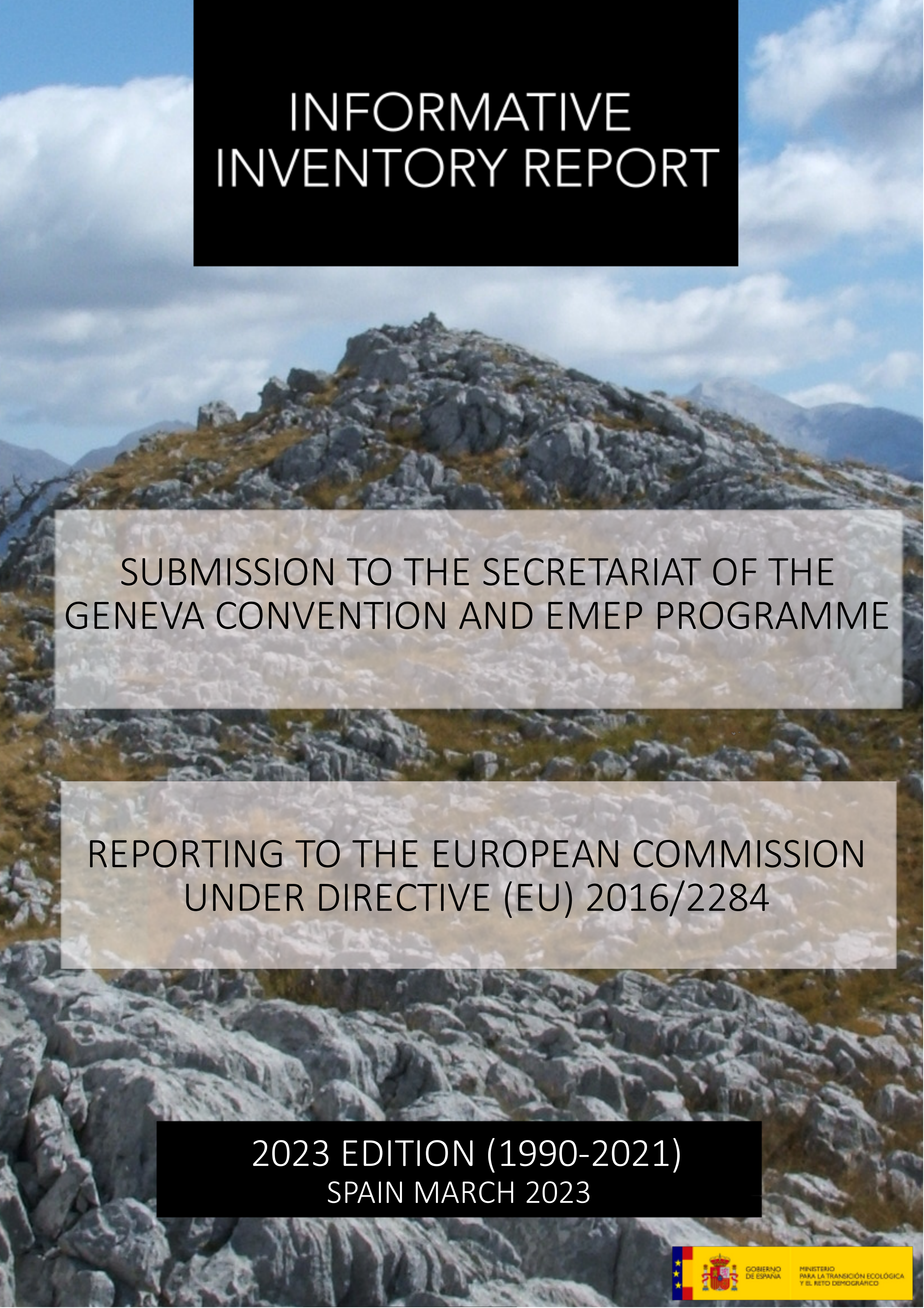

INFORMATIVE INVENTORY REPORT

SUBMISSION TO THE SECRETARIAT OF THE GENEVA CONVENTION AND EMEP PROGRAMME

REPORTING TO THE EUROPEAN COMMISSION UNDER DIRECTIVE (EU) 2016/2284

2023 EDITION (1990-2021)

SPAIN MARCH 2023

GOBIERNO DE ESPAÑA
MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA Y EL RETO DEMOGRÁFICO

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Ordesa y Monte Perdido National Park (Huesca, Spain), by David Sánchez Vicente

Chapter’s inner covers photographs:

Executive summary: Castillo d’Acher (Huesca, Spain), by Sofía Bueno Hernández

Introduction: Ares beach (A Coruña, Spain), by Sara Torre Sales

Explanation of key trends: Illa de l’Aire (Balearic Islands, Spain), by David Sánchez Vicente

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Glossary: Albarracín (Teruel, Spain), by Sara Torre Sales

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0. EXECUTIVE SUMMARY

Chapter updated in March, 2023.

0.1. General introduction

The 2023 edition of the Informative Inventory Report (IIR) has been elaborated by the Spanish National Inventory System (SEI) within the Ministry for the Ecological Transition and the Demographic Challenge (MITECO) in accordance with its regulatory framework established by Law 34/2007 for air quality and atmosphere protection, and Royal Decrees 818/2018 and 500/2020.

This report is compiled to accompany the Spain's 2023 emissions inventory data submission under the United Nations Economic Commission for Europe (UNECE) Convention on Long-Range Transboundary Air Pollution (CLRTAP), and under Directive (EU) 2016/2284 of the European Parliament and of the Council, on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC. It contains detailed information on annual emission estimates of air quality pollutants by source in Spain for the EMEP domain (excluding the Canary Islands) from 1990 onwards.

0.2. Emissions coverage

Pollutants covered by the Inventory and for which emissions data are reported, are indicated in the following table.

Table 0.2.1 Pollutants emission data reported

Pollutant's coverage	Main Pollutants.	SO_2, NOx, NH_3, CO, NMVOC	1990-2021
	Particulate Matter (PM), including condensable component.	$PM_{2.5}$, PM_{10}, TSP	2000-2021
	Heavy Metals (priority).	Pb, Cd, Hg	1990-2021
	Heavy Metals (additional).	As, Cr, Cu, Ni, Se, Zn	1990-2021
	Black Carbon.	BC	2000-2021
	Persistent Organic Pollutants (POPs).	PCDD/F, PAHs, HCB, PCBs	1990-2021

0.3. Geographical coverage

The Spanish National Emission Inventory under Directive (EU) 2016/2284 and under CLRTAP covers the whole national mainland territory in the Iberian Peninsula, the archipelago of Balearic Islands and the cities of Ceuta and Melilla.

The Canary Islands are neither covered under Directive (EU) 2016/2284, according to its article 2.2, nor by CLRTAP grid and therefore, their emissions are neither included in this report, nor in the accompanying NFR reporting tables.

Table 0.3.1 Geographical coverage under the different reporting obligations

Report obligation	Emissions geographical coverage	Observations
NEC Directive 2016/2284	NEC Directive 2016/2284	Canary Islands excluded
LRTAP Convention	EMEP grid domain	Canary Islands excluded
Regulation (EU) 2018/1999	Total National Territory	Including Canary Islands
UNFCCC Inventory for greenhouse gas emissions	Total National Territory	Including Canary Islands

The different geographic coverage (including or excluding the Canary Islands) is the main reason for differences in reported emission national totals under the respective reporting obligations (CO, NMVOC, NOx, SO_2 and NH_3 are reported to the EU and to UNFCCC under obligations related to climate change, as precursors of greenhouse gases).

Annex 4 includes the emissions corresponding to the entire national territory (Canary Islands included).

In addition, emissions of NOx and NMVOC pollutants from 1987 and 1988 are included in compliance with the Protocol concerning the Control of Emissions of Nitrogen Oxides and the Protocol concerning the Control of Emissions of Volatile Organic Compounds, respectively.

0.4. Summary of main emissions

National total emission data (excluding the Canary Islands) reported under Directive (EU) 2016/2284 and under CLRTAP in the 2023 edition of the National Inventory, excluding Memo items, are shown in the following table for all covered pollutants.

Table 0.4.1 National (excluding Canary Islands) total emission data

Year	NOx (kt)	NMVOC (kt)	SO_2 (kt)	NH_3 (kt)	$PM_{2.5}$ (kt)	PM_{10} (kt)	TSP (kt)	BC (kt)	CO (kt)
1990	1,311	1,026	2,050	489	0	0	0	0	4,104
2005	1,322	729	1,207	509	167	285	414	50	1,995
2010	936	601	245	456	161	244	320	52	1,861
2015	812	550	260	471	153	238	326	47	1,736
2019	679	551	151	478	130	211	296	42	1,534
2020	599	575	128	491	133	212	289	45	1,524
2021	620	549	123	479	135	215	297	46	1,637

Year	Pb (t)	Cd (t)	Hg (t)	As (t)	Cr (t)	Cu (t)	Ni (t)	Se (t)	Zn (t)	PCDD/PCDF (g I TEQ)	PAHs (t)	HCB (kg)	PCB (kg)
1990	3,179	26	10	10	27	80	164	7	314	580	100	381	2,185
2005	144	11	7	9	32	135	174	8	349	452	57	136	1,444
2010	132	8	4	6	25	133	91	6	386	577	56	12	725
2015	98	8	5	6	25	121	45	6	381	541	53	10	587
2019	103	7	3	4	23	124	46	6	352	453	38	13	488
2020	87	6	3	3	20	104	35	6	372	461	35	9	443
2021	101	7	3	3	21	117	37	6	382	477	36	2	451

Detailed emission data of the Spanish Inventory are available from the MITECO-SEI webpage WebTable.

0.5. Adjustments

For the 2023 edition, no adjustments have been presented.

0.6. Compliance with National Commitments

National total emission data for compliance are shown in the following tables and compared to the emission ceilings set by the NEC Directive and the CLRTAP's Gothenburg Protocol. The reduction commitments have the year 2005 as base year. Reductions of emissions that are over the commitment (marked in green) indicate compliance, while increases of emissions (negative values, marked in red) indicate non-compliance.

Table 0.6.1 Directive (EU) 2016/2284 compliance assessment

	NOx (*) Reduction commitment: 41%		NMVOC (*) Reduction commitment: 22%		SO_2 Reduction commitment: 67%		NH_3 Reduction commitment: 3%		$PM_{2.5}$ Reduction commitment: 15%	
	Emissions (kt)	Reduction attained	Emissions (kt)	Reduction attained	Emissions (kt)	Reduction attained	Emissions (kt)	Reduction attained	Emissions (kt)	Reduction attained
2005	1,244	-	621	-	1,207	-	509	-	167	-
2020	516	58.5%	465	25.2%	128	89.4%	491	3.6%	133	20.0%
2021	539	56.7%	438	29.5%	123	89.8%	479	5.9%	135	19.0%

(*) Emissions of both nitrogen oxides and non-methane volatile organic compounds from activities falling under NFR categories 3B (manure management) and 3D (agricultural soils) are not accounted for the purpose of compliance, according to the article 4.3.d) of Directive EU/2016/2284.

Table 0.6.2 Gothenburg Protocol compliance assessment

	NOx (*) Reduction commitment: 41%		NMVOC Reduction commitment: 22%		SO_2 Reduction commitment: 67%		NH_3 Reduction commitment: 3%		$PM_{2.5}$ Reduction commitment: 15%	
	Emissions (kt)	Reduction attained	Emissions (kt)	Reduction attained	Emissions (kt)	Reduction attained	Emissions (kt)	Reduction attained	Emissions (kt)	Reduction attained
2005	1,251	-	729	-	1,207	-	509	-	167	-
2020	523	58.2%	575	21.1%	128	89.4%	491	3.6%	133	20.0%
2021	546	56.4%	549	24.6%	123	89.8%	479	5.9%	135	19.0%

(*) Nitrogen oxides emissions from soils (NFR 3D) are not included in the estimates for European Union member States, according to Table 3 (Emission reduction commitments for nitrogen oxides for 2020 and beyond) of Annex II or the Gothenburg Protocol.

The emissions of pollutants in 2021 resulted in compliance with the reduction commitments set by the Directive (EU) 2016/2284 (for any year from 2020 to 2029) and by the CLRTAP's Gothenburg Protocol (for 2021 and beyond), for NOx, NMVOC, SO_2, NH_3 and $PM_{2.5}$.

0.7. Data analysis for year 2021

The following chart shows relative emissions in the year 2021 broken down by main NFR categories, as well as relative reduction of emissions (in 2021 based on 1990 levels, or 2000 for the case of particulate matter and black carbon).

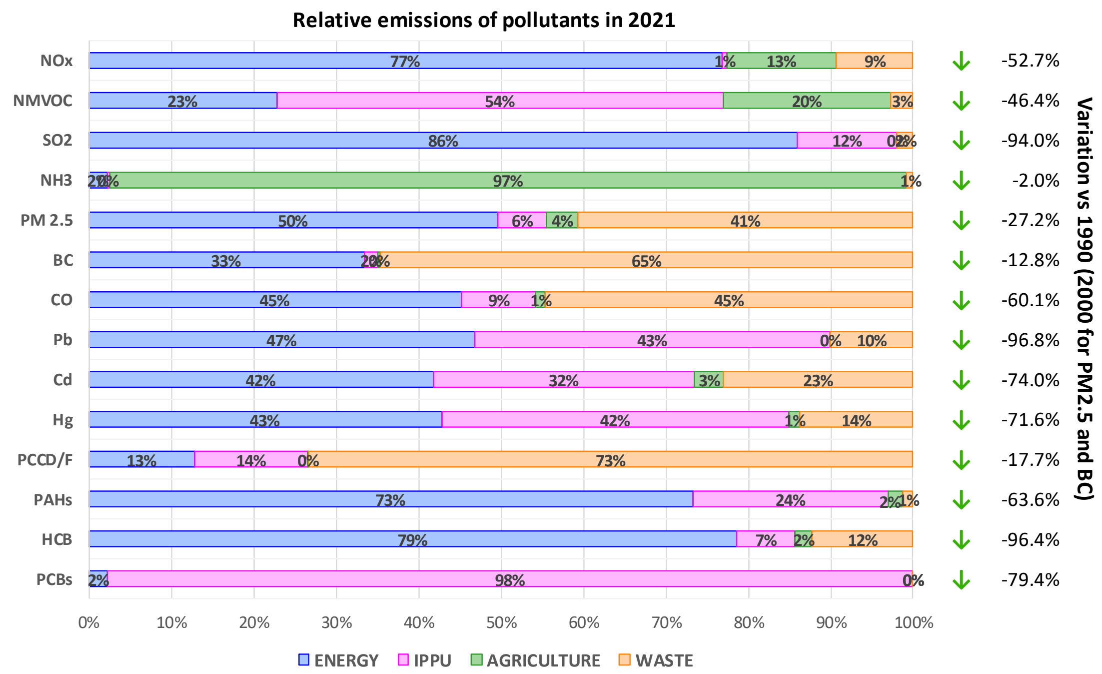


Figure 0.7.1 Distribution of emissions in year 2021 by main activity sectors

Energy activities (NFR 1) are the main contributors to most of the covered emissions. Industrial Processes and Product Use (IPPU) (NFR 2) are the main contributors for NMVOC and PCBs emissions. Agricultural activities (NFR 3) are responsible for the most part of NH_3. Finally, Waste sector (NFR 5) is a residual contributor to most of the pollutants, except for black carbon (BC) and PCDD/PCDF.

Detailed emission data of the Spanish Inventory are available from the MITECO-SEI webpage WebTable.

In 2021, approximately 620.5 kt of nitrogen oxides (NOx), expressed as nitrogen dioxide, were released in Spain. The major contributors to NOx emissions were Road transport (37% of total NOx emissions), Industries (17.6%) and Agriculture (soils) (13.2%).

Approximately 549.4 kt of NMVOC were released in 2021. The major contributors were Solvents (47.7%) of total NMVOC emissions. Livestock is the following contributing activity generating 13.3% of the national NMVOC emissions, and then Industry with 10.3%.

SO_2 emissions in 2021 accounted for 122.9 kt with Industry (58.3%), Fugitive emissions (17.4%), Other stationary combustion (14.4%) and Public power generation (4.5%) as the main contributors to these emissions.

Approximately 478.8 kt of ammonia (NH_3) were released in Spain in 2021, being the agriculture activities the main sources of emissions (96.8% of the total). AgriOther was the largest emitter representing 50.2% of total ammonia emissions. AgriLivestock accounting for 46.6%.

Finally, approximately 135 kt of Fine Particulate Matter ($PM_{2.5}$) were emitted in Spain in 2021. Waste was the largest contributing activity with 40.7% of total $PM_{2.5}$ emissions, and Other stationary combustion and Industry with 27.3% and 12.4%, respectively.

0.8. Key trends

Reduction in emissions can be observed for all pollutants covered by the National Inventory between 1990 and 2021 (see figure 0.7.1 above). More information is provided in Chapter 2 "Key trends" and in the corresponding sectorial sections of this IIR.

NOx emissions in 2021 decreased by -52.7% when compared to 1990 and continuing the trend with a -8.7% reduction compared to 2019, although they increased by +3.5 compared to 2020. Road transport (F_RoadTransport) was the first contributing activity with 37 % of total NOx emissions, with Passenger cars (1A3bi) and Heavy-duty vehicles and buses (1A3biii) accounting respectively for 22.4% and 10.6% of the total value in the Inventory. Industries (B_Industry) sector was the second contributor, accounting for 17.6% of total NOx emissions.

NMVOC emissions in 2021 declined by -46.4% compared to 1990 and decreased by -4.4% compared to 2020. Solvents (E_Solvents) was the largest contributing activity with 47.7% of the total NMVOC emissions, with Domestic solvent use (2D3a) as the main emitting sector, with 20.7% of the total of NMVOC in the Inventory, followed by Coating applications (2D3d) with 11% and Chemical products (2D3g) with 9.7 % of the total NMVOC emissions.

SO_2 emissions in 2021 decreased by -94.0% compared to 1990 and continuing the trend with a -3.7% reduction compared to 2020. Industries (B_Industry) were the first contributing activity, accounting for 58.3% of emissions, with combustion in manufacturing industries and construction, namely Non-metallic minerals (1A2f) and Iron and steel (1A2a) being respectively 16.2% and 14% of the total of the inventory. Fugitive emissions (D_Fugitive), representing 17.4% of total SO_2 emissions, was the next contributing group of activities, with Fugitive emissions from oil refining and storage (1B2aiv) accounting for 15.4% of the total estimate.

NH_3 emissions in 2021 decreased by -2.0% compared to 1990 and decreased by -2.4% when compared to 2020. Agricultural soil (L_AgriOther) was the largest contributing activity, with 50.2% of total ammonia emissions. In more detail, Animal manure applied to soils (3Da2a) was the largest emitter representing 26.4% of the total ammonia emissions of the inventory, followed by Inorganic N-fertilizers including urea application (3Da1) accounting for 15% and Urine and dung deposited by grazing animals (3Da3) accounting for 7.7 % of total NH_3 emissions.Livestock (K_AgriLivestock) was the second contributing activity, accounting for 46.6% of the total ammonia emissions of the inventory, with Manure management-Swine (3B3) accounting for 16.8%, followed by Manure management-Non-dairy Cattle (3B1b) accounting for 7.5%. Categories Manure management-Dairy cattle (3B1a) represented 6.5% and Manure management-Broilers (3B4gii) represented 4.4% of NH_3 emissions.

$PM_{2.5}$ emissions in 2021 decreased by -27.2% compared to 2000, and increased by 3.9% compared to 2019. Respect 2020, emission increased 1.2%. Waste (J_Waste) was the largest contributing activity with 40.7% of total $PM_{2.5}$ emissions, with the Open burning of pruning remains (5C2) accounting for 39.6% of the total of 2021 emissions. In the following graphs, relative variation of emissions since 1990 is shown for the main air pollutants, including BC and CO, priority heavy metals and POPs. Small Stationary Combustion (C_OtherStationaryComb) was the second contributor, accounting for 27.3% of the total, with Residential stationary combustion (1A4bi) representing 25.2% of the emissions' total of the Spanish Inventory.

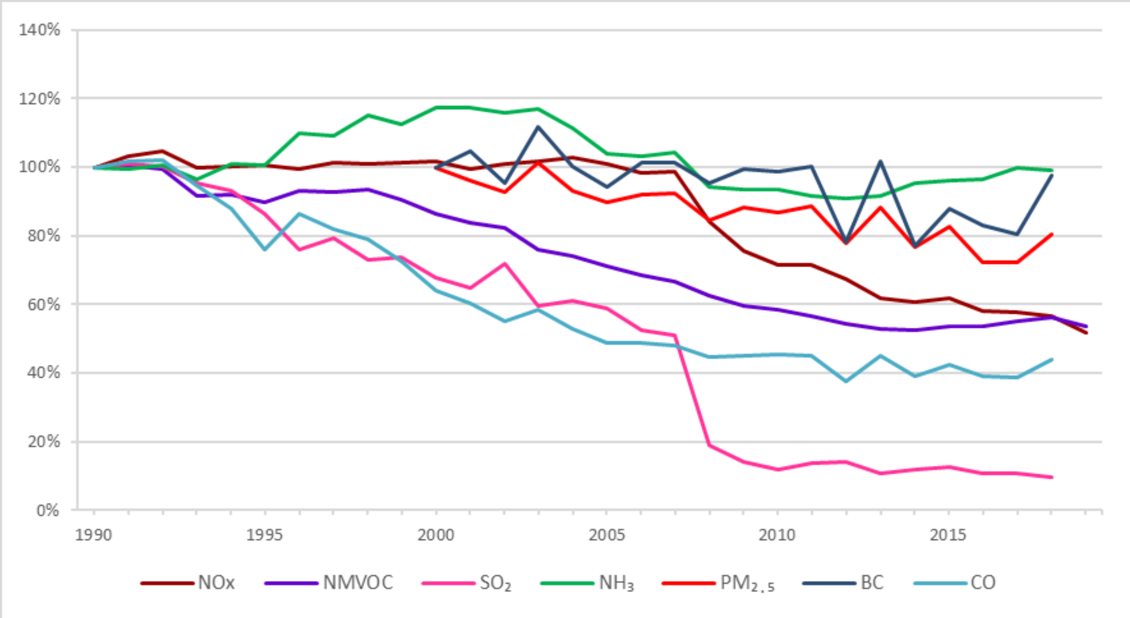


Figure 0.8.1 Relative variation of air pollutants emissions (100% in 1990 or 2000 for PM and BC)

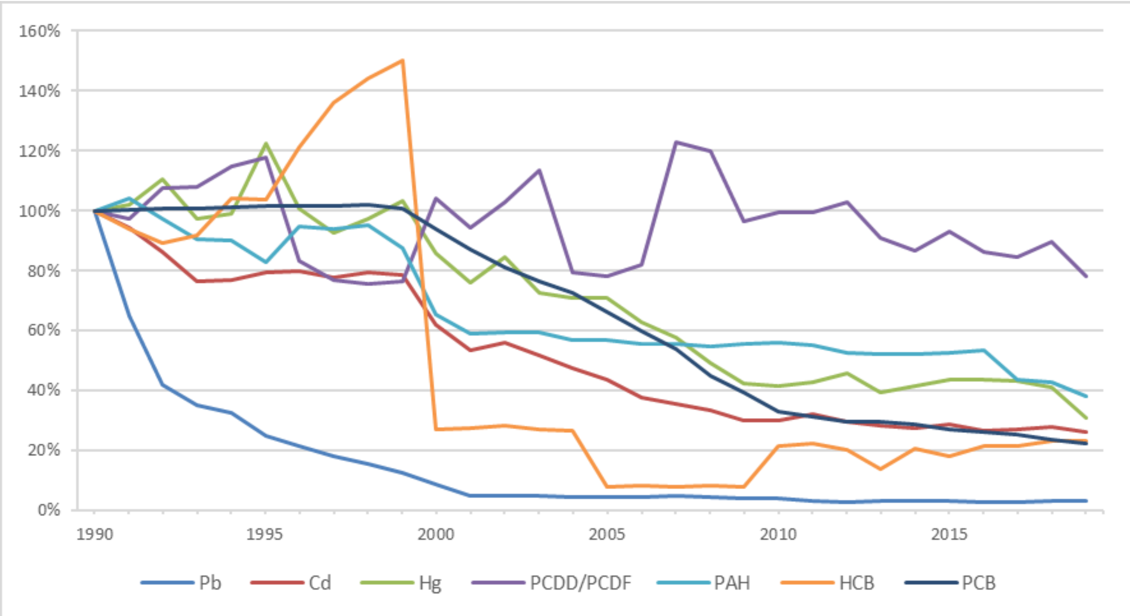


Figure 0.8.2 Relative variation of priority heavy metals and POPs emissions (100% in 1990)

0.9. Inventory recalculations and summary of main differences since last Inventory edition

Throughout the Spanish Inventory, emission estimates are updated annually across the fulltime series in response to new research and revisions to data sources, as well as error corrections and methodology changes or as a result of the implementation of reviews’ recommendations. Main features regarding revised estimates are presented below:

In this edition of the Inventory, 66 categories[1] (52% of the total accounting for the National Total) have been recalculated along with the reported period 1990-2021. Among them, for six categories' recalculations consisted of new estimations for one or several pollutants for which no estimations had been provided in the last edition. For details on completeness and use of notation keys, please refer to section 1.8.

Table 0.9.1 Summary of categories/pollutants estimated for first time in this Inventory edition

NFR Pollutant	NFR Pollutant
1A4ai	NH_3
1A4ci	NH_3
2C7c	SO_2, TSP
2K	PCB
3B4g	NO_2, NMVOC, NH_3, $PM_{2,5}$, PM_{10}, TSP
5C1biii	NO_2, NMVOC, NH_3, $PM_{2,5}$, PM_{10}, TSP

As a summary, the relative impact of recalculations in the National Totals of Emissions for pivot years is shown in the following tables.

Table 0.9.2 Relative impact of recalculations in the National Totals (excluding Canary Islands)

Year	NOx	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
1990	-1.1%	-2.3%	-0.1%	6.5%	NA	NA	NA	NA	-0.7%
2005	-1.5%	-1.2%	0.1%	6.6%	6.0%	14,6%	21,4%	-2,8%	-1,6%
2010	-1,5%	2,7%	0,2%	5,8%	5,6%	12,7%	13,2%	-3,3%	-2,4%
2015	-4,2%	1,9%	0,2%	4,6%	6,3%	17,3%	23,6%	-3,5%	-2,7%
2019	-8.4%	-3.5%	0.2%	2.2%	2.3%	13,4%	17,7%	-4,0%	-3,5%
2020	-5.3%	4.4%	9.1%	2.2%	10.8%	18,5%	18,8%	10,4%	6,5%

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/ PCDF	PAHs	HCB	PCBs
1990	0,0%	0,7%	-0,1%	1,1%	0,2%	2,6%	-1,0%	2,3%	0,1%	16,2%	-2,9%	-84,9%	7737,2%
2005	1,2%	4,2%	-0,2%	1,5%	0,5%	1,9%	-1,5%	0,5%	0,4%	67,1%	-4,8%	-96,6%	3554,7%
2010	2,2%	11,5%	0,8%	4,7%	1,9%	2,3%	-2,8%	-0,3%	0,7%	97,3%	-9,1%	2,3%	1832,1%
2015	2,7%	11,6%	2,6%	4,9%	2,3%	2,1%	1,5%	0,9%	0,6%	86,5%	-9,5%	2,4%	1848,3%
2019	2,2%	10,2%	3,1%	7,2%	2,0%	1,7%	0,1%	1,6%	0,4%	79,3%	-11,4%	1,4%	1625,6%
2020	6,4%	13,9%	8,7%	12,8%	3,4%	2,2%	-1,4%	2,7%	13,0%	100,9%	-11,8%	-32,5%	1761,6%

Regarding major changes performed, when aggregated variations per category for the reported period 1990-2020 are listed and rated from the highest to the lowest absolute value, 7 categories account for the 95% of the accumulated contribution as a percentage of the recalculation over the total variation observed in absolute value (henceforth, contribution level or CL). As shown in the following table, recalculations in categories 2K, 5C1biv and 2B10a are dominant in this Inventory Edition.

