LDV	3'902	3'992	4'141	4'342	4'455	4'928	4'899	4'915	4'958	5'027
HDV	2'103	2'083	2'107	2'146	2'128	2'264	2'258	2'203	2'119	2'154
Coaches and urban buses	384	390	396	416	425	438	449	456	460	470
2-Wheelers	2'072	2'091	2'145	2'169	2'175	2'142	2'159	2'036	2'091	2'081
Sum	66'514	67'063	68'874	69'953	70'184	62'762	64'524	65'146	66'690	66'898
(1990=100%)	121%	122%	125%	127%	128%	114%	117%	119%	121%	122%

Since 1990, the total mileage has been increasing by about 1 per cent per year on an average. This trend was halted in 2020 and 2021, as total mileages decreased compared to the years before due to the restrictions related to the COVID-19 pandemic. Since 2022 total mileages have increased again to almost pre-pandemic levels. The overwhelming part of vehicle kilometres was driven by passenger cars. In the whole reporting period on-road fuel consumption increased less strongly, indicating improved fuel efficiency. This effect is also reflected in Table 3-81 that depicts the specific fuel consumption per vehicle-km. For most vehicle categories, the specific consumption has decreased in the period 1990–2024.

Table 3-81 Specific fuel consumption of road transportation. Data are adopted from the territorial road transportation model. They include excess fuel consumption by cold starts.

Veh. Category	Fuel	1990	1995	2000	2005	2010
		MJ / veh-km				
PC	Gasoline	3.11	3.22	3.24	3.15	2.97
	Diesel oil	3.36	3.26	3.14	2.85	2.84
	Liquefied petroleum gas	NO	NO	NO	NO	2.59
	CNG	NO	NO	NO	NO	3.06
LDV	Gasoline	3.96	3.85	3.75	3.71	3.43
	Diesel oil	4.80	4.76	4.61	4.26	3.97
	CNG	NO	NO	NO	NO	3.93
HDV	Gasoline	9.06	9.07	9.07	9.11	9.15
	Diesel oil	11.2	11.3	11.0	12.2	11.9
	CNG	NO	NO	NO	25.1	14.9
Busses	Gasoline	NO	NO	NO	NO	NO
	Diesel oil	14.8	15.1	15.2	15.2	14.6
	CNG	NO	NO	NO	NO	23.8
2-Wheeler	Gasoline	1.55	1.71	1.50	1.54	1.56
Average (1990=100%)		3.51 100%	3.66 104%	3.63 103%	3.53 101%	3.35 96%

Veh. Category	Fuel	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
		MJ / veh-km									
PC	Gasoline	2.68	2.64	2.53	2.50	2.48	2.48	2.47	2.43	2.43	2.42
	Diesel oil	2.75	2.73	2.68	2.68	2.68	2.70	2.70	2.68	2.68	2.67
	Liquefied petroleum gas	2.47	2.45	2.37	2.37	2.36	2.36	2.34	2.30	2.30	2.29
	CNG	3.12	2.99	2.98	2.88	2.93	3.13	3.08	2.94	3.02	3.33
LDV	Gasoline	3.18	3.14	2.99	2.96	2.94	2.91	2.88	2.86	2.86	2.86
	Diesel oil	3.84	3.83	3.69	3.67	3.66	3.64	3.64	3.66	3.68	3.69
	CNG	3.85	3.68	3.58	3.40	3.40	3.52	3.40	3.23	3.30	3.61
HDV	Gasoline	9.15	9.19	8.82	8.82	8.82	8.83	8.83	8.83	8.84	8.84
	Diesel oil	11.7	11.8	11.7	11.6	11.5	11.4	11.3	11.1	11.1	11.1
	CNG	11.2	11.3	12.0	12.2	13.1	18.0	17.4	16.7	17.1	18.4
Busses	Gasoline	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	Diesel oil	14.1	14.0	13.2	13.0	12.9	12.6	12.6	12.5	12.5	12.3
	CNG	25.8	25.1	24.4	23.5	23.9	25.3	24.9	23.4	24.4	24.8
2-Wheeler	Gasoline	1.63	1.64	1.59	1.58	1.58	1.58	1.58	1.58	1.59	1.57
Average (1990=100%)		3.11 89%	3.08 88%	2.98 85%	2.96 84%	2.94 84%	3.01 86%	2.97 85%	2.90 83%	2.86 82%	2.83 81%

For modelling evaporative emissions, the stock, mileage, and numbers of stops of gasoline passenger cars and gasoline light duty vehicles are used. For modelling cold start emissions, numbers of starts of passenger cars and light duty vehicles are used as activity data. The corresponding numbers are summarised in Table 3-82. Vehicle stock figures correspond to registration data. The starts per vehicle are based on specific household surveys (ARE/SFSO 2005, 2012, 2017, 2023).

Table 3-82 Vehicle stock numbers (gasoline vehicles only – relevant for diurnal evaporation) and average number of starts per vehicle per day (gasoline, diesel oil, and (compressed) natural gas vehicles).

Veh. Category	1990	1995	2000	2005	2010
	stock in 1000 veh. (gasoline/bioeth.)				
PC	2905	3'134	3'403	3'480	3'311
LDV	175	174	161	129	95
2-Wheelers	764	688	712	745	766
starts per veh. per day					
PC	2.9	2.6	2.8	2.3	2.3
LDV	1.8	1.7	1.6	1.3	1.2

Veh. Category	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
	stock in 1000 veh. (gasoline/bioeth.)									
PC	3'206	3'193	3'185	3'187	3'189	3'208	3'240	3'249	3'287	3'218
LDV	75	73	71	69	68	68	67	67	68	60
2-Wheelers	765	774	778	786	784	813	830	828	850	728
starts per veh. per day										
PC	2.2	2.2	2.2	2.2	2.2	1.8	1.9	2.0	2.0	2.1
LDV	1.1	1.1	1.1	1.1	1.2	1.2	1.2	1.2	1.1	1.3

3.2.6.2.3 Railways (1A3c)

Methodology (1A3c)

Based on the decision tree Fig. 3.1 in chapter 1A3c Railways of the EMEP/EEA guidebook (EMEP/EEA 2023), the exhaust emissions of rail vehicles are calculated by a Tier 3 method with the non-road transportation model described in chp. 3.2.1.1.1.

The entire Swiss railway system is electrified (except for some short feeder tracks to private companies). Electric locomotives are used in passenger as well as freight railway traffic. Diesel locomotives are used for shunting purposes in marshalling yards and for construction activities only. Their emissions are quantified as exhaust emissions.

The non-exhaust emissions have been estimated with a separate method documented in SBB (2005) and INFRAS (2007). Several concepts have been applied including mass balances, e.g., mass loss of brake blocks and wheels, measurements on a test bench, ambient PM10 concentration measurements combined with receptor model. The emissions were quantified as a sum of brake, wheel, track and contact wire abrasion and were split into passenger and freight train origins. For projection purposes, the PM10 emissions were divided into emission factors per person-kilometre (passenger rail-transport) and tonne-kilometre (freight rail transport) and corresponding activity data. The share of PM2.5 was estimated to 15 % of the PM10 emissions.

Emission factors (1A3c)

The emission factors are country-specific. The general sources for the emission factors of the non-road model are described in chp. 3.2.1.1.1. Power class and emission standard specific emission factors are shown in Table 3-83.

- Only diesel oil and biodiesel are used as fuels, therefore all emission factors refer to the use of diesel oil and biodiesel for traffic on railways except for non-exhaust emissions.
- Non-exhaust particulate matter emission factors (PM2.5 and PM10) distinguish passenger and freight transport, i.e., they are based on passenger and tonne kilometres. Emission factors are based on a study from the Swiss Federal Railways Company (SBB 2005). Details concerning non-exhaust emission factors can be found in EMIS 2026/1A3c-Schienenverkehr.

- For the greenhouse gas inventory under UNFCCC the fossil carbon fraction of biodiesel is estimated based on the method described in chapter 3.2.1.1.1. For technical reasons in our database, there is a split of the whole biodiesel amount in fossil and biogenic biodiesel and not only for the carbon fraction and CO₂. Therefore, there are two lines with biodiesel, one with “biodiesel fossil” and one with “biodiesel biogenic”.

Implied emission factors for the reporting year are shown in Table 3-84.

Table 3-83 Illustration of emission and consumption factors for rail vehicles with diesel engines per emission standard (Pre-EU etc.) and engine power.

engine power	Pre-EU	UIC I	UIC II	EU IIIA	EU IIIB	EU V
g/kWh						
Carbon monoxide (CO)						
<560 kW	4.0	3.0	2.5	2.5	2.5	2.5
>560 kW	4.0	3.0	3.0	3.0	3.0	3.0
Hydrocarbons (HC)						
<560 kW	1.60	0.80	0.60	0.40	0.17	0.17
>560 kW	1.60	0.80	0.80	0.50	0.40	0.36
Nitrogen oxides (NO_x)						
<560 kW	13	12	6	3.2	1.8	1.8
>560 kW	16	12	9.5	5.4	3.2	3.2
Particulate matter (PM)						
<560 kW	0.600	0.500	0.250	0.180	0.025	0.025
>560 kW	0.600	0.500	0.250	0.180	0.025	0.025
Fuel consumption						
<560 kW	223	223	223	223	223	223
>560 kW	223	223	223	223	223	223
Assumptions regarding the introduction of EU emission stages						
<560 kW		2000	2003	2006	2012	2020
>560 kW		2000	2003	2009	2012	2020

Table 3-84 Implied emission factors in 2024 for 1A3c Railways. Data per TJ refer to exhaust emissions (ex), whereas data per km refer to non-exhaust emissions (nx).

1A3c Railways	Unit	NOx	NMVOc	SOx	NH3	PM2.5 ex	PM2.5 nx	PM10 ex	PM10 nx
		g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
Diesel oil	GJ	NA	NA	0.30	NA	NA	NA	NA	NA
Biodiesel fossil	GJ	768	89	0.30	0.18	4.2	NA	4.2	NA
Biodiesel biogenic	GJ	768	89	0.30	0.18	4.2	NA	4.2	NA
Working hours diesel oil	h	676	79	NA	0.16	3.7	NA	3.7	NA
Passenger kilometres diesel oil	number	NA	NA	NA	NA	NA	0.0019	NA	0.012
Ton km diesel oil	number	NA	NA	NA	NA	NA	0.0013	NA	0.0088

1A3c Railways	Unit	TSP ex	TSP nx	BC ex	BC nx	CO	Pb	Cd ex	Hg
		g/...	g/...	g/...	g/...	g/...	mg/...	mg/...	mg/...
Diesel oil	GJ	NA	NA	NA	NA	NA	NA	NA	NA
Biodiesel fossil	GJ	4.2	NA	0.77	NA	467	0.89	2.2	0.12
Biodiesel biogenic	GJ	4.2	NA	0.77	NA	467	0.89	2.2	0.12
Working hours diesel oil	h	3.7	NA	0.68	NA	412	0.78	1.9	0.10
Passenger kilometres diesel oil	number	NA	0.016	NA	NA	NA	NA	NA	NA
Ton km diesel oil	number	NA	0.012	NA	NA	NA	NA	NA	NA

1A3c Railways	Unit	PCDD/PCDF	BaP	BbF	BkF	IcdP
		ng I-Teq/...	mg/...	mg/...	mg/...	mg/...
Diesel oil	GJ	NA	NA	NA	NA	NA
Biodiesel fossil	GJ	1.5	0.78	1.3	0.97	0.19
Biodiesel biogenic	GJ	1.5	0.78	1.3	0.97	0.19
Working hours diesel oil	h	1.4	0.69	1.1	0.85	0.17
Passenger kilometres diesel oil	number	NA	NA	NA	NA	NA
Ton km diesel oil	number	NA	NA	NA	NA	NA

Activity data (1A3c)

Table 3-85 shows the activity data of 1A3c taken from FOEN (2015j). Detailed activity data can be downloaded from the online database INFRAS (2015a).

Table 3-85 Activity data for 1A3c Railways is either diesel oil and biodiesel consumption or number of driven km for freight transport as well as number of driven km for passenger transport. Data in TJ refer to exhaust emissions, whereas data in km refer to non-exhaust emissions.

1A3c Railways	Unit	1990	1995	2000	2005	2010					
Diesel oil	TJ	390	441	455	472	492					
Biodiesel fossil	TJ	NO	NO	0.026	0.072	0.082					
Biodiesel biogenic	TJ	NO	NO	0.48	1.4	1.8					
Working hours diesel oil	h	796'752	819'585	773'446	669'195	543'637					
Working hours biodiesel fossil	h	NO	NO	44	100	89					
Working hours biodiesel biogenic	h	NO	NO	804	1'955	1'924					
Passenger kilometres diesel oil	million number	51'912	54'992	57'600	63'600	69'600					
Ton km diesel oil	million number	34'696	34'488	38'720	42'360	46'000					

1A3c Railways	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Diesel oil	TJ	391	388	385	382	379	376	377	378	379	379
Biodiesel fossil	TJ	0.27	0.41	0.55	0.69	0.83	0.97	0.95	0.94	0.92	0.90
Biodiesel biogenic	TJ	4.9	7.9	11	14	17	20	19	18	17	17
Working hours diesel oil	h	454'398	450'869	447'340	443'810	440'281	436'752	437'681	438'610	439'539	440'468
Working hours biodiesel fossil	h	312	470	629	787	946	1'104	1'083	1'062	1'041	1'020
Working hours biodiesel biogenic	h	5'590	8'961	12'332	15'703	19'073	22'444	21'536	20'628	19'720	18'812
Passenger kilometres diesel oil	million number	69'600	89'120	84'734	88'520	88'395	69'600	58'458	82'752	90'572	93'135
Ton km diesel oil	million number	46'000	49'789	46'614	47'106	46'666	46'000	48'094	48'542	46'161	53'855

3.2.6.2.4 Domestic navigation (1A3d)

Methodology (1A3d)

Based on the decision tree Fig. 3.1 in the chapter 1A3d Navigation-shipping in the EMEP/EEA guidebook (EMEP/EEA 2023), the air pollutant emissions are calculated by a Tier 3 method. Emissions are calculated in line with the non-road transportation model described in chp. 3.2.1.1.1.

There are passenger ships, dredgers, fishing boats, motor and sailing boats on the lakes and rivers of Switzerland.

On the river Rhine and on Lake Geneva and Lake Constance, some of the boats cross the border and go abroad (France, Germany). Fuels bought in Switzerland will therefore become bunker fuel. Accordingly, the amount of bunker diesel oil is reported as a memo item "International maritime navigation". The emissions are calculated with a Tier 1 approach with implied emission factors from domestic navigation. Only diesel oil is concerned from navigating on the river Rhine (FCA 2015a) and of navigating two border lakes (Lake Constance, Lake Geneva) for which bunker fuel consumption was reported in INFRAS (2011a) after having performed surveys among the shipping companies involved.

Emission factors (1A3d)

The emission factors are country-specific. The general sources for the emission factors of the non-road model are described in chp. 3.2.1.1.1. Power class and emission standard-specific emission factors are shown in Table 3-86 to Table 3-89 (FOEN 2015j).

For the greenhouse gas inventory under UNFCCC the fossil carbon fraction of biodiesel is estimated based on the method described in chapter 3.2.1.1.1. For technical reasons in our database, there is a split of the whole biodiesel amount in fossil and biogenic biodiesel and not only for the carbon fraction and CO₂. Therefore, there are two lines with biodiesel, one with "biodiesel fossil" and one with "biodiesel biogenic".

Implied emission factors for the reporting year are shown in Table 3-90.

Table 3-86 Emission factors for diesel-powered ships per emission standard.

engine power	Pre-SAV	SAV	EU I	EU II	EU IIIA	EU V
	g/kWh					
Carbon monoxide (CO)						
<18 kW	6.7	6.7	6.7	6.7	6.7	6.7
18–37 kW	6.7	6.7	6.7	6.7	6.7	6.7
37–75 kW	5.9	5.9	5.9	4.5	4.5	4.5
75–130 kW	5.0	5.0	4.5	4.5	4.5	4.5
130–300 kW	5.0	5.0	4.5	4.5	4.5	3.15
300–560 kW	5.0	5.0	4.5	4.5	4.5	3.15
>560 kW	5.0	5.0	4.5	4.5	4.5	3.15
Hydrocarbons (HC)						
<18 kW	10	7.2	5.0	3.0	2.0	2.0
18–37 kW	10	7.2	5.0	3.0	2.0	2.0
37–75 kW	10	5.4	1.2	1.2	1.1	0.42
75–130 kW	10	4.1	1.2	0.9	0.8	0.49
130–300 kW	5.0	3.6	1.2	0.9	0.8	0.80
300–560 kW	5.0	3.2	1.2	0.9	0.8	0.17
>560 kW	5.0	2.8	1.2	0.9	0.8	0.17
Nitrogen oxides (NO_x)						
<18 kW	10.3	10.3	10.3	10.3	10.3	10.3
18–37 kW	10.3	10.3	10.3	10.3	10.3	10.3
37–75 kW	12.4	12.4	8.3	6.3	5.7	4.23
75–130 kW	12.5	12.5	8.3	6.3	5.7	4.86
130–300 kW	12.5	12.5	8.3	6.3	5.7	2.10
300–1000 kW	12.5	12.5	8.3	6.3	5.7	1.20
>1000 kW	12.5	12.5	8.3	6.3	5.7	0.40
Particulate matter (PM)						
<18 kW	1.50	1.20	1.00	0.80	0.70	0.70
18–37 kW	1.20	0.90	0.74	0.60	0.54	0.54
37–75 kW	1.10	0.58	0.77	0.36	0.36	0.30
75–130 kW	0.60	0.47	0.63	0.27	0.27	0.14
130–300 kW	0.60	0.47	0.49	0.18	0.18	0.11
300–1000 kW	0.60	0.47	0.49	0.18	0.18	0.02
>1000 kW	0.60	0.47	0.49	0.18	0.18	0.01
Fuel consumption						
<18 kW	248	248	248	248	248	248
18–37 kW	248	248	248	248	248	248
37–75 kW	248	248	248	248	248	248
75–130 kW	223	223	223	223	223	223
>130 kW	223	223	223	223	223	223
Assumptions regarding introduction of emission stages						
All capacities	(<1995)	1995	2003	2008	2009	2019

Table 3-87 Emission factors for diesel-powered boats per emission standard.

engine power	Pre-SAV	SAV	EU I	EU II
	g/kWh			
Carbon monoxide (CO)				
<4.4 kW	6.7	6.7	4.5	4.5
4.4–7.4 kW	6.7	6.7	4.5	4.5
7.4–37 kW	6.7	6.7	4.5	4.5
37–74 kW	5.9	5.9	4.5	4.5
74–100 kW	5.0	5.0	4.5	4.5
>100 kW	5.0	3.6 (6%)	3.6	3.6
Hydrocarbons (HC)				
<4.4 kW	10	10	2.4	2.40
4.4–7.4 kW	10	10	2.1	2.10
7.4–37 kW	10	2.0 (23%)	1.7	1.70
37–74 kW	10	1.4 (23%)	1.4	0.42
74–100 kW	10	1.2 (23%)	1.2	0.52
>100 kW	5	1.2 (30%)	1.2	0.52
Nitrogen oxides (NO_x)				
<4.4 kW	13	11	8.8	8.80
4.4–7.4 kW	13	11 (71%)	8.8	8.80
7.4–37 kW	13	11 (71%)	8.8	8.80
37–74 kW	13	11 (71%)	8.8	4.23
74–100 kW	13	11 (71%)	8.8	5.22
>100 kW	13	11 (73%)	8.8	5.22
Particulate matter (PM)				
<4.4 kW	1.5	1.2	0.9	0.9
4.4–7.4 kW	1.5	1.2	0.9	0.9
7.4–37 kW	1.2	1.1	0.9	0.9
37–74 kW	1.1	1.0	0.9	0.3
74–100 kW	0.9	0.9	0.9	0.15
>100 kW	0.9	0.9	0.9	0.15
Fuel consumption				
<4.4 kW	400	400	400	400
4.4–7.4 kW	400	400	400	400
7.4–37 kW	400	380	380	380
37–74 kW	380	350	350	350
74–100 kW	400	330	330	330
>100 kW	300	300	300	300
Assumptions regarding the introduction of emission stages				
All pow. classes	(<1995)	1995	2007	2015

Table 3-88 Emission factors for gasoline-powered boats per emission standard.

engine power	2-stroke gasoline engines			4-stroke gasoline engines		
	g/kWh					
	Pre-SAV	SAV	SAV/EU	Pre-SAV	SAV	EU
Carbon monoxide (CO)						
<4.4 kW	645	315	315	350	315	315
4.4–7.4 kW	645	200 (79%)	225	350	200 (79%)	225
7.4–37 kW	645	100 (79%)	162	350	100 (79%)	162
37–74 kW	645	65 (79%)	144	350	65 (79%)	144
74–100 kW	645	55 (79%)	141	350	55 (79%)	141
>100 kW	645	45 (73%)	139	350	45 (73%)	139
Hydrocarbons (HC)						
<4.4 kW	260	22	25	25	22	25
4.4–7.4 kW	260	12 (66%)	13	20	12 (66%)	13
7.4–37 kW	260	6.0 (66%)	8	20	6.0 (66%)	8
37–74 kW	260	4.0 (66%)	6	20	4.0 (66%)	6
74–100 kW	260	3.3 (66%)	5	20	3.3 (66%)	5
>100 kW	260	2.1 (52%)	5	20	2.1 (52%)	5
Nitrogen oxides (NO_x)						
<4.4 kW	15	13	13	3.5	13	13
4.4–7.4 kW	15	9.3 (62%)	9.3	3.5	9.3 (62%)	9.3
7.4–37 kW	15	9.3 (62%)	9.3	3.5	9.3 (62%)	9.3
37–74 kW	15	9.3 (62%)	9.3	3.5	9.3 (62%)	9.3
74–100 kW	15	9.3 (62%)	9.3	3.5	9.3 (62%)	9.3
>100 kW	15	9.6 (64%)	9.6	3.5	9.6 (64%)	9.6
Fuel consumption						
<4.4 kW	700	400	400	400	400	400
4.4–7.4 kW	700	400	400	400	400	400
7.4–37 kW	650	380	380	380	380	380
37–74 kW	650	380	380	380	380	380
74–100 kW	650	380	380	380	380	380
>100 kW	650	380	380	380	380	380
Assumptions regarding the introduction of emission stages						
All capacities	(<1995)	1995	2007	(<1995)	1995	2007
Source of consumption factors: SAEFL, 1996a						

Table 3-89 Emission factors for steam-powered vessels per emission standard.

Pollutant	Steam 1	Steam 2	Steam 3	Steam 4	Steam 5	Steam 6	Steam 7
	g/kWh						
CO	0.30	0.30	0.30	0.09	0.09	0.09	0.09
HC	0.449	0.449	0.449	0.330	0.330	0.330	0.330
NO _x	2.336	2.336	2.336	1.770	1.558	1.257	1.027
PM2.5	0.033	0.024	0.015	0.009	0.006	0.006	0.006
Fuel cons.	1406	1115	1115	1115	1115	1115	1115
Assumptions regarding the date of introduction of improvements of steamships							
All classes	<1950	1950	1980	1990	1995	2000	2005

Table 3-90 Implied emission factors in 2024 for 1A3d Navigation.

1A3d Navigation	Unit	NOx	NMVOc	SOx	NH3	PM2.5 ex	PM10 ex	TSP ex	BC ex	CO
		g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
Gasoline	GJ	NA	NA	0.19	NA	NA	NA	NA	NA	NA
Diesel oil	GJ	NA	NA	0.30	NA	NA	NA	NA	NA	NA
Gas oil	GJ	NA	NA	0.77	NA	NA	NA	NA	NA	NA
Biodiesel fossil	GJ	649	181	0.30	0.18	22	22	22	12	466
Biodiesel biogenic	GJ	649	181	0.30	0.18	22	22	22	12	466
Bioethanol	GJ	542	401	0.19	0.086	NA	NA	NA	NA	8'680
Working hours gasoline	h	117	91	NA	0.018	0.018	0.018	0.018	0.00091	1'909
Working hours diesel oil	h	571	159	NA	0.16	20	20	20	10	410
Working hours gas oil	h	388	24	NA	0.61	2.0	2.0	2.0	0.29	100

1A3d Navigation	Unit	Pb	Cd ex	Hg	PCDD/PCDF	BaP	BbF	BkF	IcdP	HCb	PCB
		mg/...	mg/...	mg/...	ng I- Teq/...	mg/...	mg/...	mg/...	mg/...	ng/...	ng/...
Gasoline	GJ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE
Diesel oil	GJ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE
Gas oil	GJ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Biodiesel fossil	GJ	0.89	2.2	0.12	1.6	0.78	1.3	0.96	0.19	NA	NE
Biodiesel biogenic	GJ	0.89	2.2	0.12	1.6	0.78	1.3	0.96	0.19	NA	NE
Bioethanol	GJ	0.59	2.2	0.19	2.6	1.1	1.1	0.11	0.29	NA	NE
Working hours gasoline	h	0.13	0.46	0.040	0.56	0.23	0.23	0.023	0.062	NA	NE
Working hours diesel oil	h	0.78	2.0	0.10	1.4	0.68	1.1	0.85	0.17	NA	NE
Working hours gas oil	h	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Activity data (1A3d)

Table 3-91 shows the activity data of 1A3di taken from FOEN (2015j). Detailed activity data can be downloaded from the online database INFRAS (2015a).

Table 3-91 Activity Data for domestic navigation.

1A3d Navigation	Unit	1990	1995	2000	2005	2010
Total fuel consumption	TJ	1'550	1'517	1'556	1'518	1'565
Gasoline	TJ	701	654	616	565	535
Diesel oil	TJ	738	724	792	800	868
Gas oil	TJ	110	139	147	150	159
Biodiesel fossil	TJ	NO	NO	0.046	0.12	0.14
Biodiesel biogenic	TJ	NO	NO	0.84	2.4	3.1
Bioethanol	TJ	NO	NO	NO	NO	0.0079

1A3d Navigation	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total fuel consumption	TJ	1'560	1'559	1'557	1'556	1'554	1'553	1'552	1'551	1'550	1'549
Gasoline	TJ	515	515	515	515	515	515	515	515	515	515
Diesel oil	TJ	880	871	863	855	847	839	839	840	841	842
Gas oil	TJ	151	150	149	148	147	146	145	144	144	143
Biodiesel fossil	TJ	0.62	0.93	1.2	1.5	1.9	2.2	2.1	2.1	2.0	2.0
Biodiesel biogenic	TJ	11	18	24	31	37	44	42	40	39	37
Bioethanol	TJ	2.5	3.4	4.4	5.4	6.4	7.4	8.1	8.9	9.7	11

3.2.6.2.5 Other transportation – pipeline transport (1A3e)

This source category contains only emissions from 1A3ei Pipeline transport of natural gas due to one compressor station of the main gas pipeline.

Methodology (1A3e)

For source 1A3ei Pipeline transport, the emissions of main pollutants, particulate matter, CO, Hg, PCDD/PCDF and PAH from a compressor station located in Ruswil are considered.

The emissions are calculated with a Tier 2 method (note that the EMEP/EEA guidebook (EMEP/EEA 2023) does not contain a decision tree to determine the Tier level specifically). For the main pollutants, TSP, PM2.5 and PM10, country-specific emission factors were used. For all other pollutants (BC, CO, Hg, PCDD/PCDF and PAH), the emission factors stem from the EMEP/EEA guidebook (EMEP/EEA 2019).

Emission factors (1A3e)

The same emission factors are used as for gas turbines (see Table 3-61). The emission factors are described in chapter 3.2.1.1.2.

Table 3-92 Emission factors of 1A3e for 2024.

1A3e Other transportation	Unit	NOx	NM VOC	SOx	NH3	PM2.5 ex	PM10 ex	TSP ex	BC ex	CO
		g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
Natural gas	GJ	29	1.6	0.43	NA	0.20	0.20	0.20	0.00050	12
Biogas	GJ	48	1.6	0.50	NA	0.20	0.20	0.20	0.00050	12

1A3e Other transportation	Unit	Pb	Cd ex	Hg	PCDD/PCDF	BaP	BbF	BkF	IcdP	HCb	PCB
		mg/...	mg/...	mg/...	ng l ⁻¹ -Teq/...	mg/...	mg/...	mg/...	mg/...	ng/...	ng/...
Natural gas	GJ	0.0015	0.00025	0.10	0.50	0.00056	0.00084	0.00084	0.00084	NA	NA
Biogas	GJ	0.0015	0.00025	0.10	0.50	0.00056	0.00084	0.00084	0.00084	NA	NA

Activity data (1A3e)

The data on fuel consumption for the operation of the compressor station in Ruswil is based on the Swiss overall energy statistics (SFOE 2025; Table 17e).

Table 3-93 Activity data of 1A3e.

1A3e Other transportation	Unit	1990	1995	2000	2005	2010
Total fuel consumption	TJ	560	310	340	1'070	830
Total, 1990 = 100 %	%	100	55	61	191	148
Natural gas	TJ	560	310	340	1'070	830
Biogas	TJ	NO	NO	NO	NO	NO

1A3e Other transportation	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total fuel consumption	TJ	760	340	470	490	600	540	138	420	192	34
Total, 1990 = 100 %	%	136	61	84	88	107	96	25	75	34	6.1
Natural gas	TJ	760	340	470	490	600	540	120	400	170	10
Biogas	TJ	NO	NO	NO	NO	NO	NO	18	20	22	24

3.2.6.3 Category-specific recalculations for 1A3 Transport

The following recalculations were implemented in submission 2026:

- 1A3ai(i) International aviation LTO (civil), 1A3aii(i) Domestic aviation LTO (civil), 1A3aii(ii) Domestic aviation Cruise: The emission factors were imported with more significant digits, and the difference is below 0.01 %.
- 1A3b: Activity data and emission factors have been updated for the years 1990-2023 because of the underlying fleet development data which have been updated to HBEFA version 5.1 (INFRAS 2025, 2025a).
- 1A3b: The entire traffic statistics have been renewed (so-called ex-post analysis, SFOE 2025e) which led to a recalculation of all activity data for the road sector.
- 1A3b: The SO_x emission factor for the period 2016-2023 has been updated to reflect the sulphur content of the gas after the odorant addition, rather than before.
- 1A3b: The fleet weighting of diurnal and soak emissions (evaporation from gasoline engines) was changed from mileage to vehicle stock weights. This leads to overall slightly increased gasoline evaporation.
- 1A3biii: Activity data for gasoline buses have been set to zero for the entire time period 1990-2024 and transferred to diesel buses. The existence of gasoline buses in previous submission was due to a classification error between the fleet database of ASTRA and the one for the road model (HBEFA).

- 1A3bvi, non-exhaust emissions of particulate matter: Due to an error in the aggregation in the EMIS database, a part of the non-exhaust emissions for source category 1A3bvi was missing. This correction affects all years from 1990 to 2023.
- 1A3c: The consumption of biodiesel (fossil and biogenic) has been set to zero for the year 1996 to insure compatibility with the national statistics. Values linearly interpolated until the next data point in 2000 are affected as well.
- 1A3d: The consumption of biodiesel (fossil and biogenic) has been set to zero for the year 1996 to insure compatibility with the national statistics. Values linearly interpolated until the next data point in 2000 are affected as well.
- 1A3e: The SO_x emission factor for the period 2016-2023 has been updated to reflect the sulphur content of the gas after the odorant addition, rather than before.

3.2.7 Source category 1A4 – Non-road and machinery in other sectors (commercial, residential, agriculture and forestry)

3.2.7.1 Source category description for 1A4 – Non-road and machinery in other sectors (commercial, residential, agriculture and forestry)

The source category 1A4 Non-road and machinery in other sectors comprises all emissions from the combustion of fuels in mobile non-road sources in commerce and institutions, households, agriculture and forestry. This includes use of conventional fossil fuels as well as biofuels. Note that information regarding stationary combustion of source categories 1A4 Stationary combustion in manufacturing industries and construction are provided in chp. 3.2.4.

Table 3-94 Specification of source category 1A4 – Non-road and machinery sources in residential, commercial, agriculture and forestry sectors.

1A4	Source category	Specification
1A4aii	Commercial/Institutional: Mobile	Emissions from mobile machinery and motorised equipment used for professional gardening
1A4bii	Residential: Household and gardening (mobile)	Emissions from mobile machinery and motorised equipment used for hobby gardening
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	Emissions from non-road vehicles and machinery in agriculture and forestry

Table 3-95 Key categories, approaches 1 and 2, level assessment 2024 (L1, L2) and trend assessment 1990-2024 (T1, T2) for source category 1A4 Non-road and machinery in other sectors (mobile).

NFR code	Source category	Pollutant	Identification criteria
1A4cii	Agriculture/forestry/fishing: off-road vehicles and other machinery	NOx	L1

3.2.7.2 Methodological issues for 1A4 - Non-road and machinery in other sectors (commercial, residential, agriculture and forestry)

Methodology (1A4 - Non-road and machinery in other sectors (commercial, residential, agriculture and forestry))

Based on the decision tree Fig. 3.1 in chapter 1A4 of the EMEP/EEA guidebook (EMEP/EEA 2023), the emissions of mobile combustion in 1A4 Other sectors are calculated by a Tier 3 method with the non-road transportation model described in chp. 3.2.1.1.1.

Emission factors (1A4 - Non-road and machinery in other sectors (commercial, residential, agriculture and forestry))

The general sources for the emission factors of the non-road model are described in chp. 3.2.1.1.1. Power class and emission standard-specific emission factors are shown in Table 3-69 to Table 3-71 (see chp. 3.2.5.2).

To avoid double counting there are no non-exhaust emissions of PM2.5, PM10 and TSP from resuspension caused by non-road vehicles and machinery in agriculture since they are included in the particle emissions from source categories 3Dc Soils operation of cropland and 3Dc Soils operation of grassland, see chp. 5.3.2.

Implied emission factors for the reporting year for all pollutants are shown in Table 3-96. For the greenhouse gas inventory under UNFCCC the fossil carbon fraction of biodiesel is estimated based on the method described in chapter 3.2.1.1.1. For technical reasons in our database, there is a split of the whole biodiesel amount in fossil and biogenic biodiesel and

not only for the carbon fraction and CO₂. Therefore, there are two lines with biodiesel, one with “biodiesel fossil” and one with “biodiesel biogenic”.

Table 3-96 Implied emission factors 1A4 - Non-road and machinery in other sectors (commercial, residential, agriculture and forestry) in 2024 based on amount of fuel consumed in GJ.

1A4 Other sectors		Unit	NOx	NM VOC	SOx	NH ₃	PM _{2.5} ex	PM ₁₀ ex	TSP ex	BC ex	CO
			g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
1A4aii	Gasoline	GJ	NA	NA	0.19	NA	NA	NA	NA	NA	NA
1A4aii	Bioethanol	GJ	77	513	0.19	0.095	NA	NA	NA	NA	24'808
1A4bii	Gasoline	GJ	NA	NA	0.19	NA	NA	NA	NA	NA	NA
1A4bii	Bioethanol	GJ	96	560	0.19	0.095	NA	NA	NA	NA	24'778
1A4cii	Gasoline	GJ	NA	NA	0.19	NA	NA	NA	NA	NA	NA
1A4cii	Diesel oil	GJ	NA	NA	0.30	NA	NA	NA	NA	NA	NA
1A4cii	Biodiesel fossil	GJ	285	33	0.30	0.16	21	21	21	14	164
1A4cii	Biodiesel biogenic	GJ	285	33	0.30	0.16	21	21	21	14	164
1A4cii	Bioethanol	GJ	106	719	0.19	0.088	NA	NA	NA	NA	23'645

1A4 Other sectors		Unit	Pb	Cd	Hg	PCDD/PCDF	BaP	BbF	BkF	lcdP	HCB	PCB
			mg/...	mg/...	mg/...	ng l- Teq/...	mg/...	mg/...	mg/...	mg/...	ng/...	ng/...
1A4aii	Gasoline	GJ	NA	NA	NA	NA	NA	NA	NA	NA	NE	NE
1A4aii	Bioethanol	GJ	0.59	2.4	0.21	2.8	0.95	0.95	0.092	0.32	NE	NE
1A4bii	Gasoline	GJ	NA	NA	NA	NA	NA	NA	NA	NA	NE	NE
1A4bii	Bioethanol	GJ	0.59	2.4	0.21	2.8	0.95	0.95	0.093	0.31	NE	NE
1A4cii	Gasoline	GJ	NA	NA	NA	NA	NA	NA	NA	NA	NE	NE
1A4cii	Diesel oil	GJ	NA	NA	NA	NA	NA	NA	NA	NA	NE	NE
1A4cii	Biodiesel fossil	GJ	0.89	1.9	0.10	1.4	0.61	1.0	0.76	0.17	NE	NE
1A4cii	Biodiesel biogenic	GJ	0.89	1.9	0.10	1.4	0.61	1.0	0.76	0.17	NE	NE
1A4cii	Bioethanol	GJ	0.59	2.2	0.19	2.6	1.1	1.1	0.10	0.29	NE	NE

Table 3-97 Implied emission factors 1A4 - Non-road and machinery in other sectors (commercial, residential, agriculture and forestry) in 2024 based on number of working hours per fuel type..

1A4 Other sectors		Unit	NOx	NM VOC	NH ₃	PM _{2.5} ex	PM ₁₀ ex	TSP ex	BC ex	CO
			g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
1A4aii	Working hours gasoline	h	2.6	21	0.0014	NA	NA	NA	NA	447
1A4bii	Working hours gasoline	h	2.1	14	0.0017	NA	NA	NA	NA	466
1A4cii	Working hours gasoline	h	10	80	0.0049	NA	NA	NA	NA	1'474
1A4cii	Working hours diesel oil	h	59	6.9	0.032	4.4	4.4	4.4	2.8	34

1A4 Other sectors		Unit	Pb	Cd	Hg	PCDD/PCDF	BaP	BbF	BkF	lcdP
			mg/...	mg/...	mg/...	ng l- Teq/...	mg/...	mg/...	mg/...	mg/...
1A4aii	Working hours gasoline	h	0.0099	0.040	0.0035	0.048	0.016	0.016	0.0016	0.0053
1A4bii	Working hours gasoline	h	0.011	0.043	0.0038	0.052	0.017	0.017	0.0017	0.0058
1A4cii	Working hours gasoline	h	0.035	0.13	0.011	0.16	0.060	0.060	0.0059	0.018
1A4cii	Working hours diesel oil	h	0.18	0.40	0.021	0.28	0.13	0.21	0.16	0.035

During the Stage 3 review in 2016, the Expert Review Team noted that the implied emission factors for NMVOC, CO and particulate matter from the non-road sector are much higher compared to other developed countries. Switzerland explained that source categories 1A4aii and 1A4bii only include garden and hobby mobile machinery that runs on gasoline or bioethanol and consists mainly of 2-stroke engines. This justifies the relatively high implied emission factor. (The Expert Review Team encouraged the Party to include this information in the IIR.)

Activity data (1A4 - Non-road and machinery in other sectors (commercial, residential, agriculture and forestry))

Table 3-98 shows the activity data of 1A4 – Non-road and machinery in other sectors (commercial, residential, agriculture and forestry) taken from FOEN (2015j). Detailed activity data can be downloaded from the online database INFRAS (2015a). In categories 1A4aii and

Energy: Source category 1A - Fuel combustion activities - Source category 1A4 – Non-road and machinery in other sectors (commercial, residential, agriculture and forestry)

1A4bii, gasoline and bioethanol are the only fuels used. In category 1A4cii, diesel oil is the main fuel, with only small amounts of gasoline (e.g., chainsaws) and biodiesel used.

Table 3-98 Activity Data for 1A4 - Non-road and machinery in other sectors (commercial, residential, agriculture and forestry).

1A4 Other sectors	Unit	1990	1995	2000	2005	2010					
Total fuel consumption	TJ	5'761	6'073	6'349	6'103	6'042					
1A4aii Gasoline	TJ	191	245	295	295	287					
1A4aii Bioethanol	TJ	NO	NO	NO	NO	0.0024					
1A4bii Gasoline	TJ	142	155	165	166	163					
1A4bii Bioethanol	TJ	NO	NO	NO	NO	0.0021					
1A4cii Gasoline	TJ	1'160	1'070	963	824	689					
1A4cii Diesel oil	TJ	4'269	4'604	4'921	4'804	4'884					
1A4cii Biodiesel fossil	TJ	NO	NO	0.28	0.73	0.81					
1A4cii Biodiesel biogenic	TJ	NO	NO	5.2	14	18					
1A4cii Bioethanol	TJ	NO	NO	NO	NO	0.0075					
1A4 Other sectors	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total fuel consumption	TJ	5'909	5'898	5'887	5'876	5'865	5'854	5'839	5'824	5'809	5'794
1A4aii Gasoline	TJ	253	252	251	250	249	248	246	245	243	241
1A4aii Bioethanol	TJ	0.75	1.0	1.3	1.6	1.9	2.2	2.5	2.7	2.9	3.1
1A4bii Gasoline	TJ	157	156	155	155	154	153	153	152	152	151
1A4bii Bioethanol	TJ	0.67	0.93	1.2	1.4	1.7	2.0	2.2	2.4	2.6	2.8
1A4cii Gasoline	TJ	569	553	538	523	508	492	480	467	454	441
1A4cii Diesel oil	TJ	4'863	4'828	4'794	4'760	4'726	4'692	4'701	4'711	4'721	4'730
1A4cii Biodiesel fossil	TJ	3.4	5.1	6.9	8.6	10	12	12	12	11	11
1A4cii Biodiesel biogenic	TJ	61	98	135	172	209	247	237	227	216	206
1A4cii Bioethanol	TJ	2.0	2.7	3.3	4.0	4.6	5.2	5.6	5.9	6.2	6.6

3.2.7.3 Category-specific recalculations for 1A4 – Non-road and machinery in other sectors (commercial, residential, agriculture and forestry)

The following recalculations were implemented in submission 2026:

- 1A4c: The consumption of biodiesel (fossil and biogenic) has been set to zero for the year 1996 to ensure compatibility with the national statistics. Values linearly interpolated until the next data point in 2000 are also affected.

3.2.8 Source category 1A5b - Other, mobile (Military)

3.2.8.1 Source category description for 1A5b Other, mobile (Military)

The source category 1A5b Other includes emissions from fuel combustion in military aircraft and military non-road activities.

Table 3-99 Specification of source category 1A5 Other, mobile (Military)

1A5	Source category	Specification
1A5b	Other mobile (including military, land based and recreational boats)	Emissions from military aircrafts and machines like power generators, tanks, bulldozers, boats etc.

Table 3-100 Key categories, approaches 1 and 2, level assessment 2024 (L1, L2) and trend assessment 1990-2024 (T1, T2) for source category 1A5 Other, mobile.

NFR code	Source category	Pollutant	Identification criteria
1A5b	Other mobile (including military land-based and recreational boats)	PM10	L1

3.2.8.2 Methodological issues for 1A5b Other, mobile (Military)

1A5bi military aviation

To calculate emissions from military aviation, a Tier 2 method is used.

1A5bii military non-road vehicles and machines

Based on the decision tree Fig. 3.1 in chapter 1A4 Non-road mobile sources and machinery of the EMEP/EEA guidebook (EMEP/EEA 2023), the emissions of military non-road vehicles and machines are calculated by a Tier 3 method with the non-road transportation model described in chp. 3.2.1.1.1.

Emission factors (1A5b)

Emission factors 1A5bi military aviation

- NO_x, NMVOC, CO: Average emission factors for military aircraft are calculated by the Federal Office of Civil Aviation (FOCA) based on information from the Federal Department of Defence, Civil Protection and Sport (DDPS) concerning fuel consumption per aircraft type for the years 2017-2018 (DDPS 2020). These emission factors remain constant for the entire time series from 1990 onwards.
- SO_x: The SO_x emission factor is taken from the EMEP/EEA guidebook (EMEP/EEA 2023, chapter 1.A.3.a Aviation 2023, Table 3-11, row "Switzerland/CCD") and is assumed to be constant over the period 1990–2024. CCD refers to climb/cruise/descent.
- TSP, PM₁₀, PM_{2.5} exhaust: Emission factors for TSP, PM₁₀, and PM_{2.5} exhaust are assumed to be equal. The implied emission factors from territorial processes (i.e., all flights occurring solely within Swiss territory) are taken for the years 1990 (15.5 g/GJ), 1995 (7.8 g/GJ) and 2000 (4.5 g/GJ), with linear interpolation applied between these years. From 2015 onwards, an average emission factor (3.4 g/GJ) was calculated by FOCA based on information from DDPS, using the same methodology as for NO_x, NMVOC, and CO (see explanation above).
- TSP, PM₁₀, PM_{2.5} non-exhaust: Emission factors for TSP, PM₁₀, and PM_{2.5} non-exhaust emissions are assumed to be equal. The implied emission factor (0.0016 g/GJ) from territorial processes (i.e., all flights occurring solely within Swiss territory) in 1990 is applied to the entire time series (FOCA 2016b).
- BC exhaust: The BC emission factor is assumed to be 48% of the PM_{2.5} exhaust emission factor, consistent with civil aviation, and remains constant over the period 1990-2024.
- Implied emission factors for the reporting year are shown in Table 3-101.

Emission factors of military non-road vehicles and machines

The general sources for the emission factors of the non-road model are described in chp. 3.2.1.1.1. Implied emission factors for the reporting year are shown in Table 3-101. For the greenhouse gas inventory under the UNFCCC the fossil carbon fraction in biodiesel is estimated based on the method described in chapter 3.2.1.1.1. For technical reasons in our database, there is a split of the whole biodiesel amount in fossil and biogenic biodiesel and not only for the carbon fraction and CO₂. Therefore, there are two lines with biodiesel, one with "biodiesel fossil" and one with "biodiesel biogenic".

Table 3-101 Emission factors for 1A5b Other (Military, mobile) in 2024.

1A5b Other Mobile	Unit	NOx	NMVOc	SOx	NH3	PM2.5 ex	PM2.5 nx	PM10 ex	PM10 nx
		g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
Gasoline	GJ	NA	NA	0.19	NA	NA	NA	NA	NA
Jet kerosene fossil	GJ	231	33	23	NA	3.4	0.0016	3.4	0.0016
Diesel oil	GJ	NA	NA	0.30	NA	NA	NA	NA	NA
Biodiesel fossil	GJ	230	23	0.30	0.15	6.6	NA	6.6	NA
Biodiesel biogenic	GJ	230	23	0.30	0.15	6.6	NA	6.6	NA
Bioethanol	GJ	77	375	0.19	0.094	NA	NA	NA	NA
Working hours gasoline	h	4.0	25	NA	0.0035	NA	NA	NA	NA
Working hours diesel oil	h	113	11	NA	0.074	3.3	NA	3.3	NA
Working hours (for non-exhaust only)	h	NA	NA	NA	NA	NA	10	NA	67

1A5b Other Mobile	Unit	TSP ex	TSP nx	BC ex	BC nx	CO	Pb	Cd	Hg
		g/...	g/...	g/...	g/...	g/...	mg/...	mg/...	mg/...
Gasoline	GJ	NA	NA	NA	NA	NA	NA	NA	NA
Jet kerosene fossil	GJ	3.4	0.0016	1.6	NA	235	NA	NA	NA
Diesel oil	GJ	NA	NA	NA	NA	NA	NA	NA	NA
Biodiesel fossil	GJ	6.6	NA	3.3	NA	111	0.89	1.9	0.10
Biodiesel biogenic	GJ	6.6	NA	3.3	NA	111	0.89	1.9	0.10
Bioethanol	GJ	NA	NA	NA	NA	24'389	0.59	2.4	0.21
Working hours gasoline	h	NA	NA	NA	NA	940	0.022	0.089	0.0078
Working hours diesel oil	h	3.3	NA	1.6	NA	55	0.44	0.93	0.049
Working hours (for non-exhaust only)	h	NA	101	NA	NA	NA	NA	NA	NA

1A5b Other Mobile	Unit	PCDD/ PCDF	BaP	BbF	BkF	IcdP	HCB	PCB
		ng I- Teq/...	mg/...	mg/...	mg/...	mg/...	ng/...	ng/...
Gasoline	GJ	NA	NA	NA	NA	NA	NE	NE
Jet kerosene fossil	GJ	NA	NA	NA	NA	NA	NE	NE
Diesel oil	GJ	NA	NA	NA	NA	NA	NE	NE
Biodiesel fossil	GJ	1.3	0.59	0.99	0.73	0.16	NE	NE
Biodiesel biogenic	GJ	1.3	0.59	0.99	0.73	0.16	NE	NE
Bioethanol	GJ	2.8	0.96	0.96	0.093	0.31	NE	NE
Working hours gasoline	h	0.11	0.036	0.036	0.0035	0.012	NE	NE
Working hours diesel oil	h	0.65	0.29	0.49	0.36	0.080	NE	NE
Working hours (for non-exhaust only)	h	NA	NA	NA	NA	NA	NA	NA

Activity data (1A5b)

The fuel consumption of 1A5bi Military aviation is taken from the logbooks of military aircraft and summed up annually by the Swiss Air Force (part of the Swiss Armed Forces, VTG) and provided to FOEN (VTG 2011, VTG 2025).

The fuel consumption of 1A5bii military non-road vehicles and machines is based on activity data provided by DDPS (DDPS 2014a) and calculated bottom-up by the non-road transportation model (chp. 3.2.1.1.1). Detailed activity data can be downloaded from the online database INFRAS (2015a).

Table 3-102 shows the activity data for both categories 1A5bi and 1A5bii.

Table 3-102 Activity data (fuel consumption) for 1A5b Other (Military, mobile).

1A5b Other Mobile	Unit	1990	1995	2000	2005	2010					
Gasoline	TJ	19	19	19	19	18					
Jet kerosene fossil	TJ	2'733	1'955	1'794	1'624	1'592					
Diesel oil	TJ	220	228	233	238	256					
Biodiesel fossil	TJ	NO	NO	0.013	0.036	0.043					
Biodiesel biogenic	TJ	NO	NO	0.25	0.71	0.92					
Bioethanol	TJ	NO	NO	NO	NO	0.00024					
Working hours gasoline	h	421'417	421'542	421'667	421'417	421'161					
Working hours diesel oil	h	431'912	448'062	483'350	486'759	526'788					
Working hours biodiesel fossil	h	NO	NO	27	73	86					
Working hours biodiesel biogenic	h	NO	NO	502	1'422	1'864					
Working hours bioethanol	h	NO	NO	NO	NO	5.2					
Working hours (for non-exhaust only)	h	3'413'313	3'478'413	3'622'184	3'638'684	3'799'620					

1A5b Other Mobile	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Gasoline	TJ	17	17	17	16	16	16	16	16	16	16
Jet kerosene fossil	TJ	1'567	1'627	1'469	1'457	1'303	1'365	1'301	1'423	1'432	1'104
Diesel oil	TJ	255	252	249	246	243	240	241	241	241	242
Biodiesel fossil	TJ	0.18	0.27	0.36	0.44	0.53	0.62	0.61	0.60	0.58	0.57
Biodiesel biogenic	TJ	3.2	5.1	7.0	8.8	11	13	12	12	11	11
Bioethanol	TJ	0.072	0.100	0.13	0.16	0.18	0.21	0.23	0.25	0.27	0.29
Working hours gasoline	h	419'250	418'548	417'847	417'146	416'445	415'744	415'233	414'723	414'212	413'701
Working hours diesel oil	h	522'764	517'850	512'936	508'022	503'108	498'194	499'216	500'237	501'258	502'280
Working hours biodiesel fossil	h	359	539	719	899	1'079	1'259	1'235	1'211	1'187	1'163
Working hours biodiesel biogenic	h	6'431	10'265	14'099	17'933	21'768	25'602	24'564	23'527	22'489	21'452
Working hours bioethanol	h	1'667	2'318	2'969	3'620	4'271	4'923	5'433	5'944	6'455	6'965
Working hours (for non-exhaust only)	h	3'801'882	3'798'084	3'794'285	3'790'487	3'786'688	3'782'890	3'782'729	3'782'567	3'782'406	3'782'245

3.2.8.3 Category-specific recalculations for 1A5b Other, mobile (Military)

The following recalculations were implemented in submission 2026:

- 1A5bi Military aviation: The activity data for the years 2004 and 2010-2012 were adapted due to changes in the underlying statistics. The difference was below 0.1%.
- 1A5b: The consumption of biodiesel (fossil and biogenic) has been set to zero for the year 1996 to ensure compatibility with the national statistics. Values linearly interpolated until the next data point in 2000 are also affected.

3.3 Source category 1B - Fugitive emissions from fuels

3.3.1 Source category 1B1 - Fugitive emissions from solid fuels

3.3.1.1 Source category description for 1B1 – Fugitive emissions from solid fuels

The source category 1B1 Fugitive emissions from solid fuels includes non-exhaust emissions from coal handling only. There is no production of solid fuels in Switzerland.

Table 3-103 Specification of source category 1B1a Coal mining and handling.

1B1	Source category	Specification
1B1a	Fugitive emission from solid fuels: Coal mining and handling	Only particulate matter emissions from handling of coal

Table 3-104 Key categories, approaches 1 and 2, level assessment 2024 (L1, L2) and trend assessment 1990-2024 (T1, T2) for source category 1B1 Fugitive emissions from solid fuels

Source category 1B1 Fugitive emission from solid fuels is not a key category.

3.3.1.2 Methodological issues for 1B1 – Fugitive emissions from solid fuels

Methodology (1B1)

There is no coal mining in Switzerland and therefore, only non-exhaust particulate matter emissions from coal handling occur.

Based on the EMEP/EEA guidebook (EMEP/EEA 2023), emissions from coal handling are determined by a Tier 2 method using technology-specific activity data and emission factors.

Emission factors (1B1)

Emission factors for TSP, PM10 and PM2.5 are based on the EMEP/EEA guidebook (EMEP/EEA 2023, Table 3-7). No BC emission factors for coal turnover are available in the literature. It is assumed that coal consists of 60 % carbon and that this share is independent of size.

Table 3-105 Emission factors in 1B1 Fugitive emissions from solid fuels in 2024.

1B1 Solid fuels		Unit	PM2.5 nx	PM10 nx	TSP nx	BC nx
			g/...	g/...	g/...	g/...
1B1a Coal handling	Other bituminous coal	t	0.30	3.0	7.5	0.18

Activity data (1B1)

Activity data are provided by the energy model as described in chapter 3.1.6.3 and are based on the total amount of other bituminous coal imported, as published in Swiss overall energy statistics (SFOE 2025).

Table 3-106 Activity data in 1B1 Fugitive emissions from solid fuels.

1B1 Solid fuels		Unit	1990	1995	2000	2005	2010						
1B1a Coal handling	Other bituminous coal	kt	535	286	210	233	248						
1B1 Solid fuels		Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
1B1a Coal handling	Other bituminous coal	kt	214	198	190	176	158	153	154	160	126	106	

3.3.1.3 Category-specific recalculations for 1B1 Fugitive emissions from solid fuels

There were no recalculations implemented in submission 2026.

3.3.2 Source category 1B2a - Fugitive emissions from oil

3.3.2.1 Source category description for 1B2a

In Switzerland, oil production does not occur. Fugitive emissions from the oil industry arise exclusively from the refineries that transform crude oil into liquid fuels, as well as from gasoline stations and storage tanks for gasoline and jet kerosene. At the beginning of 2015, one of the two refineries ceased operation, leaving only one refinery in operation. Crude oil is imported exclusively via underground pipelines. The lengths of the two oil pipelines in Switzerland are approximately 40 km and 70 km, respectively.

Table 3-107 Specification of source category 1B2a – Oil.

1B2a	Source category	Specification
1B2ai	Fugitive emissions oil: Exploration, production, transport	Oil production is not occurring in Switzerland. Emissions only originate from pipeline transport
1B2aiv	Fugitive emissions oil: Refining and storage	SO ₂ emissions from Claus units in refineries
1B2av	Distribution of oil products	Fugitive emissions caused by distribution and storage of gasoline and storage of kerosene

Table 3-108 Key categories, approaches 1 and 2, level assessment 2024 (L1, L2) and trend assessment 1990-2024 (T1, T2) for source category 1B2a fugitive emissions from oil.

NFR code	Source category	Pollutant	Identification criteria
1B2av	Distribution of oil products	NM VOC	L1, T1, T2

3.3.2.2 Methodological issues for 1B2a

Methodology (1B2a)

1B2ai Exploration, production, transport of oil - pipeline transport: Following the decision tree in Figure 3-1 of the EMEP/EEA guidebook (EMEP/EEA 2023), emissions reported under 1B2ai are estimated using a Tier 3 approach, where emission estimates are based on expert information (Canton of Neuchâtel 2019).

1B2aiv Refining and storage - leakage and emissions from Claus units in refineries: Following the decision tree in Figure 3-1 of the EMEP/EEA guidebook (EMEP/EEA 2023), NMVOC emissions at refineries due to leakage are estimated using a Tier 2 approach, for which technology-specific activity data and emission factors are available. This source category also encompasses the SO_x emissions from Claus units at refineries. A Tier 2 method using country-specific emission factors is applied to calculate these emissions.

1B2av Distribution of oil products - emissions from gasoline stations: According to the decision tree in Figure 3-1 of the EMEP/EEA guidebook (EMEP/EEA 2023), the methodology to estimate emissions from gasoline stations follows a Tier 2 approach using technology-specific activity data and emission factors. A bottom-up model was developed to estimate and sum up the emissions from each individual source that could cause emissions: (a) gasoline delivery from the main storage tank to the gasoline station, (b) underfloor storage tank filling at the gasoline station, (c) storage in underfloor tank and finally (d) the refuelling process. The model is also based on information from several gasoline station operators, technicians and Swiss cantons. This information entails emission measurements as well as details regarding the number of gasoline stations which are equipped with petrol pumps with vapour recovery systems.

1B2av Distribution of oil products - gasoline and jet kerosene storage tank facilities: According to the decision tree in Figure 3-1 of the EMEP/EEA guidebook (EMEP/EEA 2023), the methodology to estimate emissions from gasoline and jet kerosene storage tanks follows a Tier 3 methodology using facility-specific emission estimates available on a yearly basis since 2017. These estimates are used for a model validation. The model extrapolates backwards for previous years using currently available databases on numbers of storage tanks and their respective equipment.

Emission factors (1B2a)

1B2ai Exploration, production, transport of oil - pipeline transport of crude oil: In Switzerland, crude oil is transported exclusively via underground pipelines. According to expert information from the oil industry, emissions do not occur along the pipelines but only at the pig trap. There is one pig trap per pipeline and one pipeline per refinery. Based on expert estimates, 0.5 m³ air saturated with VOCs is emitted per pig trap per week. This results in negligible NMVOC emissions of approximately 10-20 kg per year.

1B2aiv NMVOC from leakage in refineries: The country-specific NMVOC emission factor is documented in the EMIS database (EMIS 2026/1B2aiv_Raffinerie, Leckverluste). It is derived from an emission estimation project conducted in one of the refineries in 1992 (CRISTAL; Raffinerie de Cressier 1992). The estimate for the other refinery is assumed to be twice as high due to the older technology of the plant. A weighted mean based on the quantity of crude oil processed in both refineries was calculated (for further details, see the internal documentation of the EMIS database, EMIS 2026/1B2aiv). This emission factor is applied to all years up to 1995. For the years 2007-2023, total NMVOC emissions from 1A1b, 1B2aiv, and 1B2c correspond to those reported in the Swiss PRTR database (PRTR 2025), including data from both refineries up to 2019. Therefore, emission factors for 1B2aiv are adjusted to match the total NMVOC emissions reported in the Swiss PRTR. For the period 1995-2007, the emission factors are linearly interpolated.

1B2aiv, SO_x emission factors from Claus units: For emissions from Claus units, the emission factors per tonne of crude oil are based on values from the CRISTAL project (Raffinerie de Cressier 1992) for the years 1990 and 1995, as well as on expert estimates from the refinery for the year 2015. Emission factors for the periods 1990-1995 and 1995-2015 are linearly interpolated; from 2015 onwards, the value is kept constant.

1B2av Distribution of oil products - gasoline stations: The emission factors of NMVOC from 1B2av are country-specific and based on a bottom-up model (Luftkollektiv 2024) that sums up the different processes generating fugitive gasoline emissions, i.e., transport to the gasoline station, unloading to the tank at the gasoline station, opening the manhole, pressure equalisation, vapour recovery and finally refuelling of the vehicles. The bottom-up model developed was applied to the state of the years 1990, 2002, 2010, 2020 and 2030, and the respective emission factors were determined. In between, the emission factors are linearly interpolated. The Pb emission factor is based on the lead content of gasoline. Pb emissions only occurred until 1999. Since 2000, only unleaded gasoline is sold.

1B2av Distribution of oil products – gasoline and jet kerosene storage tank facilities: Emission factors for storage tanks are estimated by Carbura based on two studies, one for gasoline storage tanks (Carbura 2022) and one for jet kerosene storage tanks (Carbura 2023). NMVOC emissions for the reporting year were estimated on the basis of information on tank volumes, tank equipment, throughput quantities and maintenance (Carbura 2025). For gasoline storage tanks, detailed information is available for all historical reporting years. For jet kerosene storage tanks, historical data is available since 2000. Due to lack of data for earlier years, the emission factor for 1990 is the same as the one calculated for 2000 and kept constant in between. It should be noted that the storage and handling of jet kerosene causes significantly lower NMVOC emissions than gasoline due to the significantly lower vapour pressure.

Table 3-109 NMVOC and SO_x emission factors in 1B2a – Oil, for 2024. All other emission factors, including Pb (for which emissions occurred only from 1990 to 1999), are not applicable to this source category.

1B2a Oil		Unit	NMVOC	SO _x	Pb
			g/...	g/...	mg/...
1B2ai Transport of crude oil by pipelines	Refinery	number	10'000	NA	NA
1B2aiv Refinery claus units	Crude oil	t	NA	5.0	NA
1B2aiv Refinery leakage	Crude oil	t	52	NA	NA
1B2av Gasoline station	Gasoline	GJ	21	NA	NA
1B2av Gasoline storage tank	Gasoline	GJ	0.85	NA	NA
1B2av Jet kerosene storage tanks	Jet kerosene fossil	GJ	0.070	NA	NA

Activity data (1B2a)

As crude oil is transported to the refineries in Switzerland via pipelines, activity data for 1B2ai reflect the number of pipelines, which is equal to the number of pig traps. The activity data for 1B2aiv (refining and storage) consist of the amount of crude oil imported. These data are provided by Avenergy Suisse (Avenergy 2025) in its annual statistics and are also reported in the Swiss overall energy statistics (SFOE 2025).

The activity data for 1B2av concerning fugitive emissions from gasoline stations and storage tanks is the amount of gasoline sold based on the Swiss overall energy statistics (SFOE 2025), corrected for consumption of Liechtenstein.

The activity data for 1B2av fugitive emissions from jet kerosene storage tanks is the sum of total amount of jet kerosene imported and produced in Swiss refineries. The amount of jet kerosene production in Swiss refineries has decreased steadily since 2005 and is zero since 2021.

Table 3-110 Activity data for 1B2a – Oil.

1B2a Oil		Unit	1990	1995	2000	2005	2010					
1B2ai Transport of crude oil by pipelines	Refinery	number	2.0	2.0	2.0	2.0	2.0					
1B2aiv Refinery claus units	Crude oil	kt	3'127	4'657	4'649	4'877	4'546					
1B2aiv Refinery leakage	Crude oil	kt	3'127	4'657	4'649	4'877	4'546					
1B2av Gasoline station	Gasoline	TJ	156'516	151'672	168'353	152'182	134'129					
1B2av Gasoline storage tank	Gasoline	TJ	156'516	151'672	168'353	152'182	134'129					
1B2av Jet kerosene storage tanks	Jet kerosene fossil	TJ	48'160	54'739	68'310	51'004	61'815					

1B2a Oil		Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
1B2ai Transport of crude oil by pipelines	Refinery	number	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
1B2aiv Refinery claus units	Crude oil	kt	2'836	3'006	2'889	3'076	2'789	2'857	2'339	3'102	2'868	2'605
1B2aiv Refinery leakage	Crude oil	kt	2'836	3'006	2'889	3'076	2'789	2'857	2'339	3'102	2'868	2'605
1B2av Gasoline station	Gasoline	TJ	105'664	102'367	99'223	97'654	96'850	85'769	87'628	85'110	87'891	87'038
1B2av Gasoline storage tank	Gasoline	TJ	105'664	102'367	99'223	97'654	96'850	85'769	87'628	85'110	87'891	87'038
1B2av Jet kerosene storage tanks	Jet kerosene fossil	TJ	70'857	73'853	75'027	80'262	83'698	34'816	31'736	54'264	72'472	77'564

3.3.2.3 Category-specific recalculations for 1B2a - Oil

The following recalculations were implemented in submission 2026:

- 1B2a: Small recalculation of NMVOC emissions from leakage in refineries. The total emission of NMVOC emissions in the Swiss Refinery was adapted to the latest reported total emissions in the Swiss PRTR database for the years 2019-2023.

3.3.3 Source category 1B2b - Fugitive emissions from natural gas

3.3.3.1 Source category description for 1B2b

Emissions from natural gas production only occurred during the years of operation of the only production plant in Switzerland from 1985 to 1994. The dominating emissions in source category 1B2b stem from natural gas transmission and distribution.

Table 3-111 Specification of source category 1B2b – Natural gas.

1B2b	Source category	Specification
1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)	Emissions from gas "distribution and transit" network Production of natural gas (only relevant for 1990-1994)

Table 3-112: Key categories, approaches 1 and 2, level assessment 2024 (L1, L2) and trend assessment 1990-2024 (T1, T2) for source category 1B2b Fugitive emissions from natural gas

Source category 1B2b Fugitive emissions from natural gas is not a key category.

3.3.3.2 Methodological issues for 1B2b

Methodology (1B2b)

In source category 1B2b Fugitive emissions from natural gas, fugitive emissions from production and from pipeline transport of natural gas are reported. Therefore, only NMVOC emissions occur in this source category.

According to the decision tree for natural gas systems (IPCC 2006, Volume 2 Energy, chp. 4 Fugitive Emissions, Figure 4.2.1), Switzerland follows a Tier 1 approach for fugitive emissions attributed to production of natural gas and a Tier 2 approach for fugitive emissions attributed to transmission and distribution of natural gas. As source category 1B2b is not a key category and as the contribution from production of natural gas is small, the use of a Tier 1 method for this source category is justified.

An important basis of the methodology to estimate fugitive emissions from natural gas transmission and distribution form the country-specific gas properties which are continuously measured at the various import stations. The Swiss Gas and Water Industry Association (SGWA) reports annually weighted values for densities and net calorific values as well as concentrations of greenhouse gases CO₂ and CH₄ and the air pollutant NMVOC. The same country-specific properties are used to estimate fugitive emissions from natural gas production as there are no other data available.

Those fugitive emissions from natural gas production are calculated based on annual production data and default emission factors (IPCC Tier 1 approach), taking into account the country-specific gas properties as mentioned above. There has been no natural gas production in Switzerland since 1994, due to the closure of the only production site at that time.

For transmission and distribution, a country-specific methodology – established by Quantis (2014) and fully revised by the Swiss Gas and Water Industry Association (SGWA 2023a) – is applied to derive country-specific losses for each emission source. The methodology assesses losses from transmission and distribution pipelines, including from the transit pipeline and its single compressor station. Calculations of losses from the gas network are based on the length and material of the gas pipelines, distinguishing various pressure levels. Also comprised are leakages from gas devices and network components (e.g., control units and gas meters as well as appliances in households, industry and natural gas fuelling stations), pipeline fittings, small-scale damages and maintenance work. To estimate emissions resulting from the permanent leakiness of the different gas appliances, the number and kind of end users and connected gas appliances are considered. The methodology by SGWA (2023a) provides the amount of gas lost in cubic meters per year which serves – after conversion to energy units (GJ per year) based on the country-specific net calorific values – as the activity data. Finally, emissions of NMVOC are calculated by multiplying the losses (activity data) with the country-specific composition of the gas (emission factor).

Emission factors (1B2b)

Production of natural gas

For natural gas production NMVOC default emission factors are taken from the 2006 IPCC Guidelines (IPCC 2006) as documented in the internal emission database documentation (EMIS 2026/1B2b Gasproduktion). The default emission factors are provided in grams per cubic meter of gas produced and – to match the units of the activity data – are converted to grams per energy unit (GJ) produced based on the country-specific gas properties as mentioned above. As gas production only occurred until 1994, there is no emission factor reported in Table 3-113.

Transport of natural gas

For natural gas transmission and distribution, the emission factors represent the composition of the gas lost and are based on the country-specific gas properties as mentioned above.

Table 3-113 Emission factors in 1B2b Fugitive emissions from natural gas, for 2024.

1B2b Natural gas		Unit	NMVOC
			g/...
1B2b Natural gas production	Raw gas	GJ	NO
1B2b Transmission losses natural gas network	Natural gas	GJ	2'119
1B2b Distribution losses natural gas network	Natural gas	GJ	2'119

Activity data (1B2b)

Production of natural gas

In Switzerland, production of natural gas only occurred until 1994. Activity data are based on Swiss overall energy statistics (SFOE 2025).

Transport of natural gas

For gas transmission and distribution, the activity data represent the amount of natural gas lost from the gas network. All the details are documented in SGWA (2023a) and EMIS (2026/1B2b Diffuse Emissionen).

The key points within transmission are as follows:

- **Compressor station:** Since 2016, the operator of the transit pipeline has provided annual emissions data for specific areas (such as starting gas for turbines, compressor depressurization, control valves, gas meters, etc.). For the years before 2016 and for areas not covered by the operator's data, emission factors from Battelle (1989) are used. The calculations are performed by scaling with the actual compressor power (yearly average).
- **Transit pipeline:** Since 2016, the operator of the transit pipeline has provided annual emissions data for losses from operation and maintenance of the transit pipeline. For the years before 2016, emission factors from Battelle (1989) are used. For pressure reducing and metering stations, emission factors from DVGW (2022) are applied. The calculations are performed by scaling with the pipeline length (gas statistics from SGWA).
- **Components of the transport network (excluding the transit pipeline):** Emission factors from DVGW (2022) for 2020 are converted to the structures of the Swiss gas network. The calculations are performed by scaling with the pipeline length (gas statistics from SGWA).
- **Network maintenance of the transport network (excluding the transit pipeline):** For 1990, emission factors from Battelle (1989) are used with linear interpolation to the emissions factors for 2020 based on DVGW (2022). The calculations are performed by scaling with the pipeline length (without the share of the transit pipeline; gas statistics from SGWA).

The key points within distribution are as follows:

- **Leakage:** The methodology is based on the actual number of leaks per kilometre for the years since 2017 (gas statistics from SGWA). For 1990, the number of leaks is derived from Battelle (1989). The various materials and pressure levels of the pipelines are distinguished. The losses per leak are based on measurements from DVGW (2022). The calculations are performed by scaling with the pipeline length (gas statistics from SGWA).
- **Damage by external influences (third-party damage):** The methodology is based on actual third-party damage per kilometre since 2017 (gas statistics from SGWA). For 1990, the amount of third-party damage per kilometre is derived from Battelle (1989). The losses per damage are determined based on DVGW (2022). The calculations are performed by scaling with the pipeline length (gas statistics from SGWA).
- **Permeation:** Permeation through polyethylene pipelines is estimated based on DVGW (2022), while permeation is considered to be negligible for other materials. The calculations are performed by scaling with the pipeline length (gas statistics from SGWA).
- **Components:** Emission factors from Battelle (1994) for 1990 and DVGW (2022) for 2020 are considered. The calculations are performed by scaling with the pipeline length (gas statistics from SGWA).
- **Network maintenance:** Emission factors from Battelle (1994) for 1990 and DVGW (2022) for 2020 are considered. The calculations are performed by scaling with the pipeline length (gas statistics from SGWA).
- **Industrial networks:** Emission factors are formed based on Battelle (1994), referring to the gas quantity used by industrial plants. The calculations are performed by scaling with the gas quantity used by industrial plants (based on statistics from the Swiss Gas Industry Association until 2019, and thereafter estimated based on the total gas quantity).

- **House installations:** Emission factors are based on usability tests – for 1990 based on Battelle (1994), for 2020 based on measurement campaigns by the network operators. The calculations are performed by scaling with the number of end users (gas statistics from SGWA).
- **Gas stoves:** Emission factors according to Battelle (1994) are used. The number of gas stoves is estimated based on the number of end users (as determined by a survey by SGWA).
- **Gas stations:** Emission factors according to Battelle (1994) are used.
- **Liquefied natural gas:** Calculations are based on the number of transfer operations and the dead volume of the couplings. Additional losses are estimated to amount to one per cent of the total liquefied natural gas quantity used.

Table 3-114 Activity data of 1B2b Fugitive emissions from natural gas.

1B2b Natural gas		Unit	1990	1995	2000	2005	2010						
1B2b Natural gas production	Raw gas	TJ	130	NO	NO	NO	NO						
1B2b Transmission losses natural gas network	Natural gas	TJ	12	13	14	13	48						
1B2b Distribution losses natural gas network	Natural gas	TJ	162	169	156	139	119						
1B2b Natural gas		Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
1B2b Natural gas production	Raw gas	TJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
1B2b Transmission losses natural gas network	Natural gas	TJ	12	10	18	11	11	14	7.8	8.9	7.2	7.1	
1B2b Distribution losses natural gas network	Natural gas	TJ	94	91	88	82	79	75	76	74	72	72	

3.3.3.3 Category-specific recalculations for 1B2b

The following recalculations were implemented in submission 2026:

- 1B2b: Correction of calculation lead to around 2'380 GJ less natural gas losses in the year 2023.

3.3.4 Source category 1B2c - Fugitive emissions from venting and flaring

3.3.4.1 Source category description for 1B2c

This source category includes venting and flaring from two types of activities: oil production and refining, and gas production. In Switzerland, oil production does not occur, and only one natural gas production site was operational from 1985 to 1994. Therefore, emissions from flaring primarily result from the gas torches associated with oil refining, which were operated at the two refineries. Since 2015, only one refinery has been in operation. In addition, CO₂ emissions from H₂ production at one of the two refineries since 2005 are also reported under 1B2c.

Table 3-115 Specification of source category 1B2c – Venting and flaring.

1B2c	Source category	Specification
1B2c	Venting and flaring (oil, gas, combined oil and gas)	The release/combustion of excess gas at the oil refinery Flaring of gas at gas production facility (only relevant for 1990-1994)

Table 3-116: Key categories, approaches 1 and 2, level assessment 2024 (L1, L2) and trend assessment 1990-2024 (T1, T2) for source category 1B2c - Fugitive emissions from venting and flaring (oil, gas, combined oil and gas).

Source category 1B2c – Venting and flaring (oil gas combined oil and gas) is not a key category.

3.3.4.2 Methodological issues for 1B2c

Methodology (1B2c)

Following the decision tree in Figure 3-1 of the EMEP/EEA guidebook (EMEP/EEA 2023), emissions reported under 1B2c are estimated using a Tier 3 approach, for which plant-specific activity data are available. In Switzerland, flaring occurs only at refineries, and venting does not occur. One of the two refineries in Switzerland ceased operation at the beginning of 2015. Between 1990 and 1994, a gas production facility operated in Switzerland, where gas was flared.

Emission factors (1B2c)

Emission factors are confidential and are available to reviewers upon request.

Activity data (1B2c)

1B2c Fugitive emissions from venting and flaring

Before 2005, the amount of gas flared in oil refineries (1B2ci) is assumed to be proportional to the amount of crude oil processed at the refineries. Since 2005, the industry has provided bottom-up data on the amount of gas flared at refineries. Activity data are considered confidential and are available to reviewers upon request.

For gas venting and flaring associated with gas production (occurring only from 1990 to 1994), the amount of gas flared under category 1B2cii is estimated based on the amount of gas produced.

Table 3-117 Activity data for 1B2c – Venting and flaring.

1B2c Venting and flaring		Unit	1990	1995	2000	2005	2010						
1B2c Flaring	Crude oil	kt	C	C	C	C	C						
1B2c Flaring	Raw gas	TJ	130	NO	NO	NO	NO						
1B2c Venting and flaring		Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
1B2c Flaring	Crude oil	kt	C	C	C	C	C	C	C	C	C	C	
1B2c Flaring	Raw gas	TJ	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	

3.3.4.3 Category-specific recalculations for 1B2c

There were no recalculations implemented in submission 2026.

4 Industrial processes and product use

4.1 Overview of emissions

This introductory chapter gives an overview of major emissions from sector 2 Industrial processes and product use between 1990 and 2024 and comprises process emissions only. All emissions from fuel combustion in industry are reported in sector 1 Energy. Regarding main pollutants, industrial processes and product use are the main emission source of NMVOC and contribute to a lesser extent to the emissions of SO_x and particulate matter. Industrial processes and product use are also relevant sources for emissions of priority heavy metals and dominate the PCB emissions.

The following source categories are reported:

- 2A Mineral products
- 2B Chemical industry
- 2C Metal production
- 2D, 2G Other solvent and product use
- 2H Other industry production
- 2I Wood processing
- 2K Consumption of POPs and heavy metals
- 2L Other production, consumption, storage, transportation or handling of bulk products

4.1.1 Overview and trend for NMVOC

According to Figure 4-1 and Table 4-1, total NMVOC emissions from 2 Industrial processes and product use show a considerable decrease between 1990 and 2004 with a weaker decreasing trend until 2016 and rather constant values afterwards. The trend until 2004 is mainly due to reductions in 2D Other solvent and product use and to a lesser extent to reductions in 2G Other product use. For the entire time series, the NMVOC emissions are dominated by emissions from 2D. Relevant emissions stem from 2G Other product use and 2H Other as well.

In 1990, source categories 2D3d Coating applications and 2D3g Chemical products contribute to more than half of the NMVOC emissions of source category 2D whereas all the other source categories account for the rest. In 2024, the largest shares in source category 2D come from 2D3d Coating applications and 2D3a Domestic solvent use including fungicides while the shares of 2D3b Road paving with asphalt, 2D3c Asphalt roofing, 2D3e Degreasing, 2D3f Dry cleaning, 2D3g Chemical products, 2D3h Printing and 2D3i Other solvent use account for the rest.

The reduction in 2D3d Coating applications is due to changes in the paint composition, i.e. from solvent-based to water-based paints. Accordingly, emission factors for all commercial and industrial applications show a significant decrease between 1990 and 2004. This trend is induced and driven by the EU directive (EC 2004) on the limitation of emissions of volatile organic compounds from the solvents used in certain paints and varnishes and vehicle refinishing products. In addition, noticeable decreases in paint consumption in construction (1990–1998) and industrial paint application (2001–2004) are superposed. The latter resulted from structural changes within the industrial sector and replacing of conventional paints by powder coatings. In 1990, the NMVOC emissions from 2D3d Coating applications are dominated by the emissions from industrial paint application and paint application in construction whereas in 2024, by emissions from paint application in construction and on wood.

The NMVOC emissions from the most important single source category 2D3a Household cleaning agents, cosmetics and toiletries increase between 1990 and 1996 then they drop until 2000 and since then they show a weaker decline until 2016. From 2017 onwards, the emissions are again increasing. Factors contributing to this trend are changes in the range of product used, product-specific NMVOC contents and population growth.

Within source category 2D, a significant reduction in emissions from 2D3g Chemical products and 2D3h Printing between 1990 and 2023 is observed. The reduction in source category 2D3h Printing as well as in industry and services in general is mainly a result of the ordinance on the VOC incentive tax (Swiss Confederation 1997) with enactment of the tax in 2000 and structural changes within the respective industry and service sectors.

Also process optimizations (production of acetic acid and PVC), closing of production, e.g. PVC production in 1996 (2B Chemical industry) and the production decrease in the iron foundries (2C Metal production) contribute to the observed decrease in NMVOC emissions. The NMVOC emissions from 2H Other with main contributions from source category 2H2 Bread production slightly decline as well in the period 1990–2024. In addition, general technological improvements and post-combustion installations contribute to further emission reductions.

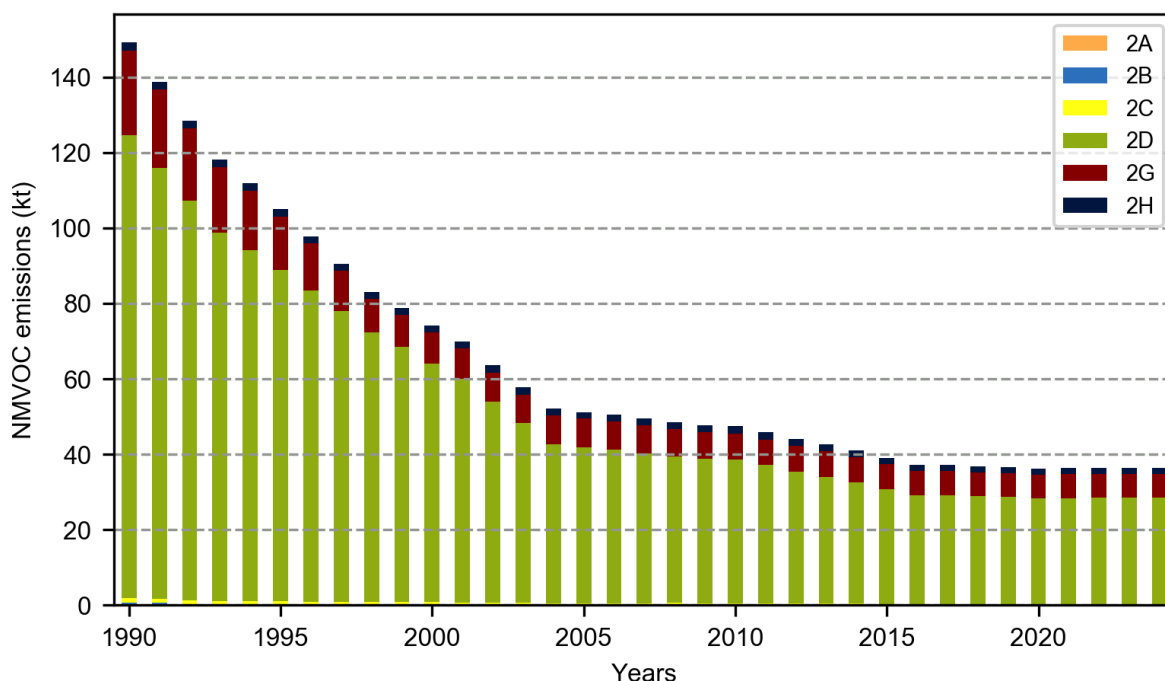


Figure 4-1 Switzerland's NMVOC emissions from industrial processes and product use by source categories 2A-2D and 2G-2H between 1990 and 2024. The corresponding data can be found in Table 4-1.

Table 4-1 NMVOC emissions from sector 2 Industrial processes and product use by source categories 2A-2D, 2G and 2H. The last column in the third part of the table indicates the relative trend.

NMVOC		1990	1995	2000	2005	2010
2A	kt	0.047	0.037	0.032	0.035	0.037
2B	kt	0.61	0.18	0.025	0.028	0.037
2C	kt	1.1	0.76	0.71	0.45	0.35
2D	kt	123	88	63	41	38
2G	kt	22	14	8.2	7.6	6.9
2H	kt	2.2	2.0	1.9	1.7	1.9
2I	kt	NA	NA	NA	NA	NA
2K	kt	NA	NA	NA	NA	NA
2L	kt	NA	NA	NA	NA	NA
Sum	kt	149	105	74	51	47

NMVOC		2015	2016	2017	2018	2019
2A	kt	0.030	0.031	0.031	0.031	0.030
2B	kt	0.020	0.016	0.013	0.015	0.016
2C	kt	0.29	0.27	0.28	0.28	0.22
2D	kt	30	29	29	28	28
2G	kt	6.6	6.5	6.4	6.3	6.3
2H	kt	1.7	1.7	1.7	1.7	1.7
2I	kt	NA	NA	NA	NA	NA
2K	kt	NA	NA	NA	NA	NA
2L	kt	NA	NA	NA	NA	NA
Sum	kt	39	37	37	37	37

NMVOC		2020	2021	2022	2023	2024	2005-2024 (%)
2A	kt	0.029	0.030	0.029	0.026	0.025	-28
2B	kt	0.015	0.016	0.015	0.015	0.015	-46
2C	kt	0.20	0.22	0.22	0.19	0.18	-61
2D	kt	28	28	28	28	28	-32
2G	kt	6.3	6.3	6.3	6.3	6.3	-17
2H	kt	1.6	1.7	1.7	1.6	1.7	-2.7
2I	kt	NA	NA	NA	NA	NA	-
2K	kt	NA	NA	NA	NA	NA	-
2L	kt	NA	NA	NA	NA	NA	-
Sum	kt	36	36	36	36	36	-29

4.1.2 Overview and trend for SO_x

According to Figure 4-2 and Table 4-2, total SO_x emissions from 2 Industrial processes and product use show an intermittent decrease of almost 70 % in the period 1990-2009. From 2010 to 2018, there is again an increase in SO_x emissions followed by a decrease 2019-2023. In 1990, source categories 2C Metal production and 2B Chemical industry show the largest contributions (around 50 % each) to the total SO_x emissions. In 2024, the emissions are dominated by 2B Chemical industry. The emissions from 2A Mineral products are negligible over the entire time period and there are no emissions from 2D. The highly fluctuating SO_x emissions from 2B Chemical industry stem mainly from the graphite and silicon carbide production, i.e. the raw materials used (petroleum coke and other bituminous coal) and reflect both the production volume and the sulphur content of raw materials between 1990 and 2024. In 2024, it is by far the largest emission source within sector 2. The SO_x emissions from 2C Metal production originate predominately from the consumption of electrodes (anodes) in the aluminium production and follow thus the aluminium production volume in Switzerland (the only primary aluminium smelter was closed in 2006). The small amount of SO_x emissions from 2G Other product use stems from the use of fireworks.

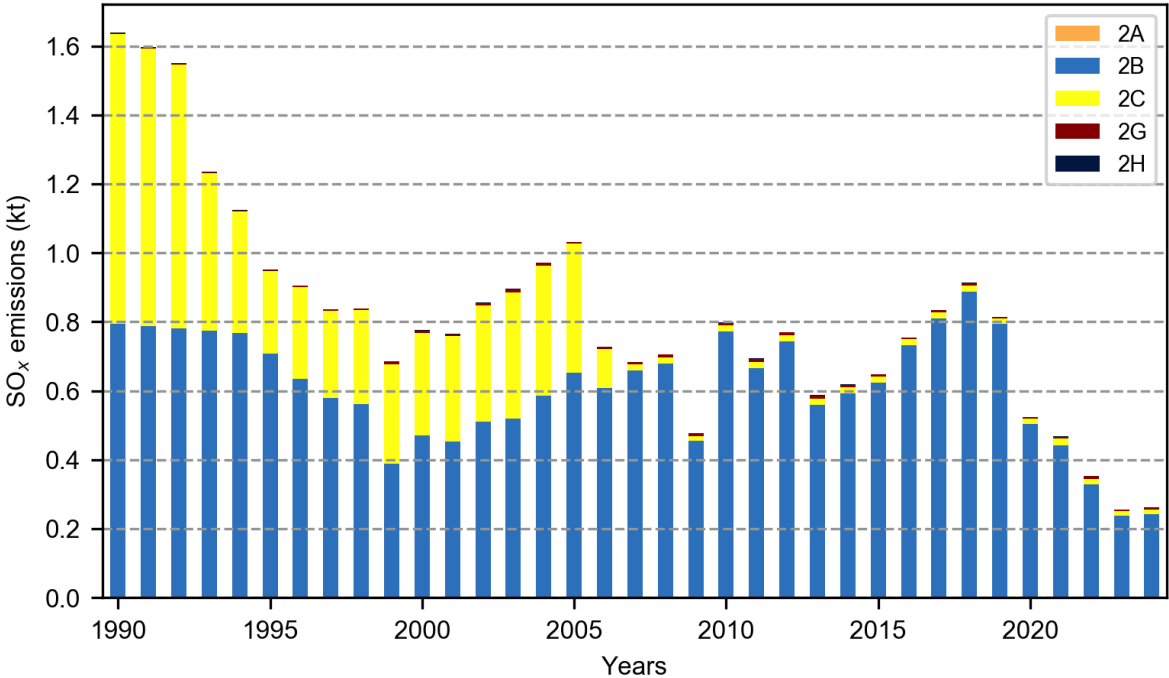


Figure 4-2 Switzerland's SO_x emissions from industrial processes and product use by source categories 2A–2C and 2G-2H between 1990 and 2024. The corresponding data can be found in Table 4-2.

Table 4-2 SO_x emissions from sector 2 Industrial processes and product use by source categories 2A-2C and 2G-2H. The last column in the third part of the table indicates the relative trend.

SO _x		1990	1995	2000	2005	2010
2A	kt	0.00078	0.00061	0.00054	0.00058	0.00061
2B	kt	0.79	0.71	0.47	0.65	0.77
2C	kt	0.84	0.24	0.30	0.37	0.017
2D	kt	NA	NA	NA	NA	NA
2G	kt	0.0034	0.0042	0.0062	0.0056	0.0069
2H	kt	0.0013	0.00066	0.00093	0.00040	0.0012
2I	kt	NA	NA	NA	NA	NA
2K	kt	NA	NA	NA	NA	NA
2L	kt	NA	NA	NA	NA	NA
Sum	kt	1.6	0.95	0.78	1.0	0.80

SO _x		2015	2016	2017	2018	2019
2A	kt	0.00050	0.00052	0.00051	0.00051	0.00051
2B	kt	0.62	0.73	0.81	0.89	0.79
2C	kt	0.018	0.017	0.018	0.018	0.016
2D	kt	NA	NA	NA	NA	NA
2G	kt	0.0066	0.0050	0.0071	0.0075	0.0041
2H	kt	0.0011	0.00033	0.00036	0.00040	0.00034
2I	kt	NA	NA	NA	NA	NA
2K	kt	NA	NA	NA	NA	NA
2L	kt	NA	NA	NA	NA	NA
Sum	kt	0.65	0.76	0.83	0.91	0.81

SO _x		2020	2021	2022	2023	2024	2005-2024 (%)
2A	kt	0.00049	0.00049	0.00048	0.00044	0.00042	-28
2B	kt	0.50	0.44	0.33	0.24	0.24	-63
2C	kt	0.016	0.018	0.017	0.013	0.014	-96
2D	kt	NA	NA	NA	NA	NA	-
2G	kt	0.0043	0.0062	0.0077	0.0033	0.0056	1.0
2H	kt	0.00032	0.00030	0.00033	0.00032	0.00045	13
2I	kt	NA	NA	NA	NA	NA	-
2K	kt	NA	NA	NA	NA	NA	-
2L	kt	NA	NA	NA	NA	NA	-
Sum	kt	0.52	0.47	0.35	0.26	0.26	-75

4.1.3 Overview and trend for PM_{2.5}

According to Figure 4-3 and Table 4-3, total PM_{2.5} emissions from sector 2 Industrial processes and product use show a decrease of about 40 % in the period 1990-1999. The emissions are fluctuating with again a decreasing trend since 2008. In 1990, the source categories 2C Metal production, 2G Other product use, 2H Other and 2A Mineral products contribute the most to the total PM_{2.5} emissions.

In 2024, the highest contribution to the total PM_{2.5} emissions is due to the source categories 2G, 2H and 2A whereas the other source categories are of minor importance. PM_{2.5} emissions from 2A Mineral products, with the main contributions from blasting operations in 2A1 Cement production and from 2A5a Quarrying and mining of minerals other than coal, decreased by about a quarter between 1990 and 1999. After a slight increase until 2010, they are decreasing again. On the other hand, PM_{2.5} emissions from 2C Metal production, which are dominated by the emissions from 2C1 Iron and steel production, show a strong decrease between 1994 and 1999 and are almost exclusively responsible for the total PM_{2.5} emission reduction in this source category between 1990 and 2024. The reason for the initial

emission reduction in 1995 is the closing down of two steel production sites, whereas the drastic emission drop in 1998/1999 is due to the installation of new filters in the remaining two steel plants. The PM2.5 emissions from 2G Other product use, i.e. from the use of fireworks and tobacco, remained about constant between 1990 and 2013 and have since decreased by about one third. In 1990, 2G emissions were dominated by tobacco use. The annual fluctuations are due to differences in the consumption of fireworks caused by bans due to dryness on the national holiday. In 2024, tobacco use is still the major emission source but also the use of fireworks contributes considerable amounts. The emissions in 2H Other decreased by about a quarter since 1990. In this source category, the main contributions currently arise from 2H1 Chipboard and fibreboard production and 2H2 Food and beverages industry.

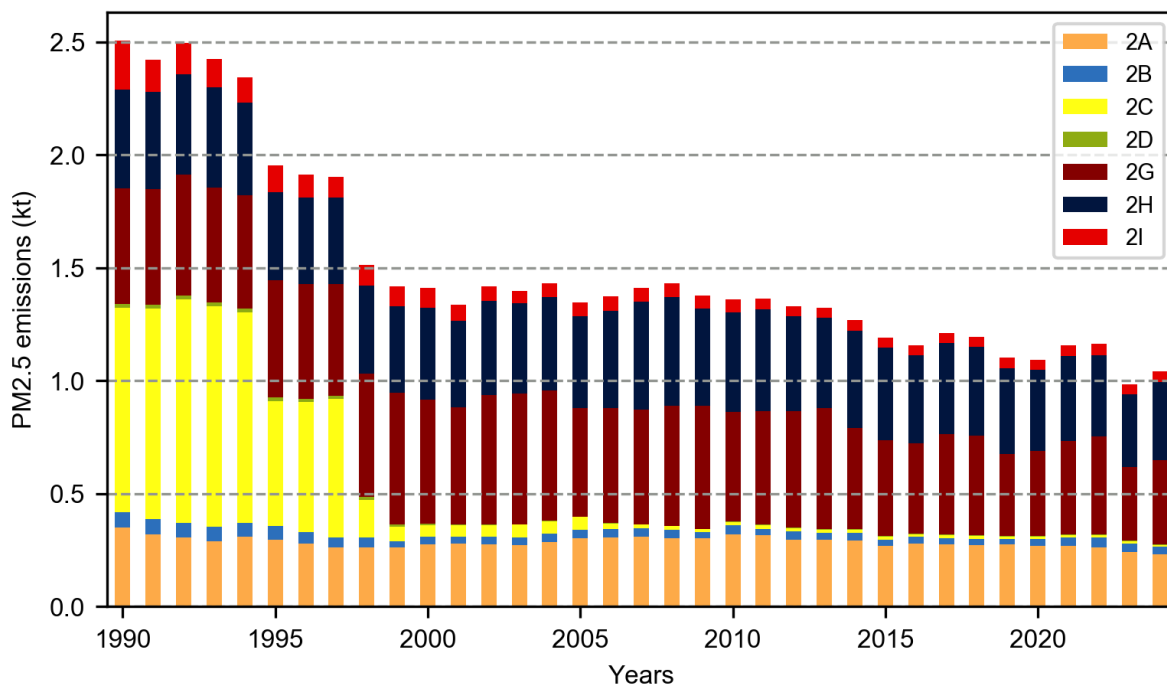


Figure 4-3 Switzerland's PM2.5 emissions from industrial processes and product use by source categories 2A-2D and 2G-2I between 1990 and 2024. The corresponding data can be found in Table 4-3.

Table 4-3 PM2.5 emissions from sector 2 Industrial processes and product use by source categories 2A-2D and 2G-2I. The last column in the third part of the table indicates the relative trend.

PM2.5		1990	1995	2000	2005	2010
2A	kt	0.35	0.30	0.28	0.30	0.32
2B	kt	0.069	0.058	0.033	0.040	0.039
2C	kt	0.90	0.56	0.051	0.055	0.014
2D	kt	0.016	0.015	0.0069	0.0024	0.0033
2G	kt	0.51	0.52	0.55	0.48	0.49
2H	kt	0.44	0.39	0.40	0.41	0.44
2I	kt	0.22	0.12	0.090	0.063	0.057
2K	kt	NA	NA	NA	NA	NA
2L	kt	NA	NA	NA	NA	NA
Sum	kt	2.5	2.0	1.4	1.3	1.4

PM2.5		2015	2016	2017	2018	2019
2A	kt	0.27	0.28	0.27	0.27	0.28
2B	kt	0.029	0.031	0.029	0.029	0.023
2C	kt	0.012	0.012	0.012	0.012	0.010
2D	kt	0.0038	0.0038	0.0038	0.0038	0.0038
2G	kt	0.42	0.40	0.44	0.44	0.36
2H	kt	0.41	0.39	0.41	0.39	0.38
2I	kt	0.046	0.046	0.043	0.044	0.044
2K	kt	NA	NA	NA	NA	NA
2L	kt	NA	NA	NA	NA	NA
Sum	kt	1.2	1.2	1.2	1.2	1.1

PM2.5		2020	2021	2022	2023	2024	2005-2024 (%)
2A	kt	0.27	0.27	0.26	0.24	0.23	-23
2B	kt	0.030	0.038	0.045	0.039	0.032	-20
2C	kt	0.0098	0.011	0.011	0.0087	0.0087	-84
2D	kt	0.0038	0.0038	0.0038	0.0039	0.0039	60
2G	kt	0.38	0.41	0.43	0.33	0.37	-22
2H	kt	0.36	0.38	0.36	0.32	0.34	-15
2I	kt	0.046	0.049	0.049	0.047	0.047	-25
2K	kt	NA	NA	NA	NA	NA	-
2L	kt	NA	NA	NA	NA	NA	-
Sum	kt	1.1	1.2	1.2	0.99	1.0	-23

4.2 Source category 2A – Mineral products

4.2.1 Source category description of 2A Mineral products

Table 4-4 Specification of source category 2A Mineral products in Switzerland.

2A	Source category	Specification
2A1	Cement production	Blasting operations of the cement production, Process emissions from calcination are reported in 1A2f
2A2	Lime production	Blasting operations of the lime production, Process emissions from calcination are reported in 1A2f
2A3	Glass production	Process emissions from glass production are reported in 1A2f
2A5a	Quarrying and mining of minerals other than coal	Gravel plants and blasting operations of the plaster production

Table 4-5 Key categories, approaches 1 and 2, level assessment 2024 (L1, L2) and trend assessment 1990-2024 (T1, T2) for source category 2A Mineral Products.

NFR code	Source category	Pollutant	Identification criteria
2A1	Cement production	PM2.5	L2, T2
2A1	Cement production	PM10	L2
2A5a	Quarrying and mining of minerals other than coal	PM2.5	L2, T2
2A5a	Quarrying and mining of minerals other than coal	PM10	L1, L2, T2

4.2.2 Methodological issues of 2A Mineral products

4.2.2.1 Cement production (2A1)

Methodology (2A1)

In Switzerland, there are six plants producing clinker and cement. The Swiss plants are rather small and do not exceed a capacity of 3'000 tonnes of clinker per day. All of them use modern dry process technology.

According to the EMEP/EEA guidebook (EMEP/EEA 2023, source category 2A1 Cement production comprises all emissions from operations other than pyroprocessing (kiln). Based on the decision tree Fig. 3.1 in chapter 2A1 Cement production of EMEP/EEA (2023), the emissions resulting from blasting operations during the digging of limestone are determined by a Tier 2 method using country-specific emission factors documented in EMIS 2026/2A1. The reported emissions of non-exhaust particulate matter contain fugitive emissions of particulate matter of the production sites including storage and handling as well.

Pollutants released from the raw material during the calcination process in the kiln are reported in source category 1A2f Cement production together with the emissions from fuel combustion.

Emission factors (2A1)

Blasting: Emission factors per tonne of clinker are derived from the emission factors of civil explosives and information on the specific consumption of explosives in the quarries as documented in the Handbook on emission factors for stationary sources (SAEFL 2000) and the EMIS database. They are assumed to be constant over the entire time period. The emission factor of BC (% of PM2.5 exh.) is taken from the EMEP/EEA guidebook (EMEP/EEA 2023 chp. 2.A.1, table 3.1).

Table 4-6 Emission factors for blasting operations of 2A1 Cement production in 2024.

2A1 Cement production	Unit of activity data	NO _x	NM _{VOC}	SO _x	PM _{2.5} ex	PM _{2.5} nx	PM ₁₀ ex	PM ₁₀ nx
		g/...	g/...	g/...	g/...	g/...	g/...	g/...
Blasting operations	t clinker	3.3	8.6	0.14	0.51	50	0.86	77

2A1 Cement production	Unit of activity data	TSP ex	TSP nx	BC ex	CO
		g/...	g/...	g/...	g/...
Blasting operations	t clinker	0.86	110	0.015	3.3

Activity data (2A1)

Since 1990, data on annual clinker production are provided by the industry association (Cemsuisse) as documented in the EMIS database (EMIS 2026/2A1_Zementwerke übriger Betrieb). From 2008 onwards, they are based on plant-specific annual monitoring reports from the Swiss Emissions Trading Scheme (ETS).

Table 4-7 Activity data of 2A1 Cement production.

2A1 Cement production	Unit	1990	1995	2000	2005	2010
Blasting operations	kt clinker	4'808	3'706	3'214	3'442	3'642

2A1 Cement production	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Blasting operations	kt clinker	3'195	3'296	3'279	3'239	3'227	3'129	3'227	3'155	2'855	2'735

4.2.2.2 Lime production (2A2)

Methodology (2A2)

There is only one producer of burnt lime in Switzerland. Based on the decision tree Fig. 3.1 in chapter 2A2 Lime production of the EMEP/EEA guidebook (EMEP/EEA 2023), emissions from blasting operations in the quarry are determined by a Tier 2 method using country-specific emission factors (EMIS 2026/2A2). The reported emissions of non-exhaust particulate matter contain fugitive emissions of particulate matter of the production site including storage and handling as well.

Pollutants released from the raw material during the calcination process in the kiln are reported in source category 1A2f Lime production together with the emissions from fuel combustion.

Emission factors (2A2)

The emission factors (NO_x, NM_{VOC}, SO_x, PM_{2.5}, PM₁₀, TSP and CO) per tonne of lime produced are confidential but available to reviewers on request. They are assumed to be constant over the entire time period. The emission factor of BC (% PM_{2.5}) is taken from EMEP/EEA guidebook (EMEP/EEA 2023, chp. 2.A.2, table 3.1).

Activity data (2A2)

Activity data on annual lime production are based on data from the only lime producer in Switzerland and are confidential but available to reviewers on request. From 2008 onwards, they are based on plant-specific annual monitoring reports from the Swiss Emissions Trading Scheme (ETS).

4.2.2.3 Glass production (2A3)

Process emissions from glass production in Switzerland, i.e. container and tableware glass as well as glass wool are reported together with the combustion emissions in source category 1A2f according to EMEP/EEA guidebook (EMEP/EEA 2023), since it is not straightforward to separate them. Therefore, emissions of NO_x, SO_x, PM2.5/PM10/TSP, BC, CO, Pb, Cd and Hg are reported as “included elsewhere” (IE).

4.2.2.4 Quarrying and mining of minerals other than coal (2A5a)

Methodology (2A5a)

In this source category there are two production processes occurring in Switzerland: Gravel plants and plaster production. In August 2020, one of the two plaster production plants was closed. The emissions stem mainly from blasting operations and crushing of stones either in plaster production or gravel plants.

Based on the EMEP/EEA guidebook (EMEP/EEA 2023), emissions from blasting operations as well as emissions of particulates from crushing and grinding work are determined by a Tier 2 method using default and country-specific emission factors for gravel plants and plaster production, respectively (EMIS 2026/2A5a). Emissions from storage and handling are also accounted for.

Emission factors (2A5a)

The emission factors per tonne of gravel and rocks are based on the calculation model of EMEP/EEA (2023) for small quarries considering the process steps material processing, material handling and operation and stockpiles. The process step internal transport was not considered as the emissions of all construction machinery are reported in source category 1A2gvii Mobile combustion (see chp. 3.2.5.2). For plaster production, the emission factors are confidential from 2021 onwards but available to reviewers on request.

Table 4-8 Emission factors of 2A5a Gravel plants and Plaster production in 2024.

2A5a Quarrying and mining of minerals	Unit of activity data	NO _x	NM VOC	SO _x	PM2.5 ex	PM2.5 nx	PM10 ex	PM10 nx
		g/...	g/...	g/...	g/...	g/...	g/...	g/...
Gravel plants	t gravel	NA	NA	NA	NA	1.6	NA	6.1
Plaster production	t rocks	C	C	C	C	C	C	C

2A5a Quarrying and mining of minerals	Unit of activity data	TSP ex	TSP nx	BC ex	CO
		g/...	g/...	g/...	g/...
Gravel plants	t gravel	NA	15	NA	NA
Plaster production	t rocks	C	C	NE	C

Activity data (2A5a)

Activity data for gravel plants and plaster production are based on industry data. For plaster production, plant-specific data are available for 1990, 2001 and from 2004 onwards. For the missing years in between the activity data are linearly interpolated. From 2021 onwards, activity data are confidential but available to reviewers on request.

Data on gravel production are provided annually by the Swiss association of gravel and concrete industry (Fachverband der Schweizerischen Kies- und Betonindustrie, FSKB). But the latest data available is always one year delayed with respect to the latest year of the submission.

Table 4-9 Activity data of 2A5a Gravel plants and Plaster production.

2A5a Quarrying and mining of minerals	Unit	1990	1995	2000	2005	2010					
Gravel plants	kt gravel	33'798	36'791	39'785	44'960	50'540					
Plaster production	kt rocks	319	304	288	327	335					
2A5a Quarrying and mining of minerals	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Gravel plants	kt gravel	50'610	52'750	51'480	49'880	54'060	54'570	53'580	52'110	48'080	48'640
Plaster production	kt rocks	140	148	146	152	149	122	C	C	C	C

4.2.2.5 Construction and demolition (2A5b)

The emissions (from resuspension) of particulate matter (PM2.5, PM10 and TSP) from construction machinery are reported in source category 1A2gvii Mobile combustion in manufacturing industries and construction. Therefore, these emissions are indicated in the reporting tables as "IE".

4.2.3 Category-specific recalculations in 2A Mineral products

The following recalculations were implemented in submission 2026:

- 2A5a Gravel plants: The last year's extrapolated activity data for 2023 was updated based on the actual production figure of the industry association.

4.3 Source category 2B – Chemical industry

4.3.1 Source category description of 2B Chemical industry

Table 4-10 Specification of source category 2B Chemical industry in Switzerland.

2B	Source category	Specification
2B1	Ammonia production	Production of ammonia
2B2	Nitric acid production	Production of nitric acid (ceased in 2018)
2B5	Carbide production	Production of silicon carbide and graphite
2B10a	Chemical industry: Other	Production of acetic acid, ammonium nitrate (ceased in 2018), chlorine gas, ethylene, niacin, PVC (ceased in 1996) and sulfuric acid

Table 4-11 Key categories, approaches 1 and 2, level assessment 2024 (L1, L2) and trend assessment 1990-2024 (T1, T2) for source category 2B Chemical Industry.

NFR code	Source category	Pollutant	Identification criteria
2B5	Carbide production	SO _x	L1, L2, T1, T2
2B10a	Chemical industry: other	SO _x	L2, T2

4.3.2 Methodological Issues of 2B Chemical industry

4.3.2.1 Ammonia production (2B1)

Methodology (2B1)

In Switzerland, ammonia is produced in one single plant by catalytic reaction of nitrogen and synthetic hydrogen. Ammonia is not produced in an isolated reaction plant but is part of an integrated production chain. Starting process of this production chain is the thermal cracking of liquefied petroleum gas and light virgin naphtha yielding ethylene and a series of by-products such as e.g. synthetic hydrogen, which are used as educts in further production steps. According to the producer it is not possible to split and allocate the NMVOC emissions of the cracking process to each single product (ethylene, ammonia, cyanic acid etc.) within the integrated production chain. Therefore, the NMVOC emissions of the cracking process are allocated completely to the primary product ethylene (source category 2B10a). The only emissions reported under 2B1 Ammonia production are NH₃ emissions escaping from the flue gas scrubber.

Based on the decision tree Fig. 3.1 in chapter 2B Chemical industry in the EMEP/EEA guidebook (EMEP/EEA 2023), the emissions from 2B1 Ammonia production are calculated by a Tier 2 method using plant-specific emission factors documented in EMIS 2026/2B1.

Emission factors (2B1)

The NH₃ emission factor per tonne of ammonia produced is confidential but available to reviewers on request. From 1990 to 2001, a constant emission factor based on measurements is applied. In 2002, the scrubber was replaced. For 2011 and since 2013 the emission factor is determined based on measurements provided by the plant. For the years 2002 – 2010 and 2012 the average value of the years 2011 and 2013 – 2017 is applied.

Table 4-12 Emission factor for 2B1 Ammonia production in 2024.

2B1 Ammonia production	Unit of activity data	NMVOC	NH3
		g/...	g/...
Ammonia production	t ammonia	IE	C

Activity data (2B1)

Plant-specific activity data on annual ammonia production are provided by the single plant that exists in Switzerland for the entire time period 1990-2024. Since 2013, activity data are taken from annual monitoring reports from the Swiss Emissions Trading Scheme (ETS). Activity data are confidential, and information is available to reviewers on request.

4.3.2.2 Nitric acid production (2B2)

Methodology (2B2)

In Switzerland there was one single plant producing nitric acid (HNO_3) which stopped production in spring 2018. Nitric acid was produced by catalytic oxidation of ammonia (NH_3) with air. At temperatures of 800°C nitric monoxide (NO) is formed. During cooling, nitrogen monoxide reacted with excess oxygen to form nitrogen dioxide (NO_2). The nitrogen dioxide reacted with water to form 60 % nitric acid (HNO_3). Today, two types of processes are used for nitric acid production: single pressure or dual pressure plants. In Switzerland a dual pressure plant was installed.

Thus, there resulted also some nitrogen oxide (NO_x) as an unintentional by-product. In the Swiss production plant abatement of NO_x was done by selective catalytic reduction (SCR, installed in 1988) which reduced NO_x to N_2 and O_2 (the SCR in this plant was also used for treatment of other flue gases and was not installed for the HNO_3 production specially). In 1990 an automatic control system for the dosing of ammonia to the SCR process was installed.

Based on the decision tree Fig. 3.1 in chapter 2B Chemical industry in the EMEP/EEA guidebook (EMEP/EEA 2023), NH_3 and NO_x emissions from 2B2 Nitric acid production are calculated by a Tier 2 method using plant-specific emission factors (see EMIS 2026/2B2).

Emission factors (2B2)

The emission factors for NO_x and NH_3 per tonne of nitric acid (100 %) are confidential but available to reviewers upon request. The emission factor values for NO_x and NH_3 are mean values based on measurements on site in 2005, 2009 and 2012, and 2007, 2009 and 2012, respectively. They are assumed to be constant between 1990 and 2012 since no modifications in the production process has been made in this period.

In 2013, a new catalyst was installed in the production line along with a measurement device for NH_3 slip to regulate ammonia dosage in the DeNOx plant. Moreover, in 2013 the volume of the DeNOx plant was duplicated. Consequently, the NH_3 emissions could be reduced significantly. Also, a slight reduction of NO_x occurred. From 2013 to 2018, emission factors were based on measurements provided by the plant.

Activity data (2B2)

Activity data on annual nitric acid (100 %) production were provided for the years 1990 to 2018 by the single production plant in Switzerland and are therefore considered as

confidential. However, this information is available to reviewers. From 2013 to 2018, activity data were taken from annual monitoring reports from the Swiss Emission Trading Scheme (ETS).

4.3.2.3 Carbide production (2B5)

Methodology (2B5)

In Switzerland, only silicon carbide is produced in a single plant. It is produced together with graphite in a coupled process in an electric furnace at temperatures above 2000°C using the Acheson process. Therefore, emissions include those from the production of both silicon carbide and graphite. Based on the decision tree Fig. 3.1 in chapter 2B Chemical industry in the EMEP/EEA guidebook (EMEP/EEA 2023), the emissions of SO_x, particulate matter and CO from 2B5 Silicon carbide production are calculated by a Tier 2 method using plant-specific emission factors (EMIS 2026/2B5).

Emission factors (2B5)

The emission factors of NO_x, SO_x, particulate matter, CO and PAHs are based on data from the production plant. The SO_x emission factor is derived from the sulphur content of the feedstocks, i.e. petroleum coke and anthracite. The CO emission factor is calculated based on the carbon mass balance of the production process and exhaust measurements. The emission factors are expressed in g/t carbide but comprise the (unsplit) emissions from the coupled production process of silicon carbide and graphite. They are confidential but available to reviewers on request.

Table 4-13 Emission factor for 2B5 Carbide production in 2024.

2B5 Carbide production	Unit of activity data	NO _x	SO _x	PM2.5 ex	PM10 ex	TSP ex	BC ex
		g/...	g/...	g/...	g/...	g/...	g/...
Silicon carbid production	t carbide	C	C	C	C	C	NE

2B5 Carbide production	Unit of activity data	CO	BaP	BbF	BkF	lcdP
		g/...	mg/...	mg/...	mg/...	mg/...
Silicon carbid production	t carbide	C	C	C	C	C

Activity data (2B5)

Activity data on annual production of silicon carbide (and graphite) are provided by the production plant from 1995 onwards. For 1990–1994 they are estimates based on industry data. The activity data are considered confidential. However, this information is available to reviewers on request.

4.3.2.4 Chemical industry: Other (2B10a)

Methodology (2B10a)

Source category 2B10a Chemical industry: Other comprises emissions from production of acetic acid, ammonium nitrate (ceased in 2018), chlorine gas, ethylene, niacin, PVC (ceased in 1996) as well as sulphuric acid. Based on the decision tree Fig. 3.1 in chapter 2B Chemical industry in the EMEP/EEA guidebook (EMEP/EEA 2023), emissions from 2B10a Chemical industry are calculated by a Tier 2 method using plant-specific emission factors (EMIS 2026/2B10a).

Acetic acid production (2B10a)

In Switzerland there is only one plant producing acetic acid (CH₃COOH) remaining after the other one stopped its production by the end of 2012. The still existing plant emits NMVOC only whereas from the latter one also emissions of CO have occurred.

Emission factors

The emission factors for NMVOC and CO (up to 2012) from acetic acid production in Switzerland are based on measurement data from industry and expert estimates documented in EMIS 2026/2B10 Essigsäure-Produktion. From 2013 onwards, the only relevant pollutant from acetic acid production is NMVOC. Since 2013 the emission factor is confidential but available to reviewers on request.

During normal operation the process emissions in the plant, which stopped production in the end of 2012, had been treated in a flue gas incineration. Thus, the reported emissions of NMVOC and CO only occurred in case of malfunction resulting in strongly fluctuating plant-specific emission factors. In addition, the resulting implied emission factors based on the emissions of both plants were modulated by considerable production fluctuations of one of the plants from 2000 onwards.

Table 4-14 Emission factors of 2B10a Chemical industry: Other in 2024.

2B10a Chemical industry Other	Unit of activity data	NOx	NMVOC	SOx	NH3	PM2.5 nx	PM10 nx	TSP nx	CO	Hg
		g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...	mg/...
Acetic acid production	t acid	NA	C	NA	NA	NA	NA	NA	NA	NA
Ammonium nitrate production	t ammonium nitrate	NO	NO	NO	NO	NO	NO	NO	NO	NO
Chlorine gas production	t chlorine	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylene production	t ethylene	NA	C	NA	NA	NA	NA	NA	NA	NA
Niacin production	t niacin	C	NA	NA	NA	NA	NA	NA	C	NA
PVC production	kg PVC	NO	NO	NO	NO	NO	NO	NO	NO	NO
Sulfuric acid production	t acid	NA	NA	C	NA	NA	NA	NA	NA	NA

Activity data

The annual amount of produced acetic acid is based on data from industry and from the Swiss business association for the chemical, pharmaceutical and biotech industry (scienceindustries) documented in EMIS 2026/2B10 Essigsäure-Produktion. The data for acetic acid production are confidential since 2013 (only one manufacturer remaining) but available for reviewers on request.

Table 4-15 Activity data of 2B10a Chemical industry: Other.

2B10a Chemical industry Other	Unit	1990	1995	2000	2005	2010
Acetic acid production	kt acid	30	27	24	8.4	20
Ammonium nitrate production	kt ammonium nitrate	C	C	C	C	C
Chlorine gas production	kt chlorine	C	C	C	C	C
Ethylene production	kt ethylene	C	C	C	C	C
Niacin production	kt niacin	C	C	C	C	C
PVC production	kt PVC	43	43	NO	NO	NO
Sulfuric acid production	kt acid	C	C	C	C	C

2B10a Chemical industry Other	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Acetic acid production	kt acid	C	C	C	C	C	C	C	C	C	C
Ammonium nitrate production	kt ammonium nitrate	C	C	C	C	NO	NO	NO	NO	NO	NO
Chlorine gas production	kt chlorine	C	C	C	C	C	C	C	C	C	C
Ethylene production	kt ethylene	C	C	C	C	C	C	C	C	C	C
Niacin production	kt niacin	C	C	C	C	C	C	C	C	C	C
PVC production	kt PVC	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Sulfuric acid production	kt acid	C	C	C	C	C	C	C	C	C	C

Ammonium nitrate production (2B10a)

In Switzerland there was only one plant producing ammonium nitrate; it stopped production in 2018. In the production process emissions of NH₃ and particulate matter occurred.

Emission factors

The emission factors for NH₃ and for particulate matter from ammonium nitrate production in Switzerland are plant-specific and based on measurement data from industry and expert estimates, which are available for 2009, 2012, 2013 and 2016 as documented in EMIS 2026/2B10 Ammoniumnitrat Produktion. From 1990-2013 average emission factors are applied based on the measurements from 2009, 2012 and 2013. The emission factors are confidential but available to reviewers on request.

Activity data

The annual amount of ammonium nitrate (pure NH₄NO₃) produced was based on data from industry for 1990 and from 1997 to 2018 as documented in EMIS 2026/2B10 Ammoniumnitrat Produktion. The activity data for ammonium nitrate production are confidential but available to reviewers on request.

Chlorine gas production (2B10a)

In Switzerland there is only one plant producing chlorine gas. Chlorine gas was produced by chlorine alkaline electrolysis in a mercury-cell process until 2016. In the course of 2016, the production was switched to mercury-free membrane process technology. Thus, from 2017 onwards, there are no more Hg emissions.

Emission factors

The emission factor for Hg from chlorine gas production by chlorine alkaline electrolysis in a mercury-cell process between 1990 and 2016 in Switzerland is plant-specific and based on measurement data from industry and expert estimates documented in EMIS 2026/2B10 Chlorgas-Produktion. The emission factor is confidential but available to reviewers on request.

Activity data

The annual amount of chlorine gas produced is based on data from industry and data from the Swiss business association for the chemical, pharmaceutical and biotech industry (scienceindustries) as documented in EMIS 2026/2B10 Chlorgas-Produktion. The activity data for chlorine gas production are confidential but available to reviewers on request.

Ethylene production (2B10a)

As described above in source category 2B1 Ammonia production, ethylene is produced within an integrated production chain and results as primary product of the first step, i.e. the cracking process. Since the NMVOC emissions of the cracking process cannot be split and allocated separately to the various chemical products, they are assigned completely to the production of ethylene and are reported here under source category 2B10a.

Emission factors

The emission factor for NMVOC from ethylene production in Switzerland is plant-specific and based on measurement data from industry documented in EMIS 2026/2B10 ethylene production. The emission factor is confidential but available to reviewers on request.

Activity data

The annual amount of ethylene produced is based on data from industry as documented in EMIS 2026/2B10 ethylene production. They refer to annual monitoring reports from the Swiss Emissions Trading Scheme (ETS). The activity data for ethylene production are confidential but available to reviewers on request.

Niacin production (2B10a)

In Switzerland, there is one plant producing niacin that emits NO_x and CO. In the production process of niacin, nitric acid is used as oxidizing agent. Since the nitric acid production plant was closed in spring 2018 the required nitric acid is directly produced within the niacin production plant using a so-called ammonia burner. In autumn 2021, a catalytic converter was installed to treat the non-absorbed gas components of the production plant (incl. ammonia burner). The nitrogen oxides are denitrified with ammonia, and nitrous oxide, hydrocyanic acid and carbon monoxide are decomposed to nitrogen, water and carbon dioxide.

Emission factors

The emission factors for NO_x and CO from niacin production in Switzerland are plant-specific. They are based on measurement data from industry in 2017, 2018, 2021 and 2024 as documented in EMIS 2026/2B10 Niacin Produktion. The emission factors are confidential but available to reviewers on request.

Activity data

Activity data of annual niacin production were provided by the Swiss production plant for the entire time period as documented in EMIS 2026/2B10 Niacin-Produktion. For the years 2005-2011 and since 2013 they are based on monitoring reports of the Swiss ETS. Activity data are considered confidential but available to reviewers on request.

Sulphuric acid production (2B10a)

Sulphuric acid (H_2SO_4) is produced by one plant only in Switzerland. From this production process SO_x is emitted.

Emission factors

The emission factor for SO_x from sulphuric acid production in Switzerland is plant-specific. Since 2009, the emission factor is based on annual measurement data from industry documented in EMIS 2026/2B10 Schwefelsäure-Produktion. Between 1990 and 2008 the mean value is applied. The SO_x emission factor is confidential but available to reviewers on request.

Activity data

The annual amount of sulphuric acid produced is based on data from industry and data from Swiss business association for the chemical, pharmaceutical and biotech industry (scienceindustries) as documented in EMIS 2026/2B10 Schwefelsäure-Produktion. The

activity data for sulphuric acid production are confidential but available to reviewers on request.

PVC (2B10a)

Until 1996 PVC was produced in Switzerland. From this production process NMVOC emissions were released.

Emission factors

For PVC production the NMVOC emission factor was based on industry information and expert estimates as documented in the EMIS database (EMIS 2026/2B10 PVC-Produktion).

Activity data

The annual amount of PVC produced was based on data from industry and expert estimates documented in EMIS 2026/2B10 PVC-Produktion (see Table 4-15).

4.3.3 Category-specific recalculations in 2B Chemical industry

The following recalculations were implemented in submission 2026:

- 2B10a: For source category 2B10a Niacin production, the emission factors of NO_x and CO were revised for the years 2022 and 2023 based on emission measurement data from 2024.

4.4 Source category 2C – Metal production

4.4.1 Source category description of 2C Metal production

Table 4-16 Specification of source category 2C Metal production in Switzerland.

2C	Source category	Specification
2C1	Iron and steel production	Secondary steel production, iron foundries
2C3	Aluminium production	Production of aluminium (ceased in 2006)
2C7a	Copper production	Non-ferrous metal foundries
2C7c	Other metal production	Battery recycling, galvanizing plants

Table 4-17 Key categories, approaches 1 and 2, level assessment 2024 (L1, L2) and trend assessment 1990-2024 (T1, T2) for source category 2C Metal Production.

NFR code	Source category	Pollutant	Identification criteria
2C1	Iron and steel production	PM2.5	T1, T2
2C1	Iron and steel production	PM10	T1, T2

4.4.2 Methodological issues of 2C Metal production

4.4.2.1 Iron and steel production (2C1)

Methodology (2C1)

In Switzerland only secondary steel production from recycled steel scrap occurs. After closing of two steel plants in 1994 another two plants remain. Both plants use electric arc furnaces (EAF) with carbon electrodes for melting the steel scrap. The PCB emissions are modelled within the disposal category of the dynamic mass flow model developed for the usage of PCBs in Switzerland (Glüge et al. 2017), see Annex A2.2. The PCB emission value of the air pollution control measurements in 2014 were included in the model.

Iron is processed in foundries only. There is no production of pig iron. Today, 14 iron foundries exist in Switzerland. About 75 % of the iron is processed in induction furnaces and 25 % in cupola furnaces.

Based on the decision tree Fig. 3.1 in chapter 2C1 in the EMEP/EEA guidebook (EMEP/EEA 2023), the emissions from 2C1 Iron and steel production are calculated by a Tier 2 method using country-specific emission factors (EMIS 2026/2C1).

Emission factors (2C1)

Emission factors for the pollutants emitted from steel production are based on air pollution control measurements of the steel plants. Emission factors of NO_x, NMVOC, SO_x, PM_{2.5}/PM₁₀/TSP, CO, Pb, Cd, PCDD/PCDF and PAH are based on air pollution control measurements at the electric arc furnaces of the two plants in 1999, 2005 and 2010 and in 1998, 2009 and 2014, respectively. The PCB emission factor comes from the dynamic mass flow model for the usage of PCBs in Switzerland, see Annex A2.2. There was a significant decrease in the PM_{2.5}/PM₁₀/TSP, Pb, Cd and Hg emission factors due to the installation of new filters in 1998/1999 at the two remaining production sites.

The emission factors from iron production in foundries are provided by the Swiss foundry association (GVS) and are assumed to be constant for the entire time period. NMVOC is mainly emitted in the finishing process of the cast iron. The NH₃ emission factor is taken from the Handbook on emission factors for stationary sources (SAEFL 2000).

The emission factor of BC (% PM_{2.5}) is taken from EMEP/EEA guidebook (EMEP/EEA 2023, chp. 2.C.1, table 3.1).

Table 4-18 Emission factors 2C1 Iron and steel production in 2024.

2C1 Iron and steel production	Unit of activity data	NOx	NM/VOC	SOx	NH3	PM2.5 ex	PM2.5 nx	PM10 ex	PM10 nx
		g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
Iron production, electric melting furnace	t iron	NA	33	NA	NA	7.0	NA	10	NA
Iron production, other processes	t iron	10	4'000	NA	70	NA	50	NA	130
Steel production, electric arc furnace	t steel	140	70	14	NA	6.0	NA	8.0	NA
Steel production, electric arc furnace (PCB)	g PCB	NA	NA	NA	NA	NA	NA	NA	NA
Steel production, other processes	t steel	NO	NO	NO	NO	NO	NO	NO	NO
Steel production, rolling mill	t steel	NA	40	NA	NA	NA	NA	NA	NA

2C1 Iron and steel production	Unit of activity data	TSP ex	TSP nx	BC ex	CO	Pb	Cd	Hg
		g/...	g/...	g/...	g/...	mg/...	mg/...	mg/...
Iron production, electric melting furnace	t iron	13	NA	0.025	93	320	1.3	NA
Iron production, other processes	t iron	NA	150	NA	4'000	NA	NA	NA
Steel production, electric arc furnace	t steel	9.0	NA	0.022	700	200	4.0	40
Steel production, electric arc furnace (PCB)	g PCB	NA	NA	NA	NA	NA	NA	NA
Steel production, other processes	t steel	NO	NO	NO	NO	NO	NO	NO
Steel production, rolling mill	t steel	NA	NA	NA	NA	NA	NA	NA

2C1 Iron and steel production	Unit of activity data	PCDD/PCDF	BaP	BbF	BkF	IcdP	PCB
		ng I-Teq/...	mg/...	mg/...	mg/...	mg/...	mg/...
Iron production, electric melting furnace	t iron	130	NA	NA	NA	NA	NA
Iron production, other processes	t iron	1'300	NA	NA	NA	NA	NA
Steel production, electric arc furnace	t steel	110	0.80	3.4	0.90	2.2	NA
Steel production, electric arc furnace (PCB)	g PCB	NA	NA	NA	NA	NA	11
Steel production, other processes	t steel	NO	NO	NO	NO	NO	NO
Steel production, rolling mill	t steel	NA	NA	NA	NA	NA	NA

Activity data (2C1)

For the steel production, annual activity data are provided by the Swiss steel producers (1990 – 1994 four plants, since 1995 two plants). Since 2009, activity data refer to monitoring reports of the Swiss ETS.

Annual activity data on iron production are provided by the Swiss foundry association for the entire time period.

The steel production decreased between 1994 and 1995 significantly due to the closing of two steel production sites in Switzerland. In 2009, there was a remarkable reduction in activity data within the metal industry because of the financial crisis. Due to the economic situation, including the strong rise in electricity prices because of the war in Ukraine, production fell sharply from 2022 to 2023.

Table 4-19 Activity data for 2C1 Iron and steel production.

2C1 Iron and steel production	Unit	1990	1995	2000	2005	2010
Iron production, electric melting furnace	kt iron	80	70	65	35	40
Iron production, other processes	kt iron	170	130	120	67	53
Steel production, electric arc furnace	kt steel	1'108	716	1'022	1'159	1'218
Steel production, electric arc furnace (PCB)	t PCB	0.12	0.098	0.13	0.16	0.17
Steel production, other processes	kt steel	1'108	716	NO	NO	NO
Steel production, rolling mill	kt steel	1'108	716	1'022	1'082	1'082

2C1 Iron and steel production	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Iron production, electric melting furnace	kt iron	28	26	27	26	18	15	16	17	16	13
Iron production, other processes	kt iron	37	34	35	34	24	20	22	23	22	18
Steel production, electric arc furnace	kt steel	1'296	1'238	1'270	1'291	1'130	1'125	1'294	1'208	936	971
Steel production, electric arc furnace (PCB)	t PCB	0.17	0.17	0.17	0.17	0.16	0.16	0.16	0.15	0.15	0.14
Steel production, other processes	kt steel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Steel production, rolling mill	kt steel	1'144	1'085	1'138	1'160	1'037	1'031	1'104	1'121	884	906

4.4.2.2 Aluminium production (2C3)

Methodology (2C3)

Today, there is no more primary aluminium production as the last production site closed in April 2006. Based on the decision tree Fig. 3.1 in chapter 2C3 in the EMEP/EEA guidebook (EMEP/EEA 2023), emissions from source category 2C3 are calculated by a Tier 2 method using country-specific emission factors (EMIS 2026/2C3).

Emission factors (2C3)

The emission factors are based on air pollution control measurements and data from the aluminium industry association (Aluminium – Verband Schweiz), literature and expert estimates documented in the EMIS database. Since production stopped in 2006, there are no emission factors to be reported for 2023.

Activity data (2C3)

From 1995 to 2006 data on aluminium production was based on data published regularly by the Swiss Aluminium Association (www.alu.ch). For earlier years, the data was provided directly by the aluminium industry. In April 2006, the last site of primary aluminium production (electrolysis) in Switzerland closed.

Table 4-20 Activity data for the 2C3 Aluminium production.

2C3 Aluminium production	Unit	1990	1995	2000	2005	2010						
Aluminium production	kt aluminium	87	21	36	45	NO						
2C3 Aluminium production	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
Aluminium production	kt aluminium	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

4.4.2.3 Copper production (2C7a)

Methodology (2C7a)

Source category 2C7a Copper production comprises one large and several small non-ferrous metal foundries, which are organized within the Swiss foundry association (GVS). In Switzerland, only casting and no primary production of non-ferrous metals occur.

Based on the decision tree Fig. 3.1 in chapter 2C7a in the EMEP/EEA guidebook (EMEP/EEA 2023), emissions from source category 2C7a are calculated by a Tier 2 method (EMIS 2026/2C7a) using country-specific emission factors.

Emission factors (2C7a)

The emission factors from non-ferrous metal foundries are based on expert estimates and data from the industry as documented in the EMIS database. They are assumed to be constant over the entire time period.

Table 4-21 Emission factors for 2C7a Foundries of non-ferrous metals in 2024.

2C7a Copper production	Unit of activity data	NMVOC	PM2.5 ex	PM10 ex	TSP ex	BC ex	CO	Pb	Cd	PCDD/ PCDF
		g/...	g/...	g/...	g/...	g/...	g/...	mg/...	mg/...	ng I- Teq/...
Foundries of non-ferrous metals	t metal	50	95	100	100	0.095	240	300	50	30'000

Activity data (2C7a)

Activity data on annual non-ferrous metal production are based on data from industry (1990 and monitoring reports of the Swiss ETS from 2006 onwards) and the Swiss foundry association (GVS, since 1996) as documented in the EMIS database.

Table 4-22 Activity data for 2C7a Foundries of non-ferrous metals.

2C7a Copper production	Unit	1990	1995	2000	2005	2010						
Foundries of non-ferrous metals	kt metal	60	56	53	33	20						
2C7a Copper production	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
Foundries of non-ferrous metals	kt metal	8.9	9.0	8.0	6.8	6.4	5.1	7.5	7.9	5.3	4.8	

4.4.2.4 Other metal production (2C7c)

Methodology (2C7c)

Source category 2C7c Other metal production comprises emissions from battery recycling and galvanizing plants. In Switzerland, there is one plant recycling batteries by applying the Sumitomo-process which started operation in 1992 and about a dozen of galvanizing plants. Based on chapter 2C7c in the EMEP/EEA guidebook (EMEP/EEA 2023), emissions from source category 2C7c are calculated by a Tier 2 approach (EMIS 2026/2C7c) using country-specific emission factors.

Emission factors (2C7c)

The emission factors for battery recycling between 1992 and 2003 are based on measurements in 2000 (TSP, Hg) and 2003 (NO_x, SO_x, CO, Pb, Cd, PCDD/PCDF) as well as mass balances of the single recycling site. Emission factors are assumed constant between 1990 and 2002.

Since 2003 emission factors of NO_x, SO_x, TSP, CO, Pb, Cd, Hg and PCDD/PCDF are assumed constant based on air pollution control measurements from 2003 and 2012.

Emission factors of NMVOC and NH₃ are also based on air pollution control measurements from 2003 and 2012. Emission factors are assumed constant for the entire time period.

All emission factors of battery recycling are confidential. These data are available to reviewers on request.

The emission factors of galvanizing plants are based on data from the Swiss galvanizing association and expert estimates documented in the EMIS database. They are assumed to be constant over the entire time period.

Table 4-23 Emission factors for 2C7c Other metal production: Battery recycling and Galvanizing in 2024.

2C7c Other metal production	Unit of activity data	NOx	NMVOC	SOx	NH3	PM2.5 ex	PM2.5 nx	PM10 ex	PM10 nx
		g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
Battery recycling	t batteries	C	C	C	C	C	NA	C	NA
Galvanising plants	t galvanised material	NA	NA	NA	90	NA	15	NA	30

2C7c Other metal production	Unit of activity data	TSP ex	TSP nx	BC ex	CO	Pb	Cd	Hg	PCDD/PCDF
		g/...	g/...	g/...	g/...	mg/...	mg/...	mg/...	ng I- Teq/...
Battery recycling	t batteries	C	NA	NE	C	C	C	C	C
Galvanising plants	t galvanised material	NA	37	NA	NA	NA	2.5	NA	700

Activity data (2C7c)

Annual activity data on the amount of metal processed are based on data from the only battery recycling site in Switzerland which started operation in 1992 and from the Swiss galvanizing association, as documented in the EMIS database (EMIS 2026/2C7c_Batterie-Recycling, EMIS 2026/2C7c_Verzinkereien).

Activity data of battery recycling are confidential. These data are available to reviewers on request.

Table 4-24 Activity data for 2C7c Other metal production: Battery recycling and Galvanizing.

2C7c Other metal production	Unit	1990	1995	2000	2005	2010
Battery recycling	kt batteries	NO	C	C	C	C
Galvanising plants	kt galvanised material	102	84	99	88	93

2C7c Other metal production	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Battery recycling	kt batteries	C	C	C	C	C	C	C	C	C	C
Galvanising plants	kt galvanised material	92	91	91	91	91	91	91	90	90	90

4.4.3 Category-specific recalculations in 2C Metal production

The following recalculations were implemented in submission 2026:

- 2C7c: Due to the adjustment of the projections period from 2025–2050 to 2030–2050, the linearly interpolated activity data for the years 2013–2023 of galvanizing plants changed.

4.5 Source category 2D3 – Other solvent use

4.5.1 Source category description of 2D3 Other solvent use

Source category 2D3 comprises mainly NMVOC emissions from about 40 different solvent applications. From 2D3c Asphalt roofing and 2D3i Fat, edible and non-edible oil extraction (ceased in 2000) also particulate matter and CO and particulate matter, respectively, are emitted.

Table 4-25 Specification of source category 2D Other solvent use in Switzerland.

2D	Source category	Specification
2D3a	Domestic solvent use including fungicides	Domestic use of cleaning agents, solvents, cosmetics and toiletries; use of pharmaceutical products in households
2D3b	Road paving with asphalt	Road paving
2D3c	Asphalt roofing	Asphalt roofing
2D3d	Coating applications	Paint application in households, industry, construction and car repairing and on wood
2D3e	Degreasing	Metal degreasing and cleaning; cleaning of electronic components; other industrial cleaning
2D3f	Dry cleaning	Dry cleaning
2D3g	Chemical products	Handling and storage of solvents; production of fine chemicals, pharmaceuticals; manufacturing of paint, inks, glues, adhesive tape (ceased in 1994); processing of rubber, PVC, polystyrene foam, polyurethane and polyester; tanning of leather (ceased in 2015)
2D3h	Printing	Package printing, other printing industry
2D3i	Other solvent use	Removal of paint and lacquer; vehicles dewaxing (ceased in 2001); production of perfume/aroma and cosmetics, paper and paper board, tobacco products, textile products; scientific laboratories; not attributable solvent emissions; extraction of oil and fats (ceased in 2000)

Table 4-26 Key categories, approaches 1 and 2, level assessment 2024 (L1, L2) and trend assessment 1990-2024 (T1, T2) for source category 2D Other Solvent Use.

NFR code	Source category	Pollutant	Identification criteria
2D3a	Domestic solvent use including fungicides	NMVOC	L1, L2, T1, T2
2D3b	Road paving with asphalt	NMVOC	L1, L2, T1, T2
2D3d	Coating applications	NMVOC	L1, L2, T1
2D3e	Degreasing	NMVOC	L1, T1, T2
2D3g	Chemical products	NMVOC	L1, L2, T1, T2
2D3h	Printing	NMVOC	L1, L2, T1
2D3i	Other solvent use	NMVOC	L1, L2, T2

4.5.2 Methodological issues of 2D3 Other solvent use

General comment:

In the past, the data collection of the about 50 processes of solvent and product use (source categories 2D3 and 2G) were carried out for the years 1990, 1998 and then at three-years intervals until 2013 for both NMVOC emission factors and activity data. Depending on the available years of the background data (e. g. data from industry associations, employment statistics), these years were preferably used for deriving emission factors and activity data. For activity data based directly on (annual) statistics, all available data is used in the inventory. As a rule of inventory, the values of emission factors and activity data of all years in-between – also between the last survey year and the projected year – are linearly interpolated. In the past, the main data sources for commercial and industrial solvent and product use stem from industry associations. Unfortunately, the availability and quality of the data as well as the technical expertise within the associations have changed over the years. For this reason, the solvent and product use processes have no longer been updated all together since 2016, but as part of a long-term project which started in 2017. This enables a much more thorough and comprehensive, often iterative approach based on different data sets. Thematic priorities are also set, e. g. all paint and coating applications and productions including printing processes (2D3d, 2D3g, 2D3h). On the basis of the thorough new surveys, the values and bases of previous surveys are also evaluated and revised if necessary. If previous values appear implausible or incorrect and cannot be adjusted because data and information are no longer available, they were partially deleted and linearly interpolated over longer periods accordingly.

4.5.2.1 Domestic solvent use including fungicides (2D3a)

Methodology (2D3a)

The source category 2D3a Domestic solvent use including fungicides comprises mainly the use of cleaning agents and solvents in private households for building and furniture cleaning and cosmetics and toiletries but also the use of pharmaceuticals. These products contain solvents, which evaporate during use or after the application. Up to submission 2022, propellant emissions from the use of spray cans in the household sector were reported as a separate source category. An in-depth discussion with a long-standing expert from the largest contract manufacturer in Switzerland revealed that the aerosol in many spray applications has the function of both propellant and solvent, and a clear distinction is usually not even possible or meaningful. Therefore, the source category 2D3a Domestic use of aerosol cans was removed and its NMVOC emissions were integrated into the respective application sources, also into the two source categories 2D3a Use of cleaning agents and 2D3a Domestic use of pharmaceuticals. Among the numerous NMVOC emission sources,

the use of household cleaning agents, cosmetics and toiletries is the largest single source in source category 2D3.

Based on the decision tree Fig. 3.1 in chapter 2D3a in the EMEP/EEA guidebook (EMEP/EEA 2023), the emissions are calculated by a Tier 2 method (EMIS 2026/2D3a) using country-specific emission factors. All emissions related to domestic solvent use are calculated proportional to the Swiss population.

Emission factors (2D3a)

Household cleaning agents

The source category 2D3a Use of cleaning agents comprises the use of cosmetics, toiletries, cleaning agents and care products including spray cans (aerosol). Its resulting emission factor bases thus on a multitude of products, their consumption figures, NMVOC contents and emission fractions. Currently, about 85 % of the NMVOC emissions stem from the use of cosmetics and toiletries whereas the rest arises from the use of cleaning agents and care products. The most important product classes are hair styling and deodorants with emission shares of about 30 % and just under 20 %, respectively, followed by air refresheners, perfumes and eaux de toilette, nail care and waterproofing sprays with shares between 10 % and 5 %.

Available data sources consist of surveys of the use of household cleaning agents, cosmetics and toiletries in Switzerland (1990) and in Germany (1996 and 2000).

For the current values, a comprehensive study was conducted based on detailed sales figures of the years 2017-2020, NMVOC contents and application-specific emission factors. The sales figures mainly come from a market research institute covering a large part of the Swiss retail trade, while information on product class-specific NMVOC contents were provided by a large retailer, production companies and a contract manufacturer and are based on the European aerosol statistics as well.

Domestic use of pharmaceutical products

Emission factors of domestic use of pharmaceutical products are available from surveys in Switzerland (1990) and Germany (1998) and from the Swiss business association for the chemical, pharmaceutical and biotech industry (scienceindustries) for 2011, as documented in the EMIS database. For years with no survey data, emission factors are interpolated.

Table 4-27 Emission factors of 2D3a Domestic solvent use including fungicides in 2024.

2D3a Domestic solvent use	Unit of activity data	NMVOC
		g/...
Domestic use of pharmaceutical products	inhabitants	32
Household cleaning agents	inhabitants	700

Activity data (2D3a)

As described in the methodology chapter, the activity data used for calculating the NMVOC emissions in 2D3a Domestic solvent use corresponds to the Swiss population (FSO 2025c).

Table 4-28 Activity data of 2D3a Domestic solvent use including fungicides.

2D3a Domestic solvent use	Unit	1990	1995	2000	2005	2010						
Domestic use of pharmaceutical products	inhabitants	6'712'000	7'041'000	7'184'000	7'437'000	7'825'000						
Household cleaning agents	inhabitants	6'712'000	7'041'000	7'184'000	7'437'000	7'825'000						
2D3a Domestic solvent use	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
Domestic use of pharmaceutical products	inhabitants	8'282'000	8'373'000	8'452'000	8'514'000	8'575'000	8'638'000	8'705'000	8'777'000	8'889'000	9'007'000	
Household cleaning agents	inhabitants	8'282'000	8'373'000	8'452'000	8'514'000	8'575'000	8'638'000	8'705'000	8'777'000	8'889'000	9'007'000	

4.5.2.2 Road paving with asphalt (2D3b)

Methodology (2D3b)

Based on the decision tree Fig. 3.1 in chapter 2D3b in the EMEP/EEA guidebook (EMEP/EEA 2023), the NMVOC emissions from 2D3b Road paving with asphalt are determined by a Tier 2 method based on country-specific emission factors as documented in EMIS 2026/2D3b. Other pollutants are not considered.

Emission factors (2D3b)

The emission factor for NMVOC emissions from 2D3b Road paving with asphalt comprises NMVOC emissions from the use of prime coatings and from the bitumen content in asphalt products (about 5 %). The NMVOC content in the bitumen has decreased considerably between 1990 and 2010. The values are based on industry data from 1990, 1998, 2007, 2010 and 2013. All other years are interpolated and complemented with expert estimates documented in the EMIS database. Emissions of particulate matter are not estimated so far.

Table 4-29 Emission factors of 2D3b Road paving with asphalt in 2024.

2D3b Road paving with asphalt	Unit of activity data	NMVOC	PM2.5 ex	PM10 ex	TSP ex	BC ex
		g/...	g/...	g/...	g/...	g/...
Asphalt concrete	t mixed goods	540	NE	NE	NE	NE

Activity data (2D3b)

Activity data on the amount of asphalt products (so-called mixed goods) used for road paving are based on annual data from the association of asphalt production industry (SMI) for 1990 and from 1998 onwards and expert estimates for the years in between.

Table 4-30 Activity data of 2D3b Road paving with asphalt.

2D3b Road paving with asphalt	Unit	1990	1995	2000	2005	2010						
Asphalt concrete	kt mixed goods	5'500	4'800	5'170	4'780	5'250						
2D3b Road paving with asphalt	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
Asphalt concrete	kt mixed goods	4'850	4'710	5'260	5'180	5'210	4'910	4'960	4'970	4'940	4'930	

4.5.2.3 Asphalt roofing (2D3c)

Methodology (2D3c)

In Switzerland there are three main producers of asphalt roofing material. Based on the decision tree Fig. 3.1 in chapter 2D3c in the EMEP/EEA guidebook (EMEP/EEA 2023), the emissions of NMVOC from Asphalt roofing are determined by a Tier 2 method based on country-specific emission factors as documented in EMIS 2026/2D3c. Emissions of PM2.5, PM10, TSP, BC and CO from the manufacture of asphalt sheeting are determined based on a Tier 1 method using default emission factors (EMEP/EEA 2023). In the past, four processes related to asphalt roofing were differentiated, i.e. production of sheeting,

production of prime coat, laying of sheeting and use of prime coat. For submission 2018, these processes were aggregated and revised resulting in an implied emission factor for the entire asphalt roofing process.

Emission factors (2D3c)

The NMVOC emission factors from Asphalt roofing are based on information from the industry association, literature and expert estimates as documented in the EMIS database. Tier 1 emission factors of PM2.5, PM10, TSP, BC (% PM2.5) and CO from the manufacture of asphalt sheeting are taken from the EMEP/EEA guidebook (EMEP/EEA 2023, chp. 2.D.3.c, table 3.1).

Table 4-31 Emission factors of 2D3c Asphalt roofing in 2024.

2D3c Asphalt roofing	Unit of activity data	NMVOC	PM2.5 ex	PM10 ex	TSP ex	BC ex	CO
		g/...	g/...	g/...	g/...	g/...	g/...
Asphalt roofing	t sheeting	4'583	49	245	978	0.0049	5.8

Activity data (2D3c)

Activity data is based on data from industry and expert estimates as documented in the EMIS database. From 2012 onwards, they are extrapolated based on the Swiss Energy Perspectives 2050+ (Prognos/INFRAS/TEP/Ecoplan 2020).

Table 4-32 Activity data of 2D3c Asphalt roofing.

2D3c Asphalt roofing	Unit	1990	1995	2000	2005	2010					
Asphalt roofing	kt sheeting	54	56	58	51	68					
2D3c Asphalt roofing	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Asphalt roofing	kt sheeting	76	76	76	77	77	78	78	78	79	79

4.5.2.4 Coating applications (2D3d)

Methodology (2D3d)

This source category comprises emissions from paint application in construction, households, industry, wood and car repair. Industrial application also includes commercial applications such as corrosion protection and road marking. A comprehensive assessment of all coating applications and paint production was carried out in 2018-2020. Based on the decision tree Fig. 3.1 in chapter 2D3d in the EMEP/EEA guidebook (EMEP/EEA 2023), for 2D3d Coating applications a bottom-up Tier 2 method based on the consumption of paints, lacquers, glazes, thinners and related materials and their solvent content. Country-specific emission factors are used. In 2024, the most important emission sources are 2D3d Paint application in construction and 2D3d Paint application, wood and to a lesser extent 2D3d Paint application, industrial.

Emission factors (2D3d)

Emission factors for NMVOC are derived from the solvent contents of the paints and thinners based on data from the Swiss association for coating and paint applications (VSLF), the biggest industrial users (incl. surveys of VOC balances), paint producers, and all major Swiss DIY (do it yourself) companies as documented in the EMIS database (EMIS 2026/2D3d). The emission factors for all commercial and industrial coating applications declined significantly between 1990 and 2004 because of both a reduction of the solvent content and replacing of

solvent-based paint by water-based paint due to increasingly strict NMVOC regulations by the EU directive (EC 2004). In addition, powder coatings, which are far more efficient, replaced in this time period the conventional paint (rough estimate: 1 t of powder coating replaces 3 t of conventional paint). Since 2004, the mean solvent content of paint applied in construction and on wood has remained about constant with some fluctuations whereas a decrease has been observed for paints in industrial applications. For paint application in car repair, even a slight increase in solvent content has been observed in the last few years. Source category 2D3d Paint application, households is based on a comprehensive study including all major Swiss DIY companies. It also covers the the aerosol emissions from spray paint cans.

Table 4-33 Emission factors of 2D3d Coating applications in 2024.

2D3d Coating applications	Unit of activity data	NMVOC
		g/...
Paint application, car repair	kg paint	550
Paint application, construction	kg paint	61
Paint application, households	kg paint	85
Paint application, industrial	kg paint	180
Paint application, wood	kg paint	312

Activity data (2D3d)

The activity data correspond to the annual consumption of paints which are estimated according to data and information from VSLF, the biggest industrial users (incl. VOC balances), Swiss paint producers, foreign trade statistics and all major Swiss DIY companies for paint applications in households (EMIS 2026/2D3d). Between 1990 and 1998, the total consumption of paint decreased considerably, increased continuously from 2004 onwards and dropped again after 2013. This trend results from the opposing trends in the different source categories:

- 2D3d Paint application, construction: The paint consumption in construction shows a substantial reduction compared to 1990 levels. The increasing tendency in paint application between 2001 and 2010, the drop thereafter and the slight increase from 2020 onwards can be explained to a certain extent by the development of construction activity in Switzerland. Before 2001, there was a decline in construction activity, which explains the decreasing tendency in paint application.
- 2D3d Paint application, wood: The paint consumption for applications on wood increased moderately between 1990 and 1998. But from 2001 onwards it shows a comparable development as the paint application in construction.
- 2D3d Paint application, industrial: Between 1990 and 2016, the activity of industrial paint application decreased significantly. There was a clear decrease between 2001 and 2004 due to structural changes in the industrial sectors and a widespread application of powder coatings from 2004 onwards. Since 2007, the activity data show a moderate decrease.

Table 4-34 Activity data of 2D3d Coating application.

2D3d Coating applications	Unit	1990	1995	2000	2005	2010
Paint application, car repair	kt paint	2.7	2.2	2.0	1.9	1.7
Paint application, construction	kt paint	60	43	33	42	54
Paint application, households	kt paint	12	13	13	12	11
Paint application, industrial	kt paint	20	21	21	8.8	8.3
Paint application, wood	kt paint	8.7	8.7	8.5	9.2	13

2D3d Coating applications	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Paint application, car repair	kt paint	0.97	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Paint application, construction	kt paint	49	47	46	46	45	45	46	46	46	47
Paint application, households	kt paint	10	10	10	10	10	10	10	10	10	10
Paint application, industrial	kt paint	7.6	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Paint application, wood	kt paint	10	9.5	9.3	9.2	9.0	9.0	9.0	9.0	9.0	9.0

4.5.2.5 Degreasing (2D3e)

Methodology (2D3e)

Source category 2D3e comprises emissions from degreasing of electronic components, metal and other industrial cleaning. It covers also the emissions from the use of spray cans in the field of industry, technical products and automotive applications without coating. Based on the decision tree Fig. 3.1 in chapter 2D3e in the EMEP/EEA guidebook (EMEP/EEA 2023), the NMVOC emissions from 2D3e Degreasing are calculated by a Tier 2 method (EMIS 2026/2D3e) using country-specific emission factors.

Emission factors (2D3e)

Emission factors for NMVOC are estimated based on data from industry surveys by swissmem (including VOC balance evaluations in 2004, 2007, 2012 and 2018) and expert estimates as documented in the EMIS database. For the use of spray cans the values are based on an (unpublished) propellant gas statistics, data from the Swiss aerosol association and statistics data of the European aerosol federation (FEA) for the years 1990, 1998 and 2019/2020, respectively.

Table 4-35 Emission factors of 2D3e Degreasing in 2024.

2D3e Degreasing	Unit of activity data	NMVOC
		g/...
Cleaning of electronic components	kg solvent	478
Degreasing of metal	kg solvent	541
Other industrial cleaning	kg solvent	543

Activity data (2D3e)

Activity data correspond to the annual consumption of solvents for degreasing and cleaning. They are based on survey data from the association of Swiss mechanical and electric engineering industries (swissmem) in 2004, 2007, 2012 and 2018, VOC balances of the most important companies, import statistics and expert estimates, documented in the EMIS database (EMIS 2026/2D3e). For the use of spray cans the data are based on an (unpublished) propellant gas statistics, data of the Swiss aerosol association and statistics data of the European aerosol federation (FEA) for the years 1990, 1998 and 2019/2020, respectively.

In 1990 metal degreasing showed by far the highest activity data, i.e. consumption of solvents and NMVOC emissions but with a subsequent sharp decline until around 2004. Since then, other industrial cleaning and metal degreasing are of similar importance.

Table 4-36 Activity data of 2D3e Degreasing (solvent consumption).

2D3e Degreasing	Unit	1990	1995	2000	2005	2010						
Cleaning of electronic components	kt solvent	1.7	1.5	1.3	1.1	0.84						
Degreasing of metal	kt solvent	13	9.1	6.2	2.7	2.3						
Other industrial cleaning	kt solvent	2.9	2.5	2.0	1.8	1.4						
2D3e Degreasing	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
Cleaning of electronic components	kt solvent	0.49	0.38	0.28	0.18	0.18	0.18	0.18	0.18	0.18	0.18	
Degreasing of metal	kt solvent	1.6	1.4	1.3	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
Other industrial cleaning	kt solvent	1.5	1.5	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	

4.5.2.6 Dry cleaning (2D3f)

Methodology (2D3f)

Based on the decision tree Fig. 3.1 in chapter 2D3f in the EMEP/EEA guidebook (EMEP/EEA 2023), the NMVOC emissions from 2D3f Dry cleaning are calculated by a Tier 2 method (EMIS 2026/2D3f) using country-specific emission factors.

Emission factors (2D3f)

Emission factors for NMVOC are estimated based on information from the emission control authority and analysis of about 170 VKTS inspection protocols from the four biggest Swiss cantons (AG, BE, VD and ZH) of 2017 as documented in the EMIS database.

Table 4-37 Emission factors of 2D3f Dry cleaning in 2024.

2D3f Dry cleaning	Unit of activity data	NMVOC
		g/...
Dry cleaning	kg solvent	900

Activity data (2D3f)

For dry cleaning, activity data are the amount of tetrachloroethylene (PER) and non-halogenated solvents used. The activity data from 2001 onwards have been calculated based on the (annual) number of dry-cleaning facilities in Switzerland according to VKTS and FSO (business census) and the mean solvent consumption per facility based on an analysis of about 170 VKTS inspection protocols from the four biggest Swiss cantons (AG, BE, VD and ZH) of 2017. Activity data for 1990 are based on net imports of PER. For the years in between, data are interpolated linearly.

Table 4-38 Activity data of 2D3f Dry cleaning.

2D3f Dry cleaning	Unit	1990	1995	2000	2005	2010						
Dry cleaning	kt solvent	1.3	0.77	0.23	0.097	0.081						
2D3f Dry cleaning	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
Dry cleaning	kt solvent	0.071	0.071	0.070	0.070	0.069	0.069	0.068	0.068	0.067	0.067	

4.5.2.7 Chemical products (2D3g)

Methodology (2D3g)

Based on the decision tree Fig. 3.1 in chapter 2D3g in the EMEP/EEA guidebook (EMEP/EEA 2023, for source category 2D3g Chemical products a Tier 2 method using country-specific emission factors is used for calculating the NMVOC emissions (EMIS 2026/2D3g).

Although asphalt roofing materials are produced in Switzerland, there is no bitumen blowing. According to information from both manufacturers, all bitumen (including very small amounts of oxidized bitumen) used to produce polymer-bitumen sealing sheeting is imported. The emissions from the coating machines of the production of polymer-bitumen sheeting and the thinner production are reported in source category 2D3c Asphalt roofing.

Note: The data for the chemical industry and plastics processing are currently being updated.

Emission factors (2D3g)

Emission factors for NMVOC in the period 1990 to approximately 2010 were mainly provided by industry associations, i.e. for

- fine chemicals production, pharmaceutical production and handling and storing of solvents: Swiss business association for the chemical, pharmaceutical and biotech industry (scienceindustries)
- paint and ink production: Swiss association for coating and paint applications (VSLF) and the Swiss Organisation for the Solvent Recovery of Industrial Enterprises in the Packaging Sector (SOLV)
- polyurethane processing: Swiss plastics association
- polyester processing: Swiss polyester association
- tanning of leather (ceased production in 2015): Swiss leather tanning association.

For the period from around 2010 and the other processes in source category 2D3g, data are based on information from individual industrial companies (e.g. ink and paint production), surveys of VOC balances (e.g. ink production), emission control authorities (e.g. polystyrene processing) and expert estimates as documented in the EMIS database.

Table 4-39 Emission factors of 2D3g Chemical products in 2024.

2D3g Chemical products	Unit of activity data	NMVOC
		g/...
Fine chemicals production	production index	3'311'667
Glue production	kg glue	0.51
Handling and storing of solvents	production index	1'500'000
Ink production	kg ink	5.0
PVC processing	kg PVC	4.0
Paint production	kg paint	3.0
Pharmaceutical production	kg pharmaceuticals	6.9
Polyester processing	kg polyester	70
Polystyrene processing	kg polystyrene	31
Polyurethane processing	kg polyurethane	3.0
Production of adhesive tape	kg adhesive tape	NO
Rubber processing	tyres	140
Tanning of leather materials	employees	NO

Activity data (2D3g)

The activity data are mainly production or consumption data provided by the Swiss Federal Office of Statistics, Swiss foreign trade statistics and industry associations, i.e. for

- fine chemicals production and handling and storing of solvents: Swiss Federal Office of Statistics
- pharmaceutical production: Swiss business association for the chemical, pharmaceutical and biotech industry (scienceindustries)

- paint and ink production: Swiss association for coating and paint applications (VSLF) and Swiss Organisation for the Solvent Recovery of Industrial Enterprises in the Packaging Sector (SOLV)
- polyurethane processing: Swiss plastics association
- polyester processing: Swiss polyester association
- polystyrene processing: Swiss foreign trade statistics (annual net import figures)
- tanning of leather: Swiss leather tanning association.

In addition, and for the other processes in source category 2D3g, data are based on information from individual industrial companies and expert estimates as documented in the EMIS database. Activity data on handling and storage of solvents, production of fine chemicals and pharmaceuticals as well as production of inks, are extrapolated on the basis of the Swiss Energy Perspectives 2050+ (Prognos/INFRAS/TEP/Ecoplan 2020) from 2012 and 2017, respectively, onwards. Since 1994 no production of adhesive tape is occurring in Switzerland anymore. The last Swiss tannery ceased production in 2015.

Table 4-40 Activity data of 2D3g Chemical products.

2D3g Chemical products	Unit	1990	1995	2000	2005	2010						
Fine chemicals production	production index	70	100	163	224	314						
Glue production	kt glue	19	39	58	72	82						
Handling and storing of solvents	production index	70	100	163	224	314						
Ink production	kt ink	20	29	36	55	65						
PVC processing	kt PVC	94	94	78	64	52						
Paint production	kt paint	88	78	72	77	78						
Pharmaceutical production	kt pharmaceuticals	16	21	20	28	30						
Polyester processing	kt polyester	11	7.0	6.5	6.9	3.4						
Polystyrene processing	kt polystyrene	20	19	19	24	35						
Polyurethane processing	kt polyurethane	17	35	45	54	54						
Production of adhesive tape	kt adhesive tape	1.5	NO	NO	NO	NO						
Rubber processing	tyres	120'000	119'375	103'667	67'000	77'500						
Tanning of leather materials	employees	110	108	102	88	65						

2D3g Chemical products	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Fine chemicals production	production index	291	289	287	285	282	280	278	276	274	272
Glue production	kt glue	97	99	102	105	106	107	108	109	109	110
Handling and storing of solvents	production index	291	289	287	285	282	280	278	276	274	272
Ink production	kt ink	43	35	35	36	36	36	36	37	37	37
PVC processing	kt PVC	36	35	34	32	31	30	30	30	30	30
Paint production	kt paint	63	60	60	60	60	60	60	60	60	60
Pharmaceutical production	kt pharmaceuticals	29	29	29	29	28	28	28	28	27	27
Polyester processing	kt polyester	3.5	3.5	3.4	3.4	3.3	3.3	3.3	3.4	3.4	3.4
Polystyrene processing	kt polystyrene	27	23	24	22	23	23	24	24	25	25
Polyurethane processing	kt polyurethane	37	37	36	36	35	35	35	35	35	35
Production of adhesive tape	kt adhesive tape	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Rubber processing	tyres	83'000	84'000	85'000	86'000	87'000	88'000	88'533	89'067	89'600	90'133
Tanning of leather materials	employees	11	NO	NO	NO	NO	NO	NO	NO	NO	NO

4.5.2.8 Printing (2D3h)

Methodology (2D3h)

The source category 2D3h Printing is differentiated into package printing and other printing industry. Based on the decision tree Fig. 3.1 in chapter 2D3g in the EMEP/EEA guidebook (EMEP/EEA 2023), a Tier 2 method using country-specific emission factors is used for calculating the NMVOC emissions from the ink applications (EMIS 2026/2D3h).

Emission factors (2D3h)

Emission factors for NMVOC are based on data from industry associations (Swiss Organisation for the Solvent Recovery of Industrial Enterprises in the Packaging Sector (SOLV), Swiss organisation for the print and media industry (viscom)), surveys on the VOC balances, emission control authorities, German studies on NMVOC emissions from solvent use (Theloke 2005) and expert estimates, as documented in the EMIS database. For

packaging printing, emission factors are derived for the years 1990, 1998, 2001, 2004, 2007, 2010, 2013 and 2016 whereas for the other printing processes for 1990, 1998, 2001, 2013 and 2016.

Table 4-41 Emission factors of 2D3h Printing in 2024.

2D3h Printing	Unit of activity data	NMVOC
		g/...
Other printing	kg ink	280
Package printing	kg ink	130

Activity data (2D3h)

The activity data correspond to the consumption of printing ink. These data stem from industry associations (SOLV, viscom), surveys on the VOC balances, Swiss Federal Office of Statistics, emission control authorities and expert estimates, documented in the EMIS database. For packaging printing, activity data are available for the years 1990, 1998, 2001, 2004, 2007, 2010, 2013 and 2016 whereas for the other printing processes for 1990, 1998, 2001, 2005, 2008, 2013 and 2016. From 2017 onwards, they are extrapolated based on the Swiss Energy Perspectives 2050+ (Prognos/INFRAS/TEP/Ecoplan 2020).

Table 4-42 Activity data of 2D3h Printing (ink consumption).

2D3h Printing	Unit	1990	1995	2000	2005	2010					
Other printing	kt ink	13	13	14	12	8.3					
Package printing	kt ink	5.9	5.9	5.5	9.1	13					
2D3h Printing	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Other printing	kt ink	7.7	7.5	7.5	7.4	7.4	7.3	7.3	7.2	7.2	7.1
Package printing	kt ink	13	13	13	13	13	13	13	12	12	12

4.5.2.9 Other solvent use (2D3i)

Methodology (2D3i)

Source category 2D3i Other solvent use consists of a number of solvent uses in various production processes and services. Based on the decision tree Fig. 3.1 in chapter 2D3i in the EMEP/EEA guidebook (EMEP/EEA 2023), a Tier 2 method using country-specific emission factors is applied for calculating the NMVOC emissions from the different solvent applications in source category 2D3i Other solvent use (EMIS 2026/2D3i). For the source category 2D3i Not-attributable solvent emissions, so-called direct emission data is available only.

Emission factors (2D3i)

Emission factors for NMVOC are based on data from industry and services, industry associations, retail trade, German studies on NMVOC emissions from solvent use (Theloke et al. 2000 and Theloke 2005), VOC balances and expert estimates, as documented in the EMIS database.

Table 4-43 Emission factors of 2D3i Other solvent use in 2024.

2D3i Other solvent use	Unit of activity data	NMVOG
		g/...
Fat, edible and non-edible oil extraction	kg oil and grease	NO
Production of cosmetics	employees	62'000
Production of flavours and fragrances	employees	30'000
Production of paper and paperboard	kg paper	0.013
Production of textiles	kg solvent	182
Production of tobacco	employees	12'000
Removal of paint and lacquer	kg removal agent	350
Scientific laboratories	employees	15'000
Vehicle dewaxing	vehicles	NO

Activity data (2D3i)

For some production processes and services – such as production of perfume and flavour and scientific laboratories – the activity data correspond to the number of employees in the respective industrial sectors (FSO 2025d). The quantity of NMVOG emission per employee originates from the bottom-up approach in these industrial sectors and the decentralised political structure in Switzerland. The determined NMVOG emissions of representative production sites or service institutions are referred to the number of employees in order to calculate the Swiss total.

For production of paper and paperboard and fat, edible and non-edible oil extraction, the activity data are based on production volumes. Annual production volumes of paper and paperboard are provided by the Swiss association of pulp, paper and paperboard industry (ZPK) and the Swiss association of paper, cardboard and foil manufacturers (SPKF) for the years 1997 – 2011 and from 2016 onwards, respectively. For production of textiles, the activity data is the solvent consumption based on VOC balances and industry data. For the removal of paint and lacquer, the activity data correspond to the amount of removal agent based on information from producers and retail trade.

Table 4-44 Activity data of 2D3i Other solvent use.

2D3i Other solvent use	Unit	1990	1995	2000	2005	2010						
Fat, edible and non-edible oil extraction	kt oil and grease	40	38	12	NO	NO						
Production of cosmetics	employees	2'200	2'200	2'267	2'100	2'100						
Production of flavours and fragrances	employees	2'200	2'325	2'567	3'200	3'475						
Production of paper and paperboard	kt paper	1'510	1'560	1'780	1'750	1'540						
Production of textiles	kt solvent	0.60	0.50	0.40	0.29	0.19						
Production of tobacco	employees	3'300	2'988	2'733	2'700	3'200						
Removal of paint and lacquer	kt removal agent	0.70	0.60	0.50	0.40	0.31						
Scientific laboratories	employees	10'194	18'604	23'217	23'000	23'000						
Vehicle dewaxing	vehicles	200'000	166'250	72'667	NO	NO						
2D3i Other solvent use	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
Fat, edible and non-edible oil extraction	kt oil and grease	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
Production of cosmetics	employees	2'100	2'100	2'100	2'100	2'100	2'100	2'100	2'100	2'100	2'100	
Production of flavours and fragrances	employees	3'220	3'150	3'080	3'010	2'940	2'870	2'800	2'800	2'800	2'800	
Production of paper and paperboard	kt paper	1'393	1'396	1'362	1'056	1'034	967	1'024	1'035	1'047	1'059	
Production of textiles	kt solvent	0.21	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.21	
Production of tobacco	employees	3'200	3'200	3'200	3'200	3'200	3'200	3'200	3'200	3'200	3'200	
Removal of paint and lacquer	kt removal agent	0.21	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	
Scientific laboratories	employees	23'333	23'417	23'500	23'583	23'667	23'750	23'833	23'917	24'000	24'083	
Vehicle dewaxing	vehicles	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	

4.5.3 Category-specific recalculations in 2D3 Other solvent use

The following recalculations were implemented in submission 2026:

- 2D3a: The population figure for 2022 was revised resulting in a recalculation of the activity data in 2D3a Domestic solvent use in 2022.

- 2D3b: The last year's extrapolated production volume of mixed goods for 2023 was replaced by the actual production figure reported by the industry association yielding revised activity data for 2D3b Road paving with asphalt in 2023.
- 2D3c: Due to the adjustment of the projections period from 2025–2050 to 2030–2050, the linearly interpolated activity data for the years 2012-2023 of asphalt roofing changed.
- 2D3g: Due to the adjustment of the projections period from 2025–2050 to 2030–2050, the linearly interpolated activity data for the years 2012-2023 of pharmaceuticals production, fine chemicals production and handling and storage of solvents changed as well as of ink production for 2017-2023.
- 2D3h: Due to the adjustment of the projections period from 2025–2050 to 2030–2050, the linearly interpolated activity data for the years 2017-2023 of package printing and other printing changed.
- 2D3i: Due to the adjustment of the projections period from 2025–2050 to 2030–2050, the linearly interpolated activity data for the years 2022-2023 of production of paper and paperboard changed.

4.6 Source category 2G – Other product use

4.6.1 Source category description of 2G Other product use

Source category 2G Other product use includes about 20 sources releasing NMVOC. In addition, there are also emissions of NO_x, SO_x, NH₃, particulate matter, BC, CO, Pb, Cd, Hg, PCDD/PCDF and PAH from use of fireworks and tobacco as well as from renovation of corrosion inhibiting coatings.

Table 4-45 Specification of source category 2G Other product use in Switzerland.

2G	Source category	Specification
2G	Other product use	Use of spray cans in industry (commercial insecticide application only), antifreeze agents in vehicles, concrete additives, cooling and other lubricants, pesticides, tobacco and fireworks; car underbody sealant; de-icing of airplanes and airport surfaces (ceased in 2011); glass and mineral wool enduction; application of glues and adhesives; house cleaning industry/craft/services; hairdressers; cosmetic institutions; preservation of wood; medical practitioners; other health care institutions; other use of gases; renovation of corrosion inhibiting coatings

Table 4-46 Key categories, approaches 1 and 2, level assessment 2024 (L1, L2) and trend assessment 1990-2024 (T1, T2) for source category 2G Other product use.

NFR code	Source category	Pollutant	Identification criteria
2G	Other product use	NMVOC	L1, L2, T2
2G	Other product use	PM2.5	L1, L2, T1, T2
2G	Other product use	PM10	L1, L2, T1, T2

4.6.2 Methodological issues of 2G Other product use

4.6.2.1 Other product use (2G)

General comment:

In the past, the data collection of the about 50 processes of solvent and product use (source categories 2D3 and 2G) were carried out for the years 1990, 1998 and then at three-years intervals until 2013 for both NMVOC emission factors and activity data. Depending on the available years of the background data (e.g., data from industry associations, employment statistics), these years were preferably used for deriving emission factors and activity data. For activity data based directly on (annual) statistics, all available data is used in the inventory. As a rule of inventory, the values of emission factors and activity data of all years in-between – also between the last survey year and the projected year – are linearly interpolated. In the past, the main data sources for commercial and industrial solvent and product use stem from industry associations. Unfortunately, the availability and quality of the data as well as the technical expertise within the associations have changed over the years. For this reason, the solvent and product use processes have no longer been updated all together since 2016, but as part of a long-term project which started in 2017. This enables a much more thorough and comprehensive, often iterative approach based on different data sets. Thematic priorities are also set, e. g. all paint and coating applications and productions including printing processes (2D3d, 2D3g, 2D3h). On the basis of the thorough new surveys, the values and bases of previous surveys are also evaluated and revised if necessary. If previous values appear implausible or incorrect and cannot be adjusted because data and information are no longer available, they were partially deleted and linearly interpolated over longer periods accordingly.

Methodology (2G)

Within source category 2G Other product use, the major NMVOC emission sources in 2024 are 2G Commercial and industrial use of cleaning agents and 2G Health care, other.

Based on the decision tree Fig. 3.1 in chapter 2G in the EMEP/EEA guidebook (EMEP/EEA 2023), for source category 2G Other product use Tier 2 methods using country-specific emission factors are applied for calculating the emissions from the different product applications and the use of fireworks and tobacco (EMIS 2026/2G).

For the source categories 2G Renovation of corrosion inhibiting coatings and 2G Use of aerosol cans in commerce and industry so-called direct emission data is available only. An in-depth discussion with a long-standing expert from the largest contract manufacturer in Switzerland revealed that the aerosol in many spray applications has the function of both propellant and solvent, and a clear distinction is usually not even possible or meaningful. Therefore, the aerosol emissions from the use of spray cans, except for a residual batch of commercial insecticide application, were integrated into the respective application sources, e.g. the use of spray cans in the field of industry and technical products and automotive without paints into 2D3e Degreasing and the disinfectant sprays in 2G Health care other and 2G Medical practices.

Emission factors (2G)

Emission factors for NMVOC are based on data from individual industrial companies, services and Swiss airports, industry associations, survey on co-formulants in pesticides, German studies on NMVOC emissions from solvent use (Theloke et al. 2000 and Theloke 2005), VOC balances, post-combustion plants, statistics (aerosol) and expert estimates, as documented in the EMIS database.

Table 4-47 Emission factors of 2G Other product use in 2024.

2G Other product use	Unit of activity data	NMVOG
		g/...
Application of glues and adhesives	kg solvent	387
Commercial and industrial use of cleaning agents	employees	400
Cosmetic institutions	employees	27'500
De-icing of airplanes	kg de-icing agent	54
De-icing of airport surfaces	kg de-icing agent	NO
Glass wool enduction	t glass wool	133
Hairdressers	employees	2'100
Health care other	employees	9'100
Medical practices	employees	8'200
Preservation of wood	kg paint	30
Rock wool enduction	t rock wool	C
Use of antifreeze agents in vehicles	Mio veh. km	8'000
Underseal treatment and conservation of vehicles	kg underseal agent	450
Use of concrete additives	kg additive	0.74
Use of cooling lubricants	kg cooling lubricant	6.0
Use of lubricants	kg lubricant	120
Use of pesticides	kg pesticides	116
Use of tobacco	Mio cigarette eq.	4'840

Emission factors for pollutants other than NMVOG from 2G Use of fireworks and tobacco and 2G Glass wool enduction (EMIS 2026/2G) are displayed in Table 4-48. Emission factors of fireworks are documented in FOEN (2014p). Emission factors for use of tobacco are according to the EMEP/EEA guidebook (EMEP/EEA 2023, chp. 2.D.3.i, 2.G, table 3-15) with the following exceptions: The emission factors for Cd and Pb are country-specific estimates based on an averaged measured Pb and Cd content in cigarettes representative for Europe (Watanabe 1987, Caruso 2013, Piadé 2014, Armendáriz 2015). They are assumed to remain constant over time due to globally sourced and therefore chemically homogenous tobacco leaves. Table 4-48 shows product-specific emission factors for glass wool production. For glass wool enduction, the NH₃ emission factor is based on various air pollution control measurements under the Ordinance on Air Pollution Control and partly on information from industry.

Table 4-48 Emission factors of all pollutants other than NMVOG from 2G Other product use in 2024.

2G Other product use	Unit of activity data	NOx	SOx	NH ₃	PM _{2.5} ex	PM ₁₀ ex	TSP ex	BC ex	CO
		g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
Fireworks	kg fireworks	0.26	4.1	NA	90	180	180	NE	7.4
Glass wool enduction	t glass wool	NA	NA	775	NA	NA	NA	NA	NA
Use of tobacco	Mio cigarette eq.	1'800	NE	4'150	27'000	27'000	27'000	122	55'100

2G Other product use	Unit of activity data	Pb	Cd	Hg	PCDD/ PCDF	BaP	BbF	BkF	lcdP
		mg/...	mg/...	mg/...	ng I- Teq/...	mg/...	mg/...	mg/...	mg/...
Fireworks	kg fireworks	130	3.0	0.10	NE	NE	NE	NE	NE
Glass wool enduction	t glass wool	NA	NA	NA	NA	NA	NA	NA	NA
Use of tobacco	Mio cigarette eq.	800	970	NE	100	111	45	45	45

Activity data (2G)

For the production processes, such as enduction of glass and rock wool and part of the applications in services or agriculture, such as preservation of wood, pesticides and application of glues and adhesives the activity data are based on production volume or employed agents. For the other part of applications in services, such as house cleaning in services, commerce and industry and medical practices the activity data correspond to the

respective number of employees. The quantity of NMVOC emission per employee originates from the bottom-up approach in these service sectors and the decentralised political structure in Switzerland. The determined NMVOC emissions of representative production sites or service institutions are referenced to the number of employees in order to calculate the Swiss total.

The activity data stem from individual industrial companies, services, Swiss airports (since 2011 no VOC-containing agents are used for de-icing of airport surfaces anymore), industry associations, Swiss Federal Statistical Office, Swiss Federal Office for Agriculture (sales statistics of pesticides), VOC balances, foreign trade statistics and expert estimates. They are documented in the EMIS database. Activity data for annual tobacco consumption and the annual firework sales are provided by the Swiss addiction prevention foundation (“Sucht Schweiz”) and the statistics of the Swiss federal office for police (FEDPOL 2025), respectively. Activity data for concrete additives are extrapolated from 2017 onwards, based on the Swiss Energy Perspectives 2050+ (Prognos/INFRAS/TEP/Ecoplan 2020).

Table 4-49 Activity data of 2G Other product use.

2G Other product use	Unit	1990	1995	2000	2005	2010
Application of glues and adhesives	kt solvent	4.8	4.0	3.2	2.7	2.5
Commercial and industrial use of cleaning agents	employees	3'950'000	3'867'500	3'954'667	4'133'667	4'404'000
Cosmetic institutions	employees	2'600	3'100	3'533	3'800	4'800
De-icing of airplanes	kt de-icing agent	1.2	2.4	1.8	2.5	3.3
De-icing of airport surfaces	kt de-icing agent	0.34	0.39	0.32	0.41	0.018
Fireworks	kt fireworks	0.84	1.0	1.5	1.4	1.7
Glass wool enduction	kt glass wool	24	24	31	37	36
Hairdressers	employees	20'553	22'826	23'530	22'200	26'761
Health care other	employees	113'000	129'250	145'667	161'667	163'000
Medical practices	employees	27'625	42'047	50'833	55'357	58'700
Preservation of wood	kt paint	4.8	6.5	7.8	6.6	0.97
Rock wool enduction	kt rock wool	C	C	C	C	C
Use of antifreeze agents in vehicles	Mio veh. km	47'523	46'479	51'142	53'723	57'039
Underseal treatment and conservation of vehicles	kt underseal agent	0.060	0.060	0.076	0.12	0.16
Use of concrete additives	kt additive	24	25	29	36	41
Use of cooling lubricants	kt cooling lubricant	5.0	5.2	5.8	7.8	7.0
Use of lubricants	kt lubricant	1.3	1.3	1.3	4.4	2.4
Use of pesticides	kt pesticides	2.4	2.4	2.3	2.3	2.1
Use of tobacco	Mio cigarette eq.	16'192	15'774	15'328	13'256	12'360

2G Other product use	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Application of glues and adhesives	kt solvent	2.4	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Commercial and industrial use of cleaning agents	employees	4'280'000	4'324'000	4'368'000	4'412'000	4'456'000	4'500'000	4'500'000	4'500'000	4'500'000	4'500'000
Cosmetic institutions	employees	5'444	5'556	5'667	5'778	5'889	6'000	6'100	6'200	6'300	6'400
De-icing of airplanes	kt de-icing agent	2.3	2.3	2.3	2.4	2.4	2.4	2.5	2.5	2.5	2.6
De-icing of airport surfaces	kt de-icing agent	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Fireworks	kt fireworks	1.6	1.2	1.7	1.8	1.0	1.0	1.5	1.9	0.80	1.4
Glass wool enduction	kt glass wool	31	32	36	40	47	40	47	45	37	31
Hairdressers	employees	29'854	30'109	30'075	30'170	30'610	30'270	30'519	30'767	31'016	31'265
Health care other	employees	163'000	163'000	163'000	163'000	163'000	163'000	163'000	163'000	163'000	163'000
Medical practices	employees	58'700	58'700	58'700	58'700	58'700	58'700	58'700	58'700	58'700	58'700
Preservation of wood	kt paint	0.62	0.68	0.70	0.49	0.60	0.60	0.60	0.60	0.60	0.60
Rock wool enduction	kt rock wool	C	C	C	C	C	C	C	C	C	C
Use of antifreeze agents in vehicles	Mio veh. km	61'881	62'260	62'638	63'017	63'395	63'774	64'259	64'744	65'229	65'714
Underseal treatment and conservation of vehicles	kt underseal agent	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Use of concrete additives	kt additive	39	39	39	40	40	40	40	40	40	40
Use of cooling lubricants	kt cooling lubricant	7.5	7.7	7.8	8.0	8.1	8.1	8.2	8.2	8.2	8.2
Use of lubricants	kt lubricant	1.6	1.7	1.7	1.7	1.8	1.8	1.8	1.8	1.8	1.8
Use of pesticides	kt pesticides	2.2	2.2	2.0	2.1	2.1	2.2	2.2	2.2	2.2	2.2
Use of tobacco	Mio cigarette eq.	10'284	10'702	10'702	10'318	10'030	10'510	10'222	9'742	9'455	9'263

4.6.3 Category-specific recalculations in 2G Other product use

The following recalculations were implemented in submission 2026:

- 2G: Due to the adjustment of the projections period from 2025–2050 to 2030–2050, the linearly interpolated activity data for the years 2021-2023 of use of concrete additives changed.
- 2G Use of tobacco: The activity data were adapted for the years 1997-2023 due to changes in the underlying statistics by the FSO. The difference was less than 0.1 %.

4.7 Source categories 2H – Other industry production

4.7.1 Source category description of 2H Other industry production

Table 4-50 Specification of source category 2H Other industry production in Switzerland.

2H	Source category	Specification
2H1	Pulp and paper industry	Production of fibreboards, chipboards and cellulose (ceased in 2008)
2H2	Food and beverages industry	Production of beer, spirits, red and white wine, bread, sugar, smoked and roasted meat and flour mills
2H3	Other industrial processes	Blasting and shooting

Table 4-51 Key categories, approaches 1 and 2, level assessment 2024 (L1, L2) and trend assessment 1990-2024 (T1, T2) for source category 2H Other industry production.

NFR code	Source category	Pollutant	Identification criteria
2H1	Pulp and paper industry	PM2.5	L1, L2, T1, T2
2H2	Food and beverages industry	NMVOC	L2, T1, T2
2H2	Food and beverages industry	PM2.5	L1, L2, T1, T2
2H2	Food and beverages industry	PM10	L1, L2, T2

4.7.2 Methodological issues of 2H Other industry production

4.7.2.1 Pulp and paper industry (2H1)

Methodology (2H1)

Today, the production of chipboard and fibreboard are the relevant industrial processes in the source category 2H1 Pulp and paper industry. In Switzerland, chipboard and fibreboard were produced in one and two plants, respectively, until 2019. Since 2020 only one plant is left. The cellulose production was closed in 2008 and is not occurring anymore in Switzerland.

Based on the decision tree Fig. 3.1 in chapter 2H1 in the EMEP/EEA guidebook (EMEP/EEA 2023), the emissions are calculated by a Tier 2 method using country-specific emission factors (EMIS 2026/2H1).

Emission factors (2H1)

Emission factors are based on measurements of the chipboard production plant whereas constant emission factors are assumed for the fibreboard production, documented in the EMIS database. They are confidential but available to reviewers on request.

Table 4-52 Emission factors for 2H1 Pulp and paper industry in 2024.

2H1 Pulp and paper industry	Unit of activity data	NOx	NMVOC	SOx	PM2.5 nx	PM10 nx	TSP nx	BC nx	CO	PCDD/PCDF
		g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...	ng I-Teq/...
Cellulose production	t cellulose	NO	NO	NO	NO	NO	NO	NO	NO	NO
Chipboard production	t chipboard	NE	C	NE	C	C	C	NE	NE	C
Fibreboard production	t fibreboard	NE	C	NE	C	C	C	NE	NE	NA

Activity data (2H1)

Activity data on annual chipboard production have been provided by the industry since 2005 and between 1990 and 2003 annual data are based on the annual statistics on forest and wood (SFSO/BUWAL 2004) as documented in the EMIS database.

Activity data on annual fibreboard production are provided by monitoring reports of the industry since 1996 as documented in the EMIS database.

Due to the production structure in Switzerland, i.e. one production site for cellulose (ceased in 2008), one for chipboard and two for fibreboard (one ceased in 2019), activity data have been confidential since 2020. Detailed data can be accessed by reviewers on request.

Table 4-53 Activity data of 2H1 Pulp and paper industry.

2H1 Pulp and paper industry	Unit	1990	1995	2000	2005	2010						
Cellulose production	kt cellulose	121	134	133	118	NO						
Chipboard production	kt chipboard	C	C	C	C	C						
Fibreboard production	kt fibreboard	51	121	192	263	297						
2H1 Pulp and paper industry	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
Cellulose production	kt cellulose	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
Chipboard production	kt chipboard	C	C	C	C	C	C	C	C	C	C	
Fibreboard production	kt fibreboard	243	243	231	240	182	C	C	C	C	C	

4.7.2.2 Food and beverages industry (2H2)

Methodology (2H2)

Based on the decision tree in Fig. 3-1 in chapter 2H2 in the EMEP/EEA guidebook (EMEP/EEA 2023), the emissions from the source category 2H2 Food and beverages industry, are calculated by a Tier 2 method using both default and country-specific emission factors (EMIS 2026/2H2).

Emission factors (2H2)

Emission factors are based on measurements, industry data, expert estimates, data from a study on emissions of volatile organic compounds (VOCs) from the food and drink industries in the European Community (Passant et al., 1993), and data from the EMEP/EEA guidebook (EMEP/EEA 2023), as documented in the EMIS database. For bread production, the emission factor is derived from the arithmetic mean of several measurement campaigns conducted at major Swiss bread producers, as documented in the EMIS database (EMIS 2026/2H2 Brot Produktion). For red and white wine production, the emission factor for NMVOC was taken from the EMEP/EEA guidebook (EMEP/EEA 2023).

Table 4-54 Emission factors for the 2H2 Food and beverages industry in 2024.

2H2 Food and beverages industry	Unit of activity data	NMVOc	NH3	PM2.5 ex	PM2.5 nx	PM10 ex	PM10 nx
		g/...	g/...	g/...	g/...	g/...	g/...
Bread production	t bread	2'900	NA	NA	NA	NA	NA
Breweries	m3 beer	250	NA	NA	NA	NA	NA
Meat smokehouses	t meat	1'300	NA	350	NA	350	NA
Milling companies	t flour	NA	NA	NA	50	NA	100
Roasting facilities	t coffee	30	NA	NA	30	NA	60
Spirits production	m3 alcohol	10'000	NA	NA	NA	NA	NA
Sugar production	t sugar	195	228	NA	260	NA	520
Wine production: Red wine	m3 red wine	810	NA	NA	NA	NA	NA
Wine production: White wine	m3 white wine	340	NA	NA	NA	NA	NA

2H2 Food and beverages industry	Unit of activity data	TSP ex	TSP nx	BC ex	CO	PCDD/ PCDF
		g/...	g/...	g/...	g/...	ng l- Teq/...
Bread production	t bread	NA	NA	NA	NA	NA
Breweries	m3 beer	NA	NA	NA	NA	NA
Meat smokehouses	t meat	350	NA	NA	250	3'000
Milling companies	t flour	NA	160	NA	NA	NA
Roasting facilities	t coffee	NA	60	NA	NA	NA
Spirits production	m3 alcohol	NA	NA	NA	NA	NA
Sugar production	t sugar	NA	600	NA	NA	NA
Wine production: Red wine	m3 red wine	NA	NA	NA	NA	NA
Wine production: White wine	m3 white wine	NA	NA	NA	NA	NA

Activity data (2H2)

Activity data on the annual production of breweries, roasting facilities, and spirits were provided by the Federal Office for Customs and Border Security (FOCBS). Information on red and white wine production was provided by the Swiss Federal Office for Agriculture (FOAG). Data on cereal production and meat smokehouses were provided by the Federal Statistical Office (FSO). Activity data on annual bread production were derived from the number of inhabitants (FSO 2025c) and annual per capita bread consumption provided by the Swiss bread statistics (Schweizerische Brotinformation, SBI 2010) for the years 1990-2010. For 2014 and 2015, the value from the National Nutrition Survey menuCH (Nationale Ernährungserhebung menuCH 2014/2015, menuCH 2014) was used. For 2017, per capita bread consumption was provided by the Federal Food Safety and Veterinary Office (FSVO) in the Swiss Nutrition Strategy 2017-2024 (Schweizer Ernährungsstrategie, SES 2017).

Table 4-55 Activity data of the 2H2 Food and beverages industry.

2H2 Food and beverages industry	Unit	1990	1995	2000	2005	2010						
Bread production	kt bread	352	344	366	353	386						
Breweries	m3 beer	414'300	367'100	354'100	341'600	353'800						
Meat smokehouses	kt meat	66	64	60	61	67						
Milling companies	kt flour	1'641	1'529	1'603	1'425	1'602						
Roasting facilities	kt coffee	56	50	58	78	102						
Spirits production	m3 alcohol	4'158	3'271	2'179	2'266	1'945						
Sugar production	kt sugar	147	129	219	197	241						
Wine production: Red wine	m3 red wine	52'671	52'940	60'579	52'228	53'335						
Wine production: White wine	m3 white wine	78'975	65'145	66'944	47'868	49'699						
2H2 Food and beverages industry	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
Bread production	kt bread	348	359	370	373	376	378	381	384	389	395	
Breweries	m3 beer	342'700	341'900	346'300	365'900	367'500	340'400	338'200	368'600	359'600	352'900	
Meat smokehouses	kt meat	68	68	68	68	67	68	69	68	65	66	
Milling companies	kt flour	1'645	1'663	1'626	1'665	1'685	1'650	1'705	1'791	1'656	1'656	
Roasting facilities	kt coffee	125	127	131	141	148	161	172	177	161	182	
Spirits production	m3 alcohol	1'636	1'211	1'010	961	1'624	1'223	1'233	743	1'067	931	
Sugar production	kt sugar	261	240	299	246	273	226	199	223	206	213	
Wine production: Red wine	m3 red wine	45'444	55'032	38'972	57'080	48'191	42'109	29'281	49'373	50'060	36'225	
Wine production: White wine	m3 white wine	39'601	52'642	40'207	54'074	49'753	41'314	31'622	49'860	50'894	38'927	

4.7.2.3 Other industrial processes (2H3)

Methodology (2H3)

Source category 2H3 Other industrial processes encompasses the emissions from blasting and shooting only. An analogous Tier 2 method with country-specific emission factors is used to calculate the emissions.

Emission factors (2H3)

Emission factors per tonne of explosive are derived from the emission factors of civil explosives and information on the specific consumption of explosives in the quarries as documented in the Handbook on emission factors for stationary sources (SAEFL 2000) and the EMIS database. They are assumed to be constant over the entire time period.

Table 4-56 Emission factors for 2H3 Other industrial processes in 2024.

2H3 Other industrial processes	Unit of activity data	NOx	NMVOc	SOx	NH3	PM2.5 ex	PM10 ex	TSP ex	BC ex	CO	Pb
		g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...	mg/...
Blasting and shooting	kg explosive	35	60	0.50	0.40	6.0	6.0	6.0	NE	310	0.010

Activity data (2H3)

Activity data for blasting and shooting are taken from federal statistics on explosives (FEDPOL 2025a).

Table 4-57 Activity data of 2H3 Other industrial processes.

2H3 Other industrial processes	Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Blasting and shooting	kt explosive	2.6	1.3	1.9	0.79	2.4	2.1	0.67	0.73	0.81	0.67	0.63	0.61	0.65	0.65	0.89

4.7.3 Category-specific recalculations in 2H Other

The following recalculations were implemented in submission 2026:

- 2H2 Bread production: The activity data for the years 1990-2018, 2020, 2022 and 2023 were adapted due to a change in the underlying statistics. The difference ranged from - 8.9 to 5.0 %.
- 2H2 Meat smokehouses: The activity data for the years 1990-2023 were adjusted due to changes in the underlying statistics by the FSO. The difference ranged from -4.0 to 1.6 %.
- 2H2 Milling companies: The activity data for the years 1990-2023 were adjusted due to changes in the underlying statistics by the FOAG. The difference ranged from -1.1 to 3.5 %.
- 2H2 Roasting facilities: The activity data for the years 1990-2023 were adjusted due to changes in the underlying statistics by the FOCBS. The difference was less than 0.1 %.
- 2H2 Spirits production: The activity data for the years 1990-2005, 2007-2014, 2016, 2017 and 2019-2023 were adapted due to a change in the underlying statistics by FOCBS. The difference was below 1 %.
- 2H2 Sugar production: The activity data for the years 2004-2012 were adjusted due to changes in the underlying statistics. The difference was less than 0.1 %.

- 2H2 Wine production: The activity data were divided into white and red wine based on the data available by the FOAG. The emission factor for NMVOC was changed from a weighted mean to the value from the guidebook and is constant across the entire time series.
- 2H3 Blasting and shooting: The activity data for the years 1991-2023 were adapted due to changes in the underlying statistics by the FEDPOL. The difference was less than 1 %.

4.8 Source categories 2I – Wood processing, 2K – Consumption of POPs and heavy metals and 2L – Other production, consumption, storage, transportation or handling of bulk products

4.8.1 Source category description of 2I Wood processing, 2K Consumption of POPs and heavy metals and 2L Other production, consumption, storage, transportation or handling of bulk products

Table 4-58 Specification of source category 2I Wood processing, 2K Consumption of POPs and heavy metals and 2L Other production, consumption, storage, transportation or handling of bulk products in Switzerland.

2I, 2K, 2L	Source category	Specification
2I	Wood processing	Wood processing
2K	Consumption of POPs and heavy metals	Emissions of PCBs from usage of PCBs in transformers, large and small capacitors, anti-corrosive paints and joint sealants as well as from demolition/renovation of PCB containing anti-corrosive paints and joint-sealants
2L	Other production, consumption, storage, transportation or handling of bulk products	Ammonia emissions from freezers (filling and storage)

Table 4-59 Key categories, approaches 1 and 2, level assessment 2024 (L1, L2) and trend assessment 1990-2024 (T1, T2) for source category 2I Wood processing, 2K Consumption of POPs and heavy metals and 2L Other production, consumption, storage, transportation or handling of bulk products.

NFR code	Source category	Pollutant	Identification criteria
2I	Wood processing	PM2.5	L2
2I	Wood processing	PM10	L2, T2

4.8.2 Methodological issues of 2I Wood processing, 2K Consumption of POPs and heavy metals and 2L Other production, consumption, storage, transportation or handling of bulk products

4.8.2.1 Wood processing (2I)

Methodology (2I)

Source category 2I includes particulate emissions of wood processing. Emissions from charcoal production are reported in 1A1c Manufacture of solid fuels and other energy industries. According to chapter 2I in the EMEP/EEA guidebook (EMEP/EEA 2023), the

calculation of emissions is based on a Tier 1 method based on country-specific emission factors (EMIS 2026/2I Holzbearbeitung).

Emission factors (2I)

Emission factors of wood processing are based on an industry survey (EMPA 2004b).

Table 4-60 Emission factors for 2I Wood processing in 2024.

2I Wood processing	Unit of activity data	PM2.5 nx	PM10 nx	TSP nx
		g/...	g/...	g/...
Wood processing	t sawnwood	74	294	735

Activity data (2I)

Activity data of wood processing are the annual amount of sawnwood based on the yearbook forest and wood (FOEN 2025f).

Table 4-61 Activity data of 2I Wood processing.

2I Wood processing	Unit	1990	1995	2000	2005	2010					
Wood processing	kt sawnwood	1'168	827	901	853	774					
2I Wood processing	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Wood processing	kt sawnwood	626	622	578	597	598	623	664	666	638	639

4.8.2.2 Usage of PCBs (2K)

Methodology (2K)

Source category 2K includes PCB emissions from use of polychlorinated biphenyls (PCBs) in transformers, small and large capacitors, anti-corrosive paints and joint sealants in Switzerland between 1946 and 1986. In 1986, a total ban was placed on any form of PCB use. The use in so-called open systems, i.e. anti-corrosive paints and joint sealants, was allowed until 1972 only. For the time being, anti-corrosive paints and joint sealants are the predominant PCB emission sources. Emissions from demolition/renovation of steel constructions and buildings containing PCBs in anti-corrosive paints and joint sealants, respectively, are also reported in source category 2K.

A dynamic mass flow model was developed for the usage of PCBs in Switzerland for the time period 1930 to 2100 (Glüge et al. 2017). The model considers the entire life cycle, i.e. import, usage, export, treatment, disposal and accidental release of PCBs. A description of the model is given in Annex A2.2.

The emissions are calculated by multiplying the annual mass of PCBs involved in a source (e.g. tonnes of PCBs in use in joint sealants) with a source-specific emission factor (e.g. tonnes of PCBs emitted/tonnes of PCBs in use). This country-specific approach corresponds to a Tier 2 method according to the EMEP/EEA guidebook (EMEP/EEA 2023).

Emission factors (2K)

The PCB emission factors from the use of PCBs in transformers, small and large capacitors, anti-corrosive paints and joint sealants are expressed in units per tonnes of PCBs available in the respective application, see Table 4-62. The PCB emission factors for

demolition/renovation of steel constructions and buildings containing PCBs in anti-corrosive paints and joint sealants are expressed in units per tonnes of PCBs demolished or renovated.

Table 4-62 Emission factors for 2K Usage of PCBs in 2024.

2K Consumption of POPs and heavy metals	Unit of activity data	PCB
		mg/...
Anti-corrosive paints	g PCB	2.5
Demolition and renovation	g PCB	2.5
Joint sealants	g PCB	2.5
Large capacitors	g PCB	0.47
Small capacitors	g PCB	0.47
Transformers	g PCB	0.0022

Activity data (2K)

The five usage categories are PCB stocks, which means that PCBs are stored in these applications and passed on through the system with a temporal delay (lifetime). In these cases, the activity data are the amounts of PCBs stored in the stock. The treatment category demolition and renovation is an instantaneous category. In this case, the activity data corresponds to the amount of PCBs treated in the respective year.

Table 4-63 Activity data for 2K Usage of PCBs.

2K Consumption of POPs and heavy metals	Unit	1990	1995	2000	2005	2010						
Anti-corrosive paints	t PCB	209	196	178	156	128						
Demolition and renovation	t PCB	2.4	4.0	6.2	8.5	10						
Joint sealants	t PCB	209	196	178	156	129						
Large capacitors	t PCB	356	235	139	73	33						
Small capacitors	t PCB	361	213	108	47	17						
Transformers	t PCB	1'257	840	501	265	123						
2K Consumption of POPs and heavy metals	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
Anti-corrosive paints	t PCB	98	92	86	80	73	68	62	56	51	46	
Demolition and renovation	t PCB	11	11	11	11	11	11	10	10	9.7	9.2	
Joint sealants	t PCB	98	92	86	80	73	68	62	56	51	46	
Large capacitors	t PCB	13	11	9.0	7.3	5.8	4.7	3.7	2.9	2.3	1.8	
Small capacitors	t PCB	5.2	4.0	3.1	2.4	1.8	1.3	1.0	0.75	0.56	0.41	
Transformers	t PCB	50	41	33	27	22	18	14	11	8.7	6.9	

4.8.2.3 Use of ammonia as cooling agent (2L)

Methodology (2L)

Ammonia is used as a cooling agent in various applications in the industry and services sector. The most important sources are ice rinks and cold storage facilities. Other relevant sources are breweries, power plants and chemical industries. An analogous Tier 2 method with country-specific emission factors is used to calculate the emissions.

Emission factors (2L)

Emission factors are expressed as share of losses from storage and from filling and recovery. Emission factors are based on expert judgement as documented in the EMIS database (EMIS 2026/2 F_2 L_NH3 aus Kühlenanlagen). Emission factors are assumed constant over the entire time period (see Table 4-64).

Industrial processes and product use: Source categories 2I – Wood processing, 2K – Consumption of POPs and heavy metals and 2L – Other production, consumption, storage, transportation or handling of bulk products - Methodological issues of 2I Wood processing, 2K Consumption of POPs and heavy metals and 2L Other production, consumption, storage, transportation or handling of bulk products

Table 4-64 Emission factors for 2L Ammonia in freezers in 2024.

2L Other	Unit of activity data	NH3
		g/...
Freezers filling	t ammonia	1'000
Freezers storage	t ammonia	2'000

Activity data (2L)

Activity data are based on data from the industry. They are calculated by multiplying the number of plants and installations that use ammonia for cooling by an average amount of ammonia consumed by the corresponding process. This includes the number of breweries, ice rinks, power plants, cold storage facilities, chemical industries, large scale heat pumps and air conditioners. Data on average ammonia consumption of each of these processes is provided by a Swiss company for cooling devices (EMIS 2026/2 F_2 L_NH3 aus Kühlanlagen) (see Table 4-65).

Table 4-65 Activity data of 2L Ammonia in freezers.

2L Other	Unit	1990	1995	2000	2005	2010						
Freezers filling	kt ammonia	0.18	0.20	0.22	0.24	0.27						
Freezers storage	kt ammonia	1.1	1.1	1.2	1.2	1.2						
2L Other	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
Freezers filling	kt ammonia	0.29	0.29	0.29	0.29	0.29	0.30	0.30	0.30	0.30	0.30	
Freezers storage	kt ammonia	1.6	1.6	1.6	1.6	1.6	1.7	1.7	1.7	1.7	1.7	

4.8.3 Category-specific recalculations in 2I Wood processing, 2K Consumption of POPs and heavy metals and 2L Other production, consumption, storage, transportation or handling of bulk products

There were no recalculations implemented in submission 2026.

5 Agriculture

5.1 Overview of emissions

This introductory chapter contains an overview of emissions from sector 3 Agriculture. NO_x, NMVOC, NH₃, PM2.5, PM10 and TSP are the reported air pollutants for this sector.

The following source categories are reported:

- 3B Manure management
- 3D Agricultural soils

Note that emissions from burning of agricultural residues is reported in sector Waste (chp. 6.4, category 5C Waste incineration and open burning of waste), since there is no field burning of crop residues, as this is prohibited in Switzerland. Even in case of diseases the fruit trees are felled, cut up and burned on piles. This usually occurs on the field, but after chopping and stacking (not as standing trees).

5.1.1 Overview and trend for NO_x

NO_x emissions from agriculture are of minor importance for the national total NO_x emissions (see Table 2-8). They show a decreasing trend over the whole period 1990-2024 (see Figure 5-1 and Table 5-1). The trend was more pronounced between 1990 and 2004, and since then continues on a lower level with some fluctuations. Main source is category 3D Agricultural soils, where 3Da2a Animal manure applied to soils is the most relevant emission source. Accordingly, the development of NO_x emissions in category 3D depends on the development of livestock numbers and thus N excretions (Kupper et al. 2026) with a similar pattern as overall NO_x emissions from the agriculture sector. The decrease in inorganic N-fertiliser use (3Da1) additionally contributed to the reduction of NO_x emissions (Kupper et al. 2026).

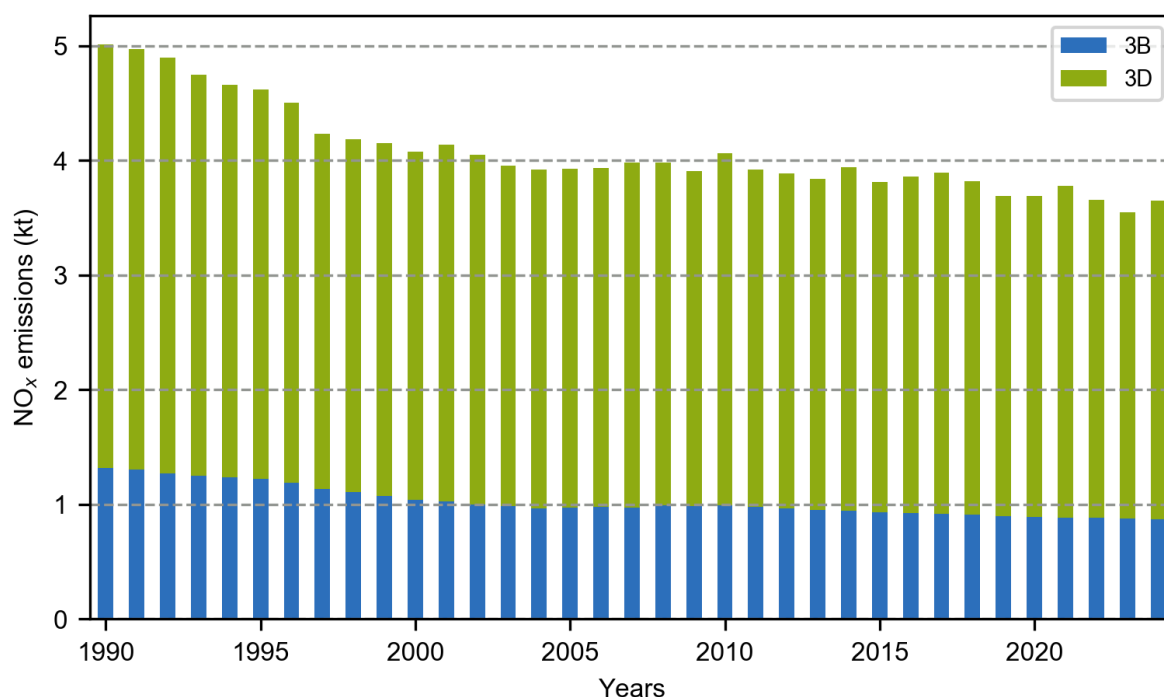


Figure 5-1 Switzerland's NO_x emissions from agriculture by source categories 3B and 3D. The corresponding data can be found in Table 5-1.

Table 5-1 NO_x emissions from Sector 3 Agriculture by source categories 3B and 3D. The last column in the third part of the table indicates the relative trend.

NO _x		1990	1995	2000	2005	2010
3B	kt	1.3	1.2	1.0	0.97	0.99
3D	kt	3.7	3.4	3.0	3.0	3.1
Sum	kt	5.0	4.6	4.1	3.9	4.1

NO _x		2015	2016	2017	2018	2019
3B	kt	0.93	0.92	0.92	0.91	0.90
3D	kt	2.9	2.9	3.0	2.9	2.8
Sum	kt	3.8	3.9	3.9	3.8	3.7

NO _x		2020	2021	2022	2023	2024	2005-2024 (%)
3B	kt	0.89	0.88	0.88	0.88	0.87	-11
3D	kt	2.8	2.9	2.8	2.7	2.8	-6.0
Sum	kt	3.7	3.8	3.7	3.5	3.6	-7.1

5.1.2 Overview and trend for NMVOC

NMVOC emissions from animal husbandry are the main reason why the emissions from sector agriculture provide a significant contribution to the national total of NMVOC emissions (see Table 2-9). The trend of NMVOC emissions within agriculture is depicted in Figure 5-2 and Table 5-2. The emissions are dominated by source category 3B Manure management, where emissions stem from cattle husbandry fed by silage, as dominant emission source. Emissions were stable between 1990 and 2000, before an increasing trend started between 2000 and 2008 due to a significant increase in the number of non-dairy cattle which predominately are fed by silage. Since 2014, the emissions have remained at about constant level.

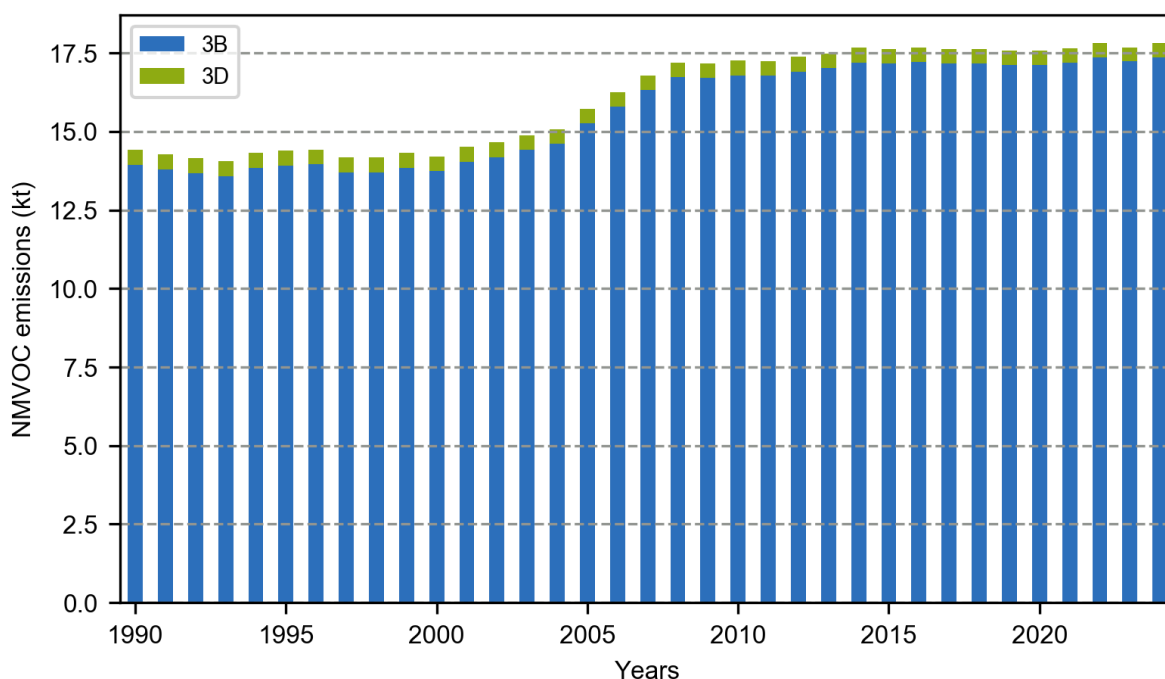


Figure 5-2 Switzerland's NMVOC emissions from agriculture by source categories 3B and 3D. The corresponding data can be found in Table 5-2.

Table 5-2 NMVOC emissions from Sector 3 Agriculture by source category 3B and 3D. The last column in the third part of the table indicates the relative trend.

NMVOC		1990	1995	2000	2005	2010
3B	kt	14	14	14	15	17
3D	kt	0.48	0.48	0.47	0.47	0.46
Sum	kt	14	14	14	16	17

NMVOC		2015	2016	2017	2018	2019
3B	kt	17	17	17	17	17
3D	kt	0.46	0.46	0.46	0.46	0.46
Sum	kt	18	18	18	18	18

NMVOC		2020	2021	2022	2023	2024	2005-2024 (%)
3B	kt	17	17	17	17	17	14
3D	kt	0.46	0.46	0.45	0.45	0.46	-3.2
Sum	kt	18	18	18	18	18	13

5.1.3 Overview and trend for NH₃

Agriculture is by far the most important source of NH₃ emissions in Switzerland (see Table 2-11). The trend of NH₃ emissions within agriculture is depicted in Figure 5-3 and Table 5-3. While source category 3B Manure management declined slightly in the period 1990-2024, category 3D Agricultural soils decreased by almost half. Both categories are about equally important in the year 2024. Agricultural ammonia emissions decreased between 1990 and 2004, followed by a slight increase until 2007 and another decrease since then. This non-monotonic trend results from a combination of changes in animal numbers, introduction of nutrient balance regulations for nitrogen, introduction of new housing systems, increase of animal productivity, changes in production techniques and a considerable decrease of N fertiliser use due to nutrient balance restrictions (Kupper et al. 2015, Kupper et al. 2018, Kupper et al. 2022, Kupper et al. 2026). A further reason for the downward trend of

agricultural NH₃ emissions is the growing importance of grazing due to animal welfare incentives (Kupper et al. 2026).⁵

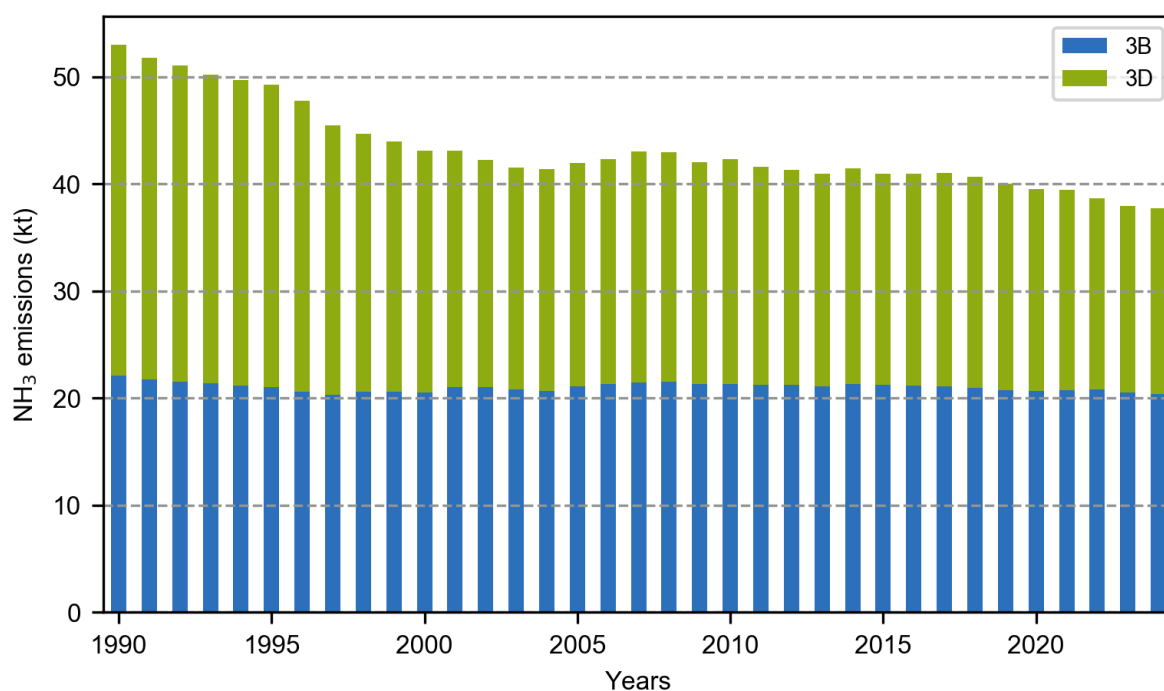


Figure 5-3 Switzerland's NH₃ emissions from agriculture by source categories 3B and 3D. The corresponding data can be found in Table 5-3.

Table 5-3 NH₃ emissions from Sector 3 Agriculture by source categories 3B and 3D. The last column in the third part of the table indicates the relative trend.

NH3		1990	1995	2000	2005	2010
3B	kt	22	21	21	21	21
3D	kt	31	28	23	21	21
Sum	kt	53	49	43	42	42

NH3		2015	2016	2017	2018	2019
3B	kt	21	21	21	21	21
3D	kt	20	20	20	20	19
Sum	kt	41	41	41	41	40

NH3		2020	2021	2022	2023	2024	2005-2024 (%)
3B	kt	21	21	21	21	20	-3.2
3D	kt	19	19	18	17	17	-17
Sum	kt	40	39	39	38	38	-10

5.2 Source category 3B – Manure management

5.2.1 Source category description of 3B Manure management

This chapter contains emissions stemming from animal husbandry. It includes emissions of NO_x and NH₃ from animal manure (except categories 3Da2a Animal manure applied to soils

⁵ There is an error in the 3Da4 emission factor which leads to slightly underestimated 3D and overall NH₃ emissions. See also Annex 8 for further information.

and 3Da3 Urine and dung deposited by grazing animals). Also, NMVOC emissions from animal husbandry are reported in the inventory with silage feeding as important emission source besides manure management. Emissions from physical activities of the animals (PM from abrasion and resuspension of dust) are included in source category 3B as well.

Table 5-4 Specification of source category 3B Manure Management.

3B	Source category	Specification
3B1a	Manure management - Dairy cattle	Mature dairy cattle, water buffalos
3B1b	Manure management - Non-dairy cattle	Other mature cattle and growing cattle: fattening calves, pre-weaned calves, breeding cattle 1st, 2nd, 3rd year, fattening cattle
3B2	Manure management - Sheep	
3B3	Manure management - Swine	Dry sows, nursing sows, boars, fattening pigs, piglets
3B4a	Manure management - Buffalo	IE (included in 3B1a)
3B4d	Manure management - Goats	
3B4e	Manure management - Horses	
3B4f	Manure management - Mules and asses	
3B4gi	Manure management - Laying hens	
3B4gii	Manure management - Broilers	
3B4giii	Manure management - Turkeys	
3B4giv	Manure management - Other poultry	Growers, other poultry (geese, ducks, ostriches, quails)
3B4h	Manure management - Other animals	Camels and llamas (3B4b), deer (3B4c), rabbits (3B4hi), bison (3B4hii)

Table 5-5 Key categories, approaches 1 and 2, level assessment 2024 (L1, L2) and trend assessment 1990-2024 (T1, T2) for source category 3B, Manure Management.

NFR code	Source category	Pollutant	Identification criteria
3B1a	Manure management - Dairy cattle	NMVOC	L1, L2, T1, T2
3B1a	Manure management - Dairy cattle	NH3	L1, L2, T1, T2
3B1b	Manure management - Non-dairy cattle	NMVOC	L1, L2, T1, T2
3B1b	Manure management - Non-dairy cattle	NH3	L1, L2, T1, T2
3B3	Manure management - Swine	NMVOC	L2
3B3	Manure management - Swine	NH3	L1, L2, T1, T2
3B4gi	Manure management - Laying hens	PM10	L2
3B4gii	Manure management - Broilers	NMVOC	L2, T1, T2
3B4gii	Manure management - Broilers	NH3	L2, T2
3B4gii	Manure management - Broilers	PM10	L2, T2

5.2.2 Methodological issues of 3B Manure management

Methodology (3B)

For calculating the ammonia emissions caused by manure management a country-specific approach is used according to the Tier 3 detailed methodology described in chapter 3B Manure management of the EMEP/EEA guidebook (EMEP/EEA 2023).

An internet-based model called AGRAMMON was developed in Switzerland allowing the calculation of ammonia emissions for single farms and for regions (<https://agrammon.ch/>). The model simulates the nitrogen flow from animal feeding to excretion (in housing systems and during grazing), to manure storage and to manure application. In the 2018 revision of the model (Kupper et al. 2018) it was extended to cover not only NH₃ emissions but all nitrogen flows (including N₂O, NO_x and N₂). The AGRAMMON revision in 2025 integrated ALFAM2 v3.10 (Hafner et al. 2025) for calculating emissions during manure spreading.

AGRAMMON considers important parameters on farm and manure management influencing the emissions of ammonia at the different levels of farm management. The Bern University of Applied Sciences, School of Agricultural, Forest and Food Sciences (HAFL) collected data on farm and manure management at farm-level with a detailed representative questionnaire in 2002, 2007, 2010, 2015, 2019 and 2024. Each of the six surveys consisted of a representative stratified random sample covering approximately 2000 to 3000 farms (in total, in 2024 there were about 47'000 farms in Switzerland). The strata cover five different farm types, three regions of Switzerland and three altitude classes (valley zone, hill zone, mountain zone). The questionnaire contained detailed questions on livestock housing, feeding and grazing for different livestock categories, as well as manure storage and spreading, and use of mineral fertiliser. For each farm in the survey, farm-specific emission calculations were done with AGRAMMON. These results were then used to calculate livestock-category specific average emission factors for each strata group and the five respective survey years. For the national extrapolation of the emission data, the weighted average (according to share of the total livestock population of the respective livestock categories) input data on production of the different strata group was used. The emission time series from 2002 to 2024 was established with the calculated emission factors for the years of the six surveys, with interpolated emission factors for the years between, and the known development of the number of animals in different livestock categories (activity data). The experience gained from the detailed surveys and from the extrapolation of the single farm data to the totality of farms in Switzerland was used, together with expert assumptions and available statistical data on farm management, to calculate the emissions between 1990 and 2002. The procedure is described in Kupper et al. (2026).

A comparison of the country-specifically calculated Tier 3 results (using the AGRAMMON version 2018) for N flows and NH₃ emissions from animal husbandry (3B Manure management, 3Da2a Animal manure applied to soils and 3Da3 Urine and dung deposited by grazing animals) with the results of the Tier 2 calculations based on the TFEIP N flow tool was performed for 2015 (at the time the last year with a representative survey on farm management). The comparison and discussion of the results are given in Annex A2.3.

For nitrogen flux calculations, AGRAMMON uses nitrogen excretions of different livestock categories according to the values valid in the respective reference years of the "Principles of Agricultural Crop Fertilisation in Switzerland" (Richner and Sinaj 2017). The values have partly changed over time depending on the development of production technology (especially breeding, feeding) and have been adjusted accordingly (Kupper et al. 2018, Kupper et al. 2022, Kupper et al. 2026), for growing cattle according to Schlegel et al. (2020) and for sheep and goats according to Lazzari and Schlegel (2025a and 2025b). To take into account the varying milk yield level of dairy cattle, a linear correction factor given in Richner and Sinaj (2017) was applied. The TAN proportions in the excreta of the animal categories which are used in AGRAMMON are as follows: Dairy cattle and other cattle categories: 55 %; swine: 70 %; poultry: 60 %; horses and other equids as well as sheep, goats and all other animals are assumed to have 40 % TAN (Kupper et al. 2018, Kupper et al. 2022, Kupper et al. 2026). N-excretion values and the proportion of TAN therein is based on models which employed experimental data obtained from dairy cattle and fattening swine. The proportion of TAN has been extrapolated from the values to the other cattle and swine categories. For poultry, horses and other equids, sheep, goats and other animals it is based on expert judgments. The proportion of TAN is equated with urine N, 'Documentation on the Technical Parameters' in AGRAMMON 2018 describes how the values were derived.

Table 5-6 shows that the share of the total N excretions from all agricultural livestock that went into the slurry flow decreased from 64 % to 54 % from 1990 to 2024. Table 5-7 shows that this was not the case for the N excretions of cattle (all categories together) that remained almost constant around 60 %. This probably was because an increase in grazing – which reduced the share of N collected in the housing area – compensated the increase of the share of N going to slurry in the housing area. The share of total N excretions of all livestock going to pasture, range and paddock (Table 5-6) roughly doubled because of animal welfare incentives and the considerable decrease of pig production. The share going to digesters

increased from 0.6 % to 8.8 % and the share going to deep litter and poultry manure rose from 5.4 % to 9.0 % due to a strong growth of poultry production. The share going to solid manure decreased by nearly half, mainly because of the shift from tied to loose housing systems for cattle. Table 5-8 shows the share of N excretions going to the liquid manure flow (including digesters) for the different livestock categories. The shares strongly increase for the cattle categories. For swine, which produce only liquid manure and for equids (horse, mules and asses), sheep, goats and poultry which produce only solid manure the values logically remained constant.

Table 5-6 Development of the share of the total N excretions from livestock (incl. cattle) going to the paths liquid slurry / solid manure / other (deep litter / poultry manure) / digesters / pasture, range and paddock in Switzerland from 1990 to 2024 (in % of total N excretions). Data based on representative surveys on farm management technique in 2002, 2007, 2010, 2015, 2019 and 2024; for 1990 and 1995 based on expert assumptions (Kupper et al. 2022).

Distribution of N excretion [%]	1990	1995	2002	2007	2010	2015	2019	2024
Liquid / Slurry	63.9%	64.0%	58.8%	59.5%	58.8%	58.9%	55.7%	53.6%
Solid manure	21.4%	20.3%	16.5%	14.0%	13.4%	11.6%	10.8%	10.1%
Other (deep litter, poultry manure)	5.3%	5.1%	5.7%	6.7%	7.6%	7.4%	8.4%	9.0%
Digesters	0.6%	0.5%	0.6%	1.6%	2.3%	4.4%	6.9%	8.8%
Pasture, range and paddock	8.9%	9.9%	18.3%	18.2%	17.9%	17.7%	18.2%	18.6%

Table 5-7 Development of the share of the N excretions from cattle (sum of all three categories) going to the paths liquid slurry / solid manure / other (deep litter) / digesters / pasture, range and paddock in Switzerland from 1990 to 2024 (in % of total N excretions). Data based on representative surveys on farm management technique in 2002, 2007, 2010, 2015, 2019 and 2024; for 1990 and 1995 based on expert assumptions (Kupper et al. 2022).

Distribution of N excretion [%]	1990	1995	2002	2007	2010	2015	2019	2024
Liquid / Slurry	60.5%	61.7%	58.8%	61.6%	61.6%	62.9%	60.8%	59.7%
Solid manure	26.9%	24.7%	18.7%	15.4%	14.5%	12.0%	11.2%	10.2%
Other (deep litter)	1.3%	1.3%	1.3%	1.2%	1.4%	1.2%	1.2%	1.3%
Digesters	0.5%	0.5%	0.6%	1.5%	2.2%	4.1%	6.4%	8.3%
Pasture, range and paddock	10.7%	11.8%	20.6%	20.3%	20.3%	19.8%	20.3%	20.5%

Table 5-8 Development of the share of N excretions going to the liquid phase of manure (including digestate) for the different livestock categories in Switzerland from 1990 to 2024 (in % of total N excretions of the respective category). Data based on representative surveys on farm management techniques in 2002, 2007, 2010, 2015, 2019 and 2024; for 1990 and 1995 based on expert assumptions (Kupper et al. 2022).

% N excretion going to liquid phase	1990	1995	2002	2007	2010	2015	2019	2024
Dairy cattle	66.2%	67.9%	66.0%	69.6%	70.8%	73.6%	74.4%	76.0%
Other mature cattle	41.6%	39.0%	43.8%	55.2%	55.9%	58.5%	55.9%	56.9%
Growing cattle	50.0%	50.5%	46.3%	50.2%	50.9%	54.9%	55.8%	55.8%
Sheep	0%	0%	0%	0%	0%	0%	0%	0%
Swine	100%	100%	98.6%	99.0%	99.4%	99.8%	99.9%	99.7%
Goats	0%	0%	0%	0%	0%	0%	0%	0%
Horses	0%	0%	0%	0%	0%	0%	0%	0%
Mules and asses	0%	0%	0%	0%	0%	0%	0%	0%
Poultry (layers, broilers, turkey, growers)	0%	0%	0%	0%	0%	0%	0%	0%

Additionally, a larger survey – but less detailed with respect to ammonia relevant farm data – was carried out in 2013 by the Swiss Federal Statistical Office at the national level covering a sample of about 17'000 farms. This allowed a plausibility check of the AGRAMMON data, which showed a good compatibility of the resulting national emissions between the two surveys. The difference in overall national emissions was about 1 %, although there were higher differences at the process- or farm-level, but these cancelled each other out (Kupper et al. 2018).

For the volatilisation of NO_x, which is also integrated in the AGRAMMON model, a Tier 2 approach based on emission factors from van Bruggen et al. (2014) was used.

The calculation of non-methane volatile organic compounds (NMVOC) and particulate matter (PM, except for all cattle categories) emissions was conducted with a Tier 1 approach using country specific and default Tier 1 emission factors from the EMEP/EEA guidebook (EMEP/EEA 2023). The PM emissions from all cattle categories (3B1) are calculated by a Tier 2 method using country specific emission factors based on literature data and expert judgement (Bühler and Kupper 2018).

A comprehensive literature study by Bühler and Kupper (2018) has shown that the data base of NMVOC emissions from animal husbandry is very scarce and the derived emission factors differ widely. The studies cited in the EMEP/EEA guidebook at that time (EMEP/EEA 2016, unchanged in EMEP/EEA 2023) showed several inconsistencies that could affect significantly the emission factors. It also remains unknown, how the emissions from the studies performed in the United States were adapted to European agricultural feeding conditions and how the corresponding emission factors were derived. Therefore, a study was conducted between 2018 and 2021 in order to measure NMVOC emissions from dairy cattle with and without silage feeding in an experimental dairy housing during summer, winter and transitional season and to derive emission factors that are representative for cattle husbandry in Switzerland (Zähner et al. 2025). However, it should be noted that the time the animals spend on pasture is not considered in this study and NMVOC emissions are thus probably rather overestimated.

Please note that we are aware that Tier 2 methodologies are in principle required for emission calculations of key categories. But due to lack of data, this was not possible to implement for all categories (e.g. NMVOC (3B) and PM (3B4gii)).

Emission factors (3B)

The consideration of structural and management parameters based on representative stratified surveys on farm management practice for the calculation of the ammonia emissions with the nitrogen flow model AGRAMMON results in livestock category specific emission factors reflecting the changes of such parameters over the assessed time period (Kupper et al. 2015, Kupper et al. 2018, Kupper et al. 2022, Kupper et al. 2026). National standard N excretion rates are used as described under methodology.

For the volatilisation of NO_x , which is also integrated in the AGRAMMON model, default values from van Bruggen et al. (2014) were used. Accordingly, it is estimated that 0.2 %, 0.5 %, 1.0 % and 0.1 % of the total nitrogen in liquid/slurry, solid storage, deep litter and poultry manure systems, respectively, are lost to the atmosphere in the form of NO_x . In this context the management systems “anaerobic digestion” is treated as liquid/slurry system.

The resulting NH_3 and NO_x emission factors for the livestock categories are listed in Table 5-9 and Table 5-10. Each emission factor reflects the sum of the emissions from animal housing and manure storage. The emissions resulting from the application of manure to soils and from grazing are reported separately under category 3Da2a and 3Da3 and are not included in the emission factors listed in Table 5-9 and Table 5-10, but are given in the tables of chp. 5.3.2.

Table 5-9 Time series of NH₃ emission factors for livestock categories (3B4a Buffalos: IE (3B1a)). Note that the emissions from grazing and for the application of manure are not included in these emission factors (see chp. 5.3.2).

NH3 emission factors	unit	1990	1995	2000	2005	2010
3B1a Dairy cattle	kg/animal	10.5	10.8	12.5	13.6	14.0
3B1b Other mature cattle	kg/animal	11.1	12.1	12.7	14.0	13.9
3B1b Growing cattle	kg/animal	4.43	4.62	4.78	4.91	5.09
3B2 Sheep	kg/animal	1.27	1.29	1.10	1.02	1.22
3B3 Swine	kg/animal	3.42	3.49	3.15	2.88	2.58
3B4d Goats	kg/animal	1.73	1.73	1.61	1.44	1.49
3B4e Horses	kg/animal	9.10	9.08	8.31	7.97	8.09
3B4f Mules and asses	kg/animal	3.34	3.34	3.20	2.99	2.90
3B4gi Laying hens	kg/animal	0.317	0.309	0.272	0.261	0.221
3B4gii Broilers	kg/animal	0.0899	0.0854	0.0839	0.0876	0.0795
3B4giii Turkeys	kg/animal	0.315	0.314	0.291	0.300	0.279
3B4giv Other poultry: Growers	kg/animal	0.168	0.156	0.129	0.112	0.0838
3B4giv Other poultry: Other	kg/animal	0.168	0.168	0.165	0.169	0.169
3B4h Rabbits	kg/animal	0.230	0.230	0.230	0.230	0.230
3B4h Bisons	kg/animal	NO	6.76	6.99	6.39	6.26
3B4h Camels and llamas	kg/animal	NO	NO	2.08	1.83	2.02
3B4h Deer	kg/animal	3.40	3.72	3.29	3.12	3.60

NH3 emission factors	unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
3B1a Dairy cattle	kg/animal	14.8	14.9	15.0	15.1	15.2	15.2	15.2	15.2	15.2	15.2
3B1b Other mature cattle	kg/animal	13.9	13.8	13.7	13.6	13.5	13.4	13.4	13.4	13.4	13.4
3B1b Growing cattle	kg/animal	5.28	5.26	5.23	5.21	5.20	5.21	5.22	5.23	5.25	5.26
3B2 Sheep	kg/animal	1.11	1.12	1.14	1.15	1.17	1.13	1.10	1.07	1.03	0.997
3B3 Swine	kg/animal	2.56	2.57	2.56	2.56	2.56	2.54	2.53	2.51	2.49	2.47
3B4d Goats	kg/animal	1.49	1.46	1.43	1.40	1.37	1.38	1.39	1.40	1.41	1.42
3B4e Horses	kg/animal	8.31	8.28	8.25	8.22	8.19	8.19	8.20	8.19	8.18	8.18
3B4f Mules and asses	kg/animal	3.00	3.01	3.02	3.02	3.03	3.05	3.07	3.09	3.10	3.12
3B4gi Laying hens	kg/animal	0.196	0.192	0.187	0.183	0.178	0.174	0.171	0.167	0.163	0.159
3B4gii Broilers	kg/animal	0.0632	0.0634	0.0636	0.0639	0.0641	0.0642	0.0642	0.0643	0.0644	0.0645
3B4giii Turkeys	kg/animal	0.314	0.300	0.287	0.273	0.259	0.258	0.256	0.255	0.253	0.252
3B4giv Other poultry: Growers	kg/animal	0.0761	0.0747	0.0733	0.0719	0.0705	0.0715	0.0724	0.0734	0.0743	0.0753
3B4giv Other poultry: Other	kg/animal	0.167	0.164	0.162	0.160	0.157	0.157	0.157	0.157	0.158	0.158
3B4h Rabbits	kg/animal	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230
3B4h Bisons	kg/animal	6.07	6.09	6.03	7.95	7.79	7.74	7.70	7.70	7.68	7.61
3B4h Camels and llamas	kg/animal	1.82	1.83	1.84	1.85	1.88	1.89	1.89	1.88	1.88	1.86
3B4h Deer	kg/animal	3.29	3.35	3.41	3.47	3.53	3.53	3.54	3.57	3.58	3.58

Table 5-10 Time series of NO_x emission factors for livestock categories (3B4a Buffalos: IE (3B1a)).

NO _x emission factors	unit	1990	1995	2000	2005	2010
3B1a Dairy cattle	g/animal	858	829	773	742	730
3B1b Other mature cattle	g/animal	635	657	558	535	518
3B1b Growing cattle	g/animal	318	317	286	270	274
3B2 Sheep	g/animal	169	171	148	140	167
3B3 Swine	g/animal	94.3	92.1	73.1	62.9	60.8
3B4d Goats	g/animal	236	236	213	203	206
3B4e Horses	g/animal	624	623	569	547	546
3B4f Mules and asses	g/animal	229	229	223	209	202
3B4gi Laying hens	g/animal	2.33	2.33	2.30	2.45	2.56
3B4gii Broilers	g/animal	1.31	1.30	1.29	1.38	1.46
3B4giii Turkeys	g/animal	4.60	4.56	4.35	4.33	4.38
3B4giv Other poultry: Growers	g/animal	1.12	1.11	1.11	1.05	1.01
3B4giv Other poultry: Other	g/animal	1.84	1.84	1.74	1.77	1.75
3B4h Rabbits	g/animal	31.5	31.5	31.5	31.5	31.5
3B4h Bisons	g/animal	NO	908	892	813	799
3B4h Camels and llamas	g/animal	NO	NO	262	224	252
3B4h Deer	g/animal	459	502	415	383	449

NO _x emission factors	unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
3B1a Dairy cattle	g/animal	717	715	713	711	707	705	702	701	699	698
3B1b Other mature cattle	g/animal	498	498	497	497	496	495	495	497	497	498
3B1b Growing cattle	g/animal	260	259	257	256	254	252	250	249	249	247
3B2 Sheep	g/animal	149	150	153	155	157	152	148	145	140	136
3B3 Swine	g/animal	59.8	60.1	59.9	59.8	59.9	59.5	59.3	58.9	58.4	57.9
3B4d Goats	g/animal	210	206	202	198	194	194	195	195	196	196
3B4e Horses	g/animal	565	562	558	555	552	552	553	553	553	553
3B4f Mules and asses	g/animal	205	206	208	210	211	212	213	214	215	216
3B4gi Laying hens	g/animal	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.55	2.55	2.55
3B4gii Broilers	g/animal	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17
3B4giii Turkeys	g/animal	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25
3B4giv Other poultry: Growers	g/animal	0.981	0.980	0.979	0.978	0.977	0.978	0.979	0.980	0.981	0.981
3B4giv Other poultry: Other	g/animal	1.71	1.71	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70
3B4h Rabbits	g/animal	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5
3B4h Bisons	g/animal	777	780	773	1'019	999	990	980	977	972	959
3B4h Camels and llamas	g/animal	229	229	231	233	236	231	224	218	211	202
3B4h Deer	g/animal	413	420	427	435	442	431	420	413	402	391

For all cattle categories country specific NMVOC emission factors are used based on a comprehensive study in which emission measurements were carried out in an experimental dairy housing (Zähler et al. 2025). NMVOC emissions from dairy cattle with and without silage feeding were measured during summer, winter and transitional season. For a representative determination of emissions from silage, measurements were carried out with three different silage rations. Based on these measurements, NMVOC emission factors were derived for dairy cattle with and without silage for the lowlands and mountain area, respectively, see Table 5-11. A distinction was also made between the summer and winter feeding period, as there are clear differences between the proportions of dairy cows with and without silage feeding in the two feeding periods. For silage feeding, emission factors (weighted for feeding periods) of 24.0 kg/animal and 21.9 kg/animal resulted for dairy cattle in the lowlands and the mountain area, respectively. The values are higher than the default Tier 1 emission factor of 17.937 provided in the EMEP/EEA guidebook (EMEP/EEA 2023, chp. 3B Manure management, Table 3.4). It should be noted that the weight of Swiss dairy cattle (660 kg, Richner and Sinaj 2017) is higher than the one of dairy cattle in EMEP/EEA (2023) (600 kg, chp. 3B, Table A1.7). On the other hand, the emission factors without silage feeding (weighted for feeding periods) of 1.1 kg/animal and 0.9 kg/animal for the lowlands and the mountain area, respectively, are considerably lower than the one given in EMEP/EEA (2023) (8.047 kg/animal). For non-dairy cattle the same emission factors are assumed whereas for young cattle categories, the emission factors were scaled with the ratio of the gross energy intake of the respective categories related to the one of dairy cattle. For the calculation of NMVOC emissions, the proportion of animals kept in the lowlands and mountain area as well as their proportion with and without silage feeding were taken into account, see Table 5-12. The proportions are derived from the on-farm surveys on farm and manure management conducted by HAFL (2002, 2007, 2010, 2015 and 2019) in connection with the AGRAMMON model (Kupper and Häni 2022). The relatively high proportion of dairy cattle that is fed without silage in Switzerland is due to the fact that unpasteurised milk is

used for hard cheese production and that farms producing milk for hard cheese production are not allowed to produce and use silage for all cattle. Between 1990 and 2019, the share of dairy cattle receiving silage increased almost continuously, e.g. in the lowlands from 37 % to 61 %. For all livestock categories other than cattle, the NMVOC emission factors are based on default Tier 1 emission factors (EMEP/EEA 2023, chp. 3B Manure management, Table 3.4). As the livestock category swine comprises of five categories, namely boars, dry sows, nursing sows (including suckling piglets), fattening pigs and weaned piglets, the NMVOC emission factor is an implied factor based on the default Tier 1 emission factors for swine (sows) and swine (finishing pigs) and also takes into account the empty periods for fattening pigs. The resulting NMVOC emission factors for cattle categories and swine as well as the default emission factors for all other animal categories are given in Table 5-13.

Table 5-11 NMVOC emission factors of dairy cattle with and without silage feeding derived by Zähler et al. 2025 for the Swiss lowlands and mountain area.

3B1 Dairy cattle	Silage	w/o Silage
NMVOC emission factors	kg/animal	kg/animal
Lowlands, summer feeding	26.5	1.3
Lowlands, winter feeding	20.6	0.8
Lowlands, weighted for feeding periods	24.0	1.1
Mountain area, summer feeding	24.5	1.1
Mountain area, winter feeding	19.3	0.7
Mountain area, weighted for feeding periods	21.9	0.9

Table 5-12 Time series of the share of cattle categories kept in the lowlands as well as of animals receiving silage feeding in the lowlands and mountain area, respectively.

	1990	1995	2000	2005	2010
3B1a Dairy cattle					
Lowlands	62%	61%	60%	60%	60%
Silage feeding, lowlands	37%	41%	45%	53%	56%
Silage feeding, mountain area	30%	31%	33%	38%	39%
3B1b Other mature cattle					
Lowlands	62%	61%	58%	58%	58%
Silage feeding, lowlands	95%	95%	95%	95%	95%
Silage feeding, mountain area	95%	95%	95%	95%	95%
3B1c Growing cattle					
Lowlands	51%	51%	55%	56%	56%
Silage feeding, lowlands	48%	52%	56%	64%	70%
Silage feeding, mountain area	43%	46%	43%	47%	58%

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
3B1a Dairy cattle										
Lowlands	60%	60%	60%	60%	59%	59%	59%	59%	59%	59%
Silage feeding, lowlands	56%	57%	59%	60%	61%	61%	61%	61%	61%	61%
Silage feeding, mountain area	43%	42%	41%	41%	40%	40%	40%	40%	40%	40%
3B1b Other mature cattle										
Lowlands	57%	56%	56%	56%	56%	56%	56%	56%	56%	56%
Silage feeding, lowlands	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%
Silage feeding, mountain area	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%
3B1c Growing cattle										
Lowlands	57%	57%	57%	57%	57%	57%	57%	57%	57%	57%
Silage feeding, lowlands	73%	73%	73%	73%	73%	73%	73%	72%	72%	72%
Silage feeding, mountain area	60%	59%	59%	59%	59%	59%	59%	59%	58%	59%

Table 5-13 Time series of NMVOC emission factors for livestock categories (3B4a Buffalos: IE (3B1a)).

NMVOC emission factors	unit	1990	1995	2000	2005	2010						
3B1a Dairy cattle	kg/animal	8.19	8.84	9.63	11.1	11.7						
3B1b Other mature cattle	kg/animal	22.1	22.0	22.0	22.0	22.0						
3B1b Growing cattle	kg/animal	4.58	4.72	4.60	4.78	5.24						
3B2 Sheep	kg/animal	0.169	0.169	0.169	0.169	0.169						
3B3 Swine	kg/animal	0.573	0.569	0.553	0.551	0.549						
3B4d Goats	kg/animal	0.542	0.542	0.542	0.542	0.542						
3B4e Horses	kg/animal	4.28	4.28	4.28	4.28	4.28						
3B4f Mules and asses	kg/animal	1.47	1.47	1.47	1.47	1.47						
3B4gi Laying hens	kg/animal	0.165	0.165	0.165	0.165	0.165						
3B4gii Broilers	kg/animal	0.108	0.108	0.108	0.108	0.108						
3B4giii Turkeys	kg/animal	0.489	0.489	0.489	0.489	0.489						
3B4giv Other poultry: Growers	kg/animal	0.165	0.165	0.165	0.165	0.165						
3B4giv Other poultry: Other	kg/animal	0.489	0.489	0.489	0.489	0.489						
3B4h Rabbits	kg/animal	0.0590	0.0590	0.0590	0.0590	0.0590						
3B4h Bisons	kg/animal	NO	3.60	3.60	3.60	3.60						
3B4h Camels and llamas	kg/animal	NO	NO	0.271	0.271	0.271						
3B4h Deer	kg/animal	0.0450	0.0450	0.0450	0.0450	0.0450						

NMVOC emission factors	unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
3B1a Dairy cattle	kg/animal	12.2	12.2	12.3	12.3	12.4	12.4	12.4	12.4	12.4	12.4
3B1b Other mature cattle	kg/animal	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
3B1b Growing cattle	kg/animal	5.39	5.33	5.31	5.23	5.23	5.20	5.15	5.18	5.10	5.12
3B2 Sheep	kg/animal	0.169	0.169	0.169	0.169	0.169	0.169	0.169	0.169	0.169	0.169
3B3 Swine	kg/animal	0.551	0.551	0.550	0.548	0.548	0.545	0.546	0.547	0.547	0.546
3B4d Goats	kg/animal	0.542	0.542	0.542	0.542	0.542	0.542	0.542	0.542	0.542	0.542
3B4e Horses	kg/animal	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28
3B4f Mules and asses	kg/animal	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47
3B4gi Laying hens	kg/animal	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165
3B4gii Broilers	kg/animal	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108
3B4giii Turkeys	kg/animal	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489
3B4giv Other poultry: Growers	kg/animal	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165
3B4giv Other poultry: Other	kg/animal	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489
3B4h Rabbits	kg/animal	0.0590	0.0590	0.0590	0.0590	0.0590	0.0590	0.0590	0.0590	0.0590	0.0590
3B4h Bisons	kg/animal	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60
3B4h Camels and llamas	kg/animal	0.271	0.271	0.271	0.271	0.271	0.271	0.271	0.271	0.271	0.271
3B4h Deer	kg/animal	0.0450	0.0450	0.0450	0.0450	0.0450	0.0450	0.0450	0.0450	0.0450	0.0450

The particulate matter emission factors (PM_{2.5}, PM₁₀, and TSP) are listed in Table 5-14. They are based on a comprehensive literature study by Bühler and Kupper (2018). The emission factors of all cattle categories were derived from literature data and expert judgment distinguishing loose- and tied-housing systems. For dairy cattle, the emission factors are based on PM₁₀ emission measurements in a loose-housing system in Switzerland (Schrade 2009). For all livestock categories other than cattle, except for fattening pigs (TSP) and sheep and goats (PM_{2.5} and PM₁₀) default Tier 1 emission factors from the EMEP/EEA guidebook (EMEP/EEA 2023, chp. 3B, Table 3.5) are used. For the mentioned exceptions other literature values are assumed. For camels/llamas, deer and bison the same emission factors as for goats are assumed whereas for rabbits the emission factors of fur animals are applied. All these emission factors are kept constant over the entire time series, except for the emission factors of the aggregated category swine. For the animals outside agriculture, i.e. sheep, goats, horses, mules and asses the same emission factors as for the corresponding agricultural animals are applied (see chp. 7.2.2).