[1] Only categories and pollutants with more than a ±0.00001% variation have been accounted for as a real recalculation. Minor variations could be found under this threshold due to rounding effects in the calculation process or minor error corrections performed.

Table 0.9.3 Main categories whose aggregated contribution level (CL) adds up the 95% of the total (reported period 1990-2020)

NFR	DESCRIPTION	Edition 2023	Edition 2022	Difference	Absolute value of the difference	CL	Aggregated CL
2K	Consumption of POPs and heavy metals (e.g., electrical, and scientific equipment)	4,1839.88	0	4,1839.88	4,1839.88	71.13%	71.1%
5C1biv	Sewage sludge incineration	7,414.69	316.90	7,097.79	7,097.79	12,07%	83.2%
2B10a	Chemical industry: Other (please specify in the IIR)	674,84	3,654.42	-2,979.58	2,979.58	5.07%	88.3%
2D3a	Domestic solvent use including fungicides	2,985.16	1,712.29	1,272.87	1,272.87	2.16%	90.4%
3B4h	Manure management - Other animals (please specify in IIR)	836.12	0	836.12	836.12	1.43%	91.9%
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	1,842.40	1,109.57	732.83	732.83	1.25%	93.1%
2A5b	Construction and demolition	1,023.17	301.51	721.65	721.65	1.23%	94.3%

In terms of impact on each pollutant, category 5C1biv registers the biggest values of CL in more cases, with 98% of PCDD/PCDF recalculation. The other categories only have an impact on one or a few pollutants but contribute the most to their recalculation, among which the most noteworthy are categories 2B10a and 2K with 100% of HCB and PCBs recalculation, respectively.

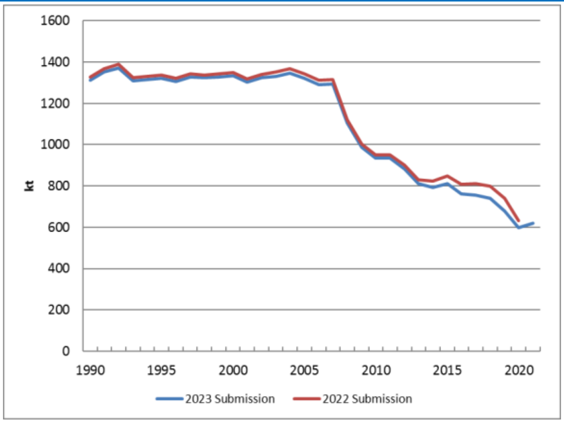
Table 0.9.4 CL by category and pollutant for the top 7 most contributing categories to the overall recalculation (reported period 1990-2020)

NFR	NOx	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/ PCDF	PAHs	HCB	PCBs
2A5b	0%	0%	0%	0%	6%	19%	49%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2B10a	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
2D3a	0%	37%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2K	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%
3B4h	4%	1%	0%	40%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
3Dc	0%	0%	0%	0%	9%	51%	30%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
5C1biv	0%	0%	0%	0%	0%	0%	0%	0%	2%	83%	86%	60%	75%	68%	62%	12%	3%	66%	98%	0%	0%	0%

In the IIR chapter 8 "Recalculations", a detailed analysis by pollutant is performed of which a summary is provided in the following tables.

Table 0.9.5 Summary of recalculations for NOx

NOx
In the 2023 inventory edition, 40 out of 62 categories estimated (65%) recalculated for reported year 2020.
For reported year 2020 recalculations implied a revised estimation of total emissions of -33.7 kt (-5.3%). On average, for the whole inventoried time series, revised emissions estimations were -2.1% lower.
Main contributor to the recalculation was category 1A3dii – National navigation (shipping): Recalculation due EF have been updated according to the December 2021 version of EMEP/EEA Guidebook (2019).
Evolution of the difference



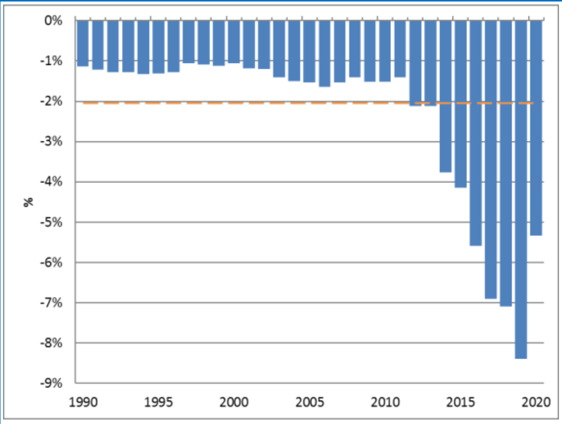
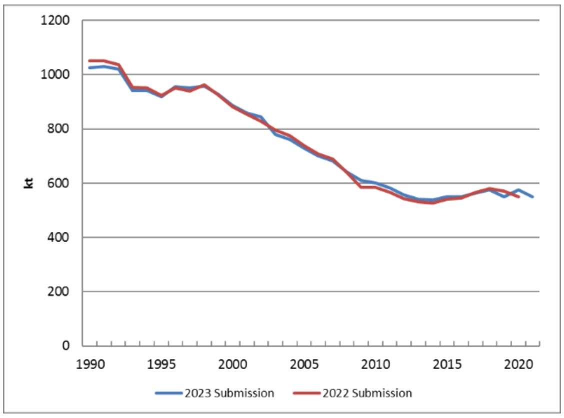


Table 0.9.6 Summary of recalculations for NMVOC

NMVOC
In the 2023 inventory edition, 54 out of 71 categories estimated (75%) recalculated for reported year 2020.
For reported year 200 recalculations implied a revised estimation of total emissions of 24.2 kt (4.4%) On average, for the whole inventoried time series, revised emissions estimations were 0.0% higher.
Main contributors to the recalculation were categories 2D3a – Domestic solvent use including fungicides: Recalculation due to revised estimate.
Evolution of the difference



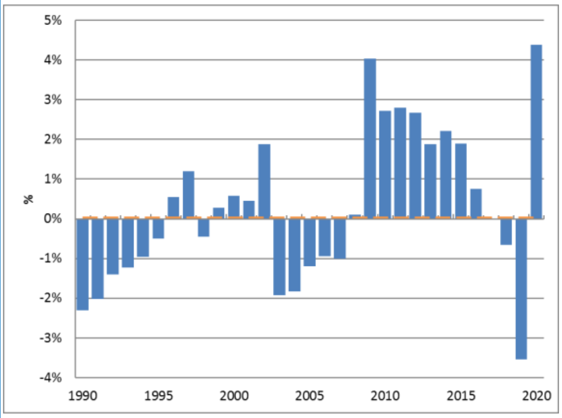
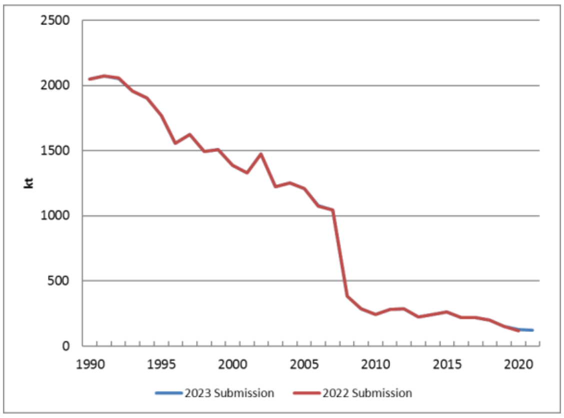


Table 0.9.7 Summary of recalculations for SO_2

SO_2
In the 2023 inventory edition, 27 out of 44 categories estimated (61%) recalculated for reported year 2020. For reported year 2020 recalculations implied a revised estimation of total emissions of 10.7kt (9.1%). On average, for the whole inventoried time series, revised emissions estimations were 0.4 kt/year 0.0% higher. Main contributor to the recalculation was category 2C7c – Other metal production: New estimation according to EMEP/EEA GB 2019.
Evolution of the difference



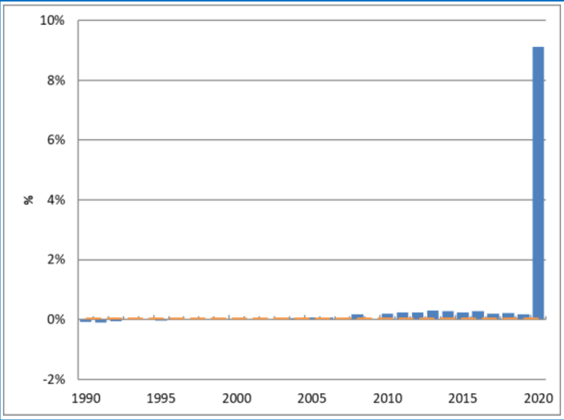
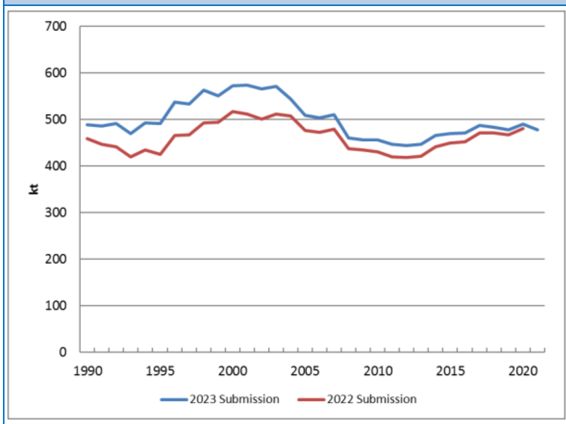


Table 0.9.8 Summary of recalculations for NH_3

NH_3
In the 2023 inventory edition, 37 out of 51 categories estimated (73%) recalculated for reported year 2020. For reported year 2020 recalculations implied a revised estimation of total emissions of 10.4 kt (2.2%). On average, for the whole inventoried time series, revised emissions estimations were 8.3% higher. Main contributor to the recalculation was category 3B4h – Manure management - Other animals: Incorporation as a new category (rabbits).
Evolution of the difference



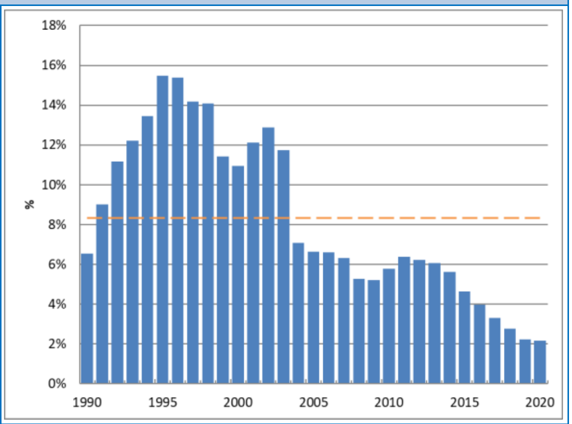
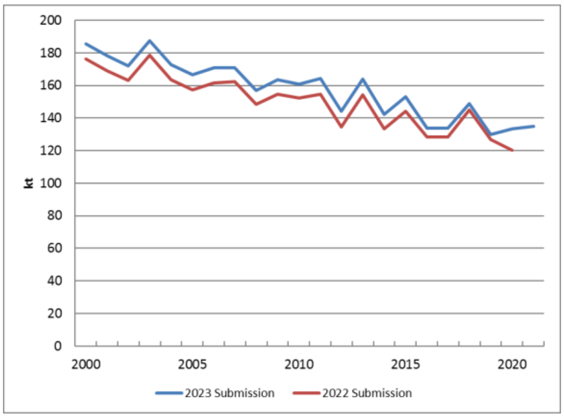
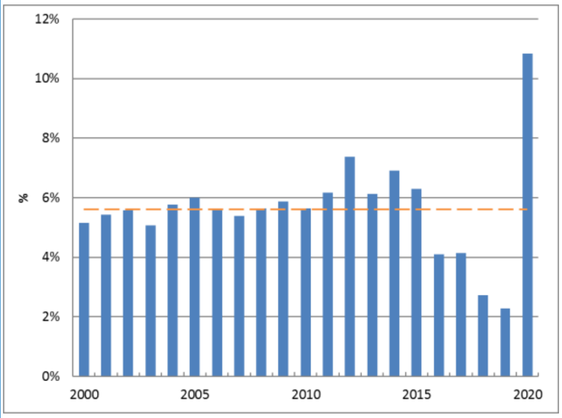


Table 0.9.9 Summary of recalculations for $PM_{2.5}$

$PM_{2.5}$
In the 2023 inventory edition, 43 out of 73 categories estimated (59%) recalculated for reported year 2020. For reported year 2020 recalculations implied a revised estimation of total emissions of 13.0 kt (10.8%). On average, for the whole inventoried time series, revised emissions estimations were 5.6% higher. Main contributor to the recalculation was category 1A4bi – Residential: Stationary: Disaggregation of biomass consumption. Update of fuel-activity allocation for the whole series. Update of natural gas consumption since 2015.
Evolution of the difference





0.10. Planned improvements

Detailed information on planned improvements is included in IIR section 8.4., as well as in the sectorial IIR chapters. The following actions can be highlighted for the entire Inventory as planned improvements:

- Complete the implementation of the EMEP/EEA GB 2019.
- Continue to check the coherence of data from the Inventory and from other registers (EU-ETS, E-PRTR, etc.).
- The review of the methodology for the elaboration of the fuel balance will continue, in collaboration with the relevant departments of the Secretary of State for Energy at MITECO. The collaboration with the IDAE-MITECO continues in the sense of providing specific information for the balance.
- Minor improvements are progressively addressed in order to achieve full implementation of EMEP/EEA GB 2019.

0.11. Reporting of PM condensable component

Condensable emissions are organic compounds that are vapour phase at stack conditions, but which condensate and form particles upon cooling, when discharged into ambient air.

Within the CLRTAP, the Executive Body at its thirty-eight session formally requested that Parties describe their practices for reporting the condensable component of PM in their IIRs. (ECE/EB.AIR/142 para 18.f). The purpose is to provide transparent information that can easily be used by the modellers. To this end, information regarding the inclusion or not of the condensable component of PM in the reported emissions is provided in annex V and the corresponding sector chapters of the IIR. Reporting of this issue has been done following the revised template for of Annex II_v2021 (Recommended Structure for Informative Inventory Report).

In general, according to current information available within the Inventory, particulate matter emissions in Energy industries (NFR 1A1) and Manufacturing industries and construction (NFR 1A2) exclude the condensable component. However, emissions from the Transport categories (NFR 1A3) include condensables. Within categories 1A4 there is a mixture of criteria depending on the fuel used. Finally, a general lack of information is found for Fugitive emissions (NFR 1B), IPPU (NFR 2), Agriculture (NFR 3) and Waste (NFR 5) sectors.

0.12. Implementation of EMEP/EEA Guidebook 2019

The table below shows the updated chapter of EMEP/EEA Guidebook 2019 indicating those for which implementation has been performed in this Inventory edition:

Table 0.12.1 Summary of implementation of updated chapters from EMEP/EEA GB 2019

NFR	Chapter title	Description of change	Status	Observation
General chapter	2. Key Category analysis and methodological choice	General update for calculating key categories	Partially implemented	Full implementation will be finished in the next edition
General chapter	9. Projections	Refinement and improved guidance and methodology to estimate projections	Implemented	
1.A.1.a	Public electricity and heat production	Emissions of PAHs for both Large Point Sources (LPS) and small power plants (Area Sources) in previous editions of the Inventory	Implemented	
1.A.1.c	Manufacture of solid fuels and other energy industries	Main Pollutants and Particulate Matter emissions. Heavy metals and POPs emissions	Implemented	
1.A.3.b	Road transport	All pollutants	Implemented	
1.A.3.b.v	Gasoline evaporation	COVs		
1.A.3.d	National navigation	All pollutants	Implemented	
1.A.4	Small Combustion	All pollutants	Implemented	
1.B.1.b	Fugitive emission from solid fuels: Solid fuel transformation	Emission factors for CO under category 1B1b have been updated	Implemented	
1.B.2.c	Venting and flaring	New Tier 2 Emission Factors	Implemented	
2.A.5.a	Quarrying and mining	New methodology and new spreadsheet calculation tool	Implemented	
2.C.1	Iron and steel production	Relocation of CO to category 1A2a, according to EMEP/EEA 2019 Guidebook	Implemented	

NFR	Chapter title	Description of change	Status	Observation
2.C.2	Ferroalloys production	Deletion of CO emissions according to EMEP/EEA 2019 Guidebook	Implemented	
2.C.6	Zinc production	Correction of the units for the Pb EF, according to EMEP/EEA 2019 Guidelines	Implemented	
2.D.3.a	Domestic solvent use of fungicides	Removed Hg EF from Table 3-1 and Table 3-6	Not applicable to Spain's Inventory	Spain uses a country-specific EF for Hg, so no changes to methodology have been applied
2.D.3.g	Chemical products	New PAH EF in Table 3-8, 3-9 and 3-10	Not applicable to Spain's Inventory	Asphalt blowing does not occur in Spain, so no changes are deemed necessary in this category
3.D.a.3	Urine and dung deposited by grazing animals	Updating NH_3-EFs from EMEP/EEA Guidebook (2019) for grazing animals emission	Implemented	
3.F	Field burning of agricultural residues	PAHs EFs update from EMEP/EEA Guidebook (2019)	Implemented	

0.13. Web-page and contact details

Further information can be consulted at the Spanish Inventory National Systems webpage:

https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/sistema-espanol-de-inventario-sei-/

Detailed emission data of the Spanish Inventory are available from the MITECO-SEI website WebTable.

Contact:

Inventories Unit
Spanish Ministry for Ecological Transition and the Demographic Challenge
Ministerio para la Transición Ecológica y el Reto Demográfico
Pza. San Juan de la Cruz, s/n
28071 Madrid
Email: Buzon-inv_emisiones@miteco.es

1. INTRODUCTION

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1. INTRODUCTION

Chapter updated in March, 2023.

1.1. National Inventory background

The 2023 edition of the Informative Inventory Report (IIR) has been elaborated by the Spanish National Inventory System (SEI) within the Ministry for the Ecological Transition and the Demographic Challenge (MITECO).

This report is compiled to accompany the Spain's 2023 emissions inventory data submission under:

– Directive (EU) 2016/2284 of the European Parliament and of the Council, on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC, and

– United Nations Economic Commission for Europe (UNECE) Convention on Long-Range Transboundary Air Pollution (CLRTAP).

It contains detailed information on annual emission estimates of air quality pollutants by source in Spain for the EMEP domain (excluding the Canary Islands) from 1990 onwards.

Main features of the Spanish IIR and emissions data included in the 2023 edition are summarised in Table 1.1.1.

Table 1.1.1 Main features of Spanish IIR 2023

Title	Spanish Inventory Informative Report (IIR)		
Edition	2023		
Formal internal national approval	23.12.2022 – Approval by the Government Delegate Commission for Economic Affairs (CDGAE).		
Submission Emission Data (NFR tables)	v1.0 (14.02.2023)	REPDAB run: yes	
Date of release-IIR	15.03.2023		
Time series	1990-2021		
Pollutant's coverage	Main Pollutants	SO_2, NOx, NH_3, CO, NMVOC	1990-2021
	Particulate Matter	TSP, PM_{10}, $PM_{2.5}$, Black Carbon (BC)	2000-2021
	Heavy Metals (priority)	Pb, Cd, Hg	1990-2021
	Heavy Metals (additional)	As, Cr, Cu, Ni, Se, Zn	1990-2021
	Persistent Organic Pollutants	PCDD/PCDF, PAHs, HCB, PCBs	1990-2021
Geographical scope	Spanish territory under the EMEP domain: including the Balearic Islands and Ceuta and Melilla autonomous cities and excluding the Canary Islands.		
Emission data reported	Emissions data reported in this IIR refer to the Spanish territory excluding the Canary Islands. Annex I NFR tables rows 14-141 show emissions from Spain excluding the Canary Islands.		
Reporting guidelines	Guidelines for reporting emissions and projections data under the CLRTAP Convention (ECE/EB.AIR/125 - 13 March 2014).		
Reporting Nomenclature	NFR-2019. Annex I: Emissions reporting template (revised version, 18.11.2019) approved by EMEP SB during its 5th Joint Session. Annex II: Recommended structure for IIR including a table for reporting information on the condensable fraction of PM. Annexes III to VI of the UNECE Reporting Guidelines: https://www.ceip.at/reporting-instructions/annexes-to-the-2014-reporting-guidelines		

Numeric format used	English standard numeric format is used in the report (comma to separate groups of thousands and point to indicate the decimal place).	
Latest Reviews	2021. Review of National Air Pollutant Emission Inventory Data 2021 under Directive 2016/2284 (National Emission reduction Commitments Directive). 2021. Review of emission data reported under the LRTAP Convention.	
Emissions Sources	LPS	Emission for the 337 Large Point Sources identified by the Inventory for the year 2021 are included, independently of their emission level or size.
	Air traffic	Emissions from domestic and international aviation during the landing and take-off included. Cruise emissions reported separately as memorandum items.
	International navigation	Emissions from domestic maritime shipping included. Emissions from international maritime shipping reported separately as memorandum items.
	Natural sources	Emissions from natural sources (volcanoes, forest fires, etc.) reported separately as memorandum items.
Record keeping	Official data, documentation and information are kept (both electronic or in paper format) at the offices of the Spanish National Inventory System.	
Inventory Database System	Spanish National Inventory System Database is based on Oracle.	
Projections	Emissions projections for Main Pollutants (SO_2, NOx, NH_3, NMVOC) and Particulate Matter ($PM_{2.5}$) to be reported in 2023.	
Gridded data	Gridded data in the EMEP 0.1 x 0.1 degree (GNFR-14) to be reported in 2023.	

1.2. Institutional arrangements

The Directorate-General for Environmental Quality and Assessment (DGCEA), at the Ministry for the Ecological Transition and the Demographic challenge (MITECO), is the competent authority of the Spanish Inventory System (SEI). The DGCEA is also the competent authority for the elaboration of the national emissions projections, a task which is also performed within the SEI.

The Subdirectorate-General for Clean Air and Industrial Sustainability (SGALSI), within the DGCEA, is the body in charge of the SEI management and the annual delivery of the National Inventory of Emissions. The Inventory Unit within the SGALSI acts as the executive body of the SEI.

The National System for the elaboration of Emissions Inventories and Projections is set and ruled by the following legal framework:

- Law 34/2007, of November 15, on air quality and protection of the atmosphere, establishes in article 27.3 the Spanish Emissions Inventory and Projections System (SEI).
- Royal Decree 818/2018, of July 6, on measures for the reduction of national emissions of certain atmospheric pollutants sets in article 10 the rules of functioning of the Spanish Emissions Inventory and Projections System.
- Royal Decree 500/2020, of April 28, which develops the basic organic structure of the Ministry for the Ecological Transition and the Demographic Challenge, designates, in article 7.f), the Directorate General of Environmental Quality and Assessment as competent authority of the Spanish Emissions Inventory and Projections System.
- Emission Inventories are considered a statistic operation within the National Statistic Plans 2017-2020 and 2021-2024 (statistic operation numbers 7105 for plan 2017-2020

and 8105 for plan 2021-2024) and according to Law 12/1989, it is compulsory to provide the necessary information for its development.

The SEI structure can be summarized in the following figure:

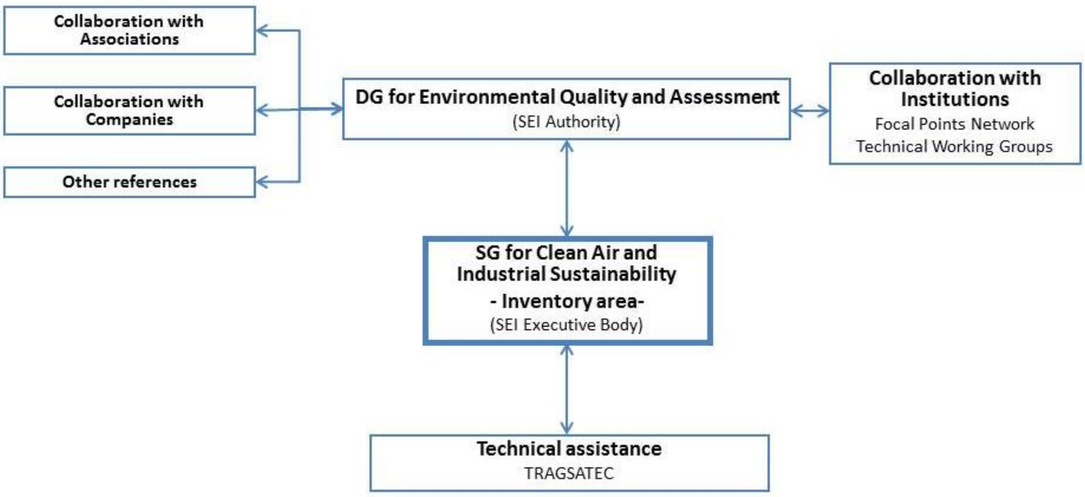

Figure 1.2.1 SEI's organisation

Within the Directorate-General for Environmental Quality and Assessment (DGCEA) of the MITECO, the Emissions Inventory Area manages the ordinary function of the SEI. Additionally, the DGCEA as National Authority of the SEI awarded in 2017 the public society TRAGSATEC a contract for the technical assistance in the management, maintenance and updating of the SEI until 2023.

Altogether, the SEI is formed by 24 specialists in total as detailed in the following table:

Table 1.2.1 Composition of the SEI

Name	Role	Organization
María José Alonso Moya	Unit coordinator	IU
Carmen Ramos Schlegel	Inventories coordinator and sector expert-Waste	IU
Fco. Javier Pérez-Ilzarbe Serrano	Projections coordinator and sector expert-IPPU and Energy	IU
Guillermo Martínez López	Sector expert-IPPU	IU
Ramiro Oliveri Martínez-Pardo	Sector expert-LULUCF	IU
Cristina Álvarez Rodríguez	Technical assistance manager	Ttec
Elena López Martín	Technical assistance	Ttec
Juan Carlos Cano Rego	Technical assistance coordinator and IT manager	Ttec
Iván José Díaz Rey	IT expert	Ttec
Miguel García Rodríguez	QA/QC Coordinator and cross-cutting issues	Ttec
José Ángel Gil Gutiérrez	Technical assistance coordinator and sector expert –Energy and IPPU	Ttec
Máximo Oyágüez Reyes	Sector expert-Energy	Ttec
José Luis Llorente Montoro	Sector expert-Energy and cross-cutting issues	Ttec
Sara Torre Sales	Sector expert-Transport	Ttec
Sonia Lázaro Navas	Sector expert-Transport	Ttec
Mª Ángela Haro Maestro	Sector expert-IPPU	Ttec
Olalla González Fontaíña	Sector expert-IPPU	Ttec
Anselmo Espinosa Vergara	Sector expert-IPPU	Ttec

Name	Role	Organization
Fco. Javier Flores Sanz	Sector expert-Agriculture	Ttec
Mª del Mar Esteban García	Sector expert-LULUCF	Ttec
Susana Pérez Pérez	Sector expert-LULUCF	Ttec
Nuria Escudero Aguado	Sector expert-Waste	Ttec
Mario Fernández Barrena	Sector expert-Projections	Ttec
David Sánchez Vicente	Sector expert-Projections	Ttec
Jose Maria Cantarero Alonso	Sector expert-Projections	Ttec

IU: Inventory Unit-DGCEA; Ttec: TRAGSATEC

Additionally, the functional structure of the SEI relies on national ministries and other public institutions articulated by the SEI's National Focal Points Network with the representation of the relevant departments. On an annual basis, the SEI's National Focal Points Network meets in the headquarters of the Inventory Unit in order to enhance interdepartmental cooperation and coordination.