Table 5-14 Emission factors of PM2.5, PM10 and TSP for livestock categories (3B4a Buffalos: IE (3B1a)) for the years 1990-2024 (based on measurements in Switzerland, literature data and EMEP/EEA (2023)).

3B Manure management	Unit of activity data	PM2.5 nx	PM10 nx	TSP nx
		g/...	g/...	g/...
3B1a Dairy cattle	animal	43	177	609
3B1b Other mature cattle	animal	22	92	314
3B1b Growing cattle	animal	22	91	313
3B2 Sheep	animal	2.0	50	140
3B3 Swine	animal	4.5	101	438
3B4d Goats	animal	2.0	50	140
3B4e Horses	animal	140	220	480
3B4f Mules and asses	animal	100	160	340
3B4gi Laying hens	animal	3.0	40	190
3B4gii Broilers	animal	2.0	20	40
3B4giii Turkeys	animal	20	110	110
3B4giv Other poultry: Growers	animal	2.0	20	40
3B4giv Other poultry: Other	animal	25	190	190
3B4h Rabbits	animal	4.0	8.0	18
3B4h Bisons	animal	2.0	50	140
3B4h Camels and llamas	animal	2.0	50	140
3B4h Deer	animal	2.0	50	140

Activity data (3B)

The number of animals in the different livestock categories (SBV 2025, FSO 2025a) for the time period 1990 to 2024 is shown in Table 5-15. The figures represent harmonised livestock numbers coming from various sources since 1990. The methodology of the harmonisation, which was a joint effort of the Agroscope Reckenholz Tänikon Research Station (ART) and the Swiss College of Agriculture (SHL) in 2011 for the 1990-2010 time series, is documented in ART/SHL (2012). The livestock category swine comprises the five categories boars, dry sows, nursing sows (including suckling piglets), fattening pigs (> 25 kg) and weaned piglets (up to 25 kg). Because the official livestock census statistics are based on a key date (1st May until 2014, 1st January since 2015), the Federal Office of Statistics provided a dataset with average livestock numbers over the whole year, as suggested by the EMEP/EEA guidebook (EMEP/EEA 2023). Thus, for fattening pigs over 25 kg and broilers also empty periods were considered. Data for horses, mules and asses were derived from background data of the gross nutrient balance of the Swiss Federal Statistical Office (FSO 2025b).

Table 5-15 Time series of animal numbers for livestock categories (in thousand animals, 3B4a Buffalos: IE (3B1a)).

3B Manure management (number of animals)	Unit	1990	1995	2000	2005	2010
3B1a Dairy cattle	1000 animals	783	740	669	621	589
3B1b Other mature cattle	1000 animals	12	23	45	78	111
3B1b Growing cattle	1000 animals	1'060	986	874	856	891
3B2 Sheep	1000 animals	395	387	421	446	434
3B3 Swine	1000 animals	1'965	1'739	1'670	1'744	1'750
3B4d Goats	1000 animals	68	53	62	74	83
3B4e Horses	1000 animals	28	41	50	55	62
3B4f Mules and asses	1000 animals	5.9	7.6	12	16	20
3B4gi Laying hens	1000 animals	3'083	2'118	2'150	2'189	2'438
3B4gii Broilers	1000 animals	3'392	3'637	3'985	5'711	7'184
3B4giii Turkeys	1000 animals	95	170	173	132	58
3B4giv Other poultry: Growers	1000 animals	719	714	832	868	926
3B4giv Other poultry: Other	1000 animals	22	17	21	11	23
3B4h Rabbits	1000 animals	61	41	28	25	35
3B4h Bisons	1000 animals	NO	0.10	0.26	0.37	0.51
3B4h Camels and llamas	1000 animals	NO	NO	1.0	3.1	6.1
3B4h Deer	1000 animals	0.17	1.4	2.8	3.8	5.5

3B Manure management (number of animals)	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
3B1a Dairy cattle	1000 animals	583	576	569	564	555	546	546	543	532	527
3B1b Other mature cattle	1000 animals	118	121	123	125	128	131	135	138	140	147
3B1b Growing cattle	1000 animals	853	859	852	854	842	837	833	845	856	859
3B2 Sheep	1000 animals	395	397	398	403	400	398	398	403	409	408
3B3 Swine	1000 animals	1'605	1'553	1'546	1'501	1'447	1'449	1'470	1'471	1'408	1'367
3B4d Goats	1000 animals	84	85	88	91	92	90	91	92	92	92
3B4e Horses	1000 animals	55	56	56	46	47	47	47	48	48	48
3B4f Mules and asses	1000 animals	20	20	21	34	34	33	33	33	33	33
3B4gi Laying hens	1000 animals	2'822	3'056	3'174	3'371	3'486	3'854	3'867	3'893	3'841	3'777
3B4gii Broilers	1000 animals	8'614	9'064	8'857	9'430	9'593	10'097	10'522	10'724	10'594	11'122
3B4giii Turkeys	1000 animals	49	71	77	84	75	88	83	82	121	88
3B4giv Other poultry: Growers	1000 animals	1'033	959	1'084	1'078	1'242	1'150	1'177	1'300	1'231	1'237
3B4giv Other poultry: Other	1000 animals	23	30	16	20	21	24	25	28	26	28
3B4h Rabbits	1000 animals	25	25	22	22	21	19	17	16	14	10
3B4h Bisons	1000 animals	0.56	0.56	0.57	0.54	0.46	0.46	0.43	0.40	0.38	0.37
3B4h Camels and llamas	1000 animals	6.4	6.5	6.6	6.7	6.6	6.5	6.5	6.7	6.8	7.0
3B4h Deer	1000 animals	6.0	6.0	6.0	6.4	6.6	6.6	6.6	6.7	6.6	6.5

5.2.3 Category-specific recalculations 3B Manure management

The following recalculations were implemented in submission 2026.

- 3B: Activity data for livestock category 3B3 Swine and 3B4gii Broilers were revised due to data update, leading to emission recalculations for 2022 and 2023.
- 3B: Emission factors (NO_x and NH₃) for manure management were recalculated for 1990-2023 due to an update of the AGRAMMON model. Allocation of manure to the different management systems and ammonia volatilisation from manure management were revised for all livestock categories except for 3B4e, 3B4f and 3B4h.
- 3B: The allocation of manure to the different management systems was revised due to updated data on manure digested anaerobically, leading to emission factor recalculations for 1990-2023 (NO_x and NH₃).

5.3 Source category 3D – Agricultural soils

5.3.1 Source category description of 3D Agricultural soils

This chapter contains direct and indirect emissions from agricultural soils, from all fertilisers (mineral (inorganic N-) fertiliser, sewage sludge, compost and other residue fertilisers) and animal manure applied on these soils as well as excretions during grazing.

Note that the application of HCB as a fungicide is prohibited in Switzerland since 1972 and its application as a seed-dressing agent since 1978 (LUBW 1995). Emissions due to potential HCB impurities or by-products in certain pesticides (3Df) are not estimated.

Table 5-16 Specification of source category 3D Agricultural Soils.

3D	Source category	Specification
3Da1	Inorganic N-fertilisers	Application of urea-containing fertilisers and other inorganic fertilisers
3Da2a	Livestock manure applied to soils	Application of livestock manure (incl. digestate from agricultural biogas plants) to soils (dairy cattle, non-dairy cattle, sheep, swine, buffalos, goats, horses, mules/asses, laying hens, broilers, turkeys, growers, other poultry, other animals)
3Da2b	Sewage sludge applied to soils	Application of sewage sludge from centralised wastewater treatment systems to soils (NO after 2009)
3Da2c	Other organic fertilisers applied to soils (including compost)	Application of compost derived from organic residues (incl. liquid and solid digestate from non-agricultural biogas plants) and of human N-excretion from decentralised wastewater treatment systems
3Da3	Urine and dung deposited by grazing livestock	Deposition of urine and dung by grazing livestock
3Da4	Crop residues applied to soils	Crop residues left on soils after harvest
3De	Cultivated crops	For particulate matter emissions: Soil cultivation and crop harvesting (operation of tractors and machinery). For NMVOC emissions: Crop production, differentiated for cropland, grassland and summering pastures

Table 5-17 Key categories, approaches 1 and 2, level assessment 2024 (L1, L2) and trend assessment 1990-2024 (T1, T2) for source category 3D Agricultural Soils.

NFR code	Source category	Pollutant	Identification criteria
3Da1	Inorganic N-fertilizers (includes also urea application)	NO _x	L2, T2
3Da1	Inorganic N-fertilizers (includes also urea application)	NH ₃	L1, L2, T2
3Da2a	Animal manure applied to soils	NO _x	L1, L2, T1, T2
3Da2a	Animal manure applied to soils	NH ₃	L1, L2, T1, T2
3Da2b	Sewage sludge applied to soils	NH ₃	T1
3Da2c	Other organic fertilisers applied to soils (including compost)	NO _x	T2
3Da2c	Other organic fertilisers applied to soils (including compost)	NH ₃	L2, T1, T2
3Da3	Urine and dung deposited by grazing animals	NO _x	T2
3Da3	Urine and dung deposited by grazing animals	NH ₃	L2, T1, T2
3De	Cultivated crops	PM10	L1, L2, T1, T2

5.3.2 Methodological issues of 3D Agricultural soils

Methodology (3D)

The emissions are calculated by Tier 3 (3Da2a, 3Da3 (NH₃)), Tier 2 (3Da1, 3De, 3Da4) and Tier 1 (3Da2b, 3Da2c, 3Da3 (NO_x)) methods based on the decision tree in Fig. 3.1 in chapter 3D Agricultural soils of the EMEP/EEA guidebook (EMEP/EEA 2023).

- 3Da1: For the application of nitrogen containing inorganic fertilisers the Tier 2 method and NH₃ emission factors according to the EMEP/EEA guidebook (EMEP/EEA 2019) were used. In 3Da1 only the agricultural use of inorganic fertilisers is reported, while private use is reported under 6A3.
- 3Da2a: As described in chapter 5.2.2, emissions from livestock manure management are calculated with livestock specific emission factors multiplied by the number of livestock. Both the emission factors for 3B and 3D are generated from stratified samples considering different farm types, regions, height above sea level and application techniques (Tier 3). This category also includes emissions from digestate originating from agricultural biogas plants (at least 80 % of the substrate is livestock manure).
- 3Da2b/3Da2c: NH₃ and NO_x emissions from field application of sewage sludge and compost (including solid and liquid digestate from non-agricultural sources) derived from

organic residues as well as human N-excretion from decentralised wastewater systems are included in this category (Tier 1 except for NH₃ from 3Da2c). For NH₃ emissions from 3Da2c, a Tier 2 method based on Kupper et al. (2026) is used. In Switzerland, the application of sewage sludge as fertiliser is prohibited since 2006 (with some exceptions, it was applied in certain cantons until the end of 2008).

- 3Da3: NH₃ emission from urine and dung deposited by grazing livestock are determined by multiplying animal specific emission factors (see chapter 5.2.2) with the number of animals. For NO_x emissions, the Tier 1 method and emission factors described in the EMEP/EEA guidebook (EMEP/EEA 2023) were used.
- 3Da4: NH₃ emission from crop residues applied to soils are determined by multiplying N-residues on soil surface from more than 3 days with specific emission factors from the model of de Ruijter and Huijsmans (2019), according to the Tier 2 explained in the EMEP/EEA guidebook (EMEP/EEA 2023). Details are described in Kupper et al. (2026).
- 3De: In this source category, NMVOC and particulate matter (PM_{2.5}, PM₁₀ and TSP) emissions from agricultural soils are reported based on a study by Bühler and Kupper (2018). The NMVOC emissions from agricultural soils are estimated with a Tier 2 approach according to the EMEP/EEA guidebook (EMEP/EEA 2016, unchanged in EMEP/EEA 2023) differentiating three agricultural areas, i.e. cropland, grassland and summering pastures. The particulate matter emissions from soil cultivation and crop harvesting originate at the sites at which the tractors and other machinery operate and are thought to consist of a mixture of organic fragments from the crop and soil mineral and organic matter. There is considerable settling of dust close to the sources and washing out of fine particles by large particles. Field operations may also lead to the resuspension of dust that has already settled (reentrainment). For the emission calculation it was differentiated between cropland and grassland.
- Since the publication of the EMEP/EEA guidebook version 2023 (EMEP/EEA 2023), it is recommended to report the activity "Sewage sludge spreading" within 3D instead of 5E. Sewage sludge spreading as a sludge drying process is not occurring in Switzerland, mostly due to restrictions in available space. In Swiss wastewater treatment plants, sewage sludge, after anaerobic digestion and generation of biogas, is stored in sludge tanks and in a first step, chemical and mechanical means are applied to dehydrate the sludge. Of the dehydrated sewage sludge, 70 – 80 % is incinerated in municipal solid waste incineration plants or in dedicated sewage sludge incineration plants. The remaining 20 – 30 % is used as alternative fuel in the cement industry (1A2f). For this purpose, the water content of the sludge has to be reduced to 10 %, which requires thermal drying processes. The thermal drying predominantly occurs in large thermal drying plants equipped with flue gas treatment systems.

Emission factors (3Da)

For fertiliser, default Tier 2 NH₃ emission factors from the EMEP/EEA guidebook (EMEP/EEA 2019, 3D Agricultural soils, Table 3.2) were used for the whole time series. The climate zone for Switzerland is "cool". Based on official fertiliser trade statistics (Agricura 2025) and an assessment of soil pH based on the Swiss agricultural soil use capability map (Frei et al. 1980), 54 % of fertilisers are used on soils with pH > 7.0 and 46 % on soils with pH > 7.0.

NH₃ emission factors for 3Da2c are based on Kupper et al. (2026). The emission factors used were 60 % of TAN for liquid residues and 80 % of TAN for solid residues. NH₃ emission factors for crop residues (3Da4) are derived from the model of de Ruijter and Huijsmans (2019), depending on the N concentration in crop residues.

Table 5-18 shows NH₃ and NO_x emission factors for nitrogen containing fertiliser, sewage sludge and compost applied to soils. For other synthetic N fertilisers, they are weighted mean

factors. A fertiliser-induced emission (FIE) value of 0.55 % from Stehfest and Bouwman (2006) is used for NO_x emission factors, both for mineral and organic fertiliser. This means that 0.0055/14*46 kg NO_x (as NO₂) is emitted per ton of nitrogen applied.

Table 5-18 NH₃ and NO_x emission factors 2024 for nitrogen containing fertiliser.⁶

3Da Direct emissions from managed soils	Unit of activity data	NO _x	NH ₃
		g/...	g/...
3Da1 Other synthetic N-fertiliser	kg N	18	36
3Da1 Urea-containing fertiliser	kg N	18	159
3Da2b Sewage sludge from centralised wastewater systems applied to soils	kg N	NO	NO
3Da2c Human N-excretion from decentr. wastewater systems applied to soils	kg N	18	164
3Da2c Other organic fertilisers applied to soils	kg N	18	154
3Da4 Crop residues applied to soils	kg N	NA	0.075

Emission factors for the application of animal manure are displayed in Table 5-19 and Table 5-20. They are based on the livestock category specific N flow calculations with AGRAMMON (see chapter 5.2.2).

Table 5-19 Time series of NH₃ emission factors for the application of animal manure to soils (3Da2a, Buffalos: IE (Dairy cattle)).

NH ₃ emission factors	unit	1990	1995	2000	2005	2010
3Da2a Dairy Cattle	kg/animal	19.0	18.8	16.4	16.1	15.8
3Da2a Other mature cattle	kg/animal	10.1	9.73	8.41	8.59	9.02
3Da2a Growing cattle	kg/animal	5.00	4.96	4.21	4.01	4.05
3Da2a Sheep	kg/animal	0.226	0.230	0.191	0.203	0.251
3Da2a Swine	kg/animal	1.60	1.53	1.08	0.899	0.846
3Da2a Goats	kg/animal	0.339	0.339	0.259	0.388	0.319
3Da2a Horses	kg/animal	1.80	1.80	1.63	1.58	1.51
3Da2a Mules and asses	kg/animal	0.663	0.663	0.644	0.630	0.663
3Da2a Laying hens	kg/animal	0.0469	0.0495	0.0584	0.0675	0.0811
3Da2a Broilers	kg/animal	0.0563	0.0570	0.0464	0.0477	0.0559
3Da2a Turkey	kg/animal	0.197	0.195	0.175	0.152	0.147
3Da2a Other poultry: Growers	kg/animal	0.0171	0.0211	0.0269	0.0276	0.0314
3Da2a Other poultry: Other	kg/animal	0.0648	0.0648	0.0579	0.0444	0.0638
3Da2a Rabbits	kg/animal	0.0368	0.0368	0.0357	0.0354	0.0353
3Da2a Bisons	kg/animal	NO	0.841	0.834	0.747	0.731
3Da2a Camels and llamas	kg/animal	NO	NO	0.227	0.195	0.225
3Da2a Deer	kg/animal	0.376	0.411	0.359	0.332	0.401

NH ₃ emission factors	unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
3Da2a Dairy Cattle	kg/animal	14.7	14.7	14.7	14.7	14.7	14.2	13.7	13.3	12.8	12.4
3Da2a Other mature cattle	kg/animal	8.47	8.37	8.28	8.18	8.08	7.90	7.72	7.54	7.36	7.18
3Da2a Growing cattle	kg/animal	3.74	3.72	3.71	3.69	3.69	3.55	3.42	3.29	3.16	3.03
3Da2a Sheep	kg/animal	0.200	0.204	0.210	0.213	0.218	0.215	0.212	0.211	0.208	0.206
3Da2a Swine	kg/animal	0.824	0.828	0.827	0.826	0.827	0.812	0.798	0.782	0.765	0.748
3Da2a Goats	kg/animal	0.343	0.344	0.345	0.346	0.347	0.335	0.323	0.311	0.299	0.287
3Da2a Horses	kg/animal	1.64	1.62	1.60	1.57	1.55	1.56	1.57	1.57	1.58	1.59
3Da2a Mules and asses	kg/animal	0.618	0.635	0.652	0.670	0.687	0.681	0.674	0.668	0.662	0.655
3Da2a Laying hens	kg/animal	0.0906	0.0901	0.0896	0.0891	0.0886	0.0882	0.0877	0.0873	0.0868	0.0863
3Da2a Broilers	kg/animal	0.0431	0.0434	0.0436	0.0439	0.0442	0.0435	0.0427	0.0420	0.0413	0.0405
3Da2a Turkey	kg/animal	0.132	0.131	0.130	0.129	0.128	0.127	0.126	0.126	0.125	0.124
3Da2a Other poultry: Growers	kg/animal	0.0352	0.0326	0.0300	0.0273	0.0247	0.0276	0.0305	0.0334	0.0363	0.0392
3Da2a Other poultry: Other	kg/animal	0.0519	0.0520	0.0522	0.0523	0.0525	0.0529	0.0532	0.0536	0.0540	0.0544
3Da2a Rabbits	kg/animal	0.0353	0.0353	0.0353	0.0352	0.0352	0.0352	0.0352	0.0352	0.0352	0.0352
3Da2a Bisons	kg/animal	0.704	0.707	0.700	0.922	0.904	0.899	0.894	0.894	0.892	0.884
3Da2a Camels and llamas	kg/animal	0.200	0.197	0.196	0.194	0.194	0.195	0.195	0.194	0.194	0.191
3Da2a Deer	kg/animal	0.360	0.361	0.362	0.363	0.364	0.364	0.365	0.368	0.369	0.370

⁶ There is an error in the 3Da4 emission factor, correct would be 0.075 g / (g N crop residues). See also Annex 8 for further information.

Table 5-20 Time series of NO_x emission factors for the application of animal manure to soils (3Da2a, Buffalos: IE (Dairy cattle)).

NO _x emission factors	unit	1990	1995	2000	2005	2010
3Da2a Dairy Cattle	g/animal	1'464	1'454	1'372	1'363	1'398
3Da2a Other mature cattle	g/animal	885	870	787	817	850
3Da2a Growing cattle	g/animal	421	420	377	357	366
3Da2a Sheep	g/animal	67.3	68.3	59.0	56.2	67.3
3Da2a Swine	g/animal	202	195	147	125	124
3Da2a Goats	g/animal	95.2	95.2	85.1	82.5	83.2
3Da2a Horses	g/animal	527	526	481	462	460
3Da2a Mules and asses	g/animal	194	194	189	178	171
3Da2a Laying hens	g/animal	7.76	7.86	8.26	9.25	10.4
3Da2a Broilers	g/animal	5.70	5.69	5.68	6.08	6.65
3Da2a Turkey	g/animal	19.9	19.7	18.9	18.7	19.3
3Da2a Other poultry: Growers	g/animal	3.48	3.65	4.05	3.98	4.17
3Da2a Other poultry: Other	g/animal	7.35	7.35	6.85	6.93	6.84
3Da2a Rabbits	g/animal	12.7	12.7	12.7	12.7	12.7
3Da2a Bisons	g/animal	NO	364	352	321	315
3Da2a Camels and llamas	g/animal	NO	NO	103	87.6	99.0
3Da2a Deer	g/animal	184	201	163	149	176

NO _x emission factors	unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
3Da2a Dairy Cattle	g/animal	1'413	1'411	1'410	1'409	1'408	1'410	1'413	1'415	1'418	1'420
3Da2a Other mature cattle	g/animal	852	847	843	838	833	835	838	841	843	846
3Da2a Growing cattle	g/animal	366	364	363	362	362	360	357	354	352	349
3Da2a Sheep	g/animal	59.7	60.1	61.4	62.0	62.7	60.9	59.4	58.1	56.3	54.9
3Da2a Swine	g/animal	122	123	123	122	123	122	121	120	119	118
3Da2a Goats	g/animal	85.3	83.7	82.0	80.4	78.8	78.9	79.0	78.9	79.0	79.2
3Da2a Horses	g/animal	476	473	470	467	464	464	465	465	465	465
3Da2a Mules and asses	g/animal	173	174	176	178	179	180	181	182	182	183
3Da2a Laying hens	g/animal	10.8	10.9	10.9	11.0	11.1	11.1	11.1	11.2	11.2	11.3
3Da2a Broilers	g/animal	5.34	5.33	5.32	5.31	5.30	5.30	5.30	5.30	5.30	5.30
3Da2a Turkey	g/animal	18.1	18.3	18.5	18.7	18.9	18.9	18.9	19.0	19.0	19.0
3Da2a Other poultry: Growers	g/animal	4.11	4.13	4.15	4.16	4.18	4.17	4.16	4.15	4.14	4.13
3Da2a Other poultry: Other	g/animal	6.66	6.69	6.71	6.74	6.76	6.76	6.76	6.76	6.75	6.75
3Da2a Rabbits	g/animal	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7
3Da2a Bisons	g/animal	307	308	306	403	395	391	387	385	383	377
3Da2a Camels and llamas	g/animal	89.9	89.8	90.8	91.3	92.6	89.9	86.6	83.4	80.0	75.9
3Da2a Deer	g/animal	162	165	168	171	174	168	162	158	152	147

In the following, Table 5-21 and Table 5-22 list the emission factors for NH₃ and NO_x for N excretion on pasture and paddock during grazing. They are based on the livestock category specific N flow calculations with AGRAMMON (see chapter 5.2.2). The considerable increase between 1990 and 2010 (e.g. dairy cattle, young cattle (calves), sheep, goats, horses) was a consequence of a strong increase of grazing linked to animal welfare incentives.

Table 5-21 Time series of NH₃ emission factors for N excretion during grazing (3Da3) for different livestock categories (Buffalos: IE: (Dairy cattle)).

NH3 emission factors	unit	1990	1995	2000	2005	2010
3Da3 Dairy cattle	kg/animal	0.470	0.550	0.871	1.03	1.06
3Da3 Other mature cattle	kg/animal	1.39	1.39	1.63	1.48	1.38
3Da3 Growing Cattle	kg/animal	0.288	0.292	0.443	0.467	0.451
3Da3 Sheep	kg/animal	0.134	0.137	0.209	0.227	0.196
3Da3 Swine	kg/animal	NA	NA	0.00356	0.0100	0.00457
3Da3 Goats	kg/animal	0.0688	0.0688	0.127	0.144	0.149
3Da3 Horses	kg/animal	0.338	0.337	0.543	0.630	0.635
3Da3 Mules and asses	kg/animal	0.124	0.124	0.146	0.198	0.224
3Da3 Laying hens	kg/animal	NA	0.00044	0.00294	0.00498	0.00576
3Da3 Broilers	kg/animal	NA	0.00113	0.00171	0.00302	0.00138
3Da3 Turkey	kg/animal	NA	0.00397	0.0224	0.0242	0.0191
3Da3 Other poultry: Growers	kg/animal	NA	0.00021	0.00020	0.00031	0.00060
3Da3 Other poultry: Other	kg/animal	NA	NA	0.00886	0.00653	0.00811
3Da3 Rabbits	kg/animal	NA	NA	NA	NA	NA
3Da3 Bisons	kg/animal	NO	0.660	0.845	0.846	0.792
3Da3 Camels and llamas	kg/animal	NO	NO	0.376	0.359	0.293
3Da3 Deer	kg/animal	0.433	0.474	0.594	0.613	0.521

NH3 emission factors	unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
3Da3 Dairy cattle	kg/animal	1.02	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.02	1.02
3Da3 Other mature cattle	kg/animal	1.38	1.40	1.42	1.44	1.46	1.45	1.44	1.44	1.43	1.42
3Da3 Growing Cattle	kg/animal	0.443	0.442	0.445	0.443	0.442	0.441	0.446	0.447	0.443	0.444
3Da3 Sheep	kg/animal	0.228	0.225	0.224	0.220	0.218	0.225	0.232	0.240	0.247	0.256
3Da3 Swine	kg/animal	0.00146	0.00132	0.00117	0.00102	0.00087	0.00084	0.00081	0.00077	0.00074	0.00070
3Da3 Goats	kg/animal	0.153	0.161	0.168	0.175	0.182	0.182	0.181	0.180	0.179	0.179
3Da3 Horses	kg/animal	0.575	0.587	0.599	0.610	0.624	0.622	0.621	0.621	0.621	0.620
3Da3 Mules and asses	kg/animal	0.215	0.209	0.203	0.196	0.190	0.187	0.183	0.179	0.176	0.172
3Da3 Laying hens	kg/animal	0.00587	0.00589	0.00591	0.00593	0.00594	0.00618	0.00641	0.00665	0.00688	0.00711
3Da3 Broilers	kg/animal	0.00078	0.00092	0.00106	0.00119	0.00133	0.00128	0.00124	0.00119	0.00115	0.00110
3Da3 Turkey	kg/animal	0.0310	0.0310	0.0310	0.0310	0.0310	0.0310	0.0309	0.0309	0.0309	0.0308
3Da3 Other poultry: Growers	kg/animal	0.00045	0.00053	0.00062	0.00070	0.00078	0.00070	0.00062	0.00054	0.00046	0.00038
3Da3 Other poultry: Other	kg/animal	0.0116	0.0118	0.0120	0.0122	0.0124	0.0124	0.0124	0.0124	0.0124	0.0124
3Da3 Rabbits	kg/animal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3Da3 Bisons	kg/animal	0.786	0.779	0.761	0.990	0.958	0.953	0.947	0.947	0.945	0.936
3Da3 Camels and llamas	kg/animal	0.350	0.344	0.340	0.335	0.334	0.336	0.334	0.334	0.333	0.329
3Da3 Deer	kg/animal	0.632	0.631	0.629	0.628	0.626	0.626	0.627	0.632	0.634	0.635

Table 5-22 Time series of NO_x emission factors for N excretion during grazing (3Da3) for different livestock categories (Buffalos: IE (Dairy cattle)).

NO _x emission factors	unit	1990	1995	2000	2005	2010
3Da3 Dairy cattle	g/animal	150	176	280	333	342
3Da3 Other mature cattle	g/animal	455	455	532	482	451
3Da3 Growing Cattle	g/animal	93.9	95.1	145	152	147
3Da3 Sheep	g/animal	40.0	40.9	62.1	67.6	58.5
3Da3 Swine	g/animal	NA	NA	0.379	1.07	0.486
3Da3 Goats	g/animal	20.5	20.5	37.7	43.0	44.3
3Da3 Horses	g/animal	101	100	162	187	189
3Da3 Mules and asses	g/animal	37.0	37.0	43.5	58.9	66.8
3Da3 Laying hens	g/animal	NA	0.0271	0.182	0.309	0.357
3Da3 Broilers	g/animal	NA	0.0703	0.106	0.187	0.0855
3Da3 Turkey	g/animal	NA	0.246	1.39	1.50	1.19
3Da3 Other poultry: Growers	g/animal	NA	0.0130	0.0121	0.0189	0.0373
3Da3 Other poultry: Other	g/animal	NA	NA	0.549	0.405	0.503
3Da3 Rabbits	g/animal	NA	NA	NA	NA	NA
3Da3 Bisons	g/animal	NO	173	251	252	235
3Da3 Camels and llamas	g/animal	NO	NO	110	109	88.2
3Da3 Deer	g/animal	109	120	175	185	157

NO _x emission factors	unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
3Da3 Dairy cattle	g/animal	331	333	334	335	337	335	334	333	332	330
3Da3 Other mature cattle	g/animal	449	456	462	469	476	473	471	468	466	464
3Da3 Growing Cattle	g/animal	144	144	145	144	144	144	145	146	144	145
3Da3 Sheep	g/animal	67.9	66.9	66.6	65.5	64.8	66.9	69.0	71.4	73.5	76.1
3Da3 Swine	g/animal	0.155	0.141	0.125	0.108	0.0927	0.0890	0.0856	0.0819	0.0783	0.0746
3Da3 Goats	g/animal	45.6	47.8	50.0	52.1	54.3	54.1	53.9	53.6	53.3	53.2
3Da3 Horses	g/animal	171	175	178	182	186	185	185	185	185	185
3Da3 Mules and asses	g/animal	63.9	62.1	60.3	58.5	56.7	55.6	54.5	53.4	52.3	51.2
3Da3 Laying hens	g/animal	0.364	0.365	0.366	0.368	0.369	0.383	0.398	0.412	0.427	0.441
3Da3 Broilers	g/animal	0.0486	0.0570	0.0655	0.0739	0.0824	0.0796	0.0768	0.0740	0.0712	0.0684
3Da3 Turkey	g/animal	1.92	1.92	1.92	1.92	1.92	1.92	1.92	1.92	1.91	1.91
3Da3 Other poultry: Growers	g/animal	0.0279	0.0330	0.0382	0.0433	0.0485	0.0435	0.0385	0.0335	0.0285	0.0234
3Da3 Other poultry: Other	g/animal	0.721	0.733	0.745	0.757	0.769	0.769	0.769	0.769	0.769	0.769
3Da3 Rabbits	g/animal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3Da3 Bisons	g/animal	230	228	223	290	281	281	281	283	284	283
3Da3 Camels and llamas	g/animal	104	102	100	98.5	97.5	102	105	108	111	113
3Da3 Deer	g/animal	188	187	186	184	183	190	196	204	211	218

Emission factors (3De)

For the calculation of the NMVOC emissions from 3De Cultivated crops soils three types of agricultural areas are differentiated, i.e. cropland, grassland and summering pastures. The NMVOC emission factors for cropland and grassland are based on the values for wheat and grass (15°C), respectively, of Table 3-4 of the EMEP/EEA guidebook (EMEP/EEA 2023) taking into account country-specific values for the mean dry matter yield (Richner and Sinaj 2017). For summering pastures, the same NMVOC emission value as of grass (15°C) and a fraction of the growing period of 0.3 (Bühler and Kupper 2018) are assumed using a country-specific value for the mean dry matter yield (Richner and Sinaj 2017). The resulting NMVOC emission factors are constant for the entire time series and are given in Table 5-23.

The particulate matter emission factors consist of an operation-specific emission factor for soil cultivation or harvesting and a factor for the annual number of the respective agricultural operation. The crop- and operation-specific emission factors are based on the Tier 2 emission factors for wet conditions of the EMEP/EEA guidebook (EMEP/EEA 2023, chp. 3D, Tables 3-6 and 3-8). The factors for the annual number of agricultural operations are country-specific and are based mainly on expert judgements (Bühler and Kupper 2018). Only for the number of grass harvests literature values are available (Richner and Sinaj 2017) for five different altitude classes. In order to derive the emission factors of the aggregated source categories cropland and grassland, the emissions from the cultivation of each single type of crop and of grassland have to be calculated, summed up and then divided by the total area of the respective crop and grassland types. Since the relative shares of grassland in the valley and the alpine area remain about constant over the entire time period constant (aggregated) emission factors result for grassland.

Unfortunately, the guidebook provides emission factors for PM10 and PM2.5 only. A couple of European countries assume for TSP the same values as of PM10. But this assumption is

not reasonable since particulate matter emissions from soil cultivation and harvesting have a large mass fraction in the coarse fraction. Therefore, the TSP emission factors have been estimated according to the Danish emission inventory (Danish Informative Inventory Report 2018) with a fraction of PM10/TSP of 10 %. The particulate matter emission factors are also given in Table 5-23.

Table 5-23 NMVOC and PM2.5 emission factors of 2024 for 3De Cultivated crops.

3De Cultivated crops	Unit of activity data	NMVOC	PM2.5 nx	PM10 nx	TSP nx
		g/...	g/...	g/...	g/...
3De Cropland	ha cropland	376	40	744	7'443
3De Grassland	ha grassland	397	47	1'100	11'000
3De Summering pastures	ha summering pastures	141	NA	NA	NA

Activity data (3Da)

The nitrogen amount applied with urea-containing and other synthetic fertilisers (SBV 2025, Agricura 2025, AGRAMMON 2018) as well as the amount applied with sewage sludge and compost (including solid and liquid digestate) derived from organic residues are shown in Table 5-24.

Activity data for emissions from N excretion resulting from the application of animal manure to soils (3Da2a) and from grazing (3Da3) are the livestock numbers for source category 3B. Manure management which are given in Table 5-15. The application of sewage sludge to soils has been prohibited (too high heavy metal content), therefore the activity data is NO from 2009 onwards.

The underlying data for compost and digestate (liquid and solid) from non-agricultural biogas plants are based on a study from the year 2017 (Schleiss 2017, covering the period from 1990 to 2015 and subsequent annual update) and on data from the statistics of renewable energies (SFOE 2025a), respectively, see description in chp. 6.3.2. Schleiss (2017) differentiates so-called back yard and industrial composting. The compost applied to soil as fertiliser in agriculture is part of the industrial compost.

Table 5-24 Time series of nitrogen amount applied on agricultural soils: synthetic N-fertilisers (urea-containing and other N-containing synthetic fertilisers), sewage sludge, N-excretion from decentralised wastewater systems, compost (derived from organic residues) and crop residues.

3Da Direct emissions from managed soils	Unit	1990	1995	2000	2005	2010					
3Da1 Other synthetic N-fertiliser	t N	50'390	47'652	43'042	43'478	45'985					
3Da1 Urea-containing fertiliser	t N	16'284	10'707	7'631	6'605	7'101					
3Da2b Sewage sludge from centralised wastewater systems applied to soils	t N	4'815	4'942	3'356	1'054	NO					
3Da2c Human N-excretion from decentr. wastewater systems applied to soils	t N	2'461	1'535	1'096	756	683					
3Da2c Other organic fertilisers applied to soils	t N	817	1'286	1'829	2'169	3'279					
3Da4 Crop residues applied to soils	t N	12'435	13'121	13'029	13'314	13'192					
3Da Direct emissions from managed soils	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
3Da1 Other synthetic N-fertiliser	t N	36'521	37'531	40'113	37'432	32'400	33'694	37'265	31'517	25'539	30'864
3Da1 Urea-containing fertiliser	t N	7'223	8'872	9'250	8'324	7'752	7'397	8'100	6'912	8'182	9'067
3Da2b Sewage sludge from centralised wastewater systems applied to soils	t N	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3Da2c Human N-excretion from decentr. wastewater systems applied to soils	t N	649	650	650	649	647	647	652	657	666	675
3Da2c Other organic fertilisers applied to soils	t N	4'906	5'433	5'539	5'666	6'208	6'354	6'545	6'392	6'803	6'912
3Da4 Crop residues applied to soils	t N	10'607	10'598	10'590	10'581	10'572	10'717	10'862	11'006	11'151	11'296

Table 5-25 Time series of agricultural areas (in ha; cropland, grassland, summering pastures).

3De Cultivated crops	Unit	1990	1995	2000	2005	2010							
3De Cropland	ha cropland	312'398	307'754	289'939	283'003	269'390							
3De Grassland	ha grassland	724'556	735'408	743'756	742'379	741'775							
3De Summering pastures	ha summering pastures	538'683	499'781	497'322	489'245	486'988							
3De Cultivated crops	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024		
3De Cropland	ha cropland	268'449	267'702	268'563	269'701	265'917	267'854	270'043	269'671	267'971	266'484		
3De Grassland	ha grassland	737'403	736'429	732'101	729'044	731'265	728'787	729'460	724'886	725'443	731'762		
3De Summering pastures	ha summering pastures	473'650	471'239	471'252	469'334	467'640	464'386	463'443	460'545	457'574	456'163		

Activity data (3De)

As activity data of source category 3De Cultivated crops two different types of agricultural areas were considered, i.e. cropland and grassland. They consist of aggregated agricultural areas based on the (annual) farm structure survey of the Swiss Federal Statistical Office (FSO 2025i). In addition, for NMVOC emissions also the emissions from summering pastures (FSO 2025b) are included where no agricultural crop operations take place. The activity data of these agricultural areas are also given in Table 5-25. While cropland and grassland are part of the agricultural farms (farmland), summering pastures are alpine land (usually at an altitude of more than 1000-2500 m) which is grazed for around 100 days per year by dairy cows (for mountain cheese production), heifers, sheep and goats.

5.3.3 Category-specific recalculations for 3D Agricultural soils

The following recalculations were implemented in submission 2026.

- 3Da1: The amount of inorganic fertilisers applied in Liechtenstein was updated due to new data. Emissions from other inorganic fertilisers were recalculated for 1990-2023.
- 3Da2a: Activity data for livestock categories swine and broilers were revised due to data update, leading to emission recalculations for 2022 and 2023.
- 3Da2a: The amount of nitrogen input from animal manure was revised due to an update of the AGRAMMON model, which includes the implementation of the ALFAM2 model. This leads to emission recalculations for all livestock categories for 1990-2023.
- 3Da2c: Emissions of NO_x and NH₃ from 3Da2c Application of sludge (human N-excretion) from decentralised wastewater are newly reported for the entire time series, leading to emission recalculations 1990-2023.
- 3Da2c: The amount of nitrogen inputs from recycling fertilisers was revised due to new activity data from SFOE 2025a. Emissions from other organic fertilisers applied to soils were recalculated for 1993-2023.
- 3Da3: Activity data for livestock categories swine and broilers were revised due to data update, leading to emission recalculations for 2022 and 2023.
- 3Da3: Updated N-excretion values for livestock categories growing cattle, sheep, goats and the share of N-excretion going to grazing for all poultry categories lead to emission recalculations for 1990-2023.
- 3Da3: An update of the AGRAMMON model with changes in grazing time periods for poultry categories leads to emission recalculations for 1990-2023.
- 3Da4: NH₃ emissions from 3Da4 Crop residues applied to soils are newly reported for the entire time series, leading to emission recalculations 1990-2023.

5.4 Source category 3F – Field burning of agricultural residuals

Burning of crop residues in fields is prohibited in Switzerland. Only the burning of branches and twigs is allowed under certain conditions. These emissions are reported in source category 5C2 Open burning of agricultural waste.

6 Waste

6.1 Overview of emissions

In this introductory chapter, an overview of emissions, separated according to the most relevant pollutants, is presented. Trends and changes for individual source categories in the period between 1990 and 2024 are analysed and discussed. In absolute figures, processes in sector 5 Waste emit mainly NMVOC and NH₃. The contributions of PM_{2.5}, heavy metals (Pb and Hg) and PCDD/F are smaller in absolute terms, but larger relative to total national emissions.

The following source categories are reported:

- 5A Biological treatment of waste - Solid waste disposal on land
- 5B Biological treatment of waste - Composting and anaerobic digestion
- 5C Waste incineration and open burning of waste
- 5D Wastewater handling
- 5E Other waste

Please note that according to EMEP/EEA guidebook (EMEP/EEA 2023) **all emissions from waste-to-energy, where waste material is used directly as fuel or converted into a fuel, are reported under the sector 1A Fuel combustion**. Therefore, the largest share of waste-related emissions in Switzerland is not reported in sector 5 Waste but in sector 1 Energy.

6.1.1 Overview and trend for NMVOC

Figure 6-1 depicts the NMVOC emissions in the waste related sectors since 1990. A clear and increasing trend of total NMVOC emissions from 2005 to 2024 can be observed. This is mainly explained by the continuous positive trend for category 5B Biological treatment of waste - Composting and anaerobic digestion, which is a key category according to the trend assessment. The contribution of the waste sector still remains small in comparison to the national total. Therefore, there are no source categories from the waste sector that are key categories for NMVOC according to the level assessment.

The main sources of NMVOC emissions are 5B Biological treatment of solid waste and 5C Incineration and open burning of waste. Nowadays the bulk emissions in this sector originate from 5B Biological treatment of solid waste. The reason for this development is the increase in industrial and commercial composting activities, particularly the digestion of organic waste. The latter has become economically more beneficial due to cost covering feed-in tariffs for electricity and due to additional revenues as CO₂ compensation projects. The increase in digested quantities is also linked to population growth. 5A Solid waste disposal shows a decreasing trend.

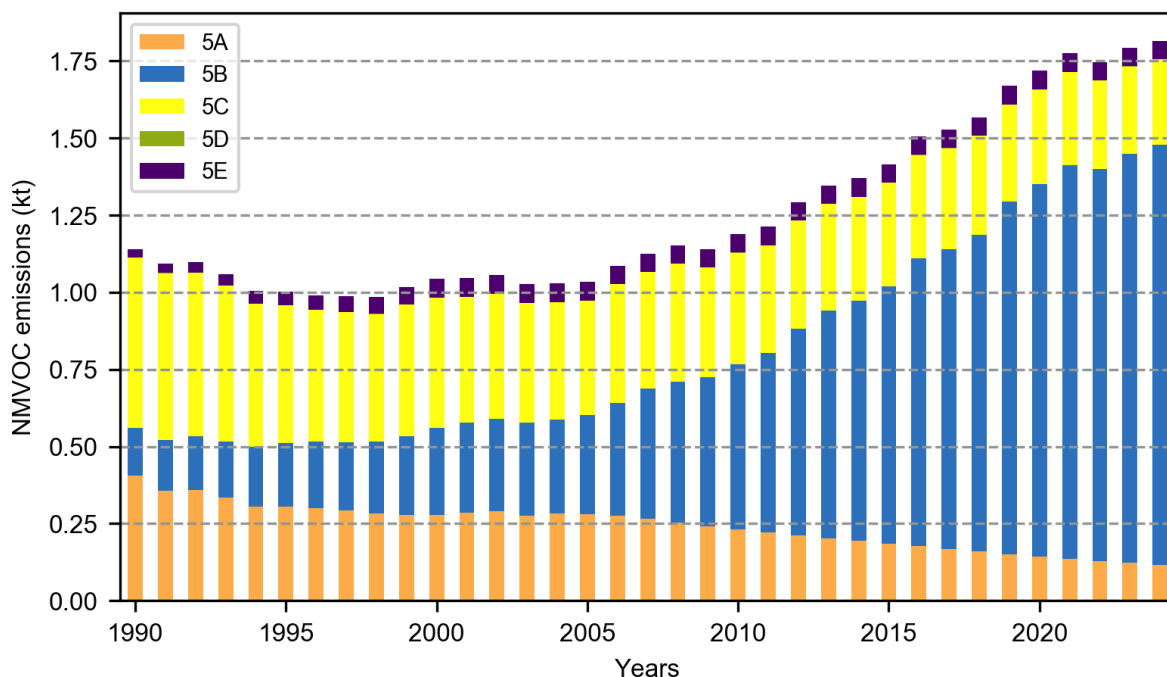


Figure 6-1 Switzerland's NMVOC emissions from the waste sector by source categories 5A-5E. The corresponding data can be found in Table 6-1.

Table 6-1 NMVOC emissions from sector 5 Waste by source categories 5A-5E. The last column in the third part of the table indicates the relative trend.

NMVOC		1990	1995	2000	2005	2010
5A	kt	0.41	0.30	0.28	0.28	0.23
5B	kt	0.15	0.21	0.28	0.32	0.54
5C	kt	0.55	0.45	0.42	0.37	0.36
5D	kt	0.00052	0.00041	0.00026	0.00011	0.000100
5E	kt	0.028	0.045	0.060	0.060	0.060
Sum	kt	1.1	1.0	1.0	1.0	1.2

NMVOC		2015	2016	2017	2018	2019
5A	kt	0.19	0.18	0.17	0.16	0.15
5B	kt	0.83	0.93	0.97	1.0	1.1
5C	kt	0.34	0.34	0.33	0.32	0.31
5D	kt	0.00011	0.00012	0.00012	0.00012	0.00012
5E	kt	0.060	0.060	0.060	0.060	0.060
Sum	kt	1.4	1.5	1.5	1.6	1.7

NMVOC		2020	2021	2022	2023	2024	2005-2024 (%)
5A	kt	0.14	0.14	0.13	0.12	0.12	-58
5B	kt	1.2	1.3	1.3	1.3	1.4	321
5C	kt	0.31	0.30	0.29	0.28	0.28	-26
5D	kt	0.00013	0.00013	0.00014	0.00014	0.00014	31
5E	kt	0.060	0.060	0.060	0.060	0.060	-
Sum	kt	1.7	1.8	1.7	1.8	1.8	76

6.1.2 Overview and trend for PM2.5

Figure 6-2 depicts the PM2.5 emissions in the waste related sectors since 1990. 5C Incineration and open burning of waste is significantly contributing to total PM2.5 emissions from the waste sector over the entire reporting period and thus is key category.

Between 1990 and 2024 a continuous decrease of total PM2.5 emissions occurred that largely can be affiliated with the emission reductions achieved in 5C Waste incineration. This is mainly due to emission reductions from sewage sludge incineration, refurbishment of crematoriums, the cessation of burning cable insulation in 1995 as well as clinical waste incineration in 2002 as well as due to an overall decreasing trend in the open burning of natural residues in agriculture and households.

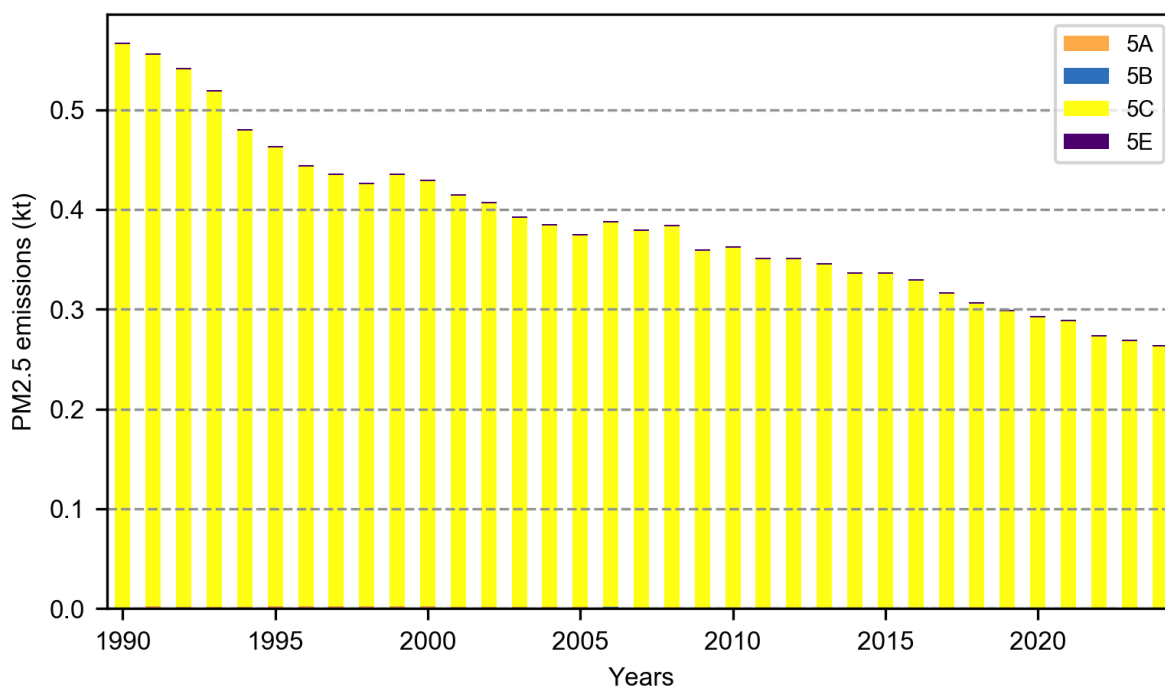


Figure 6-2 Switzerland's PM2.5 emissions from the waste sector by source categories 5 A-5C and 5E. Note that PM2.5 emissions from 5D are not occurring. The corresponding data can be found in Table 6-2.

Table 6-2 PM2.5 emissions from sector 5 Waste by source categories 5A-5C and 5E. The last column in the third part of the table indicates the relative trend.

PM2.5		1990	1995	2000	2005	2010	
5A	kt	0.00073	0.0021	0.0022	0.0014	0.00097	
5B	kt	NA	0.000001	0.000004	0.000007	0.000023	
5C	kt	0.57	0.46	0.43	0.37	0.36	
5D	kt	NA	NA	NA	NA	NA	
5E	kt	0.0014	0.0015	0.0015	0.0015	0.0015	
Sum	kt	0.57	0.46	0.43	0.38	0.36	

PM2.5		2015	2016	2017	2018	2019	
5A	kt	0.00055	0.00055	0.00055	0.00055	0.00054	
5B	kt	0.000044	0.000047	0.000049	0.000051	0.000052	
5C	kt	0.33	0.33	0.31	0.31	0.30	
5D	kt	NA	NA	NA	NA	NA	
5E	kt	0.0015	0.0015	0.0015	0.0015	0.0015	
Sum	kt	0.34	0.33	0.32	0.31	0.30	

PM2.5		2020	2021	2022	2023	2024	2005-2024 (%)
5A	kt	0.00054	0.00053	0.00051	0.00050	0.00048	-64
5B	kt	0.000054	0.000054	0.000054	0.000057	0.000057	748
5C	kt	0.29	0.29	0.27	0.27	0.26	-30
5D	kt	NA	NA	NA	NA	NA	-
5E	kt	0.0015	0.0015	0.0015	0.0015	0.0015	-
Sum	kt	0.29	0.29	0.27	0.27	0.26	-30

6.2 Source category 5A – Biological treatment of waste - Solid waste disposal on land

6.2.1 Source category description of 5A Biological treatment of waste - Solid waste disposal on land

The source category 5A Biological treatment of waste - Solid waste disposal on land includes all emissions from solid waste handling on landfill sites. Since 1987 all deposited waste in Switzerland has been deposited on managed landfill sites.

In Switzerland, managed active landfill sites where organic material is degraded in biological processes are equipped to recover landfill gas (SFOE 2025a). The landfill gas is generally used in combined heat and power plants for the production of electricity and heat (reported under 1A Fuel combustion). A fraction of landfill gas is used to generate heat only. A very small fraction of the landfill gas is flared (reported under 5A).

Methane emissions are estimated by using a First Order Decay (FOD) model compliant with the 2006 IPCC Guidelines (IPCC 2006; see below). Following legal requirements and regulations it is assumed that open burning ceased after 1990 (Consaba 2016).

Table 6-3 Specification of source category 5A Biological treatment of waste - Solid waste disposal on land.

5A	Source category	Specification
5A	Solid waste disposal on land	Emissions from handling of solid waste on landfill sites

Table 6-4 Key categories, approaches 1 and 2, level assessment 2024 (L1, L2) and trend assessment 1990-2024 (T1, T2) for source category 5A Biological treatment of waste - Solid waste disposal on land.

Source category 5A Biological treatment of waste - Solid waste disposal on land is not a key category.

6.2.2 Methodological issues of 5A Biological treatment of waste - Solid waste disposal on land

Methodology (5A)

The emission modelling corresponds to a Tier 2 approach. See decision tree in chapter 5A Biological treatment of waste – Solid waste disposal on land of the EMEP/EEA guidebook (EMEP/EEA 2023).

The main emission from landfills is the greenhouse gas CH₄, which is not relevant for the CLRTAP Inventory. However, methane is used for combined heat and power generation, or it is flared. Thereby, other pollutants are produced and emitted. They are reported in the CLRTAP Inventory. Emissions from combined heat and power generation are reported in the energy sector (1A1a Public electricity and heat production), emissions from flaring in the waste sector.

The emissions of CH₄ are calculated in several steps, the details are described in Switzerland’s National Inventory Report (FOEN 2025):

1. CH₄ emissions are modelled with the FOD model according to the 2006 IPCC Guidelines (IPCC 2006).
2. The amount of CH₄ that is recovered and used as fuel for combined heat and power generation as well as for flaring is subtracted from the total CH₄ generated in landfills.
3. Emissions of air pollutants from burning methane in engines and torches are calculated. Their amount is proportional to the CH₄ burnt.

The PCB emissions from landfills are modelled within the disposal category of the dynamic mass flow model developed for the usage of PCBs in Switzerland (Glüge et al. 2017), see Annex A2.2.

Emission factors (5A)

Emission factors are country-specific based on measurements and expert estimates, documented in EMIS (EMIS 2026/1A1a & 5A), see Table 6-5. The PCB emission factor expressed in units per tonnes of PCBs stored in landfills is based on the dynamic mass flow model for the usage of PCBs in Switzerland, see Annex A2.2. Emission factors for open burning of waste are not shown because open burning on solid waste disposal sites is assumed not to occur anymore in Switzerland since 1990.

Table 6-5 Emission factors 2024 for 5A Biological treatment of waste - Solid waste disposal on land.

5A Solid waste disposal on land	Unit of activity data	NOx	NMVOC	NH3	PM2.5 ex	PM10 ex	TSP ex	CO	PCB
		g/...	g/...	g/...	g/...	g/...	g/...	g/...	mg/...
Landfill: flaring	t CH4	1'000	82	NA	400	400	400	17'000	NA
Landfill: direct emissions	t CH4	NA	13'171	20'000	NA	NA	NA	NA	NA
Landfill: PCB quantity available in waste	g PCB	NA	NA	NA	NA	NA	NA	NA	0.0096

Activity data (5A)

The main activity data for 5A Biological treatment of waste - Solid waste disposal on land are the waste quantities disposed on landfills that are used for calculating the amount of methane produced. Activity data are taken from EMIS 2026/1A1a & 5A. Table 6-6 documents the decrease of municipal solid waste, construction waste and sewage sludge disposed in landfill sites in the reporting period. The reason for this is that incineration of combustible waste is mandatory in Switzerland since the year 2000 and therefore amounts deposited have dropped to zero in the following years.

The resulting set of activity data for 5A Biological treatment of waste - Solid waste disposal on land is the amount of CH₄ flared (see Table 6-6). The quantity of CH₄ flared on Swiss landfill sites was assessed in 2015 and is documented in a separate report (Consaba 2016). For PCB emissions, the activity data is the amount of PCBs stored in landfills based on the dynamic mass flow model for the usage of PCBs in Switzerland, see Annex A2.2.

Table 6-6 Activity data of 5A Biological treatment of waste - Solid waste disposal on land.

5A Solid waste disposal on land	Unit	1990	1995	2000	2005	2010						
Waste quantity: total	kt waste	860	628	350	16	NO						
Waste quantity: from municipal solid waste	kt waste	650	540	292	14	NO						
Waste quantity: from construction	kt waste	150	60	54	1.4	NO						
Waste quantity: from sewage sludge (dry)	kt waste	60	28	4.2	0.98	NO						
Landfill: flaring	kt CH ₄	1.8	5.3	5.6	3.4	2.4						
Landfill: direct emissions	kt CH ₄	31	23	21	21	18						
Landfill: PCB quantity available in waste	t PCB	395	374	353	333	319						
Landfill memo item: CH ₄ recovery	kt CH ₄	-4.9	-12	-11	-4.1	-0.97						
5A Solid waste disposal on land	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
Waste quantity: total	kt waste	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
Waste quantity: from municipal solid waste	kt waste	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
Waste quantity: from construction	kt waste	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
Waste quantity: from sewage sludge (dry)	kt waste	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
Landfill: flaring	kt CH ₄	1.4	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.2	1.2	
Landfill: direct emissions	kt CH ₄	14	13	13	12	11	11	10	9.8	9.3	8.9	
Landfill: PCB quantity available in waste	t PCB	309	307	305	304	302	300	299	297	295	294	
Landfill memo item: CH ₄ recovery	kt CH ₄	-0.42	-0.25	-0.13	-0.12	-0.17	-0.078	-0.078	-0.100	-0.087	-0.088	

The emissions from using methane as fuel for combined heat and power generation in engines are reported under 1A1a Energy industries.

6.2.3 Category-specific recalculations in 5A Biological treatment of waste - Solid waste disposal on land

There were no recalculations implemented in submission 2026.

6.3 Source category 5B - Biological treatment of waste - Composting and anaerobic digestion at biogas facilities

6.3.1 Source category description of 5B Biological treatment of waste - Composting and anaerobic digestion at biogas facilities

The source category 5B Biological treatment of waste comprises the emissions from 5B1 Composting and from 5B2 Anaerobic digestion at biogas facilities. Emissions from combined heat and power generation using biogas from digestion are reported under 1A2gviii Other and 1A4a Commercial/Institutional.

5B1 Composting distinguishes between industrial composting and backyard composting. Industrial composting covers emissions from centralised composting activities with a capacity of more than 100 tonnes of organic matter per year as well as the composting of organic material at the border of agricultural fields. Backyard composting in private households or communities is common practice in Switzerland. Activity data and emission factors for industrial and backyard composting have been thoroughly reassessed in 2017, new data were gained and EMIS 2026/5B1 Kompostierung has been revised accordingly.

Within 5B2 Anaerobic digestion at biogas facilities two plant types are distinguished: (1) industrial biogas plants and (2) agricultural biogas plants. Biogas upgrading is treated as a separate process covered in this source category; however, this only induces methane emissions due to leakage and is therefore not relevant for the CLRTAP Inventory. The digestion of organic waste takes place under anaerobic conditions. The digestate (solid and liquid output after completion of a process of anaerobic microbial degradation of organic

matter) is composted or directly used as fertiliser, respectively. The biogas generated during the digestion process is used for combined heat and power generation or upgraded and used as fuel for cars or fed into the natural gas grid.

Table 6-7 Specification of source category 5B Biological treatment of waste - Composting and anaerobic digestion at biogas facilities.

5B	Source category	Specification
5B1	Composting	Emissions from composting activities
5B2	Anaerobic digestion at biogas facilities	Emissions from digesting of organic waste at biogas facilities

Table 6-8 Key categories, approaches 1 and 2, level assessment 2024 (L1, L2) and trend assessment 1990-2024 (T1, T2) for source category 5B Biological treatment of waste – Composting and anaerobic digestion at biogas facilities

NFR code	Source category	Pollutant	Identification criteria
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	NMVOC	T1

6.3.2 Methodological issues of 5B Biological treatment of waste - Composting and anaerobic digestion at biogas facilities

Methodology (5B)

A Tier 2 method is applied to estimate emissions from 5B1 Composting (see decision tree in chapter 5B1 Biological treatment of waste – Composting of the EMEP/EEA guidebook (EMEP/EEA 2023).

Emissions from 5B2 Anaerobic digestion are estimated by applying a Tier 2 method (see decision tree in chapter 5B2 Biological treatment of waste – Anaerobic digestion at biogas facilities of the EMEP/EEA guidebook (EMEP/EEA 2023).

Figure 6-3 depicts a schematic design of an industrial biogas plant. Six emission-relevant process steps are taken into account. For each process step separate activity data and emission factors are used:

- P1: Emissions from the storage of organic waste
- P2: Emissions from fermentation
- P3: Emissions from the interim storage of liquid digestate
- P4: Emissions from on-site aerobic after treatment of solid digestate
- P5: Emissions from the utilisation of biogas in combined heat and power generation units
- P6: Emissions from flaring of biogas

P5 as energy-related emissions are reported in sector 1 Energy source category 1A2gviii Other.

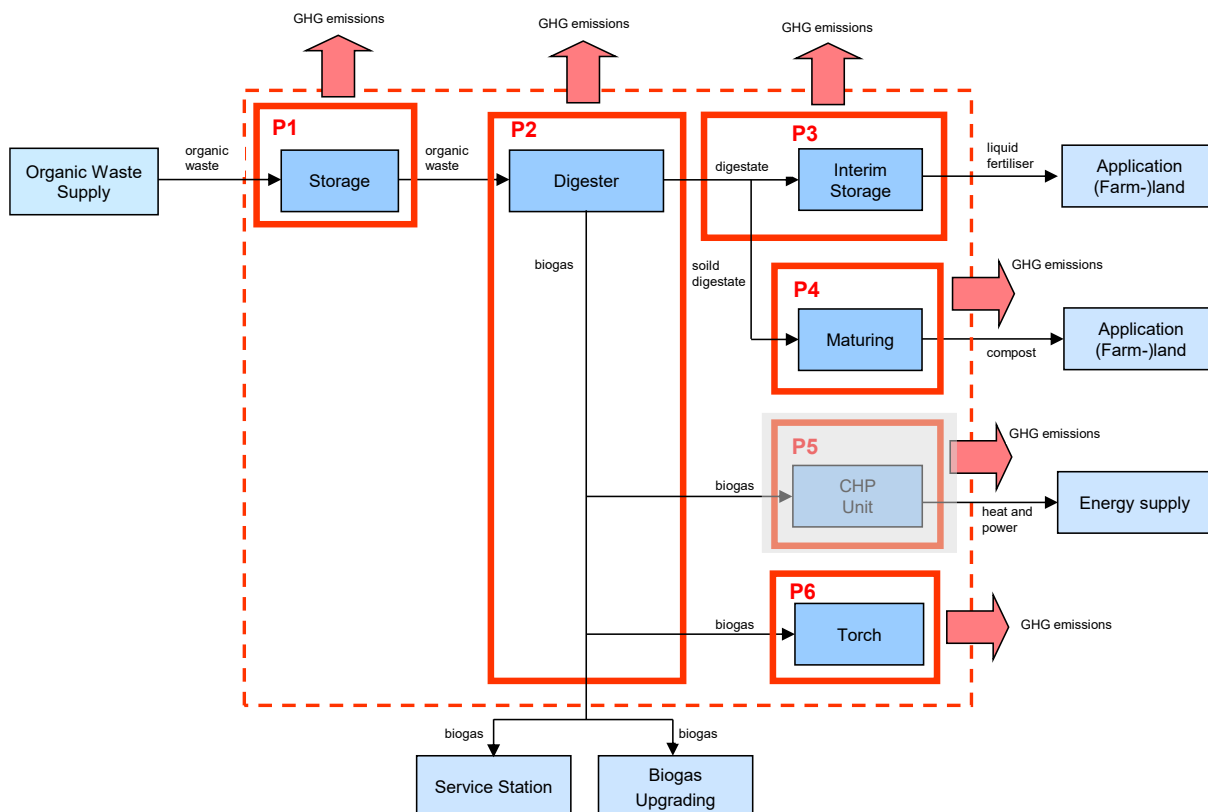


Figure 6-3 Schematic design of an industrial biogas plant.

Figure 6-4 depicts a schematic design of an agricultural biogas plant. It is very similar to the scheme of the industrial biogas plant described above. Seven process steps are distinguished where emissions might occur. For each process step separate activity data and emission factors are used:

- P1: Emissions from the intermediate storage of the waste from animal husbandry (liquid and solid manure) and the additional co-substrate.
- P2: Losses due to leakage from the fermenter, gas piping and overproduction
- P3: Emissions from the storage of liquid digestate
- P4: Emissions from aerobic after treatment of solid digestate
- P5: Emissions from the utilisation of biogas in combined heat and power generation units
- P6: Emissions from the utilisation of biogas in the gas boiler
- P7: Emissions from flaring of biogas

Emissions from P1 are reported in sector 3 Agriculture, and emissions from P5 and P6 are reported in sector 1 Energy source category 1A4ai Commercial/Institutional.

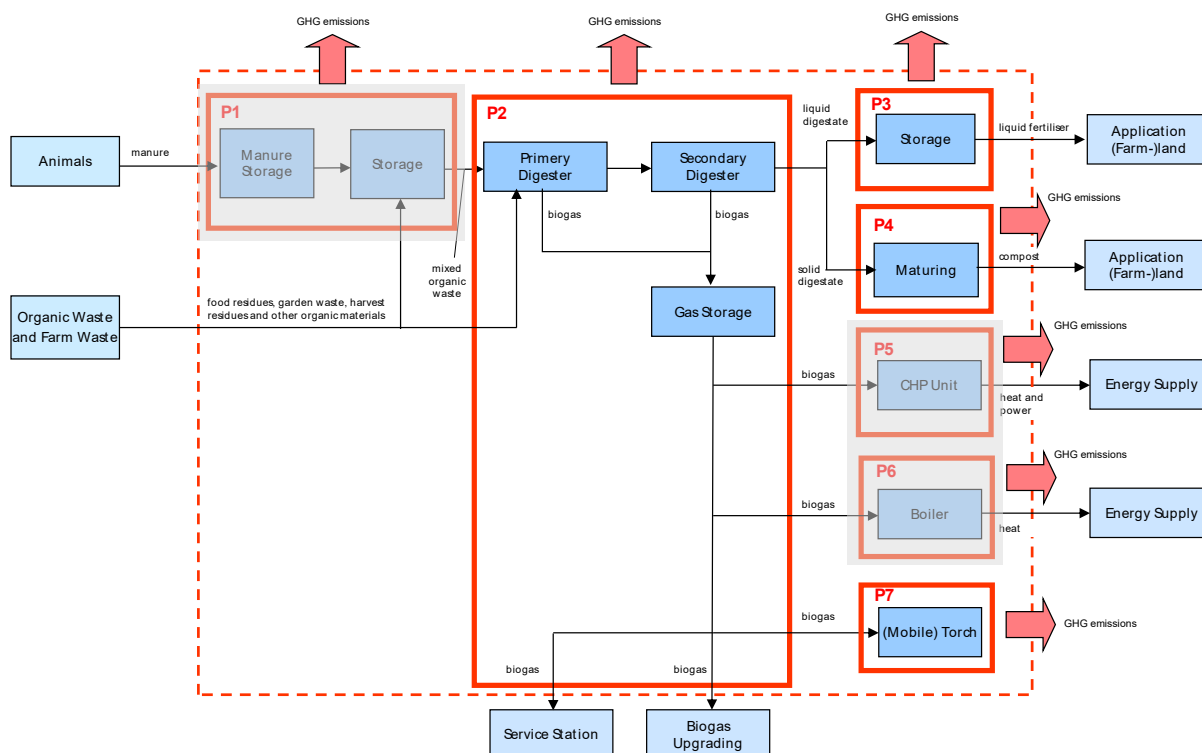


Figure 6-4 Schematic design of an agricultural biogas plant.

Emission factors (5B)

Emission factors for 5B1 Composting are country-specific based on measurements and expert estimates (EMIS 2026/5B1 Kompostierung). Emission factors are assumed to remain constant over the reporting period.

Emission factors for 5B2 Anaerobic digestion are country-specific based on measurements according to Edelmann and Schleiss (1999), Butz (2003) and Cuhls et al. (2010) as documented in comments to the database (EMIS 2026/1A2g and 5B2 Vergärung IG and EMIS 2026/1A4a and 5B2 Vergärung LW). Table 6-9 presents the emission factors used in 5B.

Table 6-9 Emission factors of 5B Biological treatment of waste - Composting and anaerobic digestion at biogas facilities in 2024.

5B Biological treatment of solid waste	Unit of activity data	NOx	NMVOC	SOx	NH3	PM2.5 ex	PM10 ex	TSP ex	BC ex	CO
		g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
Composting: industrial	t composted waste (dry)	NA	750	NA	1'250	NA	NA	NA	NA	NA
Composting: backyard	t composted waste (dry)	NA	750	NA	1'250	NA	NA	NA	NA	NA
Digestion ind.: digestable waste / storage	t digestable waste (wet)	NA	70	NA	5.6	NA	NA	NA	NA	NA
Digestion ind.: digested waste liquid / process water	t digested waste liquid (wet)	NA	400	NA	80	NA	NA	NA	NA	NA
Digestion ind.: digested waste solid / rotting	t digested waste solid (wet)	NA	230	NA	104	NA	NA	NA	NA	NA
Digestion ind.: CH4 flaring	t CH4	4'066	82	616	NA	37	37	37	0.91	2'054
Digestion agri.: digested waste liquid / process water	t digested waste liquid (wet)	NA	400	NA	80	NA	NA	NA	NA	NA
Digestion agri.: digested waste solid / rotting	t digested waste solid (wet)	NA	230	NA	104	NA	NA	NA	NA	NA
Digestion agri.: CH4 flaring	t CH4	4'066	82	616	NA	37	37	37	0.91	2'054

Activity data (5B)

Activity data for 5B Biological treatment of waste are extracted from EMIS 2026/5B1 Kompostierung, EMIS 2026/1A1a and 5B2 Vergärung IG and EMIS 2026/1A1a and 5B2 Vergärung LW. Activity data for digestion are based on reliable statistical data from the statistics of renewable energies (SFOE 2025a). Activity data for industrial and backyard composting are based on a study by Schleiss (2017) using data of the years 1989, 1993, 2000 and 2013, supplied by plant operators. From 2014 onwards, activity data for industrial composting are adopted from the annual statistical reports by the inspectorate system for the Composting and Fermentation Industry in Switzerland CVIS as recommended by Schleiss (2017). As of 2012, activity data for backyard composting are assumed to be constant as recommended by Schleiss (2017). Data on the amount of waste is provided in tonnes of wet matter. In order to comply with UNFCCC reporting guidelines, a factor 0.40 (Baier 2023) is applied for the conversion of wet substance to dry substance.

There is a continuous increase of organic material composted until the year 2000 and afterwards a strong increase of organic material digested.

Table 6-10 Activity data of 5B Biological treatment of waste.

5B Biological treatment of solid waste	Unit	1990	1995	2000	2005	2010
Composting: industrial	kt composted waste (dry)	96	144	208	210	212
Composting: backyard	kt composted waste (dry)	44	62	72	68	48
Digestion ind.: digestable waste / storage	kt digestable waste (wet)	NO	27	60	108	289
Digestion ind.: digested waste liquid / process water	kt digested waste liquid (wet)	NO	15	33	60	161
Digestion ind.: digested waste solid / rotting	kt digested waste solid (wet)	NO	9.4	20	37	99
Digestion ind.: CH4 flaring	kt CH4	NO	0.037	0.10	0.18	0.50
Digestion agri.: digested waste liquid / process water	kt digested waste liquid (wet)	120	100	124	181	567
Digestion agri.: digested waste solid / rotting	kt digested waste solid (wet)	6.3	5.2	6.5	9.5	30
Digestion agri.: CH4 flaring	kt CH4	NO	NO	NO	NO	0.12

5B Biological treatment of solid waste	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Composting: industrial	kt composted waste (dry)	172	201	196	190	218	209	219	194	205	205
Composting: backyard	kt composted waste (dry)	40	40	40	40	40	40	40	40	40	40
Digestion ind.: digestable waste / storage	kt digestable waste (wet)	650	694	712	729	770	792	792	794	861	873
Digestion ind.: digested waste liquid / process water	kt digested waste liquid (wet)	362	387	397	406	429	441	441	442	480	486
Digestion ind.: digested waste solid / rotting	kt digested waste solid (wet)	222	237	243	249	263	270	270	271	294	298
Digestion ind.: CH4 flaring	kt CH4	0.94	1.00	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.0
Digestion agri.: digested waste liquid / process water	kt digested waste liquid (wet)	1'051	1'199	1'287	1'413	1'616	1'763	1'911	1'945	1'999	2'072
Digestion agri.: digested waste solid / rotting	kt digested waste solid (wet)	55	63	68	74	85	93	101	102	105	109
Digestion agri.: CH4 flaring	kt CH4	0.25	0.29	0.31	0.34	0.39	0.43	0.47	0.48	0.49	0.50

6.3.3 Category-specific recalculations in 5B Biological treatment of waste - Anaerobic digestion at biogas facilities

The following recalculations were implemented in submission 2026.

- 5B1 Composting industrial: Activity data for 2023 were updated.
- 5B2 Anaerobic digestion at biogas facilities: The activity data for the years 1990-2023 have been reassessed due to a new rounding strategy, causing changes of less than 2 %.

6.4 Source category 5C – Waste incineration and open burning of waste

6.4.1 Source category description of 5C Waste incineration and open burning of waste

There is a long tradition in Switzerland for waste to be incinerated. Since 1991, the incineration of waste has only been legally permitted in appropriate plants with a rated thermal input of at least 350 kW (Ordinance on Air Pollution Control (Swiss Confederation 1985)). Consequently, the open burning of waste has been prohibited. It is a requirement that waste heat generated during the incineration in installations has to be recovered if technically and economically feasible. In accordance with the 2006 IPCC Guidelines provisions (IPCC 2006), emissions from the combustion of waste-to-energy activities are reported within 1A Fuel combustion activities. The sources included in source category 5C are given in Table 6-11.

Table 6-11 Specification of source category 5C Waste incineration and open burning of waste, and indication of source categories where other waste incineration activities are reported in the national inventory.

5C	Source category	Specification
5C1a	Municipal waste incineration	Emissions from illegal incineration of municipal solid wastes at home; emissions from waste incineration at construction sites (open burning) Reported under 1A1a Public electricity and heat production: Emissions from waste incineration in municipal solid waste incineration plants; emissions from incinerating industrial and hazardous wastes Reported under 1A2f Non-metallic minerals: Emissions from waste incineration as alternative fuels in cement kilns
5C1bi	Industrial waste incineration	Emissions from incinerating cable insulation materials
5C1bii	Hazardous waste incineration	PCB emissions from combustion of PCB contaminated waste oil (transformers and large capacitors, ceased in 1999) Reported under 1A1a Public electricity and heat production: Emissions from incinerating industrial and hazardous wastes
5C1biii	Clinical waste incineration	Emissions from incinerating hospital waste in hospital incinerators (ceased in 2002)
5C1biv	Sewage sludge incineration	Emissions from sewage sludge incineration plants Reported under 1A2d Pulp paper and print: Emissions from incineration of residues and sludge from industrial waste water treatment plants as fuel for paper/pulp production
5C1bv	Cremation	Emissions from the burning of dead bodies
5C2	Open burning of waste	Emissions from field burning of agricultural waste. Burning of gardening residues from private households is also integrated (small contribution compared to agriculture).

Table 6-12 Key categories, approaches 1 and 2, level assessment 2024 (L1, L2) and trend assessment 1990-2024 (T1, T2) for source category 5C Waste incineration and open burning of waste.

NFR code	Source category	Pollutant	Identification criteria
5C1a	Municipal waste incineration	PM2.5	L1, L2, T1
5C1a	Municipal waste incineration	PM10	L1

6.4.2 Methodological issues of 5C Waste incineration and open burning of waste

Methodology (5C)

For the calculation of the emissions from municipal waste incineration (illegal burning of municipal waste) a Tier 2 method is used (see decision tree in chapter 5C1a Municipal waste incineration, EMEP/EEA 2023).

For the calculation of the emissions from the incineration of insulation materials from cables a Tier 2 method is used (see decision tree in chapter 5C1b Industrial waste incineration including special waste and sewage sludge, EMEP/EEA 2023).

Until 1999, also PCB emissions from so-called open burning of PCB contaminated waste oil in outdoor fires (i.e. outside of a container) occurred in Switzerland. They are modelled within the disposal category of the dynamic mass flow model developed for the usage of PCBs in Switzerland (Glüge et al. 2017), see Annex A2.2.

For the calculation of the emissions from clinical waste incineration a Tier 2 method is used (see decision tree in chapter 5C1biii Clinical waste incineration, EMEP/EEA 2023).

For the calculation of the emissions from sewage sludge incineration plants a Tier 2 method is used (see decision tree in chapter 5C1b Industrial waste incineration including special waste and sewage sludge, EMEP/EEA 2023).

For the calculation of the emissions from cremation a Tier 2 method is used (see decision tree in chapter 5C1bv Cremation, EMEP/EEA 2023).

For the calculation of the emissions from burning of agricultural and private gardening waste a country-specific Tier 2 method is used (see decision tree in chapter 5C2 Open burning of waste, EMEP/EEA 2023).

Emission factors (5C)

Emission factors are country-specific based on measurements and expert estimates as documented in the EMIS database (EMIS 2026/5C1 Abfallverbrennung illegal, EMIS 2026/5C1 Kabelbrand, EMIS 2026/5C1 Spitalabfallverbrennung, EMIS 2026/5C1 Krematorien, EMIS 2026/5C1 Klärschlammverbrennung, EMIS 2026/5C2 Abfallverbrennung Land- und Forstwirtschaft).

The emission factor of dioxine for 5C1 Illegal waste incineration in particular is defined based on Wevers et al. (2004) and Lemieux et al. (2003). Emission factors for the other pollutants of 5C1 Illegal waste incineration are based on SAEFL (2000) and USEPA (1995, Chapter 2.5 Open Burning).

Emission factors for 5C2 Open burning of agricultural and private gardening waste were, upon recommendation by INFRAS (2014) taken from the EMEP/EEA guidebook (EMEP/EEA 2023, chp. 5.C.2, table 3-2). INFRAS (2014) concluded, that Tier 2 default emission factor for incineration of natural residues in forestry would best account for emission factors for incineration of natural residues in agriculture and private gardens as well, except for NH₃ (EMEP/EEA 2002), Hg (Sigler et al. 2003) and IcdP (USEPA 1998, Table 4.10.5-1 Open burning of Municipal Refuse).

The emission factors for 5C1b Sewage sludge incineration for the year 1990 are taken from SAEFL (2000). The emission factors for the year 2002 are based on emission declarations of plants in the region of Basel (accounting for about 1/3 of the national total quantities). Emission factors for 2015 have been re-investigated based on emission declarations of the same plants in the region of Basel. Based on 27 air pollution control measurement reports under the Ordinance on Air Pollution Control of 11 different sewage sludge incineration plants, emission factors have again been estimated for 2018 (TBF 2021). For documentation

see EMIS 2026/5C1 (5C1biv UNECE) Klärschlammverbrennung. From 1990 to 2002 from 2002 to 2015 and from 2015 to 2018 emission factors are interpolated linearly. From 2018 onwards the emission factors are assumed to be constant.

The following Table 6-13 depicts the emission factors used in 5C.

Table 6-13 Emission factors for 5C Waste incineration and open burning of waste in 2024.

5C Incineration and open burning of waste	Unit of activity data	NOx	NMVOc	SOx	NH3	PM2.5 ex	PM10 ex	TSP ex	BC ex	CO
		g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
Illegal incineration of biogenic waste	t waste biogenic	2'500	16'000	750	NA	14'400	16'000	20'000	1'008	50'000
Illegal incineration of fossil waste	t waste fossil	2'500	16'000	750	NA	14'400	16'000	20'000	1'008	50'000
Insulation material from cables	t cables	NO	NO	NO	NO	NO	NO	NO	NO	NO
Hazardous waste incineration of PCB	g PCB	NO	NO	NO	NO	NO	NO	NO	NO	NO
Clinical waste incineration	t waste fossil	NO	NO	NO	NO	NO	NO	NO	NO	NO
Sewage sludge incineration	t sewage sludge	400	189	162	19	28	40	40	0.25	97
Cremation	cremations	210	5.7	NA	NA	13	13	14	0.11	36
Open burning of natural residues in agriculture	t gardening waste	1'380	1'470	30	800	3'760	4'130	4'310	348	48'790
Open burning of natural residues in private households	t gardening waste	1'380	1'470	30	800	3'760	4'130	4'310	348	48'790

5C Incineration and open burning of waste	Unit of activity data	Pb	Cd	Hg	PCDD/ PCDF	BaP	BbF	BkF	IcdP	PCB
		mg/...	mg/...	mg/...	ng I- Teq/...	mg/...	mg/...	mg/...	mg/...	mg/...
Illegal incineration of biogenic waste	t waste biogenic	100'000	200	100	160'000	0.34	0.20	0.27	0.100	NA
Illegal incineration of fossil waste	t waste fossil	100'000	200	100	160'000	0.34	0.20	0.27	0.100	NA
Insulation material from cables	t cables	NO	NO	NO	NO	NO	NO	NO	NO	NO
Hazardous waste incineration of PCB	g PCB	NO	NO	NO	NO	NO	NO	NO	NO	NO
Clinical waste incineration	t waste fossil	NO	NO	NO	NO	NO	NO	NO	NO	NO
Sewage sludge incineration	t sewage sludge	280	33	200	140	NA	NA	NA	NA	NA
Cremation	cremations	45	NA	81	467	NA	NA	NA	NA	NA
Open burning of natural residues in agriculture	t gardening waste	320	130	60	10'000	3'150	6'450	5'150	1'700	NA
Open burning of natural residues in private households	t gardening waste	320	130	60	10'000	3'150	6'450	5'150	1'700	NA

Activity data (5C)

The clinical waste incineration quantities are based on rough expert estimates (EMIS 2026/5C1 Spitalabfallverbrennung).

Emissions from illegal waste incineration are based on the amount of municipal solid waste and waste from construction work burned in Switzerland. Due to the illegal nature of the process, there is a lack of reliable data. Thus, it is estimated that in 1990 1 % and in 2035 0.25 % of this amount is burned illegally (expert judgment). The shares for the years in between are interpolated. In order to estimate the quantity of illegal waste, the percentage quotation is multiplied by the total amount of municipal solid waste and waste from construction work (EMIS 2026/5C1 Abfallverbrennung illegal).

The sewage sludge quantity for 1990, 1994 and 1999 are taken from Külling and Stadelmann (2002). The total amount of sewage sludge produced in Switzerland as of 2000 is calculated by multiplying the per capita sludge production per person and year as reported by VBSA (2017) with the total population (FSO 2025c). The per capita sewage sludge production for 2000, 2004, 2008, 2012, 2016 and 2017 as reported in VBSA 2017 have been derived by compiling the respective amounts of sewage sludge incinerated in municipal solid waste incineration plant, sewage sludge incineration plants and used as alternative fuel in the cement industry and dividing it by the total population count (VBSA 2017). Per capita sludge productions for the intervening years were interpolated linearly. The total amount of sewage sludge incinerated is then calculated using the total amount generated minus the sewage sludge burnt in municipal solid waste incineration plants and sewage sludge used as alternative fuel in cement plants.

The activity data for burning of agricultural residues (see Table 6-14) is estimated based on a study conducted by INFRAS (2014). The burnt quantity is decreasing because legal burning is more strongly restricted since a revision of the corresponding article in the Swiss Federal Ordinance on Air Pollution Control in the year 2009 (EMIS 2026/5C2 Abfallverbrennung Land- und Forstwirtschaft). Since the greenhouse gas inventory UNFCC in-country review 2016, greenhouse gas emissions from open burning of natural residues in forestry (5C2ii) are reported under source category 4(IV)A1 in the greenhouse gas inventory. The corresponding

air pollutant emissions are reported under 11B Forest fires within the informative inventory report (chp. 7.3).

Table 6-14 Activity data for the various emission sources within source category 5C Waste incineration and open burning of waste.

5C Incineration and open burning of waste	Unit	1990	1995	2000	2005	2010						
Illegal incineration of biogenic waste	kt waste biogenic	16	13	12	11	11						
Illegal incineration of fossil waste	kt waste fossil	16	13	13	11	10						
Insulation material from cables	kt cables	7.5	NO	NO	NO	NO						
Hazardous waste incineration of PCB	t PCB	1.1	0.20	NO	NO	NO						
Clinical waste incineration	kt waste fossil	15	8.8	2.5	NO	NO						
Sewage sludge incineration	kt sewage sludge	57	50	64	95	90						
Cremation	cremations	37'513	40'968	44'821	48'169	52'813						
Open burning of natural residues in agriculture	kt gardening waste	13	12	12	12	11						
Open burning of natural residues in private households	kt gardening waste	4.4	3.6	2.8	2.0	1.2						
5C Incineration and open burning of waste	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
Illegal incineration of biogenic waste	kt waste biogenic	9.9	9.8	9.3	9.1	8.8	8.5	8.3	7.8	7.6	7.5	
Illegal incineration of fossil waste	kt waste fossil	9.4	9.3	9.0	8.8	8.6	8.4	8.3	7.8	7.7	7.4	
Insulation material from cables	kt cables	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
Hazardous waste incineration of PCB	t PCB	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
Clinical waste incineration	kt waste fossil	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
Sewage sludge incineration	kt sewage sludge	97	99	102	98	100	97	96	98	106	105	
Cremation	cremations	59'605	56'891	59'533	59'447	60'872	68'213	64'260	66'960	65'368	65'269	
Open burning of natural residues in agriculture	kt gardening waste	11	11	11	11	11	10	10	10	10	10	
Open burning of natural residues in private households	kt gardening waste	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	

Note that since 2002, all specific clinical waste incineration plants have ceased operation and all hospital waste is incinerated in municipal solid waste incineration plants (accounted for in 1A1 Energy industry). All burning of insulation material cables (industrial waste incineration in the table above) has ceased as well since 1995.

6.4.3 Category-specific recalculations in 5C Waste incineration and open burning of waste

The following recalculations were implemented in submission 2026.

- 5C1bv Cremation: The activity data for cremation, which is the number of cremated dead bodies, has been reassessed based on a survey conducted on crematoriums not part of the Swiss Union for Cremation. This caused changes from less than -1 % and up to +8 % for the national total.
- 5C2: The activity data for the quantity of incinerated sewage sludge has been reassessed for the years 2019 and 2021-2023 based on an update of the underlying statistics.

6.5 Source category 5D – Wastewater handling

6.5.1 Source category description of 5D Wastewater handling

Source category 5D1 Domestic wastewater handling comprises all emissions from liquid waste handling and sludge from housing and commercial sources (including grey water and night soil). In Switzerland, municipal wastewater treatment plants treat wastewater from either individual cities or several cities and/or municipalities together. Wastewater in general is treated in three consecutive steps: 1. mechanical treatment, 2. biological treatment, and 3. chemical treatment. The treated wastewater flows into a receiving system (lake, river or stream). The wastewater treatment infrastructure in Switzerland is now virtually complete (FOEN 2025m). The vast majority of wastewater treatment plants apply anaerobic sludge treatment with sewage gas recovery and use the sewage gas for combined heat and power production.

The source category 5D2 Industrial wastewater handling includes all emissions from liquid wastes and sludge from industrial processes such as food processing, textiles, car-washing

places and electroplating plants as well as pulp and paper production. These processes may result in effluents with a high load of organics. Depending on the contaminants, an on-site pre-treatment is necessary in order to reduce the load of pollutants in the wastewater to meet the regulatory standards (which are in place to preclude disruptions of the municipal wastewater treatment plants) and to reduce discharge fees. The on-site pre-treatment is generally anaerobic, in order to use the sewage gas as source for combined heat and power production. The pre-treated wastewater is discharged to the domestic sewage systems, where the industrial wastewater is further treated, together with domestic wastewater in municipal wastewater treatment plants.

Table 6-15 Specification of source category 5D Wastewater handling.

5D	Source category	Specification
5D1	Domestic wastewater handling	Emissions from liquid waste handling and sludge from housing and commercial sources
5D2	Industrial wastewater handling	Emissions from handling of liquid wastes and sludge from industrial processes

Table 6-16 Key categories, approaches 1 and 2, level assessment 2024 (L1, L2) and trend assessment 1990-2024 (T1, T2) for source category 5D Wastewater handling

Source category 5D Wastewater handling is not a key category.

The emissions related to wastewater treatment fall under various categories as laid out in Figure 6-5. The system boundaries of category 5D contain all emissions from direct wastewater handling, some emissions from sewage sludge drying and no emissions from sewage sludge use or disposal. The discharge of sewage sludge on agricultural soils has been phased out since 2003 and is generally forbidden since 2008, therefore this process is crossed out in the figure below. The same applies to solid waste disposal on land (5A). All sewage sludge is incinerated either in municipal solid waste incineration plants (1A1a), Sewage sludge incineration plants (5C) or used as alternative fuel in the cement industry (1A2f).

The emissions from the use of sewage gas for combined heat and power generation as well as in boilers are reported in sector 1 Energy in source category 1A2gviii Other.

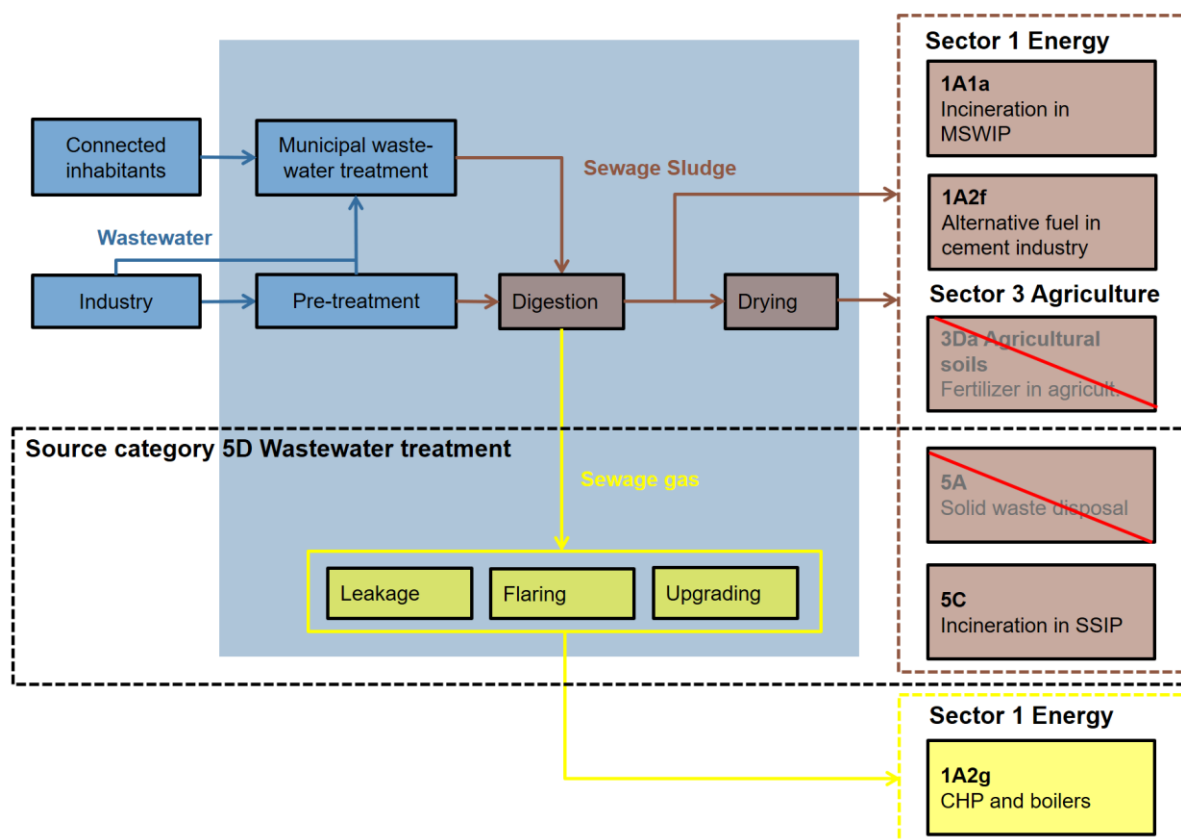


Figure 6-5 System boundaries of emissions related to wastewater handling. Abbreviations: CHP Combined Heat and Power Generation, MSWIP municipal solid waste incineration plant, SSIP sewage sludge incineration plant.

6.5.2 Methodological issues of 5D Wastewater handling

Methodology (5D)

For 5D1 Domestic wastewater handling and 5D2 Industrial wastewater handling, a Tier 2 method is used (see decision tree in chapter 5D Wastewater handling, EMEP/EEA 2023).

For 5D1 Domestic wastewater handling emission factors are calculated on the basis of the total emissions divided by the number of inhabitants (Swiss population, FSO 2025c). This number is not equivalent to the number of inhabitants connected to the wastewater system.

Emission factors (5D)

Emission factors are country-specific based on measurements and expert estimates, documented in the EMIS database (EMIS 2026/5D1, EMIS 2026/5D2), see Table 6-17.

Table 6-17 Emission factors for 5D Wastewater handling in 2024.

5D Wastewater handling	Unit of activity data	NOx	NM/OC	SOx	NH3	CO
		g/...	g/...	g/...	g/...	g/...
Domestic wastewater handling	inhabitants	0.64	0.013	0.0032	14	0.32
Industrial wastewater handling	inhabitants	0.13	0.0026	0.00066	NA	0.065

Activity data (5D)

Activity data for 5D1 Domestic wastewater handling and 5D2 Industrial wastewater handling are the total number of inhabitants extracted from FSO (2025c). The number of inhabitants connected to the system is the product of the number of inhabitants and the service level. The fraction and number of persons connected to wastewater systems are indicated for informational reason in Table 6-18.

Table 6-18: Activity data in 5D Wastewater handling: Population and fraction connected to wastewater treatment plants. Emissions resulting from CH₄ recovery are reported in Sector 1 in source category 1A2gviii Other.

5D Wastewater handling	Unit	1990	1995	2000	2005	2010								
Domestic wastewater handling	inhabitants	6'712'000	7'041'000	7'184'000	7'437'000	7'825'000								
Fraction connected to wastewater treatment plants	% sewage sludge	90.0	93.7	95.4	96.8	97.2								
Inhabitants connected	inhabitants	5'998'514	6'551'235	6'805'561	7'148'623	7'552'659								
Domestic wastewater handling memo item: CH ₄ recovery	kt CH ₄	-25.9	-29.5	-34.3	-36.5	-40.9								
Industrial wastewater handling	inhabitants	6'712'000	7'041'000	7'184'000	7'437'000	7'825'000								
5D Wastewater handling	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024			
Domestic wastewater handling	inhabitants	8'282'000	8'373'000	8'452'000	8'514'000	8'575'000	8'638'000	8'705'000	8'777'000	8'889'000	9'007'000			
Fraction connected to wastewater treatment plants	% sewage sludge	97.3	97.3	97.3	97.3	97.3	97.3	97.3	97.3	97.3	97.3			
Inhabitants connected	inhabitants	8'001'977	8'089'900	8'166'229	8'226'133	8'285'071	8'345'941	8'410'675	8'480'241	8'588'454	8'702'464			
Domestic wastewater handling memo item: CH ₄ recovery	kt CH ₄	-47.0	-48.7	-50.5	-50.8	-51.6	-57.4	-57.3	-61.3	-60.6	-61.7			
Industrial wastewater handling	inhabitants	8'282'000	8'373'000	8'452'000	8'514'000	8'575'000	8'638'000	8'705'000	8'777'000	8'889'000	9'007'000			

6.5.3 Category-specific recalculations in 5D Wastewater handling

The following recalculations were implemented in submission 2026.

- 5D1 Domestic wastewater treatment: The emission factors for the years 2016-2023 have been updated because of an update in the underlying national statistics of sewage gas production.
- 5D1 Domestic wastewater treatment: The activity data, which is the number of inhabitants in Switzerland, has been updated for the year 2022 due to an update in the underlying statistics. This caused a change in implied emission factors and in the resulting emission levels by less than 1 %.
- 5D2 Industrial wastewater treatment: The activity data, which is the number of inhabitants within Switzerland, has been updated for the year 2022 due to an update in the underlying statistics. This caused a change in implied emission factors and in the resulting emission levels by less than 1 %.

6.6 Source category 5E – Other waste, shredding

6.6.1 Source category description of 5E Other waste, shredding

In source category 5E only shredding of cars and electronic waste containing PCBs in small capacitors is considered.

Table 6-19 Specification of source category 5E Other waste, shredding

5E	Source category	Specification
5E	Other waste	Emissions from car shredding plants; PCB emissions from shredding of electronic waste containing small capacitors

Table 6-20 Key categories, approaches 1 and 2, level assessment 2024 (L1, L2) and trend assessment 1990-2024 (T1, T2) for source category 5E Other waste, shredding

Source category 5E Other waste, shredding is not a key category.
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6.6.2 Methodological issues of 5E Other waste, shredding

Methodology (5E)

For the emissions from car shredding a Tier 2 method is used (see decision tree in chapter 5E Other, EMEP/EEA 2023). Emissions are calculated by multiplying the quantity of scrap by respective emission factors. The PCB emissions from shredding of electronic waste containing PCBs in small capacitors are modelled within the treatment category of the dynamic mass flow model developed for the usage of PCBs in Switzerland (Glüge et al. 2017), see Annex A2.2.

Emission factors (5E)

For the emissions from car shredding country-specific emission factors are used (SAEFL 2000 and EMIS 2026/5E Shredder Anlagen). For all years, emission factors are considered to remain constant. The PCB emission factor expressed in units per tonnes of PCBs shredded is based on the dynamic mass flow model for the usage of PCBs in Switzerland, see Annex A2.2.

Table 6-21 Emission factors for 5E Other waste, car shredding and shredder in 2024.

5E Other waste	Unit of activity data	NMVOC	PM2.5 nx	PM10 nx	TSP nx	CO	Pb	Cd	PCDD/ PCDF	PCB
		g/...	g/...	g/...	g/...	g/...	mg/...	mg/...	ng I- Teq/...	mg/...
Car shredding	t scrap	200	5.0	10	12	5.0	22	2.5	400	NA
Shredder	g PCB	NA	NA	NA	NA	NA	NA	NA	NA	71

Activity data (5E)

The quantities of shredded cars from 1990 are data provided by the Swiss shredder association. The data from 2003 and 2007 are taken from Swiss waste statistics. Data for the years in between is interpolated. From 2007 onwards the quantities are assumed to remain constant due to the lack of data (EMIS 2026/5E Shredder Anlagen). For PCB emissions, the activity data is the amount of PCBs shredded based on the dynamic mass flow model for the usage of PCBs in Switzerland, see Annex A2.2. As a consequence of the legal ban of disposal of combustible waste in landfills, a sharp increase in shredding of small capacitors

occurred in 1999 although they should have been treated as special waste from 1998 onwards.

Table 6-22 Activity data for car shredding (source EMIS 2026/5E Shredder Anlagen)

5E Other waste	Unit	1990	1995	2000	2005	2010						
Car shredding	kt scrap	280	300	300	300	300						
Shredder	t PCB	3.0	3.3	10	3.5	0.71						
5E Other waste	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
Car shredding	kt scrap	300	300	300	300	300	300	300	300	300	300	
Shredder	t PCB	0.25	0.20	0.15	0.12	0.092	0.070	0.053	0.040	0.030	0.022	

6.6.3 Category-specific recalculations in 5E Other waste, car shredding

There were no recalculations implemented in submission 2026.

7 Other and natural emissions

7.1 Overview of emissions

In this introductory chapter, an overview of emissions separated according to the most relevant pollutants is presented. Trends and changes for individual source categories in the period between 1990 and 2024 are analysed and discussed. In sectors 6 Other and 11 Natural emissions NH₃, NO_x, PM_{2.5} and NMVOC are the most relevant pollutants.

The following source categories are reported:

- 6A1 Humans
- 6A2 Pets
- 6A3 Fertilisers (private use)
- 6A4 Fire damages buildings and motor vehicles
- 6A5 Accidental PCB release (by fire and to soil)
- 11B Forest fires and open burning of residues in forestry
- 11C Other natural emissions (NMVOC from forest stands)

There are no emissions reported under memo item 6B Other.

Active volcanoes (11A) do not occur in Switzerland.

7.1.1 Overview and trend for NH₃

Figure 7-1 shows the trend of NH₃ emissions in sector 6 Other since 1990. The source category 6A Other sources is a key category for NH₃. Total emissions fluctuate and have continuously slightly increased within the reporting period. Emissions from source category 6A2 Pets, which includes cats, dogs and livestock outside agriculture (i.e., asses, goats, horses and sheep) as well as zoo animals, contributes the largest share to total emissions. The emissions fluctuate due to the variability in the animal numbers. The emissions from 6A1 Humans show an increasing trend in line with the population growth, while the ones of 6A3 Fertilisers almost halved between 1990 and 1999 and have remained roughly constant since then. There is no ammonia emission from categories 6A4 Fire damages and 6A5 Accidental PCB release.

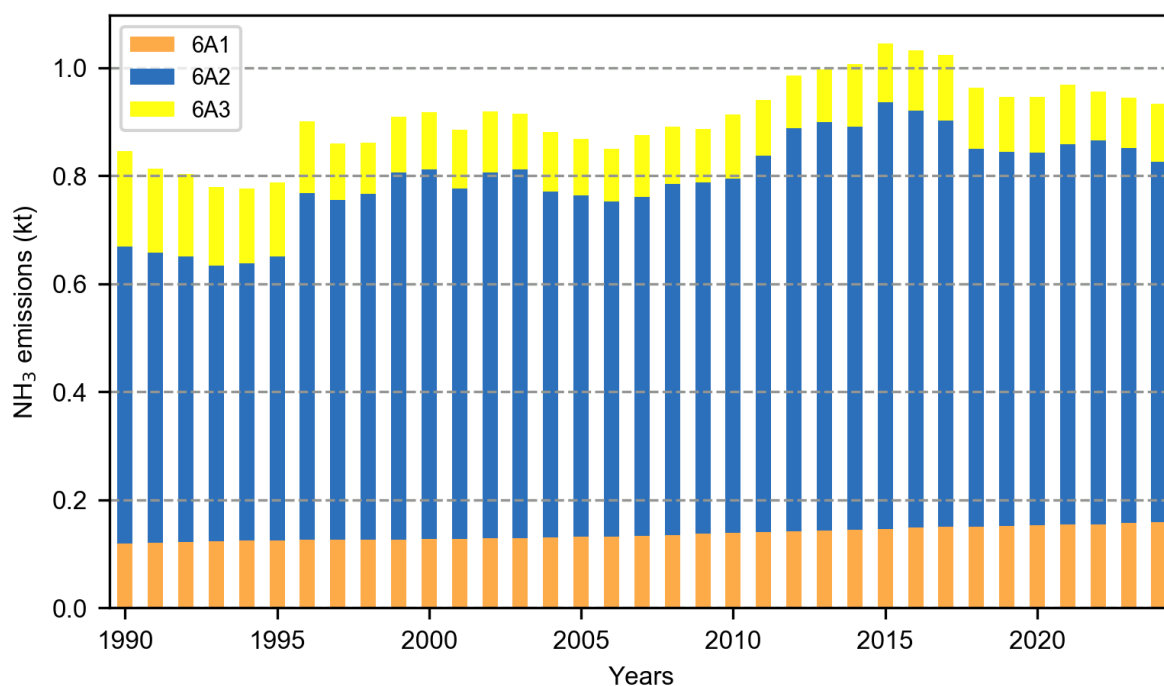


Figure 7-1 Switzerland's NH₃ emissions from sector 6 Other and natural emissions by source categories 6A1, 6A2 and 6A3. The corresponding data can be found in Table 7-1.

Table 7-1 NH₃ emissions from sector 6 Other by source categories 6A1, 6A2 and 6A3. The last column in the third part of the table indicates the relative trend.

NH ₃		1990	1995	2000	2005	2010
6A1	kt	0.12	0.12	0.13	0.13	0.14
6A2	kt	0.55	0.53	0.69	0.63	0.66
6A3	kt	0.18	0.14	0.11	0.10	0.12
6A4	kt	NA	NA	NA	NA	NA
Sum	kt	0.85	0.79	0.92	0.87	0.91

NH ₃		2015	2016	2017	2018	2019
6A1	kt	0.15	0.15	0.15	0.15	0.15
6A2	kt	0.79	0.77	0.75	0.70	0.69
6A3	kt	0.11	0.11	0.12	0.11	0.10
6A4	kt	NA	NA	NA	NA	NA
Sum	kt	1.0	1.0	1.0	0.96	0.95

NH ₃		2020	2021	2022	2023	2024	2005-2024 (%)
6A1	kt	0.15	0.15	0.16	0.16	0.16	21
6A2	kt	0.69	0.70	0.71	0.69	0.67	5.5
6A3	kt	0.10	0.11	0.091	0.094	0.11	2.2
6A4	kt	NA	NA	NA	NA	NA	-
Sum	kt	0.95	0.97	0.96	0.95	0.93	7.4

7.1.2 Overview and trend for NO_x

NO_x emissions from the source categories 6A2 Pets, 6A3 Fertilisers and 6A4 Fire damages buildings and motor vehicles between 1990 and 2024 are summarised in Figure 7-2. The contribution of sector 6A is very small in comparison to the national total and is not a key category for NO_x. The overall emissions fluctuate due to changes in the number of livestock outside agriculture (6A2) but remain at about the same (low) level within the reporting period.

For all years, 6A2 Pets and 6A3 Fertilisers contribute the most to total emissions. Emissions from 6A3 Fertilisers and 6A4 Fire damages buildings and motor vehicles show a slight decrease during the reporting period.

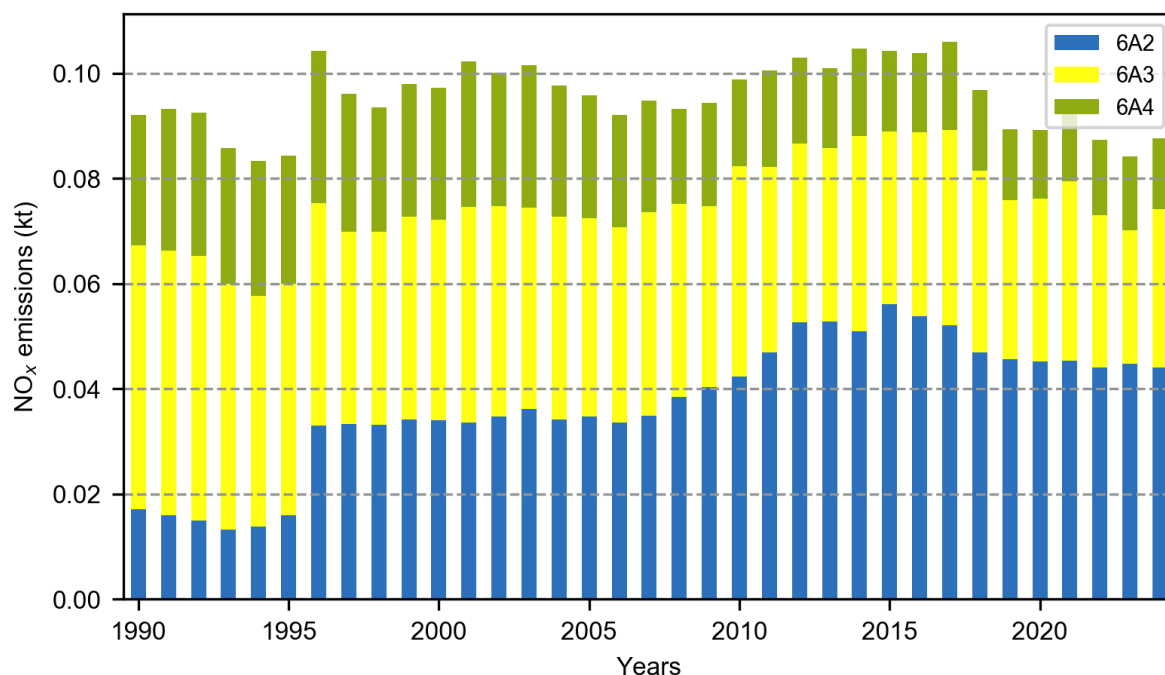


Figure 7-2 Switzerland's NO_x emissions from the sector 6 Other and natural emissions by source categories 6A2, 6A3 and 6A4. The corresponding data can be found in Table 7-2.

Table 7-2 NO_x emissions from sector 6 Other by source categories 6A2, 6A3 and 6A4. The last column in the third part of the table indicates the relative trend.

NO _x		1990	1995	2000	2005	2010
6A1	kt	NA	NA	NA	NA	NA
6A2	kt	0.017	0.016	0.034	0.035	0.042
6A3	kt	0.050	0.044	0.038	0.038	0.040
6A4	kt	0.025	0.024	0.025	0.023	0.016
Sum	kt	0.092	0.084	0.097	0.096	0.099

NO _x		2015	2016	2017	2018	2019
6A1	kt	NA	NA	NA	NA	NA
6A2	kt	0.056	0.054	0.052	0.047	0.046
6A3	kt	0.033	0.035	0.037	0.034	0.030
6A4	kt	0.015	0.015	0.017	0.015	0.013
Sum	kt	0.10	0.10	0.11	0.097	0.089

NO _x		2020	2021	2022	2023	2024	2005-2024 (%)
6A1	kt	NA	NA	NA	NA	NA	-
6A2	kt	0.045	0.045	0.044	0.045	0.044	27
6A3	kt	0.031	0.034	0.029	0.025	0.030	-20
6A4	kt	0.013	0.014	0.014	0.014	0.013	-43
Sum	kt	0.089	0.094	0.087	0.084	0.088	-8.6

7.1.3 Overview and trend for PM2.5

Figure 7-3 depicts the trend of PM2.5 emissions in sector 6 Other since 1990. The contribution of sector 6A is very small in comparison to the national total and is not a key category for PM2.5. Emissions from source category 6A2 Pets originate from livestock outside agriculture. They fluctuate due to changes in animal numbers and show an increasing trend from 2008 to 2015. Emissions from 6A4 Fire damages buildings and motor vehicles have a decreasing trend over the entire time period because the number of building fires is decreasing.

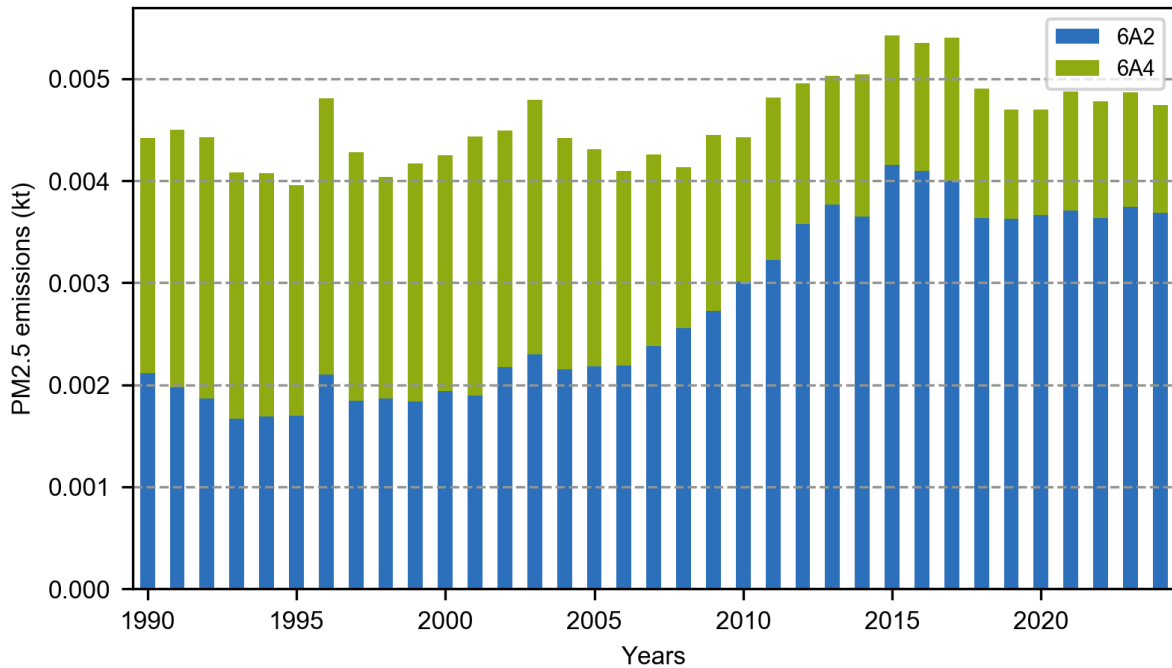


Figure 7-3 Switzerland's PM2.5 emissions from the sector 6 Other emissions. The corresponding data can be found in Table 7-3.

Table 7-3 PM2.5 emissions from sector 6 Other by source categories 6A2 and 6A4. The last column in the third part of the table indicates the relative trend.

PM2.5		1990	1995	2000	2005	2010
6A1	kt	NA	NA	NA	NA	NA
6A2	kt	0.0021	0.0017	0.0019	0.0022	0.0030
6A3	kt	NA	NA	NA	NA	NA
6A4	kt	0.0023	0.0023	0.0023	0.0021	0.0014
Sum	kt	0.0044	0.0040	0.0042	0.0043	0.0044

PM2.5		2015	2016	2017	2018	2019
6A1	kt	NA	NA	NA	NA	NA
6A2	kt	0.0042	0.0041	0.0040	0.0036	0.0036
6A3	kt	NA	NA	NA	NA	NA
6A4	kt	0.0013	0.0013	0.0014	0.0013	0.0011
Sum	kt	0.0054	0.0053	0.0054	0.0049	0.0047

PM2.5		2020	2021	2022	2023	2024	2005-2024 (%)
6A1	kt	NA	NA	NA	NA	NA	-
6A2	kt	0.0037	0.0037	0.0036	0.0037	0.0037	69
6A3	kt	NA	NA	NA	NA	NA	-
6A4	kt	0.0010	0.0012	0.0011	0.0011	0.0011	-50
Sum	kt	0.0047	0.0049	0.0048	0.0049	0.0047	10

7.1.4 Overview and trend for NMVOC from Forests

Figure 7-4 depicts the trend of NMVOC emissions in the sector 11C Other natural emissions since 1990 for various tree species. The emissions stem predominantly from Norway spruce, fir and oak stands. They are considerably high in comparison to the national total of NMVOC emissions. However, sector 11C is reported as a memo item only and is therefore not a key category for NMVOC. Total emissions in 1990 were 60.8 kt; they are increasing on average by 0.72 % per year. The annual fluctuations are due to the meteorological conditions, which influence the emission rates of the trees. The years 1990–2024 and 2050 were modelled using climate data.

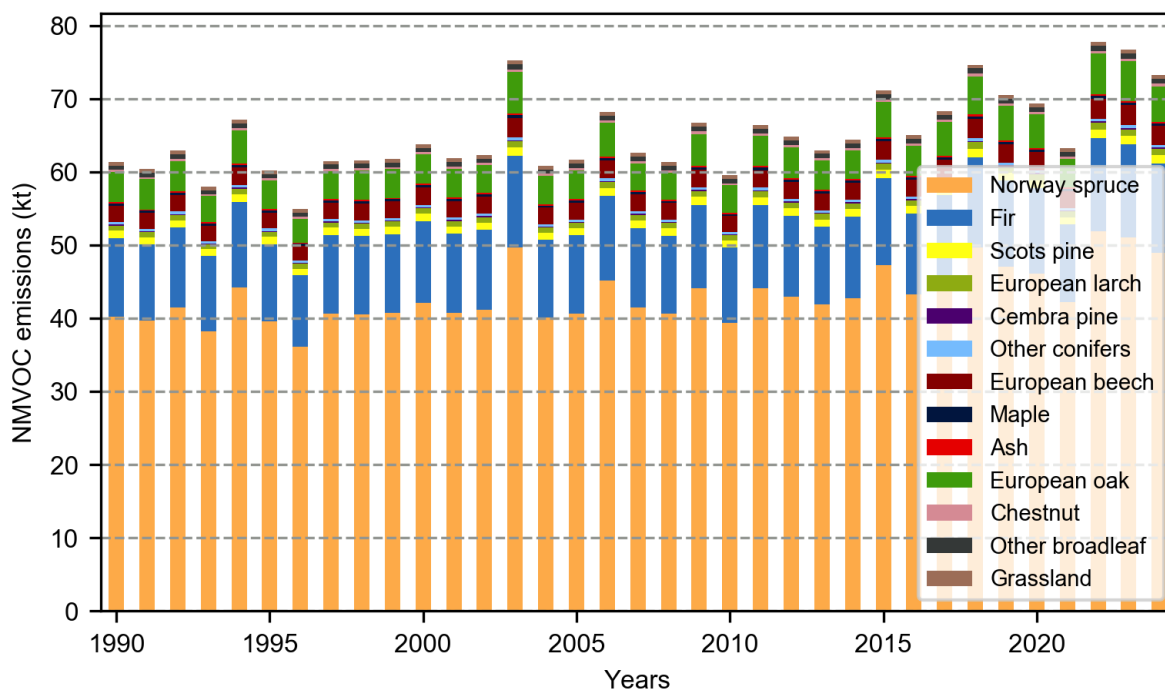


Figure 7-4 Switzerland's NMVOC emissions from the sector 11C Other natural emissions (forest stands).

7.2 Source category 6A - Other emissions

7.2.1 Source category description of 6A Other emissions

Within the sector 6 Other emissions, emissions from the sources as shown in Table 7-4 are considered.

Table 7-4 Specification of sector 6 Other emissions.

6A	Source category	Specification
6A1	Human emissions	NH3 emissions from respiration and transpiration and nappies
6A2	Pets and livestock outside agriculture	NOx, NMVOC, NH3, PM2.5, PM10 and TSP emissions of domestic and zoo animals and of livestock not included in sector 3 Agriculture
6A3	Private application of synthetic fertilizer and urea	NOx and NH3 emissions
6A4	Fire damages	Emissions from building fires and motor vehicle fires
6A5	Accidental PCB release	Emissions from accidental PCB releases by fire and to soil

Table 7-5 Key categories, approaches 1 and 2, level assessment 2024 (L1, L2) and trend assessment 1990-2024 (T1, T2) for source category 6A Other emissions.

NFR code	Source category	Pollutant	Identification criteria
6A	Other sources	NH3	L2, T2

7.2.2 Methodological issues of 6A Other emissions

Methodology (6A)

Human emissions (6A1)

Ammonia emissions of human respiration and transpiration and of diapers are considered.

Emissions from pets and livestock outside agriculture (6A2)

Ammonia emissions of domestic animals such as cats and dogs as well as of zoo animals are considered.

Emissions of NO_x, NMVOC, NH₃ and particulate matter (PM_{2.5}, PM₁₀ and TSP) from manure management of so-called livestock outside agriculture (asses, goats, horses and sheep) are considered. This livestock is not covered by the agricultural census as it consists of animals held for non-agricultural purposes (e.g., horses for sports and leisure) and/or livestock held by private persons or enterprises that do not fulfil the criteria of an agricultural enterprise. The methodology is the same as for animal husbandry in agriculture (see chp. 5.2.2).

Emissions from private fertiliser use (6A3)

The methodology for calculating emissions of NO_x and NH₃ from private use of inorganic N-fertiliser is the same as for fertilisers used in the agricultural sector (see chp. 5.3.2). The methodology for calculating NH₃ emissions from application of inorganic fertilisers in agriculture (source category 3Da1) is a Tier 2 approach of the EMEP/EEA guidebook (EMEP/EEA 2023) taking into account the specified list of fertilisers, climate zone and pH. Emission factors and activity data are given in Table 7-6 and Table 7-13, respectively.

Emissions from fire damage buildings and motor vehicles (6A4)

Activity data for 6A4 Fire damage buildings are estimated yearly based on the number of building fires reported to insurance companies for the given year. This information is annually published by the fire insurance association of the cantons (Vereinigung kantonaler Feuerversicherungen, VKF).

VKF publishes the number of fire incidents in buildings each year and the total sum of monetary damage. Using the data from 1992 to 2001, the average damage sum per fire incident in buildings amounts to approximately CHF 16'000. This corresponds – based on the assumption of typical damage costs of CHF 20'000 per 1'000 kg of burnt material – to 800 kg of flammable material per case. It is further assumed that on average 50 % of the flammable material gets destroyed during an incident because of the intervention of the fire brigade, yet without actually being set on fire. Thus, an average amount of 400 kg of burnt material per fire case is estimated and held constant throughout the time series. This is the same order of magnitude as the range of 272–417 kg of burnt material estimated based on a test fire as published in FM Global (2010). With these assumptions, the amount of burnt material for each year can be estimated using the total number of building fires published by VKF (EMIS 2026/6A), multiplied by the burnt material (400 kg) per fire incident. The resulting value of 9 kt burnt goods is used for the year 1990.

Activity data for 6A4 Fire damage motor vehicles are estimated yearly based on the vehicle number published annually by the Federal Statistical Office FSO (EMIS 2026/6A). Based on data from a Swiss insurance company with 25 % market share in 2002, the number of reported cases of fire damage to vehicles was extrapolated to the total vehicle number in Switzerland. This results in one fire case per 790 vehicles for the year 2002. It is assumed that this ratio has remained constant during the reporting period. By applying this ratio to the

actual vehicle number published annually by the FSO, the total number of vehicles with fire damages in Switzerland can be calculated for each year. During a car fire incident, a car burns down only partially. It is assumed that approximately 100 kg of material burns down during a car fire. With these assumptions, the total amount of material burnt can be calculated from the total number of cars in Switzerland.

Emissions from accidental release of PCBs by fire and to soil (6A5)

From all PCB usage in transformers, large and small capacitors, anti-corrosive paints and joint-sealants, PCBs can be accidentally released by fire or spilling to soil. These PCB emissions are modelled within the accidental release category of the dynamic mass flow model developed for the usage of PCBs in Switzerland (Glüge et al. 2017), see Annex A2.2.

Emission factors (6A)

The emission factors for the source categories 6A1 to 6A3 are depicted in Table 7-6 to Table 7-8. Emission factors for fertiliser see also Table 5-18.

Ammonia emissions (6A1-6A3)

Emission factors for human ammonia emissions are extracted from Sutton et al. (2000). Emission factors for pet (cats, dogs and zoo animals) ammonia emissions are retrieved from Reidy and Menzi (2005). The ammonia emission factors for livestock outside agriculture are derived from source category 3B – Manure management (see chp. 5.2.2).

NO_x, NMVOC, PM2.5, PM10 and TSP non-exhaust (6A2)

The emission factors for NO_x, NMVOC, PM2.5, PM10 and TSP from livestock outside agriculture are implied values based on emission factors of the respective animal categories (asses, goats, horses and sheep) in source categories 3B Manure management and 3D Agricultural soils (see chp. 5.2.2 and chp. 5.3.2).

Table 7-6 Emission factors for the year 2024 in sector 6A1 Other emissions, Humans (source EMIS 2026/6A).