Table 1.2.2 SEI's National Focal Points Network

Name	Unit
Ministry of Defence	D.G. for Infrastructure
Ministry of Home Affairs	D.G. for Traffic
Ministry of Transport, Mobility and Urban Agenda	D.G. for Roads
	State Air Safety Agency
	D.G. Merchant Navy
	State Ports Authority
	D.G. for Economic Programming and Budget
	D.G. for Road Transport
	S.G. for Infrastructure Planning and Transport
	D.G. National Geographic Institute
Ministry of Health	Spanish Agency of Medicines and Health-Care Products
Ministry of Economic Affairs and Digital Transformation	National Statistical Institute
Ministry for the Ecological Transition and the Demographic Challenge	Secretariat of State for Energy
	D.G. for Environmental Quality and Assessment
	D.G. for Water
	Spanish Office for Climate Change
	State Meteorological Agency
	D.G. for Biodiversity, Forests and Desertification
Ministry of Agriculture, Fisheries and Food	National Agency for Agricultural Insurance (ENESA)
	D.G. for Agricultural Production Health
	D.G. for Production and Agricultural Markets
	S.G. for Analysis, Coordination and Statistics
	D.G. for Food Industry
	D.G. for Fisheries and Aquaculture Management

Working groups have been set within the SEI framework in various thematic contexts.

The SEI's structure is completed by the collaboration links established with private companies and sectoral associations. These stakeholders actively participate by providing data on production or emissions, as well as expertise for the elaboration of the National Inventories.

Finally, a contact group of regional administrations linked to emission inventories was created whose main purpose is the share of information. The activity of this group is mainly via email and meets once a year.

1.3. Inventory preparation process

The Inventory preparation process is managed by the Inventory Area of the SEI, together with the technical assistance of TRAGSATEC.

The milestones of Inventory preparation are the following:

Table 1.3.1 Milestones of Inventory preparation (edition 2023)

Date	Milestones
26-Mar-22	Official start of Edition 2023 of the Inventory
23-Apr-22	Start of data collection
11-Jun-22	Start of data processing
18-Nov-22	End of data processing
2-Dec-22	Submission of data for internal national approval
23-Dec-22	Internal national approval by the CDGAE
17-Jan-23	Start of reports' preparation
15-Feb-23	First Submission of NFR tables
15-Mar-23	Submission of IIR

The main stages and features in the elaboration process are:

1.3.1. Key categories analysis

The analysis of the key categories identified in the previous edition of the Inventory constitutes the starting point for assigning the priorities in order to improve the Inventory and accomplish the remaining activities. A review of the improvement plan is performed at this stage in order to identify priority areas for improvement. At the beginning of the edition 2023, a total of 19 recommendations from previous review processes were still not fully resolved (1 not resolved and 18 addressing). Furthermore, 75 internal points of improvements of different relevance had been identified. The result of the alignment of key categories analysis with the improvement plan conditioned the following steps of the Inventory preparation process.

1.3.2. Choice of methods

This stage may include the initial selection of methods for categories not previously considered in the Inventory, as well as the revision of the selected methods for categories where a methodological change is proposed.

1.3.3. Data collection

This phase entails the collection of the necessary data and information for applying the selected methods to each different activity (activity parameters and variables; algorithms and emission factors; measured or estimated emissions). This stage started on the 21st of April 2022 with the submission of requests for information via email to the different data providers and collaborators. Preparation of the questionnaires, letters, emails and forms to request for information was done during the previous weeks. Two main groups of data providers can be distinguished in the process: the private sector, with the deadline for submitting information by 31st May 2022 and the public sector with the deadline by 30th June 2022.

In this stage, a total of 154 requests of information were delivered containing 380 questionnaires. For the data collection process an Access database is used to manage all the contact details, create emails to data providers and register delivery and reception dates of the requests (for details on the data request database, please refer to section 1.6.7 of this document). Data collection is completed with information available on the Internet, such as yearbooks, annual reports, statistics, etc.

The evolution of the data collection process is presented in the figure below. As shown, by early June, 80 % of the total pieces of information requested had been received. It must be highlighted how the proximity of the 2nd of June deadline accelerates the reception of information. The 40 % of data providers answered after the deadlines, of which a 21 % needed a second request (remainder mail).

At the end of the data collection phase, 97.3 % of the requests sent to private data providers were answered. Regarding the public data providers, 83.5 % of the information requested was sent. Some of the missing information was secondary information not essential for the estimation of emissions, and in cases where information was essential, the extrapolation splicing technique was used.

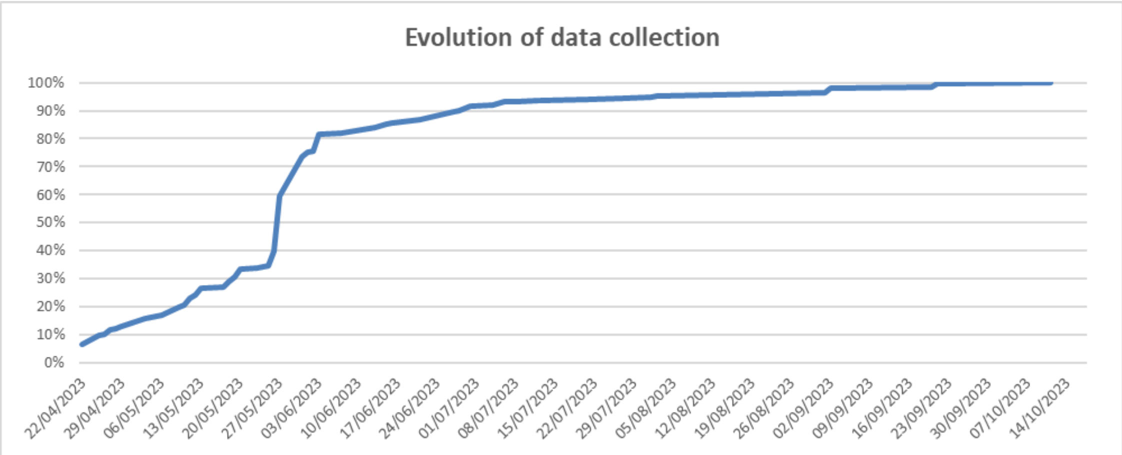

Figure 1.3.1 Evolution of data collection (edition 2023)

In summary, taking into account, both private and public data providers, 91.6 % of total pieces of information requested were received.

1.3.4. Data processing

The object of this phase is the integration of the collected data in order to feed the Core Inventory Emissions Database (CIEDB) with the necessary activity data, emission factors and parameters to estimate emissions. This stage goes from May up to the beginning of December and comprises two simultaneous activities: data processing as such and quality checks. With the arrival of the official energy statistics by the end of November and some other pieces of information due, 100 % of data processed could be reached by the 18th of November 2022. Following data processing, sector experts and the QA/QC coordinator performs quality checks with an evolution line similar to data processing but showing a certain time lag.

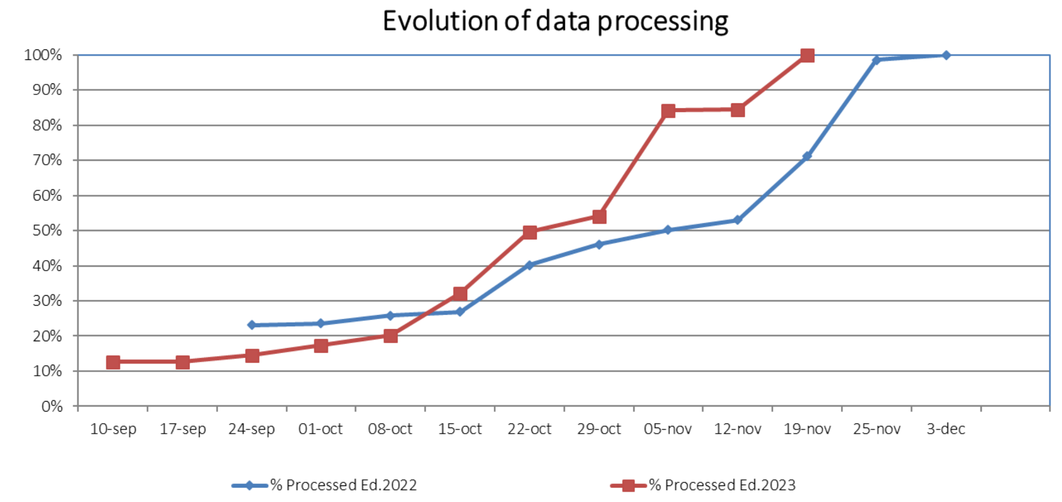

Figure 1.3.2 Evolution of data processing

1.3.5. Submission of results for approval

The emissions and removals data must be approved by the Government Delegate Commission for Economic Affairs (CDGAE), as established in Law 7/2021, of 20 May, on climate change and energy transition, (art. 40.2). The data were submitted on 2 December 2022 to the Government Delegate Commission for Economic Affairs, which agreed to approve them on 23 December 2022.

Once the inventory has been approved, the Inventory Unit elaborates, publishes and sends all the required reports and information —in the format required for each case— to the international bodies.

1.3.6. Preparation of reports

At this stage, reports and tables of results for air pollutant emissions required by the different bodies to which the SEI reports, are prepared in accordance with the established format, content and time periods. Preparation of reports is based in the performed analysis of key categories and improvement plan, and includes the revision of the notation keys used in the corresponding reporting tables.

A drafting committee has been set within the SEI at the beginning of this stage in order to establish a work timetable, to share duties and responsibilities and to agree on contents, format and style of the reports. This committee, integrated by the members of the SEI and representatives of the technical assistance, met regularly after the kick-off meeting on the 17th January 2023.

The calendar for the development of these stages is schematised in the following figure.

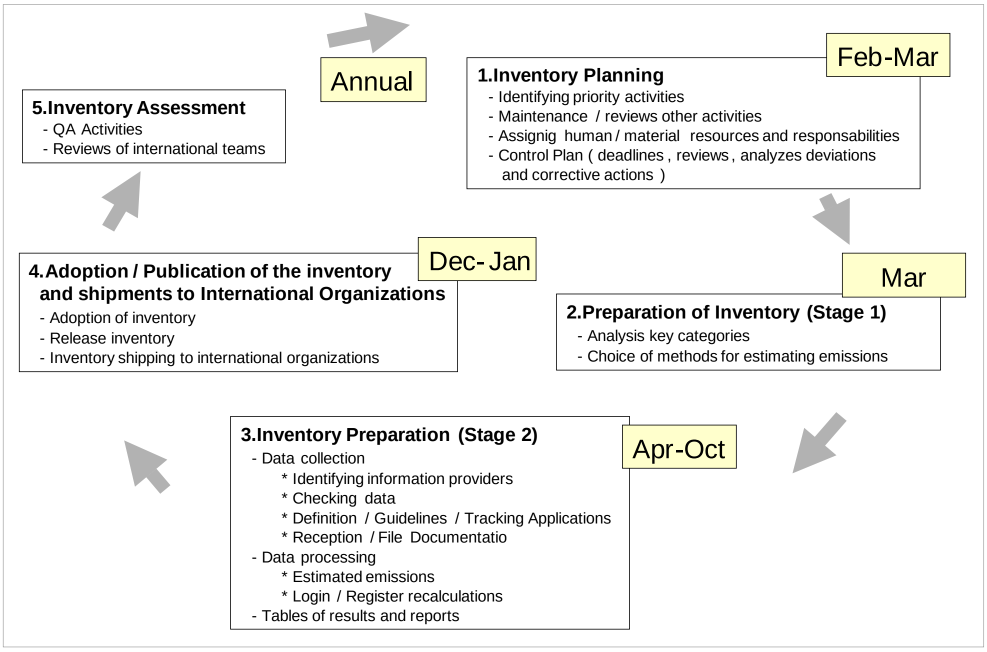

Figure 1.3.3 Diagram of the annual cycle of activities for the inventory

1.4. Methods and data sources

1.4.1. Selection of methods

The emission estimation methods applied in the Inventory depend on the nature of the activity being considered and the availability of basic data. Based on the availability of information on the emissions themselves, two major categories can be differentiated:

I. Methods based on observed emission data. Based on direct observation of the variable of interest, i.e. the emission itself. Two types can be distinguished between these methods:

a. Continuous measurement.

b. Measurement at regular intervals.

In this Inventory edition, methods based on direct observation have mainly been used in connection with the Large Point Sources, excluding airports. Data is frequently available from these sources due to their environmental importance and the size of the activity involved, whose authorization normally includes the need to measure and report certain pollutants. This information is collected from the plants themselves through individualized questionnaires.

Activities and pollutants where direct measurements have been used are included in the next table:

Table 1.4.1 Main activities with direct measures for main pollutants, TSP and CO

Activity	NOx	NMVOC	SO_2	NH_3	TSP	CO
Thermal power plants	X	X*	X	-	X*	X
Oil refineries	X	X	X	-	X	X
Integrated steel plants	X*	X*	X*	X*	X*	X*
Coke oven furnaces	X*	X*	X*	X*	X*	X*
Car manufacturing	X	X	X	-	X	X
Aluminium	-	-	X	-	X	-
Paper pulp	X*	-	X*	-	X*	X*
Sulphuric acid	-	-	X*	-	X*	-
Nitric acid	X*	-	-	X*	X*	-
Ammonia	X*	-	-	X*	X*	-
Urea	X*	-	-	X*	X*	-
Ammonium phosphate	-	-	X*	X	-	-
NPK fertilizers	X*	-	X*	X*	-	-
Soda ash	-	-	-	-	-	-
Carbon black	X	-	X	-	X	-
Waste incineration	X*	X	X	-	-	X

* Partially covered: only available for some plants and in certain years

– Other pollutants in all those point sources for which it has been possible to collect direct data. This is the case in:
  - Coal-fired thermal power plants (1995-1998) for cadmium, mercury and lead.
  - Urban waste incinerators, mainly with respect to heavy metals and dioxins.
  - Industrial waste incinerators, mainly with respect to heavy metals and dioxins.
  - Chlorine production (years 1998-2017) for mercury emissions.

II. <u>Methods based on calculation procedures</u>. This category can be split into procedures based on:

a. Simple balance of materials. This method has been applied for the estimation of sulphur dioxide in combustion facilities where information is available regarding the amount of sulphur present in the various fuels used and the retention coefficients for ash and specific parts of the combustion facilities. In installations with desulphurisation units where information was available on emission abatement techniques, the estimation of potential emissions has been corrected, where necessary, with a reduction coefficient. This procedure was also used to estimate lead emissions and other heavy metals in internal combustion engines in vehicles for road transport and mobile machinery. This has been also the approach adopted for estimating NMVOC emissions from painting lines at automobile manufacturing plants.

b. Complete balance. This method comprises the determination of all inputs and outputs of different chemical elements (using data on the types of process and facilities as well as the amounts of materials and the elements in their composition), although it was not, in fact, possible to apply it effectively in the estimation of pollutants emissions due to its complexity. In any case, it has been retained as a reference method for validating atypical estimates.

c. Methods based on functional statistical models: Modelling-correlation. This method is based on the results of earlier works into the estimation of functional relationships or correlations between certain physical and chemical variables and emissions from certain activities. This kind of simulation models has been applied to estimate emissions of some pollutants in categories 1A3a Air transport and 1A3b Road transport.

d. Methods based on emission factors: activity factors and variables. This method has been the most generally used in preparing the Inventory and applied when no other more precise option was available to estimate the emissions for an activity.

1.4.2. Consideration of the effect of abatement techniques

One point of great importance for the correct application of the estimation methods based on algorithms is the consideration of the efficiency of the abatement which is assumed in the functional relationships and in the emission factors used in this group of methodologies. For this purpose, the appropriate corrections were applied to take into account the degree of application of emission abatement techniques in the various emitting activities included in the Inventory. The following examples, among others, can be given as important illustrations of this criterion:

- Heavy metal emission factors at coal-fired thermal power plants depending on whether or not gas desulphurisation techniques in addition to particulate control techniques are used or not (please refer to table 31, Chapter B111, EMEP/CORINAIR Guidebook (2007)).
- SO_2 emission factors at primary zinc and copper production plants when there is an associated sulphuric acid production plant capable of reducing the emissions from the first plants by between 90 % and 99 %. Furthermore, in SO_2 emissions at the refineries, the number of sulphur recovery phases in Claus plants has been taken into account so as to select the most representative factor in those cases where no direct estimation was provided by the plants themselves.
- Regarding incineration plants, the emission factors have been updated to 2019 EMEP/EEA Guidebook. For the period 1996-2020, each plant has its own abatement techniques but the control technique “Particle abatement + acid gas abatement” has been considered as a minimum and thus the values shown in table 3-1 (Chapter 5C1a) have been adopted. For the period 1990-1995, it was assumed only “particle abatement”, so values from table 3-2 have been applied. In the case of particle matter and heavy metals (except mercury), table 3-1 values were considered more appropriate. Finally, abatement efficiency has been applied to PCBs and dioxin values (table 3-3).
- In cases where point sources report direct measures of TSP emissions together with the implementation of particulate abatement techniques in their facilities (including especially dry electrostatic precipitators, whose effectiveness exceeds 99 % reduction and fabric filters), this information has been used for the selection of the appropriate $PM_{2.5}$/TSP or PM_{10}/TSP ratio for the estimation of $PM_{2.5}$ and PM_{10}. In these cases, the possible existence of control measures has been used to evaluate the appropriate level of abatement and its comparison with the four abatement levels indicated by the CEPMEIP, for each unit, and this parameter determines the emission factor assigned.
- Emission factors for conventional pollutants (SO_2, NOx, NMVOC and CO), heavy metals (As, Cd, Cr, Cu, Hg, Ni, Pb and Zn) and particles (TSP) in the manufacture of cement (clinker) according to the estimated rate of penetration of emission control techniques

in the sector in the sub-periods 1990-2000 and 2001-2004. From 2005, country-specific emission factors are used based on average measured values.

- Emission factors for mercury in the manufacture of chlorine according to the estimated rate of penetration of emission control techniques in the sector and the implementation of less polluting processes during the 1998-2011 sub-period.

1.4.3. General Reference to Information sources on Activity Variables

The most important references to activity variables are listed in the following table.

Table 1.4.2 Most important activity data IIR 2023

NFR Code	Activity	Main Source of information on activity data
1A1a	Public electricity and heat production	Individualized questionnaire + Energy international statistics by the Secretariat of State for Energy of the Ministry for the ecological transition and demographic challenge (MITECO) + EU ETS data
1A1b	Petroleum refining	Individualized questionnaire + EU ETS data
1A1c	Manufacture of solid fuels and other energy industries	Individualized questionnaire + statistics by MITECO
1A2	Stationary combustion in manufacturing industries and construction.	Individualized questionnaires from plants + information from the main business associations + Energy international statistics by MITECO+ EU ETS Data
1A3ai(i)	International aviation LTO (civil)	EUROCONTROL
1A3aii(i)	Domestic aviation LTO (civil)	EUROCONTROL + Energy international statistics by MITECO
1A3b	Road transportation	National Statistics of Road Traffic and “Standing Survey of Road Freight” EPTMC by Ministry of Transport, Mobility and Urban Agenda + Energy international statistics by MITECO + “General Statistical Yearbook” published by the DGT (Spanish Traffic Department) of the Ministry of Interior + Studies of road sampling in Madrid (General Directorate of Sustainability and Environmental Control of Madrid City Council)
1A3c	Railways	Individualized questionnaire + Energy international statistics by MITECO
1A3dii	National navigation (shipping)	Energy international statistics by MITECO
1A3ei	Pipeline transport	Individualized questionnaire
1A4a	Commercial/institutional	Energy international statistics by MITECO
1A4bi	Residential	Energy international statistics by MITECO
1A4bii	Residential: Household and gardening (mobile)	Energy international statistics by MITECO
1A4ci	Agriculture/Forestry/Fishing: Stationary	Ministry of Agriculture and Fishing and Food (MAPA) Statistics
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	Energy international statistics by MITECO + Expert judgement
1A4ciii	Agriculture/Forestry/Fishing: National fishing	Energy international statistics by MAPA Statistics
1A5b	Other, Mobile (including military, land based and recreational boats)	Energy international statistics by MITECO + Ministry of Defence
1B1a	Fugitive emissions from solid fuels: Coal mining and handling	MITECO Statistics
1B1b	Fugitive emissions from solid fuels: Solid fuel transformation	Individualized questionnaire + Energy international statistics by MITECO

NFR Code	Activity	Main Source of information on activity data
1B2	Fugitive emissions Oil & Natural Gas	Individualized questionnaire + Energy international statistics by MITECO + National energy balances (IEA and EUROSTAT) + information from the main business associations + State agency of meteorology (AEMET)
2A1	Cement production	Main business association
2A2	Lime production	Main business association + Individualized questionnaire
2A3	Glass production	Main business association + Individualized questionnaire
2A5a	Quarrying and mining of minerals other than coal	Geological and Mining Institute of Spain (IGME) + Mining statistic by MITECO
2A5b	Construction and demolition	National Statistical Data (INE) + Ministry of Transport, Mobility and Urban Agenda
2A5c	Storage, handling and transport of mineral products	Spanish State ports agency
2A6	Other mineral products: Batteries manufacturing	Industry production statistics by the Ministry of Industry, Trade and Tourism
2B1	Ammonia production	Individualized questionnaire
2B2	Nitric acid production	Individualized questionnaire + Main business association + Ministry of Industry, Trade and Tourism
2B5	Carbide production	Individualized questionnaire
2B6	Titanium dioxide production	Information from the main business association
2B7	Soda ash production	Individualized questionnaire
2B10a	Other chemical industry: Processes in organic and inorganic chemical industry except for adipic acid	Individualized questionnaire + information from the main business associations
2C1	Iron and steel production	Individualized questionnaire + information from the main business association
2C2	Ferroalloys production	Individualized questionnaire
2C3	Aluminium production	Individualized questionnaire
2C5	Lead production	Individualized questionnaire + information from the main business association
2C6	Zinc production	Individualized questionnaire + international statistics yearbooks
2C7a	Copper production	Individualized questionnaire + information from the main business association + international statistics yearbooks
2D3a	Domestic solvent use including fungicides	National Statistical Data (INE)
2D3b	Road paving with asphalt	Information from the main business association
2D3c	Asphalt roofing	National Statistical Data (INE) + Information from the main business associations
2D3d	Coating applications	National Statistical Data (INE) + Information from the main business associations
2D3e	Degreasing	Individualized questionnaire
2D3f	Dry cleaning	National Statistical Data (INE)
2D3g	Chemical products	Information from the main business associations
2D3h	Printing	Information from the main business associations
2D3i	Other solvent use	National Statistical Data + Individualized questionnaire
2G	Other product use	EUROSTAT
2H1	Pulp and paper industry	Individualized questionnaires + Information from the main business associations
2H2	Food and beverages industry	National Statistical Data (INE) + MITECO Statistics
2I	Wood processing	FAOSTAT

NFR Code	Activity	Main Source of information on activity data
2K	Consumption of POPs and heavy metals	MITECO Statistics
2L	Other production, consumption, storage, transportation or handling of bulk products: NH_3 Consumption in Refrigeration and Air conditioning	Information from the main producers of NH_3 for refrigeration and air conditioning
3B	Manure management	MAPA Statistics + Husbandry Surveys + Livestock Farm Registry (REGA) + Animal Individual Identification Registry (RIIA)
3D	Agricultural Soils	MAPA Statistics + Husbandry Surveys
3F	Field burning of agricultural residues	MAPA Statistics + Nitrogen and Phosphorous Balance in Spanish Agriculture (BNyPAE)
5A	Biological treatment of waste - Solid waste disposal on land	Individualized questionnaire + MITECO Statistics
5B1	Biological treatment of waste - Composting	MITECO Statistics
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	Individualized questionnaire + MITECO Statistics
5C1a	Municipal waste incineration	Individualized questionnaire + MITECO Statistics
5C1biv	Sewage sludge incineration	MITECO Statistics
5C1bv	Cremation	Estimation based on National Statistical Data (INE) + Information from the main business associations
5C2	Open burning of waste	MAPA Statistics
5D1	Domestic wastewater handling	Expert Assessment-Ministry of Transport, Mobility and Urban Agenda + National Statistical Data (INE)
5D2	Industrial wastewater handling	Estimation based on National Statistical Data (INE)
5D3	Other wastewater handling	EUROSTAT
5E	Other waste	Madrid City Council statistics + MAPFRE foundation

The most important information required from the National Focal Points is listed in the following table.

Table 1.4.3 Information provided from the focal points

Ministry	Department	Information required
Ministry of Defence	D.G. for Infrastructure	- Fuel consumption in military tactical equipment. - Breakdown of consumption grouped by multilateral and unilateral operations.
Ministry of Interior	D.G. for Traffic	- Registration and de-registration of vehicles in the fleet. - Characteristics of registered vehicles (propulsion system...). - Vehicle fleet distribution by type of vehicle, fuel and age. - Historical technical inspection of vehicles data information.
Ministry of Transport, Mobility and Urban Agenda	D.G. for Roads	- Distances travelled by vehicles (broken down by institution responsible for the road). - Map of roads. - Historical information on running fleet. - Kilometres of roads by type of road and pavement.
	State Air Safety Agency	- Statistics on movements of civil aircraft
	D.G. for Merchant Navy State Ports Authority	- Statistics on movements of vessels, lengths of stay and port entry and departure times. - National / international shipping traffic. - Register of vessels. - Cartographic information on routes.

Ministry	Department	Information required
	D.G. for Economic Planning and Budget D.G. for Road Transport	- Permanent survey on haulage of goods by road.
	S.G. for Infrastructure, Planning and Transportation	- Passenger and freight mobility by means of transport.
	D.G. National Geographic Institute	- Soil maps (1:1.000.000).
Ministry of Health	Spanish Agency of Medicines and Health-Care Products	- Medicinal N_2O consumption data.
Ministry of Economic Affairs and Digital Transformation	National Statistical Institute	- Industrial survey of companies and products. - Industrial production index. - National accounts.
Ministry for the Ecological Transition and the Demographic Challenge	Secretariat of State for Energy	- IEA and Eurostat international questionnaires: · Heat and electricity. · Natural gas. · Oil-based products. · Coals. · Renewable energies and waste. - Other energy-related statistics. - Service stations. - Institute for the Diversification and Saving of Energy (IDAE): co-generation, biomass and activity variables in RC&I sector and in combustion plants with a thermal capacity lower than 50 MWth. NOTE: This source also edits the publication entitled “La Energía en España” (Energy in Spain) used as background information on energy.
	D.G. for Environmental Quality and Assessment	- Incinerators of waste oil. - Information of the National Sludge Register. - Generation/treatment balance of waste. - Composition of waste landfilled. - Managed landfills. - Unmanaged landfills. - Municipal waste composting plants. - Update of the survey entitled “Estimation of sewage sludge production and treatment at wastewater treatment plants” provided by CEDEX. - Information on chlor-alkali sector.
	D.G. for Water	- Information on wastewater.
	Spanish Office for Climate Change	- Basic information for the drafting of the CO_2 verification reports from the plants subject to the emissions trading regime. - Information on the accounting of Kyoto Protocol units. - Information on the national register. - Information on Article 3, paragraph 14 of the Kyoto Protocol.
	State Meteorology Agency	- Temperature (air and land) wind speed and wind direction, cloudiness, precipitation and insolation.
	D.G. for Biodiversity, Forests and Desertification	- Estimation of living biomass in afforestation and reforestation. - Wildfires statistics. - Controlled burning statistics. - Estimation of living biomass in forest land remaining as such. - Forest Statistics Yearbook. - Carbon stocks in dead wood and the detritus of forest land remaining as such.
Ministry of Agriculture and	National Agency for Agricultural Insurance (ENESA)	- Accident claims information due to fire in insured agricultural and forestry productions.

Ministry	Department	Information required
Fishing and Food	D.G. for Agricultural Production Health	- Information of biomethanization plants (slurry).
	D.G. for Production and Agricultural Markets	- Surface, yield and production of crops. - Burning of agricultural residues. - Consumption of synthetic fertilizers. - Application of fertilizers. - Consumption of pesticides and phytosanitary products. - Fleet on self-propelled mobile farm machinery. - Stationary combustion plants. - Functions and parameters for the estimation of the growing biomass function in woody crops.
	S.G. for Analysis, Coordination and Statistics	- Crop transitions including, at least, a woody crop. - Soil conservative management practices. - Censuses/Surveys of cattle breeding assets. - Statistics on husbandry production (milk, meat, etc.). - Transitions of areas that can be exploited by grazing and / or harvesting to feed livestock.
	D.G. for Food Industry	- Diet (protein content).
	D.G. for Fisheries and Aquaculture Management	- Statistics on the operational fishing fleet. - Database on the fishing fleet.