6A1 Humans	Unit of activity data	NH3
		g/...
Aged inhabitants	persons	42
Children 1-3 years	children	15
Children <1 year	children	12
Human respiration	inhabitants	3.0
Human transpiration	inhabitants	14

Table 7-7 Emission factors for the year 2024 in sector 6A2 Other emissions, Pets (source EMIS 2026/6A).

6A2 Pets and livestock outside agriculture	Unit	NO _x	NMVOC	NH3	PM2.5 nx	PM10 nx	TSP nx
		g/...	g/...	g/...	g/...	g/...	g/...
Livestock outside agriculture	number	436	1'000	3'157	36	91	219
Cats	number	NA	NA	90	NA	NA	NA
Dogs	number	NA	NA	400	NA	NA	NA
Weight of zoo and circus animals	t	NA	NA	41'400	NA	NA	NA

Table 7-8 Emission factors for the year 2024 in sector 6A3 Other emissions, Fertilisers (source EMIS 2026/6A).

6A3 Fertilisers	Unit of activity data	NO _x	NH ₃
		g/...	g/...
Fertiliser use outside agriculture	kg N	18	64

Fire damages (6A4)

Fire damages buildings (EMIS 2026/6A Immobilienbraende): Emission factors for CO, NO_x and SO_x are country-specific based on measurements and expert estimates originally derived for illegal waste incineration. It is assumed that emissions are similar in fire damage in buildings. The emission factors for Cd and Hg are country-specific and based on measurements from a study about a cable recycling company in Switzerland (Graf 1990). For Pb, the emission factor is updated yearly and derived from a bottom-up estimation based on estimation of the fraction of new or renovated buildings (therefore without lead-containing paint) and a rough inventory of lead-containing items within a building. For Pb, the emission factor decreases gradually from 1990 until the reporting year, due to the progressive ban of lead in construction items and consumption goods, as enforced by the Chemical Risk Reduction Ordinance ORRChem. It is assumed that the PCDD/PCDF emission factor is the same as for illegal waste incineration. The emission factor for B(a)P is taken from USEPA 1998 (Table 4.10.5-1 Open burning of municipal refuse).

Fire damage motor vehicles (EMIS 2026/6A Fahrzeugbraende): The following emission factors are constant over the reporting period and derived from three scientific publications reporting estimations based on real car fire experiments:

- CO and NO_x (ADEME 2013, INERIS 2019)
- Heavy metals As, Cd, Cr, Cu, Hg, Ni, Se, Zn (Lönnermark and Blomqvist 2006 and ADEME 2013)
- PCB and PCDD/PCDF (INERIS 2019)

For Pb, the emission factor reported by Lönnermark and Blomqvist 2006 (820 g/t, car model from 1998) is significantly higher than the one reported in ADEME 2013 (31 g/t, car model between 2008 and 2013). This reported discrepancy may be explained by additional legal measures to decrease lead content in cars over the years. One such measure in Switzerland is the ban of lead as wheel weight that entered into force in 2005. We therefore use for Pb an emission factor that is yearly updated and computed as an average of the two published values, weighted by the fraction of cars in service since 2005.

The emission factor for NMVOC, PM₁₀, PM_{2.5} and SO_x are country-specific and based on measurements and expert estimates originally derived for wire burn off. The emission factors for PAH are determined by USEPA 1998 (chp. 4.10.2 Open burning of scrap tires). It is assumed that the emission factor for B(a)P is slightly higher than the study-based emission factor for B(a)P of car scrap due to higher B(a)P emission factor values of car tires.

Table 7-9 presents the emission factors used for the reporting year.

Table 7-9 Emission factors for fires reported under 6A4 Fire damages buildings and motor vehicles in 2024 as kg/t burned good and g/t burned good, respectively.

6A4 Fire damages	Unit of activity data	NOx	NM VOC	SOx	PM2.5 ex	PM10 ex	TSP ex	BC ex	CO
		g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
Building fire	t burnt material biogenic	2'500	16'000	750	250	25'000	30'000	18	100'000
Building fire	t burnt material fossil	2'500	16'000	750	250	25'000	30'000	18	100'000
Fire damage motor vehicles combustion	t burnt material fossil	4'500	2'000	5'000	100	1'000	70'050	7.0	51'750

6A4 Fire damages	Unit of activity data	Pb	Cd	Hg	PCDD/ PCDF	BaP	BbF	BkF	lcdP	PCB
		mg/...	mg/...	mg/...	ng I- Teq/...	mg/...	mg/...	mg/...	mg/...	mg/...
Building fire	t burnt material biogenic	387'000	200	100	160'000	0.34	0.20	0.27	0.100	NA
Building fire	t burnt material fossil	387'000	200	100	160'000	0.34	0.20	0.27	0.100	NA
Fire damage motor vehicles combustion	t burnt material fossil	94'692	955	383	395'000	50'000	30'000	40'000	15'000	0.027

Emissions from accidental release of PCBs (6A5)

The PCB emission factors from accidental release of PCBs by fire and to soil are expressed in units per tonnes of PCBs incinerated and stored in soil, respectively, see Table 7-10. They are based on the dynamic mass flow model for the usage of PCBs in Switzerland, see Annex A2.2.

Table 7-10 PCB emission factors for accidental release of PCB by fire and to soil, respectively, reported under 6A5 Other emissions in 2024 as mg/g released PCB.

6A5 Accidental release of PCB	Unit of activity data	PCB
		mg/...
Accidental release of PCB by fire	g PCB	100
Accidental release of PCB to soil	g PCB	0.36

Activity data (6A)

Human emissions (6A1)

Activity data for human ammonia emissions is retrieved from the Swiss Federal Statistical Office and consists of the number of inhabitants for the processes of respiration and transpiration. For emissions from diapers, the number of children younger than 1 year and 3 years, respectively, are taken into account, as well as the number of residents in nursing homes.

Table 7-11 Activity data causing N emissions in sector 6A1 Other emissions, Humans.

6A1 Humans	Unit	1990	1995	2000	2005	2010
Aged inhabitants	persons	9'000	9'752	10'504	15'442	17'357
Children 1-3 years	children	238'030	253'652	237'941	217'302	229'471
Children <1 year	children	83'939	82'203	78'458	72'903	80'290
Human respiration	inhabitants	6'712'000	7'041'000	7'184'000	7'437'000	7'825'000
Human transpiration	inhabitants	6'712'000	7'041'000	7'184'000	7'437'000	7'825'000

6A1 Humans	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Aged inhabitants	persons	19'278	19'244	19'793	20'337	20'661	19'827	19'946	21'079	21'276	21'385
Children 1-3 years	children	250'182	254'577	259'729	261'823	263'115	261'404	259'937	261'730	257'929	252'039
Children <1 year	children	86'559	87'883	87'381	87'851	86'172	85'914	89'644	82'371	80'024	78'256
Human respiration	inhabitants	8'282'000	8'373'000	8'452'000	8'514'000	8'575'000	8'638'000	8'705'000	8'777'000	8'889'000	9'007'000
Human transpiration	inhabitants	8'282'000	8'373'000	8'452'000	8'514'000	8'575'000	8'638'000	8'705'000	8'777'000	8'889'000	9'007'000

Pets and livestock outside agriculture (6A2)

Activity data for pet ammonia as well as NO_x, NMVOC, PM2.5, PM10 and TSP emissions (for livestock outside agriculture) are the number of domestic animals and the total live weight of zoo animals, respectively. For domestic animals, different publications are used as a source.

The number of the most important category of dogs and cats is provided by the Swiss Association for pet food⁷.

Table 7-12 Activity data in sector 6A2 Other emissions, Pets.

6A2 Pets and livestock outside agriculture	Unit	1990	1995	2000	2005	2010							
Livestock outside agriculture	number	16'326	18'649	88'285	89'276	95'332							
Cats	number	1'164'786	1'205'000	1'379'000	1'417'000	1'507'000							
Dogs	number	456'015	438'000	513'000	487'000	445'000							
Weight of zoo and circus animals	t	140	140	140	140	140							

6A2 Pets and livestock outside agriculture	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Livestock outside agriculture	number	120'094	113'379	109'783	107'715	103'135	102'173	102'912	100'749	101'637	101'239
Cats	number	1'655'951	1'655'951	1'645'096	1'634'240	1'678'277	1'722'313	1'788'036	1'853'759	1'682'880	1'512'000
Dogs	number	521'891	521'891	513'816	505'740	504'375	503'009	523'734	544'459	529'730	515'000
Weight of zoo and circus animals	t	140	140	140	140	140	140	140	140	140	140

Emissions from private fertiliser use (6A3)

For 6A3 only mineral fertilisers (no urea-based fertilisers) are used for private applications outside agriculture.

Table 7-13 Activity data causing N emissions in sector 6 Other emissions.

6A3 Fertilisers	Unit	1990	1995	2000	2005	2010						
Fertiliser use outside agriculture	t N	2'778	2'432	2'111	2'087	2'212						

6A3 Fertilisers	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Fertiliser use outside agriculture	t N	1'823	1'933	2'057	1'907	1'673	1'712	1'890	1'601	1'405	1'664

Fire damages (6A4)

Activity data for source category 6A4 Fire damages are given in Table 7-14.

Table 7-14 Activity data in source category 6A4 Fire damages: Burnt goods (source EMIS 2026/6A).

6A4 Fire damages	Unit	1990	1995	2000	2005	2010						
Building fire	kt burnt material biogenic	2.9	2.3	1.8	1.6	1.1						
Building fire	kt burnt material fossil	6.1	6.5	7.2	6.6	4.3						
Fire damage motor vehicles combustion	kt burnt material fossil	0.48	0.52	0.58	0.64	0.68						

6A4 Fire damages	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Building fire	kt burnt material biogenic	0.95	0.94	1.1	0.95	0.79	0.76	0.87	0.85	0.83	0.78
Building fire	kt burnt material fossil	3.8	3.8	4.2	3.8	3.2	3.0	3.5	3.4	3.3	3.1
Fire damage motor vehicles combustion	kt burnt material fossil	0.75	0.76	0.77	0.77	0.78	0.79	0.80	0.81	0.82	0.82

Accidental release of PCBs (6A5)

Activity data for source category 6A5 Accidental release of PCBs by fire and to soil are given in Table 7-15. The activity data are the amounts of PCBs incinerated and stored in soil, respectively, based on the dynamic mass flow model for the usage of PCBs in Switzerland, see Annex A2.2.

⁷Verband für Heimtiernahrung VHN (<http://www.vhn.ch/>)

Table 7-15 Activity data in source category 6A5 Accidental release of PCB (source EMIS 2026/6A).

6A5 Accidental release of PCB	Unit	1990	1995	2000	2005	2010
Accidental release of PCB by fire	t PCB	2.4	1.7	1.1	0.70	0.43
Accidental release of PCB to soil	t PCB	39	41	41	41	41

6A5 Accidental release of PCB	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Accidental release of PCB by fire	t PCB	0.26	0.24	0.22	0.20	0.18	0.16	0.14	0.13	0.11	0.10
Accidental release of PCB to soil	t PCB	40	40	40	40	40	40	40	39	39	39

7.2.3 Recalculations in 6A Other emissions

The following recalculations were implemented in submission 2026:

- 6A1 Aged inhabitants: The activity data for the years 2001-2009, 2013, 2022 and 2023 were adjusted due to changes in the underlying statistics provided by the FSO. The difference for the years 2001-2008 was between 8 % and 51 %. For all other values, the change from previously reported values was below 2 %.
- 6A2: The emission factors of NO_x and NH₃ from manure management and grazing of livestock outside agriculture were recalculated for 1995-2023 and 1990-2023, respectively, due to an update of the AGRAMMON model.
- 6A2: The emission factors of NMVOC, PM2.5, PM10 and TSP of livestock outside agriculture were revised for 2023, and 1990-2023, respectively, due to an update of the AGRAMMON model.
- 6A2 Cats: The activity data for 2023 was adjusted following a new data collection, resulting in a 10 % decrease from the previous value.
- 6A2 Dogs: The activity data for 2023 was adjusted following a new data collection, resulting in a 3 % decrease from the previous value.
- 6A3: There are minimal changes in the NH₃ emission factors of inorganic N- fertilisers for domestic use in the years 1990-2023.
- 6A4 Building fire (burnt material fossil): The activity data was updated due to changes in the underlying statistics provided by the FSO. The difference from the previously reported values across the entire timeseries is less than 0.1 %.
- 6A4 Building fires (burnt material biogenic): The activity data was updated due to changes in the underlying statistics provided by the FSO. The difference from the previously reported values across the entire timeseries is less than 0.1 %.

7.3 Source category 11B - Forest fires

7.3.1 Source category description of 11B Forest fires

Within 11B Forest fires, emissions of NO_x, NMVOC, SO_x, NH₃, particulate matter, CO, Pb, Cd, Hg, PCDD/PCDF and PAH are reported.

Table 7-16 Specification of source category 11B Forest fires in Switzerland.

11B	Source category	Specification
11B	Forest fires	Emissions from natural wildfires on forest land and grassland; Emissions from open burning of natural residues in forestry

Note that emissions are reported under 11B Natural emissions but are not accounted for in the national totals and are reported as memo item only. In the greenhouse gas inventory, wildfires are reported in sector 4(IV).

As a consequence of the greenhouse gas inventory UNFCCC in-country review 2016, greenhouse gas emissions from open burning of natural residues in forestry (5C2ii) was moved from sector 5C to sector 4(IV)A1. The corresponding air pollutant emissions are reported here within source category 11B.

7.3.2 Methodology of 11B Forest fires

For calculating emissions from forest fires, a country-specific Tier 2 method is used (see the decision tree in chapter 11B Forest fires in the EMEP/EEA guidebook (EMEP/EEA 2023)). Emissions of wildfires are calculated by multiplying the annual area of forest and grassland burnt by the appropriate emission factors.

For the calculation of emissions from burning of silvicultural residues, a country-specific Tier 2 method is used (see the decision tree in chapter 5C2 Open burning of waste, EMEP/EEA 2023).

Emission factors (11B)

For forest fires, the emission factors for air pollutants NO_x, NMVOC, SO_x, NH₃, PM2.5, PM10, TSP, BC and CO are computed using the ratio to the carbon emission factor provided in the EMEP guidebook (EMEP/EEA 2023, chp. 11B Forest Fires, Table 3-3). The carbon emission factor is computed as part of the LULUCF model for Switzerland's greenhouse gas inventory, therefore ensuring consistency between the two inventories. Further emission factors are documented in the EMIS documentation (EMIS 2026/4VA1-11B-NFR_Waldbrände).

For burnt grassland, the emission factors are assumed constant over time.

Emission factors for open burning of natural residues in forestry are taken from EMEP guidebook (EMEP/EEA 2023, chp. 5.C.2, table 3-2) and USEPA as documented in EMIS 2026/5C2 Abfallverbrennung Land- und Forstwirtschaft.

Table 7-17 Emission factors 2024 of 11B Forest fires, grassland fires and open burning of natural residues in forestry.

11B Forest fires	Unit of activity data	NOx	NMVOC	SOx	NH3	PM2.5 ex	PM10 ex	TSP ex	BC ex	CO
		g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...	g/...
Forest wildfires	ha area burned	508'955	1'336'010	101'791	114'515	1'145'150	1'399'630	2'163'060	103'064	14'632'500
Grassland wildfires	ha area burned	58'016	152'292	11'603	13'054	145'040	177'271	273'964	13'054	1'667'960
Open burning of natural residues in forestry	t burned wood	1'380	1'470	30	800	3'760	4'130	4'310	348	48'790

11B Forest fires	Unit of activity data	Pb	Cd	Hg	PCDD/ PCDF	BaP	BbF	BkF	IcdP
		mg/...	mg/...	mg/...	ng I- Teq/...	mg/...	mg/...	mg/...	mg/...
Forest wildfires	ha area burned	NE	NE	1'400	400'000	80'000	140'000	140'000	180'000
Grassland wildfires	ha area burned	NE	NE	1'400	400'000	80'000	140'000	140'000	180'000
Open burning of natural residues in forestry	t burned wood	320	130	60	10'000	3'150	6'450	5'150	1'700

Activity data (11B)

The area of forest land and grassland burnt is provided by swissfire, a database of wildfires managed by the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL). For the years since 1990, the swissfire database is also used in the GHGI (FOEN 2026). Burned grassland areas also include woody grassland.

The activity data for burning of silvicultural residues is estimated based on a study conducted by INFRAS (2014). The burned quantity of silvicultural residues is decreasing since 1990

since legal burning is more strongly restricted, especially since the last revision of the corresponding article in the Swiss Federal Ordinance on Air Pollution Control in the year 2009 (Swiss Confederation 1985 as of 1 January 2009).

Table 7-18 Activity data of 11B Forest fires, grassland fires and open burning of natural residues in forestry.

11B Forest fires	Unit	1990	1995	2000	2005	2010					
Forest wildfires	ha area burned	1'067	363	58	41	29					
Grassland wildfires	ha area burned	637	82	22	20	1.3					
Open burning of natural residues in forestry	kt burned wood	34	28	23	17	11					

11B Forest fires	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Forest wildfires	ha area burned	45	256	110	58	17	15	27	274	81	32
Grassland wildfires	ha area burned	14	213	38	32	16	31	9.9	63	9.1	11
Open burning of natural residues in forestry	kt burned wood	11	11	11	11	11	10	10	10	10	10

7.3.3 Recalculations in 11B Forest fires

The following recalculations were implemented in submission 2026:

- 11B Forest and grassland wildfires: The emission factors for forest fires and grassland fires for NO_x, NMVOC, SO_x, NH₃, PM2.5, PM10, TSP, BC and CO, have been reassessed for the years 1990-2023, using the carbon emission factor computed as part of the LULUCF model for Switzerland's greenhouse gas inventory, therefore ensuring consistency between the two inventories. In addition, instead of using various literature sources, emission factors for all listed pollutants are now consistently taken from the EMEP Guidebook. Changes are significant and the resulting emissions have increased by a factor of approximately 6 for NO_x and CO, 2.7 for NH₃, 2.6 for NMVOC, 2.2 for SO_x, and 1.1 for PM2.5, PM10, TSP and BC.
- 11B Forest and grassland wildfires: The activity data for source category 11B wildfires were updated based on improvements in the swissfire database. This leads to a recalculation in the years 1996, 1997, 2010, 2011 and 2023 for forests and in 2011 and 2023 for grassland.

7.4 Category 11C – Other natural emissions

7.4.1 Category description of 11C Other natural emissions

Within 11C Other natural emissions, NMVOC emissions of Swiss forest stands are reported for different tree species. 11C also includes NMVOC emissions from natural grassland.

Note that emissions are reported under Natural emissions (11C) but are not accounted for in the national totals and are reported as memo item only.

Table 7-19 Specification of source category 11C Other natural emissions in Switzerland.

11C	Source category	Specification
11C	Other natural emissions	Natural NMVOC emissions from forest trees; NMVOC emissions from natural grassland

7.4.2 Methodology of 11C Other natural emissions

The biogenic NMVOC emissions from forests were calculated for the years 1900-2024 and 2050 on the basis of monthly maps for the parameters temperature, vegetation period and for 12 different tree species (Meteotest 2019a, EMIS 2026/11C Wald). This corresponds to the simplified method according to chapter 11C (B1101 Non-managed & managed forests) in the EMEP/EEA guidebook (EMEP/EEA 2023) which represents a Tier 2 approach. With the

method used, the emissions for isoprene, monoterpene and OVOC (Oxygenated VOC) could be modelled for each month with a spatial resolution of 100 x 100 m.

The NMVOC emission of natural grassland is 0.51 kt yr⁻¹ for all years according to SAEFL (1996a).

Emission factors (11C)

Emission factors for NMVOC emissions of different tree species are specified in the EMIS database (Table 7-20). They represent annual implied emission factors derived from the monthly emission maps.

Table 7-20 Implied emission factors 2024 of 11C NMVOC for different tree species.

11C Other natural emissions	Unit of activity data	NMVOC
		g/...
Natural emissions from forest	ha Norway spruce	83'482
Natural emissions from forest	ha fir	86'843
Natural emissions from forest	ha Scots pine	22'483
Natural emissions from forest	ha European larch	10'697
Natural emissions from forest	ha Cembra pine	14'566
Natural emissions from forest	ha Other conifers	115'313
Natural emissions from forest	ha European beech	11'012
Natural emissions from forest	ha maple	21'781
Natural emissions from forest	ha ash	8'035
Natural emissions from forest	ha European oak	192'874
Natural emissions from forest	ha chestnut	12'513
Natural emissions from forest	ha other broadleaf	10'964

Figure 7-5 shows the time series of emission factors for a coniferous species and a broadleaf species. The interannual variation is due to the monthly climatic data used in the model (Meteotest 2019a, EMIS 2026/11C Wald).

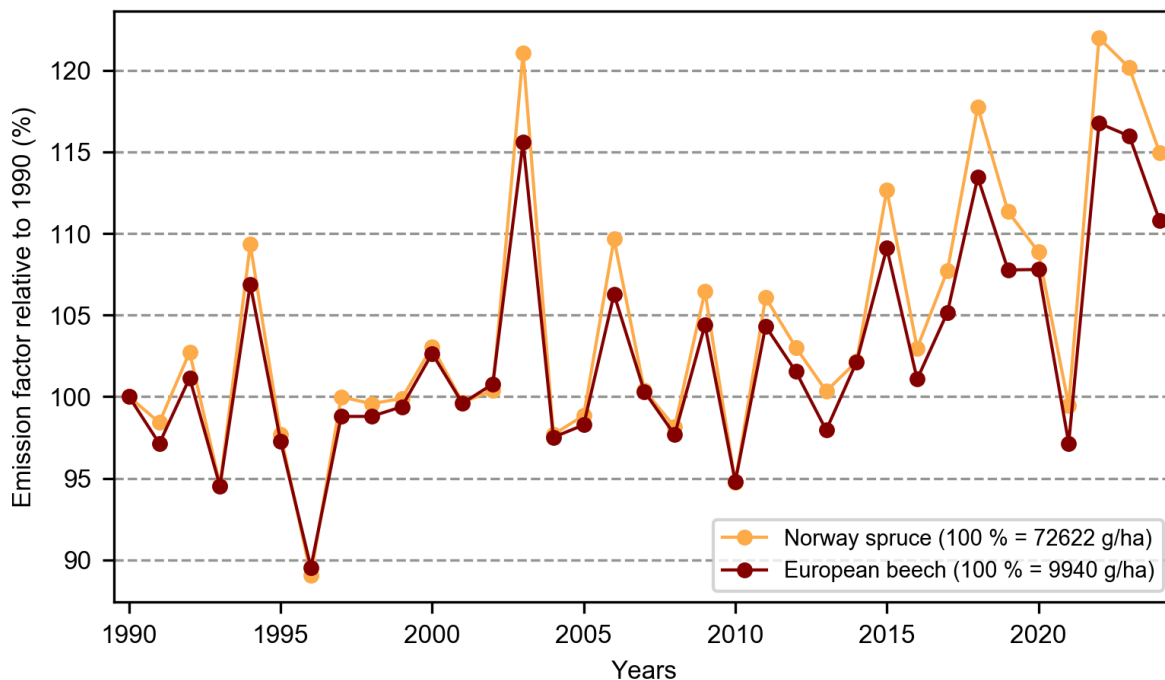


Figure 7-5 Relative trends of the (implied) NMVOC emission factors for two selected tree species 1990-2024.

Activity data (11C)

On the basis of several forest and area statistics, the area proportions of the various tree species and their temporal change over the years could be determined (Metetest 2019a) as shown in Table 7-21.

Table 7-21 Activity data of 11C; forest areas covered by the twelve main tree species.

11C Other natural emissions	Unit	1990	1995	2000	2005	2010
Total	ha	1'211'651	1'220'183	1'229'051	1'237'835	1'247'057
Natural emissions from forest	ha Norway spruce	554'168	558'151	562'292	566'457	571'778
Natural emissions from forest	ha fir	138'196	138'374	138'497	138'634	138'930
Natural emissions from forest	ha Scots pine	49'503	49'823	50'136	50'400	50'688
Natural emissions from forest	ha European larch	73'421	74'919	76'432	77'933	79'282
Natural emissions from forest	ha Cembra pine	11'025	11'261	11'502	11'745	11'964
Natural emissions from forest	ha Other conifers	3'257	3'261	3'268	3'269	3'278
Natural emissions from forest	ha European beech	226'751	227'722	228'738	229'799	230'716
Natural emissions from forest	ha maple	15'325	15'461	15'614	15'729	15'857
Natural emissions from forest	ha ash	28'555	28'655	28'782	28'911	28'991
Natural emissions from forest	ha European oak	24'911	24'919	24'978	25'023	25'027
Natural emissions from forest	ha chestnut	26'877	27'097	27'353	27'578	27'674
Natural emissions from forest	ha other broadleaf	59'662	60'540	61'459	62'357	62'872

11C Other natural emissions	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total	ha	1'256'307	1'258'136	1'260'026	1'261'840	1'263'687	1'265'518	1'267'457	1'269'355	1'269'784	1'271'553
Natural emissions from forest	ha Norway spruce	577'328	578'465	579'544	580'618	581'777	582'896	584'087	585'229	585'405	586'455
Natural emissions from forest	ha fir	139'295	139'380	139'463	139'535	139'606	139'670	139'725	139'793	139'819	139'910
Natural emissions from forest	ha Scots pine	51'002	51'056	51'119	51'163	51'219	51'269	51'343	51'418	51'382	51'436
Natural emissions from forest	ha European larch	80'532	80'733	81'007	81'244	81'478	81'748	82'013	82'274	82'294	82'533
Natural emissions from forest	ha Cembra pine	12'196	12'241	12'296	12'353	12'395	12'442	12'505	12'552	12'550	12'598
Natural emissions from forest	ha Other conifers	3'288	3'292	3'295	3'299	3'303	3'306	3'316	3'318	3'308	3'314
Natural emissions from forest	ha European beech	231'609	231'780	231'974	232'161	232'314	232'462	232'615	232'790	232'903	233'056
Natural emissions from forest	ha maple	16'007	16'039	16'067	16'095	16'125	16'158	16'180	16'210	16'238	16'265
Natural emissions from forest	ha ash	29'047	29'062	29'082	29'095	29'109	29'128	29'154	29'167	29'223	29'244
Natural emissions from forest	ha European oak	25'040	25'041	25'043	25'047	25'051	25'052	25'055	25'058	25'062	25'065
Natural emissions from forest	ha chestnut	27'700	27'706	27'715	27'724	27'731	27'739	27'741	27'750	27'753	27'758
Natural emissions from forest	ha other broadleaf	63'263	63'341	63'421	63'506	63'579	63'648	63'723	63'796	63'847	63'919

7.4.3 Recalculations in 11C Other natural emissions

The following recalculations were implemented in submission 2026:

- 11C Natural emissions: the emission factors for all tree species for forest emissions of NMVOC have been updated for the years 2021 and 2022 because of a rounding issue and for the years 2023-2024 because of a model update. The absolute difference from the previous reported values is less than 1 % for the years 2021-2022, less than 3 % for 2023 and up to 12 % for the year 2024.
- 11C Natural emissions: the activity data for all tree species for forest emissions of NMVOC have been updated for the years 2023-2024 because of a model update. The absolute difference from the previous reported values is less than 1 % for 2023 and 2024.

8 Recalculations and planned improvements

8.1 Recalculations

Several recalculations had to be carried out due to improvements in several sectors. They are listed sorted by sector in the following enumerations. Improvements realised for this submission and leading to recalculations are described in chp. 1.4.1.

8.1.1 1 Energy

8.1.1.1 Category specific recalculations for 1A1 Energy industries (stationary)

- 1A1a: The SO_x emission factor for natural gas has been updated in the period 2016-2023 to reflect the sulphur content of the gas after the odorant addition, rather than before.
- 1A1a: Based on recalculations in the Swiss overall energy statistics, yearly amounts of around 630 to 840 TJ of natural gas have been reallocated from 1A4 Other Sectors commercial/institutional to 1A1a Public electricity and heat production for the years 2020-2023.
- 1A1a: The activity data of 1A1a Public electricity and heat production, for landfill gas production, was revised due to an update in the underlying national statistics.
- 1A1a: In source category 1A2gviii, the activity data of combined chip heat and power plants were revised for 2019 and 2023 as well as of plants for renewable waste from wood products for 2023 due to recalculations in the Swiss wood energy statistics (SFOE 2025b).
- 1A1a: The fuel consumption of gas oil in 1A1a electricity generation was revised for the year 2023 due to an update in the underlying statistics of the national energy balance.
- 1A1aii Combined heat and power generation: Due to an error in the aggregation in the EMIS database, emissions were wrongly attributed to source category 1A1aii instead of 1A2gviii, for liquified petroleum gas. This correction affects all years from 1990 to 2023.
- 1A1b: The SO_x emission factor of natural gas for the period 2016-2023 has been updated to reflect the sulphur content of the gas after the odorant addition, rather than before.
- 1A1b Petroleum refining refinery residual fuel oil: The computational steps were reorganized to streamline the model, resulting in minor rounding changes for the years 1990-2019 and 2021.
- 1A1b Petroleum refining refinery gas: The computational steps were reorganized to streamline the model, resulting in minor rounding changes for the years 1990-2023.
- 1A1b Petroleum refining petroleum coke: The computational steps were reorganized to streamline the model, resulting in minor rounding changes for the years 2004-2015.
- 1A1c: The activity data of 1A1c Charcoal production was updated for 2023 based on information provided by individual charcoal producers.

8.1.1.2 Category-specific recalculations for 1A2 Stationary combustion in manufacturing industries and construction

- 1A2: The SO_x emission factor of natural gas has been updated for the period 2016-2023 to reflect the sulphur content of the gas after the odorant addition, rather than before.
- 1A2: There are recalculations in all source categories 1A2a to 1A2g in the years 2020-2023 due to reallocations of natural gas and gas oil within these categories of 1A2

Manufacturing industries and construction. The reason is that during the surveys for the energy consumption statistics in the industry and services sectors for the most recent year, the reports from the previous year are reviewed again and, if necessary, adjusted retroactively. Generally, this only affects the disaggregation and not the total amount of fuels used in 1A2 Manufacturing industries and construction for that year. However, additional recalculations were introduced in the overall energy statistics with regard to the total fuel consumption in the industry sector for natural gas (2020–2023).

- 1A2d: Due to an error in the model calculation, there was a double counting of natural gas consumption from gas turbines in 1A2d - Manufacturing industries Pulp, paper and print, for the years 1993-2015.
- 1A2f Cement production: The emission factors for NO_x, NMVOC, SO_x, NH₃, PM2.5, PM10 and TSP have been updated based on measurement reports at the factory level, for each year 2018-2023. Minimum and maximum changes in percentage per pollutant are: NO_x: [+0.3; +5]; NMVOC: [40; 10]; SO_x: [-40; -15]; NH₃: [-23; 23]; PM2.5: [-50; -8]; PM10: [-37; -3]; TSP: [40; 8].
- 1A2f: In the model to compute fuel consumption for cement production, the number of significant digits was harmonized. This caused minor value changes from 1990 until 2023 of less than 1 %.
- 1A2f: Due to updates in the underlying data reported by the factories, the fuel consumption for cement production was updated causing changes of less than 2 % for the following fuels and years. Year 2022: other bituminous coal, petroleum coke; year 2023: waste oil, waste tyres, plastics, solvents and residues from distillation, wood waste, animal meal.
- 1A2f: As the activity data (gas oil) of 1A2f Fine ceramics production was revised for the years 2010-2019, the BC emission factor, which is calculated based on the fuel mix, has also changed.
- 1A2f: The last year's extrapolated production volume of mixed goods for 2023 was replaced by the actual production figure reported by the industry association yielding revised activity data for 1A2f Mixed goods production in 2023.
- 1A2g: The fuel use of petroleum coke 2022-2023 assigned to boilers in 1A2g has been reassessed because of an update in the underlying statistics of the national energy balance.
- 1A2g: The activity data of 1A2gviii Boiler, gas oil for the years 2010-2029 and 2023 and of 1A2gviii Boiler, natural gas for 2023 were revised due to recalculations in the activity data of source category 1A2f Fine ceramics production (gas oil) in the years 2010-2019 and of source category 1A2f Mixed goods production (natural gas, gas oil) in 2023. Also, the activity data of 1A2gviii Boiler, other bituminous coal for 2022-2023 were revised due to recalculations in the fuel consumption (other bituminous coal) of source category 1A2a Secondary steel production, electric arc furnace in the years 2022-2023.
- 1A2gviii: The activity data of 1A2gviii Boilers, liquefied petroleum gas were revised for the years 2021 to 2023 due changes in the activity data of 1A2gvii Industrial machinery, liquefied petroleum gas for the years 2021 to 2023.
- 1A2gviii: Due to an error in the aggregation in the EMIS database, a part of the emissions for source category 1A2gviii, for liquified petroleum gas, was missing. This correction affects all years from 1990 to 2023.
- 1A2gviii: The activity data of automatic wood combustion installations (≥ 50 kW) in source category 1A2gviii were revised for 2010-2023 due to recalculations in the Swiss wood energy statistics (SFOE 2025b), with the largest changes occurring in 2023.

8.1.1.3 Category-specific recalculations for 1A4 Stationary combustion in other sectors (commercial, residential, agriculture and forestry)

- 1A4: The SO_x emission factor for the period 2016-2023 has been updated to reflect the sulphur content of the gas after the odorant addition, rather than before.
- 1A4/1A1a: Based on recalculations in the Swiss overall energy statistics yearly amounts of around 630 to 840 TJ natural gas has been reallocated from 1A4 Other Sectors commercial/institutional to 1A1a Public electricity and heat production for the years 2020-2023.
- 1A4a, 1A4b: The fuel consumption of gas oil in 1A4ai and 1A4bi was revised for the years 2020-2023 due to an update in the underlying statistics of the national energy balance.
- 1A4: The activity data of automatic wood combustion installations (≥ 50 kW) in source categories 1A4ai, 1A4bi and 1A4ci were revised for 2010-2023 due to recalculations in the Swiss wood energy statistics (SFOE 2025b). There were also recalculations in 2023 for open fireplaces and log wood stoves (1A4ai, 1A4bi).
- 1A4a: The activity data for 1A4ai for biogas (sewage gas) use in wastewater treatment plants have been updated for the years 1990-2019 because of a rounding issue; the activity data for sewage gas and biogas for the years 2020-2023 have been updated according to the latest available statistics.
- 1A4ai: Activity data of mobile pellet combustion installations were revised for the years 2015, 2016, 2021 and 2023 due to recalculations in the Swiss wood energy statistics publication (SFOE 2025b, chp. 1.3).
- 1A4ai: Activity data for biogas consumption in commercial/institutional stationary boilers has been reassessed and strongly reduced because of a previous computation mistake in the national energy balance.
- 1A4bi: The activity data of 1A4bi Charcoal consumption was revised for 2023 based on updated production figures derived from information provided by individual charcoal producers.

8.1.1.4 Category-specific recalculations for 1A2 Mobile combustion in manufacturing industry and construction (1A2gvii)

- 1A2gvii: The consumption of biodiesel (fossil and biogenic) has been set to zero for the year 1996 to insure compatibility with the national statistics. Values linearly interpolated until the next data point in 2000 are affected as well.

8.1.1.5 Category-specific recalculations for 1A3 Transport

- 1A3ai(i) International aviation LTO (civil), 1A3aii(i) Domestic aviation LTO (civil), 1A3aii(ii) Domestic aviation Cruise: The emission factors were imported with more significant digits, and the difference is below 0.01 %.
- 1A3b: Activity data and emission factors have been updated for the years 1990-2023 because of the underlying fleet development data which have been updated to HBEFA version 5.1 (INFRAS 2025, 2025a).
- 1A3b: The entire traffic statistics have been renewed (so-called ex-post analysis, SFOE 2025e) which led to a recalculation of all activity data for the road sector.
- 1A3b: The SO_x emission factor for the period 2016-2023 has been updated to reflect the sulphur content of the gas after the odorant addition, rather than before.

- 1A3b: The fleet weighting of diurnal and soak emissions (evaporation from gasoline engines) was changed from mileage to vehicle stock weights. This leads to overall slightly increased gasoline evaporation.
- 1A3biii: Activity data for gasoline buses have been set to zero for the entire time period 1990-2024 and transferred to diesel buses. The existence of gasoline buses in previous submission was due to a classification error between the fleet database of ASTRA and the one for the road model (HBEFA).
- 1A3bvi, non-exhaust emissions of particulate matter: Due to an error in the aggregation in the EMIS database, a part of the non-exhaust emissions for source category 1A3bvi was missing. This correction affects all years from 1990 to 2023.
- 1A3c: The consumption of biodiesel (fossil and biogenic) has been set to zero for the year 1996 to insure compatibility with the national statistics. Values linearly interpolated until the next data point in 2000 are affected as well.
- 1A3d: The consumption of biodiesel (fossil and biogenic) has been set to zero for the year 1996 to insure compatibility with the national statistics. Values linearly interpolated until the next data point in 2000 are affected as well.
- 1A3e: The SO_x emission factor for the period 2016-2023 has been updated to reflect the sulphur content of the gas after the odorant addition, rather than before.

8.1.1.6 Category-specific recalculations for 1A4 Non-road and machinery in other sectors (commercial, residential, agriculture and forestry)

- 1A4c: The consumption of biodiesel (fossil and biogenic) has been set to zero for the year 1996 to ensure compatibility with the national statistics. Values linearly interpolated until the next data point in 2000 are also affected.

8.1.1.7 Category-specific recalculations for 1A5b Other, mobile (Military)

- 1A5bi Military aviation: The activity data for the years 2004 and 2010-2012 were adapted due to changes in the underlying statistics. The difference was below 0.1%.
- 1A5b: The consumption of biodiesel (fossil and biogenic) has been set to zero for the year 1996 to ensure compatibility with the national statistics. Values linearly interpolated until the next data point in 2000 are also affected.

8.1.1.8 Category-specific recalculations for 1B Fugitive emissions from fuels

- 1B2a: Small recalculation of NMVOC emissions from leakage in refineries. The total emission of NMVOC emissions in the Swiss Refinery was adapted to the latest reported total emissions in the Swiss PRTR database for the years 2019-2023.
- 1B2b: Correction of calculation lead to around 2'380 GJ less natural gas losses in the year 2023.

8.1.2 2 Industrial processes and product use

8.1.2.1 Category-specific recalculations in 2A Mineral products

- 2A5a Gravel plants: The last year's extrapolated activity data for 2023 was updated based on the actual production figure of the industry association.

8.1.2.2 Category-specific recalculations in 2B Chemical industry

- 2B10a: For source category 2B10a Niacin production, the emission factors of NO_x and CO were revised for the years 2022 and 2023 based on emission measurement data from 2024.

8.1.2.3 Category-specific recalculations in 2C Metal production

- 2C7c: Due to the adjustment of the projections period from 2025–2050 to 2030–2050, the linearly interpolated activity data for the years 2013-2023 of galvanizing plants changed.

8.1.2.4 Category-specific recalculations in 2D Other solvent use

- 2D3a: The population figure for 2022 was revised resulting in a recalculation of the activity data in 2D3a Domestic solvent use in 2022.
- 2D3b: The last year's extrapolated production volume of mixed goods for 2023 was replaced by the actual production figure reported by the industry association yielding revised activity data for 2D3b Road paving with asphalt in 2023.
- 2D3c: Due to the adjustment of the projections period from 2025–2050 to 2030–2050, the linearly interpolated activity data for the years 2012-2023 of asphalt roofing changed.
- 2D3g: Due to the adjustment of the projections period from 2025–2050 to 2030–2050, the linearly interpolated activity data for the years 2012-2023 of pharmaceuticals production, fine chemicals production and handling and storage of solvents changed as well as of ink production for 2017-2023.
- 2D3h: Due to the adjustment of the projections period from 2025–2050 to 2030–2050, the linearly interpolated activity data for the years 2017-2023 of package printing and other printing changed.
- 2D3i: Due to the adjustment of the projections period from 2025–2050 to 2030–2050, the linearly interpolated activity data for the years 2022-2023 of production of paper and paperboard changed.

8.1.2.5 Category-specific recalculations in 2G Other product use

- 2G: Due to the adjustment of the projections period from 2025–2050 to 2030–2050, the linearly interpolated activity data for the years 2021-2023 of use of concrete additives changed.
- 2G Use of tobacco: The activity data were adapted for the years 1997-2023 due to changes in the underlying statistics by the FSO. The difference was less than 0.1 %.

8.1.2.6 Category-specific recalculations in 2H Other industry production

- 2H2 Bread production: The activity data for the years 1990-2018, 2020, 2022 and 2023 were adapted due to a change in the underlying statistics. The difference ranged from -8.9 to 5.0 %.
- 2H2 Meat smokehouses: The activity data for the years 1990-2023 were adjusted due to changes in the underlying statistics by the FSO. The difference ranged from -4.0 to 1.6 %.

- 2H2 Milling companies: The activity data for the years 1990-2023 were adjusted due to changes in the underlying statistics by the FOAG. The difference ranged from -1.1 to 3.5 %.
- 2H2 Roasting facilities: The activity data for the years 1990-2023 were adjusted due to changes in the underlying statistics by the FOCBS. The difference was less than 0.1 %.
- 2H2 Spirits production: The activity data for the years 1990-2005, 2007-2014, 2016, 2017 and 2019-2023 were adapted due to a change in the underlying statistics by FOCBS. The difference was below 1 %.
- 2H2 Sugar production: The activity data for the years 2004-2012 were adjusted due to changes in the underlying statistics. The difference was less than 0.1 %.
- 2H2 Wine production: The activity data were divided into white and red wine based on the data available by the FOAG. The emission factor for NMVOC was changed from a weighted mean to the value from the guidebook and is constant across the entire time series.
- 2H3 Blasting and shooting: The activity data for the years 1991-2023 were adapted due to changes in the underlying statistics by the FEDPOL. The difference was less than 1 %.

8.1.2.7 Category-specific recalculations in 2I Wood processing, 2K Consumption of POPs and heavy metals and 2L Other production, consumption, storage, transportation or handling of bulk products

There were no recalculations implemented in submission 2026.

8.1.3 3 Agriculture

8.1.3.1 Category-specific recalculations in 3B Manure management

- 3B: Activity data for livestock category 3B3 Swine and 3B4gii Broilers were revised due to data update, leading to emission recalculations for 2022 and 2023.
- 3B: Emission factors (NO_x and NH₃) for manure management were recalculated for 1990-2023 due to an update of the AGRAMMON model. Allocation of manure to the different management systems and ammonia volatilisation from manure management were revised for all livestock categories except for 3B4e, 3B4f and 3B4h.
- 3B: The allocation of manure to the different management systems was revised due to updated data on manure digested anaerobically, leading to emission factor recalculations for 1990-2023 (NO_x and NH₃).

8.1.3.2 Category-specific recalculations in 3D Agricultural soils

- 3Da1: The amount of inorganic fertilisers applied in Liechtenstein was updated due to new data. Emissions from other inorganic fertilisers were recalculated for 1990-2023.
- 3Da2a: Activity data for livestock categories swine and broilers were revised due to data update, leading to emission recalculations for 2022 and 2023.
- 3Da2a: The amount of nitrogen input from animal manure was revised due to an update of the AGRAMMON model, which includes the implementation of the ALFAM2 model. This leads to emission recalculations for all livestock categories for 1990-2023.

- 3Da2c: Emissions of NO_x and NH₃ from 3Da2c Application of sludge (human N-excretion) from decentralised wastewater are newly reported for the entire time series, leading to emission recalculations 1990-2023.
- 3Da2c: The amount of nitrogen inputs from recycling fertilisers was revised due to new activity data from SFOE 2025a. Emissions from other organic fertilisers applied to soils were recalculated for 1993-2023.
- 3Da3: Activity data for livestock categories swine and broilers were revised due to data update, leading to emission recalculations for 2022 and 2023.
- 3Da3: Updated N-excretion values for livestock categories growing cattle, sheep, goats and the share of N-excretion going to grazing for all poultry categories lead to emission recalculations for 1990-2023.
- 3Da3: An update of the AGRAMMON model with changes in grazing time periods for poultry categories leads to emission recalculations for 1990-2023.
- 3Da4: NH₃ emissions from 3Da4 Crop residues applied to soils are newly reported for the entire time series, leading to emission recalculations 1990-2023.

8.1.4 5 Waste

8.1.4.1 Category-specific recalculations in 5A Biological treatment of waste - Solid waste disposal on land

There were no recalculations implemented in submission 2026.

8.1.4.2 Category-specific recalculations in 5B Biological treatment of waste – Composting and anaerobic digestion at biogas facilities

- 5B1 Composting industrial: Activity data for 2023 were updated.
- 5B2 Anaerobic digestion at biogas facilities: The activity data for the years 1990-2023 have been reassessed due to a new rounding strategy, causing changes of less than 2 %.

8.1.4.3 Category-specific recalculations in 5C Waste incineration and open burning of waste

- 5C1bv Cremation: The activity data for cremation, which is the number of cremated dead bodies, has been reassessed based on a survey conducted on crematoriums not part of the Swiss Union for Cremation. This caused changes from less than -1 % and up to +8 % for the national total.
- 5C2: The activity data for the quantity of incinerated sewage sludge has been reassessed for the years 2019 and 2021-2023 based on an update of the underlying statistics.

8.1.4.4 Category-specific recalculations in 5D Wastewater handling

- 5D1 Domestic wastewater treatment: The emission factors for the years 2016-2023 have been updated because of an update in the underlying national statistics of sewage gas production.
- 5D1 Domestic wastewater treatment: The activity data, which is the number of inhabitants in Switzerland, has been updated for the year 2022 due to an update in the

underlying statistics. This caused a change in implied emission factors and in the resulting emission levels by less than 1 %.

- 5D2 Industrial wastewater treatment: The activity data, which is the number of inhabitants within Switzerland, has been updated for the year 2022 due to an update in the underlying statistics. This caused a change in implied emission factors and in the resulting emission levels by less than 1 %.

8.1.4.5 Category-specific recalculations in 5E Other waste, car shredding

There were no recalculations implemented in submission 2026.

8.1.5 6 Other

8.1.5.1 Recalculations in 6 Other emissions

- 6A1 Aged inhabitants: The activity data for the years 2001-2009, 2013, 2022 and 2023 were adjusted due to changes in the underlying statistics provided by the FSO. The difference for the years 2001-2008 was between 8 % and 51 %. For all other values, the change from previously reported values was below 2 %.
- 6A2: The emission factors of NO_x and NH₃ from manure management and grazing of livestock outside agriculture were recalculated for 1995-2023 and 1990-2023, respectively, due to an update of the AGRAMMON model.
- 6A2: The emission factors of NMVOC, PM_{2.5}, PM₁₀ and TSP of livestock outside agriculture were revised for 2023, and 1990-2023, respectively, due to an update of the AGRAMMON model.
- 6A2 Cats: The activity data for 2023 was adjusted following a new data collection, resulting in a 10 % decrease from the previous value.
- 6A2 Dogs: The activity data for 2023 was adjusted following a new data collection, resulting in a 3 % decrease from the previous value.
- 6A3: There are minimal changes in the NH₃ emission factors of inorganic N- fertilisers for domestic use in the years 1990-2023.
- 6A4 Building fire (burnt material fossil): The activity data was updated due to changes in the underlying statistics provided by the FSO. The difference from the previously reported values across the entire timeseries is less than 0.1 %.
- 6A4 Building fires (burnt material biogenic): The activity data was updated due to changes in the underlying statistics provided by the FSO. The difference from the previously reported values across the entire timeseries is less than 0.1 %.

8.1.5.2 Recalculations in 11B Forest fires

- 11B Forest and grassland wildfires: The emission factors for forest fires and grassland fires for NO_x, NMVOC, SO_x, NH₃, PM_{2.5}, PM₁₀, TSP, BC and CO, have been reassessed for the years 1990-2023, using the carbon emission factor computed as part of the LULUCF model for Switzerland's greenhouse gas inventory, therefore ensuring consistency between the two inventories. In addition, instead of using various literature sources, emission factors for all listed pollutants are now consistently taken from the EMEP Guidebook. Changes are significant and the resulting emissions have increased by a factor of approximately 6 for NO_x and CO, 2.7 for NH₃, 2.6 for NMVOC, 2.2 for SO_x, and 1.1 for PM_{2.5}, PM₁₀, TSP and BC.

- 11B Forest and grassland wildfires: The activity data for source category 11B wildfires were updated based on improvements in the swissfire database. This leads to a recalculation in the years 1996, 1997, 2010, 2011 and 2023 for forests and in 2011 and 2023 for grassland.

8.1.5.3 Recalculations in 11C Other natural emissions

- 11C Natural emissions: the emission factors for all tree species for forest emissions of NMVOC have been updated for the years 2021 and 2022 because of a rounding issue and for the years 2023-2024 because of a model update. The absolute difference from the previous reported values is less than 1 % for the years 2021-2022, less than 3 % for 2023 and up to 12 % for the year 2024.
- 11C Natural emissions: the activity data for all tree species for forest emissions of NMVOC have been updated for the years 2023-2024 because of a model update. The absolute difference from the previous reported values is less than 1 % for 2023 and 2024.

8.1.6 Implications of recalculations for emission levels

Table 8-1 shows the effect of recalculations on the emission levels 2023 and 1990, based on the previous (2025) and latest (2026) submission.

In 2023, the recalculations cause a lower emission level by 22 % for NH₃ and by 8.2 % for SO_x. For PM_{2.5}, PM₁₀, TSP, CO, Cd and total PAHs, recalculations lead to a decrease of emissions between 1 % and 3 %. For all other pollutants, the difference does not exceed 1 % in 2023.

In 1990, the recalculations cause a lower emission level by 17 % for NH₃. For NMVOC, recalculations lead to an increase of emissions by 1.0 %. For all other pollutants, the difference in emissions due to recalculations is less than 1 % for 1990.

Table 8-1 Recalculations: Implications for the emission levels 2023 and 1990. The values refer to the NFR submission 2025 (previous) and 2026 (latest). Differences are given in absolute and relative numbers for all pollutants.

Pollutant	Unit	2023			
		previous	latest	difference (abs.)	difference (rel.), %
		sub. 2025	sub. 2026		previous = 100 %
NOx	kt	47	47	-0.24	-0.50
NMVOC	kt	71	71	0.075	0.10
SOx	kt	2.8	2.6	-0.23	-8.2
NH3	kt	53	41	-12	-22
PM2.5	kt	6.2	6.0	-0.18	-2.9
PM10	kt	14	14	-0.30	-2.1
TSP	kt	28	28	-0.34	-1.2
BC	kt	0.83	0.82	-0.0081	-0.97
CO	kt	139	136	-3.2	-2.3
Pb	t	7.8	7.8	-0.013	-0.17
Cd	t	0.41	0.40	-0.0065	-1.6
Hg	t	0.56	0.56	0.00048	0.086
PCDD/ PCDF	g I-Teq	12	12	-0.088	-0.73
PAHs total	t	2.3	2.3	-0.061	-2.6
HCB	kg	0.34	0.34	0.00097	0.28
PCB	kg	310	310	-0.000007	-0.000002

Pollutant	Unit	1990			
		previous	latest	difference (abs.)	difference (rel.), %
		sub. 2025	sub. 2026		previous = 100 %
NOx	kt	141	141	0.25	0.18
NMVOC	kt	295	298	3.1	1.0
SOx	kt	39	39	0.0029	0.0075
NH3	kt	68	57	-12	-17
PM2.5	kt	27	27	0.019	0.069
PM10	kt	36	36	0.019	0.052
TSP	kt	56	56	0.019	0.033
BC	kt	5.7	5.7	0.019	0.32
CO	kt	752	755	2.9	0.38
Pb	t	355	352	-2.9	-0.80
Cd	t	3.2	3.2	0.000001	0.000033
Hg	t	6.3	6.3	-0.00037	-0.0059
PCDD/ PCDF	g I-Teq	192	192	-0.0021	-0.0011
PAHs total	t	8.0	8.0	0.00057	0.0071
HCB	kg	173	173	-	-
PCB	kg	2'332	2'332	-0.0000004	-0.0000002

The source categories with the most important recalculations implemented for main pollutants and PM_{2.5} in submission 2026 in terms of absolute emissions are listed in Table 8-2 and Table 8-3 for the years 2023 and 1990, respectively. The most important recalculations for 1990 and the last year reported in both submissions and each main pollutant are the following:

NO_x

The most important recalculations of NO_x emissions were made in source category 1A3b Road transportation due to changes in the road transportation model and in underlying activity data. These and further recalculations are documented in Table 8-2 and Table 8-3 and described as follows:

- The entire traffic statistics have been renewed, which lead to reduced mileage and thus reduced emissions in source category 1A3b Road transportation especially in the years 2020-2023. In addition, activity data and emission factors were updated for the whole time series because the underlying fleet development data was updated to the new version of the Handbook of Emission Factors for Road Transport (HBEFA, version 5.1; INFRAS 2025, 2025a). In the course of the update of the fleet development data, assumptions were adjusted which leads to a shift from mileage shares from gasoline to diesel vehicles (in particular for passenger cars and light duty vehicles). Furthermore, there were changes in the distribution of heavy-duty vehicles between rigid trucks (RT) and articulated or tractor-trailer combinations (AT/TT). In addition, a change was made regarding the fleet of buses, where gasoline-powered buses were replaced by diesel-powered buses.
- The emission factors for cement production (1A2f) were updated for the years 2018-2023 based on measurement reports at the plant level. NO_x emission factors increased by 0.3 % up to 5 %.

NM VOC

The most important recalculations regarding NM VOC emissions occurred in source category 1A3b Road transportation, where changes in the estimation of evaporation from gasoline engines and generally in the road transportation model were made. These and further recalculations are documented in Table 8-2 and Table 8-3 and described as follows:

- The fleet weighting of diurnal and soak emissions (evaporation from gasoline engines) was changed from mileage to vehicle stock weights. This leads to overall slightly increased gasoline evaporation (1A3bv).
- Activity data and emission factors in source category 1A3b Road transportation were updated for the whole time series because the underlying fleet development data was updated to the new version of the Handbook of Emission Factors for Road Transport (HBEFA, version 5.1; INFRAS 2025, 2025a). In the course of the update of the fleet development data, the fleet of mopeds and motorcycles (1A3biv) was reclassified in the road transportation model, which leads to changes in emissions. In addition, assumptions were adjusted which leads to a shift from mileage shares from gasoline to diesel vehicles (in particular for passenger cars and light duty vehicles).

SO_x

The most important recalculation regarding SO_x emissions occurred in source category 1A2f Cement production, where the emission factor was adjusted. These and further recalculations are documented in Table 8-2 and Table 8-3 and described as follows:

- The emission factors for cement production (1A2f) were updated for the years 2018-2023 based on measurement reports at the factory level. SO_x emission factors decreased by 15 % up to 40 %.
- The activity data for the years 2022-2023 for 1A2gviii Boilers, other bituminous coal, was updated as a consequence of the recalculation of other bituminous coal consumed in 1A2a Secondary steel production, electric arc furnace for the same years. Furthermore, the fuel use of petroleum coke assigned to boilers in 1A2gviii has been reassessed because of an update in the underlying statistics of the national energy balance.

NH₃

The most important recalculations regarding NH₃ emissions are based on the update of the nitrogen-flow model AGRAMMON. These and further recalculations are documented in Table 8-2 and Table 8-3 and described as follows:

- The update of the AGRAMMON model led to recalculations for all livestock categories for the whole time series. In particular the implementation of the ALFAM2 model led to changes in the amount of animal manure applied to soils (3Da2a). Furthermore, the allocation of manure to the different management systems and ammonia volatilisation from manure management were revised. This led to recalculations of NH₃ emission factors for manure management (3B) for the whole time series.
- Activity data for swine (3B3) was revised.
- In source category 3Da2c Other organic fertilisers applied to soils, the application of sludge (human N-excretion) from decentralised wastewater was newly reported in the latest submission for the whole time series. In addition, the amount of nitrogen inputs from recycling fertilisers was revised for the years 1993-2023.

PM2.5

The most important recalculation regarding PM2.5 occurred in source categories 1A4bi Residential: Stationary, where the quantity of charcoal consumption was revised and therefore decreased, and in 1A3b Road transportation due to changes in the road transportation model and in underlying activity data. These and further recalculations are documented in Table 8-2 and Table 8-3 and described as follows:

- The activity data of 1A4bi Charcoal consumption was revised for 2023 based on updated production figures derived from information provided by individual charcoal producers.
- The entire traffic statistics have been renewed, which lead to reduced mileage and thus reduced emissions in source category 1A3b Road transportation especially in the years 2020-2023. In addition, activity data and emission factors were updated for the whole time series because the underlying fleet development data was updated to the new version of the Handbook of Emission Factors for Road Transport (HBEFA, version 5.1; INFRAS 2025, 2025a). In the course of the update of the fleet development data, the fleet of mopeds and motorcycles (1A3biv) was reclassified in the road transportation model, which leads to changes in emissions.

Table 8-2 NFR categories with most important implications of recalculations on emission levels in 2023 in terms of absolute differences for the main pollutants and PM2.5. The values refer to the NFR submission 2025 and 2026. The list is ranked for each pollutant in terms of the absolute difference in emission levels due to recalculations ((fu) means fuel used approach).

Reported year: 2023									
NOx		NMVOC		SOx		NH3		PM2.5	
kt		kt		kt		kt		kt	
1A3bi(fu) Passenger cars	-1.2	1A3bv(fu) Gasoline evaporation	0.60	1A2f Non-metallic minerals	-0.23	3Da2a Animal manure applied to soils	-7.5	1A4bi Residential Stationary	-0.094
1A3biii(fu) Heavy duty vehicles and buses	0.78	1A3biv(fu) Mopeds and motorcycles	-0.37	1A2gviii Stationary combustion Other	-0.022	3B1a Dairy cattle	-2.0	1A3bvi(fu) Automobile tyre and brake wear	-0.059
1A2f Non-metallic minerals	0.10	1A4bi Residential Stationary	-0.071	1A4bi Residential Stationary	0.0076	3B3 Swine	-1.2	1A3biv(fu) Mopeds and motorcycles	-0.033
3Da2a Animal manure applied to soils	0.060	1B2aiv Refining and storage	-0.066	1A4ai Commercial/Institutional Stationary	0.0042	3B1b Non-dairy cattle	-0.87	1A4ai Commercial/Institutional Stationary	0.0075
1A4ai Commercial/Institutional Stationary	0.055	1A2f Non-metallic minerals	0.054	1A3bi(fu) Passenger cars	-0.0018	3Da2c Other organic fertilisers applied to soils	0.11	2A5a Quarrying and mining of minerals	-0.0069
1A3bii(fu) Light duty vehicles	-0.037	1A3bi(fu) Passenger cars	-0.042	1A2e Food processing beverages and tobacco	0.0015	3Da3 Urine and dung deposited by grazing animals	-0.086	1A3bi(fu) Passenger cars	0.0031

Table 8-3 NFR categories with most important implications of recalculations on emission levels in 1990 in terms of absolute differences for the main pollutants and PM2.5. The values refer to the NFR submission 2025 and 2026. The list is ranked for each pollutant in terms of the absolute difference in emission levels due to recalculations ((fu) means fuel used approach).

Reported year: 1990									
NOx		NMVOC		SOx		NH3		PM2.5	
kt		kt		kt		kt		kt	
1A3biii(fu) Heavy duty vehicles and buses	0.21	1A3bv(fu) Gasoline evaporation	2.8	1A3bii(fu) Light duty vehicles	0.024	3Da2a Animal manure applied to soils	-11	1A3biv(fu) Mopeds and motorcycles	-0.018
1A3bii(fu) Light duty vehicles	-0.10	1A3bi(fu) Passenger cars	0.57	1A3biii(fu) Heavy duty vehicles and buses	-0.022	3B1a Dairy cattle	-1.1	1A3biii(fu) Heavy duty vehicles and buses	0.015
1A3bi(fu) Passenger cars	0.064	1A3biv(fu) Mopeds and motorcycles	-0.31	1A3biv(fu) Mopeds and motorcycles	0.0012	3Da2c Other organic fertilisers applied to soils	0.73	1A3bii(fu) Light duty vehicles	0.012
3Da2c Other organic fertilisers applied to soils	0.044	1A3biii(fu) Heavy duty vehicles and buses	0.12	1A3bi(fu) Passenger cars	-0.00072	3B1b Non-dairy cattle	-0.36	1A3bi(fu) Passenger cars	0.0097
3Da2a Animal manure applied to soils	0.024	1A3bii(fu) Light duty vehicles	-0.11	6A Other	0.000002	3B3 Swine	-0.25	2H2 Food and beverages industry	-0.00013
1A3biv(fu) Mopeds and motorcycles	0.022	2H2 Food and beverages industry	0.055	1A4ai Commercial/Institutional Stationary	-0.000001	3B4d Goats	-0.040	1A3bvi(fu) Automobile tyre and brake wear	0.000009

8.1.7 Implications of recalculations for emission trends of main pollutants and PM2.5

The emission trend 1990–2023 of NH₃ is clearly affected by the recalculations in the latest submission (difference of 4.9 percentage points) due to the update of the AGRAMMON nitrogen flow model. The trends of SO_x and PM2.5 show only a slight difference of 0.6 and 0.7 percentage point, respectively. The trends of NO_x and NMVOC are almost unaffected (difference of 0.2 percentage point).

Table 8-4 Recalculations: Implications for the emission trends between 1990 and 2023 for the main pollutants. The values refer to the previous submission 2025 and latest submission 2026.

Pollutant	Trends 2023 vs 1990	
	Previous subm. 2025	Latest subm. 2026
	%	%
NO _x	-67	-67
NMVOC	-76	-76
SO _x	-93	-93
NH ₃	-28	-23
PM2.5	-78	-77

8.2 Planned improvements

The following improvements are planned for the submission 2027. Improvements for source categories which are key categories are, as much as possible, given priority.

General (not sector specific)

It is planned to analyse the recommendations from the upcoming review of the transport sector and to implement them in future submissions.

Energy (stationary)

- 1A: The emission factors of Pb, Cd, PCDD/PCDF and PAHs for boilers, gas turbines and engines fuelled with natural gas or biogas, which are still based on the values from EMEP/EEA (2019), will be changed to the ones of EMEP/EEA (2023).

Energy (mobile)

- 1A3bvi-vii: With reference to the recommendation in paragraph 88 of the last report from the stage 3 in-depth review of Switzerland's emission inventory in 2020, it is planned to report the non-exhaust emissions from automobile road abrasion separately in source category 1A3bvII instead to include them in 1A3bvi automobile tyre and brake wear in the next submission. Source category 1A3bvi is a key category for PM_{2.5} and PM₁₀.
- 1A3b: Emission factors for road transportation will be taken from the revised Handbook of Emission Factors for Road Transport (HBEFA version 5.1; INFRAS 2025, 2025a) in the next submission.

Energy (fugitive emissions)

no planned improvements

IPPU

no planned improvements

Agriculture

- 3B and 3D: NH₃ emission for the years 1980–1989 and 2025–2050 will be calculated during 2026 using the 2025 revised AGRAMMON model. A consistent time series from 1980 to 2050 is planned to be reported in the next submission.
- 3B1: Since cattle also spend part of their time grazing, and this has not yet been considered in the calculation of NMVOC emissions, a study is planned to determine average typical grazing times for the various categories of cattle. Source categories 3B1a and 3B1b are both key categories for NMVOC.
- 3Da4: The NH₃ emission factor for source category 3Da4 Crop residues applied to soils will be corrected and the time series 1990-2024 recalculated accordingly in the next submission. See also Annex 8 “Corrigendum to NH₃ emissions due to an NH₃ emission factor error in source category 3Da4 Crop residues applied to soils”.

Waste

- 5C1a: Work is ongoing to improve the estimation of activity data for the illegal incineration of municipal solid waste at households and construction sites. As part of this work, the emission factors will also be reassessed.

Other and Natural emissions

no planned improvements

9 Emission projections 2030–2050

9.1 Comments on projections

The activity data for the sectors energy, IPPU and waste are in accordance with the base scenario of the Swiss Energy Perspectives 2050+ (Prognos/INFRAS/TEP/Ecoplan 2020). The base scenario called in German “Weiter wie bisher” (WWB), which means as much as to continue with the existing policy measure at that time, bases on the reference year 2017 and is reported as “With Measures” (WM) scenario in the reporting tables of the latest submission. Other scenarios elaborated in the Swiss Energy Perspectives 2050+ (Prognos/INFRAS/TEP/Ecoplan 2020) have the focus on how to get to net zero greenhouse gas emissions in the year 2050 and beyond, which future developments in the emission sources will contribute and which further measures are necessary to achieve this goal. As these net zero greenhouse gas emissions scenarios do not include any “additional (technological and legal) measures” aimed at reducing air pollution, none of these scenarios were implemented in the database of air pollutant emissions so far. Therefore, the air pollutant emissions in chps. 9.3 to 9.6 are shown for the “With Measures” (WM) scenario only.

Note further that:

- due to lack of detailed data for all sectors with non-road vehicles and machineries (mobile sources under 1A2gvii, 1A3c/d, 1A4aai/bii/cii), the projections for these source categories are based on the previous energy scenarios (Prognos 2012a) instead of the new Swiss Energy Perspectives 2050+ (Prognos/INFRAS/TEP/Ecoplan 2020). However, total fuel consumption corresponds to the new Swiss Energy Perspectives 2050+.
- for activity data based on population size the perspectives 2020 for Switzerland’s inhabitants are used (SFSO 2020p).
- for the agricultural sector, an independent scenario was developed according to the agricultural policy 2018-2021 (Swiss Confederation 2017) and an adopted parliamentary initiative (Mack and Möhring 2021).

Note also that emission data published in the submission table for the projections (“Annex IV WM”) refer to the “national total” assessment based on the fuel sold principle for road transportation. All tables and figures in this chapter refer to the “national total for compliance” assessment based on fuel used principle (for details see chapter 1.4.2 and 3.1.6.1).

The development of new Swiss Energy Perspectives 2050+ with the reference year 2024 has started. They are expected to be published in 2028.

9.2 Assumptions for projections for the WM scenario

9.2.1 Emission factors

Emission factors for the sector 1 Energy are mainly based on available emission measurements, models, the EMEP/EEA guidebook (EMEP/EEA 2019 and EMEP/EEA 2023), expert estimates as described in chapter 3, and assumptions about their future development. Where no such assumptions can be made, the emission factors are kept constant.

Table 9-1 Overview of sources and references for emission factors in the WM scenario.

Sector	Sources and references for emission factors
1 Energy	In general, the emission factors used in fuel combustion and heating systems are described in Chapter 3 and have been kept constant for the future. The emission factors for specific models are described with the models and the references are as follows: - Wood energy combustion: Zotter and Nussbaumer (2022) - Road transportation: EMEP/EEA guidebook (EMEP/EEA 2019), INFRAS (2022) - Domestic aviation: EMEP/EEA guidebook (EMEP/EEA 2023), FOCA (2006, 2006a, 2007a, 2008-2025) - Stationary engines and gas turbines: INFRAS (2022a), EMEP/EEA guidebook (EMEP/EEA 2019, EMEP/EEA 2023) - Non-road vehicles: EMEP/EEA guidebook (EMEP/EEA 2023), FOEN (2015j), INFRAS (2015a)
2 IPPU	Emission measurements, industry data and factors from the EMEP/EEA guidebook (EMEP/EEA 2023) as described in chapter 4 and assumptions about their future development. Where no assumption can be made, emission factors are kept constant.
3 Agriculture	AGRAMMON model (Kupper et al. 2022), EMEP/EEA guidebook (EMEP/EEA 2019 and EMEP/EEA 2023) and country-specific studies (Bühler and Kupper 2018, Zähner et al. 2025). The underlying emission factors are kept constant as in 2019 due to uncertain assumptions about the evolution of production parameters (according to Kupper et al. 2022). See chapter 5 for further information.
5 Waste	Various literature sources and EMEP/EEA guidebook 2023 (EMEP/EEA 2023), see chapter 6.
6 Other	Various literature sources and EMEP/EEA guidebook (EMEP/EEA 2019 and EMEP/EEA 2023), see chapter 7.

Due to time constraints, it was only possible to perform a consistent calculation of NH₃ emissions for sector 3 Agriculture using the new AGRAMMON model version for the years 1990–2024. Accordingly, NH₃ emissions of sector 3 Agriculture and the National totals for the years 2025–2050 are reported as “not estimated”. They will be reported again in the next submission

9.2.2 Activity data

As described in chapter 9.1 and Table 9-2, activity data base mainly on the Swiss Energy Perspectives 2050+ (Prognos/INFRAS/TEP/Ecoplan 2020) the agricultural policy 2018-2021 (Swiss Confederation 2017), taking into account an adopted parliamentary initiative (Mack and Möhring 2021) and the population size according to the perspectives 2020 for Switzerland’s inhabitants (SFSO 2020p). Due to the lack of detailed, disaggregated data elaborated in the Swiss Energy Perspectives 2050+ for the non-road model, projected developments from earlier projections (Prognos 2012a) are used. The total amount of fuel used in non-road sectors is then subtracted from the projected overall fuel consumption in the Swiss Energy Perspectives 2050+, which has some influence on the allocation of fuel consumption to the different source categories, whereas the overall fuel consumption remains the same as projected in the Swiss Energy Perspectives 2050+.

The Swiss Energy Perspectives 2050+ are based on the reference year 2017 for the energy consumption in the different source categories and other statistics. Energy consumption data from the year 2017 were used to develop the future scenarios. The base scenario is the scenario “WWB” called in German “Weiter wie bisher”, which means as much as a continuation with the so far implemented energy and climate policy measures. To avoid unplausible leaps from the latest reporting year to the first projected year, projections of the Swiss Energy Perspectives 2050+ are used for the years 2030 and later and data in between are linearly interpolated. Exceptions with projections data from 2025 onwards are 1A3b Road transportation, whose model data were calculated for the Swiss Energy Perspectives 2050+ for detailed activity data with an annual resolution, and the two models for non-road transportation and engines and gas turbines.

Table 9-2 provides an overview of the respective sectoral references. A detailed description of the WM scenario can be found in Switzerland’s First Biennial Transparency Report under the Paris Agreement– therein named as “With Existing Measures (WEM)” (FOEN 2024d).

Table 9-2 Overview of sectoral underlying detailed scenarios in the WM scenario of the latest submission.

Sector	Scenario	Sectoral scenario	Reference
1 Energy	WM	Swiss Energy Perspectives 2050+ scenario "WWB" (continuation with measures implemented up to base year 2017) updated with new national reference scenario for population ("A-00-2020"). Activity data for road transportation and stationary engines and gas turbines are modelled based on assumptions in the Swiss energy perspectives 2050+. Activity data in the nonroad sectors still base on assumptions of Prognos (2012a).	Prognos/INFRAS/TEP/Ecoplan 2020 INFRAS 2022 and 2022a SFSO 2020p Prognos 2012a
2 IPPU	WM	Scenario based on key parameters of the Swiss Energy Perspectives 2050+ but updated with new national reference scenario for population ("A-00-2020")	Prognos/INFRAS/TEP/Ecoplan 2020 SFSO 2020p
3 Agriculture	WM	Continuation of Agricultural policy 2018-2021 and adopted parliamentary initiative	Swiss Confederation 2017 Mack and Möhring 2021
5 Waste	WM	Scenario based on key parameters of the Swiss Energy Perspectives 2050+ but updated with new national reference scenario for population ("A-00-2020")	Prognos/INFRAS/TEP/Ecoplan 2020 SFSO 2020p

For 1A3b Road transportation, the new version of the Handbook of Emission Factors for Road Transport (HBEFA, version 5.1; INFRAS 2025, 2025a) was used for fleet development data for the time period 1990-2024. However, the new fleet development data was not yet used for the projections 2025-2050. Accordingly, there is a methodological difference between the time series 1990-2024 and 2025-2050. It is planned to use the new version of HBEFA for the fleet development projections in the next submission.

Table 9-3 lists the key factors underlying the WM scenario of the latest submission and their assumed development until 2050.

Table 9-3 Trend of underlying key factors of the WM scenario between 2030 and 2050 (FSO 2022c and SFSO 2020p for population, INFRAS 2017 for vehicle km, and Prognos/INFRAS/TEP/Ecoplan 2020 for the rest).

Indicator	2020	2030	2040	2050	2030-2050
Population (million)	8.64	9.39	9.99	10.42	11%
GDP (prices 2017, billion CHF)	713	805	893	968	20%
Oil price (prices 2017, USD/barrel)	75	96	112	140	46%
Gas price (prices 2017, CHF/MWh)	24	28	31	35	25%
Heating degree days	3'182	3'089	2'997	2'928	-5%
Cooling degree days	177	199	226	245	23%
Energy reference area (million m ²)	782	847	890	910	7%
Passenger cars (million vehicle km)	52'990	63'330	65'583	66'943	6%

Please note that the population data in the Swiss Energy Perspectives 2050+ (Prognos/INFRAS/TEP/Ecoplan 2020) do not match the official statistics used within the air pollutant (and greenhouse gas) inventory (SFSO 2020p).

For each sector, further specific methods and respective assumptions apply that are described below in more detail:

Sector 1 Energy

As mentioned above, energy consumption is based on the scenario "WWB" of the Swiss Energy Perspectives 2050+ (Prognos/INFRAS/TEP/Ecoplan 2020). Main measures and underlying assumptions in the energy scenario "WWB" and the different source categories are described in detail in Prognos/INFRAS/TEP/Ecoplan (2020). The projections are based on an aggregation of various bottom-up models. Energy demand is determined using

separate models for private households, industry, transportation, services/agriculture and electricity supply. The energy model used for the emission projections is shown in Figure 9-1.

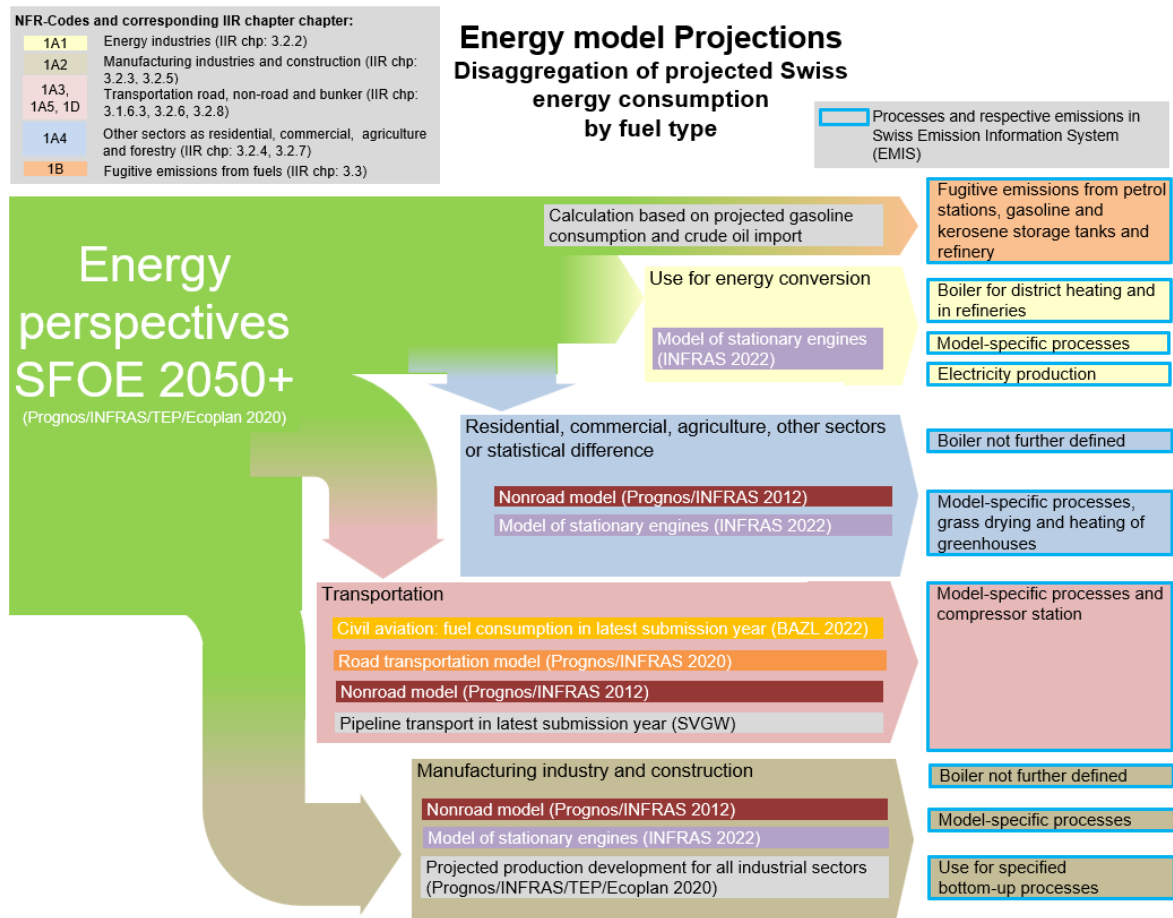


Figure 9-1 Overview of Switzerland's energy model as used for the emission projections.

Figure 9-2 depicts the total fuel consumption in recent years since 2015 and as projected for 2030 to 2050 for source categories 1A1-1A5. Figure 9-3 also shows the total fuel consumption, but broken down by fuel type or group.

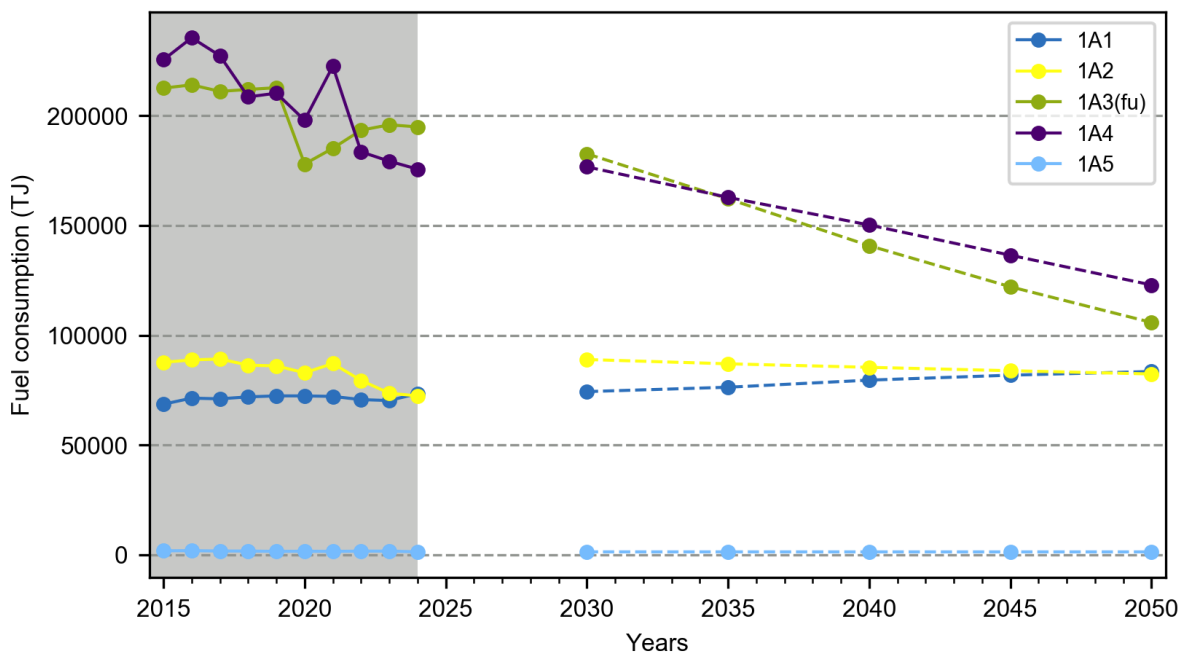


Figure 9-2 Fuel consumption in Switzerland of recent years since 2015 and as projected in the WM scenario in source categories 1A1 – 1A5 of the source category 1A Fuel combustion ((fu) means fuel used approach).

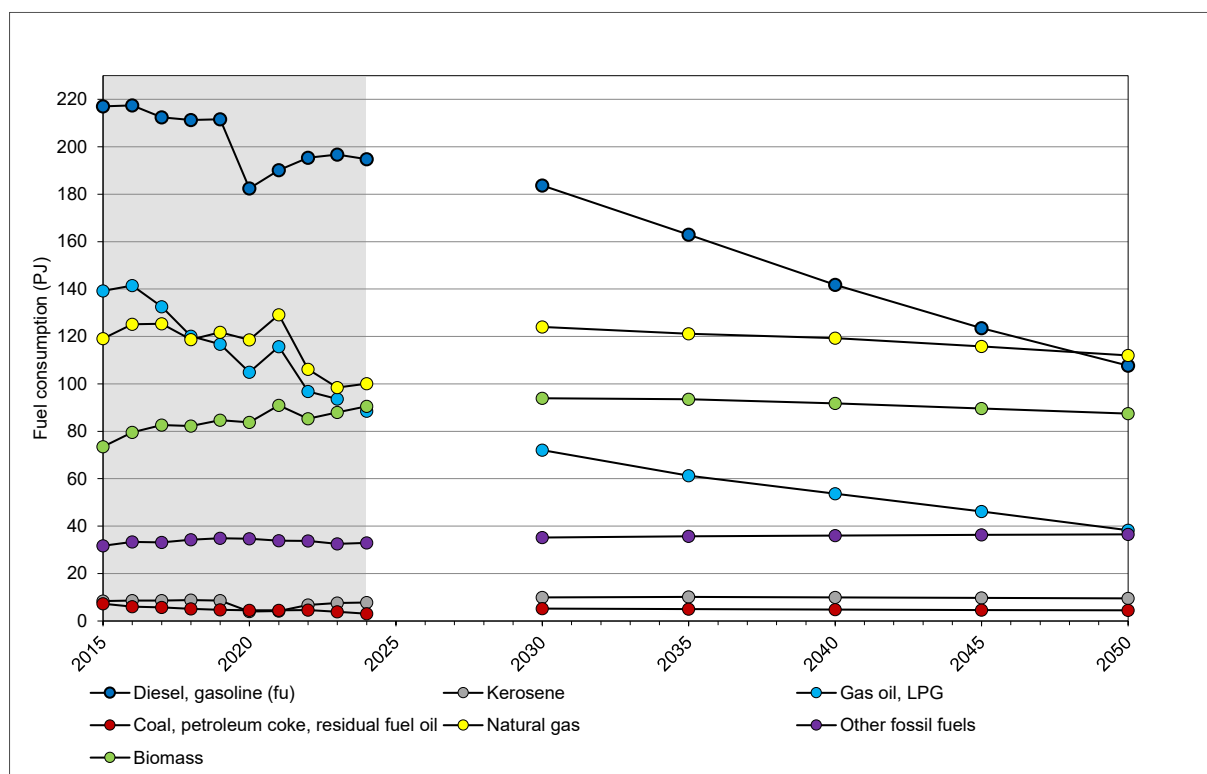


Figure 9-3 Fuel consumption in Switzerland of recent years since 2015 and as projected in the WM scenario for the source category 1A Fuel combustion ((fu) means fuel used approach).

It turns out that current fuel consumption in 1A2 Combustion in manufacturing industry and construction and 1A4 Other sectors have fallen much more than assumed when the Swiss Energy Perspectives 2050+ (Prognos/INFRAS/TEP/Ecoplan 2020) were elaborated. If we look at the development at the fuel level, this decline is mainly due to the large drop in

natural gas consumption caused by the war in Ukraine. Switzerland has also participated in the EU's voluntary gas saving target for the winters of 2022/2023 to 2024/2025, which aims to reduce consumption in the winter half-year by 15% compared to the average of the five-year reference period (2017-2022). Gas consumption was reduced by around 22 % in the winter of 2022/23, around 23 % in the winter of 2023/24 and around 17 % in the winter of 2024/2025. (In Switzerland, around three quarters of annual gas consumption during the winter months is used for heating buildings.) It is unclear, if and how large a possible recovery in natural gas may be in the future. This is particularly true given that production volumes and, accordingly, fuel consumption in fuel-intensive industries, such as cement, rock wool and glass production, and brickworks, have declined significantly in recent years and are well below the volumes projected for the future (see Figure 9-2). It can be assumed that the perspectives overestimate gas consumption, since heat demand in 1A4 was not completely saved, but probably mostly replaced by heat pumps, electricity, biomass, and local and district heating. In industry, there have also been closures of production plants, not all of which will likely be restarted in the future when natural gas prices are lower. Current consumption of heavy fossil fuels (coal, residual fuel oil (no consumption in 2024), petroleum coke), which are assumed to continue to be used primarily in fuel-intensive production processes, is also considerably below the projected values (70% lower in 2024 than projected for 2030). It is unlikely that the use of heavy fossil fuels will increase again either, but rather that their replacement or the closure of production plants have been accelerated in recent years, also due to the requirements of the emissions trading scheme. Accordingly, the consumption figures for the last container glass production (natural gas), which was closed in the summer of 2024, and for the cupola furnaces in rock wool production (decommissioned at the end of 2023), which were replaced by electric furnaces in spring 2024, were subtracted from the respective projected fuel consumption.

The minimal growing fuel consumption in 1A1 Energy industries is mainly driven by source category 1A1a Public electricity and heat production that includes waste incineration depending on the population growth. The electricity production of the existing Swiss power plant park is projected with a bottom-up approach, taking into account the lifetime of the power plants. While the amount of waste per capita is assumed to remain at the current level, the amount of waste is increasing due to population growth and therefore leading to growing fuel consumption. An increasing use of biogas in gas turbines as SCGT or CCGT and of wood and wood waste was considered, too. In recent years, there has already been a very sharp increase in the use of wood and wood waste, leading to a slight decline between the latest reporting year and the projections. Growth is expected to continue, at least in the near future. The amounts of fuels used in 1A1b Petroleum refining is hold constant for projected years based on the amount reported in the latest reporting year, assuming that the only refinery in Switzerland will maintain operations in the future at the same level as they do today. Source category 1A1c Manufacture of Solid Fuel and Other only contains a little amount of charcoal production which is considered to stay constant at the level of the latest reporting year.

Fuel consumption in 1A2 Manufacturing industries and construction is modelled for the main fuel types based on a large number of industrial production processes, taking into account their production development, broken down by the most important industrial sectors, including a residual sector for all other industrial sectors. Fuel consumption is then projected based on activity data for the sectors and specific energy use per process – including the assumption of a 5% improvement in the energy efficiency of the furnaces between the current level and 2050.

For source category 1A3 Transport, parameters such as tonne-kilometres, passenger-kilometres, vehicle-kilometres, specific energy use and substitution effects were determined on the basis of model estimations. For more detailed information see section below.

In source category 1A4ai Commercial/Institutional: Stationary, the energy demand from commercial and institutional buildings is based on energy use for heating, hot water, air conditioning, lighting, office appliances, engines and other uses, split for different energy sources, trades and services. Projections are then driven by gross value-creating activity,

number of employees, energy reference area and technical standards. Also considered are the use of biogas and sewage gas in boilers, engines and gas turbines.

In source category 1A4bi Residential: Stationary, the energy demand in households is modelled based on energy use for heating, hot water, household appliances, lighting and other electrical equipment. The model consists of a dynamic building stock in various classes. The projection is then based on population growth, average floor space per person, average household size as well as technological developments of old and new buildings. Also considered is the use of biogas in engines.

The use of these bottom-up models allows to reproduce past developments and to derive the key drivers for particular segments of energy demand. Future energy demand is projected based on assumptions on the evolution of the key drivers. The energy demand is then assigned to the relevant categories.

Source category 1A3 Transport

Activity data from transport activities are based on the same model as the one used to derive energy demand for the energy scenarios (see above). The main measures and underlying assumptions are:

- Implementation of measures such as efficiency targets set for light duty vehicles, energy efficiency labelling, as well as economic incentives for low-emission vehicles.
- Road transportation: Projections of the mileage by vehicle categories and of fuel consumption factors are given by the Swiss Federal Office of Statistics and are represented in Prognos/INFRAS/TEP/Ecoplan (2020) and Swiss Confederation (2021).
- Non-road source categories: Projections of vehicle fleets, operating hours and expected fuel consumption (see Annex A2.1.2) serve as input for projecting the fuel consumption of non-road vehicles (FOEN 2015j, INFRAS 2015a, Prognos 2012a). In addition, (compressed) natural gas in non-road has been replaced with liquefied petroleum gas, which is a more accurate reflection of the situation in Switzerland.

Sector 2 Industrial processes and product use

Activity data of sector 2 Industrial processes and product use are inferred from the sectoral production data that were used in the Swiss Energy Perspectives 2050+ (Prognos/INFRAS/TEP/Ecoplan 2020). In particular, sectoral indices of production volumes for clinker, cement, iron and steel, non-iron metals, glass, food, construction, and so-called other industry have been used. Since the reference year 2017, production volumes in fuel-intensive industrial processes, such as cement, rock wool and glass production, as well as in brickworks, have developed significantly differently than projected. They have declined, especially since 2022, and are now well below the volumes projected for the future. For other processes, such as production of basic chemicals of source category 2B Chemical industry, the provided production index scenario is not consistent with the more or less stable production volumes of the past twenty years. Therefore, constant activity data at the level of the recent years have been assumed for these source categories. Furthermore, a few activity data are only scaled with population growth (SFSO 2020p). However, the Energy Perspectives 2050+ provide no appropriate key parameters or measures for several source categories mainly within solvent and product use. For these source categories, projections are thus estimates based on information from industry, industry associations or expert judgement.

Sector 3 Agriculture

The basis of the WM scenario is the continuation of the agricultural policy 2018–2021 (Swiss Confederation 2017). The agricultural policy AP22+ should have come into force in 2022, but it was initially rejected by the parliament. A revised version of AP22+ was finally adopted by the parliament in 2023. Some key elements of the policy will therefore be implemented through a parliamentary initiative (19.475, Swiss Confederation 2019) that was adopted in 2021. Their effects were modelled by Mack and Möhring (2021) and they elaborated respective projections of animal populations, milk yields, cropping areas and fertiliser use based on the explanatory report (FOAG 2021). Thus, the so-called parliamentary initiative scenario of Mack and Möhring (2021) was used as basis for the calculations of the WM scenario. Projections are thus based on data and information available by 2021 on (i) the development of the macro-economic variables (gross domestic product, population, crop yields), (ii) the expected development of the domestic producer prices and (iii) the actual agricultural policy with the respective subsidy system. The main measures and underlying assumptions are:

- **Livestock populations:** Direct payments have been decoupled to a certain degree from cropping area and particularly from the number of animals living on the farms reducing incentives for intensification that would lead to negative environmental impacts (Swiss Confederation 2009). Consequently, the animal population numbers are more directly dependent on price levels. The cattle population is projected to decline slightly, whereas the number of swine and poultry remains more or less constant. Dairy cows are projected to exhibit a further increase in milk yield. Beyond 2027, constant population numbers were assumed for all animal categories due to the lack of further projections.
- **Manure management:** the shares of manure excreted during grazing as well as the shares of the individual manure management systems cannot be predicted satisfactorily and are thus left constant since 2019 together with all other parameters affecting manure management.
- **Crops:** Important aspects of the further development of direct payments that influence the development of the crop cultures are an improved targeting of direct payments, particularly for the promotion of common goods and the securing of a socially acceptable development (Swiss Confederation 2009, FOAG 2011). In general, arable crop production is projected to slightly decline whereas feed production from grasslands will remain more or less constant. Beyond 2027, constant yields and areas were assumed due to the lack of further projections.
- **Fertilisers and fertiliser management:** Use of commercial fertilisers is projected to decrease slightly until 2027 (Mack and Möhring 2021). Beyond 2027, constant fertiliser use was assumed due to the lack of further projections.

Sector 5 Waste

Per capita waste generation is assumed to remain at the level of 2018 in the projections up to 2050. However, in agreement with the energy scenarios, digestion of organic waste is increasing according to the use of biogas and sewage gas in the energy scenarios. Landfilling of combustible waste is prohibited in Switzerland, and it is assumed that this will also be the case in the future.

9.3 Main pollutants and CO

According to the projections, total NO_x and CO emissions will continue to decrease significantly between 2030 and 2050, NMVOC only slightly, while total emissions of SO_x will remain at more or less constant levels. The gaps in Figure 9-4 between the latest reporting year and 2030 symbolises the fact that most of the scenarios used to calculate emissions projections for the individual sectors and source categories start in 2030. Accordingly, the emissions in between are interpolated linearly.

Due to time constraints, it was only possible to perform a consistent calculation of NH₃ emissions for sector 3 Agriculture using the new AGRAMMON model version for the years 1990–2024. Accordingly, NH₃ emissions of sector 3 Agriculture and the National totals for the years 2025–2050 are reported as “not estimated”. They will be reported again in the next submission.

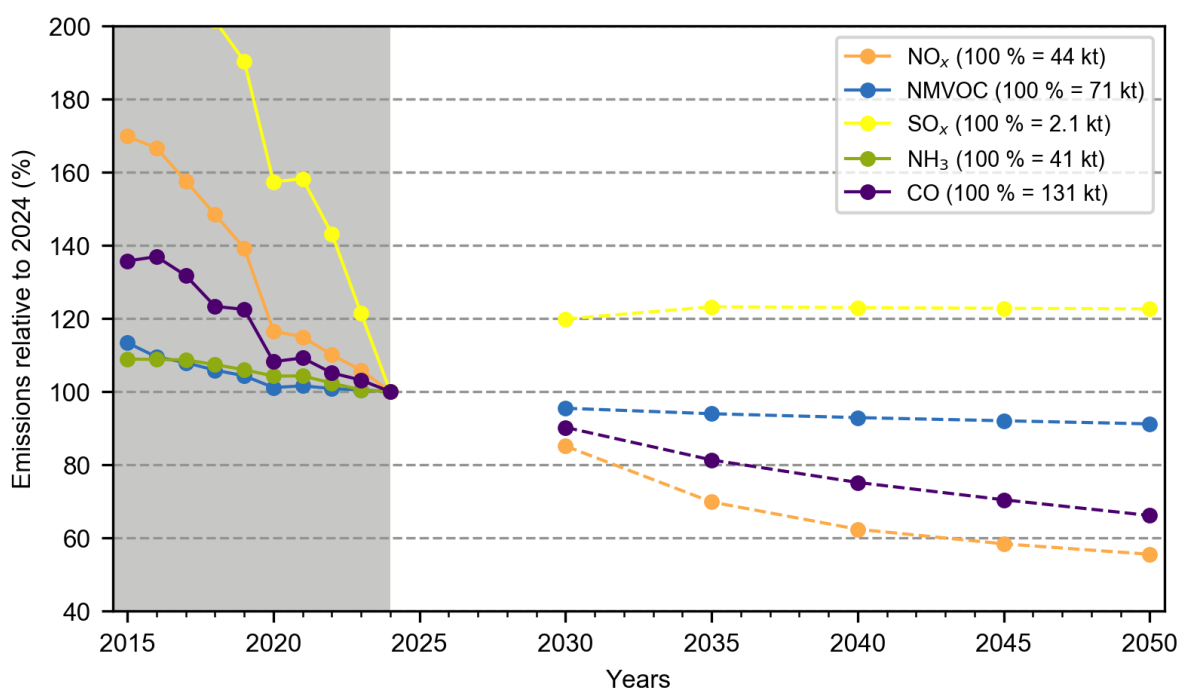


Figure 9-4 Relative trends for the total emissions of main air pollutants and CO in Switzerland as projected in the WM scenario. 100 % corresponds to levels of the latest reporting year.

Table 9-4 Main air pollutants and CO: Total emissions of the WM projections until 2050 in kt.

Year	NO _x	NM VOC	SO _x	NH ₃	CO
	kt	kt	kt	kt	kt
2005	94	114	14	48	303
2010	84	98	10	47	238
2015	75	81	5.6	45	178
2020	51	72	3.4	43	142
2024	44	71	2.1	41	131
2030	37	68	2.6	NE	119
2040	27	66	2.6	NE	99
2050	24	65	2.6	NE	87
2050 vs 2024 (%)	-44	-8.8	23	-	-34
2050 vs 2005 (%)	-74	-43	-82	-	-71
Gothenburg Protocol revised, target emission reduction 2005-2020					
	-41	-30	-21	-8.0	-

9.3.1 Projections for NO_x

NO_x emissions are projected to continue to decrease until 2050 (see Figure 9-4 and Table 9-5). The most significant reductions are projected for source category 1A3 Transport, which will also remain the main source of NO_x emissions in 2050, as in the latest reporting year. The most important source categories in the future and the reasons for their emission trends are briefly described below, in order of the emissions shares in 2050:

- **1A3 Transport:** Emissions are projected to be reduced especially in 1A3b Road transportation due to improvements in emission abatement technology, improved in-use compliance under real driving conditions for road vehicles (triggered by the Euro 6/VI standards) and a reduction of fuel consumption due to the increase of electromobility (see Figure 9-2). Emissions of 1A3ai(i) International aviation LTO (civil) will be the largest source category in 2050. They are projected to remain roughly constant between 2030 and 2050 (but compared to the latest reporting year they will increase).
- **1A2 Manufacturing industry and construction:** Emission reductions are expected due to the so-called NO_x industry agreement with the cement industry (1A2f), which includes a reduction path for the NO_x emission limit value by 2032.
- **1A4 Other sectors:** A reduction of emissions is projected due to measures related to domestic and commercial heating such as better insulation of buildings and increasing use of heat pumps and a decrease in heating degree days.
- **3 Agriculture:** NO_x emissions from agriculture are projected to remain about constant between 2030 and 2050. Similar as in the latest reporting year, source category 3D Agricultural soils (in particular 3Da2 Use of organic nitrogen fertilisers) is expected to contribute the largest share of NO_x emissions in 2050.

Table 9-5 WM projections: Trends of NO_x emissions per sector.

NO _x emissions	2024	2030	2040	2050	share in 2024	share in 2050	2024-2050
	kt	kt	kt	kt	%	%	kt
1(fu) Energy	40	34	24	21	91	84	-19
1A(fu) Combustion	40	34	24	21	91	84	-19
1A1 Energy industries	2.9	2.9	3.0	3.1	6.6	13	0.17
1A2 Manufacturing industries and construction	6.1	6.1	5.5	5.4	14	22	-0.66
1A3(fu) Transport	22	17	9.0	7.2	51	30	-15
1A4 Other sectors	8.1	7.2	5.8	4.6	18	19	-3.5
1A5 Other	0.32	0.30	0.29	0.28	0.72	1.2	-0.033
1B Fugitive emissions from fuels	0.0010	0.0014	0.0014	0.0014	0.0024	0.0055	0.00031
2 Industrial processes and product use	0.21	0.22	0.22	0.22	0.48	0.88	0.0034
3 Agriculture	3.6	3.4	3.4	3.4	8.3	14	-0.27
5 Waste	0.12	0.12	0.12	0.12	0.28	0.51	0.0010
6 Other sources	0.088	0.078	0.078	0.078	0.20	0.32	-0.0092
National total (fu)	44	37	27	24	100	100	-20

9.3.2 Projections for NMVOC

NMVOC emissions are projected to decrease only slightly between 2030 and 2050 (see Figure 9-4 and Table 9-6). On the one hand, a decrease of NMVOC emissions is expected in source categories 1A3 Transport and 1A4 Other sectors. On the other hand, an increase in the sector 2 IPPU is projected. The most important source categories in the future and the reasons for their emission trends are briefly described below, in order of the emissions shares in 2050:

- 2 IPPU: Population growth and, to some extent, the stagnation of the effects of the VOC incentive tax (Swiss Confederation 1997) are projected to lead to almost constant levels of NMVOC emissions.
- 3 Agriculture: Almost constant levels of emissions are projected due to the expected development of cattle population.
- 1A3 Transport: Emissions are projected to be reduced especially in 1A3b Road Transportation due to improvements in emission abatement technology, improved in-use compliance under real driving conditions for road vehicles (triggered by the Euro 6/VI standards) and a reduction of fuel consumption due to the increase of electromobility (see Figure 9-2).
- 1A4 Other sectors: A decline of overall fuel consumption, but in particular of log wood in manually operated furnaces, is expected to lead to a reduction of NMVOC emissions (see Figure 9-2).

Table 9-6 WM projections: Trends of NMVOC emissions per sector.

NMVOC emissions	2024	2030	2040	2050	share in 2024	share in 2050	2024-2050
	kt	kt	kt	kt	%	%	kt
1(fu) Energy	15	12	9.7	8.2	21	13	-6.6
1A(fu) Combustion	13	10	8.4	7.2	18	11	-5.4
1A1 Energy industries	0.21	0.21	0.23	0.24	0.30	0.37	0.032
1A2 Manufacturing industries and construction	0.86	0.90	0.87	0.85	1.2	1.3	-0.013
1A3(fu) Transport	6.9	5.1	4.0	3.2	9.7	4.9	-3.7
1A4 Other sectors	4.5	3.9	3.2	2.8	6.4	4.4	-1.7
1A5 Other	0.053	0.051	0.050	0.050	0.074	0.077	-0.0027
1B Fugitive emissions from fuels	2.2	1.7	1.3	1.0	3.2	1.6	-1.2
2 Industrial processes and product use	36	37	37	37	51	57	0.65
3 Agriculture	18	17	17	17	25	27	-0.52
5 Waste	1.8	1.7	1.8	2.0	2.6	3.1	0.20
6 Other sources	0.17	0.16	0.16	0.16	0.23	0.25	-0.0050
National total (fu)	71	68	66	65	100	100	-6.3

9.3.3 Projections for SO_x

SO_x emissions are projected to remain almost constant between 2030 and 2050 (see Figure 9-4 and Table 9-7). In Figure 9-4 (relative trends), a significant increase of SO_x emissions is visible. This is mainly due to the fact that production volumes in fuel-intensive industries, such as cement, rock wool and glass production, and brickworks, and correspondingly their fuel consumption, have declined significantly since 2022. These are currently well below the volumes projected for the future (see Figure 9-2). An increase is expected in sector 2 IPPU and source categories 1A2 Manufacturing industries and construction and 1A1 Energy industries. An emission reduction is mainly expected in source category 1A4 Other sectors. The most important source categories in the future and the reasons for their emission trends are briefly described below, in order of the emissions shares in 2050:

- 1A2 Manufacturing industries and construction: The projected increase in emissions between 2030 and 2050 is an artefact, caused by a missing emission factor for 1A2f Cement for the year 2030, which should have the same value as for the year 2050. Once the projection timeseries for this emission factor is completed, the emissions for 1A2f will decrease from 2030 until 2050 due to a projected decline in production volumes and an improved energy efficiency in the non-metallic minerals processing industry (rock wool, cement, brick and tile 1A2f).
- 2 IPPU: An increase of the production volume of silicon carbide and graphite (2B5) and thus of the use of sulphur-containing feedstocks is projected.
- 1A1 Energy industries: A increase of emissions in 1A1a Public electricity and heat production is expected due to growing amounts of waste incinerated.
- 1A3 Transport: The slight decrease of SO_x emissions between 2030 and 2050 is mainly due to a decrease in source category 1A3b Road transportation as fuel consumption (especially diesel oil) decreases due to the increase of electromobility. In the years 2030-2050, emissions of 1A3ai(i) International aviation LTO (civil) will be the largest source category within 1A3. They are projected to remain roughly constant (but compared to the latest reporting year they will increase).
- 1A4 Other sectors: The projected reduction in emissions is mainly due to the significant decrease in wood combustion partly because of better insulation of buildings, a higher share of heat pumps and a decrease in heating degree days as well as a continuous decline in single-room furnaces.

Table 9-7 WM projections: Trends of SO_x emissions per sector.

SO _x emissions	2024	2030	2040	2050	share in 2024	share in 2050	2024-2050
	kt	kt	kt	kt	%	%	
1(fu) Energy	1.8	2.1	2.0	2.0	86	78	0.20
1A(fu) Combustion	1.8	2.1	2.0	2.0	85	77	0.20
1A1 Energy industries	0.34	0.45	0.45	0.46	16	18	0.12
1A2 Manufacturing industries and construction	0.92	1.0	1.0	1.1	43	42	0.17
1A3(fu) Transport	0.20	0.25	0.24	0.23	9.5	8.7	0.025
1A4 Other sectors	0.34	0.32	0.26	0.21	16	8.1	-0.13
1A5 Other	0.025	0.025	0.025	0.025	1.2	0.97	-0.000003
1B Fugitive emissions from fuels	0.014	0.019	0.019	0.019	0.67	0.71	0.0043
2 Industrial processes and product use	0.26	0.45	0.55	0.55	12	21	0.29
3 Agriculture	NA	NA	NA	NA	-	-	-
5 Waste	0.030	0.028	0.027	0.029	1.4	1.1	-0.00098
6 Other sources	0.0070	0.0071	0.0071	0.0073	0.33	0.28	0.00028
National total (fu)	2.1	2.6	2.6	2.6	100	100	0.48

9.3.4 Projections for NH₃

Due to time constraints, it was only possible to perform a consistent calculation of NH₃ emissions for sector 3 Agriculture using the new AGRAMMON model version for the years 1990–2024. Accordingly, NH₃ emissions of sector 3 Agriculture and the National totals for the years 2025–2050 are reported as “not estimated”. They will be reported again in the next submission.

9.3.5 Projections for CO

CO emissions are projected to continue to decrease until 2035 (see Figure 9-4 and Table 9-8). Similar to NO_x, the most significant reductions are expected to happen in source categories 1A3 Transport and 1A4 Other sectors, which will also remain the main sources of CO emissions in 2035. The most important source categories in the future and the reasons for their emission trends are briefly described below, in order of the emissions shares in 2050:

- 1A4 Other sectors: Emission reductions are expected because of measures in domestic heating, such as better insulation of buildings, higher share of heat pumps, continuous technological improvements in wood combustion installations and a decrease in wood energy consumption in manually operated stoves and furnaces as well as further reduction in the number of emission intensive types of wood stoves (e.g. cooking stoves) as well as a decline in heating degree days.
- 1A3 Transport: Further improvements in emission abatement technology (triggered by the Euro 6/VI standards) and a reduction of fuel consumption due to the increase of electromobility (see Figure 9-2) are expected to lead to emission reductions.
- 1A2 Manufacturing industries and construction: Between 2030 and 2050, a reduction is expected due to a projected decline of production volumes and improved energy efficiencies in the non-metallic minerals processing industry (1A2f) as well as an expected higher proportion of modern wood combustion plants with lower proportions of non-optimal operating phases (1A2gviii).
- 2 IPPU: Emissions are projected to increase between 2030 and 2050, especially due to an expected increase of the production volume of silicon carbide and graphite (2B5).

Table 9-8 WM projections: Trends of CO emissions per sector.

CO emissions	2024	2030	2040	2050	share in 2024	share in 2050	2024-2050
	kt	kt	kt	kt	%	%	kt
1(fu) Energy	126	112	91	79	96	91	-47
1A(fu) Combustion	126	112	91	79	96	91	-47
1A1 Energy industries	0.89	0.84	0.83	0.86	0.68	0.99	-0.027
1A2 Manufacturing industries and construction	14	15	15	14	11	17	0.64
1A3(fu) Transport	58	48	36	29	44	34	-29
1A4 Other sectors	52	48	39	34	40	39	-18
1A5 Other	0.68	0.68	0.67	0.67	0.52	0.77	-0.012
1B Fugitive emissions from fuels	0.00021	0.00027	0.00027	0.00027	0.00016	0.00031	0.000062
2 Industrial processes and product use	3.5	5.2	6.0	6.0	2.7	6.9	2.5
3 Agriculture	NA	NA	NA	NA	-	-	-
5 Waste	1.3	1.2	1.1	1.1	1.0	1.3	-0.25
6 Other sources	0.43	0.42	0.41	0.42	0.33	0.48	-0.017
National total (fu)	131	119	99	87	100	100	-44

9.4 Suspended particulate matter

According to the projections, exhaust and non-exhaust suspended particulate matter emissions are expected to develop differently between 2030 and 2050. While non-exhaust emissions of all fractions increase, exhaust emissions decrease (see Figure 9-5, Table 9-9 and Table 9-10). Overall, this leads to a decrease of the smaller fractions of suspended particulate matter (PM2.5) and BC between 2030 and 2050 (see Figure 9-6 and Table 9-11). In contrast, the larger PM fractions (PM10, TSP) are expected to decrease only slightly (PM10) or remain at more or less constant levels (TSP). The gaps in Figure 9-5 and Figure 9-6 between the latest reporting year and 2030 symbolise the fact that most of the scenarios used to calculate emissions projections for the individual sectors and source categories start in 2030. Accordingly, the emissions in between are interpolated linearly.

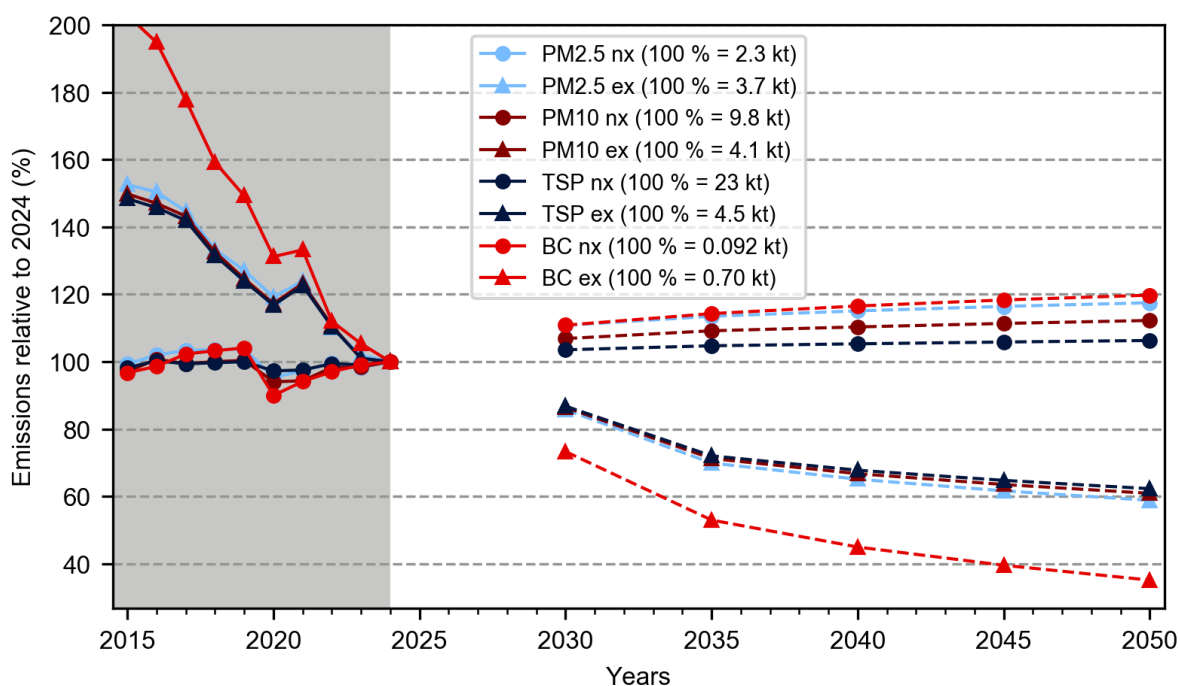


Figure 9-5 Projection of exhaust and non-exhaust emissions of suspended particulate matter PM2.5, PM10, TSP and BC in Switzerland of the WM scenario. 100 % corresponds to levels of the latest reporting year.

Table 9-9 Suspended particulate matter: Total exhaust emissions of the WM projections until 2050 in kt.

Year	PM2.5 ex	PM10 ex	TSP ex	BC ex
	kt	kt	kt	kt
2005	12	13	13	3.5
2010	8.9	9.6	10	2.5
2015	5.7	6.2	6.6	1.4
2020	4.4	4.9	5.2	0.91
2024	3.7	4.1	4.5	0.70
2030	3.2	3.6	3.9	0.51
2040	2.4	2.8	3.0	0.31
2050	2.2	2.5	2.8	0.24
2050 vs 2024 (%)	-41	-39	-38	-65

Table 9-10 Suspended particulate matter: Total non-exhaust emissions of the WM projections until 2050 in kt.

Year	PM2.5 nx	PM10 nx	TSP nx	BC nx
	kt	kt	kt	kt
2005	2.2	8.9	22	0.078
2010	2.3	9.3	23	0.083
2015	2.3	9.5	23	0.089
2020	2.2	9.2	23	0.083
2024	2.3	9.8	23	0.092
2030	2.5	10	24	0.10
2040	2.6	11	25	0.11
2050	2.7	11	25	0.11
2050 vs 2024 (%)	18	12	6.3	20

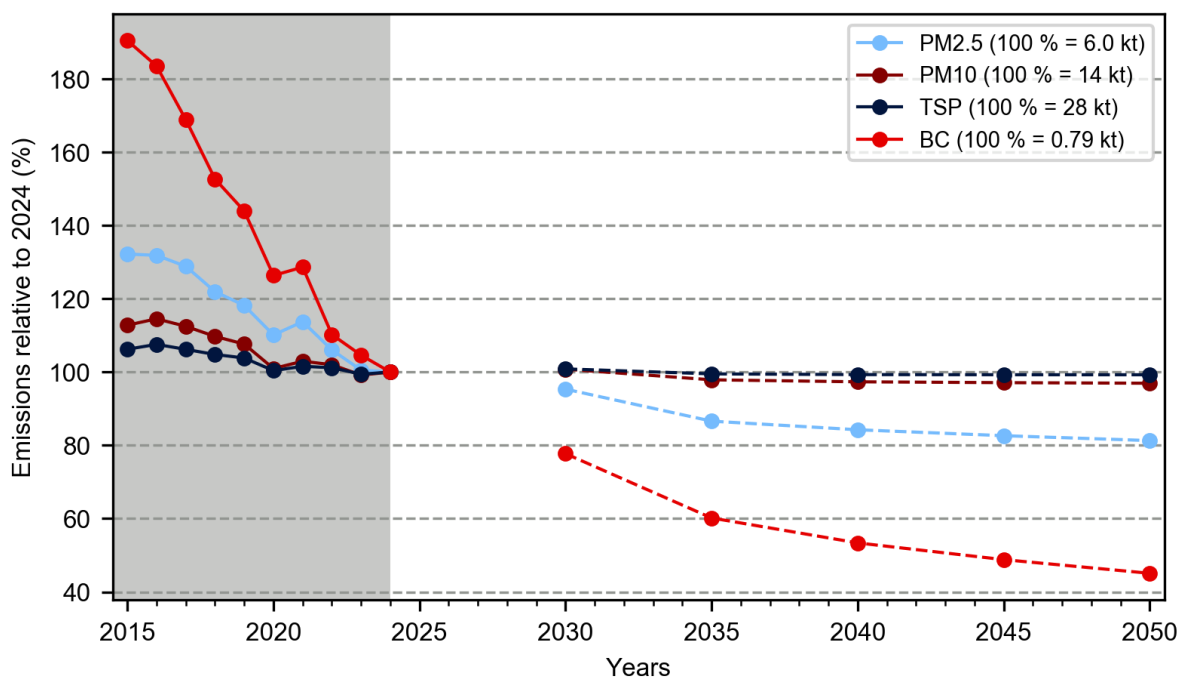


Figure 9-6 Projection of total emissions of suspended particulate matter PM2.5, PM10, TSP and BC in Switzerland of the WM (WEM) scenario. 100 % corresponds to levels of the latest reporting year. The figure shows the sum of exhaust and non-exhaust particles.

Table 9-11 Suspended particulate matter: Total emissions of the WM projections until 2050 in kt.

Year	PM2.5	PM10	TSP	BC
	kt	kt	kt	kt
2005	14	22	36	3.6
2010	11	19	33	2.6
2015	7.9	16	30	1.5
2020	6.6	14	28	1.00
2024	6.0	14	28	0.79
2030	5.7	14	28	0.61
2040	5.1	14	28	0.42
2050	4.9	13	28	0.36
2050 vs 2024 (%)	-19	-3.1	-0.74	-55
2050 vs 2005 (%)	-65	-38	-23	-90
Gothenburg Protocol revised, target emission reduction 2005-2020				
	-26	-	-	-

9.4.1 Projections for PM2.5

PM2.5 emissions are projected to continue to decrease until 2050 (see Figure 9-6 and Table 9-12). The most significant reductions are expected in source category 1A4 Other sectors. The most important source categories in the future and the reasons for their emission trends are briefly described below, in order of the emissions shares in 2050:

- **1A3 Transport:** Emissions are expected to remain about constant between 2030 and 2050. In source category 1A3b Road transportation, the ongoing replacement of older vehicles with vehicles with stricter emission standards or with electric engines will lead to reduced PM2.5 exhaust emissions. However, at the same time non-exhaust emissions are expected to increase with increasing activity (vehicle kilometres), which compensates the decrease of exhaust emissions. For the larger particles (TSP, PM10), this effect is more relevant than for smaller fractions.
- **1A4 Other sectors:** The projected decrease in emissions is mainly due to the decrease in wood combustion. Continuous technological improvements in small combustion installations (due to compliance with stricter air pollution control requirements from 2007 onwards), a general reduction in fuel consumption due to a decline in heating degree days, an accelerated reduction of consumption in manually operated stoves and furnaces and a further reduction in the number of emission-intensive wood stoves.
- **2 IPPU:** The main contributors to PM2.5 emissions are source categories 2A Mineral industry (especially 2A1 Cement production), 2G Other product manufacture and use and 2H Other (especially 2H1 Pulp and paper and 2H2 Food and beverages industry). The emissions of all these source categories are expected to remain about constant between 2030 and 2050.
- **1A2 Manufacturing industries and construction:** An emission reduction is projected due to the expected higher proportion of modern wood combustion plants with lower proportions of non-optimal operating phases (1A2gviii Other boilers and engines industry).

Table 9-12 WM projections: Trends of PM2.5 emissions per sector.

PM2.5 emissions	2024	2030	2040	2050	share in 2024	share in 2050	2024-2050
	kt	kt	kt	kt	%	%	kt
1(fu) Energy	4.6	4.2	3.6	3.4	76	69	-1.2
1A(fu) Combustion	4.6	4.2	3.6	3.4	76	69	-1.2
1A1 Energy industries	0.082	0.087	0.085	0.086	1.4	1.8	0.0037
1A2 Manufacturing industries and construction	0.59	0.57	0.53	0.54	9.7	11	-0.048
1A3(fu) Transport	1.4	1.5	1.5	1.5	23	31	0.12
1A4 Other sectors	2.4	2.0	1.4	1.2	41	24	-1.3
1A5 Other	0.044	0.044	0.042	0.042	0.73	0.86	-0.0014
1B Fugitive emissions from fuels	0.000034	0.000046	0.000042	0.000040	0.00056	0.00081	0.000006
2 Industrial processes and product use	1.0	1.2	1.2	1.2	17	24	0.14
3 Agriculture	0.15	0.14	0.14	0.14	2.4	3.0	-0.0011
5 Waste	0.26	0.22	0.19	0.20	4.4	4.1	-0.066
6 Other sources	0.0047	0.0047	0.0046	0.0047	0.079	0.095	-0.000090
National total (fu)	6.0	5.7	5.1	4.9	100	100	-1.1

9.4.2 Projections for PM10

PM10 emissions are projected to decrease only slightly between 2030 and 2050 (see Figure 9-6 and Table 9-13). A significant decrease is expected in source category 1A4 Other sectors. On the opposite, an increase is expected in source category 1A3 Transport. The most important source categories in the future and the reasons for their emission trends are briefly described below, in order of the emissions shares in 2050:

- **1A3 Transport:** Despite of a reduction of exhaust emissions in 1A3b Road transportation due to the ongoing replacement of older vehicles with vehicles with tightened emission standards or with electric engines, the projected increase of vehicle kilometres and thereby increase of non-exhaust emissions leads to an overall increase in PM10 emissions.
- **1A2 Manufacturing industries and construction:** As for PM2.5, there is an emission reduction projected for wood energy combustion (higher proportion of modern combustion plants with lower proportions of non-optimal operating phases, 1A2gviii). However, this will be offset by an increase in non-exhaust PM10 emissions from the re-suspension of construction machinery (1A2gvii), the dominant PM10 emission source within 1A2, due to a predicted increase in activity.
- **2 IPPU:** Similar to PM2.5, the main contributors to PM10 emissions are source categories 2A Mineral industry (especially 2A1 Cement production and 2A5a Quarrying and mining of minerals other than coal), 2G Other product manufacture and use and 2H Other (especially 2H1 Pulp and paper and 2H2 Food and beverages industry). In addition, also source category 2I Wood processing is relevant for PM10 emissions. The emissions of all these source categories are expected to remain about constant between 2030 and 2050.
- **3 Agriculture:** PM10 emissions originate from source categories 3De Cultivated crops and 3B Manure management (especially 3B4g Poultry, due to high livestock numbers) and are assumed to remain about constant until 2050.
- **1A4 Other sectors:** As for PM2.5, continuous technological improvements of small wood combustion installations (due to compliance with stricter air pollution control requirements from 2007 onwards), a general reduction in wood consumption due to a decline in heating degree days, an accelerated reduction of wood consumption in manually operated stoves and furnaces as well as a further reduction in the number of emission-intensive types of wood stoves lead to the projected emission reductions.

Table 9-13 WM projections: Trends of PM10 emissions per sector.