1.4.4. Geographical distribution of data

The present 2023 IIR edition uses the updated grid put forward at the 36th session of the EMEP Steering Body. The EMEP grid domain applied includes the Balearic Islands and Ceuta and Melilla autonomous cities, and excludes the Canary Islands. As a consequence, the geographical coverage of CLRTAP and NEC Directive reports fully matches.

All emission data reported in this IIR refer to the Spanish territory excluding the Canary Islands. National emissions data, including the Canary Islands, are provided in Annex 4 for information purposes only.

The Inventory team is currently working on the update and improvement of geo-location of emissions in Spain. In this light, important efforts are being carried out to widen the number of installations identified as punctual emissions sources, aiming at closing the gap between inventory LPS and installations reporting under ETS and PRTR systems. Similarly, the Inventory team is actively working in improving the estimative geo-location of other emissions, such as those related to transport activities and those occurring in urban areas.

1.5. Key categories

The Spanish Inventory System applies a Tier 1 approach to calculate the Key Categories, by level (Level Assessment) and trend (Trend Assessment) following the EMEP/EEA Guidebook (2016). EMEP/EEA Guidebook (2019) implementation will be finished on the next edition.

The identification of the key sources has been calculated for the main pollutants (NOx, NMVOC, SO_2, NH_3 and CO), Particulate Matter (TSP, PM_{10}, $PM_{2.5}$ and Black Carbon), Priority Heavy Metals (Pb, Cd and Hg) and POPs (PCDD/PCDF, PAHs and PCBs).

For ***Level Assessment***, a threshold of 95 % is defined for the cumulative distribution function of the emissions according to the activities in the Inventory. All activities included in the cumulative distribution function can be considered within that threshold to account for approximately 90 % of the overall inventory uncertainty.

For ***Trend Assessment***, Tier 1 also specifies a threshold of 95 % but defined in this case with regard to the contribution of the activities to the trend metrics[1].

The results obtained in the identification of key categories by pollutant are shown in a summary table below. It is indicated by pollutants and the identification for level (L) or trend (T).

For further details per pollutant and NFR sector are provided in Appendix 1 “Key category analysis”.

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[1] The respective metrics for the level and trend are calculated by the following formulae:

(1) $L_{x,t} = {E_{x,t}}/{E_t}$

(2) $T_{x,t} = L_{x,t} \times \left[{(E_{x,t} - E_{x,0})}/{E_{x,0}} - {(E_t - E_0)}/{E_0} \right]$

where:

$L_{x,t}$ is the level assessment for category x in year t.

$T_{x,t}$ is the trend assessment for category x in year t.

$E_{x,t}$ and $E_{x,0}$ are the emission estimations for category x in year t and 0, respectively.

0 is the base year (i.e. 1990 for main pollutants, metals and persistent organic pollutants; and 2000 for particulate matter).

Table 1.5.1 Assignation of KC

NFR	NFR Category	NOx	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	PCDD PCDF	PAHs	HCB	PCBs
1A1a	Public electricity and heat production	L-T	L-T	L-T	-	L-T	L-T	L-T	-	L	-	L	L-T	T	L-T	L-T	-
1A1b	Petroleum refining	L	-	T	-	-	-	-	-	-	-	-	-	-	-	-	-
1A1c	Manufacture of solid fuels and other energy industries	-	-	-	-	T	T	T	T	-	-	-	-	-	-	-	-
1A2	Manufacturing Industries and Construction	L-T	L	L-T	-	L-T	L-T	L-T	L-T	L-T	L-T	L-T	L-T	-	L-T	L-T	T
1A3a	Aviation LTO (civil)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A3b	Road transport	L-T	L-T	T	T	L-T	L-T	L-T	L-T	L-T	L-T	L-T	L-T	T	L-T	-	-
1A3c + 1A3e + 1A5	Other transport	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A3d	Navigation	T	-	L	-	-	-	-	-	-	-	-	-	-	-	L	-
1A4a + 1A4b	Commercial/institutional/residential	L-T	L-T	L-T	T	L-T	L-T	L-T	L-T	L-T	-	L-T	L-T	L-T	L-T	L-T	-
1A4c	Agriculture/Forestry/Fishing	L-T	-	-	-	L-T	L-T	T	L-T	L	-	-	-	-	-	-	-
1B	Fugitive Emissions from Fuels	-	L	L-T	-	-	-	-	-	-	-	-	-	-	-	-	-
2A	Mineral products	-	-	-	-	L	L-T	L-T	-	-	L-T	L-T	-	-	-	-	-
2B	Chemical industry	-	T	L	T	L	L	-	-	-	-	-	T	-	-	-	-
2C	Metal production	-	-	L-T	-	-	-	L	-	L-T	L-T	L-T	L-T	L	L-T	L-T	L-T
2D	Solvents use	-	L-T	-	-	-	-	-	-	-	-	-	L	-	-	-	-
2G + 2H + 2I + 2J + 2K + 2L	Other products use and industrial processes	-	L-T	L-T	-	L-T	L-T	L	-	-	-	L-T	-	-	-	-	L-T
3B	Manure management	L-T	L-T	-	L-T	L	L-T	L-T	-	-	-	-	-	-	-	-	-
3D	Crop production and agricultural soils	L-T	L-T	-	L	L	L-T	L-T	-	-	-	-	-	-	-	T	-
3F	Field burning of agricultural wastes	T	T	-	T	L-T	T	T	T	T	-	L-T	T	-	L-T	-	-
3I	Agriculture other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5A	Biological treatment of waste: Solid waste disposal on land	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5B	Biological treatment of waste	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5C	Incineration	L-T	L-T	L	-	L-T	L-T	L-T	L-T	L-T	L-T	L-T	L-T	L-T	-	L-T	-
5D	Wastewater handling	-	-	-	T	-	-	-	-	-	-	-	-	-	-	-	-
5E	Other waste	-	-	-	-	-	-	-	-	-	-	-	-	L	-	-	-
6A	Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

L-Level; T-Trend

1.6. Quality Assurance and Quality Control (QA/QC) and verification

This section provides an overview of the Spanish Inventory QA/QC system, including verification and treatment of confidential issues. The system has been designed following the guidance provided in the 2006 IPCC Guidelines and the 2019 EMEP/EEA Guidebook. The European Commission Staff Working Document SWD(2013)308[2] has also been used as a reference.

As stated in section 1.2 Institutional arrangements, the Spanish Inventory System (SEI) is in charge of the compilation and maintenance of both the Air Pollutant and the Greenhouse Gas Emissions Inventories, as well as in the elaboration of the national emissions projections. A complex network of data providers allows the Inventory gathering the necessary data for inventory compilation (national focal points, organizations, sectoral associations, companies). Despite most of these partners having their own QA/QC systems ensuring high-quality raw data, the Inventory System coordinates and complements QA/QC activities in order to meet quality objectives.

Since the Spanish Inventory System is responsible for the compilation and reporting of both GHG and Air Pollutants Inventories, the QA/QC system follows an integrated approach, covering both Inventories. For this reason, references to the GHG Inventory may appear in this document.

1.6.1. The QA/QC system

The Inventory QA/QC system constitutes the general framework for QA/QC planning, QA/QC implementation, documentation and archiving activities. Spanish Inventory QA/QC is well balanced against time and resources availability, and uses the widely known PDCA cycle approach (plan-do-check-act). As good practice suggests, the system consists of the following elements:

- A QA/QC and verification coordinator, also functioning as Inventory compiler.
- A QA/QC plan.
- QC procedures: both general and category-specific procedures.
- QA/QC system interaction with uncertainty analyses.
- Verification activities.
- Reporting, documentation and archiving procedures.

All these elements are included and properly described in the QA/QC Inventory plan, which is revised and implemented throughout the different stages of the annual Inventory compilation and reporting cycle.

1.6.2. The QA/QC plan

The plan is conceived as an internal tool for organising verification and QA/QC activities in order to ensure the continuous improvement of the Inventory and the fulfilment of its objectives. The plan affects all stages of the Inventory's development and is periodically reviewed to ensure that

[2] Commission Staff Working Document "Elements of the Union greenhouse gas inventory system and the Quality Assurance and Control (QA/QC) programme", available in SWD(2013)308.

includes all the changes occurring in activities and inventory processes detected by the Inventory's working group and the recommendations of external review teams.

The QA/QC plan has 6 main purposes:

1. To set general and specific goals for the quality of the Inventory emission estimates and outputs.
2. To set roles and responsibilities within the Inventory system.
3. To set general and category-specific QC activities and a scheduled time frame for its application.
4. To set QA procedures.
5. To assure that key outputs of QA procedures underpin the improvements plan.
6. To provide general procedures for reporting, documentation and archiving.

1.6.3. Quality objectives

The Inventory QA/QC system seeks to respond to Spain´s reporting obligations in a timely, transparent, consistent, comparable, complete and accurate manner. Furthermore, the QA/QC system intends to contribute to the improvement of quality of the Inventory. Specific quality objectives are established in order to provide concrete and measurable indicators to assess the quality of the Inventory system. These have been organized around general objectives of: timeliness, transparency, consistency, completeness, comparability and accuracy and inventory improvement:

Table 1.6.1 General and specific objectives from the QA/QC plan

General objectives	Specific objectives
Timeliness	To meet all the internal stage-specific deadlines during inventory compilation.
	To meet all the Inventory reporting obligations on time.
Transparency	To provide transparent information in the report, including procedures applied for gap filling.
	To provide background information on activity data and methodologies.
	To include reasonable descriptions and justifications of trends in the report.
	To use notation keys in accordance with 2006 IPCC GL and 2019 EMEP/EEA GB reporting guidelines.
	To provide transparent explanations for the use of NE and IE notation keys.
	To transparently include detailed explanations for recalculations in the report.
	To assure that Inventory review recommendations related to transparency are addressed, to the extent possible, in the subsequent inventory edition.
	To include information on QA/QC in the report.
Consistency	To assure a consistent time-series of emissions, activity data and implied emission factor.
	To assure internal consistency for emissions aggregations.
	To assure that inventory review recommendations related to consistency are addressed, to the extent possible, in the subsequent Inventory edition.
	To assure consistency among final emission estimates submitted to different reporting obligations, taking into account reasonable differences in geographical scope, categories, etc.
	To use, where possible, same methodologies and datasets along the time-series.
	To assure that estimation methods are consistent with the methodological guidance provided by 2006 IPCC GL and 2016-2019 EMEP/EEA GB.

General objectives	Specific objectives
	To assure consistency between data reported in reporting tables and data included in reports.
Completeness	To assure that all categories and gases/pollutants have been estimated. In case a category/gas/pollutant is not estimated, the appropriate explanation and notation key has been used (transparency).
	To assure that inventory review recommendations related to completeness are addressed, to the extent possible, in the subsequent inventory edition.
	To assure that all reporting tables provide an emission estimate or a notation key.
	To assure that information on completeness is included in the report.
	To assure that a summary of changes related to completeness is provided in the report.
	To assure the notation keys NE, NO, NA and IE are correctly used.
	To assure that all the information due is included in the submission to meet all the reporting obligations.
Comparability	To assure that IPCC and EMEP/EEA guidance is followed concerning selection of activity data, methods, use of notation keys and allocation of emissions into the difference categories.
	To assure the use of the latest reporting templates and nomenclature consistently with reporting requirements.
	To assure that inventory review recommendations related to comparability are addressed, to the extent possible, in the subsequent Inventory edition.
	To adequately implement decisions adopted in workshops and expert meetings addressing comparability (e.g. WG I, TFEIP, etc.).
Accuracy	To assure that category-specific emission factors are used when category-specific activity data is available.
	To assure that quantitative uncertainty assessment is performed.
	To assure that tier 2 or higher tier methods are used for estimating emissions from key categories.
	To assure that high uncertainty key categories are prioritised for methodological reviews and planned improvements.
	To assure that inventory review recommendations related to accuracy are addressed, to the extent possible, in the subsequent Inventory edition.
	To minimize transcription and unit conversion errors.
Inventory improvement	To contribute to improving the overall quality of the Inventory.
	To assure that review recommendations are prioritized and implemented.

1.6.4. Roles and responsibilities

The DGCEA of the MITECO, as the competent authority of the Spanish Inventory System (SEI), is the body responsible for the Inventory's QA/QC system, acting as QA/QC manager, and has the support of specific technical assistance for undertaking the tasks required by this system.

The main responsibilities of the QA/QC manager are:

- To coordinate QA/QC activities for the SEI.
- To collect and reference the internal procedures for QA/QC used by the information providers and other organisations which cooperate with the SEI.
- To ensure the development and application of the QA/QC plan.

1.6.5. Timeline

Throughout the annual Inventory cycle, Spain has to meet an important number of international reporting obligations, starting by the end of July with the submission to European Commission of the Proxy GHG estimates and ending the 15th April with the submission to the UNFCCC of GHG emissions estimates and NIR, or later in May if gridded and LPS emission data are to be submitted under LRTAP Convention or EU NECD. In the middle, a number of submissions are due in compliance with the LRTAP Convention, the EU NECD and the EU Regulation for the reporting of GHG emissions. In addition to these international obligations, Spain has to meet formal internal and other informal and ad-hoc data requests.

The Spanish QA/QC system takes into account this condensed sequence of reporting obligations, stablishing internal deadlines for the different stages of the Inventory cycle. Furthermore, QA/QC activities are scheduled accordingly.

Table 1.6.2 Main international emission inventory reporting requirements to be met by the SEI

<table>
<tr><th>Id</th><th>Obligation</th><th>Organization</th><th>GAS/POLLUTANTS</th><th>Deadline</th></tr>
<tr><td>1</td><td>Approximated greenhouse gas inventories.</td><td rowspan="2">European Commission (EC)</td><td rowspan="2">GHG</td><td>July, 31st</td></tr>
<tr><td>2</td><td>Greenhouse gas inventories - Regulation (EU) 2018/1999 (Governance). CRF tables.</td><td>January, 15th</td></tr>
<tr><td>3</td><td>LRTAP Convention. NFR tables.</td><td>UNECE</td><td rowspan="4">All Air Pollutants</td><td rowspan="2">February, 15th</td></tr>
<tr><td>4</td><td>National Emission Ceiling Directive (NECD) - Directive (EU) 2016/2284. NFR tables.</td><td>European Commission (EC)</td></tr>
<tr><td>5</td><td>LRTAP Convention. NFR tables + IIR.</td><td>UNECE</td><td rowspan="4">March, 15th</td></tr>
<tr><td>6</td><td>National Emission Ceiling Directive (NECD) - Directive (EU) 2016/2284. NFR tables + IIR.</td><td rowspan="3">European Commission (EC)</td></tr>
<tr><td>7</td><td>Greenhouse gas inventories - Regulation (EU) 2018/1999 (Governance). CRF tables + NIR.</td><td rowspan="3">GHG</td></tr>
<tr><td>8</td><td>Regulation (EU) 2018/841 (LULUCF).</td></tr>
<tr><td>9</td><td>Greenhouse gas inventories - UNFCCC. CRF tables + NIR.</td><td>UNFCCC</td><td>April, 15th</td></tr>
<tr><td>10</td><td>Gridded and LPS emission data under the National Emission Ceiling Directive (NECD) and LRTAP Convention.</td><td>European Commission (EC)
UNECE</td><td>Air Pollutants</td><td>May, 1st</td></tr>
</table>

The next figure shows the main reporting obligations and quality checks throughout the Spain inventory compilation process.

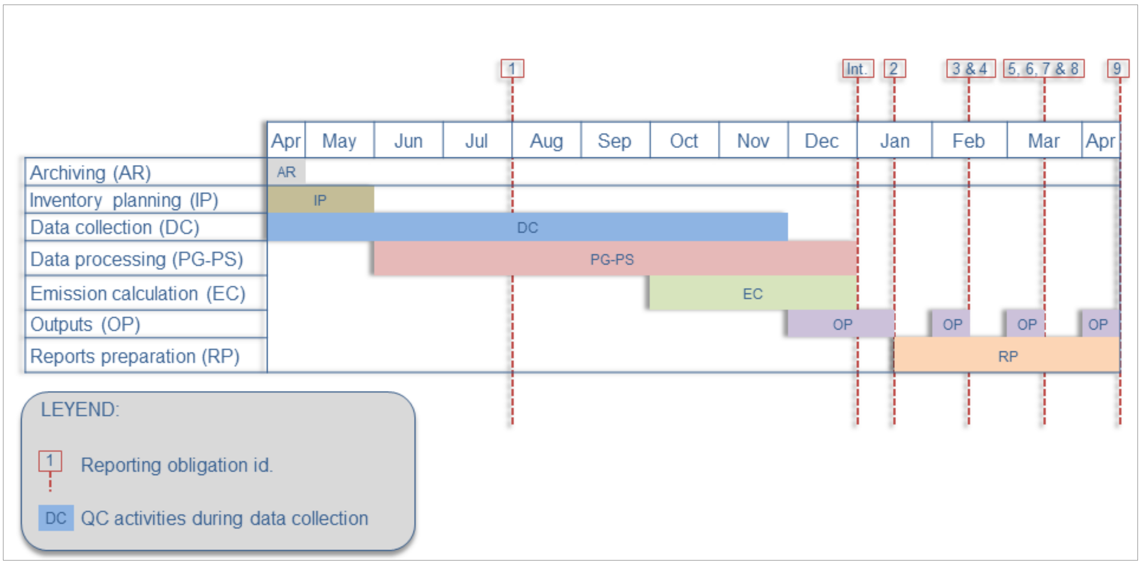

Figure 1.6.1 Timeline for the Inventory compilation process

1.6.6. Quality control and documentation

Throughout the Inventory cycle, different quality control activities and procedures are performed and properly documented. The next table includes key QC activities organized by the stage of the Inventory cycle where they occur, with details of the target quality objective and the checking and documentation tool used for their performance.

Table 1.6.3 Key QC activities included in the QA/QC plan

Inventory stage	ID	QC actions	Target quality objective[3]	Checking and documentation tools
Inventory planning (IP)	IP.01	Review of reporting obligations.	TIM	-
	IP.02	Prioritisation of improvements (general and sector-specific) based on results from QA activities (reviews and audits), uncertainty analysis, timeliness and resources.	TIM, ACC, IMP	Improvement plan
	IP.03	Development of a timeline of individual tasks, with checkpoints for the preparation of the different stages.	TIM	-
	IP.04	Review of methodologies for new key categories appeared in two consecutive Inventory editions.	IMP	Key categories analysis tool
Data collection (DC)	DC.01	Update of contact details, data format, data contents and deadlines for every data provider.	TIM, CON, COM, COP	DRDB
	DC.02	Check for relationships between every data set and the corresponding CRF/NFR activities.	COM, COP	
	DC.03	Second-person reviewing of every draft data request prior to submitting.	ACC	
	DC.04	Second-person tracking of data requests: dates of request and delivery, state of delivery, deadlines, etc.	TIM, COP	
	DC.05	Completeness and consistency checks on receipt of every data set delivered.	CON, COP	

[3] TIM: Timeliness; TRA: Transparency; CON: Consistency; COM: Completeness; COP: Comparability; ACC: Accuracy; IMP: Inventory improvement.

Inventory stage	ID	QC actions	Target quality objective[3]	Checking and documentation tools
Data processing - General (PG)	PG.01	Review of methodologies applied and comparison with methodological guidance provided by 2006 IPCC GL and 2016/2019 EMEP/EEA GB.	CON	Methodological guidelines
	PG.02	Checks of data processing spreadsheets: calculations, units, conversions.	ACC	Data processing spreadsheets
	PG.03	An uncertainty value is provided for every category at the key categories aggregation level.	ACC	Inventory emissions database
	PG.04	Embedded QC checking queries and constraints in the Inventory emissions database for integrity assurance.	CON, COM, ACC	
	PG.05	Automated data import routines.	ACC	Data import tool
	PG.06	Record date of data processing completed for every data request processed.	TIM, COM	DRDB
	PG.07 - PG.15	Source-level completeness, consistency and recalculation checks (activity data, emission factors and emission estimates).	TIM, CON, COM	QC report generating tool
	PG.16	Documentation of any change concerning methodology or activity data from previous years.	TRA	Inventory quality management tool
	PG.17	Second review of data: source-level completeness, consistency and recalculation checks.	CON, COM	QC excel tool
	PG.18 - PG.24	Consistency checks for point sources data loading into the CIEDB.	CON, COM	Inventory emissions database
Data processing - Category specific (PS)	PS.01	Inventory fuel balance vs national fuel statistics.	CON, COM, ACC	
	PS.02	Comparison between reference and sectoral approach for fuel consumption.	CON, COM	Spreadsheet
	PS.03	Product/input ratios: - Transformation of energy. - Production energy requirements (quantity of energy per unit of product). - Agricultural or livestock production. - Generation and processing of wastes.	CON	Source-specific spreadsheets
	PS.04	Composition of materials evolution: - Density - Carbon content - Carbonates content - VOC contents		
	PS.05	Composition of fuels evolution: - Molar gas composition - Carbon content - Net calorific values		
	PS.06	Correlation between fuel mix evolution, climatology and energy price.		
	PS.07	Mass balance checks.		
	PS.08	Correlation between different data sources for air traffic (EUROCONTROL vs AENA) PS.09 See category-specific chapters for detailed information.		
Emission Calculation (EC)	EC.01	Verification that the estimation algorithms operate correctly.	ACC	Inventory emissions database
	EC.02	Overall completeness check: estimates for all categories, subcategories, gases/pollutants and years.	COM	QC excel tool

Inventory stage	ID	QC actions	Target quality objective[3]	Checking and documentation tools
	EC.03	Overall IEF trend checks: outliers detection.	CON	
Outputs (OP)	OP.01	Database lockage.	TIM, CON	Inventory emissions database
	OP.02	Draft outputs generation for second-person review before submitting.	CON, COM	-
	OP.03	Total emissions cross-check: by sector and by gas/pollutant.	CON	QC excel tool
	OP.04	Checks on the correctness of emissions aggregation and allocation.	CON, COP	
	OP.05	Time-series consistency checks.	CON	
	OP.06	Version checks: current outputs are cross-checked with last edition outputs. Any changes must be explained.	TRA, CON	Recalculation analysis tool Inventory quality management tool
	OP.07	Geographical coverage checks.	COP	Inventory emissions database
	OP.08	Consistency check between Inventory and ETS GHG emissions.	COP, ACC	Annex V Reporting format (Art.10- Reg. (EU) No 749/2014
	OP.9	Notation keys checks: completeness and harmonisation.	TRA, COM, COP	Inventory notation keys database
	OP.10	Embedded database queries for consistency assurance between data exported from the Inventory database and data entered into reporting tools (CRF Reporter, NFR tables, etc.).	CON	Inventory emissions database
	OP.11	Automated data transfer between the Inventory emission database and the official reporting tools (CRF reporter/NFR) to minimize transcription errors.	CON, ACC	Data transfer tool
	OP.12	Running of the official reporting tools' built-in checks (CRF Reporter and RepDab).	CON, COM	Official reporting tools
Report Preparation (RP)	RP.01	QC checklist for reports preparation.	TRA, CON, ACC	Chapter-specific QC checklist
	RP.02	Second-person review of every draft chapter generated.	TRA, CON, ACC	-
Archiving (AR)	AR.01	Archiving of database files, spreadsheet files, source data, manuals, reports.	-	Inventory folder system
	AR.02	Update of the National Inventory System webpage[4] with all the information submitted during the Inventory cycle. Additional information on emissions at different aggregation levels and a set of methodological fact sheets are included as well.	TRA	MITECO Website

[4] https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/sistema-espanol-de-inventario-sei-/default.aspx

1.6.7. Quality control and documentation tools

A short overview of the five main QC tools used by the Inventory is provided below.

1.6.7.1. Data request database (DRDB)

Overall management of data collection and registry of QC results during data processing is carried out with the Data Request Database (DRDB). This database includes two different operating modules:

1. The contacts database connected with the data requests tracking system.
2. A QC module for the registration of the progress in data processing and all the issues raised during the performance of QC activities.

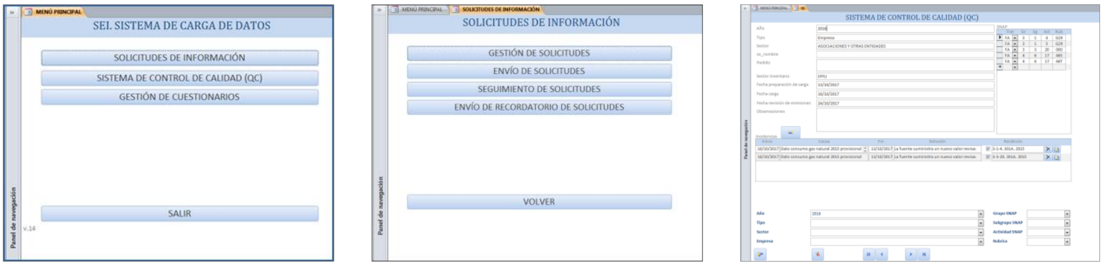

Figure 1.6.2 Examples of screenshots of the DRDB

1.6.7.2. Data import tool

An Excel-based file with embedded macros allows uploading data into the CIEDB. This tool first checks for data integrity and data structure before uploading. If integrity is not assured, an error message pops-up and a list of errors to solve are provided. Once integrity checks have been successfully passed, data are automatically imported into the database. After importing, the tool automatically executes the necessary compiling and calculating processes and produces a QC report. This report consists of a spreadsheet showing time-series for current and past edition for activity data, emission factors and emissions. Warning messages appear in the QC report if recalculations, outliers on implied emission factors or inconsistencies among particulate matter fractions are detected. In this inventory edition, improvements have been made, in particular a new consistency check of LPS coordinates, and QC reports has been enabled for CRF and NFR classifications as well. The report is checked by the sector expert, if results are satisfactory, the activity is registered as uploaded and checked in the QC module of the DRBD. If the results are unsatisfactory, corrective measures take place.

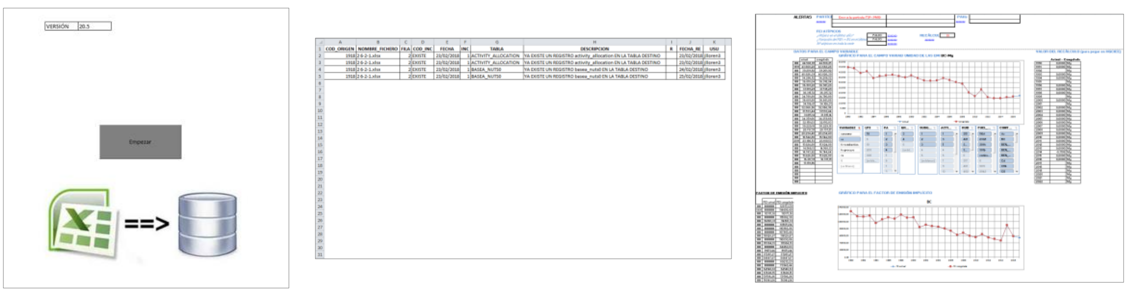

Figure 1.6.3 Appearance of the Data import tool (left), list of import errors (middle) and QC report (right)

1.6.7.3. QC excel tool

Once the emission calculation stage starts, CIEDB calculating procedures are run on a weekly basis. Resulting emissions and activity data are exported to an excel spreadsheet specially designed for QC and review purposes. With the use of pivot tables, filters and graphs, Inventory compilers are able to check emissions, activity data and IEF trends and recalculations. Checks can be performed at different levels of aggregation (sector, subsector, activity, etc.) and nomenclatures (SNAP, NFR and CRF). Furthermore, an automatic outliers' detector is included as well as annual variations ratio.

This tool, together with the QC report above mentioned, constitutes the main checking tools used in the Inventory for completeness and consistency assurance.

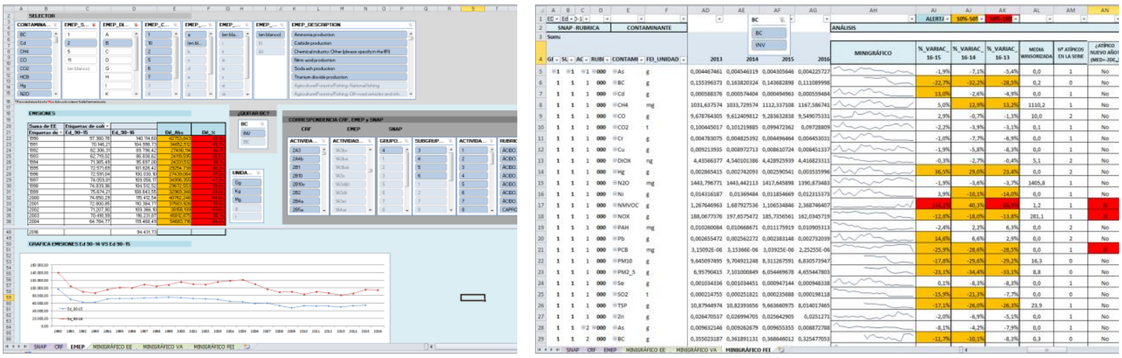

Figure 1.6.4 Appearance of the QC excel tool

1.6.7.4. Inventory quality management database (IQMDB)

The Inventory uses an Inventory quality management database (IQMDB) to allow the inventory compilers and QA/QC coordinator to register all aspects related to quality management: inventory compilation progress, improvement plan, quality checks and event log. It also allows producing different types of reports.

The current functioning of the IQMDB focuses on the event log module. This module allows registering any event or incident occurred during the data processing stage, being the recording of any change with associated recalculations of priority interest for the Inventory. For every revised estimate occurred in the Inventory, sector expert register details on the plant, category, pollutants, fuel (if any), years affected and impact. Furthermore, connections with the Inventory improvement plan can be established in order to quickly identify that certain revised estimates were due to a planned improvement. Recalculations can be classified by its origin: activity data, emission factors or other. For every origin, a range of options for details is available: error correction, updated methodology, updated activity data by the source, etc. A set of reports are also included in the event log module which presents data in different ways and levels of aggregation. . In this edition of the Inventory, a total of 103 events were registered of which 103 (100 %) with associated recalculations.

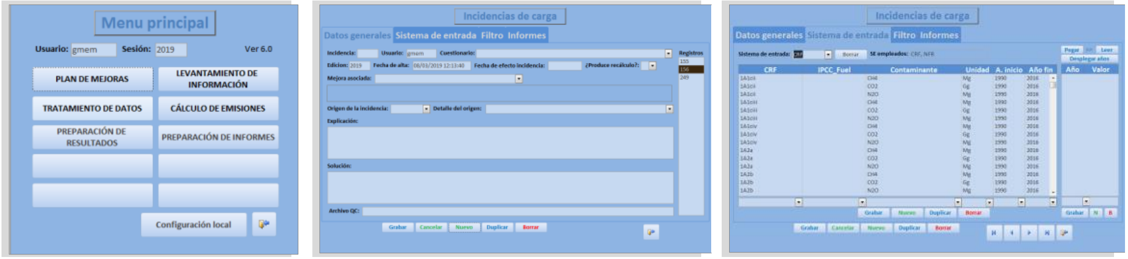

Figure 1.6.5 Appearance of the Inventory quality management tool

1.6.7.5. Recalculation analysis tool

This tool compares current edition against the past edition of the Inventory for every pollutant or gas estimated, and provides the user with valuable information on the variation of emissions, main categories recalculated, interannual changes, the number of categories recalculated, etc.

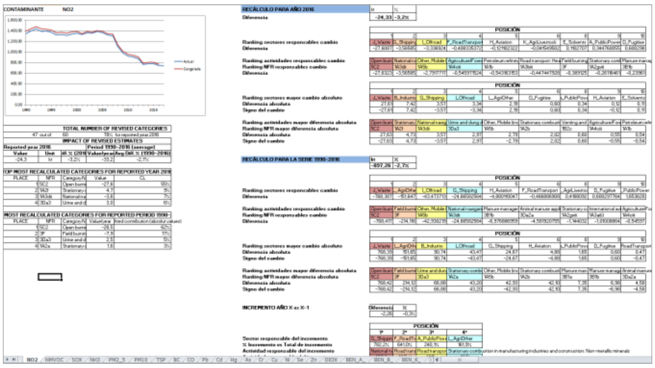

Figure 1.6.6 Appearance of the recalculation analysis tool

1.6.8. Quality assurance system

The QA system includes a number of activities conducted by third parties, not directly involved in the Inventory development process, intended to verify compliance with reporting requirements and to assess the effectiveness of the QC system.

A number of specific QA activities and procedures are detailed next:

- **Annual Inventory reviews conducted by UNFCCC, UNECE and the EU**: on an annual basis (excepting Stage 3 UNECE Review), reviews of the Spain GHG and Air Pollutants Inventories submitted under different information obligations are performed. The main outcome of these reviews is a list of issues and recommendations which feed into the Inventory improvement plan.
- **Independent QA audit (2017-2021)**: since October 2017 to May 2021, a QA audit was performed by an independent consultancy firm. The audit plan envisaged a four-year programme of work (see schedule below). The outcome of this audit is a set of checklists where every item checked is scored using a 0 to 3 scale. Additionally, suggested actions and recommendations are included. Furthermore, an audit certificate is issued, where the external auditor confirms the audit result and validate, where appropriate and according to the agreed criteria, the data and information contained in the then latest available edition of the National GHG and Air Pollutant Emissions Inventory. As planned, a comparison of a selection of countries and an in-depth review of the Inventory system

and the Waste sector was performed in 2018. In 2019, a selection of checks was reviewed for the Inventory system and the Waste sector, as well as an in-depth review of the IPPU sector. In 2020, a selection of checks was reviewed for the Inventory system, the Waste and the IPPU sector, as well as an in-depth review of the Energy sector. In 2021, an exhaustive review of the AFOLU sector was carried out, and a review of the most relevant aspects identified during the previous audit.

Overall, the result of the QA audit 2021 was "Satisfactory".

				ACTIVITIES / SECTORS						
Task	**Description**	**Year**	**Month**	**Audit Plan**	**Audit Plan Review**	**Inventory System**	**Waste**	**IPPU**	**Energy**	**AFOLU**
T1	SEI Quality Assurance Audit Plan definition	2017	November	X						
T2	SEI Quality Assurance Audit execution	2018	February			X	X			
	Comparability analysis between countries						X	X	X	X
T3	SEI Quality Assurance Audit Plan review		November		X					
T4	SEI Quality Assurance Audit execution	2019	February			x	x	X		
T5	SEI Quality Assurance Audit Plan review		November		X					
T6	SEI Quality Assurance Audit execution	2020	February			x	x	x	X	
T7	SEI Quality Assurance Audit Plan review		November		X					
T8	SEI Quality Assurance Audit execution	2021	May			x	x	x	x	X

Figure 1.6.7 QA audit schedule (X=in-depth review; x=review of selected key points)

- **Inventory users' feedback**: every year, the Inventory receives feedback, consultations and comments from regional authorities, research organizations such as CIEMAT and governmental bodies not directly related to the Inventory compilation. All these contributions help to enhance estimates and to strengthen the QA/QC system.

1.6.9. Verification

As part of the QA/QC system, two main verification activities are performed, one considered as a QC activity and another one as a QA activity.

- **Comparison between Inventory and EU ETS (QC)**: discrepancies are clarified with plant operators or the national EU ETS authority.
- **Comparison between National Inventory data at the regional level and data from regional inventories (QA)**: some regional governments have their own emission estimates which are compared against data allocated by the Inventory to their region.

Discrepancies may allow the Inventory checking its estimates or the approach used for the spatial distribution of emissions.

Furthermore, in the 2020 edition, initial comparisons between the Inventory and PRTR were performed as a new QC activity. The Inventory and the Spanish PRTR authority have enhanced its collaboration in order to share and cross-check data on emission and activity data (when available).

1.6.10. Confidentiality handling

The air pollutant emission inventories are considered to be statistics for State purposes. They are performed on the basis of the exclusive responsibility of the State and follow the rules of statistical secrecy in accordance with the provisions of the 2021-2024 National Statistical Plan.

As a general criterion, emissions data in the SEI are not considered to be confidential. However, some information on activity data related to companies or installations subject to confidentiality is not made public in the Inventory. Data on emission factors are also considered to be confidential whenever it is possible to infer data on activity variables at the company or plant level by using these emissions factors and the information on emissions. The activity variables or emission factors which are subject to confidentiality restrictions are identified with label “C”.

Confidentiality is observed when less than three economic agents operate or provided data for any item in the Inventory (activity variable, general socio-economic data, technological data, etc.).

The list of categories in the Inventory cross-referenced with the emitted substances which are considered confidential is revised annually based on the variation in the number of economic agents which are considered for an item in the Inventory in each edition.

On an annual basis, the economic agents providing information of a confidential nature for the Inventory are asked by means of a specific form whether they wish to lift the confidentiality restrictions on the information that they consider sensitive.

1.6.11. Main features from QC activities

Main features and results from a selection of QC activities are presented below:

Table 1.6.4 Main features from QC activities in the 2023 edition

ID	QC actions	MAIN RESULTS
IP.01	Review of reporting obligations.	10 international obligations.
DC.04	Second-person tracking of data requests: dates of request and delivery, state of delivery, deadlines, etc.	92 % of the requests to data providers answered, of which 40 % delivered information after the deadline. 8 % of providers needed a reminder mail. For request not answered, secondary sources of information were used.
PG.07 - PG.15	Source-level completeness, consistency and recalculation checks (activity data, emission factors and emission estimates).	357 QC reports reviewed. Besides, QC reports has been enabled for CRF and NFR classifications as well.
PG.16	Documentation of any change concerning methodology or activity data from previous years.	103 registries documenting recalculations in the Inventory quality management database.
PG.18 - PG.30	Consistency and integrity checks for load of large pollutant sources (LPS)	New consistency check of LPS coordinates
OP.06	Version checks: current outputs are cross-checked with last edition outputs. Any changes must be explained.	64 % of emitting NFR source categories recalculated.

1.7. General uncertainty evaluation

The Spanish Inventory System applies in the uncertainty assessment of the Inventory two different approaches to all the activities:

i. a quantitative approach referring to main pollutants (SO_2, NOx, NMVOC, NH_3, $PM_{2.5}$, and BC)

ii. a qualitative approach, referring to the rest of pollutants

The uncertainty assessment and classification of data quality labels for activity variable and emission factors observe the “General Guidance Chapters”, Chapter 5 “Uncertainties”, in the 2019 EMEP/EEA Guidebook.

1.7.1. Quantitative Assessment of the Uncertainty

In the 2021 Inventory edition, the Spanish Inventory System implemented a quantification of quantification of the uncertainty associated to the estimated emissions of the main pollutants based on Approach 1 of 2019 EMEP/EEA GB.

Some relevant particularities for Spain have been considered when quantifying the uncertainty of emission factors and activities variables.

The following tables show the central values and their 95 % confidence intervals of SO_2, NOx, NH_3, NMVOC, $PM_{2.5}$, and BC emissions, both for level (2021) and trend evolution (2021 with respect to the central value of 1990). The following conclusions can be drawn from their analysis:

i. The 95% confidence interval for the emissions level ranges between 18 % and 183 % for 2021, depending on the considered pollutant; whereas the trend has a more limited confidence interval (between 1 % and 76 %) depending on the pollutant.

ii. In view of these results, it can be said that the uncertainty in the inventory for 2021 is lower for SO_2 and NOx than for NH_3, NMVOC and $PM_{2.5}$, and in special BC, in accordance with previous IIR trends.

The results of the Approach 1 uncertainty analysis are presented in detail in Annex 3. The results can be summarised as follows:

Table 1.7.1 Emissions Uncertainties

Pollutant	Emission (Gg)	Uncertainty in 2021 (%)	Trend Uncertainty 1990-2021 (%)
NOx	620.5	18.3	6.4
NMVOC	549.4	39.5	12.2
SO_2	122.9	20.9	1.2
NH_3	478.8	41.5	35.2
$PM_{2.5}$	135.0	87.4	37.8
BC	46.2	183.3	75.7

1.7.2. Qualitative assessment of the uncertainty

The procedure for the qualitative determination of the uncertainty, based on quality label allocation, is described below.

1.7.2.1. Quality label allocation criteria

The allocation of quality labels to the emissions estimates is based on the labels associated with the Inventory's basic data (activity variables and emission factors) classified from A (the most precise) to E (the least precise).

Using quality labels for activity variables and emission factors, the Spanish Inventory System has assigned its emissions quality labels, in accordance with the attribution system "DATA ATTRIBUTE RATING SYSTEM", specified in the table below. This attribution system has been adopted by the Inventory Team as it is considered to be the most appropriate for the context of the Spanish Inventory.

Table 1.7.2 System adopted for the composition of the emissions quality label: "DATA ATTRIBUTE RATING SYSTEM"

Labels of the activity variables and emission factor	Label of the emissions variable	Labels of the activity variables and emission factor	Label of the emissions variable
E-E	E	C-C	C
E-D	E	D-A	D
E-C	E	C-B	C
D-D	D	C-A	C
E-B	E	B-B	B
E-A	E	B-A	B
D-C	D	A-A	A
D-B	**D**		

1.7.2.2. Quality label allocation procedure

In the present Inventory edition, the Spanish Inventory System has made the qualitative diagnosis of uncertainty by attributing quality labels to emission factors and activity variables. The allocation of a particular quality label from the range of options A-E was established by applying the following criteria:

For emissions:

The classification of quality of emissions is based on the classification, using the same categories (A-E), of their activity variables and the estimation methods (mostly emission factors), and on a composition method using the hypothesis of the independence of the quality level (label) in both data inputs (activity variables and emission factors).

For emissions factors:

The following general criteria have been applied initially for the assignment of quality labels to emission factors:

"A" for those derived from measured observations (SO_2 and NOx) and for those based on materials balance (CO_2) in combustion processes.

"B" for those derived from the methods for the balance of materials, basically SO_2, Pb and CO_2, if they have not been classified with a better quality label as described in the previous paragraph.

"B", "C" and "D" for those based on default emission factors in highly anthropogenic sectors if these have not been classified with a better label as described in the previous paragraphs.

"C", "D" and "E" for those based on emission factors and on correlation functions with agriculture and livestock sectors and natural sectors if these have not been classified with a better label as described in the previous paragraphs.

For activity variables:

The following general principles have been applied for the assignment of quality labels to the activity variables:

"A" for the data collected from the questionnaires sent by Large Point Sources, as well as the data from the Population Censuses and the Statistical Yearbooks on Registration.

"B" for sector-based statistics based on questionnaires sent to activity centres.

"B", "C" and "D" for the "Inferred" Statistical Yearbooks (e.g. statistics in the Agricultural Statistical Yearbook from the MAPA).

"C", "D" and "E" for the diagnoses based on expert opinions.

1.7.2.3. Quality labels assigned to the emissions estimates

The following table shows the quality labels associated with the estimated emissions by NFR sector. These labels have been derived using the procedure described in Section 1.7.2.1. The information in the table can be considered representative for the whole of the period in the Inventory.

Table 1.7.3 Mean quality levels (labels) of emissions

NFR	OTHER	PARTICULATE MATTER				POPs		
	CO	$PM_{2.5}$	PM_{10}	TSP	BC	HCB	PCDD/F	PAHs
1A1a	B	C	C	B	C	D	D	D
1A1b	B	C	C	B	C	-	D	-
1A1c	B	C	C	B	C	-	D	D
1A2	D	D	D	C	D	-	E	D
1A3a	C	C	C	B	C	-	-	E
1A3b	D	C	C	B	B	-	E	E
1A3c + 1A3e + 1A5	C	C	C	B	C	-	E	E
1A3d	C	C	C	B	C	E	E	E
1A4a + 1A4b	E	E	E	D	D	-	E	E
1A4c	C	C	C	B	E	E	E	E
1B	D	D	D	C	D	-	-	D
2A	-	-	-	-	-	-	-	-
2B	D	D	D	C	D	D	-	-
2C	D	D	D	C	D	D	D	D
2D	D	-	-	-	-	-	-	E
2G + 2H + 2I + 2J + 2K + 2L	D	D	D	C	D	-	-	-
3B	-	E	E	D	-	-	-	-

NFR	OTHER	PARTICULATE MATTER				POPs		
	CO	$PM_{2.5}$	PM_{10}	TSP	BC	HCB	PCDD/F	PAHs
3D	-	-	E	D	-	-	-	-
3F	D	E	E	D	E	-	E	E
3I	-	-	-	-	-	-	-	-
5A	E	D	D	C	-	-	-	-
5B	E	D	D	C	-	-	-	-
5C	E	D	D	C	C	D	B	D
5D	E	D	D	C	-	-	-	-
5E	-	-	-	-	-	-	-	-
6A	-	-	-	-	-	-	-	-

NFR	HEAVY METALS								
	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn
1A1a	D	D	D	D	D	D	D	D	D
1A1b	D	D	D	D	D	D	D	D	D
1A1c	D	D	D	D	D	D	D	D	D
1A2	D	D	D	D	D	D	D	D	D
1A3a	-	D	D	D	-	D	-	D	D
1A3b	-	E	E	E	-	E	A	D	E
1A3c + 1A3e + 1A5	-	D	D	D	D	D	-	D	D
1A3d	D	D	D	D	D	D	C	D	D
1A4a + 1A4b	D	D	D	D	D	D	D	D	D
1A4c	D	D	D	D	D	D	C	D	D
1B	-	-	-	-	-	-	-	-	-
2A	-	D	-	-	-	-	D	-	-
2B	-	D	-	-	C	-	-	-	-
2C	D	D	D	C	C	C	D	C	D
2D	-	-	-	-	-	-	-	-	-
2G + 2H + 2I + 2J + 2K + 2L	-	-	-	-	-	-	-	-	-
3B	-	-	-	-	-	-	-	-	-
3D	-	-	-	-	-	-	-	-	-
3F	-	-	-	-	-	-	-	-	-
3I	-	-	-	-	-	-	-	-	-
5A	-	-	-	-	-	-	-	-	-
5B	-	-	-	-	-	-	-	-	-
5C	D	D	D	D	D	D	D	D	D
5D	-	-	-	-	-	-	-	-	-
5E	-	-	-	-	-	-	-	-	-
6A	-	-	-	-	-	-	-	-	-

1.8. General Assessment Completeness

In this section, detailed explanations are provided on the notations keys reported for categories and pollutants where no emission data could be provided in the Spanish Inventory.

1.8.1. Sources not estimated (NE)

Since 2015 Inventory edition, completeness has been increasingly improved, with a substantial reduction of categories notated as NE, and hence, more emissions estimates have been provided since then. The table below shows this evolution.

Table 1.8.1 Evolution of the number of categories notated as NE

Edition (year of submission)	Number of categories with NE	% of the total number of categories with at least one NE
2023	54 out of 127	43 %
2022	58 out of 127	46 %
2021	57 out of 127	45 %
2020	59 out of 127	46 %
2019	57 out of 127	45 %
2018	59 out of 127	46 %

Spain ensures full adherence to the revised guidelines for reporting emissions and projections data under the LRTAP Convention (ECE/EB.AIR/125) in the use of notation keys. The apparently high number of NE used by Spain is mainly due to the fact that the 2016/2019 EMEP/EEA GB states NE for each combination category/pollutant.

For clarity reasons, identifications and explanations for NE are presented in a matrix where any NE is identified by a blue cell and the explanation is codified with a number. In order to reduce the length of this document, only categories with NE are presented.

Descriptions of the codes used are the following:

1. Despite being emission factors available in the 2016/2019 EMEP/EEA GB, the Inventory has not been able to estimate these emissions yet.
2. Emission factors are not available in the methodological guidelines.
3. No studies are available on possible traces of metals contained in coal or in its adjacent strata and those are emitted in the mining processes or in the subsequent manipulation of coal in the gaseous or particulate state.
4. There is no information on traces of sulphur originally contained in the hydrocarbons or subsequently incorporated into them in the treatment phase for SO_2 emissions; so it has not been possible to estimate these emissions, but it is presumed to be of very low importance to the total Inventory.
5. The Inventory uses NE notation key for categories and pollutants that 2016/2019 EMEP/EEA GB included under the “Not estimated” section of every emission factor table.
6. Emissions are considered negligible. A national expert judgement confirms no emissions of NMVOC in Spanish mines. However, following recommendation ES-1B1a-2017-0001 made by the ERT in the 2017 NECD review, the Spanish Inventory System has used NE notation key instead of NA.

Overall, the main reason for using NE is ID = 5, as shown in table and figure below.

Table 1.8.2 Share reasons for using NE

Reason ID	TIMES NE IS USED
1	0
2	42
3	0
4	3
5	357
6	0
TOTAL	402 out of 3302 categories x pollutants (12.2 %)

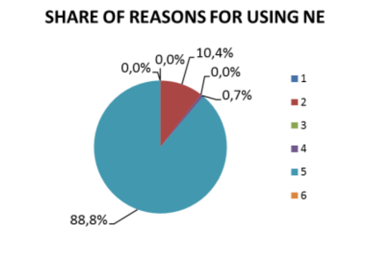

Table 1.8.3 Distribution of reasons for using NE

NFR Code	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD PCDF	PAHs					HCB	PCBs
																				benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno (1,2,3-cd) pyrene	Total 1-4		
1A1a	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A1b	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A1c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A2a	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A2b	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A2c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A2d	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A2e	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A2f	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A2gvii	-	-	-	-	-	-	-	-	-	2	-	2	2	-	-	-	-	-	2	-	-	-	-	-	-	-
1A2gviii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A3ai(i)	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
1A3aii(i)	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
1A3bi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A3bii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A3biii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A3biv	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A3bv	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

NFR Code	NO_X	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD PCDF	PAHs					HCB	PCBs
																				benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno (1,2,3-cd) pyrene	Total 1-4		
1A3bvi	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A3bvii	-	-	-	-	-	-	-	-	-	2	2	2	2	2	2	2	2	2	-	2	2	2	2	2	-	-
1A3c	-	-	-	-	-	-	-	-	-	2	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
1A3di(ii)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A3dii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A3ei	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A3eii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A4ai	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A4aii	-	-	-	-	-	-	-	-	-	-	-	5	5	-	-	-	-	-	5	-	-	-	-	-	-	-
1A4bi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A4bii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A4ci	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A4cii	-	-	-	-	-	-	-	-	-	2	-	2	2	-	-	-	-	-	2	-	-	-	-	-	-	-
1A4ciii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A5a	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A5b	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1B1a	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1B1b	-	-	-	-	-	-	-	5	-	5	5	5	5	5	5	5	5	5	-	-	5	5	5	-	-	-
1B1c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1B2ai	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
1B2aiv	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1B2av	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-

NFR Code	NO_X	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD PCDF	PAHs					HCB	PCBs
																				benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno (1,2,3-cd) pyrene	Total 1-4		
1B2b	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
1B2c	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	2	2	2	2	-	-
1B2d	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2A1	5	5	5	5	-	-	-	-	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	-
2A2	5	5	5	-	-	-	-	-	5	5	5	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2A3	5	-	5	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	5	5	5	5	5	5	5	-
2A5a	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2A5b	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2A5c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2A6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2B1	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2B2	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2B3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2B5	5	5	5	-	-	-	-	-	-	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	-
2B6	-	5	-	5	-	-	-	-	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
2B7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2B10a	-	-	-	-	-	-	-	-	-	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
2B10b	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2C1	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2C2	5	5	5	5	-	-	-	-	-	-	-	5	-	-	-	-	5	-	5	5	5	5	5	-	-	-
2C3	-	-	-	5	-	-	-	-	-	5	5	5	5	5	5	-	5	-	-	-	-	-	-	-	-	-
2C4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2C5	5	5	-	5	-	-	-	5	5	-	-	5	-	5	5	5	5	-	-	5	5	5	5	5	5	-

NFR Code	NO_X	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD PCDF	PAHs					HCB	PCBs
																				benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno (1,2,3-cd) pyrene	Total 1-4		
2C6	5	5	-	5	-	-	-	5	5	-	-	-	-	5	5	5	5	-	-	5	5	5	5	5	5	-
2C7a	5	5	-	5	-	-	-	-	5	-	-	-	-	-	-	-	5	-	-	5	5	5	5	5	5	-
2C7b	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2C7c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2C7d	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2D3a	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2D3b	5	-	5	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	5	5	5	5	5	5	5	-
2D3c	5	-	-	-	-	-	-	-	-	5	5	5	-	-	-	-	-	-	5	5	5	5	5	5	5	-
2D3d	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2D3e	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2D3f	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2D3g	5	-	5	5	5	5	-	5	5	5	-	5	-	-	5	-	-	5	5	-	-	-	-	-	5	5
2D3h	-	-	-	-	5	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2D3i	5	-	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	-	-	-	-	-	5	-
2G	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	5	5
2H1	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	5	5	5	5	5	-
2H2	-	-	-	-	5	5	5	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2H3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2I	5	5	5	5	5	5	-	5	5	-	-	-	5	-	5	-	-	-	-	-	-	-	-	-	-	-
2J	5	5	5	5	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	5
2K	-	-	-	-	-	-	-	-	-	5	5	5	5	5	5	5	5	5	-	-	-	-	-	-	5	-
2L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B1a	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

NFR Code	NOx	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD PCDF	PAHs					HCB	PCBs
																				benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno (1,2,3-cd) pyrene	Total 1-4		
3B1b	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B4a	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B4d	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B4e	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B4f	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B4gi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B4gii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B4giii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B4giv	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B4h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3Da1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3Da2a	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3Da2b	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3Da2c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3Da3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3Da4	-	-	-	**2**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3Db	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3Dc	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3Dd	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3De	-	-	-	**2**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3Df	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

NFR Code	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD PCDF	PAHs					HCB	PCBs
																				benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno (1,2,3-cd) pyrene	Total 1-4		
3F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5A	-	-	-	5	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5B1	5	5	5	-	5	5	5	5	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5B2	-	5	5	-	-	-	-	5	-	5	5	5	-	5	-	-	-	5	5	5	5	5	5	5	5	5
5C1a	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5C1bi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5C1bii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5C1biii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5C1biv	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5C1bv	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5C1bvi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5C2	-	-	-	5	-	-	-	-	-	-	-	5	-	-	-	5	-	-	-	-	-	-	5	-	5	-
5D1	-	-	-	5	-	-	-	5	-	5	5	5	5	5	5	5	5	5	-	-	-	-	-	-	-	-
5D2	-	-	-	5	-	-	-	5	-	5	5	5	5	5	5	5	5	5	-	-	-	-	-	-	-	-
5D3	-	5	-	-	5	5	5	5	-	5	5	5	5	5	5	5	5	5	-	-	-	-	-	-	-	-
5E	5	-	5	-	-	-	-	-	5	-	-	-	-	-	-	5	5	5	-	5	5	5	5	5	5	5
6A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

1.8.2. Sources included elsewhere (IE)

1.8.2.1. Energy

- **1A4bii Residential: household and gardening (mobile)**: emissions are included within the category related to the stationary source (1A4bi) since no information is available to distinguish consumption between stationary and mobile, being assumed that stationary is predominant. Planned improvements focus on separate emissions reported under 1A4bi.
- **1A5a Other stationary (including military)**: consumption rates allocated to military activities (fixed facilities) are included within the categories related to the stationary sources of their respective sector (1A4ai).

1.8.2.2. Industrial Processes and other Product Uses

The emissions of some activities from NFR sector 2 are estimated within the corresponding combustion activities associated with these production processes in Energy (NFR 1).

- **2A1 Cement production**: for PM, the Inventory estimates emissions applying a mixed Tier 2/Tier 3 approach, using a national emission factor based on measurements, provided by the main business association (OFICEMEN). These emissions are allocated under the corresponding combustion activity associated with this production process (1A2f).
- **2B1 Ammonia production**: NOx emissions have been reallocated under 1A2c category due to impossibility of splitting emissions between combustion and process. The upgrading of the chemical sector by addition of information from the chemical plants via individual questionnaire has drawn up new estimations according to measures from the plants.
- **2B10b Storage, handling and transport of chemical products**: for $PM_{2.5}$, PM_{10} and TSP, according to sections 3.2.2 and 3.3.2 from chapter 2.B of 2019 EMEP/EEA Guidebook, it is assumed that emissions from the storage and handling of chemical products are included in the process emissions, both for Tier 1 and 2.