PM10 emissions	2024	2030	2040	2050	share in 2024	share in 2050	2024-2050
	kt	kt	kt	kt	%	%	kt
1(fu) Energy	9.9	9.9	9.5	9.4	71	70	-0.55
1A(fu) Combustion	9.9	9.9	9.5	9.4	71	70	-0.55
1A1 Energy industries	0.084	0.089	0.087	0.087	0.60	0.65	0.0038
1A2 Manufacturing industries and construction	2.6	2.7	2.7	2.7	19	20	0.12
1A3(fu) Transport	4.3	4.8	4.9	5.0	31	37	0.69
1A4 Other sectors	2.6	2.1	1.5	1.3	19	9.4	-1.4
1A5 Other	0.26	0.26	0.26	0.26	1.9	1.9	-0.0048
1B Fugitive emissions from fuels	0.00032	0.00044	0.00040	0.00037	0.0023	0.0028	0.000053
2 Industrial processes and product use	1.8	2.0	2.0	2.0	13	15	0.21
3 Agriculture	1.8	1.8	1.8	1.8	13	13	-0.0057
5 Waste	0.29	0.25	0.21	0.22	2.1	1.6	-0.073
6 Other sources	0.11	0.10	0.10	0.10	0.77	0.76	-0.0056
National total (fu)	14	14	14	13	100	100	-0.42

9.4.3 Projections for TSP

The opposing trend of exhaust and non-exhaust emissions is best visible for the largest fractions of particulate matter: exhaust emissions are expected to decrease, whereas non-exhaust emissions increase. Overall, TSP emissions are projected to remain about constant between 2030 and 2050 (see Figure 9-6 and Table 9-14, Table 9-15, Table 9-16). An important source of TSP, where emissions are expected to remain constant, is sector 3 Agriculture. An increase of TSP emissions is expected in source category 1A3 Transport and a decrease in source category 1A4 Other sectors. The most important source categories in the future and the reasons for their emission trends are briefly described below, in order of the emissions shares in 2050:

- **3 Agriculture:** The sector contributes considerably to total TSP emissions. They are dominated by non-exhaust TSP emissions from source category 3De Cultivated crops (field and arable tillage) that are assumed to remain about constant until 2050. Agriculture remains the predominant emissions source, both for non-exhaust-related emissions and for total TSP emissions. It should be noted that these emissions (3De) have a very high degree of uncertainty, since the EMEP/EEA guidebook (EMEP/EEA 2023) provides emission factors for PM10 and PM2.5 only. A couple of European countries assume for TSP the same values as for PM10. But this assumption does not seem appropriate, since particulate matter emissions from soil cultivation and harvesting have a large mass fraction in the coarse fraction. Therefore, the TSP emission factors have been estimated according to the Danish emission inventory (Danish Informative Inventory Report 2018) with a fraction of PM10/TSP of 10 %.
- **1A3 Transport:** Despite a reduction of exhaust emissions due to the ongoing replacement of older vehicles with vehicles with tightened emission standards or with electric engines, the projected increase of vehicle kilometres and thereby increase of non-exhaust emissions leads to an overall increase in TSP emissions.
- **1A2 Manufacturing industries and construction:** As for PM10, an emission reduction is projected for wood energy combustion (higher proportion of modern combustion plants with lower proportions of non-optimal operating phases, 1A2gviii), which will be offset by an increase in non-exhaust PM emissions from the re-suspension of construction machinery (1A2gvii), the dominant PM emission source within 1A2, due to a predicted increase in activity.
- **2 IPPU:** Similar to PM10, the main contributors to TSP emissions are source categories 2A Mineral industry (especially 2A1 Cement production and 2A5 Quarrying and mining of minerals other than coal), 2G Other product manufacture and use, 2H Other (especially 2H1 Pulp and paper and 2H2 Food and beverages industry) and 2I Wood processing.

The emissions of all these source categories are expected to remain about constant between 2030 and 2050.

Table 9-14 WM projections: Trends of total TSP emissions per sector.

TSP emissions	2024	2030	2040	2050	share in 2024	share in 2050	2024-2050
	kt	kt	kt	kt	%	%	kt
1(fu) Energy	12	12	12	12	43	42	-0.39
1A(fu) Combustion	12	12	12	12	43	42	-0.39
1A1 Energy industries	0.088	0.094	0.092	0.093	0.31	0.33	0.0051
1A2 Manufacturing industries and construction	3.8	3.9	3.9	4.0	14	15	0.22
1A3(fu) Transport	4.9	5.4	5.6	5.7	17	20	0.80
1A4 Other sectors	2.8	2.3	1.6	1.4	9.9	4.9	-1.4
1A5 Other	0.39	0.39	0.38	0.38	1.4	1.4	-0.0067
1B Fugitive emissions from fuels	0.00080	0.0011	0.00100	0.00093	0.0029	0.0034	0.00013
2 Industrial processes and product use	2.8	3.1	3.1	3.1	10	11	0.29
3 Agriculture	13	13	13	13	45	46	-0.0062
5 Waste	0.36	0.30	0.26	0.27	1.3	0.96	-0.092
6 Other sources	0.20	0.19	0.19	0.20	0.70	0.71	-0.00088
National total (fu)	28	28	28	28	100	100	-0.21

Table 9-15 WM projections: Trends of TSP exhaust emissions per sector.

TSP ex emissions	2024	2030	2040	2050	share in 2024	share in 2050	2024-2050
	kt	kt	kt	kt	%	%	kt
1(fu) Energy	3.3	2.7	1.9	1.7	73	60	-1.6
1A(fu) Combustion	3.3	2.7	1.9	1.7	73	60	-1.6
1A1 Energy industries	0.088	0.094	0.092	0.093	2.0	3.3	0.0051
1A2 Manufacturing industries and construction	0.28	0.26	0.20	0.20	6.4	7.0	-0.089
1A3(fu) Transport	0.24	0.22	0.16	0.13	5.4	4.5	-0.11
1A4 Other sectors	2.7	2.2	1.5	1.3	60	45	-1.4
1A5 Other	0.0055	0.0052	0.0046	0.0046	0.12	0.17	-0.00086
1B Fugitive emissions from fuels	0.000002	0.000003	0.000003	0.000003	0.000044	0.000092	0.000001
2 Industrial processes and product use	0.66	0.67	0.66	0.67	15	24	0.013
3 Agriculture	NA	NA	NA	NA	-	-	-
5 Waste	0.35	0.30	0.25	0.26	7.9	9.4	-0.092
6 Other sources	0.17	0.17	0.17	0.17	3.9	6.3	-0.00032
National total (fu)	4.5	3.9	3.0	2.8	100	100	-1.7

Table 9-16 WM projections: Trends of TSP non-exhaust emissions per sector.

TSP nx emissions	2024	2030	2040	2050	share in 2024	share in 2050	2024-2050
	kt	kt	kt	kt	%	%	kt
1(fu) Energy	8.6	9.2	9.6	9.8	37	40	1.2
1A(fu) Combustion	8.6	9.2	9.6	9.8	37	40	1.2
1A1 Energy industries	NA	NA	NA	NA	-	-	-
1A2 Manufacturing industries and construction	3.5	3.6	3.7	3.8	15	15	0.31
1A3(fu) Transport	4.6	5.1	5.4	5.5	20	22	0.91
1A4 Other sectors	0.10	0.098	0.095	0.093	0.43	0.37	-0.0090
1A5 Other	0.38	0.38	0.38	0.38	1.6	1.5	-0.0059
1B Fugitive emissions from fuels	0.00080	0.0011	0.00100	0.00093	0.0034	0.0037	0.00013
2 Industrial processes and product use	2.2	2.4	2.4	2.4	9.2	9.8	0.27
3 Agriculture	13	13	13	13	54	51	-0.0062
5 Waste	0.0036	0.0036	0.0036	0.0036	0.015	0.014	-
6 Other sources	0.022	0.022	0.022	0.022	0.094	0.087	-0.00056
National total (fu)	23	24	25	25	100	100	1.5

9.4.4 Projections for BC

The decreasing trend of emissions from PM2.5 is also reflected in the trends of BC emissions and is even more pronounced since the reduction measures mainly focus on combustion particles which largely consists of BC (see Figure 9-6 and Table 9-17). The decrease is mainly expected in source category 1A4 Other sectors. The most important source categories in the future and the reasons for their emission trends are briefly described below, in order of the emissions shares in 2050:

- 1A4 Other sectors: Continuous technological improvements in small wood combustion installations (due to compliance with stricter air pollution control requirements from 2007 onwards), a general reduction in wood consumption due to a decline in heating degree days, an accelerated reduction of consumption in manually operated stoves and furnaces and a further reduction in the number of emission-intensive wood stoves lead to the projected emission reductions.
- 1A3 Transport: Emissions are expected to slightly decline between 2030 and 2050. In source category 1A3b Road transport, the ongoing replacement of older vehicles with vehicles with tightened emission standards or with electric engines will lead to reduced BC emissions. However, the reducing effect is expected to be less pronounced due to the significant increase in activity (vehicle kilometres) and thus non-exhaust emissions.

Table 9-17 WM projections: Trends of BC emissions per sector.

BC emissions	2024	2030	2040	2050	share in 2024	share in 2050	2024-2050
	kt	kt	kt	kt	%	%	kt
1(fu) Energy	0.77	0.59	0.41	0.34	97	96	-0.43
1A(fu) Combustion	0.77	0.59	0.41	0.34	97	96	-0.43
1A1 Energy industries	0.0067	0.0087	0.0086	0.0086	0.85	2.4	0.0019
1A2 Manufacturing industries and construction	0.024	0.013	0.0096	0.0094	3.1	2.7	-0.015
1A3(fu) Transport	0.18	0.16	0.14	0.14	23	38	-0.045
1A4 Other sectors	0.55	0.41	0.24	0.18	70	52	-0.37
1A5 Other	0.0026	0.0025	0.0022	0.0022	0.34	0.61	-0.00048
1B Fugitive emissions from fuels	0.000020	0.000027	0.000025	0.000023	0.0025	0.0064	0.000003
2 Industrial processes and product use	0.0012	0.0012	0.0012	0.0012	0.15	0.33	-0.000019
3 Agriculture	NA	NA	NA	NA	-	-	-
5 Waste	0.019	0.016	0.014	0.014	2.4	4.1	-0.0046
6 Other sources	0.000074	0.000072	0.000070	0.000071	0.0094	0.020	-0.000003
National total (fu)	0.79	0.61	0.42	0.36	100	100	-0.43

9.5 Priority heavy metals

According to the projections, total Pb emissions and to a lesser extent also Hg will decrease between 2030 and 2050 whereas total Cd remain about constant. The gaps in Figure 9-7 between the latest reporting year and 2030 symbolises the fact that most of the scenarios used to calculate emissions projections for the individual sectors and source categories start in 2030. Accordingly, the emissions in between are interpolated linearly.

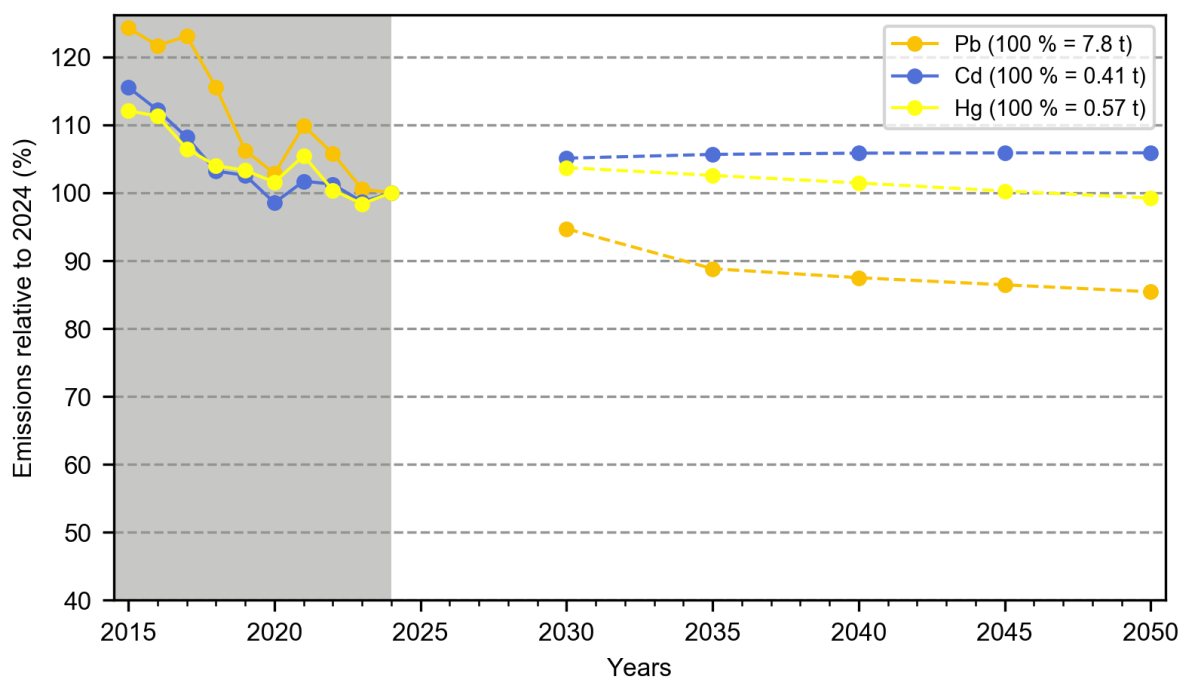


Figure 9-7 Relative trends for the total emissions of priority heavy metals in Switzerland as projected in the WM scenario. 100 % corresponds to levels of the latest reporting year.

Table 9-18 Priority heavy metals: Total emissions of the WM projections until 2050 in t.

Year	Pb	Cd	Hg
	t	t	t
2005	18	0.48	0.73
2010	12	0.50	0.74
2015	9.6	0.47	0.64
2020	8.0	0.40	0.58
2024	7.8	0.41	0.57
2030	7.3	0.43	0.59
2040	6.8	0.43	0.58
2050	6.6	0.43	0.57
2050 vs 2024 (%)	-15	5.9	-0.77

9.5.1 Projections for Pb

Pb emissions are projected to continue to decrease until 2050 (see Table 9-19 and Figure 9-7). The most significant reductions are expected in sectors 5 Waste and 6 Other and source category 1A4 Other sectors. The most important source categories in the future and the reasons for their emission trends are briefly described below, in order of the emissions shares in 2050:

- 1A1 Energy industries: Pb emissions are expected to stay about constant between 2030-2050. The increase in emissions from the growing amounts of waste incinerated in 1A1a Public electricity and heat production from the will almost be compensated by the decline in wood waste incinerated.
- 6 Other: It is assumed that the number of buildings fires in source category 6A4 Fire damage buildings and motor vehicles will continue to decrease between 2030 and 2050 due to safety improvements. At the same time, newly constructed and renovated

buildings are expected to contain significantly less lead due to the continuous expansion of the ban on lead in many products, which will be enforced by the Chemical Risk Reduction Ordinance (ORRChem, Swiss Confederation 2005).

- 5 Waste: The projected reduction of Pb emissions is mainly due to an assumed reduction of illegal waste incineration in source category 5C1a Municipal waste incineration.
- 1A2 Manufacturing industries and construction: The main contributors to Pb emissions are source categories 1A2gviii Other (especially wood waste and wood) and 1A2f Non-metallic minerals. Emissions from these categories are projected to decrease slightly between 2030 and 2050 due to the expected higher proportion of modern wood combustion plants with lower proportions of non-optimal operating phases (1A2gviii) as well as a decrease in production volumes and an improvement in energy efficiency in the non-metallic minerals processing industry (1A2f).
- 1A3 Transport: Emissions are projected to be reduced, particularly in 1A3b Road transportation, due to a reduction in fuel consumption as a result of the increase of electromobility (see Figure 9-2). Emissions of 1A3ai(ii) Domestic aviation LTO (civil) will be the largest source category within 1A3 and are projected to remain roughly constant between 2030 and 2050.
- 2 IPPU: The main contributors to Pb emissions are source categories 2C1 Iron and steel production and 2G Other product use. The emissions from these source categories are projected to remain about constant between 2030 and 2050.
- 1A4 Other sectors: A significant reduction of emissions is expected through continuous technological improvements in small wood combustion installations, a general reduction in wood consumption due to a decline in heating degree days, an accelerated reduction of consumption in manually operated stoves and furnaces and a further reduction in the number of emission-intensive wood stoves.

Table 9-19 WM projections: Trends of Pb emissions per sector.

Pb emissions	2024	2030	2040	2050	share in 2024	share in 2050	2024-2050
	t	t	t	t	%	%	t
1(fu) Energy	4.0	4.1	3.9	3.8	52	58	-0.21
1A(fu) Combustion	4.0	4.1	3.9	3.8	52	58	-0.21
1A1 Energy industries	1.9	1.9	1.9	1.9	24	29	0.062
1A2 Manufacturing industries and construction	0.80	0.92	0.89	0.86	10	13	0.063
1A3(fu) Transport	0.83	0.83	0.79	0.77	11	12	-0.065
1A4 Other sectors	0.53	0.47	0.34	0.26	6.9	4.0	-0.27
1A5 Other	0.00024	0.00024	0.00023	0.00023	0.0031	0.0034	-0.000010
1B Fugitive emissions from fuels	0.000004	0.000005	0.000005	0.000005	0.000046	0.000070	0.000001
2 Industrial processes and product use	0.59	0.59	0.59	0.59	7.6	9.0	0.0031
3 Agriculture	NA	NA	NA	NA	-	-	-
5 Waste	1.5	1.2	1.0	1.1	20	16	-0.46
6 Other sources	1.6	1.4	1.2	1.1	20	17	-0.47
National total (fu)	7.8	7.3	6.8	6.6	100	100	-1.1

9.5.2 Projections for Cd

Cd emissions are expected to remain about constant until 2050 (see Figure 9-7 and Table 9-20). Only marginal changes of Cd emission levels are projected for any sector. The most important source categories in the future and the reasons for their emission trends are briefly described below, in order of the emissions shares in 2050:

- 1A1 Energy industries: A slight increase is projected due to population growth and thereby an increased amount of waste incinerated.
- 1A3 Transport: An increase of traffic volumes is projected which will also lead to a slight increase of Cd emissions from tyre abrasion.

- 1A2 Manufacturing industries and construction: Between 2030 and 2050, a slight reduction in emissions is expected due to a projected decline of production volumes and improved energy efficiency in the non-metallic mineral processing industry (1A2f), as well as an expected higher proportion of modern wood combustion plants with lower proportions of non-optimal operating phases (1A2gviii).
- 1A4 Other sectors: A significant emission reduction is expected between 2030 and 2050 through continuous technological improvements in small wood combustion installations, a general reduction in wood consumption due to a decline in heating degree days, an accelerated reduction of consumption in manually operated stoves and furnaces and a further reduction in the number of emission-intensive wood stoves.
- 2 IPPU: The main contributor to Cd emissions is source category 2G Other product use (tobacco consumption and fireworks use), where emissions are projected to remain about constant.

Table 9-20 WM projections: Trends of Cd emissions per sector.

Cd emissions	2024	2030	2040	2050	share in 2024	share in 2050	2024-2050
	t	t	t	t	%	%	t
1(fu) Energy	0.36	0.38	0.39	0.39	89	90	0.024
1A(fu) Combustion	0.36	0.38	0.39	0.39	89	90	0.024
1A1 Energy industries	0.16	0.16	0.17	0.17	39	40	0.013
1A2 Manufacturing industries and construction	0.063	0.072	0.070	0.068	15	16	0.0057
1A3(fu) Transport	0.092	0.10	0.11	0.11	23	25	0.017
1A4 Other sectors	0.048	0.049	0.044	0.038	12	8.8	-0.010
1A5 Other	0.00053	0.00052	0.00050	0.00050	0.13	0.12	-0.000022
1B Fugitive emissions from fuels	0.000005	0.000006	0.000006	0.000006	0.0012	0.0015	0.000001
2 Industrial processes and product use	0.033	0.033	0.032	0.033	8.1	7.6	-0.00012
3 Agriculture	NA	NA	NA	NA	-	-	-
5 Waste	0.0087	0.0082	0.0080	0.0082	2.1	1.9	-0.00046
6 Other sources	0.0016	0.0016	0.0016	0.0016	0.39	0.37	0.000042
National total (fu)	0.41	0.43	0.43	0.43	100	100	0.024

9.5.3 Projections for Hg

Hg emissions are expected to decrease slightly between 2030 and 2050 (see Figure 9-7 and Table 9-21). An increase is expected in source category 1A1a Public electricity and heat production, while a decrease is projected for 1A3 Road Transport and 1A4 Other sectors. The most important source categories in the future and the reasons for their emission trends are briefly described below, in order of the emissions shares in 2050:

- 1A1 Energy industries: An increase is projected as a result of an increase in the amounts of waste, wood and wood waste incinerated.
- 1A2 Manufacturing industries and construction: Emissions are expected to slightly decrease. Changes are expected due to changes in activity data, such as reduced production volumes in source category 1A2f Non-metallic minerals (fine ceramics, bricks and tile).
- 1A4 Other sectors: A reduction of emissions is expected in stationary combustion. This reduction is due to the projected general decrease in the combustion of wood and wood waste.
- 2 IPPU: The main contributor to Hg emissions is source category 2C1 Iron and steel production, where emissions are expected to remain about constant due to projected roughly constant production volumes in secondary steel production.

Table 9-21 WM projections: Trends of Hg emissions per sector.

Hg emissions	2024	2030	2040	2050	share in 2024	share in 2050	2024-2050
	t	t	t	t	%	%	t
1(fu) Energy	0.50	0.52	0.51	0.50	88	88	-0.0042
1A(fu) Combustion	0.50	0.52	0.51	0.50	88	88	-0.0042
1A1 Energy industries	0.31	0.32	0.33	0.34	54	60	0.031
1A2 Manufacturing industries and construction	0.083	0.10	0.096	0.091	15	16	0.0078
1A3(fu) Transport	0.032	0.029	0.022	0.016	5.6	2.9	-0.016
1A4 Other sectors	0.076	0.076	0.063	0.049	13	8.7	-0.027
1A5 Other	0.000029	0.000029	0.000028	0.000028	0.0051	0.0049	-0.000001
1B Fugitive emissions from fuels	0.000001	0.000001	0.000001	0.000001	0.00014	0.00019	0.0000002
2 Industrial processes and product use	0.041	0.041	0.041	0.041	7.3	7.3	-0.000022
3 Agriculture	NA	NA	NA	NA	-	-	-
5 Waste	0.029	0.027	0.027	0.028	5.0	5.0	-0.00022
6 Other sources	0.000070	0.000070	0.000070	0.000072	0.12	0.13	0.000012
National total (fu)	0.57	0.59	0.58	0.57	100	100	-0.0044

9.6 Persistent organic pollutants

According to the projections, total emissions of all persistent organic pollutants (POPs) will decrease between 2030 and 2050. The decrease is most significant for PCB and less for the other POPs (PCDD/PCDF, PAH, HCB). The gaps in Figure 9-8 between the latest reporting year and 2030 symbolises the fact that most of the scenarios used to calculate emissions projections for the individual sectors and source categories start in 2030.. Accordingly, the emissions in between are interpolated linearly.

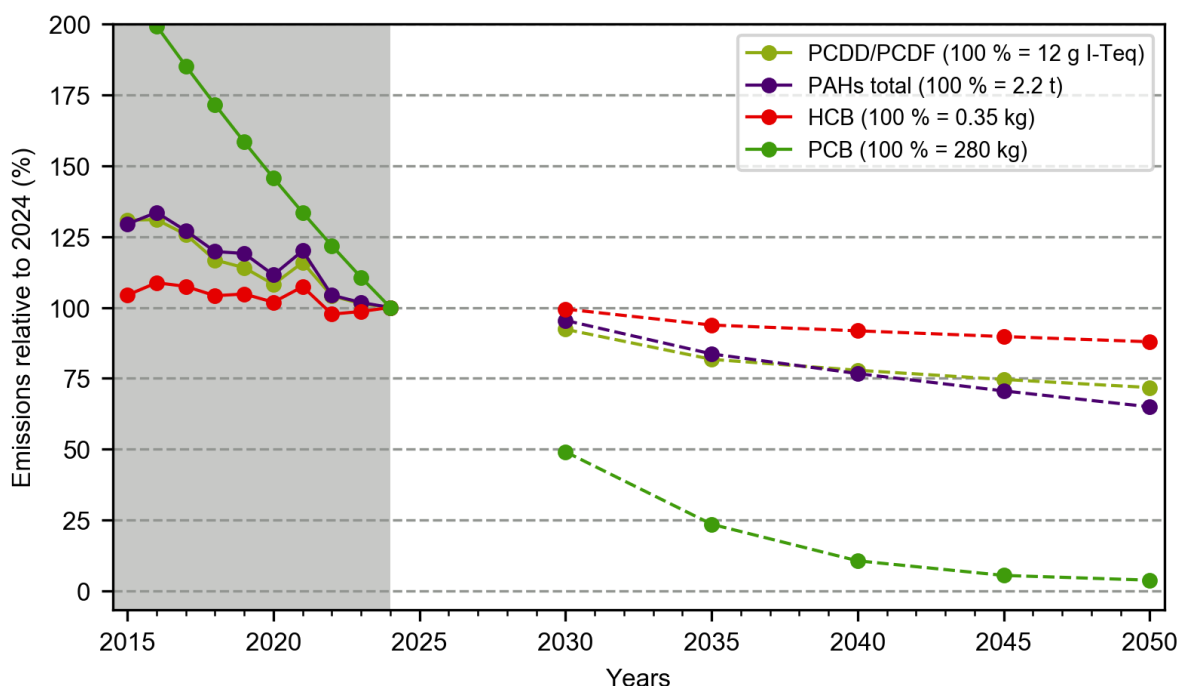


Figure 9-8 Relative trends for the total emissions of POPs: PCDD/PCDF, PAH (as the sum of benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene), and HCB in Switzerland in the WM scenario. 100 % corresponds to levels of the latest reporting year.

Table 9-22 Persistent organic pollutants (POPs): Total emissions of the WM projections until 2050 (please take note of the different units).

Year	PCDD/ PCDF	BaP	BbF	BkF	IcdP	PAHs total	HCB	PCB
	g I-Teq	t	t	t	t	t	kg	kg
2005	31	1.4	1.6	1.0	0.82	4.9	0.44	1'270
2010	25	1.3	1.3	0.77	0.71	4.0	0.45	827
2015	16	0.89	0.93	0.57	0.51	2.9	0.36	600
2020	13	0.76	0.80	0.50	0.44	2.5	0.35	408
2024	12	0.67	0.72	0.46	0.40	2.2	0.35	280
2030	11	0.64	0.69	0.43	0.37	2.1	0.34	138
2040	9.3	0.51	0.56	0.36	0.30	1.7	0.32	30
2050	8.5	0.43	0.47	0.31	0.25	1.5	0.30	11
2050 vs 2024 (%)	-28	-36	-34	-32	-38	-35	-12	-96

9.6.1 Projections for PCDD/PCDF

PCDD/PCDF emissions are projected to continue to decrease until 2050 (see Figure 9-8 and Table 9-23). The most significant reductions are expected in source category 1A4 Other sectors, which is the main source of PCDD/PCDF emissions, but reductions are also expected in sector 5 Waste. The most important source categories in the future and the reasons for their emission trends are briefly described below, in order of the emissions shares in 2050:

- 1A4 Other sectors: The emission reduction is projected to result from a continuous improvement in wood combustion installations, a general reduction in wood consumption due to a decline in heating degree days, an accelerated reduction of consumption in manually operated stoves and furnaces and a further reduction in the number of emission-intensive wood stoves.
- 5 Waste: Emission reductions are projected due to a reduction of illegally incinerated waste in source category 5C1a Municipal waste incineration.
- 1A1 Energy industries: Emissions are expected to increase due to the projected increase in volumes in waste incineration plants.
- 6 Other: Between 2030 and 2050, emissions are expected to increase slightly, as the projected increase in emissions due to the assumed increase in the number of vehicle fires will exceed the decline in emissions due to the assumed decrease in the number of building fires as a result of safety improvements (6A4d Fire damage buildings and motor vehicles).
- 1A2 Manufacturing industries and construction: The reduction is mainly due to an expected higher proportion of modern wood combustion plants with lower proportions of non-optimal operating phases (1A2gviii Other boilers and engines industry).
- 2 IPPU: The main contributors to PCDD/PCDF emissions are source categories 2H2 Meat smokehouses and 2H1 Chipboard production. Their emissions will increase between 2030 and 2050, as production volumes are projected to rise.

Table 9-23 WM projections: Trends of PCDD/PCDF emissions per sector.

PCDD/ PCDF emissions	2024	2030	2040	2050	share in 2024	share in 2050	2024-2050
	g I-Teq	g I-Teq	g I-Teq	g I-Teq	%	%	g I-Teq
1(fu) Energy	7.6	7.1	5.8	4.9	64	58	-2.7
1A(fu) Combustion	7.6	7.1	5.8	4.9	64	58	-2.7
1A1 Energy industries	1.2	1.1	1.1	1.2	9.8	14	-0.0053
1A2 Manufacturing industries and construction	0.81	0.91	0.81	0.79	6.8	9.3	-0.018
1A3(fu) Transport	0.39	0.30	0.23	0.18	3.3	2.1	-0.22
1A4 Other sectors	5.2	4.8	3.6	2.8	44	33	-2.4
1A5 Other	0.00039	0.00039	0.00037	0.00037	0.0033	0.0044	-0.000016
1B Fugitive emissions from fuels	NA	NA	NA	NA	-	-	-
2 Industrial processes and product use	0.69	0.72	0.73	0.74	5.8	8.7	0.059
3 Agriculture	NA	NA	NA	NA	-	-	-
5 Waste	2.7	2.2	1.8	1.9	22	22	-0.76
6 Other sources	0.95	0.94	0.93	0.95	8.0	11	0.00024
National total (fu)	12	11	9.3	8.5	100	100	-3.4

9.6.2 Projections for PAHs

PAH emissions are projected to continue to decrease until 2050 (see Figure 9-8 and Table 9-24). The most significant reduction is expected in source category 1A4 Other sectors, which is also the main source of PAH emissions in 2050. The most important source categories in the future and the reasons for their emission trends are briefly described below, in order of the emissions shares in 2050:

- 1A4 Other sectors: The significant emission reduction is projected to result from a continuous improvement in wood combustion installations, a general reduction in wood consumption due to a decline in heating degree days, an accelerated reduction of consumption in manually operated stoves and furnaces and a further reduction in the number of emission-intensive wood stoves.
- 1A3 Transport: PAH emissions from 1A3 Transport are expected to decrease between 2030 and 2050, due to a reduction in fuel consumption, as a result of the projected increase in electromobility (see Figure 9-2). The main contributor to the emissions are diesel passenger cars (1A3bi). (Constant PAH emission factors from the EMEP/EEA Guidebook (EMEP/EEA 2019) are used).
- 5 Waste: PAH emissions are dominated by field burning of agricultural waste (5C2 Open burning of waste), which is expected to remain about constant.
- 6 Other: PAH emissions are dominated by vehicles fires and are expected to slightly increase between 2030 and 2050 due to an increase in the number of fires (6A4b).
- 1A2 Manufacturing industries and construction: PAH emissions are expected to decrease between 2030 and 2050 mainly due to an expected higher proportion of modern wood combustion plants with lower proportions of non-optimal operating phases.

Table 9-24 WM projections: Trends of PAHs emissions per sector.

PAHs total emissions	2024	2030	2040	2050	share in 2024	share in 2050	2024-2050
	t	t	t	t	%	%	t
1(fu) Energy	1.9	1.8	1.4	1.1	86	77	-0.80
1A(fu) Combustion	1.9	1.8	1.4	1.1	86	77	-0.80
1A1 Energy industries	0.018	0.014	0.012	0.011	0.81	0.78	-0.0068
1A2 Manufacturing industries and construction	0.090	0.088	0.077	0.077	4.0	5.3	-0.013
1A3(fu) Transport	0.26	0.31	0.28	0.22	11	15	-0.036
1A4 Other sectors	1.6	1.4	1.0	0.81	70	56	-0.75
1A5 Other	0.00068	0.00067	0.00063	0.00063	0.030	0.043	-0.000044
1B Fugitive emissions from fuels	#####	#####	#####	#####	0.000003	0.000001	#####
2 Industrial processes and product use	0.018	0.021	0.021	0.022	0.80	1.5	0.0035
3 Agriculture	NA	NA	NA	NA	-	-	-
5 Waste	0.19	0.19	0.19	0.19	8.4	13	0.0011
6 Other sources	0.11	0.11	0.12	0.12	4.9	8.4	0.012
National total (fu)	2.2	2.1	1.7	1.5	100	100	-0.79

9.6.3 Projections for HCB

HCB emissions are projected to continue to decrease until 2050 (see Figure 9-8 and Table 9-25). Reductions are expected in source categories 1A2 Manufacturing industries and construction (stationary) and 1A4 Other sectors. On the opposite, an increase is projected for source category 1A1 Energy industries, which is the main source of HCB emissions in 2050. It should be noted that emissions from mobile sources (1A3, 1A2gvii, and 1A4aii/bii/cii) are not estimated in the inventory. The most important source categories in the future and the reasons for their emission trends are briefly described below, in order of the emissions shares in 2050:

- 1A1 Energy industries: Emissions are expected to increase due to the projected increase in volumes in waste incineration plants.
- 1A4 Other sectors: The emission reduction is projected to result from a continuous improvement in wood combustion installations, a general reduction in wood consumption due to a decline in heating degree days, an accelerated reduction of consumption in manually operated stoves and furnaces and a further reduction in the number of emission-intensive wood stoves.
- 1A2 Manufacturing and constructing industries: The emission reduction is mainly due to an expected higher proportion of modern wood combustion plants with lower proportions of non-optimal operating phases (1A2gviii).

Table 9-25 WM projections: Trends of HCB emissions per sector.

HCB emissions	2024	2030	2040	2050	share in 2024	share in 2050	2024-2050
	kg	kg	kg	kg	%	%	kg
1(fu) Energy	0.35	0.34	0.32	0.30	100	100	-0.042
1A(fu) Combustion	0.35	0.34	0.32	0.30	100	100	-0.042
1A1 Energy industries	0.19	0.20	0.20	0.21	56	70	0.018
1A2 Manufacturing industries and construction	0.031	0.040	0.035	0.033	9.1	11	0.0013
1A3(fu) Transport	NE	NE	NE	NE	-	-	-
1A4 Other sectors	0.12	0.11	0.078	0.060	35	20	-0.062
1A5 Other	NE	NE	NE	NE	-	-	-
1B Fugitive emissions from fuels	NA	NA	NA	NA	-	-	-
2 Industrial processes and product use	NA	NA	NA	NA	-	-	-
3 Agriculture	NA	NA	NA	NA	-	-	-
5 Waste	NA	NA	NA	NA	-	-	-
6 Other sources	NA	NA	NA	NA	-	-	-
National total (fu)	0.35	0.34	0.32	0.30	100	100	-0.042

9.6.4 Projections for PCBs

PCB emissions are projected to decrease considerably until 2050 (see Figure 9-8 and Table 9-26). By far the largest reduction is expected in sector 2 IPPU. The most important source categories in the future and the reasons for their emission trends are briefly described below, in order of the emissions shares in 2050:

- 6 Other: Due to the sharp reduction in PCB emissions between 2030 and 2050 from anti-corrosive paints and joint sealants (2K) between 2030 and 2050, emissions from accidental releases of PCB by fire and from soil due to former PCB spillages (6A5) will become the most significant emissions source in 2050. These emissions are also expected to decline between 2030 and 2050.
- 2 IPPU: Between 2030 and 2050, there will be a sharp reduction in PCB emissions between 2030 and 2050 from anti-corrosive paints and joint sealants that were applied on steel and in window frames (2K) before the ban of PCBs in so-called open application in 1972.

Table 9-26 WM projections: Trends of PCB emissions per sector.

PCB emissions	2024	2030	2040	2050	share in 2024	share in 2050	2024-2050
	kg	kg	kg	kg	%	%	kg
1(fu) Energy	0.34	0.37	0.33	0.32	0.12	3.0	-0.018
1A(fu) Combustion	0.34	0.37	0.33	0.32	0.12	3.0	-0.018
1A1 Energy industries	0.057	0.033	0.0070	0.00049	0.020	0.0046	-0.056
1A2 Manufacturing industries and construction	0.28	0.33	0.33	0.32	0.10	3.0	0.038
1A3(fu) Transport	0.000080	0.000062	0.000046	0.000034	0.000028	0.00032	-0.000045
1A4 Other sectors	0.00067	0.00062	0.00048	0.00037	0.00024	0.0035	-0.00030
1A5 Other	NE	NE	NE	NE	-	-	-
1B Fugitive emissions from fuels	NA	NA	NA	NA	-	-	-
2 Industrial processes and product use	252	118	17	0.77	90	7.2	-251
3 Agriculture	NA	NA	NA	NA	-	-	-
5 Waste	4.4	2.2	0.94	0.055	1.6	0.51	-4.3
6 Other sources	24	17	11	9.5	8.6	89	-14
National total (fu)	280	138	30	11	100	100	-270

10 Reporting of gridded emissions and LPS

Paragraph 28 of the “Guidelines for Reporting Emissions and Projections Data under the CLRTAP” requires that “Emission data calculated by Parties within the geographic scope of EMEP shall be spatially allocated in the EMEP grid as defined in paragraph 14 of these Guidelines” (ECE 2023). This chapter describes how Switzerland implemented these requirements.

10.1 EMEP grid

Definition of the EMEP grid

The EMEP grid is based on a latitude-longitude coordinate system: $0.1^\circ \times 0.1^\circ$ latitude-longitude projection in the geographic coordinate World Geodetic System latest revision, WGS 84. The domain is therefore described in degrees and not in km^2 . It extends in south-north direction from 30°N - 82°N latitude and in west-east direction from 30°W - 90°E longitude.

The grid fulfils the following requirements:

- It allows assessing globally dispersed pollutants on a hemispheric/global scale (Assessment Report, HTAP 2010).
- It allows to consider wider spatial scales to deal with tasks related to climate change and its effect on air pollution.
- Pollution levels can be assessed at a finer spatial resolution to provide more detailed information on pollution levels within territories of parties of the convention.

Figure 10-1 shows the EMEP grid domain.

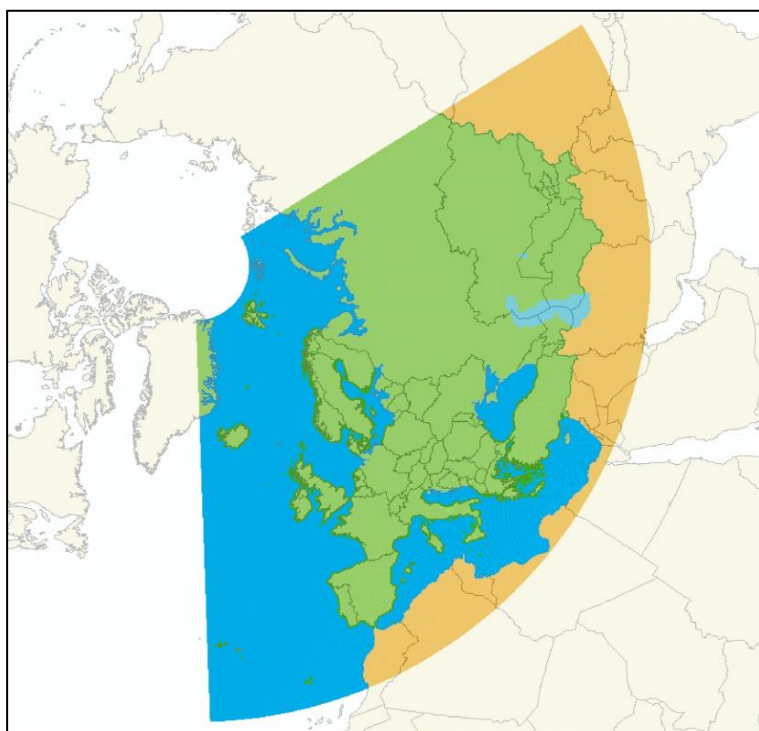


Figure 10-1 EMEP domain in the latitude-longitude projection (30°N - 82°N , 30°W - 90°E) (EMEP 2012a, <https://www.emep.int/grid/lonlatgrid.pdf>).

The EMEP domain on regional scale

In accordance with the requirements described above, grid resolution for standard EMEP regional simulations can be chosen in the range of $0.5^\circ \times 0.5^\circ$ to $0.2^\circ \times 0.2^\circ$ (EMEP 2012a). This means, for instance, that in a 0.2° -based EMEP grid the cell size at 40°N (Italy) is $17 \times 22 \text{ km}^2$ whereas at 60°N (Scandinavia) the cell size is $11 \times 22 \text{ km}^2$. In total, a $0.2^\circ \times 0.2^\circ$ resolution results in 156'000 grid cells.

EMEP domain on local scale

For a more detailed assessment of air pollution levels, spatial resolution needs to be further refined. Several studies have shown that the EMEP modelling centres can provide more accurate results if refined resolution with more detailed input data is applied (EMEP 2012a). Therefore, a spatial resolution for national/local levels is defined at $0.1^\circ \times 0.1^\circ$. This results in a spatial resolution at 40°N (Italy) of $9 \times 11 \text{ km}^2$ and $6 \times 11 \text{ km}^2$ at 60°N (Scandinavia). Figure 10-2 illustrates the EMEP grid resolution for Europe as used on local scales. In total, approximately 624'000 grid cells exist within the local EMEP domain.

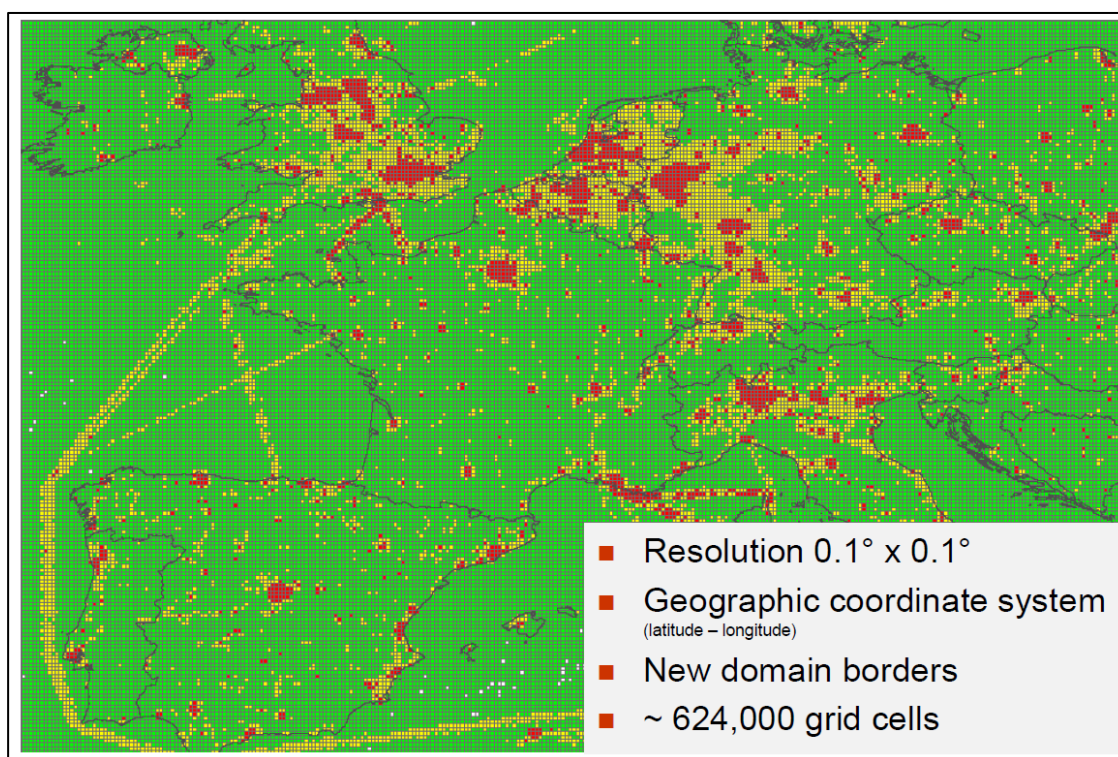


Figure 10-2 Resolution of the EMEP grid for Europe (EMEP 2012b).

In Switzerland's air pollution inventory of the latest submission 2026, the EMEP grid on local scale ($0.1^\circ \times 0.1^\circ$) is applied (see chapter 10.3) and contains 580 different grid cells. This includes also cells covering Lake of Constance. For grid cells outside Swiss borders no emissions are reported (see Figure 10-3).

The challenge in modelling on local scale ($0.1^\circ \times 0.1^\circ$) is the accurate allocation of emissions from the national total of emissions. Accordingly, emissions from national total should be processed to a resolution that is at least as fine as the resolution of the local-based EMEP grid. To achieve that, a separate study has been carried out which provides the allocation of the emissions sources within the local-scale EMEP grid (see Meteotest 2013 and 2021a).

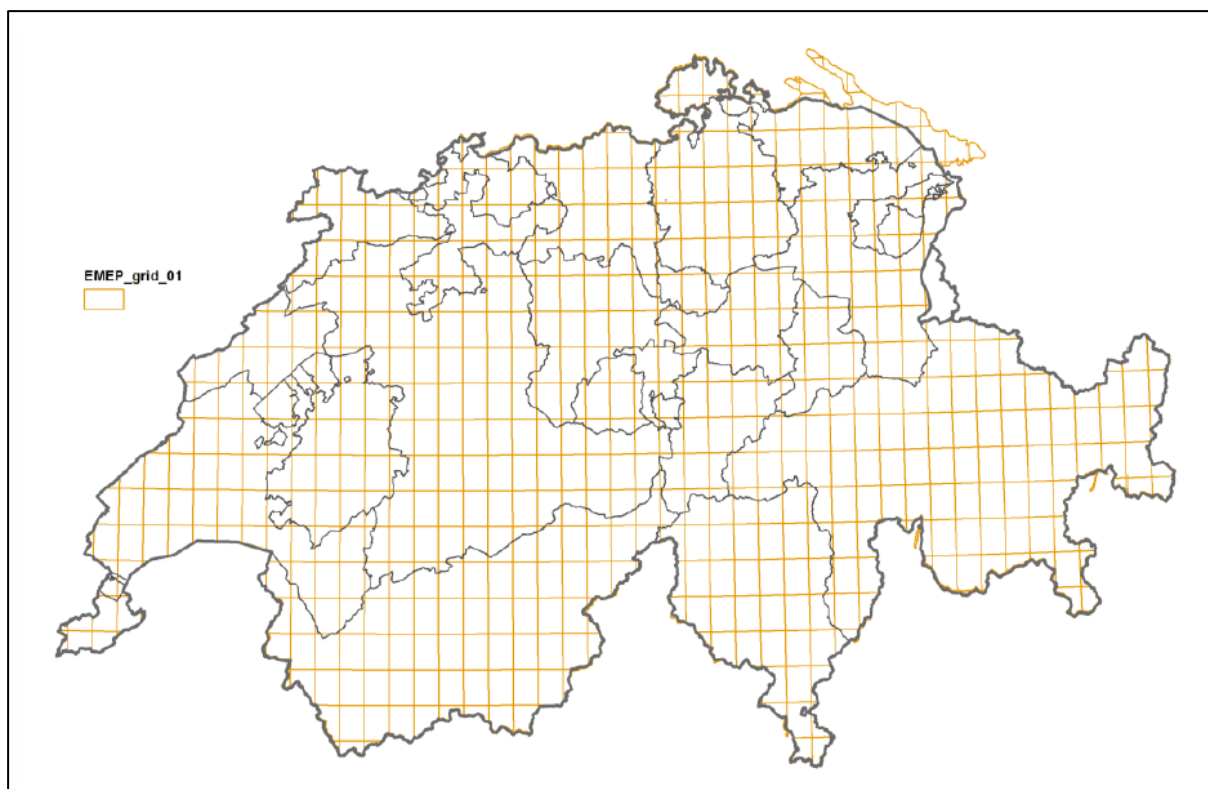


Figure 10-3 EMEP grid in Switzerland with 0.1° x 0.1° spatial resolution (from Meteotest 2013, downloaded from EMEP).

10.2 Gridding of emissions

10.2.1 Switzerland's emissions according to the GNFR-Code

As described above, the emissions of the Swiss national inventory must be allocated to the EMEP grid. Therefore, the source categories according to the NFR (Nomenclature for Reporting) code need to be aggregated to the GNFR categories (NFR Aggregation for Gridding according to annex V (GNFR) of ECE 2023a). Table 10-1 shows the relative shares of the GNFR categories of Switzerland's total emissions (national total) in 2024 for all main air pollutants including PM_{2.5} and CO.

Table 10-1 GNFR categories and their part (%) of total emissions in 2024 (national total) for the main air pollutants, PM2.5 and CO.

GNFR aggregated sectors	NO _x	NM VOC	SO _x	NH ₃	PM2.5	CO
A_PublicPower	6.0%	0.28%	13.5%	0.126%	1.16%	0.62%
B_Industry	12%	7.8%	57%	0.69%	15%	10%
C_OtherStatComb	15%	4.7%	16%	0.24%	39%	23%
D_Fugitive	0.0024%	3.2%	0.67%	NA	0.00056%	0.00016%
E_Solvents	0.039%	44%	0.26%	0.15%	6.2%	0.39%
F_RoadTransport	43%	9%	2.2%	2.1%	18%	39%
G_Shipping	2.0%	0.54%	0.022%	0.00052%	0.34%	3.8%
H_Aviation	5.1%	0.24%	7.2%	NA	0.28%	1.9%
I_Offroad	8.4%	2.1%	1.40%	0.0062%	13%	21%
J_Waste	0.28%	2.6%	1.38%	2.1%	4.4%	1.02%
K_AgriLivestock	2.0%	24%	NA	50%	1.7%	NA
L_AgriOther	6.4%	0.64%	NA	42%	0.75%	NA
M_Other	0.20%	0.23%	0.33%	2.3%	0.08%	0.33%
Total	100%	100%	100%	100%	100%	100%

10.2.2 Data availability for emission allocation

To allocate the emissions of each GNFR category, an adequate allocation key has to be determined. Numerous GNFR categories overlap with various source categories thus it is not possible to apply a single approach. Depending on the properties of each GNFR category, evaluation and identification of an appropriate allocation key is required. This ensures the adequate allocation of total emissions in the EMEP grid. For allocation purposes only relative shares of the national total emissions are relevant. Details of this work can be found in Meteotest 2013 and 2021a.

For the latest submission 2026, Switzerland calculated gridded emissions for the entire time series 1980–2024. For the allocation process of the emissions various data sources were applied for the time intervals 1980–1989, 1990–1999, 2000–2009, 2010–2015, 2016–2019 and > 2020. Table 10-2 illustrates the data source applied for each time interval.

Table 10-2 Applied data sources for gridded emission time series 1980-1989, 1990-1999, 2000-2009, 2010-2015, 2016-2019 and >2020 (Meteotest 2013 and 2021a).

Data source	Distribution pattern	Applied data source for gridded emission time series					
		1980-89	1990-99	2000-09	2010-15	2016-19	> 2020
Population data	1990, 2000, annually from 2010	1990	1990	2000	2013	2017	2020
Census of enterprises sector 1	1996, 2000, 2005, 2008, annually from 2011	1996	1996	2005	2013	2017	2018
Census of enterprises sector 2+3	1995, 2000, 2001, 2005, 2008, annually from 2011	1995	1995	2005	2013	2017	2018
Land use statistics	1979/85, 1992/97, 2004/09, 2013/18	1979/85	1992/97	2004/09	2013/18	2013/18	2013/18
NO _x emission maps	1990, 2000, 2005, 2010, 2015	2005	2005	2005	2015	2015	2015
PM10 emission maps	2005, 2010, 2015	2005	2005	2005	2015	2015	2015
NH ₃ emission maps	1990, 2000, 2007, 2010 (manure management)	1990	2000	2007	2010	2010	2010
Aviation	annual passenger numbers	1985	1995	2005	2013	2017	2019
Refineries	number of refineries	2	2	2	2	1	1
Cement production	number of cement plants (1990, 1998, 2006, 2013)	1990	1998	2006	2013	2013	2013

Population Density

At first sight, most emissions originate where people live and occur proportional to population density in an area. Therefore, population density is one of the main factors to allocate emissions in the EMEP grid. Geo-referenced population data is available annually by the Federal Statistical Office. The most populated area in Switzerland is the Swiss Plateau and the largest cities with their agglomerations in particular (see Figure 10-4).

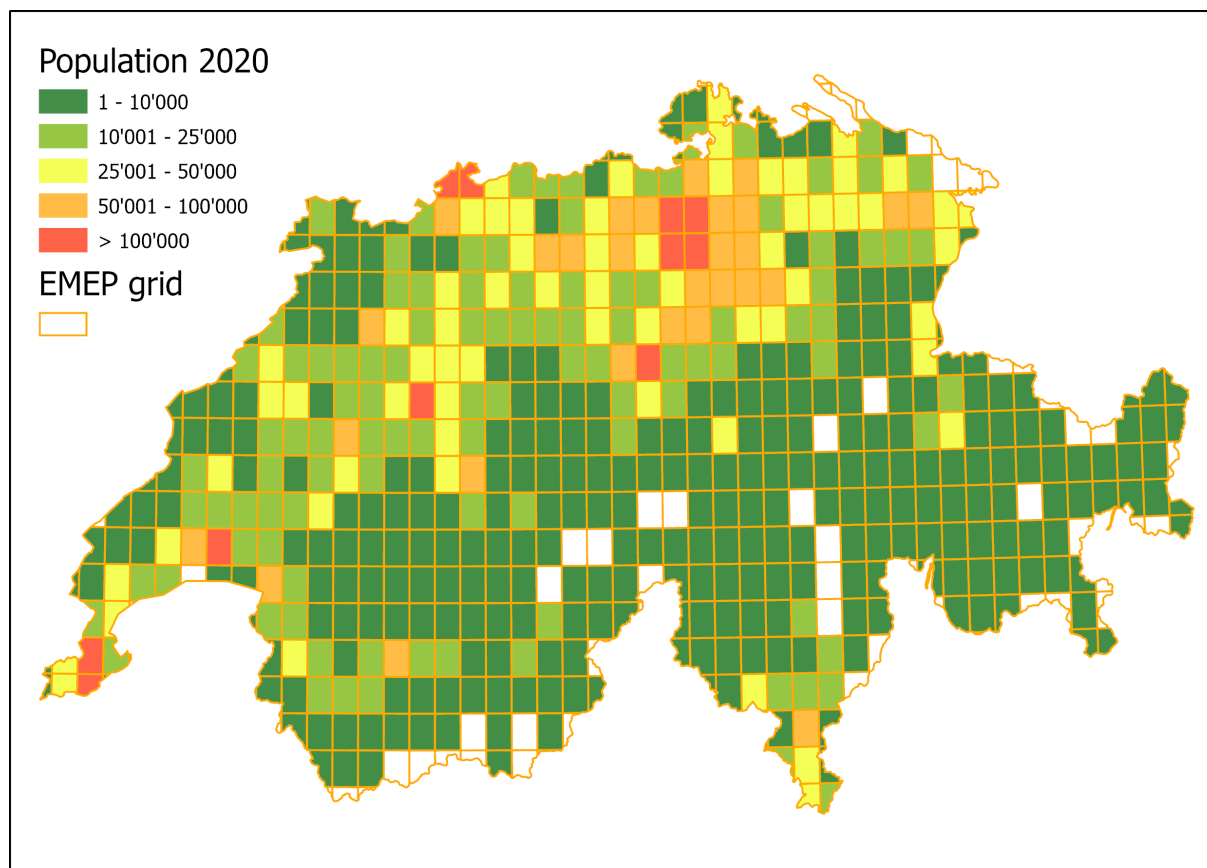


Figure 10-4 Population number per EMEP grid cell in Switzerland in 2020.

Census of enterprises/number of employees by economic sectors

Statistical surveys exist for enterprises, from which information about the specific economic use per hectare (100x100 m²) is derived. This data is provided annually by the Federal Statistical Office. For several GNFR categories covering industrial production, the number of employees per economic branch and per hectare combined with the information on the economic use per hectare is used for the allocation of the emissions in the EMEP grid.

Land Use Statistics

Switzerland's Land Use Statistics allows determining specific land use characteristics on a hectare-scale (100x100 m²). According to the Land Use Statistics by the Federal Statistical Office 74 categories are available. They are aggregated to 9 main land use categories to apply them to the EMEP grid (Meteotest 2013). The 9 main land use categories are:

- Wooded areas
- Industrial buildings
- Industrial grounds

- Residential buildings
- Surroundings of residential buildings
- Agricultural buildings
- Agricultural areas
- Unspecified buildings
- Wastewater treatment plants

Air pollution modelling data

The results of specific emissions models are used as additional data for allocation purposes. These specific emission models are described in detail in the associated documentations (FOEN 2011b, FOEN 2013a, Meteotest 2020a and Meteotest 2019b) Based on these models maps of selected emissions can be applied for allocation. For the following air pollutants and source categories, appropriate emission maps are available:

- NO_x: Emissions of road traffic (FOEN 2011b, Meteotest 2020a)
- NO_x: Emissions of navigation (FOEN 2011b, Meteotest 2020a)
- NO_x: Emissions of construction machinery (FOEN 2011b, Meteotest 2020a)
- NO_x: Emissions of industrial vehicles (FOEN 2011b, Meteotest 2020a)
- PM10: Emissions of rail traffic (FOEN 2013a, Meteotest 2020a)
- NH₃: Emissions of manure management - farming of animals without pasture (Meteotest 2019b)

10.2.3 Switzerland’s allocation of emissions for the EMEP grid

Method

The data sets described in 10.2.2 are available for the allocation of total emissions to the EMEP grid. The application of those data sets results in various spatial patterns of national emissions in each GNFR category. The attribution of GNFR categories to the patterns is given in the Table 10-3. This allocation method is applied for every pollutant (Meteotest 2021a).

Example of a GNFR category allocation in the EMEP grid in a case where the emission is attributed to the pattern “population” that means that the emission per hectare is proportional to its population:

$$Emission_{gs} = \frac{Population_g}{Total\ population\ of\ Switzerland} \times Emission_{tots}$$

Emission_{gs}: Emission of air pollutant (s) of a GNFR category in EMEP grid cell (g)

Population_g: Population of grid cell (g)

Emission_{tots}: Total emission of Switzerland of air pollutant (s) within the GNFR category
with:

$$\sum_{g=0}^{n_g} Emission_{gs} = Emission_{tots}$$

GNFR categories include by definition also Large Point Sources (LPS). The LPS are described under chp. 10.4 and illustrated in Figure 10-11.

Allocation rules and emission shares

The GNFR categories including their shares of emissions (main air pollutants, PM10 and PM2.5) and their allocation rules are presented in Meteotest (2013) and Meteotest (2021a).

Table 10-3 GNFR categories and their allocation indicators.

GNFR category	Source category	Distribution according to
A_PublicPower	1A1ai - 1A1aiii	Population density
	1A1aiv	Point sources
B_Industry	2A - 2I	Employees in the industry sector (sector 2)
	1A1b - 1A1c	Point sources
	1A2a - 1A2g	Employees in the industry sector (sector 2)
	1A2f	Point sources
C_OtherStatComb	1A4ai	Employees in the service sector (sector 3)
	1A4bi	Population density
	1A4ci	Employees in the agricultural sector (sector 1)
D_Fugitive	1B1a, 1B2aiii, 1B2av, 1B2b	Inhabited area
	1B2aiv, 1B2c	Employees in the industry sector (sector 2)
E_Solvents	2D3aCRT, 2D3b, 2D3h	Employees in the industry sector (sector 2)
	2D3aNFR	Population density
	2D3i, 2G3, 2G4	Inhabited area
F_RoadTransport	1A3bi - 1A3bvii	Air pollution modelling data of NO _x emissions from road transport (fuel sold)
G_Shipping	1A3d	Air pollution modelling data of NO _x Emissions from navigation
H_Aviation	1A3ai(i), 1A3aii(i)	Statistics of flight passengers of the six largest airports in Switzerland (excluding Basel since it lies on French territory)
I_Offroad	1A2gvii	Air pollution modelling data of NO _x -Emissions of construction machinery and industrial vehicles
	1A4aii, 1A4bii	Private gardening
	1A4cii	Agricultural area
	1A5bi, 1A5bii	Area of Switzerland below 1'500m a.s.l.
	1A3c	Air pollution modelling data of PM10-Emissions from rail transport
	1Ae	Employees in the industry sector (sector 2)
J_Waste	5A1, 5B1, 5B2, 5E	Inhabited area
	5D2	Employees in the industry sector (sector 2)
	5D1	Wastewater treatment plants
	5C1, 5C2	Population density
K_AgriLivestock	3B1 - 3B4	Air pollution modelling data of NH ₃ -Emissions of manure management - farming of animals without pasture
L_AgriOther	3Da - 3Db	Agricultural area
M_Other	3A4h, 3B4, 6Aa - 6Ad	Population density

Emissions not included in national total emissions

The following GNFR categories are not part of the national total emissions for the EMEP grid domain. These emissions are, therefore, not allocated to the EMEP grid cells.

Table 10-4 GNFR categories not included in the EMEP grid domain (according to Meteotest 2013).

GNFR	NFR Code	Longname
K_CivilAviCruise	1 A 3 a ii (ii)	1 A 3 a ii (ii) Civil Aviation (Domestic Cruise)
T_IntAviCruise	1 A 3 a i (ii)	1 A 3 a i (ii) Civil Aviation (International Cruise)
z_memo	1 A 3 d i (i)	1 A 3 d i (i) International maritime Navigation
	1 A 3	Transport (fuel used)
	7 B	Other (not included in National Total for Entire Territory)
S_Natural	11 A	11 (11 08 Volcanoes)
	11 B	Forest fires
	11 C	Other natural emissions

10.3 EMEP grid results (visualizations)

10.3.1 Spatial distribution of Switzerland’s NO_x emissions 2024

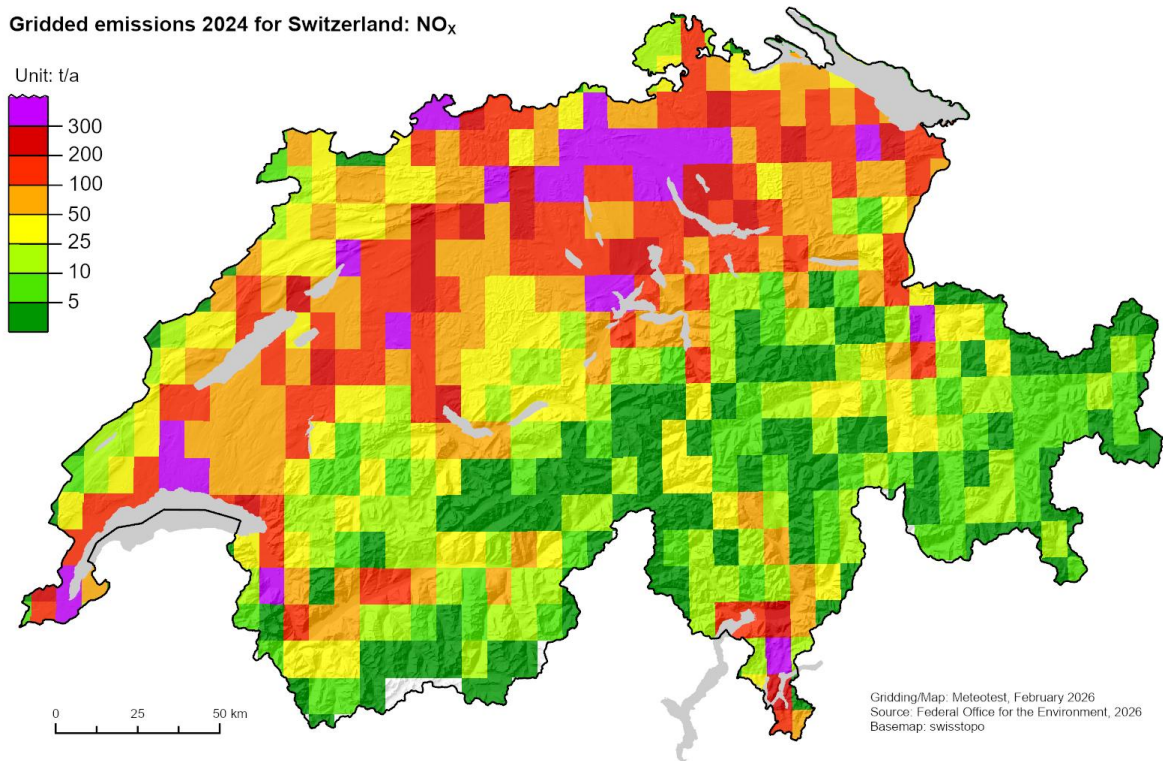


Figure 10-5 Spatial distribution of the NO_x emissions in Switzerland.

10.3.2 Spatial distribution of Switzerland's NMVOC emissions 2024

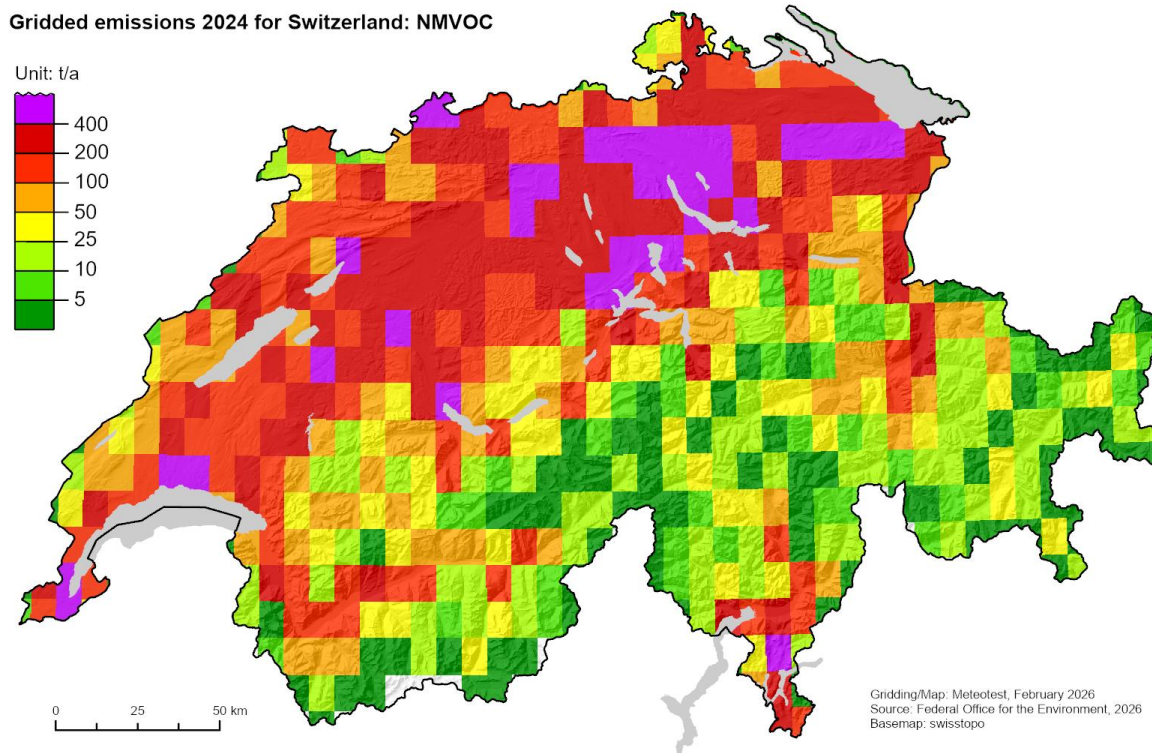


Figure 10-6 Spatial distribution of the NMVOC emissions in Switzerland.

10.3.3 Spatial distribution of Switzerland's SO_x emissions 2024

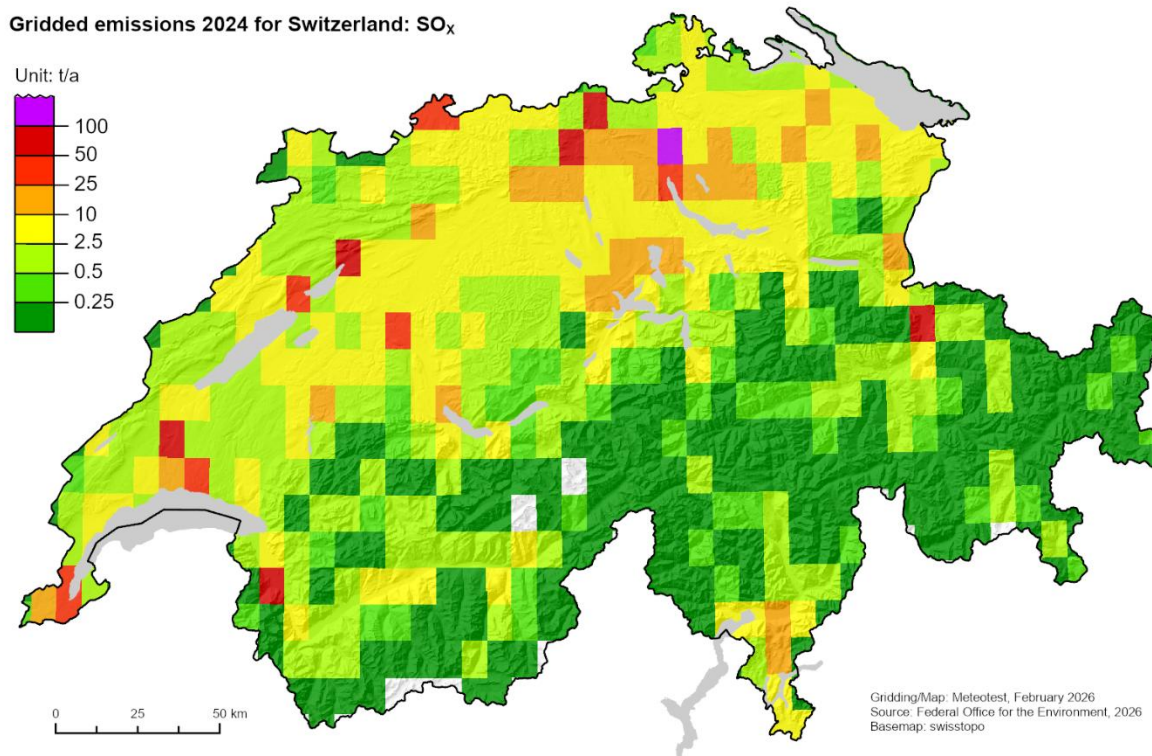


Figure 10-7 Spatial distribution of the SO_x emissions in Switzerland.

10.3.4 Spatial distribution of Switzerland's NH₃ emissions 2024

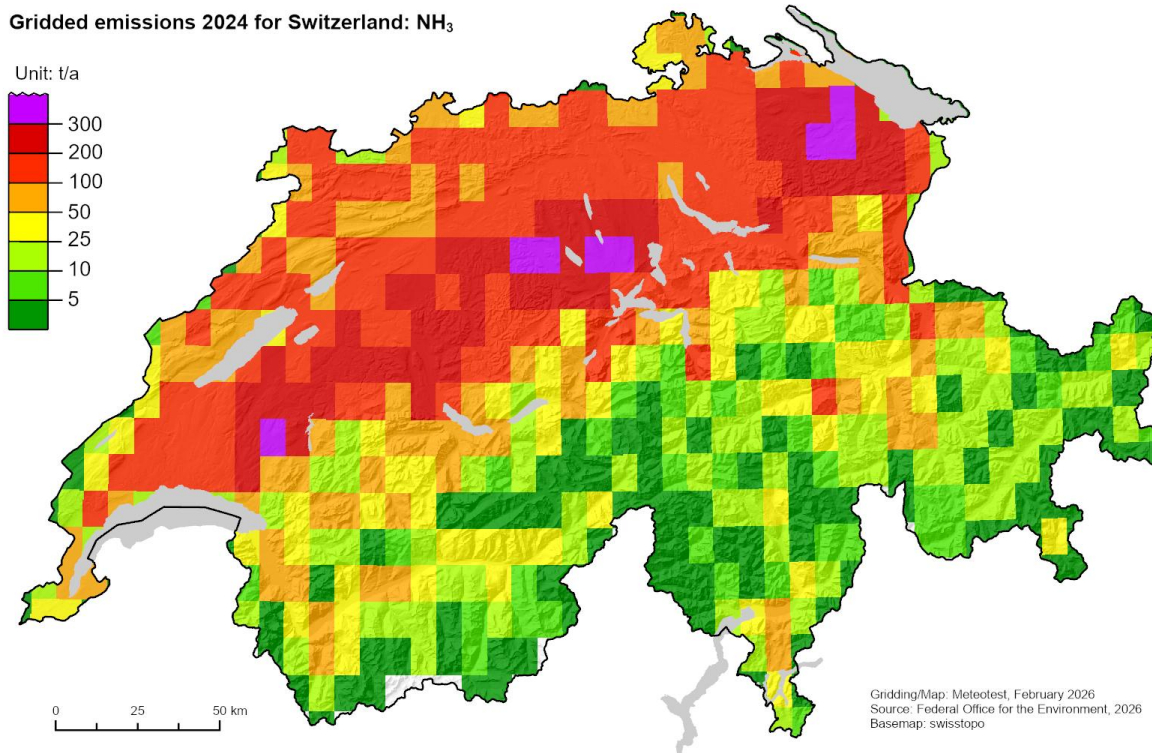


Figure 10-8 Spatial distribution of the NH₃ emissions in Switzerland.

10.3.5 Spatial distribution of Switzerland's PM_{2.5} emissions 2024

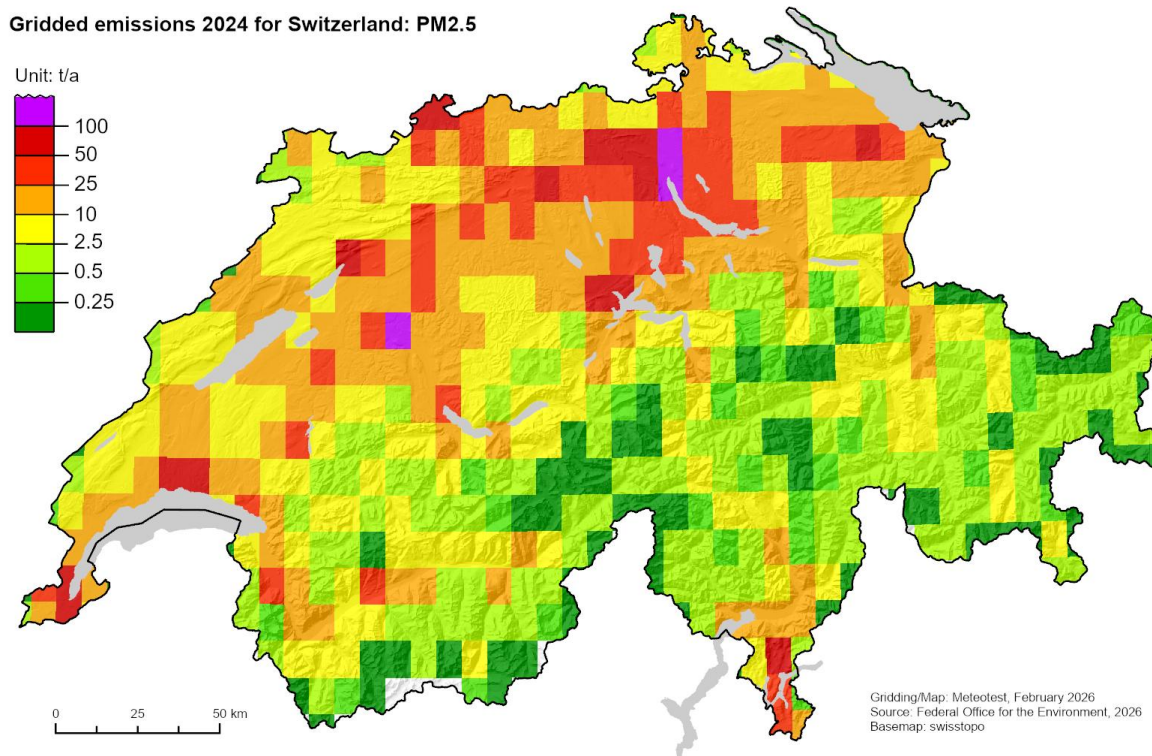


Figure 10-9 Spatial distribution of the PM_{2.5} emissions in Switzerland.

10.3.6 Spatial distribution of Switzerland's CO emissions 2024

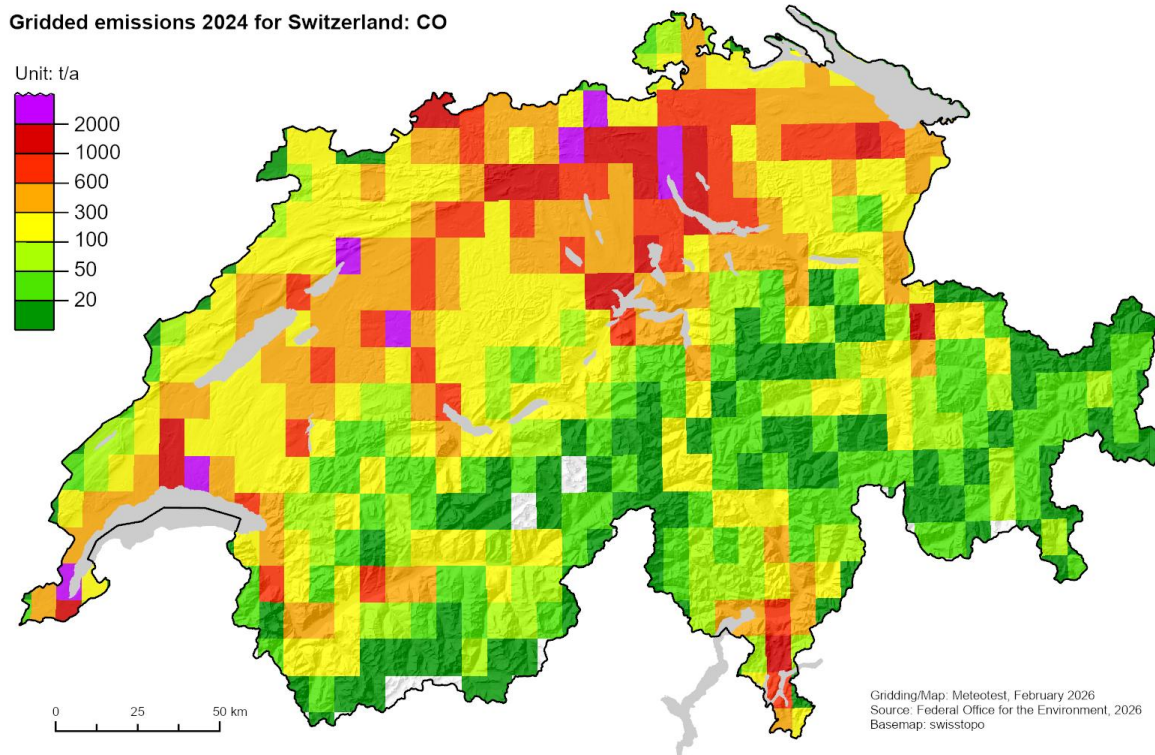


Figure 10-10 Spatial distribution of the CO emissions in Switzerland.

10.4 Large point sources (LPS)

Large Point Sources (LPS) are reported according to the definitions of the ECE Guidelines (ECE 2023). LPS are defined as facilities or installations whose emissions of at least one of 14 pollutants exceed the threshold value given in Table 1 of the ECE Guidelines (ECE 2023).

Facility designations, locations and emissions of Switzerland's LPS of the years 2007–2023 are reported based on the most recent data of the Swiss Pollution Release and Transfer Register (PRTR 2025). For the year 2024, emissions are assumed to be identical as for the year 2023. Data concerning air pollution release are reported annually by the facility operators and may be calculated based on periodic measurements, fuel consumption or other methods.

In 2023, the list of Switzerland's LPS includes 32 facilities, in particular from the industrial and waste sectors. As in previous years, most significant LPS are cement production plants and municipal solid waste incineration plants, followed by different facilities of the manufacturing industry such as steel production and chemicals (see Figure 10-11).

Information concerning the physical height of stack is reported as stack height class and the locations of the LPS are given in WGS 84 decimal coordinates, recalculated from Swiss grid coordinates (CH1903) as given in the Swiss PRTR.

The reported E-Swiss PRTR facility IDs correspond to the BER-Code (Business and Enterprise Register) of the Swiss Federal Statistical Office.

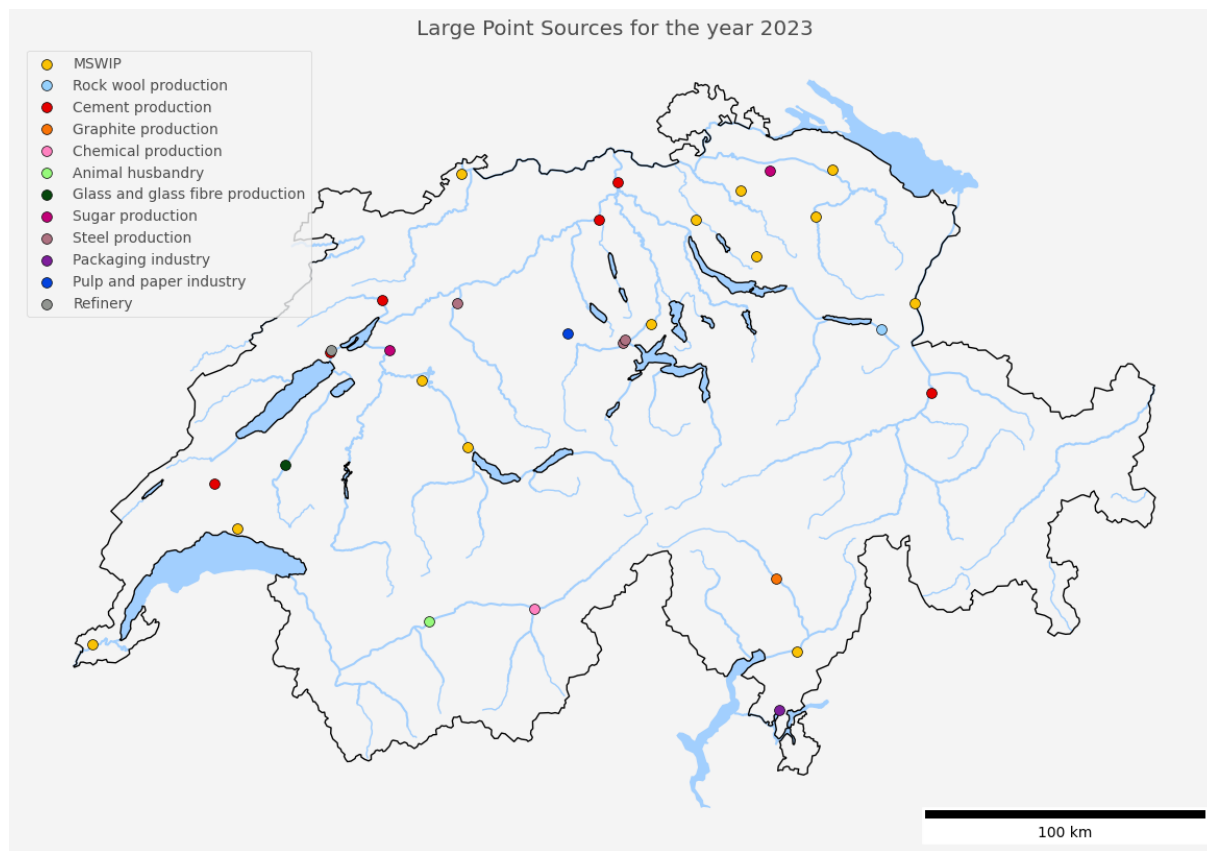


Figure 10-11 Spatial distribution of Switzerland's LPS in 2023. This figure only shows LPS exceeding the emission limit values defined in ECE (2023) and does not show all existing plants in Switzerland in the listed categories. MSWIP: Municipal solid waste incineration plant. Basemap: SFSO.

11 Adjustments

There are no adjustments in Switzerland's air pollutant emission inventory.

12 References and assignments to EMIS categories

12.1 References

- ADEME 2013:** Improvement of the knowledge of the atmospheric emission from vehicles fires – Contribution of this source to the national emission inventory. Final Report in French, 07.05.2013, decision 11-81C0087, technical coordination: Emmanuel Fiani. Programme EMBRUVE, Agence de l'Environnement et de la Maîtrise de l'Energie ADEME (FR).
- AGRAMMON 2018:** The Swiss agricultural ammonia emission calculation model, developed by the Bern University of Applied Sciences, School of Agricultural, Forest and Food Sciences in cooperation with Bonjour Engineering GmbH and Oetiker + Partner AG on behalf of the Federal Office for the Environment FOEN. Internet version 5.0 in German, French and English: <https://agrammon.ch/de/downloads/>; Technical description for download (updated periodically): <https://agrammon.ch/en/dokumentation-zum-modell/> [03.02.2026]
- Agricura 2025:** Geschäftsbericht 2023/2024. Agricura, Bern [confidential/internal].
- ARE 2002:** Fahrleistungen der Schweizer Fahrzeuge. Ergebnisse der periodischen Erhebung Fahrleistungen (PEFA) 2000. Federal Office for Spatial Development, Bern. <https://www.bafu.admin.ch/en/references-ghg-inventory>
- ARE 2022:** Schweizerische Verkehrsperspektiven 2050 - Schlussbericht. <https://www.aren.admin.ch/dam/de/sd-web/V5-l74rZMqos/verkehrsperspektiven-schlussbericht.pdf> [09.02.2026]
- ARE/SFSO 2005:** Mobilität in der Schweiz. Ergebnisse des Mikrozensus 2005 zum Verkehrsverhalten. [La mobilité en Suisse. Résultats du microrecensement 2005 sur le comportement de la population en matière de transports]. Federal Office for Spatial Development, Bern and Swiss Federal Statistical Office, Neuchâtel. <https://www.bfs.admin.ch/bfs/de/home/statistiken/kataloge-datenbanken/publikationen.assetdetail.344011.html> [09.02.2026]
- ARE/SFSO 2012:** Mobilität in der Schweiz. Ergebnisse des Mikrozensus Mobilität und Verkehr 2010. [La mobilité en Suisse. Résultats du microrecensement mobilité et transports 2010]. Federal Office for Spatial Development, Bern and Swiss Federal Statistical Office, Neuchâtel, 2012. https://www.aren.admin.ch/dam/de/sd-web/kn-UcTds2378/mobilitaet_in_derschweiz-ergebnissedesmikrozensusmobilitaetundve.pdf [09.02.2026]
- ARE/SFSO 2017:** Verkehrsverhalten der Bevölkerung – Ergebnisse des Mikrozensus Mobilität und Verkehr 2015. Federal Office for Spatial Development, Bern and Swiss Federal Statistical Office, Neuchâtel. 2017. <https://www.bfs.admin.ch/bfs/en/home/statistics/mobility-transport/passenger-transport/travel-behaviour.assetdetail.1840477.html> [09.02.2026]
- ARE/SFSO 2023:** Mobilitätsverhalten der Bevölkerung – Ergebnisse des Mikrozensus Mobilität und Verkehr 2021. Federal Office for Spatial Development, Bern and Swiss Federal Statistical Office, Neuchâtel. 2023. <https://www.bfs.admin.ch/bfs/en/home/statistics/mobility-transport/passenger-transport/travel-behaviour.assetdetail.24165261.html> [17.02.2026]
- Armendáriz, C.R., Garcia, T., Soler, A., Fernández, A.J.G., Glez-Weller, D., González, G.L., de la Torre, A.H., Gironés, C.R. 2015:** Heavy metals in cigarettes for sale in Spain. Environmental Research, Vol. 143, pp 162-169. <https://doi.org/10.1016/j.envres.2015.10.003> [29.01.2026]

- ART/SHL 2012:** Categorization of livestock animals in Switzerland. D. Bretscher and T. Kupper. Agroscope Research Station Zürich (ART), Schweizerische Hochschule für Landwirtschaft Zollikofen (SHL). March 2012. <https://www.bafu.admin.ch/en/references-ghg-inventory>
- Aschmann, V., Effenberger, M., Prager, M., Tappe, S. J. 2019:** Emissionsarmer Betrieb von Biogasmotoren. Kuratorium für Technik und Bauwesen in der Landwirtschaft e.V. (KTBL). https://www.ktbl.de/fileadmin/user_upload/Artikel/Energie/Biogasmotoren/Biogasmotoren-.pdf [03.02.2026]
- Avenergy 2025:** Jahresbericht 2024. Avenergy Suisse, Zürich. <https://www.avenergy.ch/de/publikationen/jahresbericht> [09.02.2026]
- Baier, U. 2023:** Expert judgement by Urs Baier, vice president of Biomasse Suisse, Brugg, 31.10.2023 <https://www.bafu.admin.ch/en/references-ghg-inventory>
- Battelle 1989:** Ermittlung der Methan-Freisetzung durch Stoffverluste bei der Erdgasversorgung der Bundesrepublik Deutschland – Beitrag des Methans zum Treibhauseffekt. Battelle-Institut e.V., Frankfurt am Main. [confidential/internal]
- Battelle 1994:** Methanfreisetzung bei der Erdgasnutzung in der Schweiz und Vergleich mit anderen Emittenten. V-68.225. Battelle Ingenieurtechnik GmbH, Eschborn. [confidential/internal]
- BIPM 2019:** The International System of Units (SI). 9th Edition. Bureau International des Poids et Mesures, Pavillon de Breteuil, F-92312 Sèvres Cedex, France. ISBN 978-92-822-2272-0. <https://www.bipm.org/en/publications/si-brochure/> [09.02.2026]
- Bühler and Kupper 2018:** Agricultural emissions of NMVOC and PM. Literature review and selection of emission factors, HAFL Zollikofen, Bern. <https://www.aramis.admin.ch/Default.aspx?DocumentID=49767&Load=true> [02.02.2026]
- Butz 2003:** Neuere rechtliche Vorgaben im Bereich Deponiegasanlagen – TA-Luft, EEG, Deponieverordnung. Trierer Berichte zur Abfallwirtschaft Band 14.
- BUWAL 2001:** Massnahmen zur Reduktion der PM10-Emissionen. Umwelt-Materialien Nr. 136. Bundesamt für Umwelt, Wald und Landschaft (BUWAL).
- Canton of Neuchâtel 2019:** Émissions de la raffinerie. Information concerning fugitive emissions of oil at the refinery in Cressier. E-Mail communication from F. Gretillat, Canton of Neuchâtel, to A. Bass, FOEN (15.10.2019).
- Carbotech 2000:** PM10-Emissionsfaktoren: Mechanischer Abrieb im Offroad-Bereich. Folgearbeiten zum BUWAL-Bericht SRU Nr. 255. Arbeitsunterlage 16.
- Carbura 2022:** Untersuchung der historischen VOC-Emissionen aus Benzin-Tanklagern, Carbura, 01.03.2022. Carbura, im Auftrag des Bundesamtes für Umwelt (BAFU), Bern, 2022 [confidential/internal].
- Carbura 2023:** Untersuchung der VOC-Emissionen aus Flugpetrol-Tanklagern. Carbura, 16. Januar 2023. Report on behalf of the Federal Office for the Environment, Bern. [confidential/internal]
- Carbura 2023b:** Geschäftsbericht 2023, Carbura. https://www.carbura.ch/fileadmin/user_upload/editors/web_dokumente/pdf_dokumente/Geschaeftsberichte/2023_CARBURA_GB_DE.pdf [06.03.2026]
- Carbura 2025:** VOC-Emissionen aus Benzin- und Flugpetrol-Grosstankanlagen im Jahr 2024. Carbura, 3. Oktober 2025. Report on behalf of the Federal Office for the Environment, Bern. [confidential/internal]

- Caruso, R. V., O'Connor, R. J., Stephens, W. E., Cummings, K. M., & Fong, G. T. 2014:** Toxic Metal Concentrations in Cigarettes Obtained from U.S. Smokers in 2009: Results from the International Tobacco Control (ITC) United States Survey Cohort. *International Journal of Environmental Research and Public Health*, 11(1), 202-217. <https://doi.org/10.3390/ijerph110100202> [29.01.2026]
- Cemsuisse 2010a:** Bestimmung der Emissionsfaktoren an Mischproben, Interner Bericht von Wessling im Auftrag von cemsuisse, 2010 [confidential/internal].
- Citepa 2012:** Inventaire des emissions de polluants atmospheriques en France au titre de la Convention sur la Pollution Atmospherique Transfrontaliere a longue Distance et de la Directive Europeenne relative aux plafonds d'emissions nationaux (NEC). Ministère de l'Ecologie, du Développement Durable, des Transport et du Logement. CITEPA, Mars 2012.
- Consaba 2016:** Erhebung Verwertung Deponiegas über Fackelanlagen in der Schweiz 1990 bis 2014. Consaba GmbH (A. Bauen) im Auftrag des Bundesamtes für Umwelt (BAFU), Bern, Schlussbericht, 23.09.2016. <https://www.bafu.admin.ch/en/references-ghg-inventory>
- Cuhls, C., Mähi, B., Clemens J., 2010:** Emissionen aus Biogasanlagen und technische Massnahmen zu ihrer Minderung. TK Verlag – Fachverlag für Kreislaufwirtschaft. Band 4 (2010). September 2010.
- Danish Informative Inventory Report 2018:** Annual Danish Informative Inventory Report to UNECE. Emission inventories from the base year of the protocols to year 2016. Nielsen, O.-K., Plejdrup, M.S., Winther, M., Mikkelsen, M.H., Nielsen, M., Gyldenkærne, S., Fauser, P., Albrektsen, R., Hjelgaard, K.H., Bruun, H.G. & Thomsen, M. Aarhus University, DCE – Danish Centre for Environment and Energy, 495 pp. Scientific Report from DCE – Danish Centre for Environment and Energy No. 267 <http://dce2.au.dk/pub/SR267.pdf> [02.02.2026]
- DDPS 2014a:** List of military non-road machinery (stocks, engine-power, annual operating hours). E-Mail C. Stucki (Federal Department of Defence, Civil Protection and Sport) to B. Notter (INFRAS) 27.05.2014 [confidential/internal].
- DDPS 2020:** Consumption of aviation fuel and jet kerosene of Swiss military aircraft 1990-2019. Désirée Föry (Federal Department of Defence, Civil Protection and Sport) to Anouk Aimée Bass (FOEN, Bern), 21.07.2020 [confidential/internal]
- De Ruijter, F.J. and Huijsmans, J. F. M. 2019:** A methodology for estimating the ammonia emission from crop residues at a national scale. *Atmospheric Environment*, X, 2, Article 100028. <https://doi.org/10.1016/j.aeaaoa.2019.100028> [09.02.2026]
- Düring, I., Schmidt, W. 2016:** Ermittlung von Emissionsfaktoren von Kraftfahrzeugen unter Berücksichtigung zukünftiger Antriebskonzepte und der Vorkette von Kraftstoffen Arbeitspaket 2: Emissionsfaktoren aus Abrieb und Wiederaufwirbelung. Ingenieurbüro Lohmeyer GmbH & Co. KG, Radebeul.
- DVGW 2022:** Ermittlung von Methanemissionen des Gasverteilnetzes (ME DSO) – Inventur der Datenlage zur Abschätzung von Methanemissionen aus dem deutschen Gasverteilnetz, Entwicklung und Durchführung eines repräsentativen Messprogramms zur Erhebung der erforderlichen Daten. DVGW-Förderkennzeichen G201812. Deutscher Verein des Gas- und Wasserfaches e.V. <https://www.dvgw-regelwerk.de/plus#technische-regel/dvgw-abschlussbericht-g-201812/deadc2> [09.02.2026]
- Ebertsch, G. 2021:** Ergebnisse von Langzeitmessungen von Formaldehyd, CO, NO_x und Gesamt-C an einer genehmigungsbedürftigen Biogasmotoranlage. Präsentation am Online-Workshop „Stand der Emissionsminderungstechnik bei kleinen Motoranlagen“, UBA Deutschland, 19.10.2021. https://www.umweltbundesamt.de/programm-workshop-stand-der-https://www.umweltbundesamt.de/sites/default/files/medien/3521/dokumente/ebertsch_ergebnisse_langzeitmessungen.pdf [03.02.2026]

- EC 2004:** Directive 2004/42/CE 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 certain paints and varnishes and vehicle refinishing products and amending Directive 1999/13/EC. Official Journal of the European Union. <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32004L0042&qid=1455622565462&from=EN> [29.01.2026]
- ECE 2023:** Guidelines for Reporting Emissions and Projections data under the Convention on Long-range Transboundary Air Pollution. https://www.ceip.at/fileadmin/inhalte/ceip/00_pdf_other/2022/emissions_reporting_guidelines_2023_final.pdf [29.01.2026]
- ECE 2023a:** Annexes to the 2023 reporting guideline: Annex II: Recommended Structure for Informative Inventory Report (IIR), Annex V: Gridded emissions template, Annex VI: LPS emissions template <https://www.ceip.at/reporting-instructions/annexes-to-the-2023-reporting-guidelines> [29.01.2026]
- Ecoinvent 2021:** Ecoinvent Database v3.8. Swiss Centre for Life Cycle Inventories, Dübendorf. <https://ecoinvent.org/> [03.02.2026]
- Edelmann, W., Schleiss, K. 1999:** Ökologischer, energetischer und ökonomischer Vergleich von Vergärung, Kompostierung und Verbrennung fester biogener Abfallstoffe. [Ecologic, energetic and economic comparison of treating biogenic wastes by digesting, composting or incinerating]. On behalf of the Swiss Federal Office of Energy, Bern and the Swiss Agency for the Environment, Forests and Landscape, Bern. <https://www.bafu.admin.ch/en/references-ghg-inventory> (KP1)
- EMEP 2012a:** Considerations of Changing the EMEP Grid. 36th Session of the EMEP Steering Body, 17 to 19 September 2012, Geneva, Switzerland. http://www.unece.org/fileadmin/DAM/env/documents/2012/air/EMEP_36th/n_3_EMEP_note_on_grid_scale_projection_and_reporting.pdf [09.02.2026]
- EMEP 2012b:** The new EMEP grid – An overview of the upcoming changes. https://www.ceip.at/fileadmin/inhalte/ceip/6_grid_ips/ceip_new_emep_grid.pdf [09.02.2026]
- EMEP/EEA 2002:** EMEP/CORINAIR Emission Inventory Guidebook. European Environment Agency. 3rd edition October 2002 update. <http://www.eea.europa.eu/publications/EMEPCORINAIR3/page002.html> [28.01.2026]
- EMEP/EEA 2016:** Air pollutant emission inventory guidebook – 2016. European Environment Agency. <https://www.eea.europa.eu/publications/emep-eea-guidebook-2016> [02.02.2026]
- EMEP/EEA 2019:** EMEP/EEA air pollutant emission inventory guidebook 2019. Technical guidance to prepare national emission inventories. European Environment Agency. <https://www.eea.europa.eu/en/analysis/publications/emep-eea-guidebook-2019> [09.02.2026]
- EMEP/EEA 2023:** EMEP/EEA air pollutant emission inventory guidebook 2023. Technical guidance to prepare national emission inventories. European Environment Agency. <https://www.eea.europa.eu/publications/emep-eea-guidebook-2023> [02.02.2026]
- EMIS 2026/(NFR-Code):** Comments to EMIS (Swiss Emission Information System) database. Internal documents. Federal Office for the Environment, Bern [confidential/internal]
- EMPA 1999:** Written communication from Dr. H.W. Jäckle (EMPA, Dübendorf) to Andreas Liechti (FOEN, Bern), 09.03.1999. <https://www.bafu.admin.ch/en/references-ghg-inventory>
- EMPA 2004b:** PM10-Emissionen bei Anlagen der Holzbearbeitung, Bericht zur Hauptstudie, März 2004. Swiss Federal Laboratories for Materials Testing and Research (EMPA), Dübendorf.

- EV 2014:** Jahresbericht 2013. Erdöl-Vereinigung, Zürich.
https://www.avenergy.ch/images/pdf/1621_ev_jb13_d.pdf [03.02.2026]
- FCA 2015a:** Bunkers of diesel oil 1990–2014. Written communication Wolfgang Kobler, Federal Customs Administration (FCA) to Anouk Bass (FOEN), 13.11.2015 [confidential/internal].
- FCA 2015c:** Import- und Exportstatistik Swiss-Impex. Tarifnummer 87 Automobile etc. (tarif no. 87 motorised vehicles) <https://www.swiss-impex.admin.ch> [09.02.2026]
- FEDPOL 2025:** Bundesamt für Polizei fedpol, Statistiken Pyrotechnikumsatz in der Schweiz. <https://www.fedpol.admin.ch/de/pyrotechnik> [29.01.2026]
- FEDPOL 2025a:** Bundesamt für Polizei fedpol, Sprengmittelumsatz 2024. Written communication 13.08.2025. [confidential/internal]
- FEDRO 2014:** Extract 2AA of MOFIS database (reference date 30.09.2013) of the Federal Roads Office (FEDRO) containing vehicle stock numbers. E-mail from A. Lehmann (FEDRO) to P. Wüthrich, INFRAS on 14.11.2014 [hardcopy].
- Fial 2013:** Die Schweizer Nahrungsmittel-Industrie im Jahr 2012. Foederation der Schweizerischen Nahrungsmittel-Industrien (fial).
- FM Global 2010:** Environmental impact of automatic fire sprinklers. Research technical report. By Wieczorek, C.J., Ditch, B., Bill, R.G., 2010, FM Global Research Division. <https://www.fm.com/-/media/Files/FM-Global/Research-Technical-Reports/p10062.pdf> [27.01.2026]
- FOAG 2011:** Klimastrategie Landwirtschaft: Klimaschutz und Anpassung an den Klimawandel für eine nachhaltige Schweizer Land- und Ernährungswirtschaft. Federal Office for Agriculture, Bern. <https://www.news.admin.ch/NSBSubscriber/message/attachments/23213.pdf> [05.02.2026], [in German]
- FOAG 2021:** Verordnungspaket Parlamentarische Initiative 19.475 «Das Risiko beim Einsatz von Pestiziden reduzieren». Erläuternder Bericht zur Eröffnung des Vernehmlassungsverfahrens. Bern, Schweiz. https://www.fedlex.admin.ch/filestore/fedlex.data.admin.ch/eli/dl/proj/2021/42/cons_1/doc_2/de/pdf-a/fedlex-data-admin-ch-eli-dl-proj-2021-42-cons_1-doc_2-de-pdf-a.pdf [05.02.2026]
- FOCA 1991:** Crossair confidential data 1991. Federal Office of Civil Aviation, Bern [confidential/internal].
- FOCA 1991a:** L'aviation civile Suisse en 1990. Federal Office of Civil Aviation, Bern. <https://www.bafu.admin.ch/en/references-ghg-inventory>
- FOCA 2004:** Unternehmensstatistik der Schweizerischen Helikopterunternehmen. Federal Office of Civil Aviation, Bern. <https://www.bafu.admin.ch/en/references-ghg-inventory>
- FOCA 2006:** GHG emissions of Swiss civil aircraft in 1990 and 2004: data, proceeding and description of the calculations. Written communication from Theo Rindlisbacher and Paul Stulz (FOCA, Bern) to Andreas Liechti (FOEN, Bern), 20./22.02.2006. <https://www.bafu.admin.ch/en/references-ghg-inventory>
- FOCA 2006a:** GHG emissions of Swiss civil aircraft in 1990, 1995, 2000, 2002, 2004 and 2005: data, proceeding and description of the calculations. Written communication from Theo Rindlisbacher (FOCA, Bern) to Paul Filliger (FOEN, Bern), 17.11.2006. <https://www.bafu.admin.ch/en/references-ghg-inventory>
- FOCA 2007a:** Aircraft Piston Engine Emissions. Summary Report. Federal Office of Civil Aviation. Report Ref. 0/3/33/33-05-003 ECERT. Bern. <https://www.bafu.admin.ch/en/references-ghg-inventory>

- FOCA 2008:** GHG emissions of Swiss civil aircraft in 2007. Written communication from Theo Rindlisbacher (FOCA, Bern) to Beat Müller (FOEN, Bern), 01.12.2008.
<https://www.bafu.admin.ch/en/references-ghg-inventory>
- FOCA 2009:** GHG emissions of Swiss civil aircraft in 2008. Written communication from Theo Rindlisbacher (FOCA, Bern) to Beat Müller (FOEN, Bern), 04.11.2009.
<https://www.bafu.admin.ch/en/references-ghg-inventory>
- FOCA 2010:** GHG emissions of Swiss civil aircraft in 2009. Written communication from Theo Rindlisbacher (FOCA, Bern) to Sophie Hoehn (FOEN, Bern), 18.11.2010.
<https://www.bafu.admin.ch/en/references-ghg-inventory>
- FOCA 2011:** GHG emissions of Swiss civil aircraft in 2010. Written communication from Theo Rindlisbacher (FOCA, Bern) to Sophie Hoehn (FOEN, Bern), 09.11.2011.
<https://www.bafu.admin.ch/en/references-ghg-inventory>
- FOCA 2012:** GHG emissions of Swiss civil aircraft in 2011. Written communication from Theo Rindlisbacher (FOCA, Bern) to Anouk-Aimée Bass (FOEN, Bern), 07.09.2012.
<https://www.bafu.admin.ch/en/references-ghg-inventory>
- FOCA 2013:** GHG emissions of Swiss civil aircraft in 2012. Written communication from Theo Rindlisbacher (FOCA, Bern) to Anouk-Aimée Bass (FOEN, Bern), 07.11.2013.
<https://www.bafu.admin.ch/en/references-ghg-inventory>
- FOCA 2014:** GHG emissions of Swiss civil aircraft in 2013 and corrections for the year 2011. Written communication from Theo Rindlisbacher (FOCA, Bern) to Anouk-Aimée Bass (FOEN, Bern), 30.10.2014 [confidential/internal].
- FOCA 2015:** GHG emissions of Swiss civil aircraft in 2014. Written communication from Theo Rindlisbacher (FOCA, Bern) to Anouk-Aimée Bass (FOEN, Bern), 29.10.2015 [confidential/internal].
- FOCA 2016:** GHG emissions of Swiss civil aircraft in 2015. Written communication from Theo Rindlisbacher (FOCA, Bern) to Anouk-Aimée Bass (FOEN, Bern), 6.12.2016 [confidential/internal].
- FOCA 2016b:** Estimation of PM emissions from aviation. Federal Office of Civil Aviation FOCA. 26.09.2016 [confidential/internal].
- FOCA 2017:** GHG emissions of Swiss civil aircraft in 2016. Written communication from Theo Rindlisbacher (FOCA, Bern) to Anouk-Aimée Bass (FOEN, Bern), 24.11.2017 [confidential/internal].
- FOCA 2018:** GHG emissions of Swiss civil aircraft in 2017. Written communication from Theo Rindlisbacher (FOCA, Bern) to Anouk-Aimée Bass (FOEN, Bern), 12.07.2018 [confidential/internal].
- FOCA 2019:** GHG emissions of Swiss civil aircraft in 2018. Written communication from Theo Rindlisbacher (FOCA, Bern) to Anouk-Aimée Bass (FOEN, Bern), 25.06.2019 [confidential/internal].
- FOCA 2020:** GHG emissions of Swiss civil aircraft in 2019. Written communication from Theo Rindlisbacher (FOCA, Bern) to Anouk-Aimée Bass (FOEN, Bern), 24.8.2020 [confidential/internal].
- FOCA 2021:** GHG emissions of Swiss civil aircraft in 2020. Written communication from Theo Rindlisbacher (FOCA, Bern) to Anouk-Aimée Bass (FOEN, Bern), 14.10.2021 [confidential/internal].
- FOCA 2022:** GHG emissions of Swiss civil aircraft in 2021 and update for 2020. Written communication from Theo Rindlisbacher (FOCA, Bern) to Anouk-Aimée Bass (FOEN, Bern), 18.08.2022 [confidential/internal].

- FOCA 2023:** GHG emissions of Swiss civil aircraft in 2022. Written communication from Theo Rindlisbacher (FOCA, Bern) to Anouk-Aimée Bass (FOEN, Bern), 14.07.2023 [confidential/internal].
- FOCA 2024:** GHG emissions of Swiss civil aircraft in 2023. Written communication from Theo Rindlisbacher (FOCA, Bern) to Anouk-Aimée Bass (FOEN, Bern), 17.07.2024 [confidential/internal].
- FOCA 2025:** GHG emissions of Swiss civil aircraft in 2024. Written communication from Theo Rindlisbacher (FOCA, Bern) to Anouk-Aimée Bass (FOEN, Bern), 30.06.2025 [confidential/internal].
- FOEN 2006:** Prozess EMIS (Emissions-Informationssystem Schweiz). Beschrieb des Prozesses (= Handbuch zur EMIS-Datenbank (Entwurf)). Internes Dokument. [Manual to EMIS database]. Federal Office for the Environment. 23. Mai 2006. Bern
- FOEN 2008:** Switzerland's Informative Inventory Report 2008 (IIR). Submission under the UNECE Convention on Long-range Transboundary Air Pollution. Submission of March 2008 to the United Nations ECE Secretariat
- FOEN 2011b:** NO₂ ambient concentrations in Switzerland. Modelling results for 2005, 2010, 2015. Federal Office for the Environment, Bern. Environmental studies no. 1123. INFRAS/Meteotest, Zürich, Bern.
- FOEN 2013a:** PM10 and PM2.5 ambient concentrations in Switzerland. Modelling results for 2005, 2010, 2020. Federal Office for the Environment, Bern. Environmental studies no. 1301. INFRAS/Meteotest, Zürich, Bern.
- FOEN 2014p:** Von Arx U.: Feuerwerkskörper. Umweltauswirkungen und Sicherheitsaspekte. Bundesamt für Umwelt, Bern. Umwelt-Wissen Nr. 1423.
<https://www.bafu.admin.ch/de/publication?id=-ROdXz8p8Rss> [06.03.2026]
- FOEN 2015j:** Non-road energy consumption and pollutant emissions. Study for the period from 1980 to 2050 (Original in German: Energieverbrauch und Schadstoffemissionen des Nonroad-Sektors. Studie für die Jahre 1980–2050. Schlussbericht). INFRAS. Ed. By the Federal Office for the Environment. <https://www.bafu.admin.ch/en/non-road-mobile-machinery> [04.02.2026]
- FOEN 2024d:** Switzerland's first biennial transparency report under the Paris Agreement, Swiss Federal Office for the Environment, Bern, Switzerland, December 2024.
<https://www.bafu.admin.ch/en/references-ghg-inventory>
- FOEN 2025:** Switzerland's Greenhouse Gas Inventory 1990–2023, National Inventory Document. Submission of 2025 under the United Nations Framework Convention on Climate Change. Federal Office for the Environment, Bern.
<https://www.bafu.admin.ch/en/references-ghg-inventory>
- FOEN 2025f:** Annuaire La forêt et le bois 2024. État de l'environnement n°2410. [Jahrbuch Wald und Holz 2024. Umwelt-Zustand Nr. 2410]. Federal Office for the Environment, Bern. <https://res.cloudinary.com/adminch/image/private/s--qQZNXMfw--/v1750075399/Bundespublikationen/862729757.pdf> [06.03.2026]
- FOEN 2025i:** CO₂-Emissionsfaktor Erdgas, Zeitreihe 1990–2024 für das Treibhausgasinventar der Schweiz, internal documentation, Federal Office for the Environment, Bern [confidential/internal]
- FOEN 2025j:** Abfallstatistiken des Jahres 2024 sowie Zeitreihen. Diverse Dateien. Federal Office for the Environment, Bern <https://www.bafu.admin.ch/en/waste-statistics> [03.02.2026]
- FOEN 2025m:** Connection rate to wastewater treatment plants.
<https://www.indikatoren.admin.ch/public/v2/detail?ind=WS076&lng=en> [29.01.2026]

- FOEN 2026:** Switzerland's Greenhouse Gas Inventory 1990–2024, National Inventory Document. Submission of 2026 under the United Nations Framework Convention on Climate Change. Federal Office for the Environment, Bern. Forthcoming.
- FOEN 2026a:** Qualitätsmanagement Treibhausgasinventar – Handbuch. Bundesamt für Umwelt (BAFU), Bern [German for: Quality management system Greenhouse Gas Inventory – Manual. Federal Office for the Environment (FOEN), Bern [confidential/internal]
- Frei E., Vökt U., Flückiger R., Brunner H. and Schai F. 1980:** Bodeneignungskarte der Schweiz, Masstab 1:200000. Grundlagen für die Raumplanung, Bundesämter für Raumplanung, Landwirtschaft und Forstwesen, EDMZ Bern.
- FSO 2022c:** Switzerland's population in 2021. Federal Statistical Office. Neuchâtel. <https://www.bfs.admin.ch/asset/en/1155-2100> [09.02.2026]
- FSO 2025a:** STAT-TAB: Die interaktive Statistikdatenbank; Datenwürfel für Thema 07.2 – Landwirtschaft. Federal Statistical Office, Neuchâtel. <https://www.pxweb.bfs.admin.ch/pxweb/de/> [23.01.2026]
- FSO 2025b:** Background data of the Gross Nutrient Balance of the Swiss Federal Statistical Office. Federal Statistical Office, Neuchâtel. [confidential/internal, queries from database].
- FSO 2025c:** Switzerland's population in 2024. Federal Statistical Office. Neuchâtel. <https://www.bfs.admin.ch/bfs/en/home/statistics/catalogues-databases.assetdetail.3612774.html> [23.01.2026]
- FSO 2025d:** Die Beschäftigungsstatistik der Schweiz (Job Statistics). Federal Statistical Office, Neuchâtel. <https://www.bfs.admin.ch/bfs/de/home/statistiken/industrie-dienstleistungen/unternehmen-beschaefigte/beschaefigungsstatistik.html> [23.01.2026]
- FSO 2025e:** Distribution of road vehicles by vehicle group. Federal Statistical Office, Neuchâtel. <https://www.bfs.admin.ch/bfs/en/home/statistics/mobility-transport/transport-infrastructure-vehicles/vehicles/road-vehicles-stock-level-motorisation.assetdetail.36210137.html> [23.01.2026]
- FSO 2025f:** Fahrleistungen und Fahrzeugbewegungen im Personenverkehr. Federal Statistical Office, Neuchâtel. <https://www.bfs.admin.ch/bfs/en/home/statistics/catalogues-databases.assetdetail.je-d-11.04.01.01.html> [23.01.2026]
- FSO 2025i:** Farm structure census 2024 (Landwirtschaftliche Strukturerhebung). Federal Statistical Office. Neuchâtel. <https://www.bfs.admin.ch/bfs/en/home/statistics/agriculture-forestry/farming.gnpdetail.2025-0411.html> [23.01.2026]
- Glüge J., Steinlin C., Schalles S., Wegmann L., Tremp J., Breivik K., et al. 2017:** Import, use, and emissions of PCBs in Switzerland from 1930 to 2100. <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0183768#sec039ht> [27.01.2026]
- Graf 1990:** Schmoll AG Basel Kabelzerlegungsanlage, Konzept Rauchgasreinigung.
- Hafner, S.D., Pedersen, J., Fuss, R., Kamp, J.N., Dalby, F.R., Amon, B., Pacholski, A., Adamsen, A.P., Sommer, S.G. 2025:** Improved tools for estimation of ammonia emission from field-applied animal slurry: refinement of the ALFAM2 model and database. Atmos. Environ.: 120910. <https://www.sciencedirect.com/science/article/pii/S1352231024005855> [13.02.2026]
- HTAP 2010:** Task Force on Hemispheric Transport of Air Pollution – Advice on Future O3 Boundary Conditions for Europe. Assessment Report, October 2012.