It is also remarkable the following case:

- **2C1 Iron and steel production:** the 4 PAH indicator species PAH are considered to be included in the total PAH emissions, since the 2019 EMEP/EEA Guidebook only includes emission factors for total PAH.
- **2C7d Storage, handling and transport of metal products:** for $PM_{2.5}$, PM_{10} and TSP, according to chapter 2.C of 2019 EMEP/EEA Guidebook, it is assumed that emissions from the storage and handling of metal products are included in the process emissions, both for Tier 1 and 2.

1.8.2.3. Waste

- **5C1a Municipal waste incineration**: Since 2004 emissions are reported under 1A1a as all incineration facilities have undertaken incineration with energy recovery.

- **5C1bi Industrial waste incineration**: Emissions are reported under 1A1a as all incineration facilities have undertaken incineration with energy recovery.
- **5C1biii Clinical waste incineration**: Since 2006 emissions are reported under 1A1a as no incineration without energy recovery takes place.

2. EXPLANATION OF KEY TRENDS

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2. EXPLANATION OF KEY TRENDS

Chapter updated in March, 2023.

2.1. Analysis by pollutant

This section analyses and discusses the latest estimates of emissions in Spain (excluding the Canary Islands) of the major primary pollutants, as well as the trends in these emissions along the studied time series (1990-2021), according to the 12 aggregated GNFR[1] sectors.

Detailed emission data of the Spanish Inventory are available from the MITECO-SEI website WebTable.

In the next pages, separate analyses of the following pollutants are included:

– Nitrogen Oxides (NOx)

– Non-Methane Volatile Organic Compounds (NMVOC)

– Sulphur Oxide (SO_2)

– Ammonia (NH_3)

– Fine Particulate Matter ($PM_{2.5}$)

– Carbon Monoxide (CO)

– Lead (Pb)

– Cadmium (Cd)

– Mercury (Hg)

– Dioxins and furans (PCDD/PCDF)

– Polycyclic Aromatic Hydrocarbons (PAHs)

[1] NFR aggregation for reporting of gridded data and Large Point Sources is used. GNFR for each NFR category is provided in column A of NFR tables.

2.1.1. Nitrogen Oxides (NOx)

The estimate for 2021 is of 620.5 kt of nitrogen oxides (NOx), expressed as nitrogen dioxide, emitted in Spain (excluding the Canary Islands).

NOx emissions in 2021 decreased by -52.7% when compared to 1990, and increased by 3.5% compared to 2020.

The GNFR aggregated sectors most contributing to NOx emissions were:

- Road transport (F_RoadTransport) was the first contributing activity with 37% of total NOx emissions, with Passenger cars (1A3bi) and Heavy duty vehicles and buses (1A3biii) accounting respectively for 22.4% and 10.6% of the total value in the Inventory.
- Industries (B_Industry) sector was the second contributor, accounting for 17.6% of total NOx emissions.
- L_AgriOther, emissions from agricultural soils, accounted for 12.1%.
- J_Waste had a share of 9.4% of the total.
- The emissions from A_PublicPower only accounted for 5% of NOx emissions in 2021.

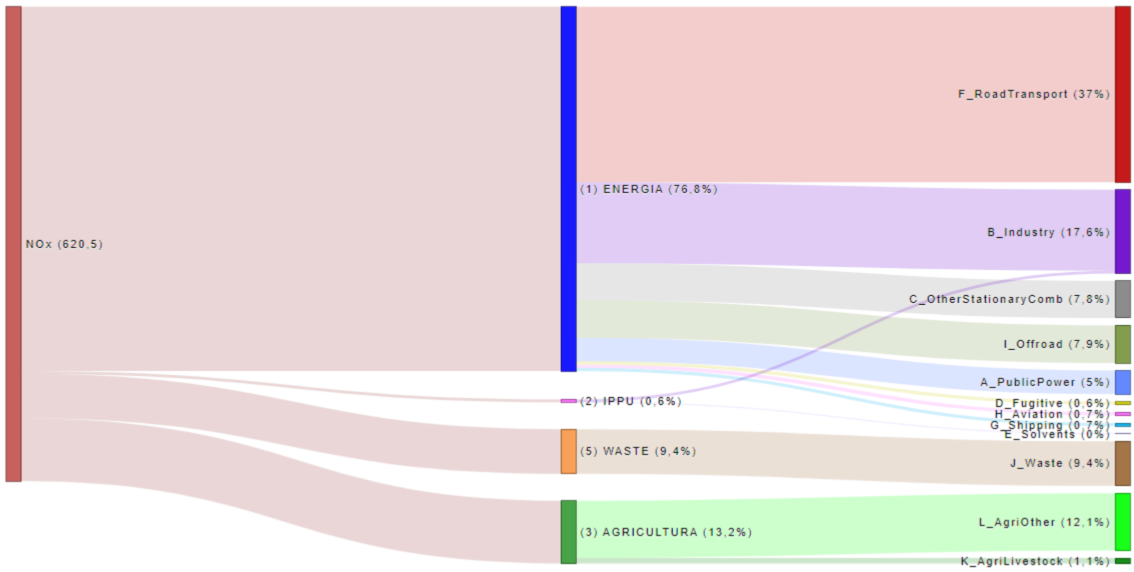


Figure 2.1.1 Distribution of NOx emissions in year 2021

Table 2.1.1 NOx emissions by sector (kt)

	1990	2005	2010	2019	2020	2021	Share 2021	2021/ 1990	2021/ 2020
A_PublicPower	208.0	293.4	84.4	42.6	31.3	30.8	5.0%	-85.2%	-1.8%
B_Industry	187.3	188.5	155.7	118.4	106.3	109.4	17.6%	-41.6%	2.8%
C_OtherStationaryComb	35.4	51.6	55.0	47.6	47.6	48.5	7.8%	37.1%	2.0%
D_Fugitive	6.3	4.5	4.1	5.0	3.9	4.0	0.6%	-36.5%	2.4%
E_Solvents	0.0	0.2	0.1	0.1	0.1	0.1	0.0%	188.4%	-5.1%
F_RoadTransport	527.4	457.4	363.2	268.3	213.1	229.6	37.0%	-56.5%	7.8%
G_Shipping	75.4	40.2	21.9	5.0	3.4	4.2	0.7%	-94.5%	22.6%

	1990	2005	2010	2019	2020	2021	Share 2021	2021/ 1990	2021/ 2020
H_Aviation	2.8	6.8	7.1	8.9	3.2	4.5	0.7%	60.9%	40.2%
I_Offroad	135.6	162.3	116.0	54.8	48.5	49.1	7.9%	-63.8%	1.2%
J_Waste	35.1	37.6	51.3	47.1	58.2	58.2	9.4%	65.7%	0.0%
K_AgriLivestock	6.1	7.6	7.0	7.1	7.0	7.1	1.1%	17.5%	1.0%
L_AgriOther	91.9	72.0	70.3	74.4	76.6	75.0	12.1%	-18.4%	-2.2%
Total (Canary Islands not included)	**1311.4**	**1322.0**	**936.1**	**679.2**	**599.4**	**620.5**	**100.0%**	**-52.7%**	**3.5%**

Detailed emission data of the Spanish Inventory are available from the MITECO-SEI website WebTable.

2.1.1.1. Trend assessment

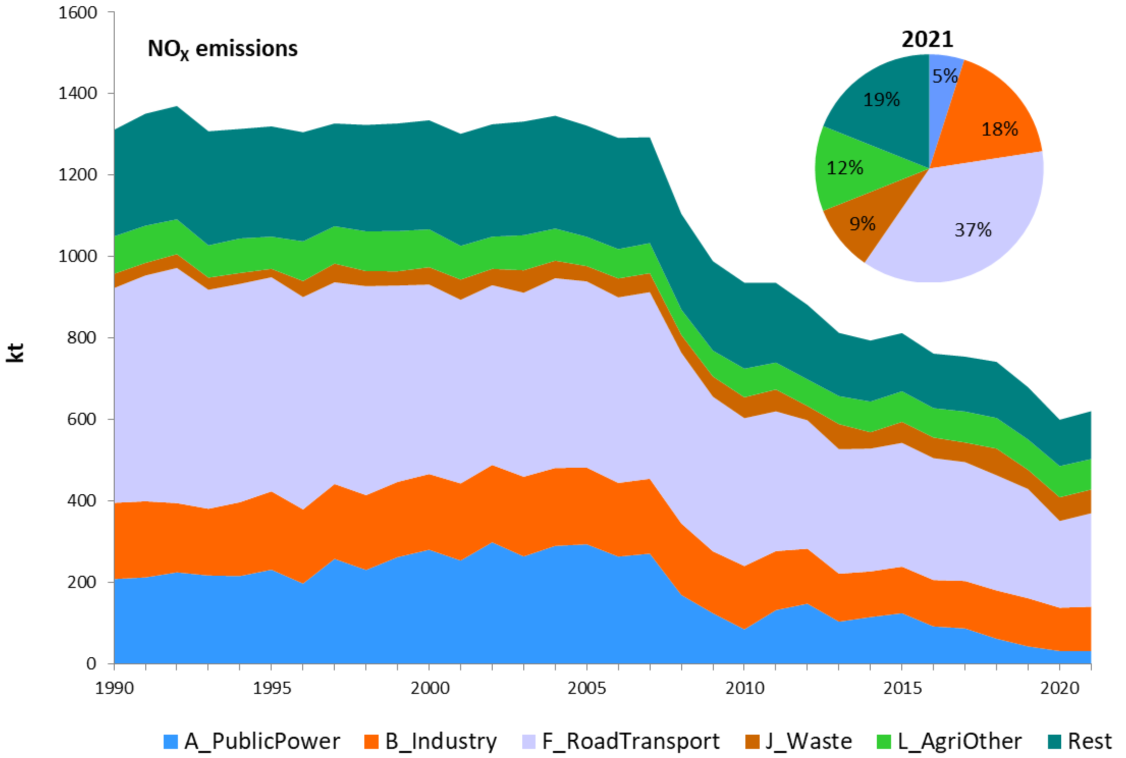


Figure 2.1.2 Evolution of NOx emissions by category and distribution in year 2021

Nitrogen Oxides emissions have clearly decreased since 1990 (-52.7%), with almost every sector showing emission reductions.

The most relevant quantitative NOx emission reductions affected F_RoadTransport, which dropped its emissions by -56.5% since 1990. This marked decline has been caused by the introduction of EURO standards in gasoline Passenger cars (1A3bi) since 1993 (Euro 1- 91/441/EEC) and in Heavy duty vehicles and buses (1A3biii) since 2000 (Euro III).

Also very relevant reductions are those from A_PublicPower (1A1a), which decreased by -85.2% since 1990. The reduction is driven by the progressive introduction of renewable energies, the introduction of abatement techniques in thermal power plants and the shift to combined cycle gas plants. For example, a drastic drop occurred in 2008, due to the closure of the main brown coal mine in Spain in 2007 and the necessary retrofitting in 2008 of the adjacent thermal plant.

Although the behaviour among the different industries varies, the reduction of NOx emissions from B_Industry by -41.6% in 2021 compared to 1990 is mainly due to the reduction by -54.3% in the Combustion in Non-metallic minerals industries (1A2f) and by -62.6% in the petroleum refining sector (1A1b). This drop is due to the progressive introduction of abatement techniques and the shift from solid and liquid fuels to natural gas.

On the other hand, NOx emission from C_OtherStationaryCombustion increased by 37.1% since 1990, reflecting the increase of fuel consumption in the Residential, Commercial and Institutional (RCI) sector.

The period with stronger reductions of total NOx emissions is between 2007 and 2009, due to the economic downturn in Spain. After this period, the reduction in NOx emissions continues with a lower slope, in a framework of economic recovery.

When comparing 2021 with 2020 emissions, the increase by 3.5% is mainly linked to the recovery in F_RoadTransport emissions (+7.8%) and B_Industry (+2.8%), related to the end of the mobility and economic activity restrictions that took place in 2020 due to the COVID-19 pandemic.

The emissions from electricity generation (A_PublicPower, 1A1a) decreased in 2021 by -1.8% with respect to 2020, in spite of the increase in total generation (+3.43%), due to an increase in the share of renewables in the Spanish energy pool[2], with increases in photovoltaic (+37.1%) and eolic (+10.2%).

2.1.2. Non-Methane Volatile Organic Compounds (NMVOC)

In 2021, the emissions of Non-Methane Volatile Organic Compounds (NMVOC) in Spain (excluding the Canary Islands) were estimated to be 549.4 kt.

NMVOC emissions in 2021 declined by -46.4% when compared to 1990, and decreased by -4.4% when compared to 2020.

The analysis of the GNFR aggregated sectors more relevant to NMVOC:

- Solvents (E_Solvents) was the largest contributing activity with 47.7% of the total NMVOC emissions, with Domestic solvent use (2D3a) as the main emitting sector, with 20.7% of the total of NMVOC in the Inventory, followed by Coating applications (2D3d) with 11% and Chemical products (2D3g) with 9.7% of the total NMVOC emissions.
- K_AgriLivestock had a share of 13.3% of the total NMVOC emissionsin 2021.
- B_Industry, including both process and combustion emissions, represented 10.3% of the total of the Inventory, from where the Food and beverages industry (2H2 NFR category) accounted for 3.7% of the total.
- F_RoadTransport, which was a large contributor in the past, in 2021 only accounted for 4.1% of the total NMVOC emissions.

[2] https://www.ree.es/es/balance-diario/nacional/2021/12/31

– Emissions from D Fugitive activities accounted for 4% of the total of NMVOC emissions.

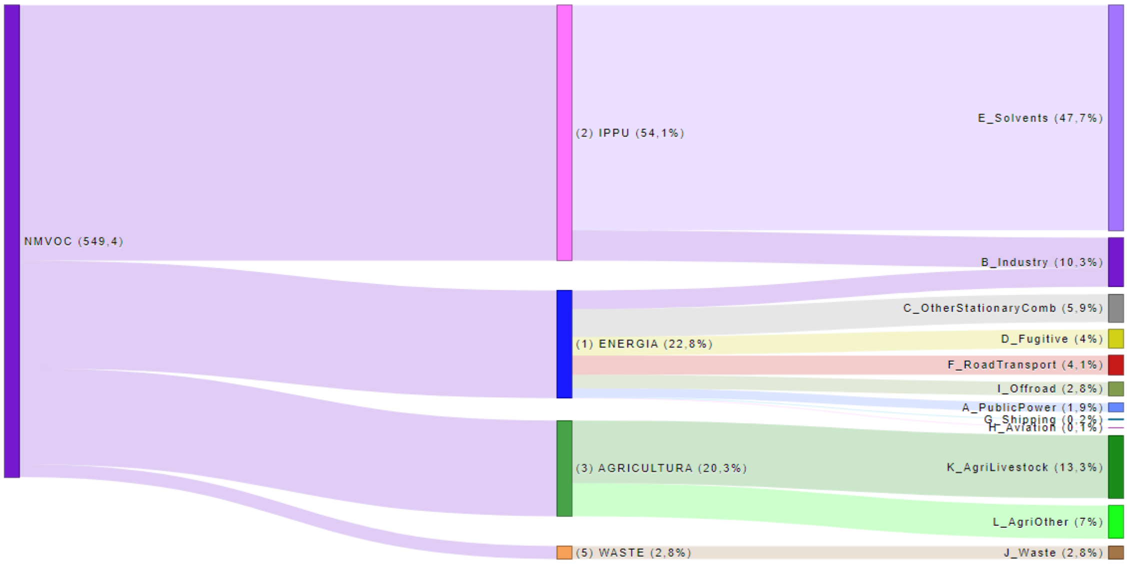


Figure 2.1.3 Distribution of NMVOC emissions in year 2021

Table 2.1.2 NMVOC emissions by sector (kt)

	1990	2005	2010	2019	2020	2021	Share 2021	2021/ 1990	2021/ 2020
A_PublicPower	0.8	2.0	2.1	8.4	8.9	10.3	1.9%	1251.6%	14.8%
B_Industry	54.6	63.5	50.3	60.7	54.9	56.8	10.3%	4.2%	3.6%
C_OtherStationaryComb	44.6	44.1	53.1	33.9	33.0	32.4	5.9%	-27.3%	-1.6%
D_Fugitive	43.2	28.9	24.5	25.1	20.8	21.8	4.0%	-49.6%	5.1%
E_Solvents	386.2	370.7	292.9	258.9	299.6	262.2	47.7%	-32.1%	-12.5%
F_RoadTransport	324.8	81.2	46.2	24.7	18.9	22.3	4.1%	-93.1%	17.9%
G_Shipping	2.5	2.0	1.2	1.2	0.8	0.9	0.2%	-62.3%	21.3%
H_Aviation	0.3	0.6	0.8	0.8	0.3	0.4	0.1%	48.3%	49.0%
I_Offroad	22.2	16.2	10.2	13.2	12.3	15.6	2.8%	-29.7%	27.0%
J_Waste	12.2	11.5	14.2	13.0	15.1	15.1	2.8%	23.9%	-0.1%
K_AgriLivestock	60.6	69.4	68.5	72.4	72.2	73.2	13.3%	20.9%	1.5%
L_AgriOther	73.7	38.9	37.0	38.2	38.2	38.4	7.0%	-47.9%	0.6%
Total (Canary Islands not included)	**1025.6**	**728.9**	**601.0**	**550.5**	**574.8**	**549.4**	**100.0%**	**-46.4%**	**-4.4%**

Detailed emission data of the Spanish Inventory are available from the MITECO-SEI website WebTable.

2.1.2.1. Trend assessment

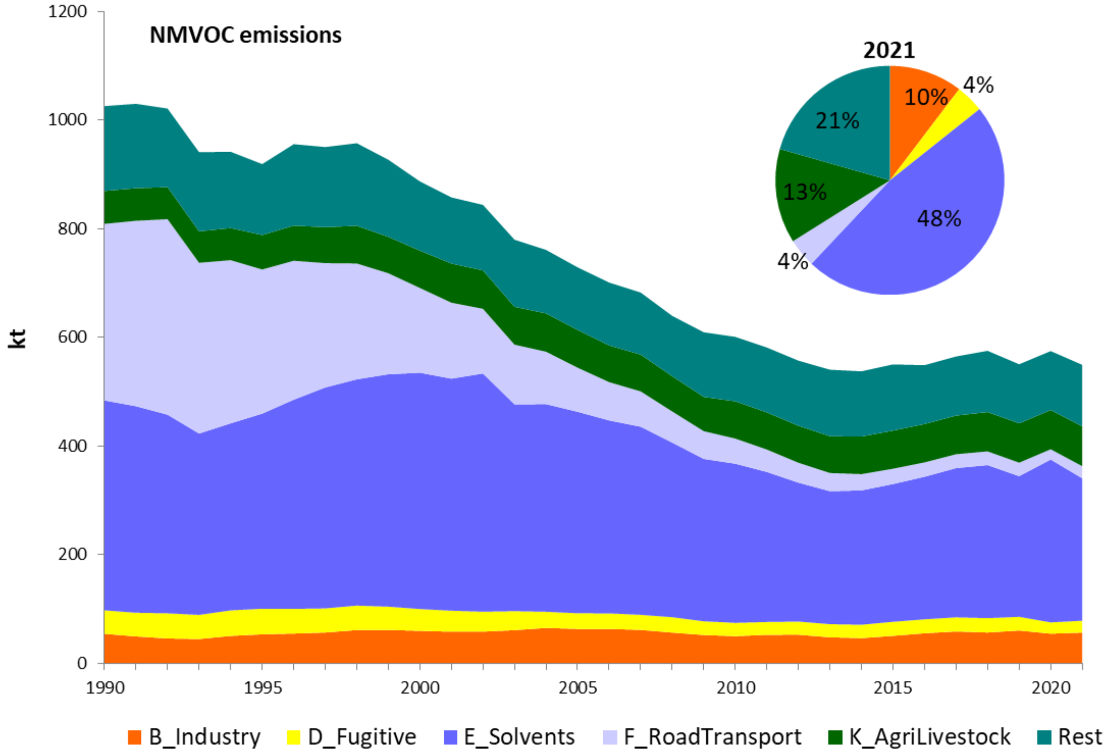


Figure 2.1.4 Evolution of NMVOC emissions by category and distribution in year 2021

The decrease in NMVOC emissions by -46.4% in 2021 with respect to 1990 is mainly related to reductions in F_RoadTransport emissions (-93.1%), secondarily to the drop of emissions under E_Solvents (-32.1%) and, to a lesser extent, to L_AgriOther (-47.9%).

Emissions from F_RoadTransport accounted for 31.7% of NMVOC emissions in 1990, and have been reduced during the time series, owing to the introduction of the EURO standards for road vehicles since 1996, and to the shift towards a diesel predominant car fleet in Spain. Between 1990 and 2021, NMVOC emissions from passenger cars (1A3bi) dropped by -95.4%. Besides, the introduction of techniques to reduce evaporation of gasoline, with the first technologies EURO (1 and 2) from 1992, together with a drop in gasoline consumption, reduced the NMVOC emissions from 1A3bv subcategory by -96%.

NMVOC emissions in 2021 for E_Solvents categories have decreased by -32.1% when compared to 1990 emissions. The drop since 2002 is a result of different regulations on paintings and painting installations (Royal Decree 117/2003 and Royal Decree 227/2006, transposition of Directives 1999/13 and 2004/42, respectively). These lead to a fall of emissions under Coating applications (2D3d) by -64.4% between 2002 and 2021. Also the economic downturn has also had a noticeable effect on the contraction of the activity data (consumption of paintings). The decreasing trend stopped by 2013, and from then a slight increasing trend in emissions is observed, with minor fluctuations.

NMVOC emissions under D_Fugitive dropped by -49.6% between 1990 and 2021. The reduction in emissions is mainly related to the Distribution of oil products (1B2av), due to the entry into force since 2000 of regulations on the distribution of oil products (RD 2102/1996, RD 1437/2002, RD 2102/1996 and RD 455/2012). The adoption of regulations relating to tanks, distribution of gasoline and gas recovery (Phase II), together with a drop in gasoline consumption, has resulted in a reduction of -81.8% in emissions of NMVOC in 1B2av sector compared to 1990.

When comparing 2021 and 2020 NMVOC emissions, the total decrease of -4.4% is due to the E_Solvents categories, that have decreased by -12.5%, mostly due to the decrease in 2D3a category (Domestic solvent use) and the lower use of hand sanitizers and other solvent-containing products that had a peak in 2020, due to the COVID-19 pandemic.

2.1.3. Sulphur Oxides (SO_2)

122.9 kt of sulphur dioxides (SO_2) were estimated as emitted in Spain (excluding the Canary Islands) in 2021.

SO_2 emissions in 2021 decreased by -94% compared to 1990 and showed a -3.7% decrease when compared to 2020.

The major GNFR aggregated sectors contributing to SO_2 emissions were:

- Industries (B_Industry) were the first contributing activity, accounting for 58.3% of emissions, with combustion in manufacturing industries and construction, namely Non-metallic minerals (1A2f) and Iron and steel (1A2a) being respectively 16.2% and 14% of the total of the inventory.
- Fugitive emissions (D_Fugitive), representing 17.4% of total SO_2 emissions, was the next contributing group of activities, with Fugitive emissions from oil refining and storage (1B2aiv) accounting for 15.4% of the total estimate.
- C_Other Stationary Combustion accounted for 14.4% of total emissions in 2021.
- Public power generation (A_PublicPower) which in the first years of the time series was the largest contributor, in 2021 accounted for 4.5% of total SO_2 emissions.
- G_Shipping (national navigation, NFR 1A3dii) accounted in 2021 for 2.3% of the total SO_2 emissions.

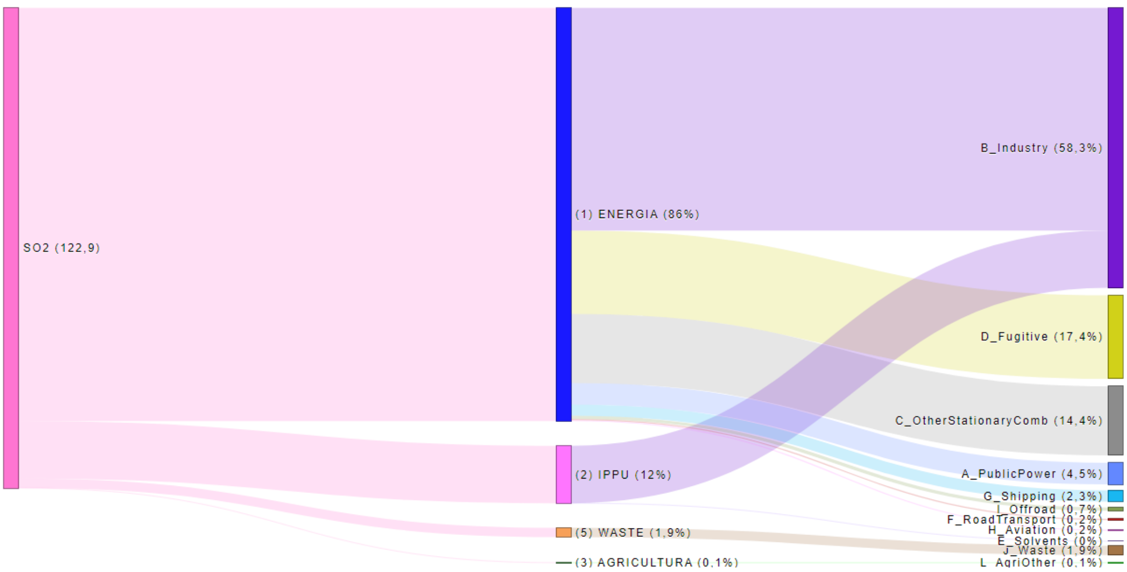


Figure 2.1.5 Distribution of SO_2 emissions in year 2021

Table 2.1.3 SO_2 emissions by sector (kt)

	1990	2005	2010	2019	2020	2021	Share 2021	2021/ 1990	2021/ 2020
A_PublicPower	1407.4	914.6	59.7	23.0	9.0	5.5	4.5%	-99.6%	-38.8%
B_Industry	427.3	195.9	124.8	71.1	73.0	71.6	58.3%	-83.2%	-1.9%
C_OtherStationaryComb	26.2	32.0	25.4	18.3	17.9	17.7	14.4%	-32.6%	-1.5%
D_Fugitive	63.1	39.6	23.0	23.7	21.5	21.4	17.4%	-66.2%	-0.6%
E_Solvents	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	-20.7%	-26.2%
F_RoadTransport	65.5	2.7	0.5	0.3	0.3	0.3	0.2%	-99.5%	7.5%
G_Shipping	34.1	8.9	3.3	11.2	2.4	2.9	2.3%	-91.6%	20.9%
H_Aviation	0.2	0.5	0.4	0.5	0.2	0.3	0.2%	44.4%	39.4%
I_Offroad	20.9	11.3	5.8	0.9	0.8	0.8	0.7%	-96.2%	3.9%
J_Waste	1.8	1.5	2.1	1.9	2.4	2.4	1.9%	29.6%	-0.1%
K_AgriLivestock	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	-	-
L_AgriOther	3.2	0.2	0.1	0.1	0.1	0.1	0.1%	-95.7%	0.0%
Total (Canary Islands not included)	**2049.6**	**1207.3**	**245.1**	**151.2**	**127.6**	**122.9**	**100.0%**	**-94.0%**	**-3.7%**

Detailed emission data of the Spanish Inventory are available from the MITECO-SEI website WebTable.