- IFEU 2010:** Aktualisierung des Modells TREMOD – Mobile Machinery (TRE-MOD-MM). Endbericht im Auftrag des Umweltbundesamtes. UBA Texte 28/2010. Institut für Energie- und Umweltforschung (IFEU), Heidelberg.
<https://www.umweltbundesamt.de/sites/default/files/medien/461/publikationen/3944.pdf>
[09.02.2026]
- IFEU/INFRAS 2010:** Ermittlung der Unsicherheiten der mit den Modellen TREMOD und TREMOD-MM berechneten Luftschadstoffemissionen des landgebundenen Verkehrs in Deutschland, Endbericht. IFEU und INFRAS im Auftrag des Umweltbundesamts Dessau/Deutschland, FKZ 360 16 023. Dessau-Rosslau. Mai 2010.
<https://www.umweltbundesamt.de/sites/default/files/medien/461/publikationen/3937.pdf>
[09.02.2026]
- INERIS 2019:** Émissions atmosphériques de dioxines et de furanes bromés lors de feux accidentels de déchets contenant des substances bromées, 15.03.2019. Institut national de l'environnement industriel et des risques, rédaction : Sabine Guerin et Serge Collet, Essais en plateforme incendie, Verneuil-en-Halatte : Ineris – 170785-00117B,
<https://www.ineris.fr/fr/emissions-atmospheriques-dioxines-furanes-bromes-lors-feux-accidentels-dechets-contenant-substances> [28.01.2026]
- INFRAS 2007:** PM10-Emissionen des Verkehrs, Teil Schienenverkehr. INFRAS commissioned by FOEN. https://www.bafu.admin.ch/dam/it/sd-web/0OU3Y9L5B9IO/pm10-emissionen_schiennenverkehr.pdf [09.02.2026]
- INFRAS 2011a:** Bunker fuels Bodensee/Genfersee, Datenverfügbarkeit und Berechnung der Bunker Fuels. Internal document. Federal Office for the Environment. September 2011.
<https://www.bafu.admin.ch/en/references-ghg-inventory>
- INFRAS 2014:** Verbrennung natürlicher Wald-, Feld- und Gartenabfälle im Freien. Datengrundlagen zur Aktualisierung der Jahresleistungen. Zürich, 29. Januar 2014. [confidential/internal]
- INFRAS 2015a:** Online database of emission factors, activity data and emissions of non-road vehicles (queries from database, corresponding report is FOEN 2015).
<https://www.bafu.admin.ch/en/nonroad-database> [04.02.2026].
- INFRAS 2015c:** Ammoniakemissionen aus der Landwirtschaft. Unsicherheitsanalyse. Schlussbericht. Zürich, 26. Juni 2015 (Uncertainties of agricultural ammonia emissions). INFRAS mandated by the Federal Office for the Environment FOEN. Internal report, 26th June 2015 Zürich.
- INFRAS 2017:** Pilotstudie zum Treibstoffverbrauch und den Treibhausgasemissionen im Verkehr 1990-2050 – Szenarien für den Strassenverkehr. Schlussbericht. INFRAS, Zurich. Mandated by the Swiss Federal Office for the Environment, Bern.
https://www.bafu.admin.ch/dam/de/sd-web/oZxNemEH2kpa/pilotstudie_treibstoffverbrauch_treibhausgasemissionen_verkehr_1990-2050_szenarien_strassenverkehr.pdf [09.02.2026]
- INFRAS 2017b:** Ammoniakemissionen aus der Landwirtschaft. Unsicherheitsanalyse Teil II. Schlussbericht. (Uncertainties of agricultural ammonia emissions – part II; Report in German only). INFRAS mandated by the Federal Office for the Environment FOEN. Internal report, January 2017 Zürich.
- INFRAS 2017c:** Luftschadstoffemissionen des Strassenverkehrs der Schweiz. 1990-2050. Schlussbericht, Bern, 24. November 2017. https://www.bafu.admin.ch/dam/de/sd-web/lyEAF9QyhSoO/Bericht_Luftschadstoffemissionen_des_Strassenverkehrs_der_Schweiz_1990_2050.pdf [09.02.2026], [in German]

- INFRAS 2019a:** HBEFA 4.1 – Development Report. Notter, B., Keller, M., Althaus, H.-J., Cox, B., Knörr, W., Heidt, C., Biemann, K., Räder, D., Jamet, M. Commissioned by FOEN/Switzerland; Umweltbundesamt Dessau/Germany; Umweltbundesamt Wien/Austria; Swedish Road Administration, ADEME/France; SFT/Norway. Bern, Heidelberg. 21.08.2019. https://assets-global.website-files.com/6207922a2acc01004530a67e/625e8c74c30e26e022b319c8_HBEFA41_Development_Report.pdf [09.02.2026]
- INFRAS 2021:** Ammoniakemissionen aus der Landwirtschaft 2021, Schlussbericht. (Uncertainties of agricultural ammonia emissions, final report; Report in German only). INFRAS mandated by the Federal Office for the Environment FOEN. Internal report, November 2021 Zürich.
- INFRAS 2022:** The Handbook Emission Factors for Road Transport (HBEFA), version 4.2 (MS Access runtime application). INFRAS in cooperation with further editors: FOEN/Switzerland; Umweltbundesamt Dessau/Germany; Umweltbundesamt Wien/Austria; Swedish Road Administration, ADEME/France; SFT/Norway. Bern, 31.01.2022. <http://www.hbefa.net/e/index.html> [09.02.2026]
- INFRAS 2022a:** Emissionsinventar stationäre Motoren und Gasturbinen, Basisjahr 2019 und Zeitreihe 1990–2060, Schlussbericht von Notter, B., Graf, C., Bieler, C., Etter, N. an das Bundesamt für Umwelt, Bern, 15.05.2022, <https://www.bafu.admin.ch/en/studies-air> [03.02.2026]
- INFRAS 2025:** The Handbook Emission Factors for Road Transport (HBEFA), version 5.1. INFRAS in cooperation with further editors: FOEN/Switzerland; Umweltbundesamt Dessau/Germany; Umweltbundesamt Wien/Austria; Swedish Road Administration, ADEME/France; SFT/Norway. Bern, 21.10.2025. <http://www.hbefa.net/e/index.html>
- INFRAS 2025a:** HBEFA 5.1 Update Documentation. Description of updates with HBEFA version 5.1. INFRAS, ITnA TU Graz, TU Dresden, ifeu, WSP Sweden, UGE, IVL, SSB. 20.10.2025. https://cdn.prod.website-files.com/6207922a2acc01004530a67e/69943df4255be4bdb9991b85_HBEFA5.1_Update_documentation_v1.1_2026-02-13.pdf [06.03.2026]
- Integer 2013:** Emissions Control in Non-Road Mobile Machinery (NRMM) Markets: 2013 Edition. Integer Research Limited, London. [confidential/internal]
- IPCC 1996:** Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Intergovernmental Panel on Climate Change. <https://www.ipcc.ch/report/revised-1996-ipcc-guidelines-for-national-greenhouse-gas-inventories> [03.02.2026]
- IPCC 2006:** 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngariza T. and Tanabe K. (eds). Published: IGES, Japan. Copyright by The Intergovernmental Panel on Climate Change (IPCC), 2006. <http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html> [28.01.2026]
- IPCC 2019:** 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Calvo Buendia, E., Tanabe, K., Kranjc, A., Baasansuren, J., Fukuda, M., Ngarize, S., Osako, A., Pyrozhenko, Y., Shermanau, P. and Federici, S. (eds). Published: IPCC, Switzerland. Copyright by The Intergovernmental Panel on Climate Change (IPCC), 2019. <https://www.ipcc-nggip.iges.or.jp/public/2019rf/index.html> [09.02.2026]
- Jardin Suisse 2012:** Zahlen zum Schweizerischen Gartenbau. Unternehmerverband Gärtner Schweiz. <https://www.bafu.admin.ch/en/references-ghg-inventory>
- Joint Committee for Guides in Metrology, 2008:** Evaluation of measurement data – Supplement 1 to the “Guide to the expression of uncertainty in measurement” – Propagation of distributions using a Monte Carlo method. https://www.bipm.org/documents/20126/2071204/JCGM_101_2008_E.pdf [09.02.2026]

- Külling, D.R., Stadelmann, F.X., 2002:** Nährstoffe und Schwermetalle im Klärschlamm 1975 – 1999. AGRARForschung 9 (5): 200-205, 2002.
- Kupper 2012:** Expert judgement on uncertainty estimates of emission factors of the AGRAMMON model, oral communication to S. Liechti and B. Achermann (FOEN), 13 March 2012
- Kupper, T., Bonjour, C., Menzi, H., 2015:** Evolution of farm and manure management and their influence on ammonia emissions from agriculture in Switzerland between 1990 and 2010. Atmospheric Environment 103, 215-221
<https://www.sciencedirect.com/science/article/pii/S1352231014009728?via%3Dihub> [02.02.2026]
- Kupper, T., Bonjour, C., Menzi, H., Zaucker, F., Bretscher, D. 2018:** Ammoniakemissionen in der Schweiz: Neuberechnung 1990–2015. Prognose bis 2030. Hochschule für Agrar-, Forst- und Lebensmittelwissenschaften. Zollikofen, Schweiz.
<https://agrammon.ch/en/downloads/> [09.02.2026]
- Kupper, T., Häni, C. 2022:** Anteil Silagefütterung von Rindvieh in der Schweiz 1990-2019. Hochschule für Agrar-, Forst- und Lebensmittelwissenschaften. Zollikofen, im Auftrag des Bundesamts für Umwelt.
- Kupper, T., Häni, C., Bretscher, D., Zaucker, F. 2022:** Ammoniakemissionen der schweizerischen Landwirtschaft 1990–2020. Hochschule für Agrar-, Forst- und Lebensmittelwissenschaften. Zollikofen, Schweiz.
<https://www.bafu.admin.ch/en/references-ghg-inventory>
- Kupper, T., Häni, C., Bretscher, D., Zaucker, F. 2026:** Ammoniakemissionen der schweizerischen Landwirtschaft 1990-2025. Hochschule für Agrar-, Forst- und Lebensmittelwissenschaften. Zollikofen, Schweiz. [German report in preparation, which will become available on the FOEN webpage later.]
- KWF 2012:** Forstmaschinenstatistik zeigt deutliche Stabilisierung des Marktes. 16. KWF-Tagung. <https://www.bauhof-online.de/d/kwf-forstmaschinenstatistik-zeigt-deutliche-stabilisierung-des-marktes/https://www.bauhof-online.de/d/kwf-forstmaschinenstatistik-zeigt-deutliche-stabilisierung-des-marktes/> [09.02.2026]
- Lazzari, G. and Schlegel, P. 2025:** Richtwerte für Futtermittelverzehr und Nährstoffausscheidungen von Schafen. Swiss Agricultural Research, Vol. 16, 2025, p. 92-95. <https://ira.agroscope.ch/de-CH/publication/59208> [in German] [19.01.2026]
- Lazzari, G. and Schlegel, P. 2025:** Richtwerte für Futtermittelverzehr und Nährstoffausscheidungen von Ziegen. Swiss Agricultural Research. Vol. 16, 2025p. 81-89. <https://doi.org/10.34776/afs16-81> [in German] [19.01.2026]
- Lemieux, P., Gullet B., Lutes C., Winterrowd C., Winters D., 2003:** Variables affecting emissions of PCDD/Fs from uncontrolled combustion of household waste in barrels. Air & Waste Management Association. 53: 523–531. USA
- Leupro 2012:** Entwicklung und Prognose der Emissionsfaktoren Feuerungen für den Zeitraum 1990–2035. <https://www.bafu.admin.ch/en/references-ghg-inventory>
- Lönnermark, A. and Blomqvist, P. 2006:** Emissions from an automobile fire. Chemosphere, 62, 7, 1043-1056, <https://doi.org/10.1016/j.chemosphere.2005.05.002>
- LUBW 1995:** Stoffbericht Hexachlorbenzol (HCB). Texte und Bericht zur Altlastenbearbeitung 18/95. Landesanstalt für Umweltschutz, Baden-Württemberg, Karlsruhe. Germany. https://pudi.lubw.de/detailseite/-/publication/27419-Stoffbericht_Hexachlorbenzol_%28HCB%29.pdf [09.02.2026]
- Luftkollektiv 2024:** NMVOC-Emissionen an Benzin-Tankstellen – Aktualisierung der Abschätzungen für die Jahre 1990 – 2030. Luftkollektiv GmbH, Basel. Forthcoming. [confidential/internal]

- Mack, G., Möhring, A. 2021:** SWISSland-Modellierung zur Palv 19.475: «Das Risiko beim Einsatz von Pestiziden reduzieren». Agroscope. Tänikon-Ettenhausen, Schweiz.
<https://www.agroscope.admin.ch/agroscope/en/home/topics/economics-technology/economic-modelling-policy-analysis.html> [09.02.2026]
- Matzer, C., Weller, K., Dippold, M., Lipp, S., Röck, M., Rexeis, M., Hausberger, S., 2019:** Update of emission factors for HBEFA 4.1. Final report. Technische Universität (TU) Graz, Austria. 09.09.2019. https://assets-global.website-files.com/6207922a2acc01004530a67e/625e8d14b70af84fba1ef10c_HBEFA41_Report_TUG_09092019.pdf [09.02.2026]
- Mejía-Centeno 2007:** Effect of low-sulfur fuels upon NH₃ and N₂O emission during operation of commercial three-way catalytic converters. Topics in Catalysis. Volume 42-43, Numbers 1-4. <https://link.springer.com/content/pdf/10.1007/s11244-007-0210-2.pdf> [09.02.2026]
- menuCH 2014:** Nationale Ernährungserhebung menuCH 2014/2015, Informationen zum Konsum von Getreideprodukten, Kartoffeln und Hülsenfrüchten
- Menzi H., 2022:** Comparison of Swiss IIR submission for NH₃ emissions from livestock production and manure management with Tier 2 approach. Internal Memo Swiss Federal Office for the Environment. Final version December 2022.
- Meteotest 2013:** Rasterung der Emissionsdaten der Schweiz auf 0.1°-Gitter – Dokumentation von Methodik und Exceltool. Meteotest im Auftrag des Bundesamtes für Umwelt (BAFU), 2013.
- Meteotest 2019a:** NMVOC-Emissionen der Waldflächen in der Schweiz; Zeitreihe 1990–2016, langfristige Entwicklung, Sensitivitätsanalyse für zwei Extremtage. Meteotest AG, Bern, commissioned by the Federal Office for the Environment (FOEN).
<https://www.bafu.admin.ch/dam/de/sd-web/hKk9lrMyOobu/nmvoc-emissionen-der-waldflaechen-in-der-schweiz.pdf> [09.02.2026]
- Meteotest 2019b:** Mapping Nitrogen Deposition 2015 for Switzerland. Technical Report on the Update of Critical Loads and Exceedance, including the years 1990, 2000, 2005 and 2010. Meteotest AG, Bern, commissioned by the Federal Office for the Environment (FOEN). <https://www.bafu.admin.ch/dam/de/sd-web/IH2yDdgvuxEH/mapping-nitrogen-deposition-2015-for-switzerland.pdf> [09.02.2026]
- Meteotest 2020a:** Emissionen Schweiz. Aufbereitung von Emissionskatastern für die Luftschadstoffe NO_x, PM₁₀ und PM_{2.5} der Jahre 2015, 2020 und 2030. Schlussbericht im Auftrag des Bundesamtes für Umwelt (BAFU). <https://www.bafu.admin.ch/dam/de/sd-web/En3aldt2NVIT/emissionskataster-schweiz.pdf> [09.02.2026]
- Meteotest 2021a:** Datengrundlagen/Verteilschlüssel für GNFR-Tool in MESAP. Meteotest im Auftrag des Bundesamtes für Umwelt (BAFU). Aktennotiz vom 16.12.2021.
- Neosys 2013:** EMIS Comments Black Carbon factors. Im Auftrag des Bundesamts für Umwelt (BAFU), 2013.
- Nielsen, O.-K., Plejdrup, M.S., Winther, M., Nielsen, M., Fauser, P., Mikkelsen, M.H., Albrektsen, R., Hjelgaard, K., Hoffmann, L., Thomsen, M., Bruun, H.G., 2013:** Danish emission inventory for hexachlorobenzene and polychlorinated biphenyls. Aarhus University, DCE – Danish Centre for Environment and Energy, 65 pp. Scientific Report from DCE – Danish Centre for Environment and Energy No. 103
<http://dce2.au.dk/pub/SR103.pdf> [03.02.2026]
- Norwegian Environment Agency 2020:** Informative Inventory Report (IIR) 2020. Norway. Air pollutant emissions 1990-2018. Norwegian Environment Agency.
<https://www.miljodirektoratet.no/publikasjoner/2020/april-2020/informative-inventory-report-2020-norway/> <https://www.miljodirektoratet.no/publikasjoner/2020/april-2020/informative-inventoryreport-2020-norway/> [03.02.2026]

Norwegian Environment Agency 2021: Informative Inventory Report (IIR) 2021. Norway – Air Pollutant Emissions 1990-2019.

<https://www.miljodirektoratet.no/publikasjoner/2021/mars-2021/informative-inventory-report--iir-2021.-norway/> [03.02.2026]

Notter, B., Cox, B., Hausberger, S., Matzer, C., Weller, K., Dippold, M., Politschnig, N., Lipp, S., Allekotte, M., Knörr, W., André, M., Gagnepain, L., Hult, C., Jerksjö, M. 2022: HBEFA 4.2: Documentation of Updates. Bundesamt für Umwelt BAFU (CH), Umweltbundesamt UBA (DE), Umweltbundesamt UBA (AT), Agence de l'Environnement et de la Maîtrise de l'Energie ADEME (FR), Trafikverket (SE), Miljødirektoratet (NO), Bern, Graz, Heidelberg, Lyon, Göteborg. https://assets-global.website-files.com/6207922a2acc01004530a67e/6217584903e9f9b63093c8c0_HBEFA42_Update_Documentation.pdf [09.02.2026]

Off-Highway Research 2005: The Market for Construction Equipment and Agricultural Tractors in Switzerland. Internal document INFRAS Bern. September 2005 [confidential/hardcopy].

Off-Highway Research 2008: The Market for Construction Equipment and Agricultural Tractors in Switzerland. Internal document FOEN. November 2008 [confidential/internal].

Off-Highway Research 2012: The Market for Construction Equipment and Agricultural Tractors in Switzerland. Internal document FOEN. April 2012 [confidential/internal].

OS 2025: Liechtenstein's energy statistics 2024. Office of statistics Liechtenstein. <https://www.statistikportal.li/de/themen/raum-umwelt-und-energie/energie> [04.02.2026]

Passant et al. 1993: Emissions of volatile organic compounds (VOCs) from the food and drink industries of the European Community, Atmospheric Environment Vol. 27A, No. 16, 1993. <https://www.sciencedirect.com/science/article/abs/pii/096016869390029X?via%3Dihub> [09.02.2026]

Piadé, J.-J., Jaccard, G., Dolka, C., Belushkin, M., Wajrock, S. 2015: Differences in cadmium transfer from tobacco to cigarette smoke, compared to arsenic or lead. Toxicology Reports, Vol. 2, pp. 12-26. <https://doi.org/10.1016/j.toxrep.2014.11.005> [26.01.2026]

Prognos 2012a: Die Energieperspektiven für die Schweiz bis 2050 – Energienachfrage und Elektrizitätsangebot in der Schweiz 2000–2050. Prognos AG im Auftrag des Bundesamtes für Energie, Basel. <https://www.bfe.admin.ch/bfe/de/home/politik/energiestrategie-2050/dokumentation/energieperspektiven-2050.exturl.html/aHR0cHM6Ly9wdWJKYi5iZmUuYWWRtaW4uY2gyZGUvcHVibGJiYX/Rpb24vZG93bmxvYWQvNjczNw==.html> [in German] [05.02.2026]

Prognos 2013: CO₂-Emissionen 1990–2012 von Industrie- und Dienstleistungen, Endbericht/Kurzdokumentation zuhanden Bundesamt für Umwelt, Bern. Prognos, Basel [confidential/internal].

Prognos/INFRAS/TEP/Ecoplan 2020: Swiss Energy Perspectives 2050+. Prognos, Basel / Infrac, Zurich / TEP Energy, Zurich / Ecoplan, Bern (mandated by the Swiss Federal Office of Energy, Bern). <https://www.bfe.admin.ch/bfe/de/home/politik/energieperspektiven-2050-plus.html> [29.01.2026]

PRTR 2021: Swiss Pollutant Release and Transfer Register (Swiss PRTR) in year 2019. <https://www.bafu.admin.ch/bafu/en/home/topics/chemicals/state/swissprtr-pollutant-register.html> [09.02.2026]

PRTR 2025: Swiss Pollutant Release and Transfer Register (Swiss PRTR) in year 2023. <https://www.bafu.admin.ch/bafu/en/home/topics/chemicals/state/swissprtr-pollutant-register.html> [09.02.2026]

- Quantis 2014:** Methanemissionen der Schweizer Gaswirtschaft. Zeitreihe 1990 bis 2012. Schlussbericht. Quantis im Auftrag des Schweizerischen Vereins des Gas- und Wasserfaches SVGW und des Bundesamts für Umwelt BAFU.
<https://www.bafu.admin.ch/en/references-ghg-inventory>
- Raffinerie de Cressier 1992:** Project CRISTAL – Influence sur l'environnement (incl. Annexes), Raffinerie de Cressier (rapports préparé en collaboration avec Badger BV, Pays-Bas), Cressier [confidential/internal].
- Reidy, B. and Menzi H. 2005:** Ammoniakemissionen in der Schweiz: Neues Emissionsinventar 1990 bis 2000 mit Hochrechnungen bis 2003. Technischer Schlussbericht, HAFL Zollikofen, Bern.
- Rentz, O., Karl, U., Haase, M., Koch, M. 2008:** Nationaler Durchführungsplan unter dem Stockholmer Abkommen zu persistenten organischen Schadstoffen (POPs). Umweltbundesamt (UBA) 2008.
<https://www.umweltbundesamt.de/publikationen/nationaler-durchfuehrungsplan-unter-stockholmer> [09.02.2026]
- Richner, W., Sinaj, S., Carlen, Ch., Flisch, R., Gilli, C., Huguenin-Elie, O., Kuster, T., Latsch, A., Mayer, J., Neuweiler, R., Spring, J.L. 2017: GRUD 2017:** Grundlagen für die Düngung landwirtschaftlicher Kulturen in der Schweiz. Agroscope. Bern, Schweiz. [hardcopy]
- SAEFL 1996a:** Luftschadstoff-Emissionen aus natürlichen Quellen der Schweiz. [Emissions polluantes dues aux sources naturelles en Suisse]. Schriftenreihe Umwelt Nr. 257. [Cahier de l'environnement No 257]. Swiss Agency for the Environment, Forests and Landscape, Bern. <https://www.bafu.admin.ch/en/references-ghg-inventory>
- SAEFL 2000:** Handbuch Emissionsfaktoren für stationäre Quellen. Ausgabe 2000, Reihe Vollzug Umwelt. Swiss Agency for the Environment, Forests and Landscape, Bern.
<https://www.bafu.admin.ch/en/references-ghg-inventory>
- SBB 2005:** PM10-Emissionen des Schienenverkehrs. Schlussbericht Teil SBB, UmweltCenter der Schweiz. Bundesbahnen. FOEN-internal document. 25. August 2005.
- SBI 2010:** Zahlen und Fakten zum Brotkonsum; Schweizerische Brotinformation, Entwicklung des Brotkonsums in der Schweiz 1990-2010edi
- SBV 2013:** Betriebsinterne Verrechnungsansätze und Inventar-Grunddaten (BIV) 2013. Schweizerischer Baumeisterverband. Verlag SBV [confidential/internal].
- SBV 2025:** Statistiques et évaluations concernant l'agriculture et l'alimentation, 2024. [Statistische Erhebungen und Schätzungen über Landwirtschaft und Ernährung, 2024]. Swiss Farmers' Union, Brugg. [available in German and French, partly online, partly hardcopy] <https://www.sbv-usp.ch/de/services/agristat-statistik-der-schweizer-landwirtschaft/statistische-erhebungen-und-schaetzungen-ses> [02.02.2026]
- Schlegel, P., Willi, C., Vollenweider, O., Morel, I. 2020:** Richtwerte für den Nährstoffanfall aus der Rindviehmast. Swiss Agricultural Research, Vol. 4, 2020, Issue 2, p. 92-95.
<https://ira.agroscope.ch/de-CH/publication/43623> [in German] [19.01.2026]
- Schleiss, K. 2017:** Erhebung Schweizer Daten zu Mengen in der Kompostierung, im Auftrag des Bundesamtes für Umwelt (BAFU), Bern, 17.11.2017.
<https://www.bafu.admin.ch/en/references-ghg-inventory>
- Schrade, S. 2009:** Ammoniak- und PM10-Emissionen im Laufstall für Milchvieh mit freier Lüftung und Laufhof anhand einer Tracer-Ratio-Methode, Christian-Albrechts-Universität, Kiel, Germany, 2009. <https://ira.agroscope.ch/de-CH/publication/20648> [02.02.2026]
- Schwager, S. 2005:** Personal communication from Stefan Schwager (FOEN, Bern) to Andreas Liechti (FOEN, Bern), 23.12.2005. <https://www.bafu.admin.ch/en/references-ghg-inventory>

- Sebos 2022:** Fossil fraction of CO₂ emissions of biofuels. Carbon Management, Vol. 13, 2022, Issue 1, p. 154-163.
<https://www.tandfonline.com/doi/full/10.1080/17583004.2022.2046173> [03.02.2026]
- SEPA 2010:** Sweden's Informative Inventory Report 2010, Submitted under the Convention on Long-Range Transboundary Air Pollution. Swedish Environmental, Protection Agency.
- SES 2017:** Schweizer Ernährungsstrategie 2017-2024, Informationen zum Brotkonsum
- SFOE 1991:** Schweizerische Gesamtenergiestatistik 1990. Statistique globale suisse de l'énergie 1990. Swiss Federal Office of Energy, Bern.
- SFOE 2015d:** Energieverbrauch in der Industrie und im Dienstleistungssektor. Resultate 2014 (German). Swiss Federal Office of Energy, Bern.
<https://www.bfe.admin.ch/bfe/en/home/supply/statistics-and-geodata/energy-statistics/sector-statistics.html#kw-107796> [03.02.2026]
- SFOE 2021c:** Thermische Stromproduktion inklusive Wärmekraftkopplung (WKK) in der Schweiz. Ausgabe 2020. Swiss Federal Office of Energy, Bern.
<https://www.bfe.admin.ch/bfe/en/home/supply/statistics-and-geodata/energy-statistics/sector-statistics.html> [03.02.2026]
- SFOE 2024:** Schweizerische Gesamtenergiestatistik 2023. Statistique globale suisse de l'énergie 2023. Swiss Federal Office of Energy, Bern. In German and French.
<https://t1p.de/BFE-GEST> [09.02.2026]
- SFOE 2025:** Schweizerische Gesamtenergiestatistik 2024. Statistique globale suisse de l'énergie 2024. Swiss Federal Office of Energy, Bern. In German and French.
<https://t1p.de/BFE-GEST>
- SFOE 2025a:** Schweizerische Statistik der erneuerbaren Energien (Swiss renewable energy statistics). Ausgabe 2024. Swiss Federal Office of Energy, Bern.
<https://www.bfe.admin.ch/bfe/en/home/supply/statistics-and-geodata/energy-statistics/sector-statistics.html> [09.02.2026]
- SFOE 2025b:** Schweizerische Holzenergiestatistik. Erhebung für das Jahr 2024. Swiss Federal Office of Energy, Bern. <https://www.bfe.admin.ch/bfe/en/home/supply/statistics-and-geodata/energy-statistics/sector-statistics.html> [09.02.2026]
- SFOE 2025c:** Thermische Stromproduktion inklusive Wärmekraftkopplung (WKK) in der Schweiz. Ausgabe 2024. Swiss Federal Office of Energy, Bern.
<https://www.bfe.admin.ch/bfe/en/home/supply/statistics-and-geodata/energy-statistics/sector-statistics.html> [09.02.2026]
- SFOE 2025d:** Energieverbrauch in der Industrie und im Dienstleistungssektor. Resultate 2024 (German/French). Swiss Federal Office of Energy, Bern.
<https://www.bfe.admin.ch/bfe/en/home/supply/statistics-and-geodata/energy-statistics/sector-statistics.html> [09.02.2026]
- SFOE 2025e:** Analyse des schweizerischen Energieverbrauchs 2000–2024 nach Verwendungszwecken. Prognos, im Auftrag des Bundesamts für Energie. 2025. Und Ex-Post-Analyse Energieverbrauch nach Verwendungszwecken 2000–2024 (xlsx, 314 KB), Tabellen. <https://www.bfe.admin.ch/bfe/en/home/supply/statistics-and-geodata/energy-statistics/analysis-of-energy-consumption-by-specific-use.html> [09.02.2026]
- SFOE 2025g:** Schweizerische Elektrizitätsstatistik (Swiss electricity statistics) 2023. Swiss Federal Office of Energy, Bern.
<https://www.bfe.admin.ch/bfe/de/home/versorgung/statistik-und-geodaten/energiestatistiken/elektrizitaetsstatistik.html/> [09.02.2026]
- SFOE/FOEN 2014:** Messung von Heizwerten und CO₂-Emissionsfaktoren von Erdölprodukten 2013. Statistische Analyse der Messresultate, Bern [confidential/internal].

- SFSO 2013a:** Landwirtschaftliche Betriebszählung – Zusatzerhebung. Swiss Federal Statistical Office (SFSO), Neuchâtel. [internal/confidential].
- SFSO 2020p:** Szenarien zur Bevölkerungsentwicklung der Schweiz 2020-2050. Referenzszenario A-00-2020. https://www.pxweb.bfs.admin.ch/pxweb/en/px-x-0104000000_102/-/px-x-0104000000_102.px/ [05.02.2026]
- SFSO/BUWAL 2004:** Wald und Holz in der Schweiz Jahrbuch 2004. Bundesamt für Statistik (SFSO) und Bundesamt für Umwelt, Wald und Landschaft (BUWAL). Bern. <https://www.bfs.admin.ch/bfs/de/home/statistiken/kataloge-datenbanken/publikationen.assetdetail.344300.html> [02.02.2026]
- SGWA 2023a:** Technischer Hintergrundbericht: Methanemissionen der Schweizer Gasindustrie – Tool zur Berechnung der Methanemissionen. Swiss Gas and Water Industry Association. 2023. <https://www.bafu.admin.ch/en/references-ghg-inventory>
- SGWA 2025:** Eigenschaften des in die Schweiz importierten Erdgases (H-Gas) und Umrechnungsfaktoren erneuerbare Gase. G10001. Swiss Gas and Water Industry Association, January 2025. https://www.svgw.ch/media/11878/g10001_d_werte2024.pdf
- Sigler, J. M., Lee, X., Munger, W. 2003:** Emission and Long-Range Transport of Gaseous Mercury from a Large-Scale Canadian Boreal Forest Fire. Environ. Sci. Technol. 2003, 37, 4343-4347. <https://pubs.acs.org/doi/full/10.1021/es026401r> [28.01.2026]
- Stehfest, E., Bouwman, L. 2006:** N₂O and NO emission from agricultural fields and soils under natural vegetation: summarizing available measurement data and modelling of global annual emissions. Nutrient Cycling in Agroecosystems 74(3): 207–228. <http://dx.doi.org/10.1007/s10705-006-9000-7> [02.02.2026]
- Sutton, M. A., U. Dragosits, Y. S. Tang, and D. Fowler. 2000:** Ammonia Emissions From Non-Agricultural Sources in the UK. Atmospheric Environment 34(6): 855-869 [https://doi.org/10.1016/S1352-2310\(99\)00362-3](https://doi.org/10.1016/S1352-2310(99)00362-3) [27.01.2026]
- Swiss Confederation 1983:** Loi fédérale du 7 octobre 1983 sur la protection de l'environnement (Loi sur la protection de l'environnement, LPE). Status as of 01 January 2018. http://www.admin.ch/ch/f/rs/c814_01.html [official text in German, French and Italian]; Federal Act on the Protection of the Environment [English translation for information purposes only]: <https://www.admin.ch/opc/en/classified-compilation/19830267/index.html> [28.01.2026]
- Swiss Confederation 1985:** Ordonnance du 16 décembre 1985 sur la protection de l'air (Opair). Status as of 1 January 2024 http://www.admin.ch/ch/f/rs/c814_318_142_1.html [official text in German, French and Italian]; Ordinance on Air Pollution Control [English translation for information purposes only]: <https://www.admin.ch/opc/en/classified-compilation/19850321/index.html> [28.01.2026]
- Swiss Confederation 1995:** Ordinance of 19 June 1995 on the Technical Standards for Motor Vehicles and Their Trailors (TAFV1). As at 1 July 2008. http://www.admin.ch/ch/d/sr/c741_412.html [official text in German/French/Italian] [26.01.2026]
- Swiss Confederation 1997:** Ordonnance du 12 novembre 1997 sur la taxe d'incitation sur les composés organiques volatils (OCOV). As at 01 January 2018. http://www.admin.ch/ch/f/rs/c814_018.html [official text in German, French and Italian]; Ordinance on the Incentive Tax on Volatile Organic Compounds [English translation for information purposes only]: https://www.fedlex.admin.ch/eli/cc/1997/2972_2972_2972/en [26.01.2026]

- Swiss Confederation 1999:** Federal Constitution of the Swiss Confederation of 18 April 1999 (Status as of 12 February 2017). In French: <https://www.admin.ch/opc/fr/classified-compilation/19995395/index.html> in English: <https://www.admin.ch/opc/en/classified-compilation/19995395/index.html> (English is not an official language of the Swiss Confederation. This translation is provided for information purposes only and has no legal force.) [28.01.2026]
- Swiss Confederation 2004:** Botschaft zur Ratifikation des Protokolls vom 30. November 1999 zum Übereinkommen von 1979 über weiträumige grenzüberschreitende Luftverunreinigung, betreffend die Verringerung von Versauerung, Eutrophierung und bodennahem Ozon. <http://www.admin.ch/ch/d/ff/2004/3013.pdf> [in German] [28.01.2026]
- Swiss Confederation 2005:** Verordnung zur Reduktion von Risiken beim Umgang mit bestimmten besonders gefährlichen Stoffen, Zubereitungen und Gegenständen (Chemikalien-Risikoreduktions-Verordnung, ChemRRV) vom 18. Mai 2005. <https://www.fedlex.admin.ch/eli/cc/2005/478/de> [in German] [09.02.2026]
- Swiss Confederation 2009:** Bericht zum Konzept betreffend Lufthygienischen Massnahmen des Bundes (LRK) vom 11. September 2009. <http://www.admin.ch/ch/d/ff/2009/6585.pdf> [in German] [28.01.2026]
- Swiss Confederation 2011:** Bundesgesetz über die Reduktion der CO₂-Emissionen (CO₂-Gesetz). Status as of 01.01.2020. http://www.admin.ch/ch/d/sr/c641_71.html [official text in German, French and Italian]; Federal Act on the Reduction of CO₂ Emissions [English translation for information purposes only]: <https://www.admin.ch/opc/en/classified-compilation/20091310/index.html> [28.01.2026]
- Swiss Confederation 2012:** Verordnung über die Reduktion der CO₂-Emissionen (CO₂-Verordnung). Status as of 19.02.2019. http://www.admin.ch/ch/d/sr/c641_711.html [official text in German, French and Italian]; Ordinance on the Reduction of CO₂ Emissions [English translation for information purposes only]: <https://www.admin.ch/opc/en/classified-compilation/20120090/index.html> [09.02.2026]
- Swiss Confederation 2017:** Verordnungspaket zur Agrarpolitik 2018-2021. Schweizerischer Bundesrat. Bern. <https://www.news.admin.ch/newsd/message/attachments/49984.pdf> [in German] [09.02.2026]
- Swiss Confederation 2019:** Parlamentarische Initiative 19.475: Das Risiko beim Einsatz von Pestiziden reduzieren. Swiss Confederation. <https://www.parlament.ch/de/ratsbetrieb/suche-curia-vista/geschaeft?AffairId=20190475> [09.02.2026]
- Swiss Confederation 2021:** Switzerland's Long-Term Climate Strategy. Swiss Confederation. <https://www.bafu.admin.ch/en/climate-strategy-2050> [05.02.2026].
- Swiss Safety Center 2025:** Quality management system according to ISO 9001:2015. Certificate. Scope: National Inventory System and Reporting under the United Nations Framework Convention on Climate Change. Registration Number: 13-299-113. Initial certification: 25.11.2013. Recertification: 22.10.2025. Valid until: 24.11.2028. <https://www.bafu.admin.ch/en/references-ghg-inventory>
- TBF 2005:** «Projekt LEA – Emissionsfaktoren aus der Abfallverbrennung». Schlussbericht. Zürich, 22. August 2005.
- TBF 2015:** Neubearbeitung des Projektes «LEA – Emissionsfaktoren aus der Abfallverbrennung». Schlussbericht. Zürich, 22. September 2015. <https://www.bafu.admin.ch/en/studies-air> [03.02.2026]
- TBF 2021:** Neubearbeitung des Projektes «LEA – Emissionsfaktoren aus der Abfallverbrennung». Schlussbericht. Zürich, 18. November 2021. <https://www.bafu.admin.ch/en/studies-air> [04.02.2026]

- Thepoke, J. 2005:** NMVOC-Emissionen aus der Lösemittelanwendung und Möglichkeiten zu ihrer Minderung. Fortschritt-Berichte VDI Reihe 15 Nr. 252. Düsseldorf: VDI-Verlag.
<http://dx.doi.org/10.18419/opus-1660> [09.02.2026]
- Thepoke, J., Obermeier, A., Friedrich, R. 2000:** Ermittlung der Lösemittlemissionen 1994 in Deutschland und Methoden zur Fortschreibung. Institut für Energiewirtschaft und Rationelle Energieanwendung (IER) der Universität Stuttgart.Forschungsbericht 295 42 628. Im Auftrag des Umweltbundesamtes.
- UBA 2020:** National Inventory Report for the German Greenhouse Gas Inventory 1990 – 2018. Submission under the United Nations Framework Convention on Climate Change and the Kyoto Protocol 2020. Umweltbundesamt Deutschland (UBA).
https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikationen/2020-04-15-climate-change_23-2020_nir_2020_en_0.pdf [03.02.2026]
- UNECE 2010:** Report for the Stage 3 in-depth review of emission inventories submitted under the UNECE LRTAP Convention and EU National Emissions Ceilings, CEIP/S3.RR/2010/SWITZERLAND, 24.11.2010.
https://www.ceip.at/fileadmin/inhalte/ceip/00_pdf_other/2010_s3/ch_stage3_review_report_2010.pdf [09.02.2026]
- UNECE 2016:** Report for the Stage 3 in-depth review of emission inventories submitted under the UNECE LRTAP Convention and EU National Emissions Ceilings, CEIP/S3.RR/2016/SWITZERLAND, 26.09.2016
https://www.ceip.at/fileadmin/inhalte/ceip/00_pdf_other/2016_s3/switzerland-s3reviewreport-2016.pdf [05.02.2026]
- UNECE 2020a:** Report for the Stage 3 in-depth review of emission inventories submitted under the UNECE LRTAP Convention and EU National Emissions Ceilings, CEIP/S3.RR/2020/SWITZERLAND, 3.11.2020.
https://www.ceip.at/fileadmin/inhalte/ceip/00_pdf_other/2020_s3/ch_s3_rr_2020_clean.pdf [05.02.2026]
- UNECE 2022a:** Report for the Stage 3 ad-hoc review of emission inventories submitted under the UNECE LRTAP Convention: Stage 3 review report, Switzerland. CEIP/S3.RR/2022, 28.09.2022. <https://www.ceip.at/status-of-reporting-and-review-results/2022-submission> [05.02.2026]
- UNECE 2023a:** Report for the Stage 3 ad-hoc review of emission inventories submitted under the UNECE LRTAP Convention: Stage 3 review report, Switzerland. CEIP/S3.RR/2023, 04.10.2023. <https://www.ceip.at/status-of-reporting-and-review-results/2023-submission> [05.02.2026]
- UNECE 2024a:** Report for the Stage 3 ad-hoc review of emission inventories submitted under the UNECE LRTAP Convention: Stage 3 review report, Switzerland. CEIP/S3.RR/2024, 12.08.2024. <https://www.ceip.at/status-of-reporting-and-review-results/2024-submission> [09.02.2026]
- UNECE 2025:** Stage 1 review report and Stage 2 review data from the Annual Synthesis & Assessment CLRTAP Inventory review. <https://www.ceip.at/status-of-reporting-and-review-results/2025-submission> [23.01.2026]
- UNECE 2025a:** Report for the Stage 3 ad-hoc review of emission inventories submitted under the UNECE LRTAP Convention: Stage 3 review report, Switzerland. CEIP/S3.RR/2025, 21.08.2025. <https://www.ceip.at/status-of-reporting-and-review-results/2025-submission> [23.01.2026]
- UNFCCC 2019:** Modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement. Decision 18/CMA.1 (FCCC/PA/CMA/2018/3/Add.2), 19 March 2019.
https://unfccc.int/sites/default/files/resource/cma2018_3_add2_new_advance.pdf [09.02.2026]

- UNFCCC 2022a:** Report on the individual review of the annual submission of Switzerland submitted in 2021. FCCC/ARR/2021/CHE, 18.01.2022.
https://unfccc.int/sites/default/files/resource/arr2021_CHE.pdf [09.02.2026]
- USEPA 1995:** Compilation of air pollutant emission factors (AP-42). <https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors> [28.01.2026]
- USEPA 1998:** Locating and Estimating Air Emissions from Sources of Polycyclic Organic Matter. EPA document No. 454/R-98-014.
- USEPA 2010:** Exhaust and Crankcase Emission Factors for Nonroad Engine Modelling – Compression Ignition. EPA-420-R-10-018 / NR-009d. Assessment and Standards Division Office of Transportation and Air Quality U.S. Environmental Protection Agency. July 2010.
<https://nepis.epa.gov/Exe/ZyPDF.cgi/P10005BI.PDF?Dockey=P10005BI.PDF> [04.02.2026]
- van Bruggen, C., Bannink, A., Groenestein, C.M., de Haan, B.J., Huijsmans, J.F.M., Luesink, H.H., van der Sluis, S.M., Velthof, G.L. 2014:** Emissions into the atmosphere from agricultural activities in 2012. Calculations for ammonia, nitric oxide, nitrous oxide, methane and fine particulate matter using the NEMA model. Wageningen. Wot technical report 3 (in Dutch). Wageningen, NL: The Statutory Research Task Unit for Nature and the Environment (WOT Natuur & Milieu). <https://edepot.wur.nl/299687> [02.02.2026]
- VBSA 2017:** Klärschlamm Entsorgung in der Schweiz – Erhebung der Daten 2016. B. Freidl, VBSA, im Auftrag des Bundesamtes für Umwelt.
- VTG 2011:** Consumption of aviation fuel and jet kerosene of Swiss military aircraft 1990–2000. Written communication from Urs Baserga (VTG, Dübendorf) to Paul Filliger (FOEN, Bern), 04.07.2011 [confidential/internal]
- VTG 2025:** Consumption of aviation fuel and jet kerosene of Swiss military aircraft 2001–2024. Philipp Merz (VTG, Dübendorf) to Anouk Aimée Bass (FOEN, Bern), 05.06.2025 [confidential/internal]
- Watanabe, T., Kasahara, M., Nakatsuka, H., Ikeda, M. 1987:** Cadmium and lead contents of cigarettes produced in various areas of the world. Science of The Total Environment, Vol. 66, pp. 29-37. [https://doi.org/10.1016/0048-9697\(87\)90074-X](https://doi.org/10.1016/0048-9697(87)90074-X) [29.01.2026]
- Wevers, M., De Fré, R., Desmedt, M., 2004:** Effect of backyard burning on dioxin deposition and air concentrations. Chemosphere 54, pp. 1351-1356.
<https://www.sciencedirect.com/science/article/pii/S0045653503002534> [28.01.2026]
- Zähner, M., Zeyer, K., Wyss, S., Steger, D., Mohn, J., Schrade, S. 2025:** Emissionen von flüchtigen organischen Verbindungen (NMVOC), Ammoniak (NH₃) und Treibhausgasen (CH₄, CO₂) aus der Rindviehhaltung. Agroscope und Empa, im Auftrag des Bundesamtes für Umwelt, Bern. [German report, which will become available on the FOEN webpage later.]
- Zotter, P. and Nussbaumer T. 2026:** Aktualisierung Emissionsmodell Oel und Gasfeuerungen 2024, in preparation.
- Zotter, P. and Nussbaumer, T. 2022:** Aktualisierung Emissionsmodell Holzfeuerungen 2020. Verenum, im Auftrag des Bundesamtes für Umwelt 2022.
<https://www.bafu.admin.ch/en/studies-air> [in German] [03.02.2026]

12.2 Assignment of EMIS categories to NFR codes

Table 12-1 Assignment of NFR codes to titles of EMIS database comments. If the NFR code according to the CLRTAP nomenclature (UNECE) differs from the code according to the CRT nomenclature (UNFCCC), or if the code only applies to CLRTAP, the code for CLRTAP is indicated in square brackets.

NFR codes for inventory reporting to UNECE and UNFCCC, if different, codes for UNECE in []	Title in EMIS	NFR codes for inventory reporting to UNECE and UNFCCC, if different, codes for UNECE in []	Title in EMIS
1 A	Energiemodell***	2 D 3 a [2 D 3 g]	Feinchemikalien-Produktion**
1 A	Holzfeuerungen	2 D 3 a [2 D 3 g]	Gummi-Verarbeitung**
1 A	Non-Road	2 D 3 a [2 D 3 g]	Klebband-Produktion
1 A	Stationary engines and gas turbines	2 D 3 a [2 D 3 g]	Klebstoff-Produktion**
1 A 2	Sektorgliederung Industrie	2 D 3 a [2 D 3 g]	Lösungsmittel-Umschlag und -Lager
1 A 1 a	Kehrichtverbrennungsanlagen	2 D 3 a [2 D 3 g]	Pharmazeutische Produktion**
1 A 1 a	Sondermüllverbrennungsanlagen	2 D 3 a [2 D 3 g]	Polyester-Verarbeitung**
1 A 1 a & 5 A	Kehrichtdeponien	2 D 3 a [2 D 3 g]	Polystyrol-Verarbeitung**
1 A 1 b	Heizkessel Raffinerien* (ab 2015)	2 D 3 a [2 D 3 g]	Polyurethan-Verarbeitung
1 A 1 c	Holzkohle Produktion	2 D 3 a [2 D 3 g]	PVC-Verarbeitung
1 A 2 a & 2 C 1	Eisengießereien Kupolöfen	2 D 3 a [2 D 3 g]	Gerben von Ledermaterialien
1 A 2 a	Stahl-Produktion Wärmeöfen**	2 D 3 b	Strassenbelagsarbeiten**
1 A 2 b	Buntmetallgiessereien übriger Betrieb**	2 D 3 c	Dachpappe**
1 A 2 b & 2 C 3	Aluminium Produktion	2 D 3 d	Urea (AdBlue) Einsatz Strassenverkehr
1 A 2 c & 2 B 8 b [2 B 10 a]	Ethen-Produktion*	2 G 3 a	Lachgasanwendung Spitäler**
1 A 2 d & 2 A 4 d	Zellulose-Produktion Feuerung*	2 G 3 b	Lachgasanwendung Haushalt**
1 A 2 f	Kalkproduktion, Feuerung*	2 G 4 [2 D 3 a]	Pharma-Produkte im Haushalt
1 A 2 f	Mischgut Produktion	2 G 4 [2 D 3 a]	Reinigungs- und Lösemittel; Haushalte
1 A 2 f	Zementwerke Feuerung	2 G 4 [2 D 3 h]	Verpackungsdruckereien**
1 A 2 f & 2 A 3	Glas übrige Produktion*	2 G 4 [2 D 3 h]	Druckereien übrige**
1 A 2 f & 2 A 3	Glaswolle Produktion Rohprodukt**	2 G 4 [2 D 3 i]	Entfernung von Farben und Lacken**
1 A 2 f & 2 A 3	Hohlglas Produktion*	2 G 4 [2 D 3 i]	Entwachsung von Fahrzeugen
1 A 2 f & 2 A 4 a	Feinkeramik Produktion*	2 G 4 [2 D 3 i]	Kosmetika-Produktion**
1 A 2 f & 2 A 4 a	Ziegeleien**	2 G 4 [2 D 3 i]	Lösungsmittel-Emissionen IG nicht zugeordnet
1 A 2 f & 2 A 4 d	Steinwolle Produktion*	2 G 4 [2 D 3 i]	Öl- und Fettgewinnung
1 A 2 g iv [1 A 2 g viii]	Faserplatten Produktion* (ab 2020)	2 G 4 [2 D 3 i]	Papier- und Karton-Produktion**
1 A 2 g viii & 5 B 2	Vergärung IG (industriell-gewerblich)	2 G 4 [2 D 3 i]	Parfum- und Aromen-Produktion**
1 A 3 a & 1 A 5	Flugverkehr	2 G 4 [2 D 3 i]	Tabakwaren Produktion**
1 A 3 b i-v [1 A 3 b i-vi]	Strassenverkehr	2 G 4 [2 D 3 i]	Textilien-Produktion**
1 A 3 c	Schiennenverkehr	2 G 4 [2 D 3 i]	Wissenschaftliche Laboratorien
1 A 3 e	Gastransport Kompressorstation	2 G 4 [2 G]	Korrosionsschutz im Freien
1 A 4 b i	Holzkohle-Verbrauch	2 G 4 [2 G]	Betonzusatzmittel-Anwendung
1 A 4 b i	Lagerfeuer	2 G 4 [2 G]	Coiffeursalons
1 A 4 c i	Gewächshäuser**	2 G 4 [2 G]	Fahrzeug-Unterbodenschutz**
1 A 4 c i	Graströcknung**	2 G 4 [2 G]	Feuerwerke
1 A 4 c i & 5 B 2	Vergärung LW (landwirtschaftlich)	2 G 4 [2 G]	Flaechenteisierung Flughafens
1 B 2 a iii	Raffinerie, Pipelinetransport	2 G 4 [2 G]	Flugzeug-Enteisung
1 B 2 a iv	Raffinerie Leckverluste*	2 G 4 [2 G]	Frostschutzmittel Automobil
1 B 2 a iv	H2-Produktion*	2 G 4 [2 G]	Gas-Anwendung
1 B 2 a iv	Raffinerie Clausanlage*	2 G 4 [2 G]	Gesundheitswesen, übrige**
1 B 2 a v	Benzinumschlag Tanklager	2 G 4 [2 G]	Glaswolle Imprägnierung**
1 B 2 a v	Benzinumschlag Tankstellen	2 G 4 [2 G]	Holzschutzmittel-Anwendung
1 B 2 b ii & 1 B 2 c ii 2	Gasproduktion & Gasproduktion, Flaring	2 G 4 [2 G]	Klebstoff-Anwendung**
1 B 2 b iv-vi	Netzverluste Erdgas	2 G 4 [2 G]	Kosmetik-Institute
1 B 2 c ii 1	Raffinerie, Abfackelung	2 G 4 [2 G]	Kühlschmiermittel-Verwendung
2 A 1	Zementwerke Rohmaterial	2 G 4 [2 G]	Medizinische Praxen**
2 A 4 d [2 A 1]	Zementwerke übriger Betrieb	2 G 4 [2 G]	Pflanzenschutzmittel-Verwendung
2 A 2	Kalkproduktion, Rohmaterial**	2 G 4 [2 G]	Reinigung Gebäude IGD**
2 A 4 d [2 A 2]	Kalkproduktion, übriger Betrieb*	2 G 4 [2 G]	Schmierstoff-Verwendung
2 A 4 d	Kehrichtverbrennungsanlagen Karbonat**	2 G 4 [2 G]	Spraydosens IndustrieGewerbe
2 A 4 d	Karbonatanwendung weitere	2 G 4 [2 G]	Tabakwaren Konsum
2 A 4 d [2 A 5 a]	Gips-Produktion übriger Betrieb* (ab 2021)	2 G 4 [2 G]	Steinwolle-Imprägnierung*
2 A 5 a	Kieswerke	2 H 1	Faserplatten Produktion* (ab 2020)
2 B 1	Ammoniak-Produktion*	2 H 1	Zellulose Produktion übriger Betrieb*
2 B 10 b [2 B 10 a]	Ammoniumnitrat-Produktion*	2 H 1	Spanplatten Produktion*
2 B 10 b [2 B 10 a]	Chlorgas-Produktion*	2 H 2	Bierbrauereien
2 B 10 b [2 B 10 a]	Essigsäure-Produktion* (ab 2013)	2 H 2	Branntwein Produktion
2 B 10 b [2 B 10 a]	Formaldehyd-Produktion	2 H 2	Brot Produktion
2 B 10 b [2 B 10 a]	PVC-Produktion	2 H 2	Fleischräuchereien
2 B 10 b [2 B 10 a]	Salzsäure-Produktion*	2 H 2	Kaffeeröstereien
2 B 10 b [2 B 10 a]	Schwefelsäure-Produktion*	2 H 2	Müllereien
2 B 10 b	Kalksteingrube*	2 H 2	Wein Produktion
2 B 10 b [2 B 10 a]	Niacin-Produktion*	2 H 2	Zucker Produktion
2 B 2	Salpetersäure Produktion*	2 H 3	Sprengen und Schiessen
2 B 5	Graphit und Siliziumkarbid Produktion*	[2 I]	Holzbearbeitung
2 C - 2 G	Synthetische Gase	[2K, 1A1a, 2C1, 5A, 5C1, 5E & 6A5]	Emissions due to former PCB usage
2 C 1	Eisengießereien Elektroschmelzöfen	2 H 3 [2 L]	NH3 aus Kühlanlagen
2 C 1	Eisengießereien übriger Betrieb	3	Landwirtschaft
2 C 1 & 1 A 2 a	Stahl-Produktion Elektroschmelzöfen**	3 B	Tierhaltung
2 C 1	Stahl-Produktion übriger Betrieb**	3 C	Reisanbau
2 C 1	Stahl-Produktion Walzwerke**	[3 D e]	Landwirtschaftsflächen
2 C 7 a	Buntmetallgiessereien Elektroöfen**	4(IV) A 1 [11 B]	Waldbrände
2 C 7 c	Verzinkereien	5 B 1	Kompostierung
2 C 7 c	Batterie-Recycling*	5 B 2	Biogasaufbereitung (Methanverlust)
2 D 1	Schmiermittel-Anwendung	5 C 1 a i & 5 C 1 b i [5 C 1 a]	Abfallverbrennung illegal
2 D 1	Schmiermittel-Verbrauch B2T	5 C 1 b ii [5 C 1 b i]	Kabelabbrand
2 D 2	Paraffinwachs-Anwendung	5 C 1 b iii [5 C 1 b iii]	Spitalabfallverbrennung
2 D 3 a [2 D 3 d]	Farben-Anwendung Bau	5 C 1 a ii 4 [5 C 1 b iv]	Klärschlammverbrennung
2 D 3 a [2 D 3 d]	Farben-Anwendung andere	5 C 1 [5 C 1 b v]	Krematorien
2 D 3 a [2 D 3 d]	Farben-Anwendung Haushalte**	5 C 2 & 4(IV) A 1 (Forstwirtschaft)	Abfallverbrennung Land- und Forstwirtschaft und Private
2 D 3 a [2 D 3 d]	Farben-Anwendung Holz	5 D 1	Kläranlagen kommunal (Luftschadstoffe)
2 D 3 a [2 D 3 d]	Farben-Anwendung Autoreparatur**	5 D 2	Kläranlagen industriell (Luftschadstoffe)
2 D 3 a [2 D 3 e]	Elektronik-Reinigung**	5 D 1 & 5 D 2	Abwasserbehandlung GHG
2 D 3 a [2 D 3 e]	Metallreinigung**	5 E	Shredder Anlagen
2 D 3 a [2 D 3 e]	Reinigung Industrie übrige**	6 A 1 [6 A 4]	Brand- und Feuerschäden Immobilien
2 D 3 a [2 D 3 f]	Chemische Reinigung**	6 A 1 [6 A 4]	Brand- und Feuerschäden Motorfahrzeuge
2 D 3 a [2 D 3 g]	Druckfarben Produktion**	[11 C]	NM/OC Emissionen Wald
2 D 3 a [2 D 3 g]	Farben-Produktion**	1, 2, 5, 6 - indirect	Indirekte Emissionen

* confidential process

** confidential EMIS comment

*** work in progress

Italic: process not relevant for the years after 1990.

Annexes

Annex 1 Key category analysis (KCA)

A1.1 Overview

The following table provides an overview over the level (1990 and 2024) and trend (1990-2024) assessments based on approach 1 and approach 2 of the key category analysis. Note that the key category analysis is performed based on the approach “fuels used” (in contrast to “fuels sold”; for differentiation of the two approaches see chapter 3.1.6.1). Columns A to D in the following two tables are labelled according to Table 2-6 from the EMEP/EEA guidebook (EMEP/EEA 2023, part A, chp. 2, “Methodological choice and Key category analysis”).

Table A - 1 Summary of Switzerland's key category analysis, for the main pollutants, PM2.5 and PM10. L: level assessment (2024); T: trend assessment (1990-2024); 1: KCA approach 1; 2: KCA approach 2. Note that categories which are key for the level assessment for the base year only are not reported in this table.

SUMMARIES TO IDENTIFY KEY CATEGORIES							
A	B	C & D					
NFR Code	Source category	NOx	NMVOC	SOx	NH3	PM2.5	PM10
1A1a	Public electricity and heat production	L1, L2, T1, T2		L1, L2, T1, T2			T1
1A2d	Stationary combustion in manufacturing industries and construction: pulp paper and print			T1, T2			
1A2e	Stationary combustion in manufacturing industries and construction: food processing beverages and tobacco			T2			
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	L1, L2, T1, T2		L1, L2, T1, T2			
1A2gvii	Mobile combustion in manufacturing industries and construction					L1, L2, T1, T2	L1, L2, T1, T2
1A2gviii	Stationary combustion in manufacturing industries and construction: other	T1, T2		L1, L2		L1	
1A3ai(i)	Civil aviation (domestic landing/take-off (LTO))	L1, L2, T1, T2		L1, L2, T1, T2			
1A3bi(fu)	Road transportation: passenger cars (fuel used)	L1, L2, T1, T2	L1, L2, T1, T2	T1			
1A3bii(fu)	Road transportation: light duty vehicles (fuel used)	L1, L2, T1, T2					
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	L1, L2, T1, T2		T1, T2		T1, T2	T1
1A3biv(fu)	Road transportation: mopeds and motorcycles (fuel used)		T2				
1A3bv(fu)	Road transportation: gasoline evaporation (fuel used)		L1, T1, T2				
1A3bvi(fu)	Road transportation: automobile tyre and brake wear (fuel used)					L1, L2, T1, T2	L1, L2, T1, T2
1A3c	Railways					L1, L2, T1, T2	L1, L2, T1, T2
1A3dii	National navigation (shipping)	T1					
1A4ai	Commercial/institutional: stationary	L1, L2, T1, T2		L1, T1, T2		L1, L2	L1, L2
1A4bi	Residential: stationary plants	L1, L2	L1, L2	L1, L2, T1, T2		L1, L2, T1, T2	L1, L2, T1, T2
1A4ci	Agriculture/forestry/fishing: stationary			L2, T2		L1	
1A4cii	Agriculture/forestry/fishing: off-road vehicles and other machinery	L1					
1A5b	Other mobile (including military land-based and recreational boats)						L1
1B2av	Distribution of oil products		L1, T1, T2				
2A1	Cement production					L2, T2	L2
2A5a	Quarrying and mining of minerals other than coal					L2, T2	L1, L2, T2
2B5	Carbide production			L1, L2, T1, T2			
2B10a	Chemical industry: other			L2, T2			
2C1	Iron and steel production					T1, T2	T1, T2
2D3a	Domestic solvent use including fungicides		L1, L2, T1, T2				
2D3b	Road paving with asphalt		L1, L2, T1, T2				
2D3d	Coating applications		L1, L2, T1				
2D3e	Degreasing		L1, T1, T2				
2D3g	Chemical products		L1, L2, T1, T2				
2D3h	Printing		L1, L2, T1				
2D3i	Other solvent use		L1, L2, T2				
2G	Other product use		L1, L2, T2			L1, L2, T1, T2	L1, L2, T1, T2
2H1	Pulp and paper industry					L1, L2, T1, T2	
2H2	Food and beverages industry		L2, T1, T2			L1, L2, T1, T2	L1, L2, T2
2I	Wood processing					L2	L2, T2
3B1a	Manure management - Dairy cattle		L1, L2, T1, T2		L1, L2, T1, T2		
3B1b	Manure management - Non-dairy cattle		L1, L2, T1, T2		L1, L2, T1, T2		
3B3	Manure management - Swine		L2		L1, L2, T1, T2		
3B4gi	Manure management - Laying hens						L2
3B4gii	Manure management - Broilers		L2, T1, T2		L2, T2		L2, T2
3Da1	Inorganic N-fertilizers (includes also urea application)	L2, T2			L1, L2, T2		
3Da2a	Animal manure applied to soils	L1, L2, T1, T2			L1, L2, T1, T2		
3Da2b	Sewage sludge applied to soils				T1		
3Da2c	Other organic fertilisers applied to soils (including compost)	T2			L2, T1, T2		
3Da3	Urine and dung deposited by grazing animals	T2			L2, T1, T2		
3De	Cultivated crops						L1, L2, T1, T2
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities		T1				
5C1a	Municipal waste incineration					L1, L2, T1	L1
6A	Other sources				L2, T2		

Table A - 2 Summary of Switzerland's key category analysis, for TSP, BC, CO, priority heavy metals, PCDD/PCDF, PAHs total, HCB and PCBs. L: level assessment (2024); T: trend assessment (1990-2024); 1: KCA approach 1. No approach 2 analysis was conducted. Note that categories which are key for the level assessment for the base year only are not reported in this table.

A NFR Code	B Source category	C & D									
		TSP	BC	CO	Pb	Cd	Hg	PCDD/P CDF	PAHs total	HCB	PCB
1A1a	Public electricity and heat production				L1, T1	L1, T1	L1, T1	L1, T1		L1, T1	T1
1A2b	Stationary combustion in manufacturing industries and construction: non-ferrous metals									T1	
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	T1		L1, T1		L1, T1	L1, T1				
1A2gvii	Mobile combustion in manufacturing industries and construction	L1, T1	T1	L1		L1, T1					
1A2gviii	Stationary combustion in manufacturing industries and construction: other				L1		L1, T1				
1A3aii(i)	Civil aviation (domestic cruise)				L1, T1						
1A3bi(fu)	Road transportation: passenger cars (fuel used)			L1, T1	T1				L1, T1		
1A3bii(fu)	Road transportation: light duty vehicles (fuel used)			T1							
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	T1	T1								
1A3bvi(fu)	Road transportation: automobile tyre and brake wear (fuel used)	L1, T1	L1, T1			L1, T1					
1A3c	Railways	L1, T1									
1A3dii	National navigation (shipping)			L1							
1A4ai	Commercial/institutional: stationary		L1, T1	L1, T1			T1	L1, T1	L1, T1		
1A4aii	Commercial/institutional: mobile			L1, T1							
1A4bi	Residential: stationary plants	L1, T1	L1, T1	L1, T1		L1	L1, T1	L1, T1	L1, T1	L1, T1	
1A4bii	Residential: household and gardening (mobile)			T1							
1A4cii	Agriculture/forestry/fishing: off-road vehicles and other machinery		L1, T1	L1, T1							
2A5a	Quarrying and mining of minerals other than coal	L1									
2B10a	Chemical industry: other						T1				
2C1	Iron and steel production	T1			T1	T1	L1, T1				
2C3	Aluminium production								T1		
2G	Other product use	L1			L1	L1, T1					
2I	Wood processing	T1									
2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)										L1, T1
3B3	Manure management - Swine	L1									
3B4gi	Manure management - Laying hens	L1									
3De	Cultivated crops	L1, T1									
5C1a	Municipal waste incineration				L1, T1			L1, T1			
5C2	Open burning of waste								L1, T1		
5E	Other waste										T1
6A	Other sources				L1, T1			L1, T1			

A1.2 Detailed results of approach 1 assessment

The following tables report the detailed results for the key category analysis, approach 1, level and trend assessments, for the reporting year 2024 and the base year 1990. Columns labelled A to F for the level assessments correspond exactly to columns A to F from Table 3-1 from the EMEP/EEA guidebook (EMEP/EEA 2023, part A, chp. 2, “Key category analysis and methodological choice 2019”). For the table reporting the trend assessment, columns labelled A to H correspond exactly to columns A to H from Table 3-2 from the same guidelines. Equations referenced hereafter are also from the same guidelines.

Explanations of headers for tables in this Annex are:

- $E_{x,t}$: emission estimate for the reporting year.
- $E_{x,0}$: emission estimate for the base year.
- $L_{x,t}$: level assessment for the reporting year (EMEP/EAA guidebook part A, chp. 2, equ. 1 for approach 1).
- $L_{x,0}$: level assessment for the base year (EMEP/EAA guidebook part A, chp. 2, equ. 1 for approach 1).
- Trend assessment: computed according to EMEP/EAA guidebook part A, chp. 2, equ. 2 for approach 1.

Table A - 3 Switzerland's key categories according to approach 1 level assessment for the year 2024, sorted by decreasing contribution, for the main pollutants, PM2.5 and PM10. Categories in grey are not key and are given for information only.

KCA APPROACH 1 LEVEL ASSESSMENT FOR 2024					
A	B	C	D	E	F
NFR code	Source category	Pollutant	Ex, t (t)	Lx, t (%)	Cumulative Total (%)
1A3bi(fu)	Road transportation: passenger cars (fuel used)	NOx	12'539	28.5	28.5
1A4bi	Residential: stationary plants	NOx	3'494	8.0	36.5
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	NOx	3'370	7.7	44.2
1A3bii(fu)	Road transportation: light duty vehicles (fuel used)	NOx	3'023	6.9	51.1
1A4ai	Commercial/institutional: stationary	NOx	2'677	6.1	57.2
1A1a	Public electricity and heat production	NOx	2'615	6.0	63.1
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	NOx	2'564	5.8	68.9
1A3ai(i)	Civil aviation (domestic landing/take-off (LTO))	NOx	2'144	4.9	73.8
1A4cii	Agriculture/forestry/fishing: off-road vehicles and other machinery	NOx	1'514	3.4	77.3
3Da2a	Animal manure applied to soils	NOx	1'503	3.4	80.7
1A2gviii	Stationary combustion in manufacturing industries and construction: other	NOx	1'497	3.4	84.1
1A2gvii	Mobile combustion in manufacturing industries and construction	NOx	1'443	3.3	87.4
2D3d	Coating applications	NMVOc	8'289	11.7	11.7
3B1b	Manure management - Non-dairy cattle	NMVOc	7'626	10.7	22.4
2D3a	Domestic solvent use including fungicides	NMVOc	6'593	9.3	31.7
3B1a	Manure management - Dairy cattle	NMVOc	6'524	9.2	40.9
2G	Other product use	NMVOc	6'322	8.9	49.8
2D3h	Printing	NMVOc	3'587	5.0	54.8
1A3bi(fu)	Road transportation: passenger cars (fuel used)	NMVOc	3'506	4.9	59.7
2D3g	Chemical products	NMVOc	3'169	4.5	64.2
2D3b	Road paving with asphalt	NMVOc	2'662	3.7	68.0
1A3bv(fu)	Road transportation: gasoline evaporation (fuel used)	NMVOc	2'225	3.1	71.1
1A4bi	Residential: stationary plants	NMVOc	2'218	3.1	74.2
1B2av	Distribution of oil products	NMVOc	1'940	2.7	76.9
2D3i	Other solvent use	NMVOc	1'933	2.7	79.7
2D3e	Degreasing	NMVOc	1'566	2.2	81.9
2H2	Food and beverages industry	NMVOc	1'417	2.0	83.9
3B4gii	Manure management - Broilers	NMVOc	1'201	1.7	85.6
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	SOx	669	31.3	31.3
1A1a	Public electricity and heat production	SOx	289	13.5	44.8
1A4bi	Residential: stationary plants	SOx	212	9.9	54.7
2B5	Carbide production	SOx	197	9.2	63.9
1A2gviii	Stationary combustion in manufacturing industries and construction: other	SOx	168	7.8	71.7
1A3ai(i)	Civil aviation (domestic landing/take-off (LTO))	SOx	149	7.0	78.7
1A4ai	Commercial/institutional: stationary	SOx	74	3.5	82.1
1A2c	Stationary combustion in manufacturing industries and construction: chemicals	SOx	71	3.3	85.5
3Da2a	Animal manure applied to soils	NH3	12'261	30.0	30.0
3B1a	Manure management - Dairy cattle	NH3	8'023	19.6	49.6
3B1b	Manure management - Non-dairy cattle	NH3	6'483	15.9	65.5
3B3	Manure management - Swine	NH3	3'380	8.3	73.7
3Da1	Inorganic N-fertilizers (includes also urea application)	NH3	2'562	6.3	80.0
3Da3	Urine and dung deposited by grazing animals	NH3	1'334	3.3	83.3
3Da2c	Other organic fertilisers applied to soils (including compost)	NH3	1'174	2.9	86.1
1A4bi	Residential: stationary plants	PM2.5	1'725	28.7	28.7
1A3bvi(fu)	Road transportation: automobile tyre and brake wear (fuel used)	PM2.5	908	15.1	43.8
1A4ai	Commercial/institutional: stationary	PM2.5	409	6.8	50.6
1A2gvii	Mobile combustion in manufacturing industries and construction	PM2.5	381	6.3	57.0
2G	Other product use	PM2.5	374	6.2	63.2
1A3c	Railways	PM2.5	248	4.1	67.3
5C1a	Municipal waste incineration	PM2.5	215	3.6	70.9
1A4ci	Agriculture/forestry/fishing: stationary	PM2.5	198	3.3	74.2
2H1	Pulp and paper industry	PM2.5	172	2.9	77.0
2H2	Food and beverages industry	PM2.5	167	2.8	79.8
1A2gviii	Stationary combustion in manufacturing industries and construction: other	PM2.5	162	2.7	82.5
2A1	Cement production	PM2.5	137	2.3	84.8
1A4cii	Agriculture/forestry/fishing: off-road vehicles and other machinery	PM2.5	116	1.9	86.7
1A3bvi(fu)	Road transportation: automobile tyre and brake wear (fuel used)	PM10	2'478	17.8	17.8
1A2gvii	Mobile combustion in manufacturing industries and construction	PM10	2'374	17.1	34.9
1A4bi	Residential: stationary plants	PM10	1'817	13.1	48.0
1A3c	Railways	PM10	1'615	11.6	59.6
3De	Cultivated crops	PM10	1'003	7.2	66.8
2G	Other product use	PM10	497	3.6	70.4
1A4ai	Commercial/institutional: stationary	PM10	435	3.1	73.5
2A5a	Quarrying and mining of minerals other than coal	PM10	318	2.3	75.8
2H2	Food and beverages industry	PM10	310	2.2	78.1
1A5b	Other mobile (including military land-based and recreational boats)	PM10	260	1.9	79.9
5C1a	Municipal waste incineration	PM10	239	1.7	81.7
3B4gii	Manure management - Broilers	PM10	222	1.6	83.3
2A1	Cement production	PM10	213	1.5	84.8
1A4ci	Agriculture/forestry/fishing: stationary	PM10	201	1.4	86.2

Table A - 4 Switzerland's key categories according to approach 1 level assessment for the year 1990, sorted by decreasing contribution, for the main pollutants, PM2.5 and PM10. Categories in grey are not key and are given for information only.

KCA APPROACH 1 LEVEL ASSESSMENT FOR 1990					
A	B	C	D	E	F
NFR code	Source category	Pollutant	Ex, 0 (t)	Lx, 0 (%)	Cumulative Total (%)
1A3bi(fu)	Road transportation: passenger cars (fuel used)	NOx	43'812	31.1	31.1
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	NOx	29'839	21.2	52.3
1A4bi	Residential: stationary plants	NOx	11'636	8.3	60.5
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	NOx	10'535	7.5	68.0
1A2gvii	Mobile combustion in manufacturing industries and construction	NOx	6'334	4.5	72.5
1A1a	Public electricity and heat production	NOx	6'279	4.5	76.9
1A3bii(fu)	Road transportation: light duty vehicles (fuel used)	NOx	6'095	4.3	81.3
1A4ai	Commercial/institutional: stationary	NOx	5'139	3.6	84.9
1A4cii	Agriculture/forestry/fishing: off-road vehicles and other machinery	NOx	4'358	3.1	88.0
1A3bi(fu)	Road transportation: passenger cars (fuel used)	NMVOC	56'149	18.8	18.8
2D3d	Coating applications	NMVOC	40'731	13.7	32.5
2D3g	Chemical products	NMVOC	27'504	9.2	41.7
2G	Other product use	NMVOC	22'432	7.5	49.3
2D3h	Printing	NMVOC	20'354	6.8	56.1
1A3bv(fu)	Road transportation: gasoline evaporation (fuel used)	NMVOC	19'931	6.7	62.8
1B2av	Distribution of oil products	NMVOC	19'127	6.4	69.2
2D3e	Degreasing	NMVOC	11'731	3.9	73.1
1A4bi	Residential: stationary plants	NMVOC	10'056	3.4	76.5
2D3a	Domestic solvent use including fungicides	NMVOC	8'867	3.0	79.5
3B1a	Manure management - Dairy cattle	NMVOC	6'413	2.2	81.6
2D3i	Other solvent use	NMVOC	5'470	1.8	83.5
1A3biv(fu)	Road transportation: mopeds and motorcycles (fuel used)	NMVOC	5'429	1.8	85.3
1A4bi	Residential: stationary plants	SOx	10'355	26.4	26.4
1A4ai	Commercial/institutional: stationary	SOx	3'870	9.9	36.3
1A1a	Public electricity and heat production	SOx	3'679	9.4	45.7
1A2gviii	Stationary combustion in manufacturing industries and construction: other	SOx	3'534	9.0	54.7
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	SOx	3'530	9.0	63.7
1A2d	Stationary combustion in manufacturing industries and construction: pulp paper and print	SOx	3'238	8.3	72.0
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	SOx	1'821	4.6	76.6
1A3bi(fu)	Road transportation: passenger cars (fuel used)	SOx	1'618	4.1	80.8
1A2c	Stationary combustion in manufacturing industries and construction: chemicals	SOx	1'187	3.0	83.8
1A2e	Stationary combustion in manufacturing industries and construction: food processing beverages and tobacco	SOx	1'078	2.7	86.5
3Da2a	Animal manure applied to soils	NH3	23'970	42.2	42.2
3B1a	Manure management - Dairy cattle	NH3	8'190	14.4	56.6
3B3	Manure management - Swine	NH3	6'717	11.8	68.4
3B1b	Manure management - Non-dairy cattle	NH3	4'827	8.5	76.9
3Da1	Inorganic N-fertilizers (includes also urea application)	NH3	4'258	7.5	84.4
1A3bi(fu)	Road transportation: passenger cars (fuel used)	NH3	1'323	2.3	86.7
1A4bi	Residential: stationary plants	PM2.5	14'536	53.5	53.5
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	PM2.5	1'599	5.9	59.3
1A4ai	Commercial/institutional: stationary	PM2.5	1'354	5.0	64.3
1A2gviii	Stationary combustion in manufacturing industries and construction: other	PM2.5	873	3.2	67.5
2C1	Iron and steel production	PM2.5	818	3.0	70.5
1A1a	Public electricity and heat production	PM2.5	782	2.9	73.4
1A2gvii	Mobile combustion in manufacturing industries and construction	PM2.5	729	2.7	76.1
1A4ci	Agriculture/forestry/fishing: stationary	PM2.5	697	2.6	78.7
1A3bv(fu)	Road transportation: automobile tyre and brake wear (fuel used)	PM2.5	690	2.5	81.2
1A3bi(fu)	Road transportation: passenger cars (fuel used)	PM2.5	589	2.2	83.4
2G	Other product use	PM2.5	513	1.9	85.2
1A4bi	Residential: stationary plants	PM10	15'326	42.0	42.0
1A2gvii	Mobile combustion in manufacturing industries and construction	PM10	2'173	6.0	48.0
1A3bv(fu)	Road transportation: automobile tyre and brake wear (fuel used)	PM10	2'046	5.6	53.6
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	PM10	1'599	4.4	57.9
2C1	Iron and steel production	PM10	1'485	4.1	62.0
1A4ai	Commercial/institutional: stationary	PM10	1'428	3.9	65.9
3De	Cultivated crops	PM10	1'054	2.9	68.8
1A1a	Public electricity and heat production	PM10	1'045	2.9	71.7
1A3c	Railways	PM10	970	2.7	74.3
1A2gviii	Stationary combustion in manufacturing industries and construction: other	PM10	913	2.5	76.8
2I	Wood processing	PM10	864	2.4	79.2
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	PM10	833	2.3	81.5
1A4ci	Agriculture/forestry/fishing: stationary	PM10	710	1.9	83.4
1A3bi(fu)	Road transportation: passenger cars (fuel used)	PM10	589	1.6	85.0

Table A - 5 Switzerland's key categories according to approach 1 trend assessment for 1990-2024, sorted by decreasing contribution, for the main pollutants, PM2.5 and PM10. Categories in orange have increased emissions in 2024 compared to 1990. Categories in grey are not key and are given for information only.

KCA APPROACH 1 TREND ASSESSMENT 1990 - 2024							
A	B	C	D	E	F	G	H
NFR code	Source category	Pollutant	Ex, 0 (t)	Ex, t (t)	Trend Assessment	Contribution to trend assess. (%)	Cumulative Total (%)
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	NOx	29'839	3'370	0.042	32.6	32.6
1A3ai(i)	Civil aviation (domestic landing/take-off (LTO))	NOx	1'214	2'144	0.013	9.7	42.3
1A3bii(fu)	Road transportation: light duty vehicles (fuel used)	NOx	6'095	3'023	0.008	6.2	48.4
1A3bi(fu)	Road transportation: passenger cars (fuel used)	NOx	43'812	12'539	0.008	6.1	54.5
1A4ai	Commercial/institutional: stationary	NOx	5'139	2'677	0.008	5.9	60.5
3Da2a	Animal manure applied to soils	NOx	2'099	1'503	0.006	4.7	65.1
1A2gviii	Stationary combustion in manufacturing industries and construction: other	NOx	2'182	1'497	0.006	4.5	69.6
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	NOx	10'535	2'564	0.005	3.9	73.6
1A1a	Public electricity and heat production	NOx	6'279	2'615	0.005	3.6	77.2
1A3dii	National navigation (shipping)	NOx	1'055	870	0.004	3.0	80.1
1A2gvii	Mobile combustion in manufacturing industries and construction	NOx	6'334	1'443	0.004	2.9	83.1
1A2d	Stationary combustion in manufacturing industries and construction: pulp paper and print	NOx	1'262	34	0.003	2.0	85.0
1A3bi(fu)	Road transportation: passenger cars (fuel used)	NMVOc	56'149	3'506	0.033	18.8	18.8
3B1b	Manure management - Non-dairy cattle	NMVOc	5'122	7'626	0.021	12.2	30.9
3B1a	Manure management - Dairy cattle	NMVOc	6'413	6'524	0.017	9.5	40.4
2D3a	Domestic solvent use including fungicides	NMVOc	8'867	6'593	0.015	8.5	48.9
2D3g	Chemical products	NMVOc	27'504	3'169	0.011	6.4	55.3
1B2av	Distribution of oil products	NMVOc	19'127	1'940	0.009	5.0	60.3
1A3bv(fu)	Road transportation: gasoline evaporation (fuel used)	NMVOc	19'931	2'225	0.008	4.8	65.1
2D3b	Road paving with asphalt	NMVOc	4'895	2'662	0.005	2.8	67.9
2D3d	Coating applications	NMVOc	40'731	8'289	0.005	2.7	70.6
2D3h	Printing	NMVOc	20'354	3'587	0.004	2.4	73.0
2D3e	Degreasing	NMVOc	11'731	1'566	0.004	2.3	75.4
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	NMVOc	50	1'178	0.004	2.2	77.6
3B4gii	Manure management - Broilers	NMVOc	366	1'201	0.004	2.1	79.7
2H2	Food and beverages industry	NMVOc	1'468	1'417	0.004	2.0	81.7
1A3bii(fu)	Road transportation: light duty vehicles (fuel used)	NMVOc	4'762	112	0.003	1.9	83.7
2G	Other product use	NMVOc	22'432	6'322	0.003	1.9	85.5
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	SOx	3'530	669	0.012	23.3	23.3
1A4bi	Residential: stationary plants	SOx	10'355	212	0.009	17.3	40.5
1A2d	Stationary combustion in manufacturing industries and construction: pulp paper and print	SOx	3'238	1	0.004	8.6	49.1
2B5	Carbide production	SOx	625	197	0.004	8.0	57.1
1A3ai(i)	Civil aviation (domestic landing/take-off (LTO))	SOx	100	149	0.004	7.0	64.1
1A4ai	Commercial/institutional: stationary	SOx	3'870	74	0.003	6.7	70.8
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	SOx	1'821	9	0.002	4.4	75.2
1A1a	Public electricity and heat production	SOx	3'679	289	0.002	4.3	79.5
1A3bi(fu)	Road transportation: passenger cars (fuel used)	SOx	1'618	32	0.001	2.7	82.3
1A2e	Stationary combustion in manufacturing industries and construction: food processing beverages and tobacco	SOx	1'078	5	0.001	2.6	84.9
2C3	Aluminium production	SOx	696	0	0.001	1.9	86.7
3Da2a	Animal manure applied to soils	NH3	23'970	12'261	0.088	29.2	29.2
3B1b	Manure management - Non-dairy cattle	NH3	4'827	6'483	0.053	17.6	46.8
3B1a	Manure management - Dairy cattle	NH3	8'190	8'023	0.037	12.5	59.3
3B3	Manure management - Swine	NH3	6'717	3'380	0.026	8.5	67.8
3Da2b	Sewage sludge applied to soils	NH3	1'169	0	0.015	4.9	72.8
3Da3	Urine and dung deposited by grazing animals	NH3	759	1'334	0.014	4.6	77.4
3Da2c	Other organic fertilisers applied to soils (including compost)	NH3	766	1'174	0.011	3.6	81.0
3Da1	Inorganic N-fertilizers (includes also urea application)	NH3	4'258	2'562	0.009	2.9	84.0
3B4gii	Manure management - Broilers	NH3	305	717	0.009	2.9	86.9
1A4bi	Residential: stationary plants	PM2.5	14'536	1'725	0.055	31.7	31.7
1A3bvi(fu)	Road transportation: automobile tyre and brake wear (fuel used)	PM2.5	690	908	0.028	16.1	47.7
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	PM2.5	1'599	32	0.012	6.8	54.6
2G	Other product use	PM2.5	513	374	0.010	5.5	60.1
1A2gvii	Mobile combustion in manufacturing industries and construction	PM2.5	729	381	0.008	4.7	64.8
1A3c	Railways	PM2.5	173	248	0.008	4.5	69.2
2C1	Iron and steel production	PM2.5	818	7	0.006	3.7	72.9
2H2	Food and beverages industry	PM2.5	188	167	0.005	2.7	75.6
2H1	Pulp and paper industry	PM2.5	236	172	0.004	2.5	78.2
5C1a	Municipal waste incineration	PM2.5	465	215	0.004	2.4	80.5
1A4ai	Commercial/institutional: stationary	PM2.5	1'354	409	0.004	2.3	82.9
1A1a	Public electricity and heat production	PM2.5	782	69	0.004	2.2	85.1
1A4bi	Residential: stationary plants	PM10	15'326	1'817	0.110	29.8	29.8
1A3bvi(fu)	Road transportation: automobile tyre and brake wear (fuel used)	PM10	2'046	2'478	0.047	12.6	42.4
1A2gvii	Mobile combustion in manufacturing industries and construction	PM10	2'173	2'374	0.042	11.5	53.9
1A3c	Railways	PM10	970	1'615	0.034	9.2	63.2
3De	Cultivated crops	PM10	1'054	1'003	0.017	4.5	67.6
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	PM10	1'599	32	0.016	4.3	71.9
2C1	Iron and steel production	PM10	1'485	10	0.015	4.1	76.1
1A1a	Public electricity and heat production	PM10	1'045	71	0.009	2.4	78.5
2G	Other product use	PM10	588	497	0.007	2.0	80.5
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	PM10	833	59	0.007	1.9	82.4
2A5a	Quarrying and mining of minerals other than coal	PM10	302	318	0.006	1.5	83.9
3B4gii	Manure management - Broilers	PM10	68	222	0.005	1.5	85.4

Table A - 6 Switzerland's key categories according to approach 1 level assessment for the year 2024, sorted by decreasing contribution, for TSP, BC, CO, priority heavy metals, PCDD/PCDF, PAHs total, HCB and PCBs. Categories in grey are not key and are given for information only.

KCA APPROACH 1 LEVEL ASSESSMENT FOR 2024					
A	B	C	D	E	F
NFR code	Source category	Pollutant (unit)	Ex, t	Lx, t (%)	Cumulative Total (%)
3De	Cultivated crops	TSP (t)	10'033	36.0	36.0
1A2gvii	Mobile combustion in manufacturing industries and construction	TSP (t)	3'546	12.7	48.7
1A3bvi(fu)	Road transportation: automobile tyre and brake wear (fuel used)	TSP (t)	2'478	8.9	57.6
1A3c	Railways	TSP (t)	2'146	7.7	65.3
1A4bi	Residential: stationary plants	TSP (t)	1'902	6.8	72.1
2A5a	Quarrying and mining of minerals other than coal	TSP (t)	762	2.7	74.8
3B4gi	Manure management - Laying hens	TSP (t)	718	2.6	77.4
3B3	Manure management - Swine	TSP (t)	599	2.1	79.6
2G	Other product use	TSP (t)	497	1.8	81.3
2I	Wood processing	TSP (t)	470	1.7	83.0
1A4ai	Commercial/institutional: stationary	TSP (t)	452	1.6	84.6
3B4gii	Manure management - Broilers	TSP (t)	445	1.6	86.2
1A4bi	Residential: stationary plants	BC (t)	397	50.4	50.4
1A3bvi(fu)	Road transportation: automobile tyre and brake wear (fuel used)	BC (t)	91	11.6	62.0
1A4ai	Commercial/institutional: stationary	BC (t)	74	9.3	71.3
1A4cii	Agriculture/forestry/fishing: off-road vehicles and other machinery	BC (t)	70	8.9	80.2
1A3bii(fu)	Road transportation: passenger cars (fuel used)	BC (t)	37	4.7	84.9
1A3biii(fu)	Road transportation: light duty vehicles (fuel used)	BC (t)	22	2.8	87.6
1A3bi(fu)	Road transportation: passenger cars (fuel used)	CO (t)	43'322	33.0	33.0
1A4bi	Residential: stationary plants	CO (t)	23'141	17.6	50.6
1A4cii	Agriculture/forestry/fishing: off-road vehicles and other machinery	CO (t)	11'912	9.1	59.7
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	CO (t)	7'797	5.9	65.6
1A4aii	Commercial/institutional: mobile	CO (t)	6'434	4.9	70.5
1A4ai	Commercial/institutional: stationary	CO (t)	6'024	4.6	75.1
1A3dii	National navigation (shipping)	CO (t)	5'017	3.8	78.9
1A2gvii	Mobile combustion in manufacturing industries and construction	CO (t)	4'032	3.1	82.0
1A4bii	Residential: household and gardening (mobile)	CO (t)	3'878	3.0	84.9
1A3biv(fu)	Road transportation: mopeds and motorcycles (fuel used)	CO (t)	3'656	2.8	87.7
1A1a	Public electricity and heat production	Pb (kg)	1'873	24.2	24.2
6A	Other sources	Pb (kg)	1'587	20.5	44.6
5C1a	Municipal waste incineration	Pb (kg)	1'494	19.3	63.9
1A3aii(i)	Civil aviation (domestic cruise)	Pb (kg)	655	8.4	72.4
1A2gviii	Stationary combustion in manufacturing industries and construction: other	Pb (kg)	519	6.7	79.1
2G	Other product use	Pb (kg)	386	5.0	84.0
1A4bi	Residential: stationary plants	Pb (kg)	362	4.7	88.7
1A1a	Public electricity and heat production	Cd (kg)	159	39.3	39.3
1A3bvi(fu)	Road transportation: automobile tyre and brake wear (fuel used)	Cd (kg)	87	21.5	60.8
2G	Other product use	Cd (kg)	28	6.9	67.7
1A4bi	Residential: stationary plants	Cd (kg)	25	6.1	73.8
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	Cd (kg)	24	5.8	79.6
1A2gvii	Mobile combustion in manufacturing industries and construction	Cd (kg)	19	4.8	84.4
1A2gviii	Stationary combustion in manufacturing industries and construction: other	Cd (kg)	16	3.9	88.3
1A1a	Public electricity and heat production	Hg (kg)	309	54.0	54.0
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	Hg (kg)	53	9.3	63.3
1A4bi	Residential: stationary plants	Hg (kg)	48	8.5	71.8
2C1	Iron and steel production	Hg (kg)	39	6.8	78.5
1A2gviii	Stationary combustion in manufacturing industries and construction: other	Hg (kg)	26	4.6	83.1
1A4ai	Commercial/institutional: stationary	Hg (kg)	25	4.4	87.5
1A4bi	Residential: stationary plants	PCDD/PCDF (mg I-TEQ)	4'071	34.2	34.2
5C1a	Municipal waste incineration	PCDD/PCDF (mg I-TEQ)	2'390	20.1	54.3
1A1a	Public electricity and heat production	PCDD/PCDF (mg I-TEQ)	1'169	9.8	64.1
1A4ai	Commercial/institutional: stationary	PCDD/PCDF (mg I-TEQ)	1'081	9.1	73.2
6A	Other sources	PCDD/PCDF (mg I-TEQ)	948	8.0	81.1
1A2gviii	Stationary combustion in manufacturing industries and construction: other	PCDD/PCDF (mg I-TEQ)	603	5.1	86.2
1A4bi	Residential: stationary plants	PAHs total (kg)	1'282	57.1	57.1
1A4ai	Commercial/institutional: stationary	PAHs total (kg)	248	11.0	68.2
5C2	Open burning of waste	PAHs total (kg)	189	8.4	76.6
1A3bi(fu)	Road transportation: passenger cars (fuel used)	PAHs total (kg)	181	8.1	84.7
6A	Other sources	PAHs total (kg)	111	4.9	89.6
1A1a	Public electricity and heat production	HCB (g)	193	55.8	55.8
1A4bi	Residential: stationary plants	HCB (g)	86	24.8	80.5
1A4ai	Commercial/institutional: stationary	HCB (g)	34	9.7	90.2
2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)	PCB (g)	250'151	89.2	89.2

Table A - 7 Switzerland's key categories according to approach 1 level assessment for the year 1990, sorted by decreasing contribution, for TSP, BC, CO, priority heavy metals, PCDD/PCDF, PAHs total, HCB and PCBs. Categories in grey are not key and are given for information only.

KCA APPROACH 1 LEVEL ASSESSMENT FOR 1990					
A	B	C	D	E	F
NFR code	Source category	Pollutant (unit)	Ex, 0	Lx, 0 (%)	Cumulative Total (%)
1A4bi	Residential: stationary plants	TSP (t)	16'162	28.8	28.8
3De	Cultivated crops	TSP (t)	10'536	18.8	47.6
2I	Wood processing	TSP (t)	4'322	7.7	55.3
1A2gvii	Mobile combustion in manufacturing industries and construction	TSP (t)	3'023	5.4	60.7
2C1	Iron and steel production	TSP (t)	2'686	4.8	65.4
1A3bvii(fu)	Road transportation: automobile tyre and brake wear (fuel used)	TSP (t)	2'046	3.6	69.1
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	TSP (t)	1'599	2.8	71.9
1A4ai	Commercial/institutional: stationary	TSP (t)	1'501	2.7	74.6
1A3c	Railways	TSP (t)	1'280	2.3	76.9
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	TSP (t)	1'227	2.2	79.1
1A1a	Public electricity and heat production	TSP (t)	1'059	1.9	81.0
1A2gviii	Stationary combustion in manufacturing industries and construction: other	TSP (t)	972	1.7	82.7
3B3	Manure management - Swine	TSP (t)	915	1.6	84.3
1A4ci	Agriculture/forestry/fishing: stationary	TSP (t)	724	1.3	85.6
1A4bi	Residential: stationary plants	BC (t)	3'220	56.0	56.0
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	BC (t)	800	13.9	69.9
1A4ai	Commercial/institutional: stationary	BC (t)	301	5.2	75.2
1A2gvii	Mobile combustion in manufacturing industries and construction	BC (t)	256	4.4	79.6
1A3bi(fu)	Road transportation: passenger cars (fuel used)	BC (t)	248	4.3	83.9
1A4cii	Agriculture/forestry/fishing: off-road vehicles and other machinery	BC (t)	232	4.0	88.0
1A3bi(fu)	Road transportation: passenger cars (fuel used)	CO (t)	425'754	56.4	56.4
1A4bi	Residential: stationary plants	CO (t)	111'881	14.8	71.3
1A3biii(fu)	Road transportation: light duty vehicles (fuel used)	CO (t)	70'405	9.3	80.6
1A4cii	Agriculture/forestry/fishing: off-road vehicles and other machinery	CO (t)	28'368	3.8	84.3
1A3biv(fu)	Road transportation: mopeds and motorcycles (fuel used)	CO (t)	24'451	3.2	87.6
1A3bi(fu)	Road transportation: passenger cars (fuel used)	Pb (kg)	208'539	59.3	59.3
2C1	Iron and steel production	Pb (kg)	59'858	17.0	76.3
1A1a	Public electricity and heat production	Pb (kg)	29'818	8.5	84.8
1A3biii(fu)	Road transportation: light duty vehicles (fuel used)	Pb (kg)	12'036	3.4	88.2
1A1a	Public electricity and heat production	Cd (kg)	1'754	55.1	55.1
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	Cd (kg)	665	20.9	76.0
2C1	Iron and steel production	Cd (kg)	443	13.9	90.0
1A1a	Public electricity and heat production	Hg (kg)	3'915	62.1	62.1
2C1	Iron and steel production	Hg (kg)	1'108	17.6	79.7
2B10a	Chemical industry: other	Hg (kg)	384	6.1	85.7
1A1a	Public electricity and heat production	PCDD/PCDF (mg I-TEQ)	130'484	67.8	67.8
1A4bi	Residential: stationary plants	PCDD/PCDF (mg I-TEQ)	17'674	9.2	77.0
2C1	Iron and steel production	PCDD/PCDF (mg I-TEQ)	12'419	6.5	83.5
5C1biii	Clinical waste incineration	PCDD/PCDF (mg I-TEQ)	6'900	3.6	87.0
1A4bi	Residential: stationary plants	PAHs total (kg)	5'698	70.9	70.9
2C3	Aluminium production	PAHs total (kg)	940	11.7	82.5
1A4ai	Commercial/institutional: stationary	PAHs total (kg)	516	6.4	89.0
1A2b	Stationary combustion in manufacturing industries and construction: non-ferrous metals	HCB (g)	172'000	99.7	99.7
2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)	PCB (g)	1'525'788	65.4	65.4
6A	Other sources	PCB (g)	281'955	12.1	77.5
5E	Other waste	PCB (g)	215'511	9.2	86.8

Table A - 8 Switzerland's key categories according to approach 1 trend assessment for 1990-2024, sorted by decreasing contribution, for TSP, BC, CO, priority heavy metals, PCDD/PCDF, PAHs total, HCB and PCBs. Categories in orange have increased emissions in 2024 compared to 1990. Categories in grey are not key and are given for information only.

KCA APPROACH 1 TREND ASSESSMENT 1990 - 2024							
A	B	C	D	E	F	G	H
NFR code	Source category	Pollutant (unit)	Ex, 0	Ex, t	Trend Assessment	Contribution to trend assess. (%)	Cumulative Total (%)
1A4bi	Residential: stationary plants	TSP (t)	16'162	1'902	0.109	24.5	24.5
3De	Cultivated crops	TSP (t)	10'536	10'033	0.085	19.2	43.7
1A2gvii	Mobile combustion in manufacturing industries and construction	TSP (t)	3'023	3'546	0.036	8.2	51.9
2I	Wood processing	TSP (t)	4'322	470	0.030	6.7	58.6
1A3c	Railways	TSP (t)	1'280	2'146	0.027	6.0	64.6
1A3bvi(fu)	Road transportation: automobile tyre and brake wear (fuel used)	TSP (t)	2'046	2'478	0.026	5.8	70.4
2C1	Iron and steel production	TSP (t)	2'686	12	0.024	5.3	75.7
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	TSP (t)	1'599	32	0.014	3.1	78.8
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	TSP (t)	1'227	65	0.010	2.2	81.0
1A1a	Public electricity and heat production	TSP (t)	1'059	72	0.008	1.8	82.8
2A5a	Quarrying and mining of minerals other than coal	TSP (t)	651	762	0.008	1.8	84.5
3B4gi	Manure management - Laying hens	TSP (t)	586	718	0.008	1.7	86.2
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	BC (t)	800	10	0.017	26.7	26.7
1A3bvi(fu)	Road transportation: automobile tyre and brake wear (fuel used)	BC (t)	69	91	0.014	21.9	48.6
1A4bi	Residential: stationary plants	BC (t)	3'220	397	0.008	11.9	60.5
1A4cii	Agriculture/forestry/fishing: off-road vehicles and other machinery	BC (t)	232	70	0.007	10.2	70.7
1A4ai	Commercial/institutional: stationary	BC (t)	301	74	0.006	8.7	79.4
1A2gvii	Mobile combustion in manufacturing industries and construction	BC (t)	256	13	0.004	5.8	85.2
1A3bi(fu)	Road transportation: passenger cars (fuel used)	CO (t)	425'754	43'322	0.041	36.3	36.3
1A3biii(fu)	Road transportation: light duty vehicles (fuel used)	CO (t)	70'405	2'687	0.013	11.3	47.5
1A4cii	Agriculture/forestry/fishing: off-road vehicles and other machinery	CO (t)	28'368	11'912	0.009	8.2	55.7
1A4aii	Commercial/institutional: mobile	CO (t)	4'117	6'434	0.008	6.7	62.5
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	CO (t)	13'126	7'797	0.007	6.5	68.9
1A4ai	Commercial/institutional: stationary	CO (t)	11'356	6'024	0.005	4.8	73.7
1A4bi	Residential: stationary plants	CO (t)	111'881	23'141	0.005	4.3	78.0
1A4bii	Residential: household and gardening (mobile)	CO (t)	3'271	3'878	0.004	3.9	81.9
1A2gvii	Mobile combustion in manufacturing industries and construction	CO (t)	7'253	4'032	0.004	3.3	85.2
1A3bi(fu)	Road transportation: passenger cars (fuel used)	Pb (kg)	208'539	97	0.013	36.5	36.5
5C1a	Municipal waste incineration	Pb (kg)	3'230	1'494	0.004	11.5	48.1
6A	Other sources	Pb (kg)	7'614	1'587	0.004	11.5	59.6
1A1a	Public electricity and heat production	Pb (kg)	29'818	1'873	0.003	9.9	69.5
2C1	Iron and steel production	Pb (kg)	59'858	199	0.003	9.1	78.6
1A3aii(i)	Civil aviation (domestic cruise)	Pb (kg)	2'027	655	0.002	5.0	83.5
1A2gvii	Stationary combustion in manufacturing industries and construction: other	Pb (kg)	975	519	0.001	4.0	87.6
1A3bvi(fu)	Road transportation: automobile tyre and brake wear (fuel used)	Cd (kg)	65	87	0.025	21.4	21.4
1A1a	Public electricity and heat production	Cd (kg)	1'754	159	0.020	17.4	38.8
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	Cd (kg)	665	24	0.019	16.6	55.3
2C1	Iron and steel production	Cd (kg)	443	4	0.017	14.2	69.6
2G	Other product use	Cd (kg)	30	28	0.008	6.6	76.1
1A2gvii	Mobile combustion in manufacturing industries and construction	Cd (kg)	12	19	0.006	4.8	80.9
1A4bi	Residential: stationary plants	Cd (kg)	62	25	0.005	4.5	85.4
2C1	Iron and steel production	Hg (kg)	1'108	39	0.010	18.7	18.7
1A1a	Public electricity and heat production	Hg (kg)	3'915	309	0.007	14.0	32.6
1A4bi	Residential: stationary plants	Hg (kg)	72	48	0.007	12.7	45.3
2B10a	Chemical industry: other	Hg (kg)	384	0	0.006	10.5	55.8
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	Hg (kg)	226	53	0.005	9.9	65.7
1A2gvii	Stationary combustion in manufacturing industries and construction: other	Hg (kg)	13	26	0.004	7.6	73.3
1A4ai	Commercial/institutional: stationary	Hg (kg)	14	25	0.004	7.2	80.5
5C1biii	Clinical waste incineration	Hg (kg)	240	0	0.003	6.6	87.1
1A1a	Public electricity and heat production	PCDD/PCDF (mg I-TEQ)	130'484	1'169	0.036	41.0	41.0
1A4bi	Residential: stationary plants	PCDD/PCDF (mg I-TEQ)	17'674	4'071	0.015	17.7	58.6
5C1a	Municipal waste incineration	PCDD/PCDF (mg I-TEQ)	5'168	2'390	0.011	12.3	70.9
1A4ai	Commercial/institutional: stationary	PCDD/PCDF (mg I-TEQ)	2'112	1'081	0.005	5.6	76.5
6A	Other sources	PCDD/PCDF (mg I-TEQ)	1'634	948	0.004	5.0	81.6
2C1	Iron and steel production	PCDD/PCDF (mg I-TEQ)	12'419	132	0.003	3.8	85.3
1A4bi	Residential: stationary plants	PAHs total (kg)	5'698	1'282	0.038	26.4	26.4
2C3	Aluminium production	PAHs total (kg)	940	0	0.033	22.4	48.8
1A3bi(fu)	Road transportation: passenger cars (fuel used)	PAHs total (kg)	103	181	0.019	13.0	61.8
5C2	Open burning of waste	PAHs total (kg)	282	189	0.014	9.4	71.3
1A4ai	Commercial/institutional: stationary	PAHs total (kg)	516	248	0.013	8.9	80.1
6A	Other sources	PAHs total (kg)	65	111	0.012	7.9	88.1
1A2b	Stationary combustion in manufacturing industries and construction: non-ferrous metals	HCB (g)	172'000	0	0.002	50.0	50.0
1A1a	Public electricity and heat production	HCB (g)	114	193	0.001	27.9	77.9
1A4bi	Residential: stationary plants	HCB (g)	322	86	0.000	12.3	90.3
2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)	PCB (g)	1'525'788	250'151	0.029	49.5	49.5
5E	Other waste	PCB (g)	215'511	1'571	0.010	18.0	67.5
1A1a	Public electricity and heat production	PCB (g)	164'493	57	0.008	14.6	82.1
5C1bii	Hazardous waste incineration	PCB (g)	111'813	0	0.006	10.0	92.1

A1.3 Detailed results of approach 2 assessment

The following tables report the detailed results for the key category analysis, approach 2, level and trend assessments, for the reporting year 2024 and the base year 1990. Columns labelled A to F for the level assessments correspond exactly to columns A to F from Table 3-1 from the EMEP/EEA guidebook (EMEP/EEA 2023, part A, chp. 2, “Methodological choice and Key category analysis”. For the table reporting the trend assessment, columns labelled A to H correspond exactly to columns A to H from Table 3-2 from the same guidelines. Equations referenced hereafter are also from the same guidelines.

Explanations of headers for tables in this Annex are:

- $E_{x,t}$: emission estimate for the reporting year.
- $E_{x,0}$: emission estimate for the base year.
- $L_{x,t}$: level assessment for the reporting year (EMEP/EAA guidebook part A, chp. 2, equ. 3 for approach 2).
- $L_{x,0}$: level assessment for the base year (EMEP/EAA guidebook part A, chp. 2, equ. 3 for approach 2).
- Trend assessment: computed according to the EMEP/EAA guidebook part A, chp. 2, equ. 4 for approach 2.

Table A - 9 Switzerland's key categories according to approach 2 level assessment for the year 2024, sorted by decreasing contribution, for the main pollutants, PM2.5 and PM10. Categories in grey are not key and are given for information only.

KCA APPROACH 2, UNCERTAINTY APPROACH 2, LEVEL ASSESSMENT FOR 2024					
A	B	C	D	E	F
NFR code	Source category	Pollutant	Ex, t (t)	Lx, t (%)	Cumulative Total (%)
1A3bi(fu)	Road transportation: passenger cars (fuel used)	NOx	12'539	37.9	37.9
1A3bii(fu)	Road transportation: light duty vehicles (fuel used)	NOx	3'023	7.7	45.6
3Da2a	Animal manure applied to soils	NOx	1'503	6.0	51.6
3Da1	Inorganic N-fertilizers (includes also urea application)	NOx	722	5.7	57.3
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	NOx	3'370	4.8	62.1
1A1a	Public electricity and heat production	NOx	2'615	4.4	66.6
1A4bi	Residential: stationary plants	NOx	3'494	3.7	70.3
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	NOx	2'564	3.5	73.7
1A4ai	Commercial/institutional: stationary	NOx	2'677	3.4	77.2
1A3ai(i)	Civil aviation (domestic landing/take-off (LTO))	NOx	2'144	3.4	80.5
3Da3	Urine and dung deposited by grazing animals	NOx	418	3.3	83.8
1A2gviii	Stationary combustion in manufacturing industries and construction: other	NOx	1'497	2.0	85.9
2G	Other product use	NMVOG	6'322	17.9	17.9
3B1b	Manure management - Non-dairy cattle	NMVOG	7'626	9.9	27.8
3B1a	Manure management - Dairy cattle	NMVOG	6'524	7.3	35.1
2D3d	Coating applications	NMVOG	8'289	6.9	42.0
2D3a	Domestic solvent use including fungicides	NMVOG	6'593	6.1	48.1
2D3g	Chemical products	NMVOG	3'169	5.6	53.7
2D3i	Other solvent use	NMVOG	1'933	5.1	58.8
2D3b	Road paving with asphalt	NMVOG	2'662	4.5	63.3
3B4gii	Manure management - Broilers	NMVOG	1'201	3.4	66.7
1A3bi(fu)	Road transportation: passenger cars (fuel used)	NMVOG	3'506	3.4	70.1
2D3h	Printing	NMVOG	3'587	3.0	73.1
1A4bi	Residential: stationary plants	NMVOG	2'218	2.8	75.9
2H2	Food and beverages industry	NMVOG	1'417	2.4	78.3
3B3	Manure management - Swine	NMVOG	746	2.1	80.4
1A3biv(fu)	Road transportation: mopeds and motorcycles (fuel used)	NMVOG	411	1.9	82.2
2D3e	Degreasing	NMVOG	1'566	1.8	84.1
3B4gi	Manure management - Laying hens	NMVOG	623	1.8	85.8
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	SOx	669	30.4	30.4
1A1a	Public electricity and heat production	SOx	289	16.6	47.1
2B5	Carbide production	SOx	197	9.4	56.5
1A2gviii	Stationary combustion in manufacturing industries and construction: other	SOx	168	7.6	64.1
1A4bi	Residential: stationary plants	SOx	212	5.4	69.5
2B10a	Chemical industry: other	SOx	44	4.2	73.7
1A3ai(i)	Civil aviation (domestic landing/take-off (LTO))	SOx	149	3.6	77.3
1A4ci	Agriculture/forestry/fishing: stationary	SOx	51	3.3	80.7
2C1	Iron and steel production	SOx	14	3.0	83.7
1A1b	Petroleum refining	SOx	47	2.3	85.9
3Da2a	Animal manure applied to soils	NH3	12'261	17.6	17.6
3B1a	Manure management - Dairy cattle	NH3	8'023	15.6	33.3
3B1b	Manure management - Non-dairy cattle	NH3	6'483	11.8	45.0
3B3	Manure management - Swine	NH3	3'380	9.0	54.0
3Da1	Inorganic N-fertilizers (includes also urea application)	NH3	2'562	8.4	62.4
6A	Other sources	NH3	933	6.5	68.9
3Da3	Urine and dung deposited by grazing animals	NH3	1'334	5.4	74.3
3Da2c	Other organic fertilisers applied to soils (including compost)	NH3	1'174	4.2	78.5
3B4gii	Manure management - Broilers	NH3	717	4.1	82.6
3B4gi	Manure management - Laying hens	NH3	601	3.2	85.8
1A4bi	Residential: stationary plants	PM2.5	1'725	25.8	25.8
2H2	Food and beverages industry	PM2.5	167	9.0	34.8
1A3bvi(fu)	Road transportation: automobile tyre and brake wear (fuel used)	PM2.5	908	8.9	43.7
2G	Other product use	PM2.5	374	6.9	50.6
1A4ai	Commercial/institutional: stationary	PM2.5	409	6.3	56.9
2H1	Pulp and paper industry	PM2.5	172	5.2	62.1
2A5a	Quarrying and mining of minerals other than coal	PM2.5	89	4.8	66.9
2A1	Cement production	PM2.5	137	4.1	71.0
1A2gvii	Mobile combustion in manufacturing industries and construction	PM2.5	381	3.7	74.7
2I	Wood processing	PM2.5	47	2.5	77.2
5C1a	Municipal waste incineration	PM2.5	215	2.5	79.7
1A3c	Railways	PM2.5	248	2.4	82.1
1A2gviii	Stationary combustion in manufacturing industries and construction: other	PM2.5	162	2.1	84.2
1A4cii	Agriculture/forestry/fishing: off-road vehicles and other machinery	PM2.5	116	1.8	86.0
3De	Cultivated crops	PM10	1'003	12.2	12.2
1A4bi	Residential: stationary plants	PM10	1'817	11.1	23.3
1A3bvi(fu)	Road transportation: automobile tyre and brake wear (fuel used)	PM10	2'478	9.9	33.3
1A2gvii	Mobile combustion in manufacturing industries and construction	PM10	2'374	9.6	42.8
2A5a	Quarrying and mining of minerals other than coal	PM10	318	7.0	49.8
2H2	Food and beverages industry	PM10	310	6.8	56.7
1A3c	Railways	PM10	1'615	6.5	63.1
2I	Wood processing	PM10	188	4.1	67.3
2G	Other product use	PM10	497	3.8	71.0
3B4gii	Manure management - Broilers	PM10	222	3.6	74.6
1A4ai	Commercial/institutional: stationary	PM10	435	2.7	77.4
2A1	Cement production	PM10	213	2.6	80.0
3B4gi	Manure management - Laying hens	PM10	151	2.5	82.4
3B3	Manure management - Swine	PM10	138	2.3	84.7
2H1	Pulp and paper industry	PM10	177	2.2	86.8

Table A - 10 Switzerland's key categories according to approach 2 level assessment for the year 1990, sorted by decreasing contribution, for the main pollutants, PM2.5 and PM10. Categories in grey are not key and are given for information only.

KCA APPROACH 2, UNCERTAINTY APPROACH 2, LEVEL ASSESSMENT FOR 1990					
A	B	C	D	E	F
NFR code	Source category	Pollutant	Ex, 0 (t)	Lx, 0 (%)	Cumulative Total (%)
1A3bi(fu)	Road transportation: passenger cars (fuel used)	NOx	43'812	45.3	45.3
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	NOx	29'839	14.5	59.8
1A3bii(fu)	Road transportation: light duty vehicles (fuel used)	NOx	6'095	5.3	65.1
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	NOx	10'535	4.9	69.9
1A4bi	Residential: stationary plants	NOx	11'636	4.2	74.2
1A1a	Public electricity and heat production	NOx	6'279	3.6	77.8
3Da1	Inorganic N-fertilizers (includes also urea application)	NOx	1'205	3.3	81.1
3Da2a	Animal manure applied to soils	NOx	2'099	2.9	83.9
1A4ai	Commercial/institutional: stationary	NOx	5'139	2.2	86.2
2G	Other product use	NM VOC	22'432	16.6	16.6
1A3bi(fu)	Road transportation: passenger cars (fuel used)	NM VOC	56'149	14.1	30.7
2D3g	Chemical products	NM VOC	27'504	12.7	43.4
2D3d	Coating applications	NM VOC	40'731	8.8	52.2
1A3biv(fu)	Road transportation: mopeds and motorcycles (fuel used)	NM VOC	5'429	6.4	58.6
2D3h	Printing	NM VOC	20'354	4.4	63.0
1A3bv(fu)	Road transportation: gasoline evaporation (fuel used)	NM VOC	19'931	3.8	66.8
2D3i	Other solvent use	NM VOC	5'470	3.8	70.6
1B2av	Distribution of oil products	NM VOC	19'127	3.6	74.3
2D3e	Degreasing	NM VOC	11'731	3.6	77.9
1A4bi	Residential: stationary plants	NM VOC	10'056	3.3	81.2
2D3b	Road paving with asphalt	NM VOC	4'895	2.2	83.3
2D3a	Domestic solvent use including fungicides	NM VOC	8'867	2.1	85.5
1A4bi	Residential: stationary plants	SOx	10'355	15.7	15.7
2C3	Aluminium production	SOx	696	15.0	30.7
1A1a	Public electricity and heat production	SOx	3'679	12.6	43.4
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	SOx	3'530	9.6	53.0
1A2gviii	Stationary combustion in manufacturing industries and construction: other	SOx	3'534	9.6	62.5
1A2d	Stationary combustion in manufacturing industries and construction: pulp paper and print	SOx	3'238	6.5	69.1
1A4ai	Commercial/institutional: stationary	SOx	3'870	5.6	74.6
1B2ai	Fugitive emissions oil: refining / storage	SOx	419	3.3	77.9
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	SOx	1'821	2.6	80.6
1A3bi(fu)	Road transportation: passenger cars (fuel used)	SOx	1'618	2.3	82.9
1A2c	Stationary combustion in manufacturing industries and construction: chemicals	SOx	1'187	1.9	84.8
2C1	Iron and steel production	SOx	144	1.9	86.6
3Da2a	Animal manure applied to soils	NH3	23'970	26.4	26.4
3B3	Manure management - Swine	NH3	6'717	13.7	40.1
3B1a	Manure management - Dairy cattle	NH3	8'190	12.2	52.3
3Da1	Inorganic N-fertilizers (includes also urea application)	NH3	4'258	10.7	63.1
3B1b	Manure management - Non-dairy cattle	NH3	4'827	6.7	69.8
6A	Other sources	NH3	846	4.5	74.3
3B4gi	Manure management - Laying hens	NH3	979	4.0	78.3
1A3bi(fu)	Road transportation: passenger cars (fuel used)	NH3	1'323	3.3	81.6
3Da2b	Sewage sludge applied to soils	NH3	1'169	3.0	84.6
3Da3	Urine and dung deposited by grazing animals	NH3	759	2.4	87.0
1A4bi	Residential: stationary plants	PM2.5	14'536	53.8	53.8
1A4ai	Commercial/institutional: stationary	PM2.5	1'354	5.1	58.9
2C1	Iron and steel production	PM2.5	818	4.4	63.3
2I	Wood processing	PM2.5	216	2.9	66.2
1A2gviii	Stationary combustion in manufacturing industries and construction: other	PM2.5	873	2.8	68.9
1A1a	Public electricity and heat production	PM2.5	782	2.7	71.6
2H2	Food and beverages industry	PM2.5	188	2.5	74.1
2G	Other product use	PM2.5	513	2.4	76.5
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	PM2.5	1'599	2.1	78.6
2A1	Cement production	PM2.5	240	1.8	80.4
1A2gvii	Mobile combustion in manufacturing industries and construction	PM2.5	729	1.8	82.1
2H1	Pulp and paper industry	PM2.5	236	1.8	83.9
1A4cii	Agriculture/forestry/fishing: off-road vehicles and other machinery	PM2.5	435	1.7	85.6
1A4bi	Residential: stationary plants	PM10	15'326	38.4	38.4
2I	Wood processing	PM10	864	7.8	46.2
2C1	Iron and steel production	PM10	1'485	5.4	51.5
3De	Cultivated crops	PM10	1'054	5.3	56.8
1A4ai	Commercial/institutional: stationary	PM10	1'428	3.7	60.5
1A2gvii	Mobile combustion in manufacturing industries and construction	PM10	2'173	3.6	64.0
1A3bvi(fu)	Road transportation: automobile tyre and brake wear (fuel used)	PM10	2'046	3.4	67.4
2H2	Food and beverages industry	PM10	310	2.8	70.2
2A5a	Quarrying and mining of minerals other than coal	PM10	302	2.7	72.9
1A1a	Public electricity and heat production	PM10	1'045	2.5	75.4
1A2gviii	Stationary combustion in manufacturing industries and construction: other	PM10	913	2.0	77.4
2A1	Cement production	PM10	374	1.9	79.2
2G	Other product use	PM10	588	1.8	81.1
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	PM10	833	1.8	82.9
1A3c	Railways	PM10	970	1.6	84.5
3B3	Manure management - Swine	PM10	213	1.4	85.9

Table A - 11 Switzerland's key categories according to approach 2 trend assessment for 1990-2024, sorted by decreasing contribution, for the main pollutants, PM2.5 and PM10. Categories in orange have increased emissions in 2024 compared to 1990. Categories in grey are not key and are given for information only.

KCA APPROACH 2, UNCERTAINTY APPROACH 2, TREND ASSESSMENT 1990 - 2024							
A	B	C	D	E	F	G	H
NFR code	Source category	Pollutant	Ex, 0 (t)	Ex, t (t)	Trend Assessment	Contribution to trend assess. (%)	Cumulative Total (%)
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	NOx	29'839	3'370	5.861	21.9	21.9
3Da2a	Animal manure applied to soils	NOx	2'099	1'503	2.354	8.8	30.6
1A3bi(fu)	Road transportation: passenger cars (fuel used)	NOx	43'812	12'539	2.346	8.7	39.4
1A3bii(fu)	Road transportation: light duty vehicles (fuel used)	NOx	6'095	3'023	1.993	7.4	46.8
1A3ai(i)	Civil aviation (domestic landing/take-off (LTO))	NOx	1'214	2'144	1.943	7.2	54.1
3Da1	Inorganic N-fertilizers (includes also urea application)	NOx	1'205	722	1.902	7.1	61.1
3Da3	Urine and dung deposited by grazing animals	NOx	243	418	1.883	7.0	68.2
1A4ai	Commercial/institutional: stationary	NOx	5'139	2'677	0.953	3.6	71.7
1A1a	Public electricity and heat production	NOx	6'279	2'615	0.777	2.9	74.6
1A2gviii	Stationary combustion in manufacturing industries and construction: other	NOx	2'182	1'497	0.766	2.9	77.5
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	NOx	10'535	2'564	0.675	2.5	80.0
3Da2c	Other organic fertilisers applied to soils (including compost)	NOx	59	137	0.670	2.5	82.5
1B2c	Venting and flaring (oil gas combined oil and gas)	NOx	211	1	0.543	2.0	84.5
3B1b	Manure management - Non-dairy cattle	NOx	344	286	0.494	1.8	86.4
1A3bi(fu)	Road transportation: passenger cars (fuel used)	NMVOG	56'149	3'506	9.791	14.0	14.0
3B1b	Manure management - Non-dairy cattle	NMVOG	5'122	7'626	8.533	12.2	26.2
2D3g	Chemical products	NMVOG	27'504	3'169	6.154	8.8	35.0
3B1a	Manure management - Dairy cattle	NMVOG	6'413	6'524	5.733	8.2	43.2
2D3a	Domestic solvent use including fungicides	NMVOG	8'867	6'593	4.258	6.1	49.3
1A3biv(fu)	Road transportation: mopeds and motorcycles (fuel used)	NMVOG	5'429	411	4.107	5.9	55.1
3B4gii	Manure management - Broilers	NMVOG	366	1'201	3.224	4.6	59.7
2G	Other product use	NMVOG	22'432	6'322	2.832	4.0	63.8
2D3b	Road paving with asphalt	NMVOG	4'895	2'662	2.621	3.7	67.5
1B2av	Distribution of oil products	NMVOG	19'127	1'940	1.963	2.8	70.3
1A3bv(fu)	Road transportation: gasoline evaporation (fuel used)	NMVOG	19'931	2'225	1.915	2.7	73.1
2H2	Food and beverages industry	NMVOG	1'468	1'417	1.871	2.7	75.8
2D3i	Other solvent use	NMVOG	5'470	1'933	1.710	2.4	78.2
2D3e	Degreasing	NMVOG	11'731	1'566	1.491	2.1	80.3
3B4gi	Manure management - Laying hens	NMVOG	509	623	1.449	2.1	82.4
3B3	Manure management - Swine	NMVOG	1'126	746	1.382	2.0	84.4
2D3d	Coating applications	NMVOG	40'731	8'289	1.210	1.7	86.1
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	SOx	3'530	669	4.444	27.0	27.0
1A4bi	Residential: stationary plants	SOx	10'355	212	1.841	11.2	38.2
2B5	Carbide production	SOx	625	197	1.597	9.7	47.9
1A2d	Stationary combustion in manufacturing industries and construction: pulp paper and print	SOx	3'238	1	1.213	7.4	55.3
1A1a	Public electricity and heat production	SOx	3'679	289	1.038	6.3	61.6
1A3ai(i)	Civil aviation (domestic landing/take-off (LTO))	SOx	100	149	0.708	4.3	65.9
2B10a	Chemical industry: other	SOx	168	44	0.687	4.2	70.1
1A4ai	Commercial/institutional: stationary	SOx	3'870	74	0.679	4.1	74.2
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	SOx	1'821	9	0.445	2.7	76.9
1A4ci	Agriculture/forestry/fishing: stationary	SOx	336	51	0.437	2.7	79.6
1A2e	Stationary combustion in manufacturing industries and construction: food processing beverages and tobacco	SOx	1'078	5	0.319	1.9	81.5
5C1a	Municipal waste incineration	SOx	24	11	0.307	1.9	83.4
1B2c	Venting and flaring (oil gas combined oil and gas)	SOx	301	1	0.280	1.7	85.1
3Da2a	Animal manure applied to soils	NH3	23'970	12'261	6.421	17.6	17.6
3B1b	Manure management - Non-dairy cattle	NH3	4'827	6'483	4.886	13.4	30.9
3B1a	Manure management - Dairy cattle	NH3	8'190	8'023	3.710	10.1	41.1
3B3	Manure management - Swine	NH3	6'717	3'380	3.452	9.4	50.5
3Da3	Urine and dung deposited by grazing animals	NH3	759	1'334	2.880	7.9	58.4
3B4gii	Manure management - Broilers	NH3	305	717	2.521	6.9	65.3
6A	Other sources	NH3	846	933	2.011	5.5	70.8
3Da2c	Other organic fertilisers applied to soils (including compost)	NH3	766	1'174	1.976	5.4	76.2
3Da1	Inorganic N-fertilizers (includes also urea application)	NH3	4'258	2'562	1.480	4.0	80.3
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	NH3	10	252	1.120	3.1	83.3
5B1	Biological treatment of waste - Composting	NH3	175	306	1.083	3.0	86.3
1A4bi	Residential: stationary plants	PM2.5	14'536	1'725	24.117	29.9	29.9
1A3bvi(fu)	Road transportation: automobile tyre and brake wear (fuel used)	PM2.5	690	908	8.032	10.0	39.8
2H2	Food and beverages industry	PM2.5	188	167	7.282	9.0	48.9
2G	Other product use	PM2.5	513	374	5.235	6.5	55.4
2C1	Iron and steel production	PM2.5	818	7	4.053	5.0	60.4
2H1	Pulp and paper industry	PM2.5	236	172	3.901	4.8	65.2
2A5a	Quarrying and mining of minerals other than coal	PM2.5	102	89	3.869	4.8	70.0
2A1	Cement production	PM2.5	240	137	2.700	3.3	73.4
1A2gvii	Mobile combustion in manufacturing industries and construction	PM2.5	729	381	2.344	2.9	76.3
1A3c	Railways	PM2.5	173	248	2.231	2.8	79.0
1A3biii(fu)	Road transportation: heavy duty vehicles and buses (fuel used)	PM2.5	1'599	32	1.847	2.3	81.3
1A4ai	Commercial/institutional: stationary	PM2.5	1'354	409	1.824	2.3	83.6
1A1a	Public electricity and heat production	PM2.5	782	69	1.579	2.0	85.5
1A4bi	Residential: stationary plants	PM10	15'326	1'817	22.695	27.6	27.6
3De	Cultivated crops	PM10	1'054	1'003	6.795	8.3	35.9
1A3bvi(fu)	Road transportation: automobile tyre and brake wear (fuel used)	PM10	2'046	2'478	6.303	7.7	43.5
1A2gvii	Mobile combustion in manufacturing industries and construction	PM10	2'173	2'374	5.755	7.0	50.5
1A3c	Railways	PM10	970	1'615	4.622	5.6	56.1
2C1	Iron and steel production	PM10	1'485	10	4.510	5.5	61.6
2A5a	Quarrying and mining of minerals other than coal	PM10	302	318	4.125	5.0	66.6
2H2	Food and beverages industry	PM10	310	310	3.919	4.8	71.4
3B4gii	Manure management - Broilers	PM10	68	222	2.956	3.6	75.0
2I	Wood processing	PM10	864	188	2.865	3.5	78.5
2G	Other product use	PM10	588	497	1.916	2.3	80.8
1A1a	Public electricity and heat production	PM10	1'045	71	1.741	2.1	82.9
3B4gi	Manure management - Laying hens	PM10	123	151	1.568	1.9	84.8
1A2f	Stationary combustion in manufacturing industries and construction: non-metallic minerals	PM10	833	59	1.246	1.5	86.4

Annex 2 Other detailed methodological descriptions for individual source categories

A2.1 Sector Energy: non-road vehicles

A2.1.1 Emission and fuel consumption factors for non-road vehicles

As mentioned in chp. 3.2.1.1.1 (non-road transportation model), emission factors and activity data can be downloaded by query from the non-road database INFRAS (2015a⁸), which is the data pool of FOEN (2015j). They can be queried by year, non-road family (see categories in Table A - 13), machine type, engine type (diesel, gasoline/2-/4-stroke, liquefied petroleum gas, gas oil), engine capacity (power class) and emission concept (standard), pollutant either at aggregated or disaggregated levels. The following table illustrates a query for the family 'construction machinery'.

Table A - 12 Excerpt of the non-road database INFRAS (2015a).

Construction machinery, 2010								
Machine type	Engine type	Engine capacity	Emission concept	Poll.	Op. hrs. (h/a)	EF (kg/h)	EF [w/o PF] (kg/h)	EF [100% PF] (kg/h)
Road finishing machines	diesel	18-37 kW	Nonr D PreEUB	PM	112.7	0.0074	0.0074	0.0007
Road finishing machines	diesel	18-37 kW	Nonr D EU2	PM	259.9	0.0045	0.0045	0.0005
Road finishing machines	diesel	18-37 kW	Nonr D EU3A	PM	305.8	0.0006	0.0046	0.0005
Road finishing machines	diesel	37-75 kW	Nonr D PreEUB	PM	130.1	0.0133	0.0133	0.0013
Road finishing machines	diesel	37-75 kW	Nonr D EU1	PM	248.6	0.0073	0.0073	0.0007
Road finishing machines	diesel	37-75 kW	Nonr D EU2	PM	327.8	0.0014	0.0047	0.0005
Road finishing machines	diesel	37-75 kW	Nonr D EU3A	PM	357.7	0.0005	0.0053	0.0005
Road finishing machines	diesel	75-130 kW	Nonr D PreEUB	PM	138.8	0.0129	0.0129	0.0013
Road finishing machines	diesel	75-130 kW	Nonr D EU1	PM	239.4	0.0096	0.0096	0.001
Road finishing machines	diesel	75-130 kW	Nonr D EU2	PM	332.7	0.0031	0.0062	0.0006
Road finishing machines	diesel	75-130 kW	Nonr D EU3A	PM	376.4	0.0007	0.007	0.0007
Hydraulic rammers of all types	diesel	75-130 kW	Nonr D PreEUB	PM	131.7	0.0104	0.0104	0.001
Hydraulic rammers of all types	diesel	75-130 kW	Nonr D EU1	PM	227.2	0.0077	0.0077	0.0008
Hydraulic rammers of all types	diesel	75-130 kW	Nonr D EU2	PM	315.7	0.0025	0.005	0.0005
Hydraulic rammers of all types	diesel	75-130 kW	Nonr D EU3A	PM	357.2	0.0005	0.0048	0.0005
Rolling mill engines of all types	diesel	<18 kW	Nonr D PreEUB	PM	130.9	0.005	0.005	0.0005
Rolling mill engines of all types	diesel	<18 kW	Nonr D EU1	PM	250.1	0.0042	0.0042	0.0004
Rolling mill engines of all types	diesel	<18 kW	Nonr D EU2	PM	329.7	0.0032	0.0032	0.0003
Rolling mill engines of all types	diesel	<18 kW	Nonr D EU3A	PM	359.8	0.0029	0.0032	0.0003
Rolling mill engines of all types	diesel	18-37 kW	Nonr D PreEUB	PM	148.3	0.0077	0.0077	0.0008
Rolling mill engines of all types	diesel	18-37 kW	Nonr D EU2	PM	341.8	0.0046	0.0046	0.0005
Rolling mill engines of all types	diesel	18-37 kW	Nonr D EU3A	PM	402.3	0.0006	0.0047	0.0005
Rolling mill engines of all types	diesel	37-75 kW	Nonr D PreEUB	PM	168.8	0.0138	0.0138	0.0014
Rolling mill engines of all types	diesel	37-75 kW	Nonr D EU1	PM	322.6	0.0076	0.0076	0.0008
Rolling mill engines of all types	diesel	37-75 kW	Nonr D EU2	PM	425.3	0.0014	0.0048	0.0005
Rolling mill engines of all types	diesel	37-75 kW	Nonr D EU3A	PM	464.1	0.0005	0.0054	0.0005
Rolling mill engines of all types	diesel	75-130 kW	Nonr D PreEUB	PM	174.5	0.0133	0.0133	0.0013
Rolling mill engines of all types	diesel	75-130 kW	Nonr D EU1	PM	301	0.0099	0.0099	0.001
Rolling mill engines of all types	diesel	75-130 kW	Nonr D EU2	PM	418.3	0.0032	0.0064	0.0006
Rolling mill engines of all types	diesel	75-130 kW	Nonr D EU3A	PM	473.2	0.0007	0.0071	0.0007
Rolling mill engines of all types	diesel	130-300 kW	Nonr D PreEUB	PM	174.5	0.0279	0.0279	0.0028
Rolling mill engines of all types	diesel	130-300 kW	Nonr D EU2	PM	387.1	0.0068	0.0094	0.0009
Rolling mill engines of all types	diesel	130-300 kW	Nonr D EU3A	PM	467.7	0.001	0.0104	0.001
Mechanical vibrators	diesel	18-37 kW	Nonr D PreEUB	PM	100.6	0.0059	0.0059	0.0006
Mechanical vibrators	diesel	18-37 kW	Nonr D EU2	PM	232	0.0036	0.0036	0.0004
Mechanical vibrators	diesel	18-37 kW	Nonr D EU3A	PM	273	0.0004	0.0031	0.0003
Mechanical vibrators	diesel	37-75 kW	Nonr D PreEUB	PM	131.3	0.0108	0.0108	0.0011
Mechanical vibrators	diesel	37-75 kW	Nonr D EU1	PM	250.9	0.0059	0.0059	0.0006
Mechanical vibrators	diesel	37-75 kW	Nonr D EU2	PM	330.7	0.0011	0.0038	0.0004
Mechanical vibrators	diesel	37-75 kW	Nonr D EU3A	PM	361	0.0004	0.0036	0.0004
Mechanical vibrators	diesel	75-130 kW	Nonr D PreEUB	PM	140	0.0105	0.0105	0.0011
Mechanical vibrators	diesel	75-130 kW	Nonr D EU1	PM	241.6	0.0078	0.0078	0.0008
Mechanical vibrators	diesel	75-130 kW	Nonr D EU2	PM	335.8	0.0025	0.0051	0.0005
Mechanical vibrators	diesel	75-130 kW	Nonr D EU3A	PM	379.8	0.0005	0.0048	0.0005

⁸ <https://www.bafu.admin.ch/en/nonroad-database> [29.01.2026]

A2.1.2 Activity data non-road vehicles

The following table gives an overview on the stock and the operating hours of non-road vehicles (FOEN 2015j).