2.1.3.1. Trend assessment

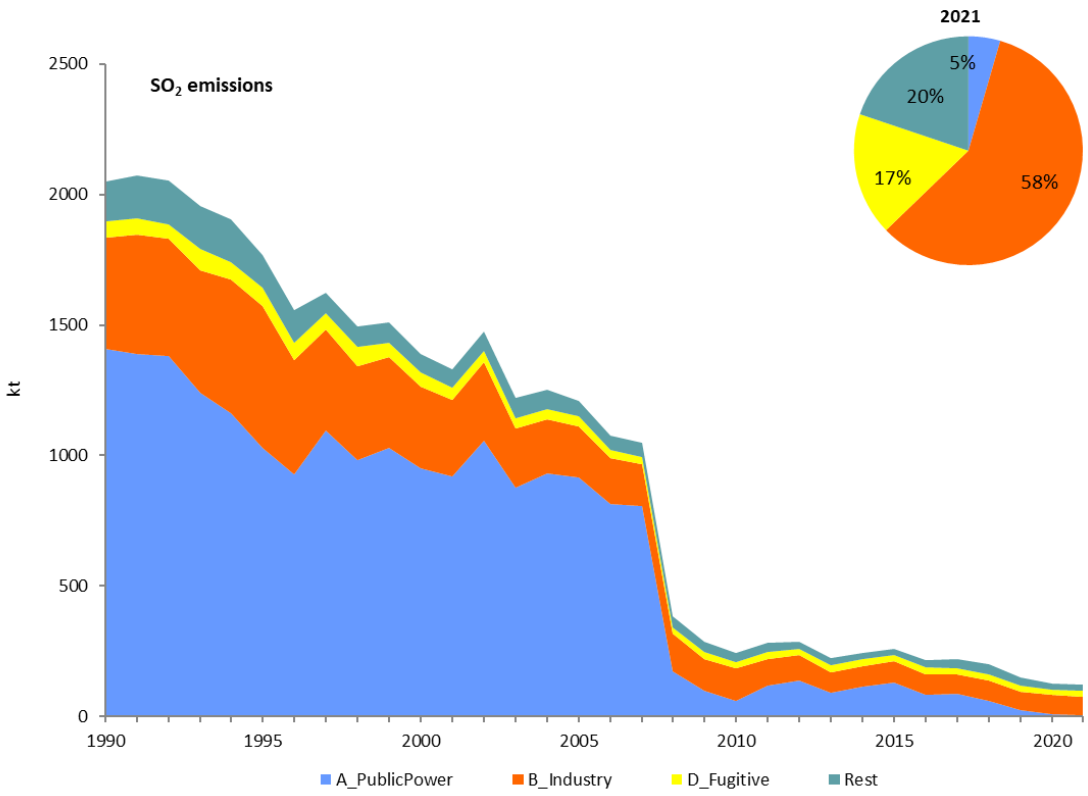


Figure 2.1.6 Evolution of SO_2 emissions by category and distribution in year 2021

Sulphur Oxides emissions in Spain have experienced a drastic drop (-94%) since 1990, due to the substantial reduction of SO_2 emissions in the main contributing activities:

- A_PublicPower (1A1a) has reduced SO_2 emissions by -99.6% since 1990. The reduction has been caused by the progressive introduction of desulphurization abatement techniques in thermal power plants and the shift from coal power plants to combined cycle gas plants. The sharp drop observed in 2008 was due to the closure of the main brown coal mine in Spain in 2007 and the necessary retrofitting in 2008 of the adjacent thermal plant.
- SO_2 emissions in B_Industry also decreased by 83.2% since 1990. This drop is mainly linked to reductions in Petroleum refining sector (1A1b) by 98.2%, followed by Combustion in the non-metallic minerals industry (1A2f) (-76.2%) and Stationary combustion in the chemical industry (1A2c) (-87.2%). Similarly to Public Power production, the reduction of SO_2 emissions from the Stationary combustion in industries is directly linked to the progressive introduction of desulphurization abatement techniques and the shift towards fuels with less sulphur content.
- D_Fugitive emissions have been reduced by -66.2%, in which fugitive emissions from refining and storage of oil (1B2aiv) and from oil/gas venting and flaring (1B2c) dropped by -51.7% and -89.7% respectively, linked to the aforementioned reduction observed in the Petroleum refining sector (1A1b).

Another driver in the SO_2 emissions' reduction since 1990 has been F_RoadTransport, whose emissions were almost completely removed (-99.5%) as a result of the reduction of the sulphur content in road fuels since 1994, due to the effect of the Directive 93/12/EEC relating to the sulphur content of certain liquid fuels.

The closure of the brown coal mine in 2007 accounts for a dramatic drop in emissions, but the total SO_2 emissions still showed a decrease of -68.1% between 2008 and 2021, due to the decline in the consumption of coal and solid fossil fuels with high sulphur content in most activity sectors.

When comparing the years 2021 and 2020, total SO_2 emissions showed a reduction of -3.7%, linked to decreases of -38.8% in A_PublicPower and -1-9% in B_industry emissions, in which the increase of renewables in the Spanish energy pool and the further reduction of coal consumption counterbalance the economic recovery that took place after the COVID pandemic.

2.1.4. Ammonia (NH_3)

In 2021, an estimate of 478.8 kt of ammonia (NH_3) were emitted in Spain (excluding the Canary Islands).

This means a decrease by -2.0% of the NH_3 emissions estimated for 2021, when compared to 1990, and also a decrease by -2.4%, when compared to 2020 estimates.

The major GNFR aggregated sectors contributing to NH_3 emissions were:

- Agricultural soil (L_AgriOther) was the largest contributing activity, with 50.2% of total ammonia emissions. In more detail, Animal manure applied to soils (3Da2a) was the largest emitter representing 26.4% of the total ammonia emissions of the inventory, followed by Inorganic N-fertilizers including urea application (3Da1) accounting for 15% and Urine and dung deposited by grazing animals (3Da3) accounting for 7.7% of total NH_3 emissions.

– Livestock (K_AgriLivestock) was the second contributing activity, accounting for 46.6% of the total ammonia emissions of the inventory, with Manure management-Swine (3B3) accounting for 16.8%, followed by Manure management-Non-dairy Cattle (3B1b) accounting for 7.5%. Categories Manure management-Dairy cattle (3B1a) represented 6.5% and Manure management-Broilers (3B4gii) represented 4.4% of NH_3 emissions.

– C_OtherStationaryComb and J_Waste were the next-largest contributing activities, representing 0.9% and 0.7% of the total NH_3 emissions of the Spanish Inventory.

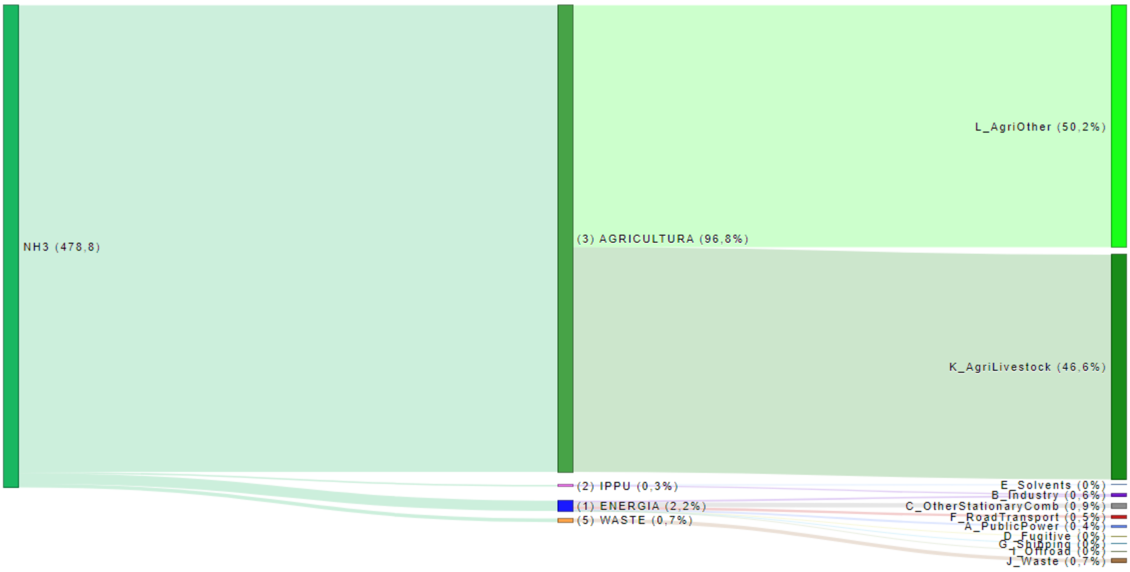


Figure 2.1.7 Distribution of NH_3 emissions in year 2021

Table 2.1.4 NH_3 emissions by sector (kt)

	1990	2005	2010	2019	2020	2021	Share 2021	2021/ 1990	2021/ 2020
A_PublicPower	0.0	0.1	0.2	1.3	1.6	1.9	0.4%	-	14.7%
B_Industry	5.2	4.4	4.0	3.4	3.0	3.0	0.6%	-42.8%	-1.8%
C_OtherStationaryComb	5.5	5.4	6.4	4.4	4.4	4.3	0.9%	-20.4%	-1.1%
D_Fugitive	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	-42.1%	36.0%
E_Solvents	0.1	0.4	0.3	0.3	0.2	0.2	0.0%	191.3%	-5.0%
F_RoadTransport	0.3	4.6	3.3	2.6	2.1	2.4	0.5%	618.6%	15.3%
G_Shipping	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	-60.7%	21.6%
H_Aviation	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	-	-
I_Offroad	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	25.4%	2.5%
J_Waste	8.6	5.5	2.6	3.4	3.5	3.5	0.7%	-59.0%	1.2%
K_AgriLivestock	201.3	234.0	204.2	219.5	222.6	223.1	46.6%	10.9%	0.2%
L_AgriOther	267.7	254.2	235.4	242.6	253.0	240.2	50.2%	-10.3%	-5.1%
Total (Canary Islands not included)	**488.7**	**508.7**	**456.4**	**477.7**	**490.6**	**478.8**	**100.0%**	**-2.0%**	**-2.4%**

Detailed emission data of the Spanish Inventory are available from the MITECO-SEI website WebTable.

2.1.4.1. Trend assessment

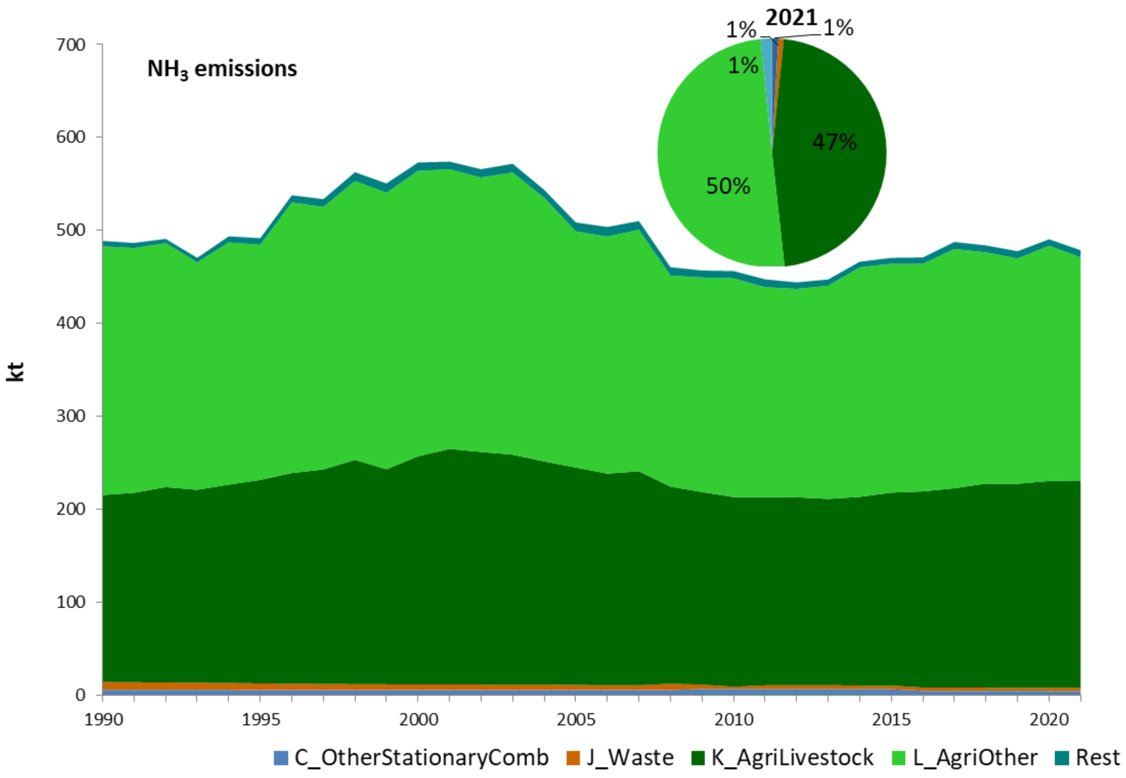


Figure 2.1.8 Evolution of NH_3 emissions by category and distribution in year 2021

The trend of Ammonia emissions is essentially ruled by the evolution of Agriculture activities, by far the largest contributing sector to these emissions.

Total NH_3 emissions in 2021 have decreased by -2% when compared to 1990 level. Even with no sharp variations in the time series, the declines are related to economic recession periods in Spain, and the increases to the growing number of livestock heads, mainly non-dairy cattle and white swine. The growing evolution of the livestock is also reflected in Soil fertilization activities under L_AgriOther, *via* the ammonia emissions derived from Animal manure applied to soils (3Da2a). Occasionally, drought episodies lead to decreases in emissions from inorganic N-fertilizers use (3Da1) (the fact that fertilization intensifies drought stress results in a decrease in the fertilizer market during poor rainfall periods).

The introduction of fertilization practices with measures for abatement of NH_3 emissions from 2004 onwards and the progressive introduction of abatement techniques in white swine manure management (3B3), improvements in animal feed formulations, as well as the enforcement of animal welfare legislation affecting laying hens since 2010 leads to decreases in emissions between 2005 and 2012. The last period of Ammonia emission evolution shows a slight upward trend, driven by increases in fertilizing activities (3Da1 and 3Da2a) manure management.

Total ammonia emissions decreased by -2.4% in 2021 with respect to 2020, mainly due to a decrease of -5.1% in L_AgriOther emissions, that come from N-containing fertilizers.

2.1.5. Fine Particulate Matter ($PM_{2.5}$)

In 2021, 135.0 kt of Fine Particulate Matter ($PM_{2.5}$: particles with an aerodynamic diameter equal to or less than 2.5 micrometres) were emitted in Spain (excluding the Canary Islands).

$PM_{2.5}$ emissions in 2021 decreased by -27.2% compared to 2000, which is the base year for particulate matter, and increased by 1.2% when compared to 2020.

The analysis of GNFR aggregated sectors contributing to $PM_{2.5}$ emissions is:

- Waste (J_Waste) was the largest contributing activity with 40.7% of total $PM_{2.5}$ emissions, with the Open burning of pruning remains (5C2) accounting for 39.6% of the total of 2021 emissions.
- Small Stationary Combustion (C_OtherStationaryComb) was the second contributor, accounting for 27.3% of the total, with Residential stationary combustion (1A4bi) representing 25.2% of the emissions' total of the Spanish Inventory.
- Industries (B_Industry) accounted for 12.4% of the total of fine particulate emissions.
- F_RoadTransport, a former important contributor, represented only 9.6% of the total $PM_{2.5}$ emissions in 2021.

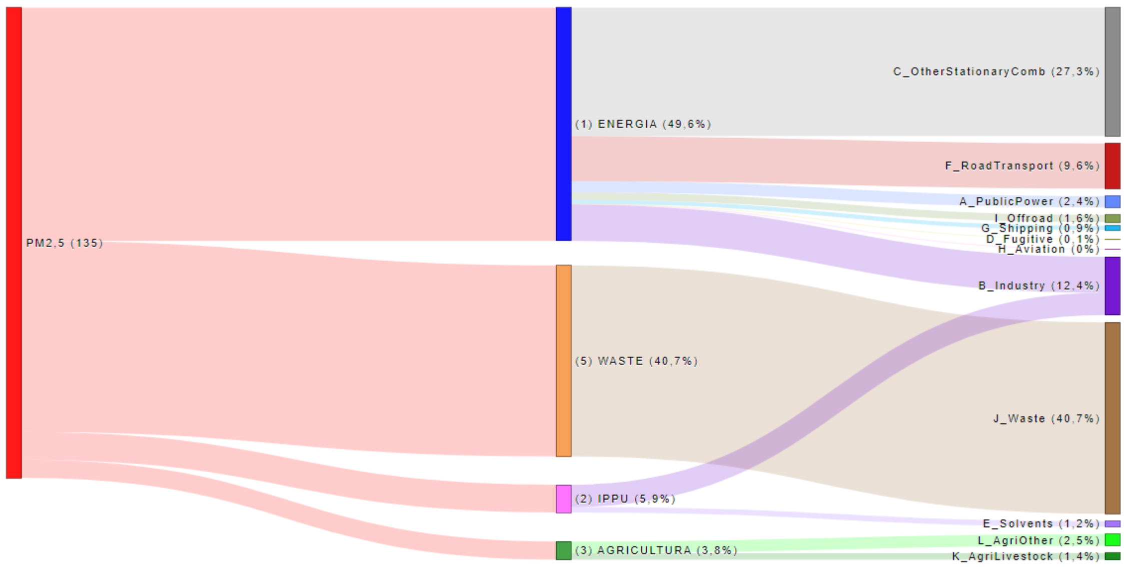


Figure 2.1.9 Distribution of $PM_{2.5}$ emissions in year 2021

Table 2.1.5 $PM_{2.5}$ emissions by sector (kt)

	2000	2005	2010	2019	2020	2021	Share 2021	2021/ 2000	2021/ 2020
A_PublicPower	10.1	9.8	2.4	2.9	3.0	3.2	2.4%	-67.7%	9.2%
B_Industry	20.6	22.6	15.3	17.0	16.5	16.7	12.4%	-18.7%	1.7%
C_OtherStationaryComb	52.3	53.9	61.3	39.0	37.6	36.9	27.3%	-29.5%	-1.9%
D_Fugitive	0.5	0.4	0.4	0.2	0.1	0.2	0.1%	-62.7%	33.0%
E_Solvents	0.7	3.0	2.3	2.1	1.7	1.6	1.2%	113.0%	-6.3%
F_RoadTransport	25.8	24.7	20.3	14.5	11.5	12.9	9.6%	-49.8%	12.8%
G_Shipping	1.1	0.9	0.7	1.7	1.0	1.2	0.9%	10.2%	21.2%

	2000	2005	2010	2019	2020	2021	Share 2021	2021/ 2000	2021/ 2020
H_Aviation	0.1	0.1	0.1	0.1	0.0	0.0	0.0%	-35.1%	49.2%
I_Offroad	9.8	8.3	5.3	2.4	2.1	2.1	1.6%	-78.2%	3.7%
J_Waste	41.2	36.5	48.3	44.8	54.9	54.9	40.7%	33.4%	0.1%
K_AgriLivestock	2.0	1.9	1.7	1.8	1.8	1.9	1.4%	-5.3%	2.5%
L_AgriOther	21.4	4.6	2.7	3.5	3.3	3.3	2.5%	-84.4%	0.0%
Total (Canary Islands not included)	**185.4**	**166.7**	**160.7**	**129.9**	**133.4**	**135.0**	**100.0%**	**-27.2%**	**1.2%**

Detailed emission data of the Spanish Inventory are available from the MITECO-SEI website WebTable.

2.1.5.1. Trend assessment

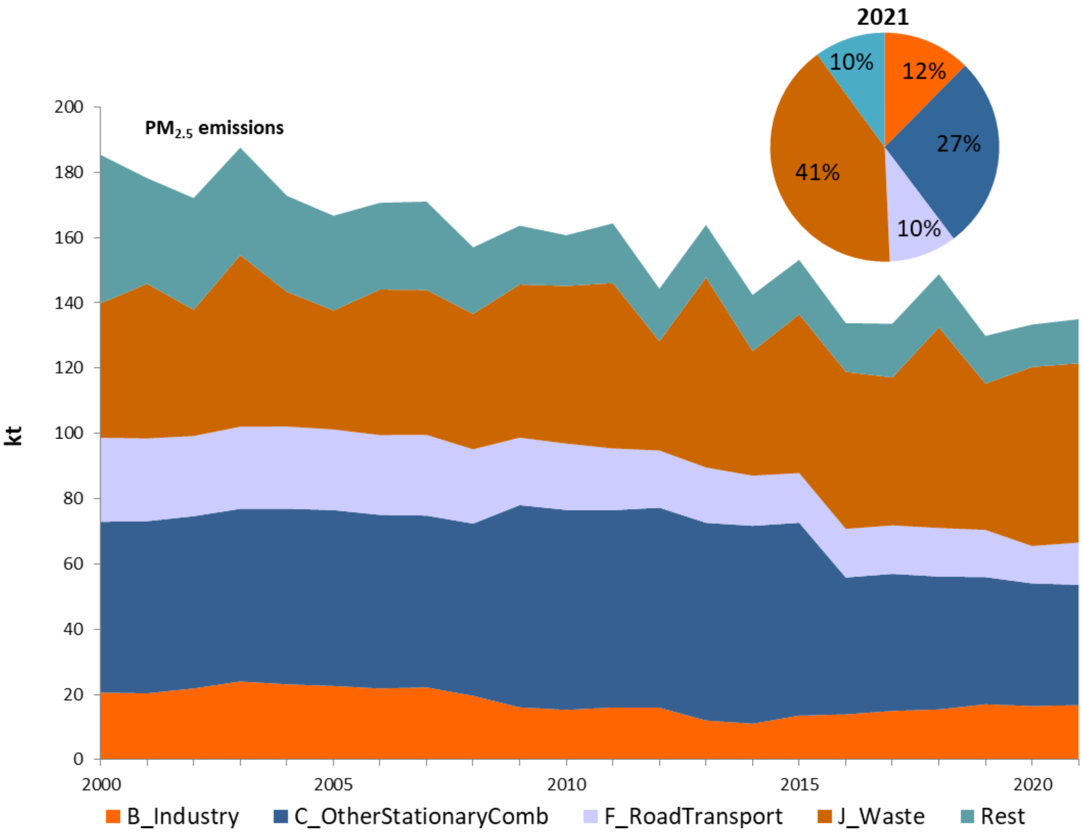


Figure 2.1.10 Evolution of $PM_{2.5}$ emissions by category and distribution in year 2021

Fine Particulate Matter ($PM_{2.5}$) emissions have decreased by -27,2% since 2000, even if the most contributing sector, J_Waste, shows an increase of 33.4% in $PM_{2.5}$ emissions since 2000.

The $PM_{2.5}$ emissions from F_RoadTransport have dropped by -49.8% since 2000, mostly driven by the introduction of EURO standards in Heavy duty vehicles and buses (1A3biii), which showed a reduction in their $PM_{2.5}$ emissions by -84.6% since 2000, and in passenger cars (1A3bi), which showed a reduction of $PM_{2.5}$ by -41.3% since 2000.

Since the year 2000, $PM_{2.5}$ emissions coming from C_OtherStationaryComb have decreased by -31.5%, caused by the abandonment of coal as fuel in the Residential stationary sector, and by the increase of use of pellets and advanced stoves and boilers.

The fine particulate emissions from A_PublicPower (1A1a) reduced its $PM_{2.5}$ emissions by -67.7% since 2000. B_Industry had a similar evolution and has decreased by -18.7% since 2000, mainly motivated by the shift from solid and liquid fuels to a more predominant gas consumption, and the installation of abatement techniques. L_AgriOther experienced a fall of -84.4% of its emissions, due to the abandonment of the practice of field burning (3F), restricted by forest fire prevention legislation and the conditionality of CAP (Common Agricultural Policy) payments.

Comparing 2021 with 2020, $PM_{2.5}$ emissions rose by 12.8% in F_RoadTransport category, after a decrease of -24.8% in 2020 compared to 2019, because of the mobility restrictions imposed by the COVID-19 pandemic.

2.1.6. Carbon Monoxide (CO)

In 2021, approximately 1,636.7 kt of carbon monoxide (CO) were emitted in Spain (excluding the Canary Islands).

CO emissions in 2021 decreased by -60.1% compared to 1990 and increased by 7.4% when compared to 2020.

The GNFR aggregated sectors which were the major contributors to CO emissions:

- J_Waste sector, with an increasing contribution that reached a 44.7% of the total CO emissions, was the main emitting sector in 2021, because of the 5C2 activity (Open burning of pruning remains).
- Industries (B_Industry) contributed with a 19.7% of CO total emissions, with Iron and steel process emissions (2C1), combustion in Iron and steel industries (1A2a) and Combustion in Non-metallic minerals (1A2f) accounting respectively for 5.6%, 5.2% and 3% of the total of the Spanish Inventory.
- Small Stationary Combustion (C_OtherStationaryComb) accounted for 15.6% of total CO emissions in 2021, with Residential sector (1A4bi) as the principal subsector, with 14.8% of total CO emissions.
- F_RoadTransport, which used to be the main contributor to CO emissions, in 2021 accounted for a 13% of the total.
- L_AgriOther activities have reduced their contribution to 1.1% of the total.

Table 2.1.6 CO emissions by sector (kt)

	1990	2005	2010	2019	2020	2021	Share 2021	2021/ 1990	2021/ 2020
A_PublicPower	6.6	15.4	14.2	24.2	26.2	29.2	1.8%	341.4%	11.5%
B_Industry	434.1	408.0	339.7	328.2	257.6	323.0	19.7%	-25.6%	25.4%
C_OtherStationaryComb	401.5	375.0	421.6	268.6	260.6	255.1	15.6%	-36.5%	-2.1%
D_Fugitive	2.7	2.6	2.2	2.0	1.6	1.9	0.1%	-29.2%	22.8%
E_Solvents	1.1	5.7	4.2	3.8	3.2	3.1	0.2%	188.7%	-5.1%

	1990	2005	2010	2019	2020	2021	Share 2021	2021/ 1990	2021/ 2020
F_RoadTransport	2088.0	626.2	380.8	236.7	174.2	212.9	13.0%	-89.8%	22.2%
G_Shipping	5.2	4.2	2.5	2.5	1.7	2.0	0.1%	-61.5%	20.9%
H_Aviation	2.9	5.6	5.6	6.2	2.4	3.2	0.2%	7.8%	34.0%
I_Offroad	59.2	49.4	35.8	50.7	48.1	57.5	3.5%	-2.7%	19.6%
J_Waste	437.5	472.1	644.1	591.1	730.8	730.8	44.7%	67.1%	0.0%
K_AgriLivestock	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	-	-
L_AgriOther	664.7	31.2	9.8	19.7	18.1	18.1	1.1%	-97.3%	0.0%
Total (Canary Islands not included)	**4103.6**	**1995.3**	**1860.5**	**1533.7**	**1524.5**	**1636.7**	100.0%	-60.1%	7.4%

Detailed emission data of the Spanish Inventory are available from the MITECO-SEI website WebTable.