Table A - 13 Number of vehicles, specific operating hours per year and total operating hours per year for all non-road families/categories (FOEN 2015j).

Category	1980	1990	2000	2010	2020	2030
	number of vehicles					
Construction machinery	63'364	58'816	52'729	57'102	60'384	62'726
Industrial machinery	26'714	43'244	70'671	69'786	69'757	70'083
Agricultural machinery	292'773	324'567	337'869	318'876	309'825	305'235
Forestry machinery	11'815	13'844	13'055	11'857	10'831	10'170
Garden-care / hobby appliances	1'198'841	1'539'624	1'944'373	2'322'737	2'464'323	2'499'627
Navigation machinery	94'866	103'383	93'912	95'055	97'522	99'104
Railway machinery	529	1'300	1'255	697	640	640
Military machinery	13'092	13'373	14'272	13'083	12'853	12'856
Total	1'701'994	2'098'151	2'528'136	2'889'193	3'026'135	3'060'441

Category	1980	1990	2000	2010	2020	2030
	Specific operating hours per year					
Construction machinery	247	322	406	417	424	429
Industrial machinery	666	670	684	680	675	671
Agricultural machinery	136	119	112	103	99	95
Forestry machinery	203	199	203	193	188	182
Garden-care / hobby appliances	12	17	20	64	77	81
Navigation machinery	39	38	38	36	35	35
Railway machinery	877	613	617	783	719	719
Military machinery	64	64	63	73	74	74

Category	1980	1990	2000	2010	2020	2030
	million operating hours per year					
Construction machinery	16	19	21	24	26	27
Industrial machinery	18	29	48	48	47	47
Agricultural machinery	40	39	38	33	31	29
Forestry machinery	2.4	2.8	2.6	2.3	2.0	1.9
Garden-care / hobby appliances	15	26	39	150	191	201
Navigation machinery	3.7	3.9	3.5	3.4	3.4	3.4
Railway machinery	0.50	0.80	0.80	0.50	0.50	0.50
Military machinery	0.80	0.90	0.90	0.90	0.90	0.90
Total	95	121	155	261	301	311

A2.2 Emissions due to former usage (2K) and subsequent disposal of polychlorinated biphenyls (1A1a, 2C1, 5A, 5C1, 5E, 6A)

A2.2.1 Mass flow and emission model of former use and disposal of PCBs

Polychlorinated biphenyls (PCBs) were used in Switzerland between 1946 and 1986. In 1986, a total ban was placed on any form of PCB use. The use in so-called 'open applications' was allowed until 1972. Open applications include joint (elastic) sealants, anti-corrosion coatings, paints and varnishes. All other uses were allowed until 1986.

An emission inventory based on a dynamic mass flow model was developed for PCBs for Switzerland for the time period 1930 to 2100. The model takes into account the import, usage, export, treatment, disposal and accidental release of PCBs, see Figure A - 1. PCB emissions to the environment occur from all stages of their lifecycle. A detailed documentation of the emission inventory is available in Glüge et al. 2017. Additionally, the underlying model is available in Microsoft Excel/VBA and can be downloaded.

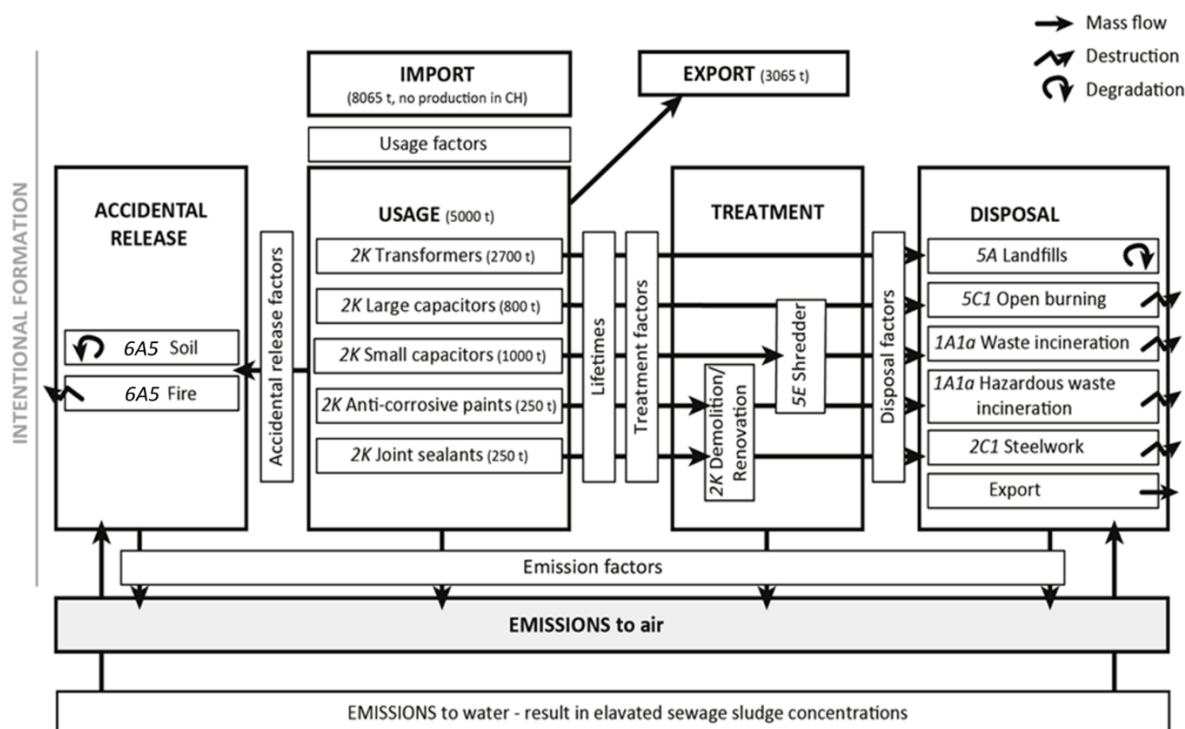


Figure A - 1 Model setup for the dynamic mass flow and emissions of PCBs taking into account the import, usage, export, treatment, disposal and accidental release. Emissions to air occur from usage, treatment, disposal, and accidental release. (Waste and hazardous waste incineration correspond to municipal solid waste and special waste incineration, respectively.)

Besides this intentional usage of PCBs, PCBs can also be emitted by unintentional formation, e.g. in combustion processes. Emissions from unintentional formation are not part of this mass flow model but are included in the air pollutant emission inventory for stationary combustion of solid and liquid fossil fuels as well as of wood and wood waste, see chapters 3.2.2 – 3.2.4.

Import and usage

PCBs have not been produced in Switzerland. Therefore, the chemicals enter the system solely through import (Figure A - 1, top part). The imported amounts are then distributed to the usage categories according to usage factors (Figure A - 1, middle part). The imported amounts, as well as the usage factors, vary over time. In this study, five usage categories that were identified to be important for Switzerland are included: transformers, large capacitors (> 1 kg), small capacitors (< 1 kg), anti-corrosive paints on steel and joint sealants. Other uses, such as PCBs in hydraulic oils (used in mining), plastics, or insecticides are considered as being of minor importance in Switzerland and are thus, not included in the model. For the time being, anti-corrosive paints and joint sealants are the predominant PCB emission sources (see Figure A - 2). The emissions from the five usage categories are reported in source category 2K Consumption of POPs and heavy metals.

Export

The exported amounts to other countries could have been estimated only roughly. PCBs were mainly exported in disposed PCB-containing transformers and capacitors and electronic waste, but also in old installations, such as for example hydraulic turbines with PCB-containing paints.

Disposal

When a PCB-containing product reaches its end of life it is disposed of. In the model, six disposal categories that have been relevant in Switzerland are included: landfills (5A), open burning (5C1), municipal waste incineration (1A1a), special waste incineration (1A1a), steelworks (2C1), and export (Figure A - 1, right part). For all usage categories, specific disposal factors, which vary over time, are applied to the six disposal categories and export. Here, open burning refers to combustion of PCB contaminated waste oil in outdoor fires (i.e. outside of a container). Open burning was ceased in 1999. Steelworks represent scrap metal that is melted in electric arc furnaces of secondary steel production plants. Thereby PCB-containing paint residues are combusted at temperatures of around 1600°C. Landfills are disposal sites where the waste is dumped. Since 2000, the incineration of combustible waste is mandatory in Switzerland, therefore, disposing of to landfills stopped. In landfills, PCBs are partly stored and partly degraded. When waste is exported, its emissions abroad are not included in the Swiss emission inventory. When combusted, PCBs are partly destroyed by high temperatures and partly emitted to the environment.

Treatment

Before disposal, some usage categories undergo specific treatment processes (Figure A - 1, right part). Two treatment categories are included in the model: Demolition/renovation of steel constructions and buildings containing PCBs in anti-corrosive paints and joint sealants, respectively (2K), as well as Shredding of electronic waste containing PCBs in small capacitors (5E).

Demolition/renovation can induce elevated emissions to the environment, as has been observed for buildings. Shredding of electronic waste occurs at fast rotation velocity that leads to increased temperature and dust production. As a consequence of the legal ban of disposal of combustible waste in landfills, a sharp increase in shredding of small capacitors occurred in 1999 although they should have been treated as special waste from 1998 onwards (see Figure A - 2). Shearing of steel constructions (heavy scrap), otherwise, is supposed to produce little dust and yield no evaporation of the substances in the coating. Therefore, no emissions to air from the shearing of steel constructions were assumed.

Accidental release

From each usage category, PCBs can be accidentally released (Figure A - 1, left part). The model includes two release categories: soil and fire (6A5). When released to soil, PCBs are partly stored and partly degraded. In the case of fire, PCBs are partly destroyed by high temperatures and partly emitted to the environment.

Release to water

The release of PCBs to water bodies is only partly included in this model. Release to water bodies is important for anti-corrosive paints and to a smaller degree also for leachate from landfills. The measured PCB concentrations in sewage sludge and the total amount of produced sewage sludge per year was used to determine the mass of PCBs released to water. This approach overlooks emissions to natural water bodies, but it captures emissions to wastewater.

A2.2.2 Emission methodology

Emissions to air occur from the entire system: usage, treatment, disposal and accidental release. The emissions are calculated by multiplying the annual mass of PCBs involved in a source category (e.g. tonnes of PCBs in use in joint sealants) with a source-specific emission factor (e.g. tonnes of PCBs emitted/tonnes of PCBs in use). This country-specific approach corresponds to a Tier 2 method according to EMEP/EEA (2023).

The five usage categories as well as landfills and soils are PCB stocks, which means that PCBs are stored in these categories and passed on through the system with a temporal delay according to their lifetime or residence time. In these cases, the activity data are the amounts of PCBs stored in the stock. The treatment categories of renovation and shredder and all incineration categories (including fire) are instantaneous categories, where PCBs are not stored. In these cases, the activity data correspond to the amount of PCBs treated or incinerated in the respective year.

PCB emissions are sometimes reported as sum of the so-called indicator PCBs (iPCBs, i.e. PCB congeners 28, 52, 101, 138, 153, and 180), sometimes as sum of the dioxin-like PCBs (dl-PCBs, i.e. PCB congeners 77, 81, 105, 114, 118, 123, 126, 156, 157, 167, 169, and 189) and sometimes as sum of all 209 congeners. The emission model is run for all congeners, so emission numbers are available for all three sums. Where data such as typically emission factors are not available for all congeners, estimates are derived from the iPCBs using the chlorination degrees of the congeners. Please note that the PCB emissions reported in Switzerland's air pollutant emission inventory comprise the sum of all 209 congeners.

Figure A - 2 shows the resulting PCB emissions from all stages of the life cycle of PCB applications, i.e. usage, treatment, disposal and accidental release. Anti-corrosive paints and joint sealants are the predominant PCB emission sources for most of the time. Between 1975 and 1985 and around 2000, open burning and the above-mentioned shredding of small capacitors, respectively, were the dominant PCB sources. Only after 2040, emissions from soil due to former accidental releases to soil become the most important emission source. Mainly in the seventies and eighties, accidental release by fire, small and large capacitors and waste incineration were important emission sources as well.

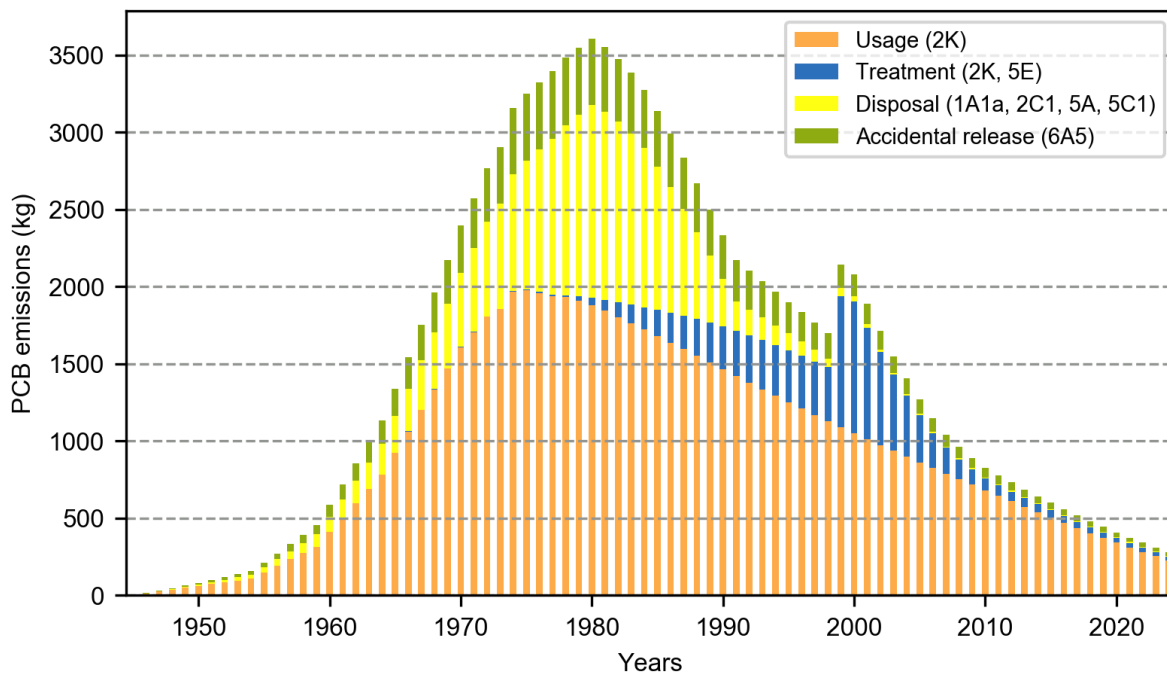


Figure A - 2 PCB emissions from usage (2K Transformers, large and small condensators, anti-corrosive paints and joint sealants), treatment (2K Demolition and renovation, 5E Shredder), disposal (1A1a Municipal solid waste and special waste incineration, 2C1 Secondary steel production, 5A Landfills, 5C1 Open burning (until 1999)) and accidental release (6A5 Accidental release by fire and to soil).

A2.3 Comparison of the country-specifically calculated Tier 3 results for N flows and NH₃ emissions from animal husbandry with the results of the Tier 2 calculations using the TFEIP N-flow tool (3B, 3Da2a, 3Da3)

In the report of the Stage 3 in-depth review in summer 2020 it was recommended “To present more details regarding the country-specific emission factors as well as a comparison of the national emission factors and the Guidebook emission factors with a rationale of the discrepancies.” Because it is not only the emission factors that have a strong influence on the emission inventory calculations but also other assumptions like N excretions, length of housed period or percentage of TAN in the manure, it was decided to not only compare the emission factors but rather the total N flows and NH₃ emissions resulting from the calculations with the model AGRAMMON (see chp. 5.2.2) and the TFEIP N flow tool (downloaded from <https://www.eea.europa.eu/en/analysis/publications/emep-eea-guidebook-2019/part-b-sectoral-guidance-chapters/4-agriculture/manure-management-n-flow-tool>, version January 2021). The comparison was made for the year 2015, which at the time was the last year with data from a representative survey on farm and manure management, using the AGRAMMON version 2018 (Kupper et al. 2018). The procedure and the results are summarised in an internal memo (Menzi 2022). An overview of the results is shown in Tables A-14 to A-16. The main results can be summarised as follows:

N excretions

- Total N excretions from livestock production shown for the livestock categories used in the N flow tool were 4 % lower in the N flow tool than according to the Swiss AGRAMMON tool (Swiss reporting). The lower total N excretion was mainly due to cattle and swine which contributed over 75 % and over 10 %, respectively, of the N excretions from agricultural livestock.
- For dairy cows the value used in the N flow tool is 6 % lower than in the Swiss reporting. This can be explained by the average weight assumed. In the N flow tool, it is 600 kg while it is 660 kg in Switzerland (according to Swiss Fertiliser Guidelines). With a correction to 660 kg N the N flow tool shows excretions of 113.9 kg N per dairy cow place and year, which is 1.8 % more than the Swiss value.
- For all main livestock categories except small ruminants and equids the difference of N excretion between the two approaches was less than 10 %.

NH₃ emissions livestock

- Total NH₃ emissions from livestock and manure management differ less than 10 % between the two approaches, the N flow tool being a bit lower than the Swiss reporting. This holds for both 3B (housing and manure storage) and 3D (manure application and grazing) emission categories and is also true for cattle, which contribute about three fourths of the NH₃ emissions from livestock and manure management. For the cattle categories the relative difference is in the same proportion as the difference for N excretion. Total emissions from pig production were well comparable between the two approaches (N flow tool 4 % lower than Swiss reporting). Pig production in 2015 was responsible for around 15 % of the emissions from livestock and manure management. According to the N flow tool the values for the category 3B were nearly 20 % lower than according to the Swiss reporting and those for the category 3D about 25 % higher. This can mainly be explained by the high importance of animal friendly housing system in Switzerland, which cannot be considered in the N flow tool.

Distribution of NH₃ emissions to the stages of the manure management chain

- The distribution of NH₃ emissions to housing, storage, application and grazing the N-flow tool has a lower share for housing and a higher share for grazing as compared to the Swiss reporting. Housing emissions (including yards) were 22 % lower in the N flow tool compared to the Swiss reporting because of the assumptions on grazing and housing and the high importance of special animal friendly housing systems which cannot be considered in the N flow tool.
- In spite of the lower N flow through the manure cascade (because of assumption about grazing) emissions from manure storage were 21 % higher in the N flow tool than in the Swiss reporting (slurry +37 %, solid manure -12 %), probably mainly because of the high share of covered slurry stores (89 %; not considered in the N flow tool) and the importance of liquid and solid manure (Switzerland 2015 share N flow going to storage: 74 % slurry, 26 % solid manure).
- Emissions from manure application were 19 % lower in the N flow tool than in the Swiss reporting, probably mainly because of the lower N flow through the manure cascade and the importance of low emission spreading technique in Switzerland (2015 38 % of the slurry) which cannot be considered in the N flow tool.
- Emissions from grazing were nearly fourfold as high in the N low tool as compared to the Swiss reporting because of the assumptions about housing and grazing.
- The distribution of emissions from livestock and manure management to the Guidebook categories 3B (housing, manure storage) and 3D (Manure application, grazing) agreed well between the two approaches (share 3B: N flow tool 54 %, Swiss reporting 55 %). However, within the category 3B the distribution to housing and manure storage differed quite a bit (N flow tool 58 %/42 %, Swiss reporting 68 %/32 %). For the category 3D the distribution to manure application and grazing was 77 %/23 % for the N flow tool and 94 %/6 % for the Swiss reporting. Looking at the distribution of total emissions to housing/manure storage/manure application/grazing the distribution was 31 %/23 %/36 %/10 % for the N flow tool and 37 %/17 %/43 %/3 % for the Swiss reporting.

A direct comparison of N flows or emission factors is impeded in various places by the differences between the models in the allocation of N flows. Important examples are:

- a) The N-flow tool differentiates between emission factors for liquid and solid manure in the housing area while AGRAMMON has only one emission factor for housing because a clear allocation of excreta and soiled surfaces to liquid and solid manure is not possible.
- b) For slurry storage, the emission factors are in percent of TAN in the N flow model and in g per m² slurry surface and day in AGRAMMON.
- c) AGRAMMON takes into account a different allocation of TAN excretions to liquid and solid manure. As urine (containing soluble N, which is potentially emitted) is primarily collected in the liquid manure, the emissions are higher than for a comparable N flow in the form of faeces, which primarily contain organic N and mostly go into solid manure.
- d) AGRAMMON takes into account the immobilisation of TAN and the release of TAN from the degradation of organic N in housing and during manure storage, which is not considered in the N flow tool.

The comparison of the two approaches shows that the Tier 2 approach can hardly cope with farm management conditions that differ strongly from the assumption in the N-flow tool and can only be transferred to the input variables with difficulty. If such detailed farm management data is available, it is more reliable and maybe even easier to use a country-specific Tier 3 approach.

Table A - 14 N excretions of livestock in Switzerland according to the Swiss reporting (AGRAMMON model, Tier 3 methodology) and the N flow tool (Tier 2 methodology) for the year 2015.

Swiss reporting (Tier 3) AGRAMMON Model		dairy cows	non-d. cattle	calves	cattle exc DC	cattle total	finishing pigs	sows	pigs total	sheep	goats	small ruminants	horses	mules+a sses	equids	laying hens	broilers	turkeys	poultry total	total
N excretion housing & yard	kt N	54.74	25.63	3.18	28.80	83.55	11.43	3.59	15.02	2.10	0.84	2.94	1.91	0.24	2.16	2.41	3.09	0.07	5.57	109.24
N excretion grazing	kt N	10.38	8.81	0.67	9.49	19.86	0.002	0.002	0.003	1.23	0.11	1.34	0.52	0.07	0.59	0.16	0.01	0.002	0.17	21.96
N excretion total	kt N	65.12	34.44	3.85	38.29	103.41	11.44	3.59	15.02	3.33	0.95	4.29	2.43	0.31	2.75	2.57	3.10	0.07	5.74	131.21
% category of total		49.6%	26.2%	2.9%	29.2%	78.8%	8.7%	2.7%	11.5%	2.5%	0.7%	3.3%	1.9%	0.2%	2.1%	2.0%	2.4%	0.1%	4.4%	100%
% during grazing		16%	26%	17%	25%	19%	0.02%	0.05%	0.02%	37%	12%	31%	21%	22%	21%	6%	0.2%	3%	9%	17%
N flow tool (Tier 2)		dairy cows	non-d. cattle	calves	cattle exc DC	cattle total	finishing pigs	sows	pigs total	sheep	goats	small ruminants	horses	mules+a sses	equids	laying hens	broilers	turkeys	poultry total	total
N excretion housing & yard	kt N	38.01	17.31	1.90	19.22	57.22	9.44	4.23	13.67	0.54	0.14	0.68	1.30	0.32	1.62	2.97	2.77	0.09	5.83	79.02
N excretion grazing	kt N	23.31	14.52	1.60	16.12	39.43	-	-	-	4.84	1.53	6.37	1.33	0.33	1.67	-	-	-	-	47.46
N excretion total	kt N	61.31	31.83	3.50	35.33	96.65	9.44	4.23	13.67	5.38	1.66	7.05	2.63	0.65	3.29	2.97	2.77	0.09	5.83	126.48
% category of total		48.5%	25.2%	2.8%	27.9%	76.4%	7.5%	3.3%	10.8%	4.3%	1.3%	5.6%	2.1%	0.5%	2.6%	2.3%	2.2%	0.1%	4.6%	100.0%
% during grazing		38%	46%	46%	46%	41%	-	-	-	90%	92%	90%	51%	51%	51%	-	-	-	-	38%

Table A - 15 NH₃ emissions from livestock and manure management in Switzerland according to the Swiss reporting (AGRAMMON model) for the different livestock categories and steps of the manure cascade for the year 2015.

Swiss reporting (Tier 3) AGRAMMON Model	dairy cows	non-d. cattle	calves	cattle exc DC	cattle total	finishing pigs	sows	pigs total	sheep	goats	small ruminants	horses	mules+ asses	equids	laying hens	broilers	turkeys	poultry total	total
N excretion housing & yard	54.74	25.63	3.18	28.80	83.55	11.43	3.59	15.02	2.10	0.84	2.94	1.91	0.24	2.16	2.41	3.09	0.07	5.57	109.24
N excretion grazing	10.38	8.81	0.67	9.49	19.86	0.00	0.00	0.00	1.23	0.11	1.34	0.52	0.07	0.59	0.16	0.01	0.00	0.17	21.96
N excretion total	65.12	34.44	3.85	38.29	103.41	11.44	3.59	15.02	3.33	0.95	4.29	2.43	0.31	2.75	2.57	3.10	0.07	5.74	131.21
% category of total	49.6%	26.2%	2.9%	29.2%	78.8%	8.7%	2.7%	11.5%	2.5%	0.7%	3.3%	1.9%	0.2%	2.1%	2.0%	2.4%	0.1%	4.4%	100%
% during grazing	16%	26%	17%	25%	19%	0.02%	0.05%	0.02%	37%	12%	31%	21%	22%	21%	6%	0%	3%	9%	17%
emissions housing	4.34	2.14	0.31	2.45	6.79	2.78	0.93	3.72	0.25	0.10	0.35	0.14	0.01	0.15	0.37	0.38	0.01	0.76	11.77
emissions yard	1.55	1.33	0.10	1.43	2.98	-	-	-	-	-	-	0.11	0.02	0.13	-	-	-	-	3.11
emissions housing & yard	5.89	3.47	0.41	3.88	9.77	2.78	0.93	3.72	0.25	0.10	0.35	0.25	0.03	0.28	0.37	0.38	0.01	0.76	14.88
emissions storage liq.	2.72	1.19	0.08	1.28	4.00	0.47	0.16	0.63	-	-	-	-	-	-	-	-	-	-	4.63
storage solid	0.80	0.70	0.19	0.89	1.69	-	-	0.17	0.17	0.06	0.22	0.14	0.02	0.16	0.12	0.065	0.00	0.19	2.27
storage total	3.53	1.89	0.27	2.16	5.69	0.47	0.16	0.63	0.17	0.06	0.22	0.14	0.02	0.16	0.12	0.06	0.00	0.19	6.89
application liquid	8.58	3.14	0.23	3.36	11.95	1.44	0.42	1.86	-	-	-	0.08	0.01	-	-	-	-	-	13.80
application solid	1.16	1.02	0.25	1.27	2.44	-	-	-	0.07	0.04	0.11	0.08	0.01	0.08	0.26	0.34	0.01	0.61	3.24
application total	9.75	4.16	0.48	4.64	14.38	1.44	0.42	1.86	0.07	0.04	0.11	0.08	0.01	0.08	0.26	0.34	0.01	0.61	17.05
emissions grazing	0.48	0.40	0.03	0.43	0.91	0.0002	0.0002	0.001	0.06	0.01	0.07	0.03	0.00	0.03	0.07	0.003	0.001	0.07	1.08
% of grazing emissions	44.2%	37.4%	2.9%	40.3%	84.5%	0.02%	0.02%	0.05%	5.7%	0.5%	6.2%	2.4%	0.3%	2.7%	6.1%	0.3%	0.1%	6.5%	100%
% of total emissions	1.2%	1.0%	0.1%	1.1%	2.3%	0.001%	0.001%	0.001%	0.2%	0.0%	0.2%	0.06%	0.01%	0.1%	0.2%	0.01%	0.002%	0.2%	2.7%
3B total	9.41	5.37	0.68	6.05	15.46	3.25	1.09	4.34	0.42	0.16	0.58	0.39	0.05	0.44	0.49	0.45	0.01	0.95	21.77
% category of total	43.2%	24.6%	3.1%	27.8%	71.0%	14.9%	5.0%	20.0%	1.9%	0.7%	2.7%	1.8%	0.2%	2.0%	2.3%	2.0%	0.1%	4.4%	100%
3D total (manure)	10.22	4.56	0.51	5.07	15.29	1.44	0.42	1.86	0.14	0.04	0.18	0.10	0.01	0.11	0.33	0.35	0.01	0.68	18.12
% category of total	56.4%	25.2%	2.8%	28.0%	84.4%	7.9%	2.3%	10.3%	0.7%	0.2%	1.0%	0.6%	0.1%	0.6%	1.8%	1.9%	0.0%	3.8%	100%
Emissions manure tot.	19.64	9.93	1.19	11.11	30.75	4.69	1.51	6.20	0.55	0.20	0.75	0.49	0.06	0.56	0.82	0.79	0.02	1.63	39.90
% category of total	49.2%	24.9%	3.0%	27.9%	77.1%	11.8%	3.8%	15.5%	1.4%	0.5%	1.9%	1.2%	0.2%	1.4%	2.0%	2.0%	0.1%	4.1%	100%
% of N excretion	30.2%	28.8%	30.8%	29.0%	29.7%	41.0%	42.1%	41.3%	16.6%	21.0%	17.6%	20.3%	20.1%	20.2%	31.8%	25.6%	29.5%	28.4%	30.4%

Annexes: Other detailed methodological descriptions for individual source categories

Table A - 16 NH₃ emissions from livestock and manure management in Switzerland according to the N flow tool for the different livestock categories and steps of the manure cascade for the year 2015.

N flow tool (Tier 2)	dairy cows	non-d cattle	calves	cattle exc DC	cattle total	finishing pigs	sows	pigs total	sheep	goats	small ruminants	horses	mules+ asses	equids	laying hens	broilers	turkeys	poultry total	total
N excretion housing & yard	38.01	17.31	1.90	19.22	57.22	9.44	4.23	13.67	0.54	0.14	0.68	1.30	0.32	1.62	2.97	2.77	0.09	5.83	79.02
N excretion grazing	23.31	14.52	1.60	16.12	39.43	-	-	-	4.84	1.53	6.37	1.33	0.33	1.67	-	-	-	-	47.46
N excretion total	61.31	31.83	3.50	35.33	96.65	9.44	4.23	13.67	5.38	1.66	7.05	2.63	0.65	3.29	2.97	2.77	0.09	5.83	126.48
% category of total	48.5%	25.2%	2.8%	27.9%	76.4%	7.5%	3.3%	10.8%	4.3%	1.3%	5.6%	2.1%	0.5%	2.6%	2.3%	2.2%	0.1%	4.6%	100%
% during grazing	38%	46%	46%	46%	41%	0%	0%	0%	90%	92%	90%	51%	51%	51%	0%	0%	0%	0%	38%
emissions housing	2.08	1.49	0.14	1.63	3.71	1.78	1.04	2.82	0.05	0.02	0.06	0.17	0.04	0.21	0.42	0.41	0.02	0.85	7.65
emissions yards	2.76	1.01	0.11	1.12	3.88	-	-	-	0.04	-	-	-	-	-	-	-	-	-	3.92
emissions housing & yard	4.84	2.50	0.25	2.75	7.59	1.78	1.04	2.82	0.09	0.02	0.10	0.17	0.04	0.21	0.42	0.41	0.02	0.85	11.57
storage liquid	4.14	1.30	0.11	1.41	5.55	0.56	0.23	0.79	-	-	-	-	-	-	-	-	-	-	6.34
storage solid	0.46	0.67	0.04	0.71	1.17	-	-	-	0.04	0.01	0.05	0.15	0.03	0.18	0.13	0.46	0.01	0.60	2.00
storage total	4.60	1.97	0.15	2.12	6.72	0.56	0.23	0.79	0.04	0.01	0.05	0.15	0.03	0.18	0.13	0.46	0.01	0.60	8.34
application liquid	6.73	2.11	0.18	2.29	9.03	1.81	0.53	2.34	-	-	-	-	-	-	-	-	-	-	11.37
application solid	0.34	0.50	0.03	0.53	0.87	-	-	-	0.04	0.02	0.05	0.12	0.02	0.15	0.46	0.23	0.01	0.69	1.76
application total	7.08	2.61	0.21	2.82	9.90	1.81	0.53	2.34	0.04	0.02	0.05	0.12	0.02	0.15	0.46	0.23	0.01	0.69	13.13
grazing	1.96	1.22	0.13	1.35	3.31	-	-	-	0.22	0.07	0.29	0.28	0.07	0.35	-	-	-	-	3.95
% of grazing emissions	49.6%	30.9%	3.4%	34.3%	83.9%	-	-	-	5.5%	1.7%	7.3%	7.1%	1.8%	8.9%	-	-	-	-	100%
% of total emissions	5.3%	3.3%	0.4%	3.7%	9.0%	-	-	-	0.6%	0.2%	0.8%	0.8%	0.2%	0.9%	-	-	-	-	10.7%
3B total	9.44	4.47	0.40	4.87	14.32	2.35	1.26	3.61	0.13	0.03	0.15	0.32	0.07	0.39	0.55	0.87	0.03	1.45	19.92
% category of total	47.4%	22.4%	2.0%	24.5%	71.9%	11.8%	6.3%	18.1%	0.6%	0.1%	0.8%	1.6%	0.4%	2.0%	2.8%	4.4%	0.2%	7.3%	100%
3D total (manure)	9.03	3.83	0.35	4.18	13.21	1.81	0.53	2.34	0.26	0.08	0.34	0.40	0.09	0.50	0.46	0.23	0.01	0.69	17.08
% category of total	52.9%	22.4%	2.0%	24.5%	77.4%	10.6%	3.1%	13.7%	1.5%	0.5%	2.0%	2.4%	0.6%	2.9%	2.7%	1.3%	0.1%	4.0%	100%
Emissions manure tot.	18.48	8.30	0.75	9.05	27.53	4.16	1.79	5.95	0.38	0.11	0.50	0.72	0.17	0.89	1.00	1.09	0.04	2.14	36.99
% category of total	49.9%	22.4%	2.0%	24.5%	74.4%	11.2%	4.8%	16.1%	1.0%	0.3%	1.3%	1.9%	0.4%	2.4%	2.7%	3.0%	0.1%	5.8%	100%
% of N excretion	30.1%	26.1%	21.4%	25.6%	28.5%	44.0%	42.3%	43.5%	7.1%	6.7%	7.0%	27.4%	25.4%	27.0%	33.8%	39.4%	46.4%	36.7%	29.2%

Annex 3 Additional information and explanations concerning the NFR tables

Table A - 17 Explanation of the NE notation key in the NFR tables from the latest submission.

NFR code	Substance(s)	Reason for notation key NE
all	As, Cr, Cu, Ni, Se, Zn	Lack of data: The available data for non-priority heavy metals is insufficient to enable accurate emissions reporting.
1A (Nonroad)	HCB, PCBs	Lack of data: no or not enough information on emission factors available.
1A (mobile)	HCB, PCBs	Lack of data: no or not enough information on emission factors and activity data available. (for the years 1980-1989)
1A1c	SO _x , NH ₃ , Pb, Cd, Hg, POPs	Lack of data: no information on emission factors available.
1A3b	HCB	no EF available
1A3di(i)	TSP, PM ₁₀ , PM _{2.5} , BC, Pb, Cd, Hg, PCDD/PCDF, PAHs, PCBs	no EF available
1A3dii	PCBs	no EF available
2A5a	BC	no EF available
2B5	BC	no EF available
2C3	Pb, Hg, PCDD/PCDF, HCB, PCBs	no EF available (production only from 1980 to 2006)
2C7c	BC	no EF available
2D3b	PM _{2.5} , PM ₁₀ , TSP, BC	Lack of data
2H1	NO _x , SO _x , BC, CO	no EF available
2H2	BC	no EF available
2H3	BC	no EF available
3B	NH ₃	1980-1989, 2025-2050: There are no calculations of NH ₃ emissions for sector 3 Agriculture for these years using the new AGRAMMON model version. Consistent NH ₃ emission time series for 1980-2050 will be reported again in the next submission.
3Da	NH ₃	
3Df	HCB	Lack of data
11B	BC, PCBs	no EF available
NATIONAL TOTAL	NH ₃	1980-1989, 2025-2050: As no calculations of NH ₃ emissions for sector 3 Agriculture, which accounts for more than 90% of total NH ₃ emissions, are available for these years, the national totals cannot be reported in the latest submission either.
COMPLIANCE TOTAL (CLRTAP)	NH ₃	

Table A - 18 Explanation of the IE Notation key in the NFR tables from the latest submission.

NFR code	Substance(s)	Included in NFR code
1A1b	Activity Data "Gaseous Fuels"	1A1b - Activity Data "Liquid Fuels" (for the years 2017 onwards)
1A3bvii	TSP, PM ₁₀ , PM _{2.5} , BC, Cd, Activity Data "Other activity"	1A3bvi
1A4ciii	NO _x , NMVOC, SO _x , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Hg, PCDD/PCDF, PAHs, Activity Data "Liquid Fuels", "Biomass", "Other activity"	1A3dii
2A3	NO _x , SO _x , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Hg	1A2f
2A5b	PM _{2.5} , PM ₁₀ , TSP	1A2gvii
2B1	NMVOC	2B10a
2D3c	NMVOC	2D3i (for the years 1980-1989)
2D3e	NMVOC	2D3i (for the years 1980-1989)
2D3f	NMVOC	2D3i (for the years 1980-1989)
2D3g	NMVOC	2D3i (for the years 1980-1989)
2D3h	NMVOC	2D3i (for the years 1980-1989)
3B4a	NO _x , NMVOC, NH ₃ , PM _{2.5} , PM ₁₀ , TSP, Activity Data "Other activity"	3B1a
5D2	NO _x , NMVOC, SO _x , NH ₃ , CO, Activity Data "Other activity"	5D1 (for the years 1980-1989)

Table A - 19 List of sub-sources accounted for in reporting codes "other" in the NFR tables from the latest submission.

NFR code	Substance(s) reported	Sub-source description
1A2gviii	NO _x , NMVOC, SO _x , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Hg, PCDD/PCDF, PAHs, HCB, PCB	Industrial combustion of wood and wood waste, other boilers and engines in industry, fibreboard production
1A3eii	-	NO
1A5a	-	NO
1A5b	NO _x , NMVOC, SO _x , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Hg, PCDD/PCDF, PAHs	Military mobile only (aviation and nonroad)
1B1c	-	NO
1B2d	-	NO
2A6	-	NO
2B10a	NO _x , NMVOC, SO _x , CO, Hg (until 2016)	Acetic acid, ammonium nitrate (until 2018), chlorine gas, ethylene, formaldehyde (until 1989), PVC (until 1996), niacin and sulphuric acid
2C7c	NO _x , NMVOC, SO _x , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, CO, Pb, Cd, Hg, PCDD/PCDF	Battery recycling, galvanizing plants, silicium production (until 1988)
2D3i	NMVOC	Removal of paint and lacquer, vehicles dewaxing (until 2001), production of perfume/arome, cosmetics, paper/paper board, tobacco products and textiles, extraction of oil and fat (until 2000) and scientific laboratories, unspecified commercial and industrial solvent emissions
2G	NO _x , NMVOC, SO _x , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Hg, PCDD/PCDF, PAHs	Application of glues and adhesives, commercial and industrial use of cleaning agents, cosmetic institutions, de-icing of airplanes and air-port surfaces (until 2011), glass wool enduction, hairdressers, health care other, medical practices, preservation of wood, renovation of anti-corrosive coatings, rock wool enduction, underseal treatment and conservation of vehicles and use of concrete additives, cooling lubricants, fireworks, lubricants and pesticides
2H3	NO, NMVOC, SO _x , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, CO, Pb	Blasting and shooting
2L	NH ₃	Use of NH ₃ as refrigerant
3B4h	NO _x , NMVOC, NH ₃ , PM _{2.5} , PM ₁₀ , TSP	Bisons, camels and llamas, deer, rabbits
3I	-	NO
5C1bvi	-	NO
5D3	-	NO
5E	NMVOC, PM _{2.5} , PM ₁₀ , TSP, CO, Pb, Cd, PCDD/F, PCBs	Car shredding
6A	NO _x , NMVOC, SO _x , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Hg, PCDD/PCDF, PAHs, PCB	Human ammonia emissions (breath, transpiration, nappies), pet ammonia emissions, pet PM emissions (keeping of horses, sheep, goats and donkeys outside agriculture), domestic use of fertilisers, fire damages estates and motor vehicles, accidental release of PCB
6B	-	NO
11C	NMVOC	Natural NMVOC emissions from forest and grassland.

Table A - 20 Basis for estimating emissions from mobile sources in the NFR tables from the latest submission.

NFR code	Description	Fuel sold	Fuel used	Comment
1 A 3 a i (i)	International Aviation (LTO)	X		
1 A 3 a i (ii)	International Aviation (Cruise)	X		
1 A 3 a ii (i)	1 A 3 a ii Civil Aviation (Domestic, LTO)	X		
1 A 3 a ii (ii)	1 A 3 a ii Civil Aviation (Domestic, Cruise)	X		
1A3b	Road transport	X		"NATIONAL TOTAL" reported as "fuel sold"
1A3b (fu)	Road transport		X	"COMPLIANCE TOTAL (CLRTAP)" as "fuel used"
1A3c	Railways		X	
1A3di (i)	International maritime Navigation	X		
1A3di (ii)	International inland waterways			NO
1A3dii	National Navigation	X		
1A4ci	Agriculture; stationary		X	
1A4cii	Off-road Vehicles and Other Machinery		X	
1A4ciii	National Fishing		IE	Included in 1A3dii
1 A 5 b	Other, Mobile (Including military)		X	

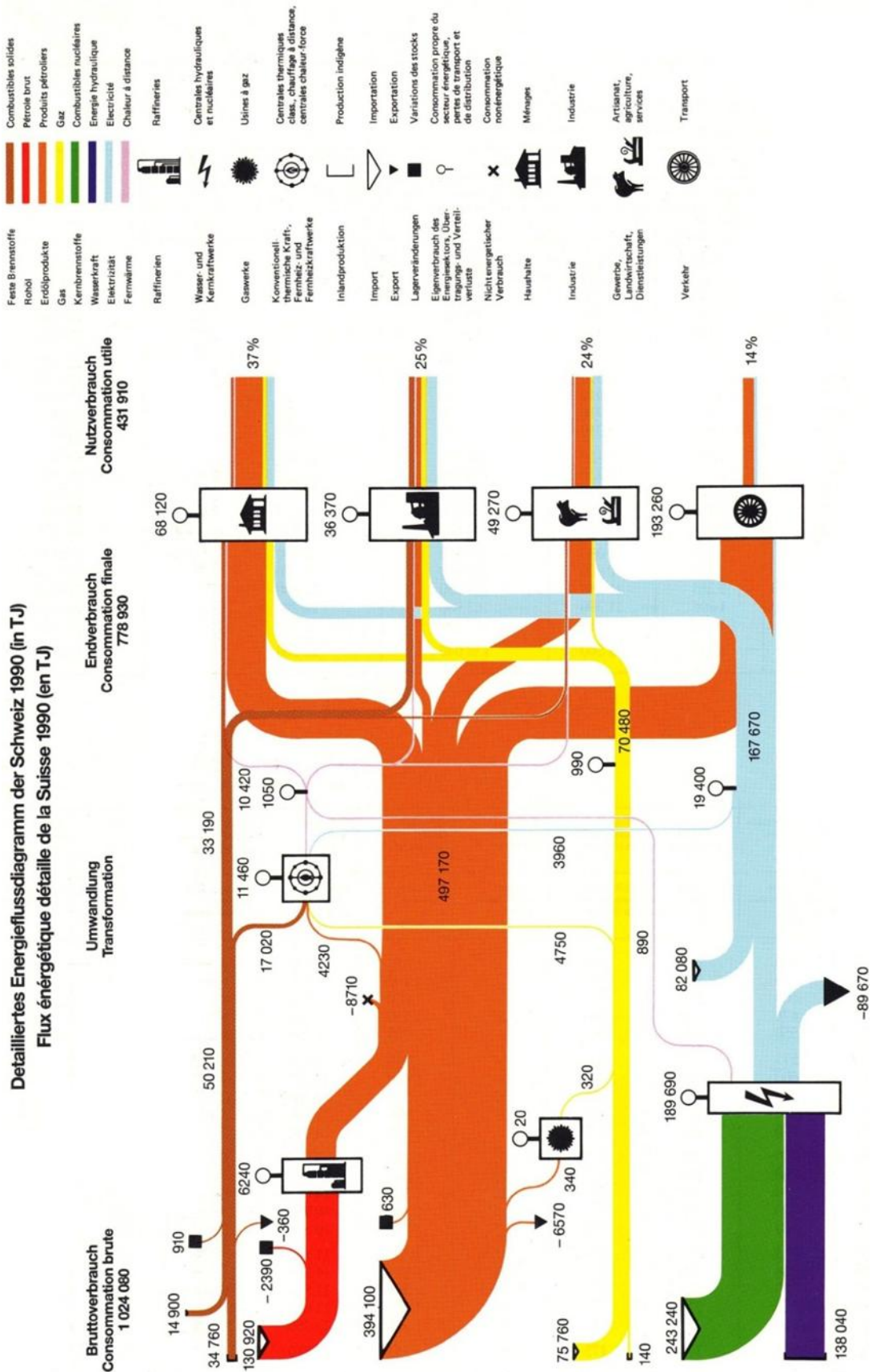


Figure A - 4 Energy flow in Switzerland 1990 (SFOE 1991). Depicted values are in TJ.

Table A - 21 Energy balance for Switzerland 2024 (table 4, Swiss overall energy statistics, SFOE 2025) in TJ.⁹

Tab.4 Energiebilanz der Schweiz für das Jahr 2024 (in TJ)
Bilan énergétique de la Suisse pour 2024 (en TJ)

	Holzenergie		Kohle	Müll und Industrieabfälle	Rohöl	Erdölprodukte	Gas	Wasserkraft	Kernbrennstoffe	Übrige erneuerbare Energien	Elektrizität	Fernwärme	Total
	Energie du bois	(1)											
Inlandsproduktion	48 860	-	-	55 440	0	-	0	174 010	-	56 320	-	-	334 630
+ Import	2 400	2 510	-	4 740	112 000	285 470	100 480	-	-	8 750	93 440	-	860 510
+ Export	-80	-10	-	-	0	-16 290	-	-	250 720	-	-145 270	-	-161 650
+ Lagerveränderung ¹	-	60	-	-	780	-4 350	-	-	-	-	-	-	-3 510
= Bruttoverbrauch	51 180	2 560	60 180	112 780	264 830	100 480	100 480	174 010	250 720	65 070	-51 830	0	1 029 980
+ Energieumwandlung:													
- Wasserkraftwerke	-	-	-	-	-	-	-	-174 010	-	-	174 010	-	0
- Kernkraftwerke	-	-	-	-	-	-	-	-	-250 720	-	82 740	1 370	-166 610
- konventionell-thermische Kraftwerke	-	-	-	-	-	-	-	-	-	-	-	-	-
- Heiz- und Fernheizkraftwerke	-4 970	0	-48 240	-	-	-390	-6 570	-	-	-	9 110	25 440	-25 620
- Gaswerke	-	-	-	-	-	-	0	-	-	-	-	-	0
- Raffinerien	-	-	-	-	-112 780	112 780	-	-	-	-	-	-	0
- Diverse Erneuerbare	-4 290	-	-	-	-	-	1 700	-	-	-26 680	25 930	0	-3 340
+ Eigenverbrauch des Energiesektors, Netzverluste, Verbrauch der Spiecherungen	-	-	-	-	-	-	-130	-	-	-	-32 920	-2 730	-41 270
+ Nichtenergetischer Verbrauch	-	-	-	-	-	-16 920	-	-	-	-	-	-	-16 920
= Endverbrauch	41 920	2 560	119 400	119 400	0	354 810	95 480	0	0	38 390	207 040	24 080	776 220
Haushalte	18 950	40	-	-	-	47 830	42 660	-	-	21 840	71 340	10 060	212 720
Industrie	12 450	2 520	11 590	-	-	9 250	30 910	-	-	2 280	59 110	9 130	137 240
Dienstleistungen	9 700	-	350	-	-	25 090	19 210	-	-	4 470	58 190	4 890	121 900
Verkehr	-	-	-	-	-	27 0610	480	-	-	9 200	15 070	-	295 360
Statistische Differenz inkl. Landwirtschaft	820	-	-	-	-	2 030	2 220	-	-	600	3 330	0	9 000

¹ +: Lagerabnahme
-: Lagerzunahme

BFE, Schweizerische Gesamtenergiestatistik 2024 (Tab. 4)
OFEN, Statistique globale suisse de l'énergie 2024 (tabl. 4)

Annex 5 Additional information concerning uncertainties

The tables in the following chapters provide information about the level and trend uncertainty analysis of all relevant air pollutant emissions in 1990 and 2024. Input data used for the uncertainty estimation are the same for approach 1 (uncertainty propagation) and approach 2 (Monte Carlo simulations) and listed in Annex A5.1. Uncertainty estimates obtained by approach 1 are given in the tables in Annex A5.2 and uncertainty estimates obtained by approach 2 are given in the tables in Annex A5.3.

Categories for which no emission is quantified for neither the base year nor the reporting year are not listed in the tables.

For tables reporting input uncertainties in Annex A5.1 and results from approach 1 in Annex A5.2, columns labelled A to M correspond exactly to columns A to M from Table 5-1 from the EMEP/EEA guidebook (EMEP/EEA 2023, part A, chp. 5, "Uncertainties", or Table 3.2, chp. 3, from the 2006 IPCC Guidelines (IPCC 2006).

For tables reporting uncertainty results from approach 2, columns labelled A to J correspond exactly to columns A to J from Table 3.3, chp. 3, from the 2006 IPCC Guidelines (IPCC 2006).

A5.1 Uncertainty estimations: input data

Bibliographic references for tables of Annex A5.1:

EMEP/EEA 2019: Default values of EMEP/EEA 2019 and associated uncertainty ranges (activity data and emission factors).

EMIS: Uncertainties that are implemented in the EMIS database (activity data and emission factors).

GHGI: Uncertainty analysis of Switzerland's greenhouse gas inventory (FOEN 2026); mainly activity data.

France/Sweden: Uncertainties from France's or Sweden's Informative Inventory Reports (Citepa 2012, SEPA 2010); mainly emission factors.

UBA: Uncertainties for mobile sources from IFEU/INFRAS (2010), in which uncertainties are evaluated for road and non-road vehicles via Monte Carlo simulations (for emission factors).

UBA/INFRAS: PM10 emission factor uncertainties derived from raw data of IFEU/INFRAS (2010).

Kupper 2012: see References (chp. 12.1).

INFRAS 2017b: see References (chp. 12.1).

INFRAS 2021: see References (chp. 12.1).

Schleiss 2017: see References (chp. 12.1).

Zähner et al. 2025: see References (chp. 12.1).

⁹ Note that Liechtenstein's consumption of liquid fuels is included in these numbers (see chp. 3.1.6.3).

Table A - 22 Input uncertainties for NO_x (as NO₂) for the year 2024, assigned to activity data (col. E) and emissions factors (col. F). For normal and gamma distributions, the given uncertainty is the standard deviation with a coverage factor of 2, expressed in percentage of the mean ((fu) means fuel used approach).

Year 2024									
A	B	E				F			
		Activity data uncertainty for a 95 % confidence				Emission factor uncertainty for a 95 %			
NFR code	Pollutant	Distribu- tion type	std. dev. %	Corr.	Ref.	Distribu- tion type	std. dev. %	Corr.	Ref.
1A1a	NOx (as NO2)	normal	10	no	GHGI	normal	19	yes	EMIS
1A1b	NOx (as NO2)	normal	1	no	GHGI	normal	20	yes	EMIS
1A1c	NOx (as NO2)	normal	5	no	EMIS	normal	20	yes	EMEP/EEA 2019
1A2a	NOx (as NO2)	normal	2	no	GHGI	normal	27	yes	EMIS
1A2b	NOx (as NO2)	normal	2	no	GHGI	normal	20	yes	EMIS
1A2c	NOx (as NO2)	normal	2	no	GHGI	normal	10	yes	EMIS
1A2d	NOx (as NO2)	normal	2	no	GHGI	normal	10	yes	EMIS
1A2e	NOx (as NO2)	normal	2	no	GHGI	normal	10	yes	EMIS
1A2f	NOx (as NO2)	normal	2	no	GHGI	normal	17	yes	EMIS
1A2gvii	NOx (as NO2)	normal	1	no	GHGI	normal	13	yes	UBA
1A2gviii	NOx (as NO2)	normal	2	no	GHGI	normal	17	yes	EMIS
1A3ai(i)	NOx (as NO2)	normal	1	no	GHGI	normal	20	yes	EMEP/EEA 2019
1A3aii(i)	NOx (as NO2)	normal	1	no	GHGI	normal	20	yes	EMEP/EEA 2019
1A3bi(fu)	NOx (as NO2)	normal	1	no	GHGI	normal	38	yes	UBA
1A3bii(fu)	NOx (as NO2)	normal	1	no	GHGI	normal	32	yes	UBA
1A3biii(fu)	NOx (as NO2)	normal	1	no	GHGI	normal	18	yes	UBA
1A3biv(fu)	NOx (as NO2)	normal	1	no	GHGI	normal	36	yes	UBA
1A3c	NOx (as NO2)	normal	1	no	GHGI	normal	13	yes	UBA
1A3dii	NOx (as NO2)	normal	1	no	GHGI	normal	13	yes	UBA
1A3ei	NOx (as NO2)	normal	2	no	GHGI	normal	50	yes	EMEP/EEA 2019
1A4ai	NOx (as NO2)	normal	2	no	GHGI	normal	16	yes	EMIS
1A4aii	NOx (as NO2)	normal	1	no	GHGI	normal	13	yes	UBA
1A4bi	NOx (as NO2)	normal	4	no	GHGI	normal	13	yes	EMIS
1A4bii	NOx (as NO2)	normal	1	no	GHGI	normal	30	yes	EMIS
1A4ci	NOx (as NO2)	normal	21	no	GHGI	normal	30	yes	EMIS
1A4cii	NOx (as NO2)	normal	1	no	GHGI	normal	13	yes	UBA
1A5b	NOx (as NO2)	normal	1	no	GHGI	normal	13	yes	UBA
1B2c	NOx (as NO2)	normal	22	no	EMIS	gamma	200	yes	EMIS
2A1	NOx (as NO2)	normal	2	no	GHGI	gamma	200	yes	EMEP/EEA 2019
2A2	NOx (as NO2)	normal	2	no	GHGI	gamma	500	yes	EMEP/EEA 2019
2A5a	NOx (as NO2)	normal	5	no	EMIS	gamma	500	yes	EMEP/EEA 2019
2B2	NOx (as NO2)	normal	2	no	GHGI	normal	10	yes	EMEP/EEA 2019
2B5	NOx (as NO2)	normal	2	no	GHGI	normal	40	yes	EMEP/EEA 2019
2B10a	NOx (as NO2)	normal	2	no	GHGI	normal	60	yes	EMEP/EEA 2019
2C1	NOx (as NO2)	normal	2	no	GHGI	normal	50	yes	EMEP/EEA 2019
2C3	NOx (as NO2)	normal	5	no	GHGI	gamma	200	yes	EMEP/EEA 2019
2C7c	NOx (as NO2)	normal	5	no	EMIS	gamma	100	yes	EMEP/EEA 2019
2G	NOx (as NO2)	normal	25	no	EMIS	gamma	100	yes	EMEP/EEA 2019
2H3	NOx (as NO2)	normal	3	no	EMIS	gamma	200	yes	EMEP/EEA 2019
3B1a	NOx (as NO2)	normal	6	no	GHGI	normal	50	yes	EMEP/EEA 2019
3B1b	NOx (as NO2)	normal	6	no	GHGI	normal	50	yes	EMEP/EEA 2019
3B2	NOx (as NO2)	normal	6	no	GHGI	normal	50	yes	EMEP/EEA 2019
3B3	NOx (as NO2)	normal	6	no	GHGI	normal	50	yes	EMEP/EEA 2019
3B4d	NOx (as NO2)	normal	6	no	GHGI	normal	50	yes	EMEP/EEA 2019
3B4e	NOx (as NO2)	normal	6	no	GHGI	normal	50	yes	EMEP/EEA 2019
3B4f	NOx (as NO2)	normal	6	no	GHGI	normal	50	yes	EMEP/EEA 2019
3B4gi	NOx (as NO2)	normal	6	no	GHGI	normal	50	yes	EMEP/EEA 2019
3B4gii	NOx (as NO2)	normal	6	no	GHGI	normal	50	yes	EMEP/EEA 2019
3B4giii	NOx (as NO2)	normal	6	no	GHGI	normal	50	yes	EMEP/EEA 2019
3B4giv	NOx (as NO2)	normal	6	no	GHGI	normal	50	yes	EMEP/EEA 2019
3B4h	NOx (as NO2)	normal	6	no	GHGI	normal	50	yes	EMEP/EEA 2019
3Da1	NOx (as NO2)	normal	5	no	GHGI	normal	100	yes	EMEP/EEA 2019
3Da2a	NOx (as NO2)	normal	6	no	GHGI	normal	50	yes	EMEP/EEA 2019
3Da2b	NOx (as NO2)	normal	6	no	GHGI	normal	100	yes	EMEP/EEA 2019
3Da2c	NOx (as NO2)	normal	20	no	Schleiss 2017	normal	100	yes	EMEP/EEA 2019
3Da3	NOx (as NO2)	normal	6	no	GHGI	normal	100	yes	EMEP/EEA 2019
5A	NOx (as NO2)	normal	10	no	GHGI	normal	50	yes	EMIS
5B2	NOx (as NO2)	normal	20	no	EMIS	normal	100	yes	EMEP/EEA 2019
5C1a	NOx (as NO2)	normal	50	no	EMIS	normal	40	yes	EMIS
5C1bi	NOx (as NO2)	normal	30	no	EMIS	normal	30	yes	EMIS
5C1biii	NOx (as NO2)	normal	30	no	EMIS	normal	30	yes	EMIS
5C1biv	NOx (as NO2)	normal	20	no	EMIS	normal	50	yes	EMIS
5C1bv	NOx (as NO2)	normal	5	no	EMIS	normal	30	yes	EMIS
5C2	NOx (as NO2)	normal	48	no	EMIS	gamma	156	yes	EMIS
5D1	NOx (as NO2)	normal	1	no	EMIS	normal	10	yes	EMIS
5D2	NOx (as NO2)	normal	10	no	EMIS	normal	10	yes	EMIS
6A	NOx (as NO2)	normal	30	no	EMIS	normal	50	yes	EMIS

Table A - 23 Input uncertainties for NMVOC for the year 2024, assigned to activity data (col. E) and emissions factors (col. F). For normal and gamma distributions, the given uncertainty is the standard deviation with a coverage factor of 2, expressed in percentage of the mean ((fu) means fuel used approach).

Year 2024									
NFR code	Pollutant	Activity data uncertainty for a 95 % confidence				Emission factor uncertainty for a 95 % confidence interval			
		Distribu- tion type	std. dev. %	Corr.	Ref.	Distribu- tion type	std. dev. %	Corr.	Ref.
1A1a	NMVOC	normal	10	no	GHGI	normal	32	yes	EMIS
1A1b	NMVOC	normal	1	no	GHGI	normal	20	yes	EMIS
1A1c	NMVOC	normal	5	no	EMIS	normal	20	yes	EMEP/EEA 2019
1A2a	NMVOC	normal	2	no	GHGI	normal	18	yes	EMIS
1A2b	NMVOC	normal	2	no	GHGI	normal	19	yes	EMIS
1A2c	NMVOC	normal	2	no	GHGI	normal	10	yes	EMIS
1A2d	NMVOC	normal	2	no	GHGI	normal	10	yes	EMIS
1A2e	NMVOC	normal	2	no	GHGI	normal	10	yes	EMIS
1A2f	NMVOC	normal	2	no	GHGI	normal	30	yes	EMIS
1A2gvii	NMVOC	normal	1	no	GHGI	normal	34	yes	UBA
1A2gviii	NMVOC	normal	2	no	GHGI	normal	30	yes	EMIS
1A3ai(i)	NMVOC	normal	1	no	GHGI	normal	50	yes	EMEP/EEA 2019
1A3aii(i)	NMVOC	normal	1	no	GHGI	normal	50	yes	EMEP/EEA 2019
1A3bi(fu)	NMVOC	normal	1	no	GHGI	normal	52	yes	UBA
1A3bii(fu)	NMVOC	normal	1	no	GHGI	normal	46	yes	UBA
1A3biii(fu)	NMVOC	normal	1	no	GHGI	normal	22	yes	UBA
1A3biv(fu)	NMVOC	normal	1	no	GHGI	gamma	400	yes	UBA
1A3bv(fu)	NMVOC	normal	1	no	GHGI	normal	40	yes	UBA
1A3c	NMVOC	normal	1	no	GHGI	normal	34	yes	UBA
1A3dii	NMVOC	normal	1	no	GHGI	normal	34	yes	UBA
1A3ei	NMVOC	normal	2	no	GHGI	normal	50	yes	EMEP/EEA 2019
1A4ai	NMVOC	normal	2	no	GHGI	normal	56	yes	EMIS
1A4aii	NMVOC	normal	1	no	GHGI	normal	75	yes	Sweden
1A4bi	NMVOC	normal	4	no	GHGI	normal	68	yes	EMIS
1A4bii	NMVOC	normal	1	no	GHGI	normal	75	yes	Sweden
1A4ci	NMVOC	normal	21	no	GHGI	normal	75	yes	EMIS
1A4cii	NMVOC	normal	1	no	GHGI	normal	75	yes	Sweden
1A5b	NMVOC	normal	1	no	GHGI	normal	34	yes	UBA
1B2ai	NMVOC	normal	30	no		normal	50	yes	EMEP/EEA 2019
1B2aiv	NMVOC	normal	30	no	EMEP/EEA 2019	normal	47	yes	EMIS
1B2av	NMVOC	normal	1	no	EMEP/EEA 2019	gamma	40	yes	EMIS
1B2b	NMVOC	normal	22	no	EMIS	normal	50	yes	EMEP/EEA 2019
1B2c	NMVOC	normal	22	no	EMIS	gamma	100	yes	EMIS
2A1	NMVOC	normal	2	no	GHGI	gamma	200	yes	EMEP/EEA 2019
2A2	NMVOC	normal	2	no	GHGI	gamma	500	yes	EMEP/EEA 2019
2A5a	NMVOC	normal	5	no	EMIS	gamma	500	yes	EMEP/EEA 2019
2B10a	NMVOC	normal	2	no	GHGI	normal	40	yes	EMEP/EEA 2019
2C1	NMVOC	normal	2	no	GHGI	gamma	100	yes	EMEP/EEA 2019
2C3	NMVOC	normal	5	no	GHGI	gamma	200	yes	EMEP/EEA 2019
2C7a	NMVOC	normal	5	no	EMIS	gamma	200	yes	EMEP/EEA 2019
2C7c	NMVOC	normal	5	no	EMIS	gamma	100	yes	EMEP/EEA 2019
2D3a	NMVOC	normal	1	no	EMIS	normal	50	no	IPPU_uncertainty.xlsx
2D3b	NMVOC	normal	5	no	EMIS	gamma	100	yes	EMEP/EEA 2019
2D3c	NMVOC	normal	20	no	EMIS	gamma	100	yes	EMEP/EEA 2019
2D3d	NMVOC	normal	20	no	EMIS	normal	40	yes	EMEP/EEA 2019
2D3e	NMVOC	normal	40	no	EMIS	normal	50	yes	EMEP/EEA 2019
2D3f	NMVOC	normal	20	no	EMIS	normal	40	yes	EMEP/EEA 2019
2D3g	NMVOC	normal	30	no	EMIS	gamma	100	yes	EMEP/EEA 2019
2D3h	NMVOC	normal	20	no	EMIS	normal	40	yes	EMEP/EEA 2019
2D3i	NMVOC	normal	30	no	EMEP/EEA 2019	gamma	180	yes	EMEP/EEA 2019
2G	NMVOC	normal	25	no	EMIS	gamma	200	yes	EMEP/EEA 2019
2H1	NMVOC	normal	30	no	EMEP/EEA 2019	gamma	200	yes	EMEP/EEA 2019
2H2	NMVOC	normal	10	no	EMEP/EEA 2019	gamma	100	yes	EMEP/EEA 2019
2H3	NMVOC	normal	3	no	EMIS	gamma	200	yes	EMEP/EEA 2019
3B1a	NMVOC	normal	6	no	GHGI	normal	60	yes	Zähner 2025, EMEP/EEA 2019
3B1b	NMVOC	normal	6	no	GHGI	normal	70	yes	Zähner 2025, EMEP/EEA 2019
3B2	NMVOC	normal	6	no	GHGI	gamma	200	yes	EMEP/EEA 2019
3B3	NMVOC	normal	6	no	GHGI	gamma	200	yes	EMEP/EEA 2019
3B4d	NMVOC	normal	6	no	GHGI	gamma	200	yes	EMEP/EEA 2019
3B4e	NMVOC	normal	6	no	GHGI	gamma	200	yes	EMEP/EEA 2019
3B4f	NMVOC	normal	6	no	GHGI	gamma	200	yes	EMEP/EEA 2019
3B4gi	NMVOC	normal	6	no	GHGI	gamma	200	yes	EMEP/EEA 2019
3B4gii	NMVOC	normal	6	no	GHGI	gamma	200	yes	EMEP/EEA 2019
3B4giii	NMVOC	normal	6	no	GHGI	gamma	200	yes	EMEP/EEA 2019
3B4giv	NMVOC	normal	6	no	GHGI	gamma	200	yes	EMEP/EEA 2019
3B4h	NMVOC	normal	6	no	GHGI	gamma	200	yes	EMEP/EEA 2019
3De	NMVOC	normal	5	no	GHGI (LULUCF)	gamma	200	yes	EMEP/EEA 2019
5A	NMVOC	normal	10	no	GHGI	normal	50	yes	EMIS
5B1	NMVOC	normal	20	no	Schleiss 2017	normal	100	yes	EMIS
5B2	NMVOC	normal	20	no	EMIS	normal	30	yes	EMIS
5C1a	NMVOC	normal	50	no	EMIS	normal	50	yes	EMIS
5C1bi	NMVOC	normal	30	no	EMIS	normal	30	yes	EMIS
5C1biii	NMVOC	normal	30	no	EMIS	normal	30	yes	EMIS
5C1biv	NMVOC	normal	20	no	EMIS	normal	20	yes	EMIS
5C1bv	NMVOC	normal	5	no	EMIS	normal	30	yes	EMIS
5C2	NMVOC	normal	48	no	EMIS	gamma	156	yes	EMIS
5D1	NMVOC	normal	1	no	EMIS	normal	27	yes	EMIS
5D2	NMVOC	normal	10	no	EMIS	normal	20	yes	EMIS
5E	NMVOC	normal	20	no	EMIS	normal	24	yes	EMIS
6A	NMVOC	normal	30	no	EMIS	normal	50	yes	EMIS

Table A - 24 Input uncertainties for SO_x for the year 2024, assigned to activity data (col. E) and emissions factors (col. F). For normal and gamma distributions, the given uncertainty is the standard deviation with a coverage factor of 2, expressed in percentage of the mean ((fu) means fuel used approach).

Year 2024									
NFR code	Pollutant	Activity data uncertainty for a 95 % confidence				Emission factor uncertainty for a 95 %			
		Distrib- tion type	std. dev. %	Corr.	Ref.	Distrib- tion type	std. dev. %	Corr.	Ref.
1A1a	SOx (as SO2)	normal	10	no	GHGI	normal	22	yes	EMIS
1A1b	SOx (as SO2)	normal	1	no	GHGI	normal	20	yes	EMIS
1A2a	SOx (as SO2)	normal	2	no	GHGI	normal	15	yes	EMIS
1A2b	SOx (as SO2)	normal	2	no	GHGI	normal	10	yes	EMIS
1A2c	SOx (as SO2)	normal	2	no	GHGI	normal	11	yes	EMIS
1A2d	SOx (as SO2)	normal	2	no	GHGI	normal	14	yes	EMIS
1A2e	SOx (as SO2)	normal	2	no	GHGI	normal	12	yes	EMIS
1A2f	SOx (as SO2)	normal	2	no	GHGI	normal	19	yes	EMIS
1A2gvii	SOx (as SO2)	normal	1	no	GHGI	normal	10	yes	EMEP/EEA 2019
1A2gviii	SOx (as SO2)	normal	2	no	GHGI	normal	19	yes	EMIS
1A3ai(i)	SOx (as SO2)	normal	1	no	GHGI	normal	10	yes	EMEP/EEA 2019
1A3aii(i)	SOx (as SO2)	normal	1	no	GHGI	normal	10	yes	EMEP/EEA 2019
1A3bi(fu)	SOx (as SO2)	normal	1	no	GHGI	normal	10	yes	EMEP/EEA 2019
1A3bii(fu)	SOx (as SO2)	normal	1	no	GHGI	normal	10	yes	EMEP/EEA 2019
1A3biii(fu)	SOx (as SO2)	normal	1	no	GHGI	normal	10	yes	EMEP/EEA 2019
1A3biv(fu)	SOx (as SO2)	normal	1	no	GHGI	normal	10	yes	EMEP/EEA 2019
1A3c	SOx (as SO2)	normal	1	no	GHGI	normal	10	yes	EMEP/EEA 2019
1A3dii	SOx (as SO2)	normal	1	no	GHGI	normal	10	yes	EMEP/EEA 2019
1A3ei	SOx (as SO2)	normal	2	no	GHGI	normal	10	yes	EMEP/EEA 2019
1A4ai	SOx (as SO2)	normal	2	no	GHGI	normal	10	yes	EMIS
1A4aii	SOx (as SO2)	normal	1	no	GHGI	normal	10	yes	EMEP/EEA 2019
1A4bi	SOx (as SO2)	normal	4	no	GHGI	normal	10	yes	EMIS
1A4bii	SOx (as SO2)	normal	1	no	GHGI	normal	10	yes	EMEP/EEA 2019
1A4ci	SOx (as SO2)	normal	21	no	GHGI	normal	18	yes	EMIS
1A4cii	SOx (as SO2)	normal	1	no	GHGI	normal	10	yes	EMEP/EEA 2019
1A5b	SOx (as SO2)	normal	1	no	GHGI	normal	10	yes	EMEP/EEA 2019
1B2aiv	SOx (as SO2)	normal	30	no	EMEP/EEA 2019	normal	47	yes	EMIS
1B2c	SOx (as SO2)	normal	22	no	EMIS	normal	31	yes	EMIS
2A1	SOx (as SO2)	normal	2	no	GHGI	gamma	200	yes	EMEP/EEA 2019
2A2	SOx (as SO2)	normal	2	no	GHGI	gamma	500	yes	EMEP/EEA 2019
2A5a	SOx (as SO2)	normal	5	no	EMIS	gamma	500	yes	EMEP/EEA 2019
2B5	SOx (as SO2)	normal	2	no	GHGI	normal	20	yes	EMEP/EEA 2019
2B10a	SOx (as SO2)	normal	2	no	GHGI	normal	40	yes	EMEP/EEA 2019
2C1	SOx (as SO2)	normal	2	no	GHGI	gamma	100	yes	EMEP/EEA 2019
2C3	SOx (as SO2)	normal	5	no	GHGI	gamma	200	yes	EMEP/EEA 2019
2C7c	SOx (as SO2)	normal	5	no	EMIS	gamma	100	yes	EMEP/EEA 2019
2G	SOx (as SO2)	normal	25	no	EMIS	gamma	100	yes	EMEP/EEA 2019
2H3	SOx (as SO2)	normal	3	no	EMIS	gamma	200	yes	EMEP/EEA 2019
5B2	SOx (as SO2)	normal	20	no	EMIS	normal	100	yes	EMIS
5C1a	SOx (as SO2)	normal	50	no	EMIS	normal	40	yes	EMIS
5C1bi	SOx (as SO2)	normal	30	no	EMIS	normal	30	yes	EMIS
5C1biii	SOx (as SO2)	normal	30	no	EMIS	normal	30	yes	EMIS
5C1biv	SOx (as SO2)	normal	20	no	EMIS	normal	30	yes	EMIS
5C2	SOx (as SO2)	normal	48	no	EMIS	gamma	133	yes	EMIS
5D1	SOx (as SO2)	normal	1	no	EMIS	normal	37	yes	EMIS
5D2	SOx (as SO2)	normal	10	no	EMIS	normal	20	yes	EMIS
6A	SOx (as SO2)	normal	30	no	EMIS	normal	50	yes	EMIS

Table A - 25 Input uncertainties for NH₃ for the year 2024, assigned to activity data (col. E) and emissions factors (col. F). For normal and gamma distributions, the given uncertainty is the standard deviation with a coverage factor of 2, expressed in percentage of the mean ((fu) means fuel used approach).

Year 2024									
A	B	E				F			
		Activity data uncertainty for a 95 % confidence				Emission factor uncertainty for a 95 %			
NFR code	Pollutant	Distribution type	std. dev. %	Corr.	Ref.	Distribution type	std. dev. %	Corr.	Ref.
1A1a	NH3	normal	10	no	GHGI	normal	20	yes	EMIS
1A1b	NH3	normal	1	no	GHGI	normal	10	yes	EMIS
1A2a	NH3	normal	2	no	GHGI	normal	10	yes	EMIS
1A2b	NH3	normal	2	no	GHGI	normal	10	yes	EMIS
1A2c	NH3	normal	2	no	GHGI	normal	10	yes	EMIS
1A2d	NH3	normal	2	no	GHGI	normal	10	yes	EMIS
1A2e	NH3	normal	2	no	GHGI	normal	10	yes	EMIS
1A2f	NH3	normal	2	no	GHGI	normal	9	yes	EMIS
1A2gvii	NH3	normal	1	no	GHGI	normal	50	yes	France
1A2gviii	NH3	normal	2	no	GHGI	normal	9	yes	EMIS
1A3bi(fu)	NH3	normal	1	no	GHGI	normal	50	yes	France
1A3bii(fu)	NH3	normal	1	no	GHGI	normal	50	yes	France
1A3biii(fu)	NH3	normal	1	no	GHGI	normal	50	yes	France
1A3biv(fu)	NH3	normal	1	no	GHGI	normal	50	yes	France
1A3c	NH3	normal	1	no	GHGI	normal	50	yes	France
1A3dii	NH3	normal	1	no	GHGI	normal	50	yes	France
1A4ai	NH3	normal	2	no	GHGI	normal	10	yes	EMIS
1A4aaii	NH3	normal	1	no	GHGI	normal	10	yes	EMIS
1A4bi	NH3	normal	4	no	GHGI	normal	10	yes	EMIS
1A4bii	NH3	normal	1	no	GHGI	normal	10	yes	EMIS
1A4ci	NH3	normal	21	no	GHGI	normal	10	yes	EMIS
1A4cii	NH3	normal	1	no	GHGI	normal	50	yes	France
1A5b	NH3	normal	1	no	GHGI	normal	50	yes	France
2B1	NH3	normal	2	no	GHGI	normal	10	yes	EMEP/EEA 2019
2B2	NH3	normal	2	no	GHGI	normal	10	yes	EMEP/EEA 2019
2B10a	NH3	normal	2	no	GHGI	normal	40	yes	EMEP/EEA 2019
2C1	NH3	normal	2	no	GHGI	gamma	200	yes	EMEP/EEA 2019
2C7c	NH3	normal	5	no	EMIS	gamma	500	yes	EMEP/EEA 2019
2G	NH3	normal	25	no	EMIS	normal	40	yes	EMEP/EEA 2019
2H2	NH3	normal	10	no	EMEP/EEA 2019	gamma	500	yes	EMEP/EEA 2019
2H3	NH3	normal	3	no	EMIS	gamma	200	yes	EMEP/EEA 2019
2L	NH3	normal	25	no	EMIS	normal	100	yes	EMEP/EEA 2019
3B1a	NH3	normal	6	no	GHGI	normal	29	yes	INFRAS 2021
3B1b	NH3	normal	6	no	GHGI	normal	27	yes	INFRAS 2021
3B2	NH3	normal	6	no	GHGI	normal	87	yes	INFRAS 2021
3B3	NH3	normal	6	no	GHGI	normal	40	yes	INFRAS 2021
3B4d	NH3	normal	6	no	GHGI	normal	65	yes	INFRAS 2021
3B4e	NH3	normal	6	no	GHGI	normal	52	yes	INFRAS 2021
3B4f	NH3	normal	6	no	GHGI	normal	68	yes	INFRAS 2021
3B4gi	NH3	normal	6	no	GHGI	normal	82	yes	INFRAS 2021
3B4gii	NH3	normal	6	no	GHGI	normal	86	yes	INFRAS 2021
3B4giii	NH3	normal	6	no	GHGI	normal	93	yes	INFRAS 2021
3B4giv	NH3	normal	6	no	GHGI	normal	85	yes	INFRAS 2021
3B4h	NH3	normal	6	no	GHGI	normal	50	yes	INFRAS 2021
3Da1	NH3	normal	5	no	GHGI	normal	50	yes	Kupper 2012
3Da2a	NH3	normal	6	no	GHGI	normal	21	yes	INFRAS 2021
3Da2b	NH3	normal	6	no	GHGI	normal	50	yes	Kupper 2012
3Da2c	NH3	normal	20	no	Schleiss 2017	normal	50	yes	Kupper 2012
3Da3	NH3	normal	6	no	GHGI	normal	62	yes	INFRAS 2021
3Da4	NH3	NO	NO	NO		NO	NO	NO	
5A	NH3	normal	10	no	GHGI	normal	50	yes	EMIS
5B1	NH3	normal	20	no	Schleiss 2017	normal	100	yes	EMIS
5B2	NH3	normal	20	no	EMIS	normal	75	yes	INFRAS 2014
5C1biv	NH3	normal	20	no	EMIS	normal	50	yes	EMIS
5C2	NH3	normal	48	no	EMIS	normal	25	yes	EMIS
5D1	NH3	normal	1	no	EMIS	normal	50	yes	EMIS
6A	NH3	normal	30	no	EMIS	normal	100	yes	EMEP/EEA 2019

Table A - 26 Input uncertainties for PM2.5 for the year 2024, assigned to activity data (col. E) and emissions factors (col. F). For normal and gamma distributions, the given uncertainty is the standard deviation with a coverage factor of 2, expressed in percentage of the mean ((fu) means fuel used approach).

Year 2024									
A	B	E				F			
		Activity data uncertainty for a 95 % confidence				Emission factor uncertainty for a 95 %			
NFR code	Pollutant	Distribu- tion type	std. dev. %	Corr.	Ref.	Distribu- tion type	std. dev. %	Corr.	Ref.
1A1a	PM2.5	normal	10	no	GHGI	normal	71	yes	EMIS
1A1b	PM2.5	normal	1	no	GHGI	normal	20	yes	EMIS
1A1c	PM2.5	normal	5	no	EMIS	normal	20	yes	EMEP/EEA 2019
1A2a	PM2.5	normal	2	no	GHGI	normal	28	yes	EMIS
1A2b	PM2.5	normal	2	no	GHGI	normal	30	yes	EMIS
1A2c	PM2.5	normal	2	no	GHGI	normal	10	yes	EMIS
1A2d	PM2.5	normal	2	no	GHGI	normal	33	yes	EMIS
1A2e	PM2.5	normal	2	no	GHGI	normal	10	yes	EMIS
1A2f	PM2.5	normal	2	no	GHGI	normal	65	yes	EMIS
1A2gvii	PM2.5	normal	1	no	GHGI	normal	50	yes	UBA/INFRAS
1A2gviii	PM2.5	normal	2	no	GHGI	normal	65	yes	EMIS
1A3ai(i)	PM2.5	normal	1	no	GHGI	normal	30	yes	UBA/INFRAS
1A3aii(i)	PM2.5	normal	1	no	GHGI	normal	30	yes	UBA/INFRAS
1A3bi(fu)	PM2.5	normal	1	no	GHGI	normal	57	yes	UBA/INFRAS
1A3bii(fu)	PM2.5	normal	1	no	GHGI	normal	48	yes	UBA/INFRAS
1A3biii(fu)	PM2.5	normal	1	no	GHGI	normal	27	yes	UBA/INFRAS
1A3biv(fu)	PM2.5	normal	1	no	GHGI	normal	54	yes	UBA/INFRAS
1A3bvi(fu)	PM2.5	normal	1	no	GHGI	normal	50	yes	UBA/INFRAS
1A3c	PM2.5	normal	1	no	GHGI	normal	50	yes	UBA/INFRAS
1A3dii	PM2.5	normal	1	no	GHGI	normal	50	yes	UBA/INFRAS
1A3ei	PM2.5	normal	2	no	GHGI	normal	27	yes	UBA/INFRAS
1A4ai	PM2.5	normal	2	no	GHGI	normal	78	yes	EMIS
1A4bi	PM2.5	normal	4	no	GHGI	normal	76	yes	EMIS
1A4ci	PM2.5	normal	21	no	GHGI	normal	39	yes	EMIS
1A4cii	PM2.5	normal	1	no	GHGI	normal	80	yes	EMIS
1A5b	PM2.5	normal	1	no	GHGI	normal	50	yes	UBA/INFRAS
1B1a	PM2.5	normal	30	no	EMEP/EEA 2019	normal	40	yes	EMIS
1B2c	PM2.5	normal	22	no	EMIS	gamma	237	yes	EMEP/EEA 2019
2A1	PM2.5	normal	2	no	GHGI	gamma	200	yes	EMEP/EEA 2019
2A2	PM2.5	normal	2	no	GHGI	gamma	500	yes	EMEP/EEA 2019
2A5a	PM2.5	normal	5	no	EMIS	gamma	500	yes	EMEP/EEA 2019
2B5	PM2.5	normal	2	no	GHGI	gamma	100	yes	EMEP/EEA 2019
2B10a	PM2.5	normal	2	no	GHGI	normal	40	yes	EMEP/EEA 2019
2C1	PM2.5	normal	2	no	GHGI	gamma	125	yes	EMEP/EEA 2019
2C3	PM2.5	normal	5	no	GHGI	gamma	200	yes	EMEP/EEA 2019
2C7a	PM2.5	normal	5	no	EMIS	gamma	200	yes	EMEP/EEA 2019
2C7c	PM2.5	normal	5	no	EMIS	gamma	500	yes	EMEP/EEA 2019
2D3c	PM2.5	normal	20	no	EMIS	gamma	200	yes	EMEP/EEA 2019
2D3i	PM2.5	normal	30	no	EMEP/EEA 2019	gamma	500	yes	EMEP/EEA 2019
2G	PM2.5	normal	25	no	EMIS	gamma	100	yes	EMEP/EEA 2019
2H1	PM2.5	normal	30	no	EMEP/EEA 2019	gamma	200	yes	EMEP/EEA 2019
2H2	PM2.5	normal	10	no	EMEP/EEA 2019	gamma	500	yes	EMEP/EEA 2019
2H3	PM2.5	normal	3	no	EMIS	gamma	200	yes	EMEP/EEA 2019
2I	PM2.5	normal	10	no	EMEP/EEA 2019	gamma	500	yes	EMEP/EEA 2019
3B1a	PM2.5	normal	6	no	GHGI	gamma	300	yes	EMIS
3B1b	PM2.5	normal	6	no	GHGI	gamma	300	yes	EMIS
3B2	PM2.5	normal	6	no	GHGI	gamma	300	yes	EMIS
3B3	PM2.5	normal	6	no	GHGI	gamma	300	yes	EMIS
3B4d	PM2.5	normal	6	no	GHGI	gamma	300	yes	EMIS
3B4e	PM2.5	normal	6	no	GHGI	gamma	300	yes	EMIS
3B4f	PM2.5	normal	6	no	GHGI	gamma	300	yes	EMIS
3B4gi	PM2.5	normal	6	no	GHGI	gamma	300	yes	EMIS
3B4gii	PM2.5	normal	6	no	GHGI	gamma	300	yes	
3B4giii	PM2.5	normal	6	no	GHGI	gamma	300	yes	
3B4giv	PM2.5	normal	6	no	GHGI	gamma	300	yes	
3B4h	PM2.5	normal	6	no	GHGI	gamma	300	yes	
3De	PM2.5	normal	5	no	GHGI (LULUCF)	gamma	200	yes	EMEP/EEA 2019
5A	PM2.5	normal	10	no	GHGI	normal	30	yes	EMIS
5B2	PM2.5	normal	20	no	EMIS	normal	100	yes	EMIS
5C1a	PM2.5	normal	50	no	EMIS	normal	30	yes	EMIS
5C1bi	PM2.5	normal	30	no	EMIS	normal	30	yes	EMIS
5C1biii	PM2.5	normal	30	no	EMIS	normal	30	yes	EMIS
5C1biv	PM2.5	normal	20	no	EMIS	normal	34	yes	EMIS
5C1bv	PM2.5	normal	5	no	EMIS	normal	33	yes	EMIS
5C2	PM2.5	normal	48	no	EMIS	gamma	156	yes	EMIS
5E	PM2.5	normal	20	no	EMIS	normal	30	yes	EMIS
6A	PM2.5	normal	30	no	EMIS	normal	40	yes	EMIS

Table A - 27 Input uncertainties for PM10 for the year 2024, assigned to activity data (col. E) and emissions factors (col. F). For normal and gamma distributions, the given uncertainty is the standard deviation with a coverage factor of 2, expressed in percentage of the mean ((fu) means fuel used approach).

A	B	E				F			
Year 2024									
NFR code	Pollutant	Activity data uncertainty for a 95 % confidence				Emission factor uncertainty for a 95 %			
		Distrib- tion type	std. dev. %	Corr.	Ref.	Distrib- tion type	std. dev. %	Corr.	Ref.
1A1a	PM10	normal	10	no	GHGI	normal	71	yes	EMIS
1A1b	PM10	normal	1	no	GHGI	normal	20	yes	EMIS
1A1c	PM10	normal	5	no	EMIS	normal	20	yes	EMEP/EEA 2019
1A2a	PM10	normal	2	no	GHGI	normal	28	yes	EMIS
1A2b	PM10	normal	2	no	GHGI	normal	30	yes	EMIS
1A2c	PM10	normal	2	no	GHGI	normal	10	yes	EMIS
1A2d	PM10	normal	2	no	GHGI	normal	33	yes	EMIS
1A2e	PM10	normal	2	no	GHGI	normal	10	yes	EMIS
1A2f	PM10	normal	2	no	GHGI	normal	65	yes	EMIS
1A2gvii	PM10	normal	1	no	GHGI	normal	50	yes	UBA/INFRAS
1A2gviii	PM10	normal	2	no	GHGI	normal	65	yes	EMIS
1A3ai(i)	PM10	normal	1	no	GHGI	normal	30	yes	UBA/INFRAS
1A3aii(j)	PM10	normal	1	no	GHGI	normal	30	yes	UBA/INFRAS
1A3bi(fu)	PM10	normal	1	no	GHGI	normal	47	yes	UBA/INFRAS
1A3bii(fu)	PM10	normal	1	no	GHGI	normal	58	yes	UBA/INFRAS
1A3biii(fu)	PM10	normal	1	no	GHGI	normal	27	yes	UBA/INFRAS
1A3biv(fu)	PM10	normal	1	no	GHGI	normal	54	yes	UBA/INFRAS
1A3bvi(fu)	PM10	normal	1	no	GHGI	normal	50	yes	UBA/INFRAS
1A3c	PM10	normal	1	no	GHGI	normal	50	yes	UBA/INFRAS
1A3dii	PM10	normal	1	no	GHGI	normal	50	yes	UBA/INFRAS
1A3ei	PM10	normal	2	no	GHGI	normal	27	yes	UBA/INFRAS
1A4ai	PM10	normal	2	no	GHGI	normal	78	yes	EMIS
1A4bi	PM10	normal	4	no	GHGI	normal	76	yes	EMIS
1A4ci	PM10	normal	21	no	GHGI	normal	39	yes	EMIS
1A4cii	PM10	normal	1	no	GHGI	normal	80	yes	EMIS
1A5b	PM10	normal	1	no	GHGI	normal	50	yes	UBA/INFRAS
1B1a	PM10	normal	30	no	EMEP/EEA 2019	normal	40	yes	EMIS
1B2c	PM10	normal	22	no	EMIS	gamma	237	yes	EMEP/EEA 2019
2A1	PM10	normal	2	no	GHGI	gamma	200	yes	EMEP/EEA 2019
2A2	PM10	normal	2	no	GHGI	gamma	500	yes	EMEP/EEA 2019
2A5a	PM10	normal	5	no	EMIS	gamma	500	yes	EMEP/EEA 2019
2B5	PM10	normal	2	no	GHGI	gamma	100	yes	EMEP/EEA 2019
2B10a	PM10	normal	2	no	GHGI	normal	40	yes	EMEP/EEA 2019
2C1	PM10	normal	2	no	GHGI	gamma	125	yes	EMEP/EEA 2019
2C3	PM10	normal	5	no	GHGI	gamma	200	yes	EMEP/EEA 2019
2C7a	PM10	normal	5	no	EMIS	gamma	200	yes	EMEP/EEA 2019
2C7c	PM10	normal	5	no	EMIS	gamma	500	yes	EMEP/EEA 2019
2D3c	PM10	normal	20	no	EMIS	gamma	200	yes	EMEP/EEA 2019
2D3i	PM10	normal	30	no	EMEP/EEA 2019	gamma	500	yes	EMEP/EEA 2019
2G	PM10	normal	25	no	EMIS	gamma	100	yes	EMEP/EEA 2019
2H1	PM10	normal	30	no	EMEP/EEA 2019	gamma	200	yes	EMEP/EEA 2019
2H2	PM10	normal	10	no	EMEP/EEA 2019	gamma	500	yes	EMEP/EEA 2019
2H3	PM10	normal	3	no	EMIS	gamma	200	yes	EMEP/EEA 2019
2I	PM10	normal	10	no	EMEP/EEA 2019	gamma	500	yes	EMEP/EEA 2019
3B1a	PM10	normal	6	no	GHGI	gamma	300	yes	EMIS
3B1b	PM10	normal	6	no	GHGI	gamma	300	yes	EMIS
3B2	PM10	normal	6	no	GHGI	gamma	300	yes	EMIS
3B3	PM10	normal	6	no	GHGI	gamma	300	yes	EMIS
3B4d	PM10	normal	6	no	GHGI	gamma	300	yes	EMIS
3B4e	PM10	normal	6	no	GHGI	gamma	300	yes	EMIS
3B4f	PM10	normal	6	no	GHGI	gamma	300	yes	EMIS
3B4gi	PM10	normal	6	no	GHGI	gamma	300	yes	EMIS
3B4gii	PM10	normal	6	no	GHGI	gamma	300	yes	
3B4giii	PM10	normal	6	no	GHGI	gamma	300	yes	
3B4giv	PM10	normal	6	no	GHGI	gamma	300	yes	
3B4h	PM10	normal	6	no	GHGI	gamma	300	yes	
3De	PM10	normal	5	no	GHGI (LULUCF)	gamma	200	yes	EMEP/EEA 2019
5A	PM10	normal	10	no	GHGI	normal	30	yes	EMIS
5B2	PM10	normal	20	no	EMIS	normal	100	yes	EMIS
5C1a	PM10	normal	50	no	EMIS	normal	50	yes	EMIS
5C1bi	PM10	normal	30	no	EMIS	normal	30	yes	EMIS
5C1biii	PM10	normal	30	no	EMIS	normal	30	yes	EMIS
5C1biv	PM10	normal	20	no	EMIS	normal	35	yes	EMIS
5C1bv	PM10	normal	5	no	EMIS	normal	33	yes	EMIS
5C2	PM10	normal	48	no	EMIS	gamma	156	yes	EMIS
5E	PM10	normal	20	no	EMIS	normal	30	yes	EMIS
6A	PM10	normal	30	no	EMIS	normal	40	yes	EMIS

A5.2 Uncertainty estimations: results from approach 1

Table A - 28 Uncertainty analysis of NO_x emissions, approach 1, for 2024 and for the trend 1990-2024. The uncertainties are given considering a 95 % confidence interval and expressed as the distance from edge to mean, in percentage of the mean ((fu) means fuel used approach). AD: activity data; EF: emission factor; EM: emission; corr.: correlated.

A	B	C	D	G		H		I	J	K		L		M					
				Emissions 1990	Emissions 2024	Emission combined uncertainty 2024				Category contribution to inventory variance 2024		Sensitivity if corr. (type A)	Sensitivity if not corr. (type B)	Contribution to inventory trend uncertainty from AD		Contribution to inventory trend uncertainty from EF		Contribution to inventory trend uncertainty from EM	
						(-)%	(+)%			(-)%	(+)%			(-)%	(+)%	(-)%	(+)%	(-)%	(+)%
1A1a	NOx (as NC)	6'279.37	2'615.26	21	21	1.634	1.634	0.005	0.019	0.262	0.262	0.089	0.089	0.077	0.077				
1A1b	NOx (as NC)	494.17	301.54	20	20	0.019	0.019	0.001	0.002	0.004	0.004	0.021	0.021	0.000	0.000				
1A1c	NOx (as NC)	0.01	0.03	21	21	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
1A2a	NOx (as NC)	279.07	94.91	27	27	0.003	0.003	0.000	0.001	0.002	0.002	0.002	0.002	0.000	0.000				
1A2b	NOx (as NC)	127.53	25.52	20	20	0.000	0.000	0.000	0.000	0.001	0.001	0.002	0.002	0.000	0.000				
1A2c	NOx (as NC)	1'050.42	200.97	10	10	0.002	0.002	0.001	0.001	0.004	0.004	0.009	0.009	0.000	0.000				
1A2d	NOx (as NC)	1'261.91	34.47	10	10	0.000	0.000	0.003	0.000	0.001	0.001	0.025	0.025	0.001	0.001				
1A2e	NOx (as NC)	743.69	192.28	10	10	0.002	0.002	0.000	0.001	0.004	0.004	0.003	0.003	0.000	0.000				
1A2f	NOx (as NC)	10'534.54	2'563.91	17	17	0.998	0.998	0.005	0.018	0.051	0.051	0.087	0.087	0.010	0.010				
1A2gvii	NOx (as NC)	6'333.94	1'443.28	13	13	0.184	0.184	0.004	0.010	0.019	0.019	0.049	0.049	0.003	0.003				
1A2gviii	NOx (as NC)	2'181.62	1'496.96	17	17	0.341	0.341	0.006	0.011	0.031	0.031	0.099	0.099	0.011	0.011				
1A3ai(i)	NOx (as NC)	1'214.30	2'143.64	20	20	0.957	0.957	0.013	0.015	0.028	0.028	0.250	0.250	0.063	0.063				
1A3aii(j)	NOx (as NC)	153.76	62.06	20	20	0.001	0.001	0.000	0.000	0.001	0.001	0.002	0.002	0.000	0.000				
1A3bi(fu)	NOx (as NC)	43'812.31	12'539.29	38	38	119.169	119.169	0.008	0.089	0.162	0.162	0.301	0.301	0.117	0.117				
1A3bii(fu)	NOx (as NC)	6'094.80	3'023.23	32	32	4.919	4.919	0.008	0.021	0.039	0.039	0.257	0.257	0.067	0.067				
1A3biii(fu)	NOx (as NC)	29'839.33	3'370.34	18	18	1.917	1.917	0.042	0.024	0.044	0.044	0.755	0.755	0.573	0.573				
1A3biv(fu)	NOx (as NC)	330.77	150.31	36	36	0.015	0.015	0.000	0.001	0.002	0.002	0.012	0.012	0.000	0.000				
1A3c	NOx (as NC)	595.50	311.14	13	13	0.009	0.009	0.001	0.002	0.004	0.004	0.012	0.012	0.000	0.000				
1A3dii	NOx (as NC)	1'054.73	869.53	13	13	0.067	0.067	0.004	0.006	0.011	0.011	0.050	0.050	0.003	0.003				
1A3ei	NOx (as NC)	19.41	1.45	50	50	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.002	0.000	0.000				
1A4ai	NOx (as NC)	5'139.24	2'677.14	16	16	0.960	0.960	0.008	0.019	0.042	0.042	0.122	0.122	0.017	0.017				
1A4aii	NOx (as NC)	16.28	37.67	13	13	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.003	0.000	0.000				
1A4bi	NOx (as NC)	11'636.07	3'494.37	14	14	1.157	1.157	0.001	0.025	0.130	0.130	0.012	0.012	0.017	0.017				
1A4bii	NOx (as NC)	18.76	17.56	30	30	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.002	0.000	0.000				
1A4ci	NOx (as NC)	388.54	356.11	37	37	0.089	0.089	0.002	0.003	0.076	0.076	0.050	0.050	0.008	0.008				
1A4cii	NOx (as NC)	4'357.53	1'513.58	13	13	0.203	0.203	0.001	0.011	0.020	0.020	0.014	0.014	0.001	0.001				
1A5b	NOx (as NC)	882.99	316.53	13	13	0.009	0.009	0.000	0.002	0.004	0.004	0.004	0.004	0.000	0.000				
1B2c	NOx (as NC)	211.21	1.04	100	276	0.000	0.000	0.000	0.000	0.000	0.000	0.045	0.127	0.002	0.016				
2A1	NOx (as NC)	15.87	9.03	98	275	0.000	0.003	0.000	0.000	0.000	0.000	0.003	0.008	0.000	0.000				
2A2	NOx (as NC)	0.27	0.24	100	740	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
2A5a	NOx (as NC)	1.79	0.40	100	741	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000				
2B2	NOx (as NC)	82.78	NO	NO	NO	NO	NO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
2B5	NOx (as NC)	22.20	14.64	40	40	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.002	0.000	0.000				
2B10a	NOx (as NC)	8.93	1.95	60	60	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
2C1	NOx (as NC)	245.46	136.13	50	50	0.024	0.024	0.000	0.001	0.003	0.003	0.021	0.021	0.000	0.000				
2C3	NOx (as NC)	17.41	NO	NO	NO	NO	NO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
2C7c	NOx (as NC)	NA	1.54	74	122	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000				
2G	NOx (as NC)	29.36	17.03	78	125	0.001	0.002	0.000	0.000	0.004	0.004	0.004	0.007	0.000	0.000				
2H3	NOx (as NC)	91.00	31.29	98	275	0.005	0.038	0.000	0.000	0.001	0.001	0.002	0.006	0.000	0.000				
3B1a	NOx (as NC)	672.26	367.90	50	50	0.178	0.178	0.001	0.003	0.024	0.024	0.056	0.056	0.004	0.004				
3B1b	NOx (as NC)	344.28	285.62	50	50	0.107	0.107	0.001	0.002	0.018	0.018	0.063	0.063	0.004	0.004				
3B2	NOx (as NC)	66.63	55.69	50	50	0.004	0.004	0.000	0.000	0.004	0.004	0.012	0.012	0.000	0.000				
3B3	NOx (as NC)	185.29	79.15	50	50	0.008	0.008	0.000	0.001	0.005	0.005	0.008	0.008	0.000	0.000				
3B4d	NOx (as NC)	16.15	18.04	50	50	0.000	0.000	0.000	0.000	0.001	0.001	0.005	0.005	0.000	0.000				
3B4e	NOx (as NC)	17.58	26.53	50	50	0.001	0.001	0.000	0.000	0.002	0.002	0.007	0.007	0.000	0.000				
3B4f	NOx (as NC)	1.35	7.20	50	50	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.002	0.000	0.000				
3B4gi	NOx (as NC)	7.19	9.63	50	50	0.000	0.000	0.000	0.000	0.001	0.001	0.003	0.003	0.000	0.000				
3B4gii	NOx (as NC)	4.46	13.02	50	50	0.000	0.000	0.000	0.000	0.001	0.001	0.004	0.004	0.000	0.000				
3B4giii	NOx (as NC)	0.44	0.38	50	50	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
3B4giv	NOx (as NC)	0.84	1.26	50	50	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
3B4h	NOx (as NC)	2.00	4.65	50	50	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000				
3Da1	NOx (as NC)	1'204.90	721.61	100	100	2.705	2.705	0.002	0.005	0.036	0.036	0.246	0.246	0.062	0.062				
3Da2a	NOx (as NC)	2'098.58	1'503.08	50	50	2.976	2.976	0.006	0.011	0.097	0.097	0.301	0.301	0.100	0.100				
3Da2b	NOx (as NC)	87.01	NO	NO	NO	NO	NO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
3Da2c	NOx (as NC)	59.24	137.10	102	102	0.101	0.101	0.001	0.001	0.028	0.028	0.084	0.084	0.008	0.008				
3Da3	NOx (as NC)	242.72	418.32	100	100	0.911	0.911	0.002	0.003	0.027	0.027	0.243	0.243	0.060	0.060				
5A	NOx (as NC)	1.83	1.20	51	51	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
5B2	NOx (as NC)	NA	6.30	102	102	0.000	0.000	0.000	0.000	0.001	0.001	0.004	0.004	0.000	0.000				
5C1a	NOx (as NC)	80.75	37.34	64	64	0.003	0.003	0.000	0.000	0.019	0.019	0.003	0.003	0.000	0.000				
5C1bi	NOx (as NC)	9.75	NO	NO	NO	NO	NO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
5C1biii	NOx (as NC)	22.50	NO	NO	NO	NO	NO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
5C1biv	NOx (as NC)	114.00	42.13	54	54	0.003	0.003	0.000	0.000	0.008	0.008	0.002	0.002	0.000	0.000				
5C1bv	NOx (as NC)	11.25	13.71	30	30	0.000	0.000	0.000	0.000	0.001	0.001	0.002	0.002	0.000	0.000				
5C2	NOx (as NC)	23.65	15.85	104	211	0.001	0.006	0.000	0.000	0.008	0.008	0.006	0.012	0.000	0.000				
5D1	NOx (as NC)	25.35	5.80	10	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
5D2	NOx (as NC)	0.23	1.17	14	14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
6A	NOx (as NC)	92.05	87.61	58	58	0.014	0.014	0.000	0.001	0.026	0.026	0.021	0.021	0.001	0.001				
Total						139.7	139.7							1.2	1.2				
Total		140'959.1	43'926.6	Emissions 2024 uncertainty (%):		11.8	11.8			Trend uncertainty (%):				1.1	1.1				

Table A - 30 Uncertainty analysis of SO_x emissions, approach 1, for 2024 and for the trend 1990-2024. The uncertainties are given considering a 95 % confidence interval and expressed as the distance from edge to mean, in percentage of the mean ((fu) means fuel used approach). AD: activity data; EF: emission factor; EM: emission; corr.: correlated.

A	B	C	D	G		H		I	J	K		L		M	
				Emissions 1990	Emissions 2024	Emission combined uncertainty 2024				Category contribution to inventory variance 2024		Sensitivity if corr. (type A)	Sensitivity if not corr. (type B)	Contribution to inventory trend uncertainty from AD	
(-)%	(+)%	(-)%	(+)%			(-)%	(+)%	(-)%	(+)%	(-)%	(+)%			(-)%	(+)%
1A1a	SOx (as SO	3'679.11	288.61	24	24	10.636	10.636	0.002	0.007	0.104	0.104	0.049	0.049	0.013	0.013
1A1b	SOx (as SO	660.41	47.35	20	20	0.197	0.197	0.000	0.001	0.002	0.002	0.006	0.006	0.000	0.000
1A2a	SOx (as SO	362.55	8.10	15	15	0.003	0.003	0.000	0.000	0.001	0.001	0.004	0.004	0.000	0.000
1A2b	SOx (as SO	67.34	0.67	10	10	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000
1A2c	SOx (as SO	1'187.10	71.04	11	11	0.138	0.138	0.000	0.002	0.005	0.005	0.002	0.002	0.000	0.000
1A2d	SOx (as SO	3'238.01	0.89	14	14	0.000	0.000	0.004	0.000	0.000	0.000	0.063	0.063	0.004	0.004
1A2e	SOx (as SO	1'077.50	5.04	12	12	0.001	0.001	0.001	0.000	0.000	0.000	0.016	0.016	0.000	0.000
1A2f	SOx (as SO	3'530.25	668.56	19	19	35.672	35.672	0.012	0.017	0.048	0.048	0.231	0.231	0.055	0.055
1A2gvii	SOx (as SO	370.66	2.68	10	10	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.000	0.000
1A2gviii	SOx (as SO	3'533.86	167.51	19	19	2.241	2.241	0.001	0.004	0.012	0.012	0.012	0.012	0.000	0.000
1A3ai(i)	SOx (as SO	99.68	148.96	10	10	0.493	0.493	0.004	0.004	0.007	0.007	0.037	0.037	0.001	0.001
1A3aii(j)	SOx (as SO	24.94	5.23	10	10	0.001	0.001	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000
1A3bi(fu)	SOx (as SO	1'618.25	32.24	10	10	0.023	0.023	0.001	0.001	0.001	0.001	0.014	0.014	0.000	0.000
1A3bii(fu)	SOx (as SO	317.41	5.44	10	10	0.001	0.001	0.000	0.000	0.000	0.000	0.003	0.003	0.000	0.000
1A3biii(fu)	SOx (as SO	1'820.88	9.11	10	10	0.002	0.002	0.002	0.000	0.000	0.000	0.023	0.023	0.001	0.001
1A3biv(fu)	SOx (as SO	26.63	0.50	10	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1A3c	SOx (as SO	26.92	0.12	10	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1A3dii	SOx (as SO	64.88	0.48	10	10	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000
1A3ei	SOx (as SO	0.28	0.02	10	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1A4ai	SOx (as SO	3'869.92	74.18	10	10	0.123	0.123	0.003	0.002	0.004	0.004	0.035	0.035	0.001	0.001
1A4aii	SOx (as SO	1.61	0.05	10	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1A4bi	SOx (as SO	10'354.85	212.17	11	11	1.120	1.120	0.009	0.005	0.028	0.028	0.090	0.090	0.009	0.009
1A4bii	SOx (as SO	1.20	0.03	10	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1A4ci	SOx (as SO	335.80	50.51	28	28	0.432	0.432	0.001	0.001	0.039	0.039	0.015	0.015	0.002	0.002
1A4cii	SOx (as SO	304.60	1.59	10	10	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.000	0.000
1A5b	SOx (as SO	78.17	25.47	10	10	0.014	0.014	0.001	0.001	0.001	0.001	0.005	0.005	0.000	0.000
1B2aiv	SOx (as SO	419.02	13.03	56	56	0.115	0.115	0.000	0.000	0.014	0.014	0.012	0.012	0.000	0.000
1B2c	SOx (as SO	300.98	1.33	38	38	0.001	0.001	0.000	0.000	0.001	0.001	0.012	0.012	0.000	0.000
2A1	SOx (as SO	0.69	0.39	98	275	0.000	0.003	0.000	0.000	0.000	0.000	0.001	0.002	0.000	0.000
2A2	SOx (as SO	0.01	0.01	100	740	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2A5a	SOx (as SO	0.08	0.02	100	741	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2B5	SOx (as SO	625.20	196.69	20	20	3.418	3.418	0.004	0.005	0.014	0.014	0.083	0.083	0.007	0.007
2B10a	SOx (as SO	168.00	44.26	40	40	0.687	0.687	0.001	0.001	0.003	0.003	0.036	0.036	0.001	0.001
2C1	SOx (as SO	144.04	13.59	74	122	0.220	0.602	0.000	0.000	0.001	0.001	0.011	0.018	0.000	0.000
2C3	SOx (as SO	696.30	NO	NO	NO	NO	NO	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2C7c	SOx (as SO	NA	0.02	74	122	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2G	SOx (as SO	3.44	5.63	78	125	0.042	0.107	0.000	0.000	0.005	0.005	0.010	0.017	0.000	0.000
2H3	SOx (as SO	1.30	0.45	98	275	0.000	0.003	0.000	0.000	0.000	0.000	0.001	0.003	0.000	0.000
5B2	SOx (as SO	NA	0.95	102	102	0.002	0.002	0.000	0.000	0.001	0.001	0.002	0.002	0.000	0.000
5C1a	SOx (as SO	24.23	11.20	64	64	0.112	0.112	0.000	0.000	0.020	0.020	0.010	0.010	0.001	0.001
5C1bi	SOx (as SO	45.00	NO	NO	NO	NO	NO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5C1biii	SOx (as SO	19.50	NO	NO	NO	NO	NO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5C1biv	SOx (as SO	74.10	17.06	36	36	0.083	0.083	0.000	0.000	0.012	0.012	0.010	0.010	0.000	0.000
5C2	SOx (as SO	0.51	0.34	99	177	0.000	0.001	0.000	0.000	0.001	0.001	0.001	0.001	0.000	0.000
5D1	SOx (as SO	0.13	0.03	37	37	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5D2	SOx (as SO	0.00	0.01	22	22	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6A	SOx (as SO	9.17	7.03	58	58	0.037	0.037	0.000	0.000	0.008	0.008	0.008	0.008	0.000	0.000
Total						55.8	56.3							0.1	0.1
Total		39'184.5	2'138.6	Emissions 2024 uncertainty (%):		7.5	7.5			Trend uncertainty (%):				0.3	0.3

Table A - 31 Uncertainty analysis of NH₃ emissions, approach 1, for 2024 and for the trend 1990-2024. The uncertainties are given considering a 95 % confidence interval and expressed as the distance from edge to mean, in percentage of the mean ((fu) means fuel used approach). AD: activity data; EF: emission factor; EM: emission; corr.: correlated.

A	B	C	D	G		H		I	J	K		L		M	
				Emissions 1990	Emissions 2024	Emission combined uncertainty 2024				Category contribution to inventory variance 2024		Sensitivity if corr. (type A)	Sensitivity if not corr. (type B)	Contribution to inventory trend uncertainty from AD	
(-)%	(+)%	(-)%	(+)%			(-)%	(+)%	(-)%	(+)%	(-)%	(+)%			(-)%	(+)%
1A1a	NH3	4.85	51.71	22	22	0.001	0.001	0.001	0.001	0.013	0.013	0.017	0.017	0.000	0.000
1A1b	NH3	0.01	0.01	10	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1A2a	NH3	0.00	0.00	10	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1A2b	NH3	0.11	0.00	10	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1A2c	NH3	0.02	0.01	10	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1A2d	NH3	0.02	0.00	10	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1A2e	NH3	0.02	0.01	10	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1A2f	NH3	147.02	184.76	9	9	0.002	0.002	0.001	0.003	0.009	0.009	0.013	0.013	0.000	0.000
1A2g	NH3	1.00	1.56	50	50	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000
1A2g	NH3	17.00	36.37	9	9	0.000	0.000	0.000	0.001	0.002	0.002	0.004	0.004	0.000	0.000
1A3b	(fu) NH3	1'322.85	767.28	50	50	0.881	0.881	0.003	0.014	0.025	0.025	0.162	0.162	0.027	0.027
1A3b	(fu) NH3	8.24	34.84	50	50	0.002	0.002	0.001	0.001	0.001	0.001	0.025	0.025	0.001	0.001
1A3b	(fu) NH3	4.20	33.16	50	50	0.002	0.002	0.001	0.001	0.001	0.001	0.027	0.027	0.001	0.001
1A3b	(fu) NH3	3.39	3.22	50	50	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000
1A3c	NH3	0.07	0.07	50	50	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1A3d	NH3	0.20	0.21	50	50	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1A4a	NH3	19.80	34.69	10	10	0.000	0.000	0.000	0.001	0.001	0.001	0.004	0.004	0.000	0.000
1A4a	NH3	0.01	0.02	10	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1A4b	NH3	153.12	57.00	11	11	0.000	0.000	0.001	0.001	0.005	0.005	0.009	0.009	0.000	0.000
1A4b	NH3	0.01	0.01	10	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1A4c	NH3	2.88	8.38	23	23	0.000	0.000	0.000	0.000	0.004	0.004	0.001	0.001	0.000	0.000
1A4c	NH3	0.76	0.82	50	50	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1A5b	NH3	0.04	0.04	50	50	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2B1	NH3	0.07	0.01	10	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2B2	NH3	0.73	NO	NO	NO	NO	NO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2B10a	NH3	7.73	NA	NA	NA	NA	NA	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2C1	NH3	11.90	1.26	98	275	0.000	0.000	0.000	0.000	0.000	0.000	0.013	0.035	0.000	0.001
2C7c	NH3	9.19	8.13	100	741	0.000	0.022	0.000	0.000	0.001	0.001	0.003	0.020	0.000	0.000
2G	NH3	203.15	62.45	47	47	0.005	0.005	0.001	0.001	0.039	0.039	0.059	0.059	0.005	0.005
2H2	NH3	132.33	48.45	100	741	0.014	0.770	0.001	0.001	0.012	0.012	0.082	0.609	0.007	0.372
2H3	NH3	1.04	0.36	98	275	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.000	0.000
2L	NH3	2.38	3.72	103	103	0.000	0.000	0.000	0.000	0.002	0.002	0.004	0.004	0.000	0.000
3B1a	NH3	8'190.44	8'022.92	30	30	33.987	33.987	0.037	0.141	1.286	1.286	1.085	1.085	2.832	2.832
3B1b	NH3	4'826.53	6'482.83	28	28	19.375	19.375	0.053	0.114	1.039	1.039	1.429	1.429	3.123	3.123
3B2	NH3	502.48	407.02	87	87	0.754	0.754	0.001	0.007	0.065	0.065	0.070	0.070	0.009	0.009
3B3	NH3	6'716.54	3'380.27	41	41	11.222	11.222	0.026	0.059	0.542	0.542	1.021	1.021	1.337	1.337
3B4d	NH3	118.13	130.96	65	65	0.044	0.044	0.001	0.002	0.021	0.021	0.053	0.053	0.003	0.003
3B4e	NH3	256.31	392.62	52	52	0.253	0.253	0.004	0.007	0.063	0.063	0.191	0.191	0.040	0.040
3B4f	NH3	19.65	104.01	68	68	0.030	0.030	0.002	0.002	0.017	0.017	0.108	0.108	0.012	0.012
3B4g	NH3	978.79	601.46	82	82	1.464	1.464	0.002	0.011	0.096	0.096	0.148	0.148	0.031	0.031
3B4g	NH3	304.87	717.24	86	86	2.289	2.289	0.009	0.013	0.115	0.115	0.754	0.754	0.581	0.581
3B4g	NH3	29.77	22.19	93	93	0.003	0.003	0.000	0.000	0.004	0.004	0.001	0.001	0.000	0.000
3B4g	NH3	124.46	97.51	85	85	0.041	0.041	0.000	0.002	0.016	0.016	0.012	0.012	0.000	0.000
3B4h	NH3	14.55	41.56	50	50	0.003	0.003	0.001	0.001	0.007	0.007	0.027	0.027	0.001	0.001
3Da1	NH3	4'258.33	2'562.00	50	50	9.917	9.917	0.009	0.045	0.319	0.319	0.441	0.441	0.297	0.297
3Da2a	NH3	23'969.58	12'261.37	22	22	43.401	43.401	0.087	0.216	1.966	1.966	1.835	1.835	7.231	7.231
3Da2b	NH3	1'169.36	NO	NO	NO	NO	NO	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3Da2c	NH3	766.21	1'174.30	54	54	2.393	2.393	0.011	0.021	0.585	0.585	0.548	0.548	0.642	0.642
3Da3	NH3	758.59	1'333.83	62	62	4.136	4.136	0.014	0.023	0.214	0.214	0.860	0.860	0.785	0.785
3Da4	NH3	0.63	0.84	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5A	NH3	615.79	177.52	51	51	0.049	0.049	0.005	0.003	0.044	0.044	0.234	0.234	0.057	0.057
5B1	NH3	175.08	306.00	102	102	0.583	0.583	0.003	0.005	0.152	0.152	0.317	0.317	0.124	0.124
5B2	NH3	10.28	251.86	78	78	0.229	0.229	0.004	0.004	0.125	0.125	0.323	0.323	0.120	0.120
5C1b	NH3	5.70	2.00	54	54	0.000	0.000	0.000	0.000	0.001	0.001	0.002	0.002	0.000	0.000
5C2	NH3	13.71	9.19	54	54	0.000	0.000	0.000	0.000	0.011	0.011	0.000	0.000	0.000	0.000
5D1	NH3	89.98	130.54	50	50	0.026	0.026	0.001	0.002	0.004	0.004	0.058	0.058	0.003	0.003
6A	NH3	846.09	933.00	104	104	5.677	5.677	0.006	0.016	0.697	0.697	0.571	0.571	0.811	0.811
Total								136.8	137.6					18.1	18.4
Total		56'816.0	40'881.6	Emissions 2024 uncertainty (%)		11.7	11.7			Trend uncertainty (%)				4.3	4.3

Table A - 32 Uncertainty analysis of PM2.5 emissions, approach 1, for 2024 and for the trend 1990-2024. The uncertainties are given considering a 95 % confidence interval and expressed as the distance from edge to mean, in percentage of the mean ((fu) means fuel used approach). AD: activity data; EF: emission factor; EM: emission; corr.: correlated.

A	B	C	D	G		H		I	J	K		L		M					
				Emissions 1990	Emissions 2024	Emission combined uncertainty 2024				Category contribution to inventory variance 2024		Sensitivity if corr. (type A)	Sensitivity if not corr. (type B)	Contribution to inventory trend uncertainty from AD		Contribution to inventory trend uncertainty from EF		Contribution to inventory trend uncertainty from EM	
						(-)%	(+)%			(-)%	(+)%			(-)%	(+)%	(-)%	(+)%	(-)%	(+)%
1A1a	PM2.5	781.83	69.40	72	72	0.685	0.685	0.004	0.003	0.036	0.036	0.270	0.270	0.074	0.074				
1A1b	PM2.5	47.66	1.25	20	20	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.007	0.000	0.000				
1A1c	PM2.5	4.64	11.30	21	21	0.002	0.002	0.000	0.000	0.003	0.003	0.008	0.008	0.000	0.000				
1A2a	PM2.5	14.81	2.31	28	28	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000				
1A2b	PM2.5	20.39	0.90	30	30	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.000	0.000				
1A2c	PM2.5	40.77	5.65	10	10	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.000	0.000				
1A2d	PM2.5	149.62	0.19	33	33	0.000	0.000	0.001	0.000	0.000	0.000	0.040	0.040	0.002	0.002				
1A2e	PM2.5	25.68	1.07	10	10	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.002	0.000	0.000				
1A2f	PM2.5	437.58	32.39	65	65	0.123	0.123	0.002	0.001	0.003	0.003	0.154	0.154	0.024	0.024				
1A2gvii	PM2.5	728.86	381.30	50	50	10.068	10.068	0.008	0.014	0.026	0.026	0.405	0.405	0.164	0.164				
1A2gviii	PM2.5	872.51	161.92	65	65	3.069	3.069	0.001	0.006	0.017	0.017	0.074	0.074	0.006	0.006				
1A3ai(i)	PM2.5	92.39	15.28	30	30	0.006	0.006	0.000	0.001	0.001	0.001	0.006	0.006	0.000	0.000				
1A3aii(f)	PM2.5	22.67	1.70	30	30	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.000	0.000				
1A3bi(fu)	PM2.5	588.85	100.26	57	57	0.915	0.915	0.001	0.004	0.007	0.007	0.063	0.063	0.004	0.004				
1A3bii(fu)	PM2.5	340.96	47.50	48	48	0.146	0.146	0.001	0.002	0.003	0.003	0.050	0.050	0.002	0.002				
1A3biii(fu)	PM2.5	1'599.49	31.66	27	27	0.020	0.020	0.012	0.001	0.002	0.002	0.319	0.319	0.102	0.102				
1A3biv(fu)	PM2.5	191.03	22.36	54	54	0.040	0.040	0.001	0.001	0.001	0.001	0.039	0.039	0.002	0.002				
1A3bvi(fu)	PM2.5	689.51	908.11	50	50	57.105	57.105	0.028	0.033	0.061	0.061	1.389	1.389	1.934	1.934				
1A3c	PM2.5	172.71	247.67	50	50	4.248	4.248	0.008	0.009	0.017	0.017	0.385	0.385	0.149	0.149				
1A3dii	PM2.5	59.09	20.24	50	50	0.028	0.028	0.000	0.001	0.001	0.001	0.013	0.013	0.000	0.000				
1A3ei	PM2.5	0.11	0.01	27	27	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
1A4ai	PM2.5	1'354.47	409.32	78	78	28.227	28.227	0.004	0.015	0.033	0.033	0.315	0.315	0.100	0.100				
1A4bi	PM2.5	14'535.91	1'724.85	76	76	476.806	476.806	0.054	0.063	0.334	0.334	4.138	4.138	17.233	17.233				
1A4ci	PM2.5	696.98	198.03	44	44	2.139	2.139	0.002	0.007	0.218	0.218	0.063	0.063	0.052	0.052				
1A4cii	PM2.5	435.10	116.42	80	80	2.402	2.402	0.001	0.004	0.008	0.008	0.060	0.060	0.004	0.004				
1A5b	PM2.5	86.95	43.69	50	50	0.132	0.132	0.001	0.002	0.003	0.003	0.045	0.045	0.002	0.002				
1B1a	PM2.5	0.16	0.03	50	50	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
1B2c	PM2.5	0.44	0.00	102	337	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000				
2A1	PM2.5	240.48	136.79	98	275	4.954	39.278	0.003	0.005	0.014	0.014	0.301	0.847	0.091	0.717				
2A2	PM2.5	7.21	6.61	100	740	0.012	0.663	0.000	0.000	0.001	0.001	0.018	0.137	0.000	0.019				
2A5a	PM2.5	102.21	88.70	100	741	2.184	119.432	0.002	0.003	0.023	0.023	0.243	1.800	0.060	3.242				
2B5	PM2.5	61.20	31.61	74	122	0.150	0.412	0.001	0.001	0.003	0.003	0.049	0.081	0.002	0.007				
2B10a	PM2.5	7.86	NA	NA	NA	NA	NA	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
2C1	PM2.5	817.90	6.82	84	158	0.009	0.032	0.006	0.000	0.001	0.001	0.536	1.012	0.287	1.024				
2C3	PM2.5	78.33	NO	NO	NO	NO	NO	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
2C7a	PM2.5	5.66	0.46	98	275	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.008	0.000	0.000				
2C7c	PM2.5	1.53	1.40	100	741	0.001	0.030	0.000	0.000	0.000	0.000	0.004	0.029	0.000	0.001				
2D3c	PM2.5	4.00	3.87	100	276	0.004	0.032	0.000	0.000	0.004	0.004	0.011	0.030	0.000	0.001				
2D3i	PM2.5	12.00	NA	NA	NA	NA	NA	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
2G	PM2.5	512.78	373.57	78	125	23.395	59.907	0.010	0.014	0.486	0.486	0.705	1.167	0.733	1.599				
2H1	PM2.5	235.77	171.56	102	277	8.522	62.510	0.004	0.006	0.268	0.268	0.429	1.210	0.256	1.535				
2H2	PM2.5	187.86	166.78	100	741	7.777	422.271	0.005	0.006	0.087	0.087	0.461	3.411	0.220	11.642				
2H3	PM2.5	15.60	5.36	98	275	0.008	0.060	0.000	0.000	0.001	0.001	0.007	0.019	0.000	0.000				
2I	PM2.5	216.08	47.32	100	741	0.626	33.993	0.000	0.002	0.025	0.025	0.002	0.012	0.001	0.001				
3B1a	PM2.5	20.61	22.83	100	440	0.145	2.794	0.001	0.001	0.008	0.008	0.067	0.296	0.005	0.088				
3B1b	PM2.5	18.26	22.41	100	440	0.140	2.692	0.001	0.001	0.008	0.008	0.068	0.297	0.005	0.088				
3B2	PM2.5	0.79	0.82	100	440	0.000	0.004	0.000	0.000	0.000	0.000	0.002	0.010	0.000	0.000				
3B3	PM2.5	9.57	6.15	100	440	0.011	0.203	0.000	0.000	0.002	0.002	0.015	0.065	0.000	0.004				
3B4d	PM2.5	0.14	0.18	100	440	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.000	0.000				
3B4e	PM2.5	3.94	6.72	100	440	0.013	0.242	0.000	0.000	0.002	0.002	0.022	0.095	0.000	0.009				
3B4f	PM2.5	0.59	3.33	100	440	0.003	0.059	0.000	0.000	0.001	0.001	0.012	0.052	0.000	0.003				
3B4gi	PM2.5	9.25	11.33	100	440	0.036	0.688	0.000	0.000	0.004	0.004	0.034	0.150	0.001	0.023				
3B4gii	PM2.5	6.78	22.24	100	440	0.137	2.651	0.001	0.001	0.007	0.007	0.076	0.336	0.006	0.113				
3B4giii	PM2.5	1.89	1.76	100	440	0.001	0.017	0.000	0.000	0.001	0.001	0.005	0.022	0.000	0.000				
3B4giv	PM2.5	1.98	3.17	100	440	0.003	0.054	0.000	0.000	0.001	0.001	0.010	0.044	0.000	0.002				
3B4h	PM2.5	0.24	0.07	100	440	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
3De	PM2.5	47.48	45.03	98	275	0.538	4.257	0.001	0.002	0.012	0.012	0.124	0.350	0.016	0.122				
5A	PM2.5	0.73	0.48	32	32	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
5B2	PM2.5	NA	0.06	102	102	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
5C1a	PM2.5	465.12	215.06	58	58	4.353	4.353	0.004	0.008	0.559	0.559	0.124	0.124	0.328	0.328				
5C1bi	PM2.5	0.47	NO	NO	NO	NO	NO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
5C1biii	PM2.5	16.50	NO	NO	NO	NO	NO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
5C1biv	PM2.5	14.25	2.95	39	39	0.000	0.000	0.000	0.000	0.003	0.003	0.000	0.000	0.000	0.000				
5C1bv	PM2.5	4.39	0.83	33	33	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
5C2	PM2.5	64.43	43.18	104	211	0.556	2.295	0.001	0.002	0.108	0.108	0.098	0.219	0.021	0.059				
5E	PM2.5	1.40	1.50	36	36	0.000	0.000	0.000	0.000	0.002	0.002	0.001	0.001	0.000	0.000				
6A	PM2.5	4.42	4.75	50	50	0.002	0.002	0.000	0.000	0.007	0.007	0.006	0.006	0.000	0.000				
Total						639.7	1'345.1							21.9	40.5				
Total		27'190.9	6'010.5	Emissions 2024 uncertainty (%):		25.3	36.7			Trend uncertainty (%):				4.7	6.4				

Table A - 33 Uncertainty analysis of PM10 emissions, approach 1, for 2024 and for the trend 1990-2024. The uncertainties are given considering a 95 % confidence interval and expressed as the distance from edge to mean, in percentage of the mean ((fu) means fuel used approach). AD: activity data; EF: emission factor; EM: emission; corr.: correlated.

A	B	C	D	G		H		I	J	K		L		M					
				Emissions 1990	Emissions 2024	Emission combined uncertainty 2024				Category contribution to inventory variance 2024		Sensitivity if corr. (type A)	Sensitivity if not corr. (type B)	Contribution to inventory trend uncertainty from AD		Contribution to inventory trend uncertainty from EF		Contribution to inventory trend uncertainty from EM	
						(-)%	(+)%			(-)%	(+)%			(-)%	(+)%	(-)%	(+)%	(-)%	(+)%
1A1a	PM10	1'044.54	70.57	72	72	0.133	0.133	0.009	0.002	0.027	0.027	0.636	0.636	0.406	0.406				
1A1b	PM10	47.66	1.25	20	20	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.009	0.000	0.000				
1A1c	PM10	4.89	11.91	21	21	0.000	0.000	0.000	0.000	0.002	0.002	0.006	0.006	0.000	0.000				
1A2a	PM10	20.53	2.54	28	28	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.000	0.000				
1A2b	PM10	29.24	0.95	30	30	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.008	0.000	0.000				
1A2c	PM10	40.77	5.65	10	10	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.003	0.000	0.000				
1A2d	PM10	166.58	0.19	33	33	0.000	0.000	0.002	0.000	0.000	0.000	0.007	0.057	0.003	0.003				
1A2e	PM10	25.68	1.07	10	10	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.002	0.000	0.000				
1A2f	PM10	832.63	59.10	65	65	0.076	0.076	0.007	0.002	0.005	0.005	0.459	0.459	0.211	0.211				
1A2gvii	PM10	2'173.23	2'373.78	50	50	73.010	73.010	0.042	0.065	0.119	0.119	2.117	2.117	4.498	4.498				
1A2gviii	PM10	913.14	171.41	65	65	0.644	0.644	0.005	0.005	0.014	0.014	0.314	0.314	0.099	0.099				
1A3ai(i)	PM10	102.65	15.28	30	30	0.001	0.001	0.001	0.000	0.001	0.001	0.020	0.020	0.000	0.000				
1A3aii(f)	PM10	25.19	1.70	30	30	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.006	0.000	0.000				
1A3bi(fu)	PM10	588.85	100.26	57	57	0.171	0.171	0.003	0.003	0.005	0.005	0.195	0.195	0.038	0.038				
1A3bii(fu)	PM10	340.96	47.50	48	48	0.027	0.027	0.002	0.001	0.002	0.002	0.109	0.109	0.012	0.012				
1A3biii(fu)	PM10	1'599.49	31.66	27	27	0.004	0.004	0.016	0.001	0.002	0.002	0.427	0.427	0.182	0.182				
1A3biv(fu)	PM10	191.03	22.36	54	54	0.008	0.008	0.001	0.001	0.001	0.001	0.075	0.075	0.006	0.006				
1A3bvi(fu)	PM10	2'046.08	2'477.55	50	50	79.533	79.533	0.047	0.068	0.124	0.124	2.326	2.326	5.425	5.425				
1A3c	PM10	969.78	1'615.17	50	50	33.802	33.802	0.034	0.044	0.081	0.081	1.707	1.707	2.919	2.919				
1A3dii	PM10	59.09	20.24	50	50	0.005	0.005	0.000	0.001	0.001	0.001	0.003	0.003	0.000	0.000				
1A3ei	PM10	0.11	0.01	27	27	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
1A4ai	PM10	1'427.63	434.63	78	78	5.955	5.955	0.003	0.012	0.026	0.026	0.233	0.233	0.055	0.055				
1A4bi	PM10	15'325.72	1'817.17	76	76	99.022	99.022	0.110	0.050	0.262	0.262	8.335	8.335	69.540	69.540				
1A4ci	PM10	710.36	200.57	44	44	0.411	0.411	0.002	0.005	0.165	0.165	0.075	0.075	0.033	0.033				
1A4cii	PM10	511.19	174.11	80	80	1.005	1.005	0.001	0.005	0.009	0.009	0.045	0.045	0.002	0.002				
1A5b	PM10	286.52	260.30	50	50	0.878	0.878	0.004	0.007	0.013	0.013	0.207	0.207	0.043	0.043				
1B1a	PM10	1.60	0.32	50	50	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
1B2c	PM10	0.44	0.00	102	337	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000				
2A1	PM10	374.35	212.95	98	275	2.246	17.810	0.002	0.006	0.017	0.017	0.189	0.531	0.036	0.282				
2A2	PM10	14.41	13.21	100	740	0.009	0.495	0.000	0.000	0.001	0.001	0.021	0.157	0.000	0.025				
2A5a	PM10	302.32	318.44	100	741	5.265	287.991	0.006	0.009	0.062	0.062	0.557	4.126	0.314	17.024				
2B5	PM10	73.80	38.05	74	122	0.041	0.112	0.000	0.001	0.003	0.003	0.020	0.033	0.000	0.001				
2B10a	PM10	17.07	NA	NA	NA	NA	NA	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
2C1	PM10	1'485.46	10.24	84	158	0.004	0.014	0.015	0.000	0.001	0.001	1.274	2.407	1.623	5.792				
2C3	PM10	113.15	NO	NO	NO	NO	NO	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
2C7a	PM10	5.96	0.48	98	275	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.013	0.000	0.000				
2C7c	PM10	3.06	2.77	100	741	0.000	0.022	0.000	0.000	0.001	0.001	0.004	0.033	0.000	0.001				
2D3c	PM10	19.98	19.35	100	276	0.019	0.148	0.000	0.001	0.015	0.015	0.031	0.089	0.001	0.008				
2D3i	PM10	24.00	NA	NA	NA	NA	NA	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
2G	PM10	588.38	497.05	78	125	7.750	19.844	0.007	0.014	0.482	0.482	0.551	0.913	0.536	1.065				
2H1	PM10	243.80	177.35	102	277	1.704	12.499	0.002	0.005	0.206	0.206	0.226	0.638	0.094	0.449				
2H2	PM10	310.12	310.37	100	741	5.039	273.609	0.005	0.009	0.120	0.120	0.527	3.901	0.292	15.235				
2H3	PM10	15.60	5.36	98	275	0.001	0.011	0.000	0.000	0.001	0.001	0.002	0.004	0.000	0.000				
2I	PM10	864.32	188.01	100	741	1.849	100.398	0.004	0.005	0.073	0.073	0.387	2.863	0.155	8.202				
3B1a	PM10	84.47	93.57	100	440	0.455	8.780	0.002	0.003	0.023	0.023	0.168	0.740	0.029	0.549				
3B1b	PM10	74.85	91.85	100	440	0.438	8.459	0.002	0.003	0.023	0.023	0.174	0.764	0.031	0.584				
3B2	PM10	19.76	20.41	100	440	0.022	0.418	0.000	0.001	0.005	0.005	0.035	0.155	0.001	0.024				
3B3	PM10	213.16	138.11	100	440	0.991	19.128	0.002	0.004	0.034	0.034	0.156	0.687	0.026	0.473				
3B4d	PM10	3.42	4.60	100	440	0.001	0.021	0.000	0.000	0.001	0.001	0.009	0.040	0.000	0.002				
3B4e	PM10	6.20	10.56	100	440	0.006	0.112	0.000	0.000	0.003	0.003	0.022	0.099	0.001	0.010				
3B4f	PM10	0.94	5.33	100	440	0.001	0.028	0.000	0.000	0.001	0.001	0.014	0.060	0.000	0.004				
3B4gi	PM10	123.32	151.10	100	440	1.187	22.893	0.003	0.004	0.038	0.038	0.285	1.256	0.083	1.578				
3B4gii	PM10	67.84	222.43	100	440	2.572	49.612	0.005	0.006	0.056	0.056	0.539	2.370	0.293	5.622				
3B4giii	PM10	10.41	9.70	100	440	0.005	0.094	0.000	0.000	0.002	0.002	0.016	0.069	0.000	0.005				
3B4giv	PM10	18.52	30.06	100	440	0.047	0.906	0.001	0.001	0.008	0.008	0.063	0.277	0.004	0.077				
3B4h	PM10	0.50	0.78	100	440	0.000	0.001	0.000	0.000	0.000	0.000	0.002	0.007	0.000	0.000				
3De	PM10	1'053.57	1'003.29	98	275	49.974	395.458	0.016	0.027	0.194	0.194	1.613	4.542	2.639	20.671				
5A	PM10	0.73	0.48	32	32	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
5B2	PM10	NA	0.06	102	102	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
5C1a	PM10	516.80	238.96	71	71	1.479	1.479	0.001	0.007	0.463	0.463	0.058	0.058	0.218	0.218				
5C1bi	PM10	3.08	NO	NO	NO	NO	NO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
5C1biii	PM10	24.00	NO	NO	NO	NO	NO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
5C1biv	PM10	19.95	4.21	40	40	0.000	0.000	0.000	0.000	0.003	0.003	0.003	0.003	0.000	0.000				
5C1bv	PM10	4.39	0.83	33	33	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000				
5C2	PM10	70.77	47.43	104	211	0.126	0.518	0.001	0.001	0.088	0.088	0.052	0.115	0.010	0.021				
5E	PM10	2.80	3.00	36	36	0.000	0.000	0.000	0.000	0.002	0.002	0.002	0.002	0.000	0.000				
6A	PM10	229.46	107.53	50	50	0.150	0.150	0.001	0.003	0.125	0.125	0.022	0.022	0.016	0.016				
Total						376.1	1'515.7							89.9	161.4				
Total		36'490.3	13'895.2	Emissions 2024 uncertainty (%):		19.4	38.9			Trend uncertainty (%):				9.5	12.7				

A5.3 Uncertainty estimations: results from approach 2

Numeric results of the uncertainty estimations using Monte Carlo simulations are summarised in the tables in Annex A5.3.1. In these tables, columns labelled A to J correspond exactly to columns A to J from Table 3.3, chp. 3, from the 2006 IPCC Guidelines (IPCC 2006).

Results of the sensitivity analysis between input emissions from each category and inventory emission are depicted by tornado plots in the figures in Annex A5.3.2 (see also discussion in chp. 1.7.3).

Distributions of inventory emissions obtained from the 500'000 Monte Carlo simulations are shown as histograms, for each pollutant, for the base year, the reporting year and the trend, in the figures in Annex A5.3.3.

A5.3.1 Uncertainty estimations, approach 2, numeric results

Table A - 34 Uncertainty analysis of NO_x emissions, approach 2, for 2024 and for the trend 1990-2024. Monte Carlo simulations were run 500'000 times. The reported uncertainties correspond to the borders of the narrowest 95.0 % confidence interval. Contributions to inventory trend (mean, uncertainties, columns I and J) are values normalised by the total inventory base year emission ((fu) means fuel used approach).

A	B	C		D		E		F		G		H	I	J	
		Emissions 1990	Emissions 2024	Activity data uncertainty 2024		Emission factor uncertainty 2024		Emission combined uncertainty 2024		Emission contribution to variance 2024	Contribution to trend	Contribution to uncertainty of trend			
				t	t	(-)%	(+)%	(-)%	(+)%			(-)%	(+)%	Fraction	%
1A1a	NOx (as NO2)	6'279.37	2'615.26	10	10	19	19	21	22	0.012	-2.609	0.762	0.733		
1A1b	NOx (as NO2)	494.17	301.54	1	1	20	20	20	20	0.000	-0.137	0.034	0.032		
1A1c	NOx (as NO2)	0.01	0.03	5	5	20	20	20	21	0.000	0.000	0.000	0.000		
1A2a	NOx (as NO2)	279.07	94.91	2	2	27	27	27	27	0.000	-0.131	0.040	0.039		
1A2b	NOx (as NO2)	127.53	25.52	2	2	20	20	20	20	0.000	-0.073	0.018	0.017		
1A2c	NOx (as NO2)	1'050.42	200.97	2	2	10	10	10	10	0.000	-0.605	0.103	0.096		
1A2d	NOx (as NO2)	1'261.91	34.47	2	2	10	10	10	10	0.000	-0.875	0.146	0.141		
1A2e	NOx (as NO2)	743.69	192.28	2	2	10	10	10	10	0.000	-0.393	0.066	0.063		
1A2f	NOx (as NO2)	10'534.54	2'563.91	2	2	17	17	17	17	0.007	-5.676	1.181	1.146		
1A2gvii	NOx (as NO2)	6'333.94	1'443.28	1	1	13	13	13	13	0.001	-3.484	0.636	0.616		
1A2gviii	NOx (as NO2)	2'181.62	1'496.96	2	2	17	17	17	17	0.002	-0.488	0.113	0.107		
1A3ai(i)	NOx (as NO2)	1'214.30	2'143.64	1	1	20	20	20	20	0.007	0.662	0.155	0.161		
1A3aii(j)	NOx (as NO2)	153.76	62.06	1	1	20	20	20	20	0.000	-0.065	0.016	0.016		
1A3bi(fu)	NOx (as NO2)	43'812.31	12'539.29	1	1	38	39	39	38	0.853	-22.016	5.897	6.130		
1A3bii(fu)	NOx (as NO2)	6'094.80	3'023.23	1	1	32	33	32	32	0.035	-2.186	0.740	0.731		
1A3biii(fu)	NOx (as NO2)	29'839.33	3'370.34	1	1	18	18	18	18	0.014	-18.824	3.624	3.468		
1A3biv(fu)	NOx (as NO2)	330.77	150.31	1	1	36	36	36	36	0.000	-0.129	0.050	0.049		
1A3c	NOx (as NO2)	595.50	311.14	1	1	13	13	13	13	0.000	-0.203	0.038	0.037		
1A3dii	NOx (as NO2)	1'054.73	869.53	1	1	13	13	13	13	0.000	-0.132	0.028	0.026		
1A3ei	NOx (as NO2)	19.41	1.45	2	2	50	50	50	50	0.000	-0.013	0.007	0.007		
1A4ai	NOx (as NO2)	5'139.24	2'677.14	2	2	16	16	16	16	0.007	-1.753	0.360	0.358		
1A4aii	NOx (as NO2)	16.28	37.67	1	1	13	13	13	13	0.000	0.015	0.003	0.003		
1A4bi	NOx (as NO2)	11'636.07	3'494.37	4	4	13	13	13	14	0.008	-5.798	1.089	1.034		
1A4bii	NOx (as NO2)	18.76	17.56	1	1	30	30	30	30	0.000	-0.001	0.000	0.000		
1A4ci	NOx (as NO2)	388.54	356.11	21	21	30	30	36	37	0.001	-0.023	0.082	0.082		
1A4cii	NOx (as NO2)	4'357.53	1'513.58	1	1	13	13	13	13	0.001	-2.026	0.374	0.362		
1A5b	NOx (as NO2)	882.99	316.53	1	1	13	13	13	13	0.000	-0.404	0.075	0.074		
1B2c	NOx (as NO2)	211.21	1.04	22	22	100	204	100	205	0.000	-0.149	0.307	0.149		
2A1	NOx (as NO2)	15.87	9.03	2	2	100	205	100	204	0.000	-0.005	0.010	0.005		
2A2	NOx (as NO2)	0.27	0.24	2	2	100	449	100	449	0.000	0.000	0.000	0.000		
2A5a	NOx (as NO2)	1.79	0.40	5	5	100	448	100	448	0.000	-0.001	0.004	0.001		
2B2	NOx (as NO2)	82.78	NO	NO	NO	NO	NO	NO	NO	0.000	-0.059	0.010	0.009		
2B5	NOx (as NO2)	22.20	14.64	2	2	39	41	40	40	0.000	-0.005	0.002	0.002		
2B10a	NOx (as NO2)	8.93	1.95	2	2	60	60	60	59	0.000	-0.005	0.003	0.003		
2C1	NOx (as NO2)	245.46	136.13	2	2	50	50	50	50	0.000	-0.078	0.041	0.041		
2C3	NOx (as NO2)	17.41	NO	NO	NO	NO	NO	NO	NO	0.000	-0.012	0.025	0.012		
2C7c	NOx (as NO2)	NA	1.54	5	5	84	100	83	100	0.000	0.001	0.001	0.001		
2G	NOx (as NO2)	29.36	17.03	25	25	83	101	84	104	0.000	-0.009	0.011	0.008		
2H3	NOx (as NO2)	91.00	31.29	3	3	100	204	100	204	0.000	-0.043	0.087	0.043		
3B1a	NOx (as NO2)	672.26	367.90	6	6	50	50	50	50	0.001	-0.217	0.118	0.116		
3B1b	NOx (as NO2)	344.28	285.62	6	6	50	49	50	50	0.001	-0.042	0.031	0.028		
3B2	NOx (as NO2)	66.63	55.69	6	6	51	49	50	51	0.000	-0.008	0.006	0.005		
3B3	NOx (as NO2)	185.29	79.15	6	6	50	50	50	51	0.000	-0.076	0.041	0.040		
3B4d	NOx (as NO2)	16.15	18.04	6	7	50	50	50	51	0.000	0.001	0.001	0.001		
3B4e	NOx (as NO2)	17.58	26.53	6	6	50	50	51	51	0.000	0.006	0.003	0.004		
3B4f	NOx (as NO2)	1.35	7.20	6	7	50	50	50	51	0.000	0.004	0.002	0.002		
3B4gi	NOx (as NO2)	7.19	9.63	6	6	50	50	51	50	0.000	0.002	0.001	0.001		
3B4gii	NOx (as NO2)	4.46	13.02	7	6	49	51	50	51	0.000	0.006	0.003	0.003		
3B4giii	NOx (as NO2)	0.44	0.38	6	6	50	50	50	51	0.000	0.000	0.000	0.000		
3B4giv	NOx (as NO2)	0.84	1.26	6	6	50	50	51	50	0.000	0.000	0.000	0.000		
3B4h	NOx (as NO2)	2.00	4.65	7	6	50	49	51	50	0.000	0.002	0.001	0.001		
3Da1	NOx (as NO2)	1'204.90	721.61	5	5	99	100	99	101	0.019	-0.344	0.354	0.348		
3Da2a	NOx (as NO2)	2'098.58	1'503.08	6	6	50	50	50	50	0.021	-0.424	0.254	0.239		
3Da2b	NOx (as NO2)	87.01	NO	NO	NO	NO	NO	NO	NO	0.000	-0.062	0.064	0.062		
3Da2c	NOx (as NO2)	59.24	137.10	20	20	101	99	102	104	0.001	0.055	0.058	0.064		
3Da3	NOx (as NO2)	242.72	418.32	6	6	100	99	100	100	0.006	0.125	0.127	0.130		
5A	NOx (as NO2)	1.83	1.20	10	10	49	50	51	51	0.000	0.000	0.000	0.000		
5B2	NOx (as NO2)	NA	6.30	20	20	100	100	102	104	0.000	0.004	0.005	0.005		
5C1a	NOx (as NO2)	80.75	37.34	50	50	39	40	61	67	0.000	-0.031	0.036	0.033		
5C1bi	NOx (as NO2)	9.75	NO	NO	NO	NO	NO	NO	NO	0.000	-0.007	0.003	0.003		
5C1biii	NOx (as NO2)	22.50	NO	NO	NO	NO	NO	NO	NO	0.000	-0.016	0.007	0.007		
5C1biv	NOx (as NO2)	114.00	42.13	20	20	50	50	53	55	0.000	-0.051	0.033	0.030		
5C1bv	NOx (as NO2)	11.25	13.71	5	5	30	30	30	31	0.000	0.002	0.001	0.001		
5C2	NOx (as NO2)	23.65	15.85	49	47	100	156	100	167	0.000	-0.006	0.017	0.012		
5D1	NOx (as NO2)	25.35	5.80	1	1	10	10	10	10	0.000	-0.014	0.002	0.002		
5D2	NOx (as NO2)	0.23	1.17	10	10	10	10	14	14	0.000	0.001	0.000	0.000		
6A	NOx (as NO2)	92.05	87.61	30	30	50	50	57	59	0.000	-0.003	0.029	0.029		
Total, Monte Carlo simulations		140'961.0	43'928.0					11.8	11.8	1.0	-68.8	1.1	1.1		
Total, inventory		140'959.1	43'926.6								-68.8				

Table A - 35 Uncertainty analysis of NMVOC emissions, approach 2, for 2024 and for the trend 1990-2024. Monte Carlo simulations were run 500'000 times. The reported uncertainties correspond to the borders of the narrowest 95.0 % confidence interval. Contributions to inventory trend (mean, uncertainties, columns I and J) are values normalised by the total inventory base year emission ((fu) means fuel used approach).

A	B	C		D		E		F		G		H	I	J	
		Emissions 1990	Emissions 2024	Activity data uncertainty 2024		Emission factor uncertainty 2024		Emission combined uncertainty 2024		Emission contribution to variance 2024	Contribution to trend			Contribution to uncertainty of trend	
				t	t	(-)%	(+)%	(-)%	(+)%					(-)%	(+)%
1A1a	NMVOC	320.80	201.58	10	10	31	33	34	34	0.000	-0.041	0.021	0.019		
1A1b	NMVOC	6.95	3.72	1	1	20	20	20	20	0.000	-0.001	0.000	0.000		
1A1c	NMVOC	2.13	5.19	5	5	20	20	21	21	0.000	0.001	0.000	0.000		
1A2a	NMVOC	8.95	5.80	2	2	18	18	18	18	0.000	-0.001	0.000	0.000		
1A2b	NMVOC	53.62	4.93	2	2	19	19	19	19	0.000	-0.017	0.005	0.005		
1A2c	NMVOC	34.22	19.26	2	2	10	10	10	10	0.000	-0.005	0.001	0.001		
1A2d	NMVOC	29.90	3.86	2	2	10	10	10	10	0.000	-0.009	0.002	0.002		
1A2e	NMVOC	22.05	20.45	2	2	10	10	10	10	0.000	-0.001	0.000	0.000		
1A2f	NMVOC	596.56	443.79	2	2	30	30	30	30	0.000	-0.052	0.021	0.020		
1A2gvii	NMVOC	1'331.50	249.29	1	1	34	34	34	34	0.000	-0.368	0.152	0.150		
1A2gviii	NMVOC	294.30	111.21	2	2	30	30	30	31	0.000	-0.062	0.024	0.023		
1A3ai(i)	NMVOC	247.46	139.05	1	1	50	50	50	50	0.000	-0.037	0.021	0.020		
1A3ai(ii)	NMVOC	58.81	30.03	1	1	49	50	50	50	0.000	-0.010	0.005	0.005		
1A3bi(fu)	NMVOC	56'148.61	3'506.16	1	1	53	52	52	52	0.011	-17.674	8.370	8.525		
1A3biii(fu)	NMVOC	4'762.29	111.63	1	1	46	46	45	46	0.000	-1.582	0.808	0.797		
1A3biii(fu)	NMVOC	3'554.39	76.08	1	1	22	22	22	22	0.000	-1.184	0.385	0.366		
1A3biv(fu)	NMVOC	5'429.26	411.20	1	1	100	390	100	390	0.009	-1.589	6.198	1.589		
1A3bv(fu)	NMVOC	19'930.76	2'225.23	1	1	40	40	40	40	0.003	-6.010	2.662	2.608		
1A3c	NMVOC	83.76	36.14	1	1	34	34	34	34	0.000	-0.016	0.007	0.007		
1A3dii	NMVOC	1'640.55	380.76	1	1	34	34	34	34	0.000	-0.429	0.181	0.171		
1A3ei	NMVOC	0.90	0.05	2	2	50	50	50	50	0.000	0.000	0.000	0.000		
1A4ai	NMVOC	1'329.00	880.96	2	2	56	56	56	56	0.001	-0.152	0.094	0.091		
1A4aii	NMVOC	1'091.65	298.65	1	1	75	75	76	74	0.000	-0.270	0.218	0.206		
1A4bi	NMVOC	10'056.33	2'217.78	4	4	68	68	68	68	0.008	-2.656	1.903	1.834		
1A4bii	NMVOC	398.23	114.38	1	1	75	75	74	75	0.000	-0.097	0.078	0.075		
1A4ci	NMVOC	235.07	256.84	21	21	75	75	77	80	0.000	0.007	0.027	0.030		
1A4cii	NMVOC	4'369.08	761.61	1	1	75	75	75	74	0.001	-1.225	0.975	0.938		
1A5b	NMVOC	160.25	52.58	1	1	34	34	34	34	0.000	-0.037	0.015	0.015		
1B2ai	NMVOC	0.02	0.01	30	30	50	50	56	60	0.000	0.000	0.000	0.000		
1B2aiv	NMVOC	1'344.61	135.46	30	30	47	47	55	56	0.000	-0.411	0.265	0.242		
1B2av	NMVOC	19'127.24	1'940.37	1	1	38	41	38	41	0.002	-5.835	2.620	2.435		
1B2b	NMVOC	323.52	167.81	22	22	50	50	54	56	0.000	-0.053	0.041	0.038		
1B2c	NMVOC	13.72	0.05	22	22	84	100	84	104	0.000	-0.005	0.005	0.004		
2A1	NMVOC	41.25	23.47	2	2	100	204	100	204	0.000	-0.006	0.013	0.006		
2A2	NMVOC	0.69	0.63	2	2	100	447	100	447	0.000	0.000	0.000	0.000		
2A5a	NMVOC	4.59	1.04	5	5	100	449	100	449	0.000	-0.001	0.005	0.001		
2B10a	NMVOC	608.61	15.26	2	2	40	40	40	40	0.000	-0.202	0.095	0.092		
2C1	NMVOC	1'053.60	176.65	2	2	83	101	83	101	0.000	-0.298	0.310	0.250		
2C3	NMVOC	56.57	NO	NO	NO	NO	NO	NO	NO	0.000	-0.019	0.040	0.019		
2C7a	NMVOC	2.98	0.24	5	5	100	204	100	204	0.000	-0.001	0.002	0.001		
2C7c	NMVOC	NA	0.50	5	5	84	100	84	101	0.000	0.000	0.000	0.000		
2D3a	NMVOC	8'866.55	6'593.12	1	1	50	50	49	51	0.037	-0.769	1.907	1.903		
2D3b	NMVOC	4'895.00	2'662.20	5	5	83	101	84	101	0.024	-0.757	0.781	0.636		
2D3c	NMVOC	2'430.00	362.56	20	20	83	101	85	102	0.000	-0.702	0.745	0.599		
2D3d	NMVOC	40'731.00	8'288.73	20	20	40	40	44	45	0.048	-10.961	5.235	5.063		
2D3e	NMVOC	11'731.23	1'566.25	40	40	50	50	61	67	0.004	-3.446	2.510	2.266		
2D3f	NMVOC	910.00	60.20	20	20	40	40	44	46	0.000	-0.289	0.152	0.142		
2D3g	NMVOC	27'503.97	3'169.20	30	30	84	100	86	105	0.038	-8.058	7.930	6.641		
2D3h	NMVOC	20'353.80	3'586.57	20	20	40	40	44	45	0.009	-5.681	2.860	2.761		
2D3i	NMVOC	5'470.21	1'933.04	30	30	100	182	100	186	0.043	-1.182	2.248	1.182		
2G	NMVOC	22'431.61	6'321.55	25	25	100	204	100	206	0.563	-5.084	9.567	5.084		
2H1	NMVOC	554.99	206.18	30	30	100	203	100	207	0.001	-0.119	0.256	0.119		
2H2	NMVOC	1'467.64	1'417.31	10	10	83	100	83	101	0.007	-0.017	0.090	0.079		
2H3	NMVOC	156.00	53.64	3	3	100	204	100	204	0.000	-0.035	0.072	0.035		
3B1a	NMVOC	6'412.83	6'523.73	6	7	60	60	60	61	0.053	0.038	0.214	0.224		
3B1b	NMVOC	5'121.56	7'625.56	6	6	70	70	70	70	0.098	0.851	0.638	0.671		
3B2	NMVOC	66.79	68.99	6	6	100	204	100	205	0.000	0.001	0.003	0.004		
3B3	NMVOC	1'126.15	746.47	7	6	100	204	100	205	0.008	-0.129	0.268	0.129		
3B4d	NMVOC	37.02	49.82	6	6	100	203	100	203	0.000	0.004	0.004	0.009		
3B4e	NMVOC	120.39	205.23	6	6	100	204	100	204	0.001	0.029	0.029	0.060		
3B4f	NMVOC	8.64	48.96	6	6	100	204	100	204	0.000	0.014	0.014	0.028		
3B4gi	NMVOC	508.70	623.28	6	6	100	204	100	204	0.005	0.039	0.039	0.083		
3B4gii	NMVOC	366.34	1'201.13	6	6	100	205	100	205	0.020	0.284	0.284	0.587		
3B4giii	NMVOC	46.28	43.14	6	6	100	204	100	204	0.000	-0.001	0.003	0.002		
3B4giv	NMVOC	129.27	217.80	6	6	100	204	100	204	0.001	0.030	0.030	0.062		
3B4h	NMVOC	3.60	4.13	6	6	100	204	100	204	0.000	0.000	0.000	0.000		
3De	NMVOC	481.06	455.03	5	5	100	204	100	204	0.003	-0.009	0.027	0.013		
5A	NMVOC	405.68	117.00	10	10	50	50	51	51	0.000	-0.098	0.058	0.054		
5B1	NMVOC	105.05	183.60	20	20	101	99	101	105	0.000	0.027	0.029	0.034		
5B2	NMVOC	49.56	1'178.07	20	20	30	30	36	36	0.001	0.384	0.159	0.172		
5C1a	NMVOC	516.80	238.96	50	50	50	50	68	73	0.000	-0.094	0.120	0.103		
5C1bi	NMVOC	3.75	NO	NO	NO	NO	NO	NO	NO	0.000	-0.001	0.001	0.001		
5C1biii	NMVOC	4.50	NO	NO	NO	NO	NO	NO	NO	0.000	-0.002	0.001	0.001		
5C1biv	NMVOC	0.46	19.91	20	20	20	20	28	29	0.000	0.007	0.002	0.002		
5C1bv	NMVOC	1.20	0.37	5	5	30	30	30	31	0.000	0.000	0.000	0.000		
5C2	NMVOC	25.19	16.88	48	48	100	156	100	168	0.000	-0.003	0.009	0.006		
5D1	NMVOC	0.51	0.12	1	1	27	27	27	27	0.000	0.000	0.000	0.000		
5D2	NMVOC	0.00	0.02	10	10	20	20	22	22	0.000	0.000	0.000	0.000		
5E	NMVOC	28.00	60.00	20	20	23	24	31	31	0.000	0.011	0.006	0.006		
6A	NMVOC	203.03	165.30	30	30	50	50	57	59	0.000	-0.013	0.030	0.028		
Total, Monte Carlo simulations		298'031.5	71'037.0					22.4	24.5	1.0	-76.1	3.8	4.0		
Total, inventory		298'049.2	71'043.8								-76.2				

Table A - 36 Uncertainty analysis of SO_x emissions, approach 2, for 2024 and for the trend 1990-2024. Monte Carlo simulations were run 500'000 times. The reported uncertainties correspond to the borders of the narrowest 95.0 % confidence interval. Contributions to inventory trend (mean, uncertainties, columns I and J) are values normalised by the total inventory base year emission ((fu) means fuel used approach).

A	B	C	D	E		F		G		H	I	J					
				Emissions 1990	Emissions 2024	Activity data uncertainty 2024		Emission factor uncertainty 2024				Emission combined uncertainty 2024		Emission contribution to variance 2024	Contribution to trend	Contribution to uncertainty of trend	
						t	t	(-)%	(+)%			(-)%	(+)%			(-)%	(+)%
1A1a	SOx (as SO2)	3'679.11	288.61	10	10	22	22	24	24	0.190	-8.649	1.988	1.976				
1A1b	SOx (as SO2)	660.41	47.35	1	1	20	20	20	20	0.004	-1.566	0.322	0.321				
1A2a	SOx (as SO2)	362.55	8.10	2	2	15	15	15	15	0.000	-0.905	0.147	0.145				
1A2b	SOx (as SO2)	67.34	0.67	2	2	10	10	10	10	0.000	-0.170	0.020	0.020				
1A2c	SOx (as SO2)	1'187.10	71.04	2	2	11	11	11	11	0.002	-2.851	0.356	0.348				
1A2d	SOx (as SO2)	3'238.01	0.89	2	2	14	14	14	14	0.000	-8.265	1.173	1.168				
1A2e	SOx (as SO2)	1'077.50	5.04	2	2	12	12	12	12	0.000	-2.739	0.362	0.361				
1A2f	SOx (as SO2)	3'530.25	668.56	2	2	19	19	19	19	0.636	-7.302	1.326	1.353				
1A2gvii	SOx (as SO2)	370.66	2.68	1	1	10	10	10	10	0.000	-0.940	0.110	0.108				
1A2gviii	SOx (as SO2)	3'533.86	167.51	2	2	19	19	19	19	0.040	-8.593	1.582	1.557				
1A3ai(i)	SOx (as SO2)	99.68	148.96	1	1	10	10	10	10	0.009	0.126	0.015	0.016				
1A3aii(i)	SOx (as SO2)	24.94	5.23	1	1	10	10	10	10	0.000	-0.050	0.006	0.006				
1A3bi(fu)	SOx (as SO2)	1'618.25	32.24	1	1	10	10	10	10	0.000	-4.051	0.462	0.458				
1A3bii(fu)	SOx (as SO2)	317.41	5.44	1	1	10	10	10	10	0.000	-0.797	0.093	0.092				
1A3biii(fu)	SOx (as SO2)	1'820.88	9.11	1	1	10	10	10	10	0.000	-4.627	0.527	0.515				
1A3biv(fu)	SOx (as SO2)	26.63	0.50	1	1	10	10	10	10	0.000	-0.067	0.008	0.008				
1A3c	SOx (as SO2)	26.92	0.12	1	1	10	10	10	10	0.000	-0.068	0.008	0.008				
1A3dii	SOx (as SO2)	64.88	0.48	1	1	10	10	10	10	0.000	-0.165	0.019	0.019				
1A3ei	SOx (as SO2)	0.28	0.02	2	2	10	10	10	10	0.000	-0.001	0.000	0.000				
1A4ai	SOx (as SO2)	3'869.92	74.18	2	2	10	10	10	10	0.002	-9.693	1.034	1.066				
1A4aii	SOx (as SO2)	1.61	0.05	1	1	10	10	10	10	0.000	-0.004	0.000	0.000				
1A4bi	SOx (as SO2)	10'354.85	212.17	4	4	10	10	11	11	0.020	-25.888	2.451	2.427				
1A4bii	SOx (as SO2)	1.20	0.03	1	1	10	10	10	10	0.000	-0.003	0.000	0.000				
1A4ci	SOx (as SO2)	335.80	50.51	21	21	18	18	28	28	0.008	-0.728	0.233	0.223				
1A4cii	SOx (as SO2)	304.60	1.59	1	1	10	10	10	10	0.000	-0.774	0.090	0.090				
1A5b	SOx (as SO2)	78.17	25.47	1	1	10	10	10	10	0.000	-0.135	0.016	0.016				
1B2aiv	SOx (as SO2)	419.02	13.03	30	30	47	47	54	57	0.002	-1.036	0.595	0.564				
1B2c	SOx (as SO2)	300.98	1.33	22	22	31	31	37	39	0.000	-0.765	0.300	0.285				
2A1	SOx (as SO2)	0.69	0.39	2	2	100	204	100	204	0.000	-0.001	0.002	0.001				
2A2	SOx (as SO2)	0.01	0.01	2	2	100	448	100	448	0.000	0.000	0.000	0.000				
2A5a	SOx (as SO2)	0.08	0.02	5	5	100	449	100	449	0.000	0.000	0.001	0.000				
2B5	SOx (as SO2)	625.20	196.69	2	2	20	20	20	20	0.061	-1.094	0.228	0.227				
2B10a	SOx (as SO2)	168.00	44.26	2	2	40	40	40	40	0.012	-0.316	0.127	0.128				
2C1	SOx (as SO2)	144.04	13.59	2	2	84	100	84	100	0.007	-0.333	0.331	0.281				
2C3	SOx (as SO2)	696.30	NO	NO	NO	NO	NO	NO	NO	0.000	-1.747	3.474	1.747				
2C7c	SOx (as SO2)	NA	0.02	5	5	83	101	83	101	0.000	0.000	0.000	0.000				
2G	SOx (as SO2)	3.44	5.63	25	25	83	100	84	104	0.001	0.006	0.005	0.008				
2H3	SOx (as SO2)	1.30	0.45	3	3	100	204	100	204	0.000	-0.002	0.004	0.002				
5B2	SOx (as SO2)	NA	0.95	20	20	100	100	101	104	0.000	0.002	0.002	0.003				
5C1a	SOx (as SO2)	24.23	11.20	50	49	40	40	61	66	0.002	-0.033	0.039	0.036				
5C1bi	SOx (as SO2)	45.00	NO	NO	NO	NO	NO	NO	NO	0.000	-0.115	0.050	0.048				
5C1biii	SOx (as SO2)	19.50	NO	NO	NO	NO	NO	NO	NO	0.000	-0.050	0.022	0.021				
5C1biv	SOx (as SO2)	74.10	17.06	20	20	30	30	35	37	0.001	-0.146	0.060	0.058				
5C2	SOx (as SO2)	0.51	0.34	48	48	96	133	98	145	0.000	0.000	0.001	0.001				
5D1	SOx (as SO2)	0.13	0.03	1	1	37	37	37	37	0.000	0.000	0.000	0.000				
5D2	SOx (as SO2)	0.00	0.01	10	10	20	20	22	23	0.000	0.000	0.000	0.000				
6A	SOx (as SO2)	9.17	7.03	30	30	50	50	57	60	0.001	-0.005	0.010	0.009				
Total, Monte Carlo simulations		39'183.0	2'138.5					7.5	7.5	1.0	-94.5	0.4	0.4				
Total, inventory		39'184.5	2'138.6								-94.5						

Table A - 37 Uncertainty analysis of NH₃ emissions, approach 2, for 2024 and for the trend 1990-2024. Monte Carlo simulations were run 500'000 times. The reported uncertainties correspond to the borders of the narrowest 95.0 % confidence interval. Contributions to inventory trend (mean, uncertainties, columns I and J) are values normalised by the total inventory base year emission ((fu) means fuel used approach).

A	B	C	D	E		F		G		H	I	J					
				Emissions 1990	Emissions 2024	Activity data uncertainty 2024		Emission factor uncertainty 2024				Emission combined uncertainty 2024		Emission contribution to variance 2024	Contribution to trend	Contribution to uncertainty of trend	
						t	t	(-)%	(+)%			(-)%	(+)%			(-)%	(+)%
1A1a	NH3	4.85	51.71	10	10	20	20	22	23	0.000	0.083	0.021	0.022				
1A1b	NH3	0.01	0.01	1	1	10	10	10	10	0.000	0.000	0.000	0.000				
1A2a	NH3	0.00	0.00	2	2	10	10	10	10	0.000	0.000	0.000	0.000				
1A2b	NH3	0.11	0.00	2	2	10	10	10	10	0.000	0.000	0.000	0.000				
1A2c	NH3	0.02	0.01	2	2	10	10	10	10	0.000	0.000	0.000	0.000				
1A2d	NH3	0.02	0.00	2	2	10	10	10	10	0.000	0.000	0.000	0.000				
1A2e	NH3	0.02	0.01	2	2	10	10	10	10	0.000	0.000	0.000	0.000				
1A2f	NH3	147.02	184.76	2	2	9	9	9	9	0.000	0.067	0.013	0.014				
1A2gvii	NH3	1.00	1.56	1	1	50	50	50	50	0.000	0.001	0.001	0.001				
1A2gviii	NH3	17.00	36.37	2	2	9	9	9	9	0.000	0.034	0.005	0.006				
1A3bi(fu)	NH3	1'322.85	767.28	1	1	50	50	50	50	0.006	-0.980	0.497	0.498				
1A3bii(fu)	NH3	8.24	34.84	1	1	50	49	51	49	0.000	0.047	0.024	0.024				
1A3biii(fu)	NH3	4.20	33.16	1	1	50	50	50	50	0.000	0.051	0.026	0.027				
1A3biv(fu)	NH3	3.39	3.22	1	1	50	50	50	50	0.000	0.000	0.000	0.000				
1A3c	NH3	0.07	0.07	1	1	50	50	49	51	0.000	0.000	0.000	0.000				
1A3dii	NH3	0.20	0.21	1	1	50	50	50	51	0.000	0.000	0.000	0.000				
1A4ai	NH3	19.80	34.69	2	2	10	10	10	10	0.000	0.026	0.004	0.004				
1A4aii	NH3	0.01	0.02	1	1	10	10	10	10	0.000	0.000	0.000	0.000				
1A4bi	NH3	153.12	57.00	4	4	10	10	11	11	0.000	-0.170	0.030	0.029				
1A4bii	NH3	0.01	0.01	1	1	10	10	10	10	0.000	0.000	0.000	0.000				
1A4ci	NH3	2.88	8.38	21	21	10	10	23	24	0.000	0.010	0.004	0.004				
1A4cii	NH3	0.76	0.82	1	1	50	51	50	50	0.000	0.000	0.000	0.000				
1A5b	NH3	0.04	0.04	1	1	50	50	50	50	0.000	0.000	0.000	0.000				
2B1	NH3	0.07	0.01	2	2	10	10	10	10	0.000	0.000	0.000	0.000				
2B2	NH3	0.73	NO	NO	NO	NO	NO	NO	NO	0.000	-0.001	0.000	0.000				
2B10a	NH3	7.73	NA	NA	NA	NA	NA	NA	NA	0.000	-0.014	0.006	0.006				
2C1	NH3	11.90	1.26	2	2	100	204	100	204	0.000	-0.019	0.039	0.019				
2C7c	NH3	9.19	8.13	5	5	100	446	100	445	0.000	-0.002	0.008	0.002				
2G	NH3	203.15	62.45	25	25	40	40	46	48	0.000	-0.249	0.145	0.134				
2H2	NH3	132.33	48.45	10	10	100	448	100	448	0.003	-0.145	0.650	0.145				
2H3	NH3	1.04	0.36	3	3	100	204	100	204	0.000	-0.001	0.002	0.001				
2L	NH3	2.38	3.72	25	25	100	100	102	107	0.000	0.002	0.003	0.003				
3B1a	NH3	8'190.44	8'022.92	6	6	29	29	30	30	0.248	-0.293	1.324	1.325				
3B1b	NH3	4'826.53	6'482.83	6	6	27	27	28	28	0.141	2.925	1.205	1.251				
3B2	NH3	502.48	407.02	6	7	87	87	87	87	0.006	-0.168	0.175	0.157				
3B3	NH3	6'716.54	3'380.27	7	6	40	40	40	41	0.082	-5.863	2.355	2.330				
3B4d	NH3	118.13	130.96	6	6	64	66	65	66	0.000	0.023	0.023	0.027				
3B4e	NH3	256.31	392.62	6	6	52	52	52	53	0.002	0.241	0.137	0.143				
3B4f	NH3	19.65	104.01	6	7	69	68	68	69	0.000	0.149	0.104	0.105				
3B4gi	NH3	978.79	601.46	6	7	82	82	82	83	0.011	-0.664	0.570	0.558				
3B4gii	NH3	304.87	717.24	7	6	86	87	86	87	0.017	0.728	0.629	0.653				
3B4giii	NH3	29.77	22.19	6	6	94	92	91	96	0.000	-0.013	0.014	0.013				
3B4giv	NH3	124.46	97.51	6	6	84	85	85	85	0.000	-0.048	0.047	0.043				
3B4h	NH3	14.55	41.56	6	6	50	50	51	50	0.000	0.048	0.025	0.025				
3Da1	NH3	4'258.33	2'562.00	5	5	49	51	50	51	0.072	-2.983	1.506	1.500				
3Da2a	NH3	23'969.58	12'261.37	6	6	21	21	22	22	0.317	-20.571	4.059	3.930				
3Da2b	NH3	1'169.36	NO	NO	NO	NO	NO	NO	NO	0.000	-2.064	1.061	1.058				
3Da2c	NH3	766.21	1'174.30	20	20	50	50	53	55	0.018	0.721	0.581	0.650				
3Da3	NH3	758.59	1'333.83	6	6	62	62	63	62	0.030	1.016	0.656	0.672				
3Da4	NH3	0.63	0.84							0.000	0.000	0.000	0.000				
5A	NH3	615.79	177.52	10	10	50	50	51	51	0.000	-0.774	0.419	0.405				
5B1	NH3	175.08	306.00	20	20	100	100	101	105	0.004	0.231	0.250	0.285				
5B2	NH3	10.28	251.86	20	20	75	75	77	79	0.002	0.427	0.337	0.342				
5C1biv	NH3	5.70	2.00	20	20	50	50	53	54	0.000	-0.007	0.004	0.004				
5C2	NH3	13.71	9.19	48	48	25	25	53	56	0.000	-0.008	0.014	0.014				
5D1	NH3	89.98	130.54	1	1	51	49	49	51	0.000	0.072	0.037	0.037				
6A	NH3	846.09	933.00	30	30	100	100	104	107	0.042	0.153	0.755	0.864				
Total, Monte Carlo simulations		56'802.3	40'875.7					11.8	11.7	1.0	-28.0	4.5	4.5				
Total, inventory		56'816.0	40'881.6								-28.0						

Table A - 38 Uncertainty analysis of PM2.5 emissions, approach 2, for 2024 and for the trend 1990-2024. Monte Carlo simulations were run 500'000 times. The reported uncertainties correspond to the borders of the narrowest 95.0 % confidence interval. Contributions to inventory trend (mean, uncertainties, columns I and J) are values normalised by the total inventory base year emission ((fu) means fuel used approach).

A	B	C		D		E		F		G		H	I	J	
		Emissions 1990	Emissions 2024	Activity data uncertainty 2024		Emission factor uncertainty 2024		Emission combined uncertainty 2024		Emission contribution to variance 2024	Contribution to trend	Contribution to uncertainty of trend			
				t	t	(-)%	(+)%	(-)%	(+)%	(-)%		(+)%	Fraction	%	(-)%
1A1a	PM2.5	781.83	69.40	10	10	71	71	72	71	0.001	-2.747	2.442	2.218		
1A1b	PM2.5	47.66	1.25	1	1	20	20	20	20	0.000	-0.180	0.095	0.079		
1A1c	PM2.5	4.64	11.30	5	5	20	20	20	21	0.000	0.026	0.011	0.014		
1A2a	PM2.5	14.81	2.31	2	2	28	28	28	28	0.000	-0.048	0.028	0.023		
1A2b	PM2.5	20.39	0.90	2	2	30	30	30	30	0.000	-0.076	0.044	0.037		
1A2c	PM2.5	40.77	5.65	2	2	10	10	10	10	0.000	-0.136	0.068	0.054		
1A2d	PM2.5	149.62	0.19	2	2	33	33	33	33	0.000	-0.579	0.347	0.294		
1A2e	PM2.5	25.68	1.07	2	2	10	10	10	10	0.000	-0.095	0.048	0.038		
1A2f	PM2.5	437.58	32.39	2	2	65	65	64	66	0.000	-1.567	1.315	1.194		
1A2gvii	PM2.5	728.86	381.30	1	1	49	51	49	51	0.011	-1.344	0.963	0.836		
1A2gviii	PM2.5	872.51	161.92	2	2	65	65	65	65	0.003	-2.742	2.303	2.034		
1A3ai(i)	PM2.5	92.39	15.28	1	1	30	30	30	30	0.000	-0.299	0.175	0.145		
1A3aii(i)	PM2.5	22.67	1.70	1	1	30	30	30	30	0.000	-0.081	0.048	0.039		
1A3bi(fu)	PM2.5	588.85	100.26	1	1	57	58	58	57	0.001	-1.891	1.472	1.287		
1A3bii(fu)	PM2.5	340.96	47.50	1	1	48	49	48	48	0.000	-1.137	0.799	0.705		
1A3biii(fu)	PM2.5	1'599.49	31.66	1	1	27	27	27	27	0.000	-6.073	3.343	2.836		
1A3biv(fu)	PM2.5	191.03	22.36	1	1	54	54	54	54	0.000	-0.653	0.493	0.433		
1A3bvi(fu)	PM2.5	689.51	908.11	1	1	50	50	50	50	0.060	0.845	0.532	0.606		
1A3c	PM2.5	172.71	247.67	1	1	50	50	50	50	0.004	0.290	0.185	0.210		
1A3dii	PM2.5	59.09	20.24	1	1	50	50	50	50	0.000	-0.151	0.109	0.096		
1A3ei	PM2.5	0.11	0.01	2	2	27	27	27	27	0.000	0.000	0.000	0.000		
1A4ai	PM2.5	1'354.47	409.32	2	2	79	77	78	78	0.030	-3.633	3.376	3.101		
1A4bi	PM2.5	14'535.91	1'724.85	4	4	75	77	76	77	0.499	-45.140	16.931	20.929		
1A4ci	PM2.5	696.98	198.03	21	21	39	39	43	46	0.002	-1.931	1.366	1.157		
1A4cii	PM2.5	435.10	116.42	1	1	79	81	81	80	0.003	-1.231	1.197	1.100		
1A5b	PM2.5	86.95	43.69	1	1	50	49	50	49	0.000	-0.168	0.121	0.106		
1B1a	PM2.5	0.16	0.03	30	30	40	40	48	52	0.000	0.000	0.000	0.000		
1B2c	PM2.5	0.44	0.00	22	22	100	243	100	245	0.000	-0.002	0.004	0.002		
2A1	PM2.5	240.48	136.79	2	2	100	204	100	204	0.022	-0.398	0.830	0.398		
2A2	PM2.5	7.21	6.61	2	2	100	448	100	448	0.000	-0.002	0.010	0.002		
2A5a	PM2.5	102.21	88.70	5	5	100	451	100	450	0.058	-0.051	0.227	0.051		
2B5	PM2.5	61.20	31.61	2	2	84	100	83	101	0.000	-0.115	0.130	0.099		
2B10a	PM2.5	7.86	NA	NA	NA	NA	NA	NA	NA	0.000	-0.030	0.020	0.017		
2C1	PM2.5	817.90	6.82	2	2	95	125	94	125	0.000	-3.104	4.051	2.947		
2C3	PM2.5	78.33	NO	NO	NO	NO	NO	NO	NO	0.000	-0.303	0.635	0.303		
2C7a	PM2.5	5.66	0.46	5	5	100	204	100	204	0.000	-0.020	0.042	0.020		
2C7c	PM2.5	1.53	1.40	5	5	100	449	100	449	0.000	-0.001	0.002	0.001		
2D3c	PM2.5	4.00	3.87	20	20	100	203	100	205	0.000	0.000	0.007	0.006		
2D3i	PM2.5	12.00	NA	NA	NA	NA	NA	NA	NA	0.000	-0.046	0.204	0.046		
2G	PM2.5	512.78	373.57	25	25	83	101	85	104	0.044	-0.536	1.009	0.687		
2H1	PM2.5	235.77	171.56	30	30	100	204	100	207	0.036	-0.246	0.784	0.396		
2H2	PM2.5	187.86	166.78	10	10	100	447	100	447	0.198	-0.077	0.397	0.115		
2H3	PM2.5	15.60	5.36	3	3	100	205	100	205	0.000	-0.040	0.084	0.040		
2I	PM2.5	216.08	47.32	10	10	100	448	100	447	0.016	-0.621	2.800	0.621		
3B1a	PM2.5	20.61	22.83	6	6	100	305	100	305	0.001	0.009	0.010	0.030		
3B1b	PM2.5	18.26	22.41	6	6	100	307	100	307	0.001	0.016	0.016	0.050		
3B2	PM2.5	0.79	0.82	6	6	100	307	100	308	0.000	0.000	0.000	0.001		
3B3	PM2.5	9.57	6.15	6	6	100	307	100	307	0.000	-0.013	0.041	0.013		
3B4d	PM2.5	0.14	0.18	6	6	100	306	100	306	0.000	0.000	0.000	0.001		
3B4e	PM2.5	3.94	6.72	6	6	100	305	100	306	0.000	0.011	0.011	0.033		
3B4f	PM2.5	0.59	3.33	6	6	100	306	100	306	0.000	0.011	0.011	0.033		
3B4gi	PM2.5	9.25	11.33	6	6	100	306	100	306	0.000	0.008	0.008	0.025		
3B4gii	PM2.5	6.78	22.24	6	6	100	306	100	307	0.001	0.060	0.060	0.184		
3B4giii	PM2.5	1.89	1.76	6	6	100	307	100	306	0.000	0.000	0.002	0.001		
3B4giv	PM2.5	1.98	3.17	6	6	100	305	100	305	0.000	0.005	0.005	0.014		
3B4h	PM2.5	0.24	0.07	6	6	100	305	100	306	0.000	-0.001	0.002	0.001		
3De	PM2.5	47.48	45.03	5	5	100	204	100	204	0.002	-0.009	0.030	0.015		
5A	PM2.5	0.73	0.48	10	10	30	30	32	32	0.000	-0.001	0.001	0.001		
5B2	PM2.5	NA	0.06	20	20	100	100	103	103	0.000	0.000	0.000	0.000		
5C1a	PM2.5	465.12	215.06	50	50	30	30	56	61	0.005	-0.967	1.219	1.075		
5C1bi	PM2.5	0.47	NO	NO	NO	NO	NO	NO	NO	0.000	-0.002	0.001	0.001		
5C1bii	PM2.5	16.50	NO	NO	NO	NO	NO	NO	NO	0.000	-0.064	0.042	0.035		
5C1biv	PM2.5	14.25	2.95	20	20	34	34	39	40	0.000	-0.044	0.029	0.024		
5C1bv	PM2.5	4.39	0.83	5	5	33	33	33	33	0.000	-0.014	0.008	0.007		
5C2	PM2.5	64.43	43.18	48	48	100	157	100	168	0.002	-0.082	0.267	0.169		
5E	PM2.5	1.40	1.50	20	20	30	30	35	37	0.000	0.000	0.002	0.002		
6A	PM2.5	4.42	4.75	30	30	40	40	49	51	0.000	0.001	0.008	0.008		
Total, Monte Carlo simulations		27'188.1	6'009.1					30.2	30.8	1.0	-77.4	5.2	6.3		
Total, inventory		27'190.9	6'010.5								-77.9				

Table A - 39 Uncertainty analysis of PM10 emissions, approach 2, for 2024 and for the trend 1990-2024. Monte Carlo simulations were run 500'000 times. The reported uncertainties correspond to the borders of the narrowest 95.0 % confidence interval. Contributions to inventory trend (mean, uncertainties, columns I and J) are values normalised by the total inventory base year emission ((fu) means fuel used approach).

A	B	C		D		E		F		G		H		I		J	
		Emissions 1990	Emissions 2024	Activity data uncertainty 2024		Emission factor uncertainty 2024		Emission combined uncertainty 2024		Emission contribution to variance 2024		Contribution to trend		Contribution to uncertainty of trend			
				t	t	(-)%	(+)%	(-)%	(+)%	(-)%	(+)%	Fraction	%	(-)%	(+)%		
1A1a	PM10	1'044.54	70.57	10	10	71	70	71	72	0.000	-2.758	2.321	2.134				
1A1b	PM10	47.66	1.25	1	1	20	20	20	20	0.000	-0.132	0.060	0.051				
1A1c	PM10	4.89	11.91	5	5	20	20	21	21	0.000	0.020	0.008	0.009				
1A2a	PM10	20.53	2.54	2	2	28	28	28	28	0.000	-0.051	0.025	0.023				
1A2b	PM10	29.24	0.95	2	2	30	30	30	30	0.000	-0.080	0.041	0.036				
1A2c	PM10	40.77	5.65	2	2	10	10	10	10	0.000	-0.100	0.042	0.035				
1A2d	PM10	166.58	0.19	2	2	33	33	33	33	0.000	-0.473	0.251	0.220				
1A2e	PM10	25.68	1.07	2	2	10	10	10	10	0.000	-0.070	0.029	0.025				
1A2f	PM10	832.63	59.10	2	2	65	65	65	65	0.000	-2.192	1.712	1.587				
1A2gvii	PM10	2'173.23	2'373.78	1	1	50	50	50	50	0.082	0.567	0.346	0.380				
1A2gviii	PM10	913.14	171.41	2	2	65	66	65	66	0.001	-2.099	1.611	1.536				
1A3ai(i)	PM10	102.65	15.28	1	1	30	30	30	30	0.000	-0.248	0.127	0.111				
1A3aii(i)	PM10	25.19	1.70	1	1	30	30	30	30	0.000	-0.067	0.034	0.030				
1A3bi(fu)	PM10	588.85	100.26	1	1	57	58	57	58	0.000	-1.387	0.994	0.908				
1A3bii(fu)	PM10	340.96	47.50	1	1	48	49	48	49	0.000	-0.833	0.538	0.483				
1A3biii(fu)	PM10	1'599.49	31.66	1	1	27	27	27	27	0.000	-4.450	2.147	1.893				
1A3biv(fu)	PM10	191.03	22.36	1	1	54	54	54	54	0.000	-0.479	0.333	0.302				
1A3bvi(fu)	PM10	2'046.08	2'477.55	1	1	50	50	50	50	0.089	1.221	0.720	0.783				
1A3c	PM10	969.78	1'615.17	1	1	50	50	50	50	0.038	1.830	1.086	1.189				
1A3dii	PM10	59.09	20.24	1	1	50	50	50	50	0.000	-0.110	0.073	0.067				
1A3ei	PM10	0.11	0.01	2	2	27	27	27	27	0.000	0.000	0.000	0.000				
1A4ai	PM10	1'427.63	434.63	2	2	78	78	78	78	0.007	-2.804	2.493	2.308				
1A4bi	PM10	15'325.72	1'817.17	4	4	75	77	76	77	0.111	-35.770	16.856	19.615				
1A4ci	PM10	710.36	200.57	21	21	39	39	44	45	0.000	-1.446	0.930	0.830				
1A4cii	PM10	511.19	174.11	1	1	80	81	80	80	0.001	-0.956	0.883	0.822				
1A5b	PM10	286.52	260.30	1	1	50	50	49	50	0.001	-0.075	0.051	0.046				
1B1a	PM10	1.60	0.32	30	30	40	40	49	51	0.000	-0.004	0.003	0.002				
1B2c	PM10	0.44	0.00	22	22	100	243	100	245	0.000	-0.001	0.003	0.001				
2A1	PM10	374.35	212.95	2	2	100	204	100	204	0.011	-0.453	0.936	0.453				
2A2	PM10	14.41	13.21	2	2	100	447	100	447	0.000	-0.003	0.015	0.003				
2A5a	PM10	302.32	318.44	5	5	100	447	100	447	0.148	0.044	0.074	0.239				
2B5	PM10	73.80	38.05	2	2	84	100	83	101	0.000	-0.101	0.111	0.087				
2B10a	PM10	17.07	NA	NA	NA	NA	NA	NA	NA	0.000	-0.048	0.028	0.025				
2C1	PM10	1'485.46	10.24	2	2	94	125	94	125	0.000	-4.118	5.133	3.903				
2C3	PM10	113.15	NO	NO	NO	NO	NO	NO	NO	0.000	-0.322	0.673	0.322				
2C7a	PM10	5.96	0.48	5	5	100	203	100	203	0.000	-0.016	0.032	0.016				
2C7c	PM10	3.06	2.77	5	5	100	446	100	446	0.000	-0.001	0.004	0.001				
2D3c	PM10	19.98	19.35	20	20	100	205	100	206	0.000	-0.002	0.026	0.023				
2D3i	PM10	24.00	NA	NA	NA	NA	NA	NA	NA	0.000	-0.068	0.300	0.068				
2G	PM10	588.38	497.05	25	25	84	100	85	104	0.016	-0.258	0.760	0.613				
2H1	PM10	243.80	177.35	30	30	100	204	100	207	0.008	-0.187	0.596	0.302				
2H2	PM10	310.12	310.37	10	10	100	449	100	449	0.141	0.001	0.253	0.259				
2H3	PM10	15.60	5.36	3	3	100	204	100	204	0.000	-0.029	0.061	0.029				
2I	PM10	864.32	188.01	10	10	100	447	100	447	0.051	-1.682	7.719	1.682				
3B1a	PM10	84.47	93.57	6	7	100	306	100	306	0.005	0.026	0.029	0.090				
3B1b	PM10	74.85	91.85	6	6	100	306	100	306	0.004	0.048	0.048	0.150				
3B2	PM10	19.76	20.41	6	6	100	306	100	306	0.000	0.002	0.008	0.012				
3B3	PM10	213.16	138.11	6	7	100	306	100	306	0.010	-0.211	0.649	0.211				
3B4d	PM10	3.42	4.60	6	6	100	306	100	306	0.000	0.003	0.003	0.010				
3B4e	PM10	6.20	10.56	6	6	100	307	100	307	0.000	0.012	0.012	0.038				
3B4f	PM10	0.94	5.33	6	7	100	308	100	308	0.000	0.012	0.012	0.039				
3B4gi	PM10	123.32	151.10	6	6	100	305	100	306	0.012	0.078	0.078	0.243				
3B4gii	PM10	67.84	222.43	6	6	100	305	100	305	0.026	0.437	0.437	1.346				
3B4giii	PM10	10.41	9.70	6	7	100	306	100	306	0.000	-0.002	0.008	0.003				
3B4giv	PM10	18.52	30.06	6	6	100	307	100	307	0.000	0.033	0.033	0.102				
3B4h	PM10	0.50	0.78	6	6	100	306	100	307	0.000	0.001	0.001	0.002				
3De	PM10	1'053.57	1'003.29	5	5	100	204	100	204	0.234	-0.139	0.456	0.230				
5A	PM10	0.73	0.48	10	10	30	30	31	32	0.000	-0.001	0.000	0.000				
5B2	PM10	NA	0.06	20	20	100	100	102	103	0.000	0.000	0.000	0.000				
5C1a	PM10	516.80	238.96	49	51	50	50	67	73	0.002	-0.786	1.046	0.867				
5C1bi	PM10	3.08	NO	NO	NO	NO	NO	NO	NO	0.000	-0.009	0.005	0.005				
5C1biii	PM10	24.00	NO	NO	NO	NO	NO	NO	NO	0.000	-0.068	0.041	0.036				
5C1biv	PM10	19.95	4.21	20	20	35	36	39	42	0.000	-0.045	0.027	0.024				
5C1bv	PM10	4.39	0.83	5	5	33	33	33	34	0.000	-0.010	0.005	0.005				
5C2	PM10	70.77	47.43	48	48	100	156	100	168	0.000	-0.066	0.217	0.133				
5E	PM10	2.80	3.00	20	20	30	30	36	36	0.000	0.001	0.002	0.002				
6A	PM10	229.46	107.53	30	30	40	40	49	51	0.000	-0.346	0.302	0.270				
Total, Monte Carlo simulations		36'494.0	13'896.5					27.6	30.9	1.0	-61.2	10.6	12.2				
Total, inventory		36'490.3	13'895.2								-61.9						

A5.3.2 Uncertainty estimations, approach 2, sensitivity results

Results for the sensitivity analysis between emissions from each category and inventory emission are given as tornado plots, in Figure A - 5 to Figure A - 10.

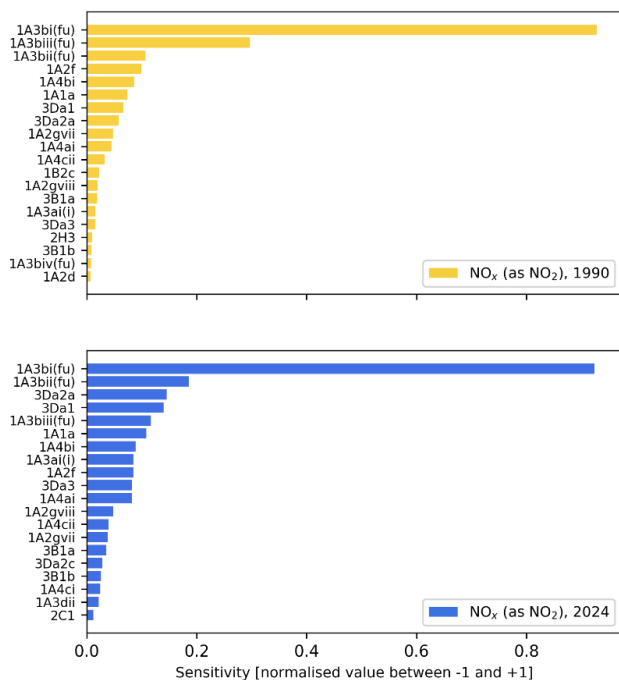


Figure A - 5 Results of the sensitivity analysis between emissions from each category and inventory emissions for NO_x, for the base year 1990 and the reporting year 2024 ((fu) means fuel used approach). Only the twenty categories ranked first are listed. See chp. 1.7 for details and compare also with Table 1-9 (results for the key category analysis approach 2, i.e. using uncertainties).

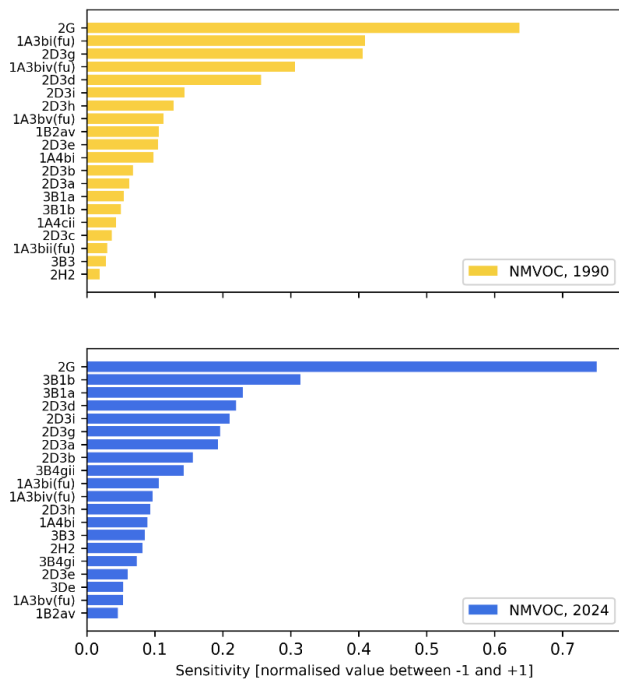


Figure A - 6 Results of the sensitivity analysis between emissions from each category and inventory emissions for NMVOC, for the base year 1990 and the reporting year 2024 ((fu) means fuel used approach). Only the twenty categories ranked first are listed. See chp. 1.7 for details and compare also with Table 1-9 (results for the key category analysis approach 2, i.e. using uncertainties).

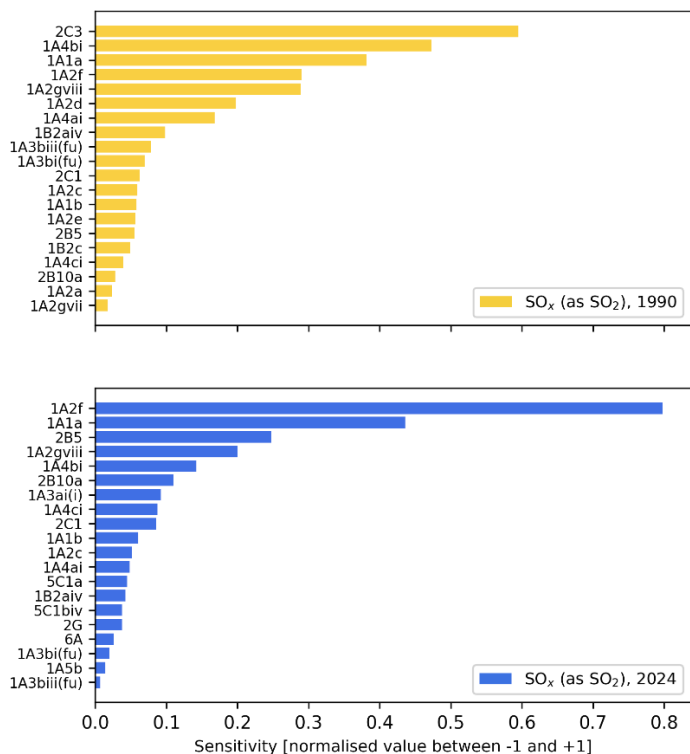


Figure A - 7 Results of the sensitivity analysis between emissions from each category and inventory emissions for SO_x (expressed as SO₂ equivalents), for the base year 1990 and the reporting year 2024 ((fu) means fuel used approach). Only the twenty categories ranked first are listed. See chp. 1.7 for details and compare also with Table 1-9 (results for the key category analysis approach 2, i.e. using uncertainties).

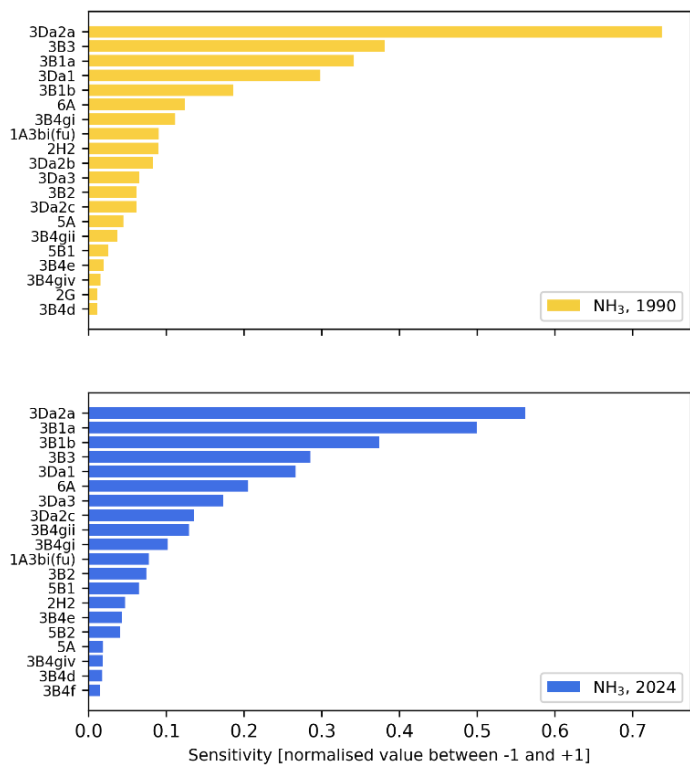


Figure A - 8 Results of the sensitivity analysis between emissions from each category and inventory emissions for NH₃, for the base year 1990 and the reporting year 2024 ((fu) means fuel used approach). Only the twenty categories ranked first are listed. See chp. 1.7 for details and compare also with Table 1-9 (results for the key category analysis approach 2, i.e. using uncertainties).

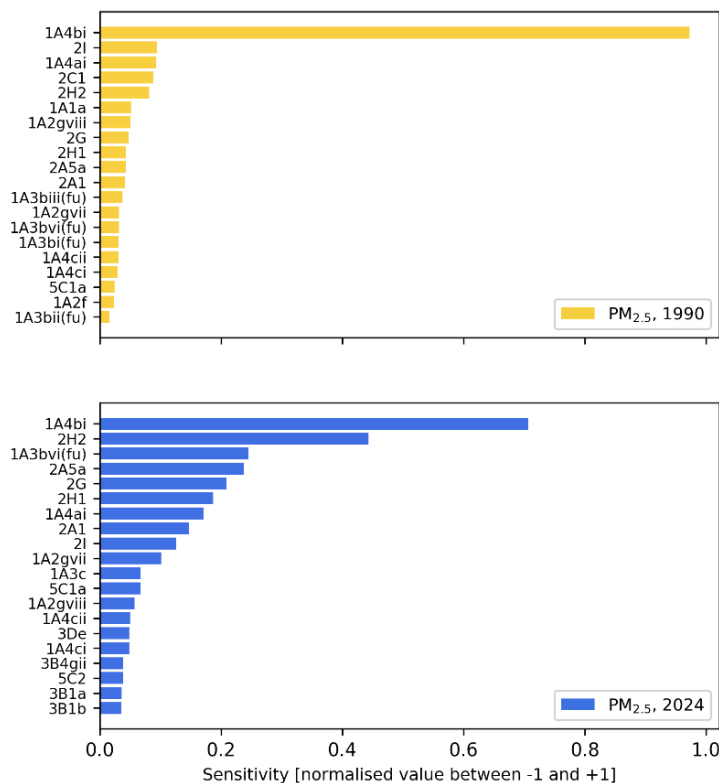


Figure A - 9 Results of the sensitivity analysis between emissions from each category and inventory emissions for PM_{2.5}, for the base year 1990 and the reporting year 2024 ((fu) means fuel used approach). Only the twenty categories ranked first are listed. See chp. 1.7 for details and compare also with Table 1-9 (results for the key category analysis approach 2, i.e. using uncertainties).

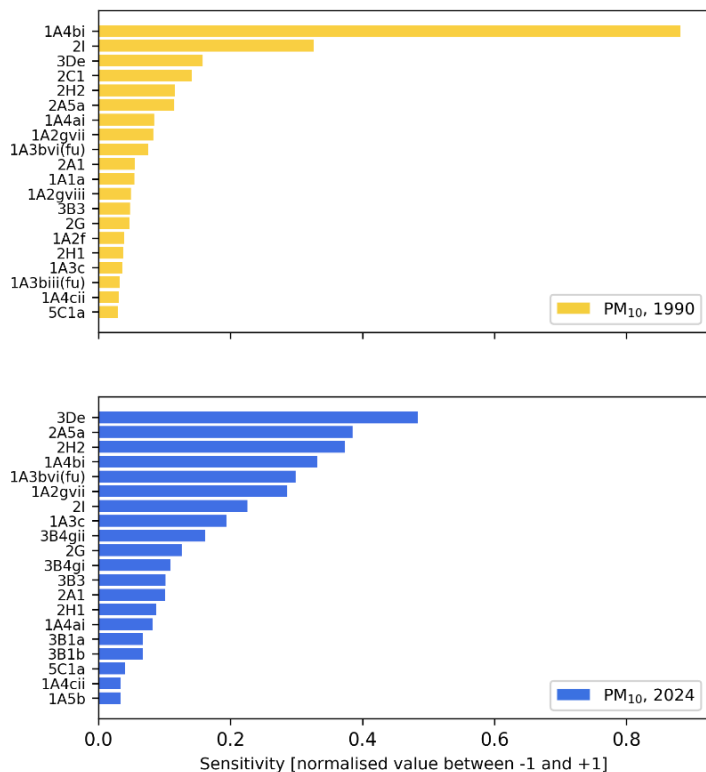


Figure A - 10 Results of the sensitivity analysis between emissions from each category and inventory emissions for PM₁₀, for the base year 1990 and the reporting year 2024. Only the twenty categories ranked first are listed. See chp. 1.7 for details and compare also with Table 1-9 (results for the key category analysis approach 2, i.e. using uncertainties).

A5.3.3 Uncertainty estimations, approach 2, generated distributions for inventory emissions

The following figures present the probability distributions generated by Monte Carlo simulations for each pollutant, for the base year, the reporting year and the trend. Each distribution is fitted using a continuous, normal probability density function, whose integral (or total area) has a value of one, by definition. Therefore, for variables with a large uncertainty, the probability values, depicted on the y-axis, can be very low.

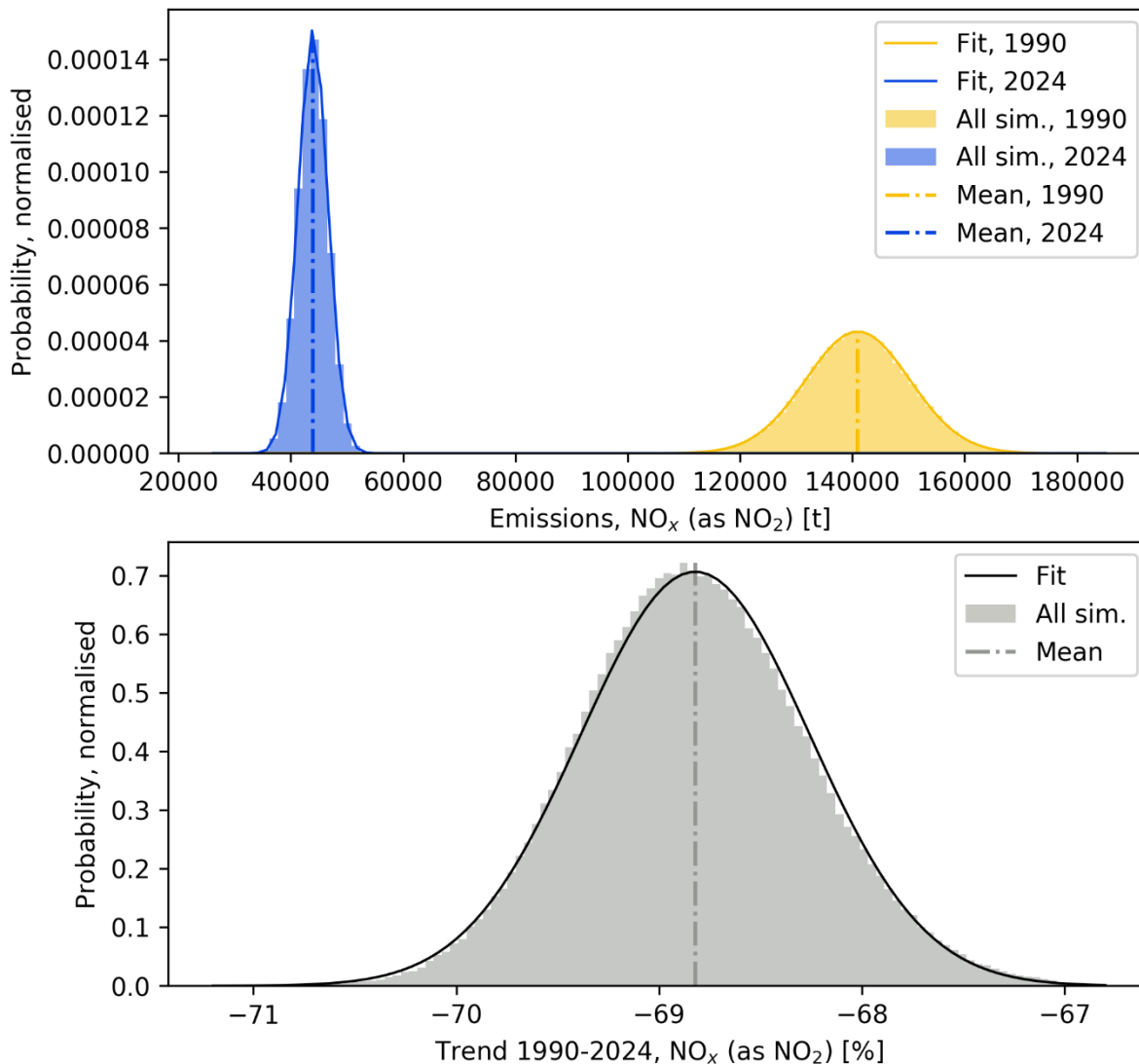


Figure A - 11 Monte Carlo simulations: Distributions obtained for the inventory mean emission for NO_x, for the base year 1990 (top panel, yellow), the reporting year 2024 (top panel, blue) and the trend 1990-2024 (bottom panel, grey). All sim.: all simulations (500'000 values for each distribution). Fit: fit of the distribution using a normal distribution. Mean: mean inventory emission obtained from the simulations.

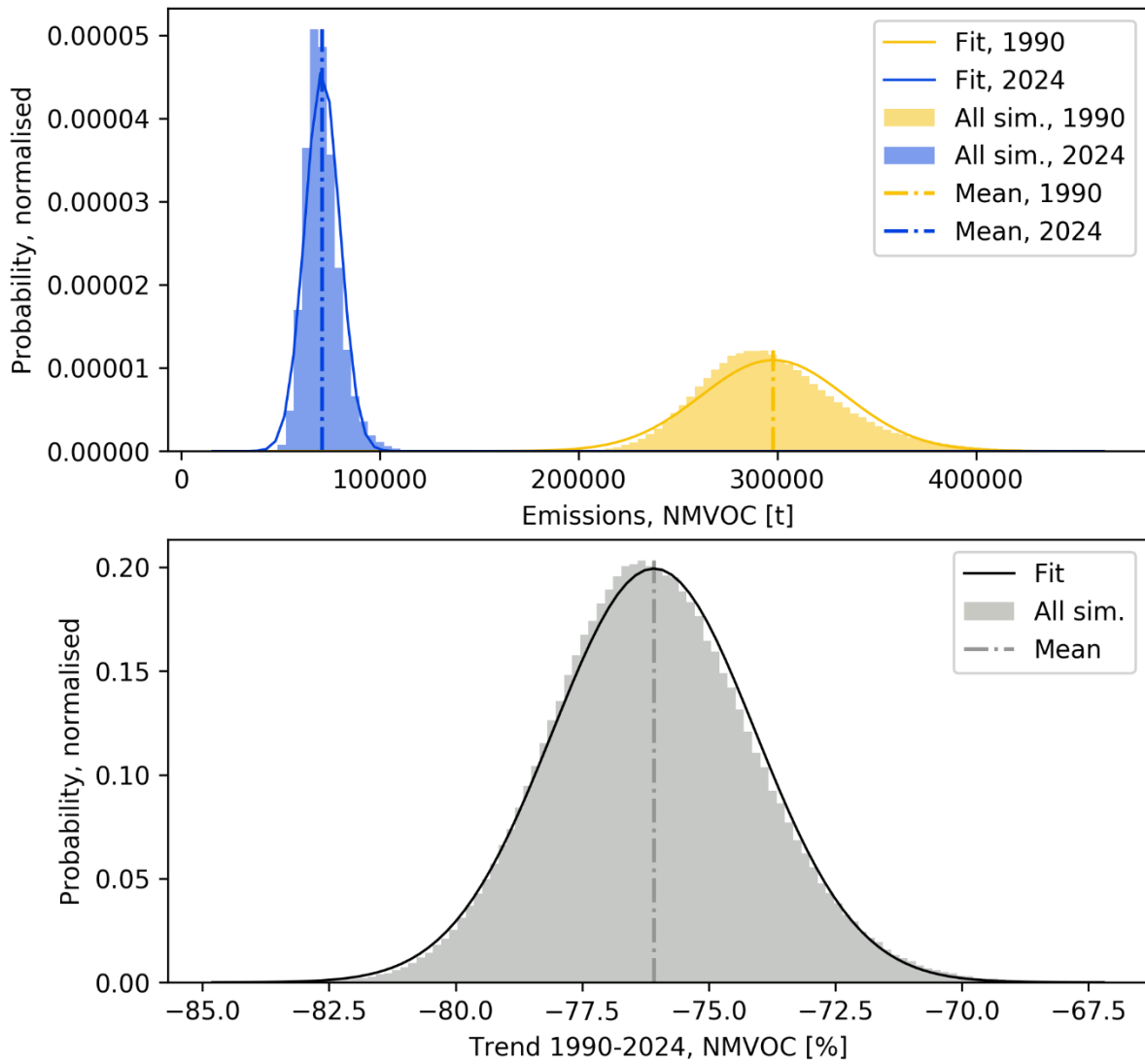


Figure A - 12 Monte Carlo simulations: Distributions obtained for the inventory mean emission for NMVOC, for the base year 1990 (top panel, yellow), the reporting year 2024 (top panel, blue) and the trend 1990-2024 (bottom panel, grey). All sim: all simulations (500'000 values for each distribution). Fit: fit of the distribution using a normal distribution. Mean: mean inventory emission obtained from the simulations.

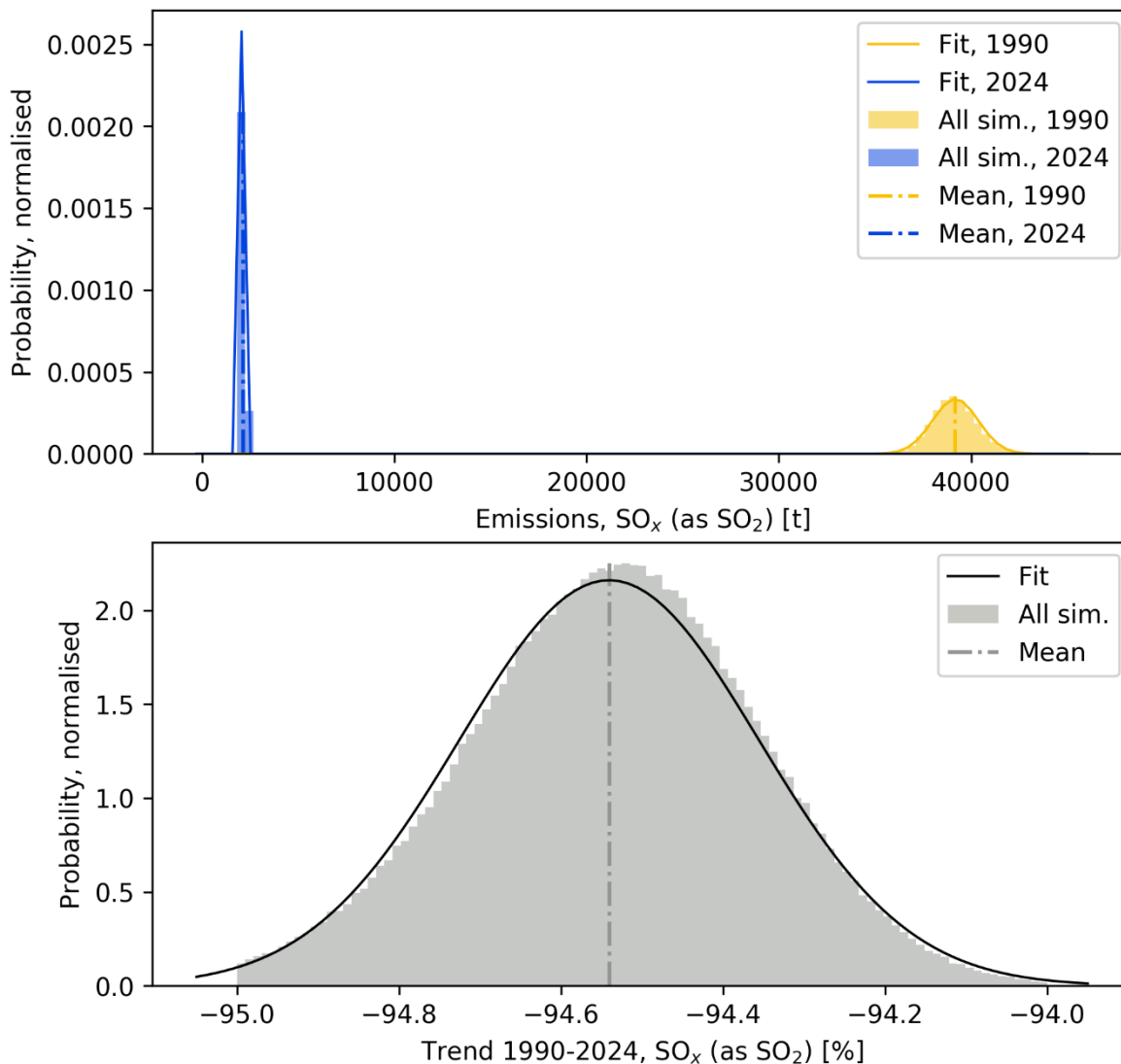


Figure A - 13 Monte Carlo simulations: Distributions obtained for the inventory mean emission for SO_x, for the base year 1990 (top panel, yellow), the reporting year 2024 (top panel, blue) and the trend 1990-2024 (bottom panel, grey). All sim: all simulations (500'000 values for each distribution). Fit: fit of the distribution using a normal distribution. Mean: mean inventory emission obtained from the simulations.

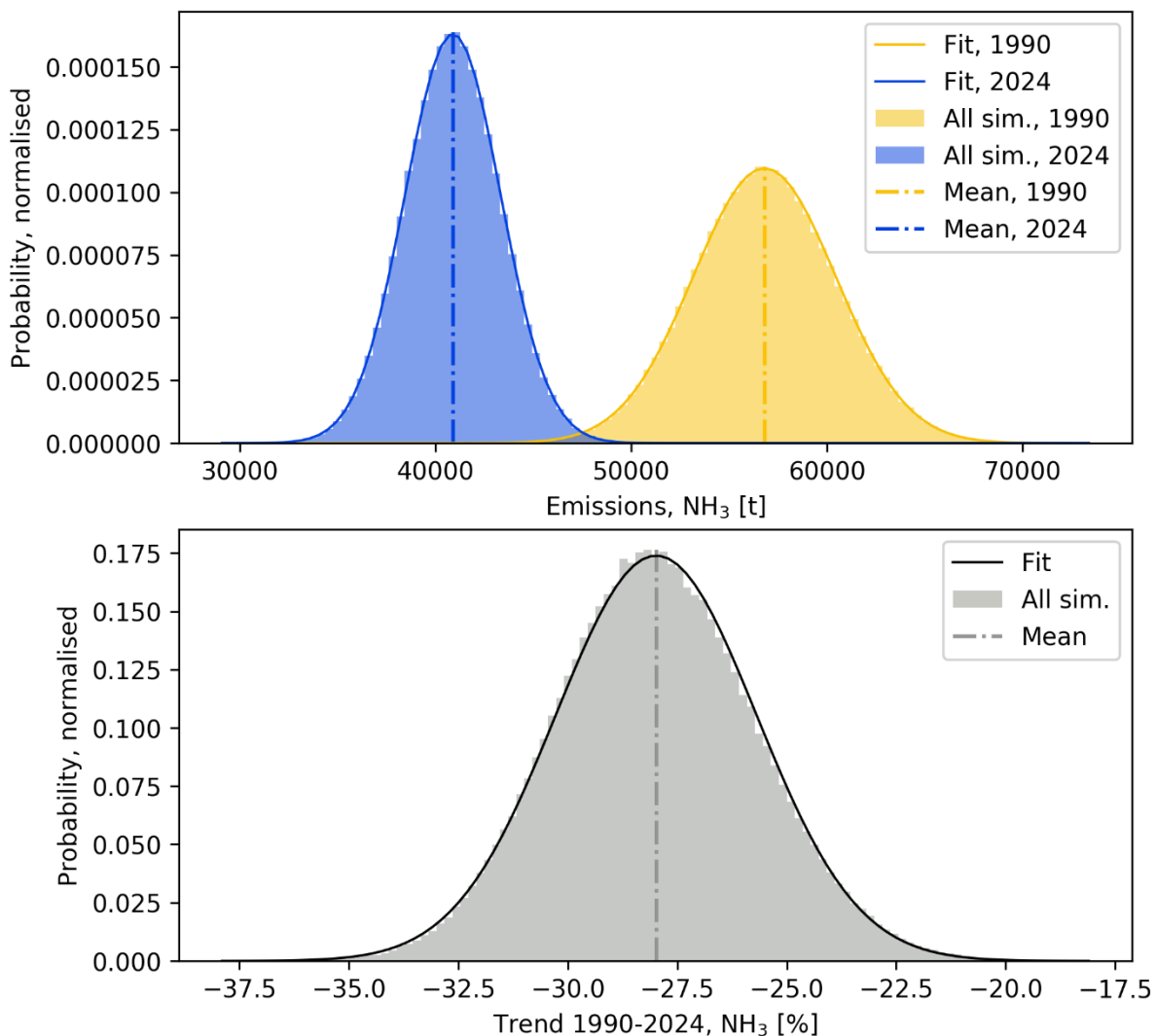


Figure A - 14 Monte Carlo simulations: Distributions obtained for the inventory mean emission for NH₃, for the base year 1990 (top panel, yellow), the reporting year 2024 (top panel, blue) and the trend 1990-2024 (bottom panel, grey). All sim: all simulations (500'000 values for each distribution). Fit: fit of the distribution using a normal distribution. Mean: mean inventory emission obtained from the simulations.

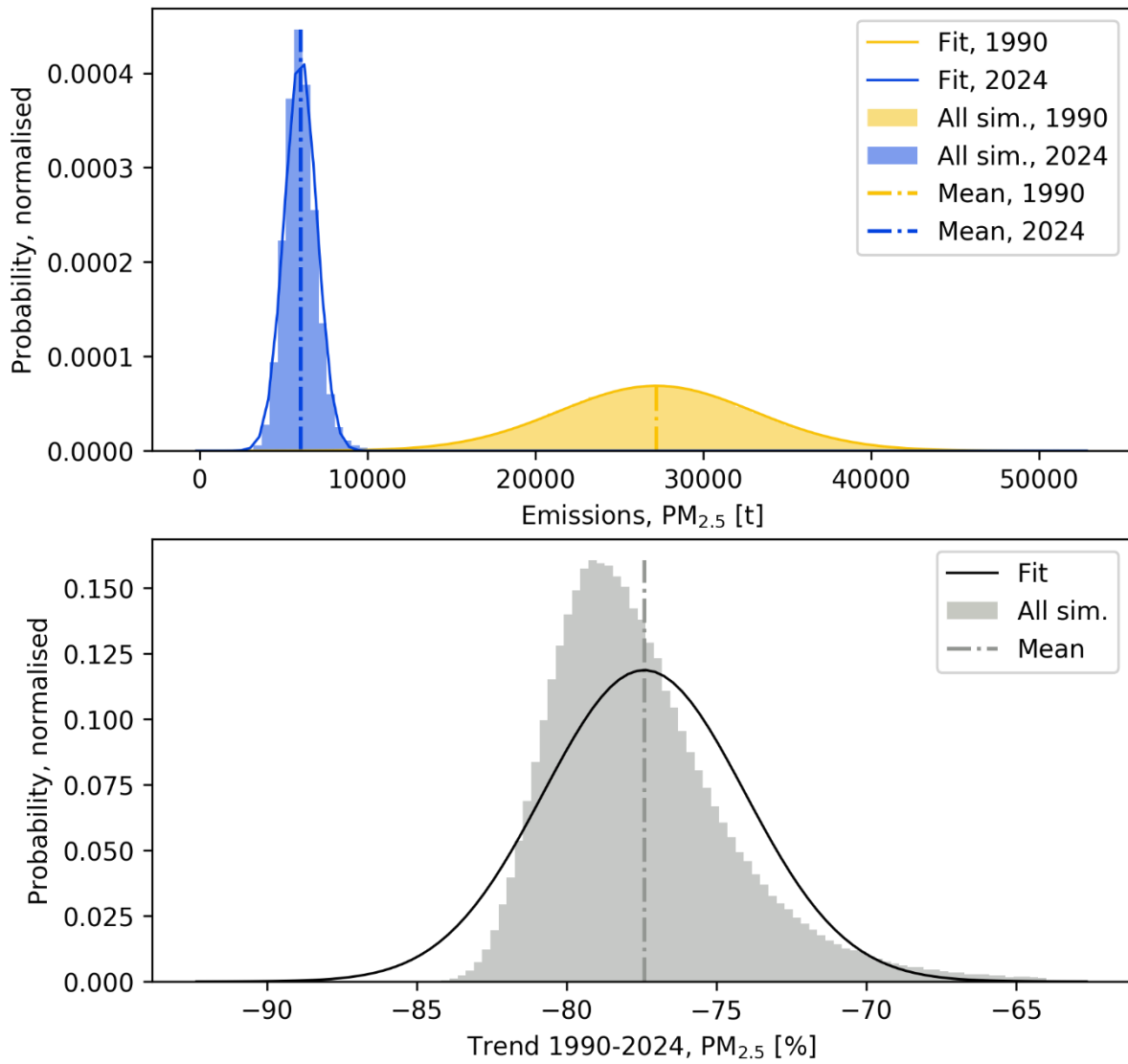


Figure A - 15 Monte Carlo simulations: Distributions obtained for the inventory mean emission for PM_{2.5}, for the base year 1990 (top panel, yellow), the reporting year 2024 (top panel, blue) and the trend 1990-2024 (bottom panel, grey). All sim: all simulations (500'000 values for each distribution). Fit: fit of the distribution using a normal distribution. Mean: mean inventory emission obtained from the simulations.

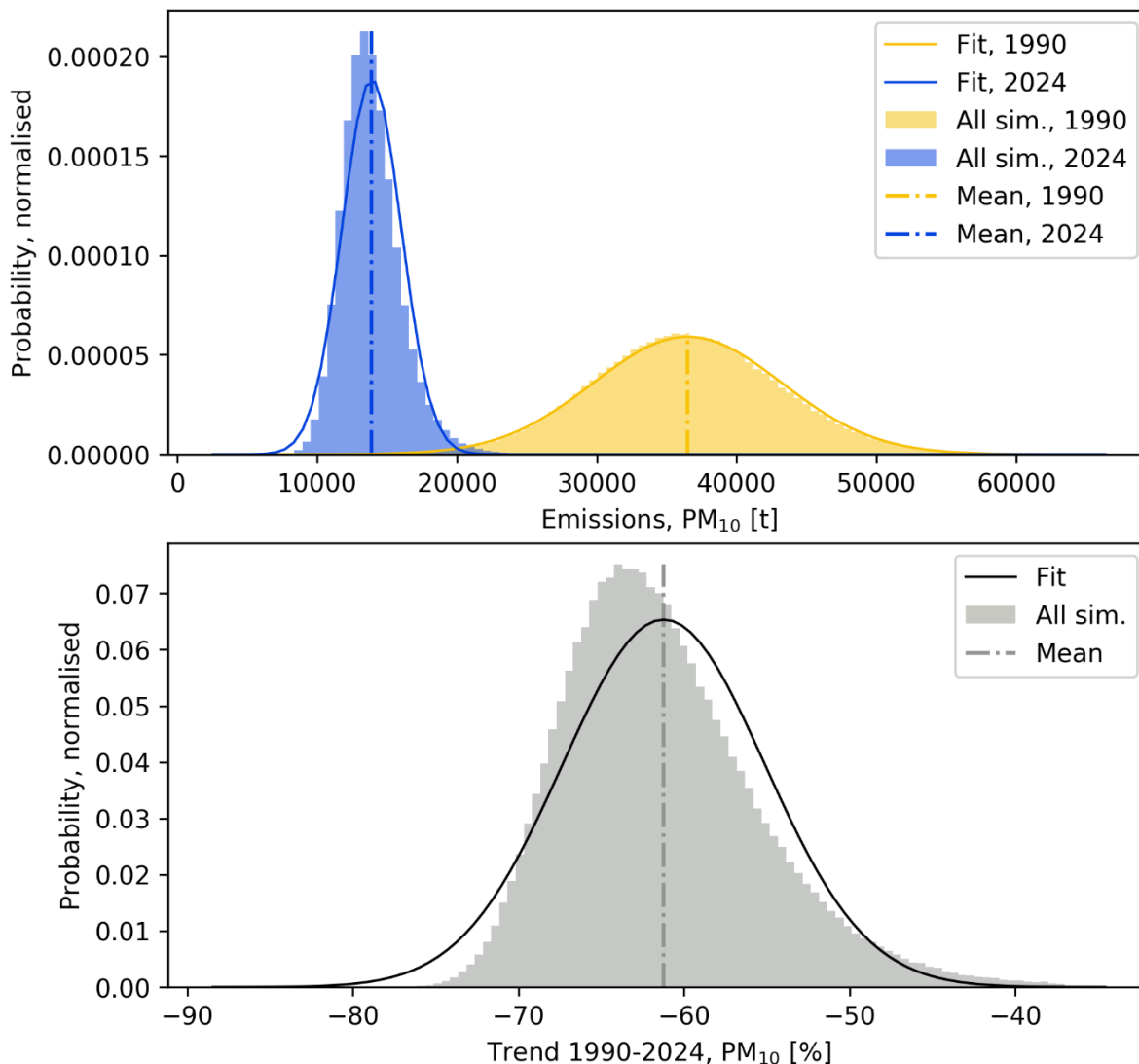


Figure A - 16 Monte Carlo simulations: Distributions obtained for the inventory mean emission for PM10, for the base year 1990 (top panel, yellow), the reporting year 2024 (top panel, blue) and the trend 1990-2024 (bottom panel, grey). All sim: all simulations (500'000 values for each distribution). Fit: fit of the distribution using a normal distribution. Mean: mean inventory emission obtained from the simulations.

Annex 6 Summary information on condensables in PM

Table A - 40 Inclusion/exclusion of the condensable component from PM10 and PM2.5 emission factors.

NFR codes	Source/sector name	PM emissions: the condensable		Emission factor reference and comments
		included	excluded	
1	Energy		X	With the exception of the source categories listed below, no condensables are included in the reported PM emissions.
1A1a, 1A2gviii, 1A4ai/bi/ci	Wood energy combustion	X		The emission factors of particulate matter from wood energy combustion comprise both the filterable and condensable fractions.
1A2gvii, 1A3b-d, 1A4aii/bii/cii, 1A5	Road transportation, Nonroad machinery and vehicles	X		Considering the measuring procedure and the maximum temperature of 52°C, it can be assumed that PM condensables are also included in the measurements. The installed technology also plays a role in this context (gasoline engines with/without catalytic converter, diesel engines with/without particulate filter, etc.).
1A4bi	Charcoal use, Bonfire	X		The emission factor of particulate matter of these two source categories are based on default Tier-2 emission factor of the EMEP/EEA Guidebook 2019 (chp. 1A4, Table 3-39). These emission factor values correspond to total particles which include both filterable and condensable PM.
2	IPPU		X	
3	Agriculture	NA	NA	
5	Waste		X	
6	Other		X	

Annex 7 Emission time series of main air pollutants, PM2.5 and BC for 1990–2024 at aggregated sector levels

A7.1 NO_x emission time series

Table A - 41 NO_x emissions by sector ((fu) means fuel used approach). The last column in the third part of the table indicates the relative trend.

NO _x		1990	1995	2000	2005	2010
1(fu)	kt	135	112	99	89	79
2	kt	0.52	0.34	0.36	0.34	0.40
3	kt	5.0	4.6	4.1	3.9	4.1
5	kt	0.29	0.21	0.18	0.16	0.15
6	kt	0.092	0.084	0.097	0.096	0.099
Sum	kt	141	117	103	94	84

NO _x		2015	2016	2017	2018	2019
1(fu)	kt	70	69	65	61	57
2	kt	0.35	0.31	0.33	0.30	0.26
3	kt	3.8	3.9	3.9	3.8	3.7
5	kt	0.15	0.14	0.14	0.13	0.13
6	kt	0.10	0.10	0.11	0.097	0.089
Sum	kt	75	73	69	65	61

NO _x		2020	2021	2022	2023	2024	2005-2024 (%)
1(fu)	kt	47	46	44	43	40	-55
2	kt	0.25	0.27	0.25	0.20	0.21	-37
3	kt	3.7	3.8	3.7	3.5	3.6	-7.1
5	kt	0.13	0.12	0.12	0.12	0.12	-23
6	kt	0.089	0.094	0.087	0.084	0.088	-8.6
Sum	kt	51	50	48	47	44	-53

A7.2 NMVOC emission time series

Table A - 42 NMVOC emissions by sector ((fu) means fuel used approach). The last column in the third part of the table indicates the relative trend.

NMVOC		1990	1995	2000	2005	2010
1(fu)	kt	133	88	65	46	32
2	kt	149	105	74	51	47
3	kt	14	14	14	16	17
5	kt	1.1	1.0	1.0	1.0	1.2
6	kt	0.20	0.19	0.21	0.20	0.18
Sum	kt	298	208	155	114	98

NMVOC		2015	2016	2017	2018	2019
1(fu)	kt	22	21	20	19	18
2	kt	39	37	37	37	37
3	kt	18	18	18	18	18
5	kt	1.4	1.5	1.5	1.6	1.7
6	kt	0.20	0.20	0.21	0.18	0.17
Sum	kt	81	78	77	75	74

NMVOC		2020	2021	2022	2023	2024	2005-2024 (%)
1(fu)	kt	16	16	16	15	15	-68
2	kt	36	36	36	36	36	-29
3	kt	18	18	18	18	18	13
5	kt	1.7	1.8	1.7	1.8	1.8	76
6	kt	0.16	0.17	0.17	0.17	0.17	-19
Sum	kt	72	72	72	71	71	-38

A7.3 SO_x emission time series

Table A - 43 SO_x emissions by sector ((fu) means fuel used approach). The last column in the third part of the table indicates the relative trend.

SO _x		1990	1995	2000	2005	2010	
1(fu)	kt	37	25	15	13	9.2	
2	kt	1.6	0.95	0.78	1.0	0.80	
3	kt	NA	NA	NA	NA	NA	
5	kt	0.16	0.080	0.062	0.063	0.063	
6	kt	0.0092	0.0092	0.0097	0.0094	0.0074	
Sum	kt	39	26	16	14	10	

SO _x		2015	2016	2017	2018	2019	
1(fu)	kt	4.9	4.1	3.7	3.4	3.2	
2	kt	0.65	0.76	0.83	0.91	0.81	
3	kt	NA	NA	NA	NA	NA	
5	kt	0.070	0.058	0.045	0.031	0.031	
6	kt	0.0073	0.0073	0.0078	0.0074	0.0069	
Sum	kt	5.6	4.9	4.6	4.3	4.1	

SO _x		2020	2021	2022	2023	2024	2005-2024 (%)
1(fu)	kt	2.8	2.9	2.7	2.3	1.8	-86
2	kt	0.52	0.47	0.35	0.26	0.26	-75
3	kt	NA	NA	NA	NA	NA	-
5	kt	0.030	0.029	0.029	0.030	0.030	-53
6	kt	0.0068	0.0072	0.0072	0.0072	0.0070	-25
Sum	kt	3.4	3.4	3.1	2.6	2.1	-85

A7.4 NH₃ emission time series

Table A - 44 NH₃ emissions by sector ((fu) means fuel used approach). The last column in the third part of the table indicates the relative trend.

NH3		1990	1995	2000	2005	2010
1(fu)	kt	1.7	2.9	4.9	3.9	2.7
2	kt	0.37	0.32	0.40	0.35	0.21
3	kt	53	49	43	42	42
5	kt	0.91	0.85	0.91	0.93	0.89
6	kt	0.85	0.79	0.92	0.87	0.91
Sum	kt	57	54	50	48	47

NH3		2015	2016	2017	2018	2019
1(fu)	kt	1.5	1.4	1.4	1.3	1.3
2	kt	0.17	0.16	0.18	0.17	0.17
3	kt	41	41	41	41	40
5	kt	0.85	0.88	0.86	0.85	0.89
6	kt	1.0	1.0	1.0	0.96	0.95
Sum	kt	45	44	44	44	43

NH3		2020	2021	2022	2023	2024	2005-2024 (%)
1(fu)	kt	1.1	1.2	1.2	1.2	1.2	-69
2	kt	0.15	0.14	0.15	0.13	0.12	-65
3	kt	40	39	39	38	38	-10
5	kt	0.88	0.90	0.86	0.88	0.88	-5.5
6	kt	0.95	0.97	0.96	0.95	0.93	7.4
Sum	kt	43	43	42	41	41	-15

A7.5 PM2.5 emission time series

Table A - 45 PM2.5 emissions by sector ((fu) means fuel used approach). The last column in the third part of the table indicates the relative trend.

PM2.5		1990	1995	2000	2005	2010	
1(fu)	kt	24	20	15	12	9.3	
2	kt	2.5	2.0	1.4	1.3	1.4	
3	kt	0.12	0.12	0.12	0.13	0.13	
5	kt	0.57	0.46	0.43	0.38	0.36	
6	kt	0.0044	0.0040	0.0042	0.0043	0.0044	
Sum	kt	27	22	17	14	11	

PM2.5		2015	2016	2017	2018	2019	
1(fu)	kt	6.3	6.3	6.1	5.7	5.6	
2	kt	1.2	1.2	1.2	1.2	1.1	
3	kt	0.14	0.14	0.14	0.14	0.14	
5	kt	0.34	0.33	0.32	0.31	0.30	
6	kt	0.0054	0.0053	0.0054	0.0049	0.0047	
Sum	kt	7.9	7.9	7.7	7.3	7.1	

PM2.5		2020	2021	2022	2023	2024	2005-2024 (%)
1(fu)	kt	5.1	5.2	4.8	4.6	4.6	-62
2	kt	1.1	1.2	1.2	0.99	1.0	-23
3	kt	0.14	0.15	0.15	0.15	0.15	14
5	kt	0.29	0.29	0.27	0.27	0.26	-30
6	kt	0.0047	0.0049	0.0048	0.0049	0.0047	10
Sum	kt	6.6	6.8	6.4	6.0	6.0	-57

A7.6 BC emission time series

Table A - 46 BC emissions by sector ((fu) means fuel used approach). The last column in the third part of the table indicates the relative trend.

BC		1990	1995	2000	2005	2010	
1(fu)	kt	5.7	5.1	4.1	3.6	2.6	
2	kt	0.0063	0.0040	0.0027	0.0026	0.0016	
3	kt	NA	NA	NA	NA	NA	
5	kt	0.040	0.033	0.030	0.027	0.026	
6	kt	0.00016	0.00016	0.00016	0.00015	0.000099	
Sum	kt	5.7	5.1	4.1	3.6	2.6	

BC		2015	2016	2017	2018	2019	
1(fu)	kt	1.5	1.4	1.3	1.2	1.1	
2	kt	0.0013	0.0014	0.0014	0.0013	0.0013	
3	kt	NA	NA	NA	NA	NA	
5	kt	0.024	0.023	0.023	0.022	0.022	
6	kt	0.000089	0.000088	0.000098	0.000089	0.000075	
Sum	kt	1.5	1.4	1.3	1.2	1.1	

BC		2020	2021	2022	2023	2024	2005-2024 (%)
1(fu)	kt	0.97	0.99	0.85	0.80	0.77	-78
2	kt	0.0014	0.0013	0.0013	0.0012	0.0012	-55
3	kt	NA	NA	NA	NA	NA	-
5	kt	0.021	0.021	0.020	0.019	0.019	-29
6	kt	0.000072	0.000081	0.000080	0.000078	0.000074	-50
Sum	kt	1.00	1.0	0.87	0.82	0.79	-78

Annex 8 Corrigendum to NH₃ emissions in source category 3Da4 Crop residues applied to soils

There has been a unit error in the NH₃ emission factor for source category 3Da4 Crop residues applied to soils (chp. 5.3.2, Table 5-18). The emission factor values are too low by a factor of 1000.

Source category 3Da4 Crop residues applied to soils was newly introduced in the latest submission. The error was noticed too late to be corrected for the submission of the NFR tables. As a result, the reported NH₃ emissions from crop residues are too low by a factor of 1'000. For the next submission, the corrected values will be implemented.

The time series 1990–2024 of the incorrect, underestimated NH₃ emission factor of 3Da4 and of all NH₃ emissions affected, as well as the correct NH₃ emission factor and the correspondingly corrected NH₃ emissions, are listed in the following two tables.

Table A - 47 Erroneous NH₃ emission factor of source category 3Da4 Crop residues applied to soils and NH₃ emissions of latest submission for the years 1990–2024.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
NH ₃ emission factor	kg/t N crop residues									
3Da4 Crop residues applied to soils	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
NH ₃ emissions	kt									
3Da4 Crop residues applied to soils	0.0006	0.0006	0.0006	0.0006	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007
3Da Agricultural soils - Direct emissions	30.923	30.039	29.502	28.801	28.548	28.268	27.171	25.169	24.132	23.390
3D Agricultural soils	30.923	30.039	29.502	28.801	28.548	28.268	27.171	25.169	24.132	23.390
3 Agriculture	53.005	51.803	51.047	50.197	49.680	49.292	47.788	45.458	44.708	43.982
National total (based on fuel used)	56.816	55.866	55.413	54.703	54.296	54.161	53.012	50.864	50.368	49.945

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
NH ₃ emission factor	kg/t N crop residues									
3Da4 Crop residues applied to soils	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
NH ₃ emissions	kt									
3Da4 Crop residues applied to soils	0.0007	0.0007	0.0006	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007
3Da Agricultural soils - Direct emissions	22.585	22.091	21.240	20.720	20.723	20.910	20.987	21.586	21.444	20.706
3D Agricultural soils	22.585	22.091	21.240	20.720	20.723	20.910	20.987	21.586	21.444	20.706
3 Agriculture	43.103	43.084	42.277	41.500	41.351	41.985	42.299	43.006	42.961	42.021
National total (based on fuel used)	50.253	50.091	49.083	47.995	47.603	47.995	47.971	48.497	48.260	47.089

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NH ₃ emission factor	kg/t N crop residues									
3Da4 Crop residues applied to soils	0.050	0.054	0.058	0.062	0.066	0.070	0.070	0.071	0.071	0.071
NH ₃ emissions	kt									
3Da4 Crop residues applied to soils	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008
3Da Agricultural soils - Direct emissions	20.997	20.398	20.127	19.867	20.184	19.741	19.803	19.936	19.675	19.282
3D Agricultural soils	20.997	20.398	20.127	19.867	20.184	19.741	19.803	19.936	19.675	19.282
3 Agriculture	42.334	41.633	41.333	40.971	41.478	40.969	40.966	41.009	40.642	40.002
National total (based on fuel used)	47.055	46.064	45.512	44.892	45.225	44.532	44.476	44.435	43.903	43.327

	2020	2021	2022	2023	2024
NH ₃ emission factor	kg/t N crop residues				
3Da4 Crop residues applied to soils	0.072	0.073	0.073	0.074	0.075
NH ₃ emissions	kt				
3Da4 Crop residues applied to soils	0.0008	0.0008	0.0008	0.0008	0.0008
3Da Agricultural soils - Direct emissions	18.865	18.692	17.868	17.429	17.332
3D Agricultural soils	18.865	18.692	17.868	17.429	17.332
3 Agriculture	39.530	39.419	38.650	37.933	37.733
National total (based on fuel used)	42.623	42.638	41.836	41.073	40.882

Table A - 48 Corrected NH₃ emission factor of source category 3Da4 Crop residues applied to soils and resulting revised NH₃ emissions for the years 1990–2024.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
NH ₃ emission factor, corrected	kg/t N crop residues									
3Da4 Crop residues applied to soils	50.3	50.3	50.2	50.2	50.1	50.1	50.0	50.0	50.0	50.0
NH ₃ emissions, corrected	kt									
3Da4 Crop residues applied to soils	0.626	0.632	0.638	0.645	0.651	0.657	0.656	0.655	0.654	0.653
3Da Agricultural soils - Direct emissions	31.548	30.670	30.140	29.445	29.198	28.924	27.826	25.823	24.785	24.042
3D Agricultural soils	31.548	30.670	30.140	29.445	29.198	28.924	27.826	25.823	24.785	24.042
3 Agriculture	53.631	52.435	51.685	50.841	50.330	49.948	48.443	46.112	45.361	44.634
National total (based on fuel used)	57.441	56.497	56.051	55.347	54.946	54.817	53.667	51.518	51.021	50.597
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
NH ₃ emission factor, corrected	kg/t N crop residues									
3Da4 Crop residues applied to soils	50.0	50.0	50.0	49.9	49.9	49.8	49.8	49.7	49.9	50.0
NH ₃ emissions, corrected	kt									
3Da4 Crop residues applied to soils	0.651	0.650	0.649	0.654	0.659	0.663	0.668	0.673	0.669	0.665
3Da Agricultural soils - Direct emissions	23.236	22.741	21.889	21.374	21.381	21.573	21.654	22.258	22.112	21.370
3D Agricultural soils	23.236	22.741	21.889	21.374	21.381	21.573	21.654	22.258	22.112	21.370
3 Agriculture	43.754	43.734	42.926	42.154	42.009	42.647	42.967	43.678	43.629	42.686
National total (based on fuel used)	50.904	50.740	49.732	48.648	48.261	48.658	48.638	49.169	48.928	47.753
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NH ₃ emission factor, corrected	kg/t N crop residues									
3Da4 Crop residues applied to soils	50.1	54.1	58.0	62.0	65.9	69.9	70.3	70.6	71.0	71.4
NH ₃ emissions, corrected	kt									
3Da4 Crop residues applied to soils	0.661	0.685	0.705	0.722	0.733	0.741	0.745	0.748	0.751	0.754
3Da Agricultural soils - Direct emissions	21.658	21.083	20.832	20.588	20.917	20.481	20.547	20.684	20.425	20.035
3D Agricultural soils	21.658	21.083	20.832	20.588	20.917	20.481	20.547	20.684	20.425	20.035
3 Agriculture	42.995	42.317	42.038	41.692	42.211	41.709	41.710	41.756	41.393	40.756
National total (based on fuel used)	47.716	46.749	46.217	45.613	45.958	45.273	45.220	45.182	44.654	44.081
	2020	2021	2022	2023	2024					
NH ₃ emission factor, corrected	kg/t N crop residues									
3Da4 Crop residues applied to soils	72.0	72.7	73.4	74.0	74.7					
NH ₃ emissions, corrected	kt									
3Da4 Crop residues applied to soils	0.772	0.790	0.808	0.826	0.844					
3Da Agricultural soils - Direct emissions	19.636	19.480	18.675	18.254	18.175					
3D Agricultural soils	19.636	19.480	18.675	18.254	18.175					
3 Agriculture	40.301	40.208	39.456	38.758	38.576					
National total (based on fuel used)	43.394	43.427	42.643	41.898	41.725					