2.1.6.1. Trend assessment

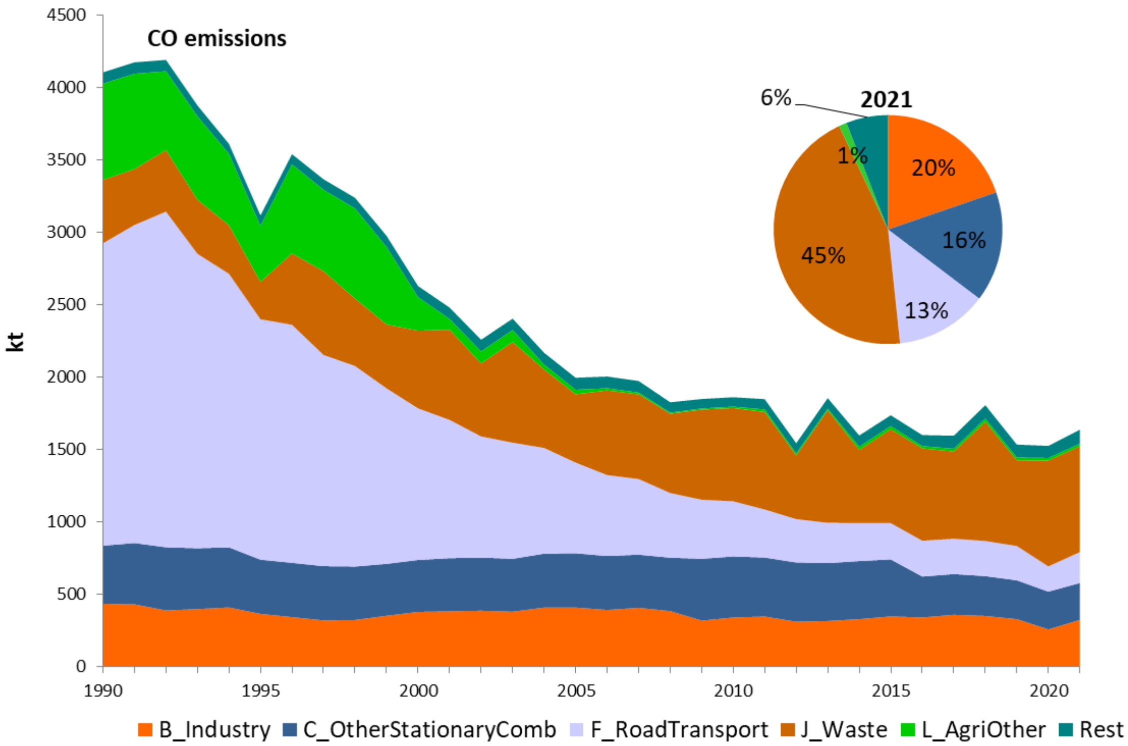


Figure 2.1.11 Evolution of CO emissions by category and distribution in year 2021

Carbon Monoxide emissions have decreased by -60.1% since 1990, this drop being essentially driven by the reductions in F_RoadTransport which dropped by -89.8% along the time series. Reductions were ruled by the introduction of EURO standards, that since 1993 (EURO-1-91/441/EEC) resulted in a global reduction of CO emissions from passenger cars (1A3bi) (-94.1% in 2021 with respect to 1990).

Particular mention deserves the CO emissions from L_AgriOther, which drastically decreased as from 2000, due to the abandonment of the practice of field burning (3F), restricted by forest fire prevention legislation and the conditionality of CAP (Common Agricultural Policy) payments (-97.3% reduction with respect to 1990).

Regarding CO emissions in C_OtherStationaryComb, a decrease can be observed (-36.5% reduction since 1990). On the contrary, J_Waste sector has increased its emissions by 67.1% since 1990.

2.1.7. Lead (Pb)

In year 2021, some 100.7 t of lead (Pb) were emitted in Spain (excluding the Canary Islands).

Pb emissions in 2021 decreased by -96.8% compared to 1990 but increased by 15.2%, when compared to year 2020.

The major GNFR aggregated sector contributing to Pb emissions was Industries (B_Industry), accounting for 53.6% of total Pb emissions, with Iron and steel production (2C1) with a 32.8% of the total of emissions, Glass production emissions (2A3) with 8.5%, and Combustion in Iron and steel (1A2a) with 7.7%.

F_RoadTransport was the second contributing activity, accounting for 31.8% of lead emissions in 2021, followed by J_Waste with a 10.1% of the total of the Inventory.

Table 2.1.7 Pb emissions by sector (t)

	1990	2005	2010	2019	2020	2021	Share 2021	2021/ 1990	2021/ 2020
A_PublicPower	2.9	4.4	1.6	0.8	0.5	0.4	0.4%	-84.9%	-19.9%
B_Industry	81.3	65.2	60.7	54.1	44.2	53.9	53.6%	-33.7%	22.0%
C_OtherStationaryComb	5.9	5.3	5.3	3.6	3.4	3.4	3.3%	-42.5%	-1.8%
D_Fugitive	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	2.7%	10.5%
E_Solvents	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	-20.7%	-26.2%
F_RoadTransport	3081.7	60.9	53.5	35.0	28.5	32.0	31.8%	-99.0%	12.4%
G_Shipping	0.2	0.1	0.1	0.1	0.1	0.1	0.1%	-57.8%	21.4%
H_Aviation	0.7	0.6	0.5	0.3	0.3	0.3	0.3%	-54.2%	22.5%
I_Offroad	0.8	0.3	0.2	0.3	0.3	0.4	0.4%	-49.3%	30.9%
J_Waste	5.5	7.0	10.0	8.6	10.1	10.1	10.1%	85.4%	0.0%
K_AgriLivestock	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	-	-
L_AgriOther	0.6	0.1	0.0	0.0	0.0	0.0	0.0%	-95.0%	0.0%
Total (Canary Islands not included)	**3179.4**	**143.8**	**131.9**	**102.8**	**87.4**	**100.7**	**100.0%**	**-96.8%**	**15.2%**

Detailed emission data of the Spanish Inventory are available from the MITECO-SEI website WebTable.

2.1.7.1. Trend assessment

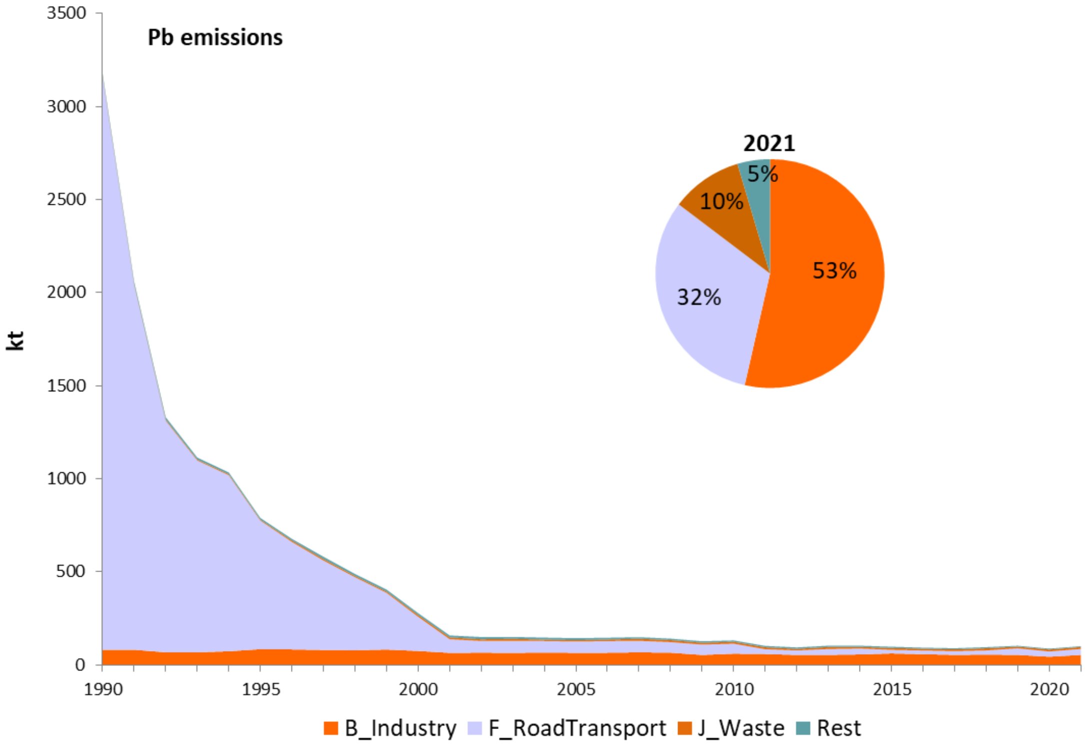


Figure 2.1.12 Evolution of Pb emissions by category and distribution in year 2021

The trend of Pb emissions in Spain is driven by the paramount decrease of emissions from F_RoadTransport (-99%) since 1990. This is due to the introduction of non-leaded petrol since 1989 and the ban of supply of leaded petrol in 2000 (Directive 98/70/CE). The increased by 15.2% in Pb emissions in 2021 when compared to year 2020 is due to increases of 22% in B_Industry and of 12.4% in F_RoadTransport, caused by the end of the restrictions in mobility and activity during the COVID pandemic.

2.1.8. Cadmium (Cd)

In 2021, approximately 6.8 t of Cadmium (Cd) were emitted in Spain (excluding the Canary Islands).

Cd emissions in 2021 decreased by -74% compared to 1990 but increased by 7.2%., when compared to the previous year.

The major GNFR aggregated sector contributing to Cd emissions was B_Industry, accounting for 43% of total Cd emissions, with Iron and steel production (2C1) accounting for 20% of the estimated total.

J_Waste and C_OtherStationaryComb were the next largest contributing activities, representing 23% and 16% of Cd total emissions, respectively.

Public Power generation (A_PublicPower) represented 5.3% of total Cd emissions in 2021.

Table 2.1.8 Cd emissions by sector (t)

	1990	2005	2010	2019	2020	2021	Share 2021	2021/ 1990	2021/ 2020
A_PublicPower	1.2	2.1	0.5	0.3	0.2	0.4	5.3%	-70.5%	75.5%
B_Industry	17.5	5.7	3.3	3.1	2.7	2.9	43.0%	-83.2%	10.4%
C_OtherStationaryComb	1.2	1.2	1.4	1.1	1.1	1.1	16.0%	-5.9%	0.6%
D_Fugitive	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	2.7%	10.5%
E_Solvents	0.1	0.6	0.4	0.4	0.3	0.3	4.4%	191.3%	-5.0%
F_RoadTransport	0.1	0.3	0.3	0.3	0.2	0.3	4.1%	88.8%	14.4%
G_Shipping	0.0	0.0	0.0	0.0	0.0	0.0	0.1%	-54.0%	21.3%
H_Aviation	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	43.2%	39.3%
I_Offroad	0.0	0.0	0.0	0.0	0.0	0.0	0.6%	9.7%	2.7%
J_Waste	0.8	1.2	1.7	1.4	1.6	1.6	23.0%	105.6%	0.0%
K_AgriLivestock	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	-	-
L_AgriOther	5.3	0.4	0.1	0.3	0.2	0.2	3.5%	-95.5%	0.0%
Total (Canary Islands not included)	**26.3**	**11.5**	**7.8**	**6.8**	**6.4**	**6.8**	**100.0%**	**-74.0%**	**7.2%**

Detailed emission data of the Spanish Inventory are available from the MITECO-SEI website WebTable.

2.1.8.1. Trend assessment

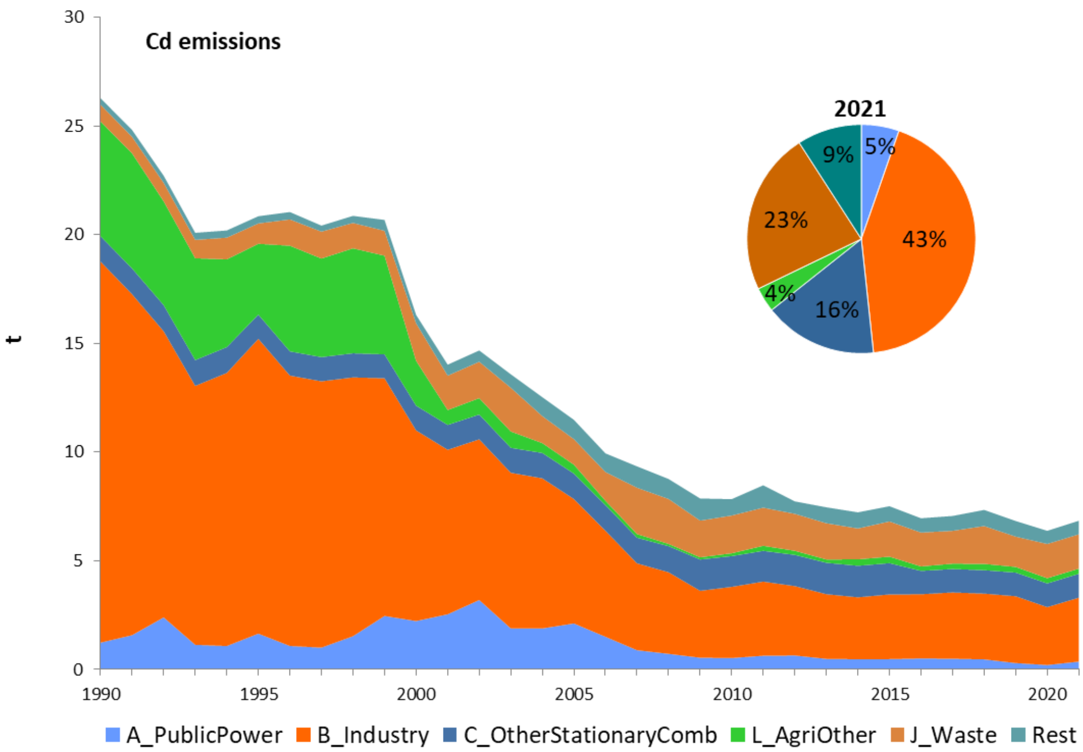


Figure 2.1.13 Evolution of Cd emissions by category and distribution in year 2021

The trend of Cd emissions is basically ruled by the decrease of emissions from B_Industry (-83.2% along the whole time series), and particularly in Combustion Non-metallic minerals (1A2f). Emissions in this sub-activity have been reduced by 99.4%, due to the introduction of abatement techniques in combustion facilities and the decline of coal consumption. A drastic reduction (-95.5%) is also observed in L_AgriOther, specifically in Field burning (3F), linked to the implemented legal restrictions of this practice by forest fire preventive legislation and the conditionality of CAP (Common Agricultural Policy) payments.

When comparing 2021 with 2020, most sectors show increases in Cd emissions, mostly in A_PublicPower (75.5%) and B_Industry (10.4%), owing to the recovery of industrial and economic activity after the COVID pandemic.

2.1.9. Mercury (Hg)

In 2021, approximately 2.9 t of Mercury were emitted in Spain (excluding the Canary Islands).

Mercury emissions in 2021 showed a decrease of -71.6% when compared to 1990 and a litht increase of 1.1% when compared to 2020.

These are the major GNFR aggregated sectors contributing to Hg emissions:

- Industries (B_Industry), as the first contributing activity, accounting for 61.4% of total Hg emissions, with Iron and steel production (2C1) accounting for 25.2% of the total of emissions. Combustion in Non-metallic minerals manufacturing industries (1A2f) stands for 14% of the total and Zinc production (2C6) for 11.4%.
- J_Waste accounted for 13.8% of the total of the inventory in 2021.
- (A_PublicPower), namely Public electricity and heat production (1A1a) represented a 9.7% of total Hg emissions and.

Table 2.1.9 Hg emissions by sector (t)

	1990	2005	2010	2019	2020	2021	Share 2021	2021/ 1990	2021/ 2020
A_PublicPower	3.4	3.5	1.2	0.6	0.4	0.3	9.7%	-91.6%	-25.7%
B_Industry	4.7	3.0	2.3	1.7	1.7	1.8	61.4%	-61.5%	8.4%
C_OtherStationaryComb	0.2	0.2	0.2	0.1	0.1	0.1	4.5%	-24.2%	-2.8%
D_Fugitive	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	2.7%	10.5%
E_Solvents	0.2	0.2	0.2	0.1	0.1	0.1	3.5%	-50.0%	0.0%
F_RoadTransport	0.1	0.2	0.2	0.2	0.1	0.1	5.0%	35.4%	14.4%
G_Shipping	0.0	0.0	0.0	0.0	0.0	0.0	0.4%	-63.7%	21.8%
H_Aviation	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	43.3%	39.3%
I_Offroad	0.0	0.0	0.0	0.0	0.0	0.0	0.3%	-56.0%	1.3%
J_Waste	0.7	0.2	0.3	0.4	0.4	0.4	13.8%	-45.3%	-6.3%
K_AgriLivestock	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	-	-
L_AgriOther	1.0	0.1	0.0	0.0	0.0	0.0	1.3%	-96.3%	0.0%
Total (Canary Islands not included)	**10.4**	**7.4**	**4.3**	**3.2**	**2.9**	**2.9**	**100.0%**	**-71.6%**	**1.1%**

Detailed emission data of the Spanish Inventory are available from the MITECO-SEI website WebTable.

2.1.9.1. Trend assessment

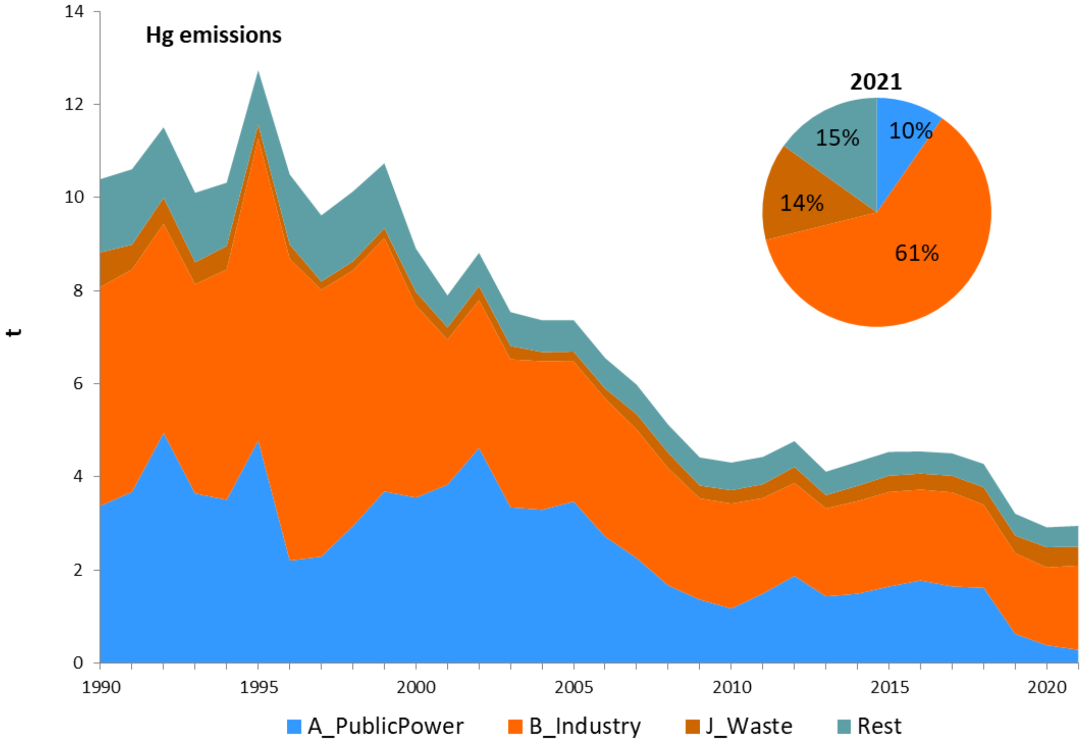


Figure 2.1.14 Evolution of Hg emissions by category and distribution in year 2021

The trend of Hg emissions in Spain is mainly led by the decrease of emissions from A_PublicPower (-91.6%) and B_Industry (-61.5%), when comparing 2021 with 1990 emissions. The reduction in the public electricity production sector has been caused by the shift from coal power plants to combined cycle gas plants and the implementation of abatement techniques in thermal power plants. With respect to industry, the Chlorine production using mercury technologies (2B10a), which accounted for 18.1% of total Hg emissions in 1990, halted its emissions in 2018 pursuant the Implementing Decision 2013/732/EU adopted under the Directive 2010/75/EU on industrial emissions, which prohibits the use of mercury as a cathode in the chlor-alkali industry. Additionally, Stationary Combustion in Non-metallic mineral industries (1A2f), which accounted for 14.3% of total Hg emissions in 1990, reduced its emissions by -72.8% in 2020, with respect to 1990.

The Hg emissions in 2021 in B_Industry sectors increased by 8.4% with respect to 2020, again due to the recovery of industrial activity after the COVID pandemic.

2.1.10. Dioxins and Furans (PCDD/PCDF)

In 2021, approximately 477 g I-TEQ of polychlorinated dibenzo-*p*-dioxins and dibenzofurans (PCDD/PCDF, dioxins and furans) were emitted in Spain (excluding the Canary Islands).

Such dioxins and furans emissions in 2021 decreased by -17.7% when compared to 1990, and increased by 3.4%, compared to 2020 emissions.

The major GNFR aggregated sector contributing to PCDD/PCDF emissions was J_Waste, which accounted for 73.4% of the total emissions of the Spanish inventory in 2021, in which sewage sludge incineration (5C1biv) open burning of pruning residues (5C2) accounted each for 46.1% and 24.3% of the total of the Spanish Inventory.

Industries (B_Industry) represented 15.8% of PCDD/PCDF total emissions, with Iron and steel production (2C1) and Aluminium production (2C3) industries respectively accounting for 11.2% and 1.6% of the total PCDD/PCDF emissions in 2021.

Small Stationary Combustion (C_OtherStationaryComb) was the next-largest contributing activity, accounting for 8.1% of the total of emissions in 2021, originated from the stationary combustion of biomass.

Table 2.1.10 PCDD/PCDF emissions by sector (g i-TEQ)

	1990	2005	2010	2019	2020	2021	Share 2021	2021/ 1990	2021/ 2020
A_PublicPower	133.8	4.4	1.3	1.9	1.5	1.9	0.4%	-98.6%	25.2%
B_Industry	88.1	88.3	83.4	76.5	60.7	75.3	15.8%	-14.6%	24.0%
C_OtherStationaryComb	60.6	57.6	65.1	41.1	39.6	38.8	8.1%	-36.1%	-2.2%
D_Fugitive	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	37.9%	20.8%
E_Solvents	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	191.3%	-5.0%
F_RoadTransport	5.2	18.0	18.7	12.3	9.6	10.7	2.2%	107.4%	11.2%
G_Shipping	0.3	0.1	0.1	0.2	0.1	0.1	0.0%	-47.3%	21.0%
H_Aviation	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	-	-
I_Offroad	0.1	0.1	0.1	0.1	0.0	0.0	0.0%	-50.4%	0.2%
J_Waste	286.8	283.6	408.4	321.0	349.6	350.1	73.4%	22.1%	0.1%
K_AgriLivestock	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	-	-
L_AgriOther	4.6	0.2	0.1	0.1	0.1	0.1	0.0%	-97.1%	0.0%
Total (Canary Islands not included)	**579.6**	**452.4**	**577.1**	**453.2**	**461.4**	**477.0**	**100.0%**	**-17.7%**	**3.4%**

Detailed emission data of the Spanish Inventory are available from the MITECO-SEI website WebTable.

2.1.10.1. Trend assessment

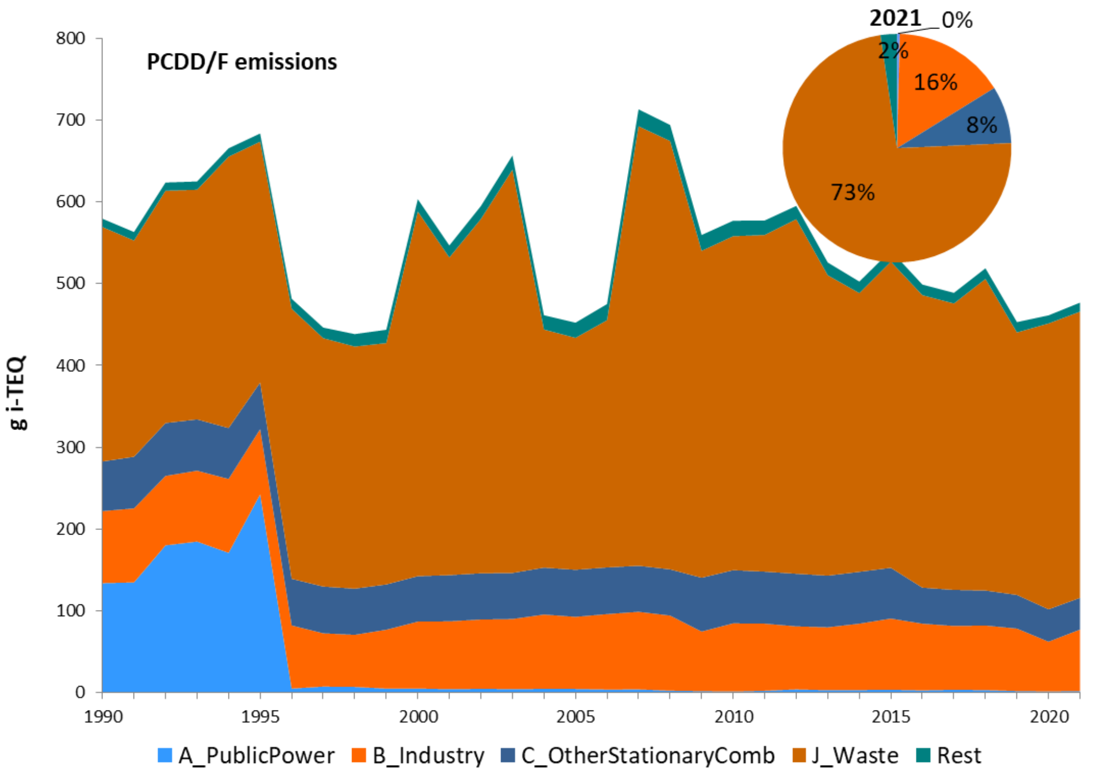


Figure 2.1.15 Evolution of PCDD/PCDF emissions by category and distribution in year 2021

Along the studied series, the trend of PCDD/PCDF emissions reflects the reduction of PCDD/PCDF emissions from the activities A_PublicPower (-98.6% decrease since 1990, linked to the emission levels set by legislation in sector 1A1a), C_OtherStationaryComb (-36.1%) and B_Industry (-14.6%). J_Waste is the main contributor, with a growing (+22.1% in 2021 with respect to 1990) but erratic trend. This is explained by the different nature of the activities that contribute to PCDD/PCDF emissions. In the first years of the series, there is a decrease as from 2001 of emissions from incineration of municipal waste (5C1a) and clinical waste incineration (5C1biii), due to the compliance of waste incineration facilities to the limit emission levels set by legislation, and in the latter years to the introduction of energy recovery technologies, that result in these activities being reported under A_PublicPower, and. The remaining activities most contributing to dioxins and furans emissions (sewage sludge incineration, 5C1biv and open burning of pruning residues, 5C2) are quite erratic in their trends.

2.1.11. Polycyclic Aromatic Hydrocarbons (PAHs)

In 2021, approximately 36.4 t of polycyclic aromatic hydrocarbons (1-4 total PAHs: sum of benzo(*a*)pyrene, benzo(*b*)fluoranthene, benzo(*k*)fluoranthene, and indeno(*1,2,3-cd*)pyrene) were emitted in Spain (excluding the Canary Islands).

The total PAHs emissions in 2021 decreased by -63.6% when compared to 1990, and increased by 4.5%, when compared to 2020.

The major GNFR aggregated sectors contributing to PAHs emissions in 2020 were C_OtherStationaryComb, representing a 55.7% of the total of emissions, and Industries (B_Industry) which accounted for 29.8% of total PAHs emissions in 2021.

Table 2.1.11 PAHs emissions by sector (t)

	1990	2005	2010	2019	2020	2021	Share 2021	2021/ 1990	2021/ 2020
A_PublicPower	0.0	0.1	0.1	0.9	1.0	1.0	2.7%	2054%	2.8%
B_Industry	16.6	17.3	15.1	10.8	9.2	10.8	29.8%	-34.9%	17.6%
C_OtherStationaryComb	38.1	34.0	36.2	22.0	20.9	20.3	55.7%	-46.8%	-3.0%
D_Fugitive	1.5	1.2	0.9	0.5	0.2	0.5	1.4%	-65.4%	111.0%
E_Solvents	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	120.2%	-4.7%
F_RoadTransport	0.9	2.2	2.3	2.4	2.0	2.2	6.1%	151.7%	12.7%
G_Shipping	0.0	0.0	0.0	0.0	0.0	0.0	0.1%	-50.3%	21.1%
H_Aviation	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	48.9%	49.5%
I_Offroad	0.4	0.5	0.4	0.4	0.4	0.4	1.2%	22.7%	2.8%
J_Waste	0.3	0.3	0.4	0.4	0.5	0.5	1.3%	69.1%	0.0%
K_AgriLivestock	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	-	-
L_AgriOther	42.1	1.1	0.3	0.7	0.6	0.6	1.7%	-98.5%	0.0%
Total (Canary Islands not included)	**99.9**	**56.7**	**56.0**	**38.2**	**34.8**	**36.4**	**100.0%**	**-63.6%**	**4.5%**

Detailed emission data of the Spanish Inventory are available from the MITECO-SEI website WebTable.

2.1.11.1. Trend assessment

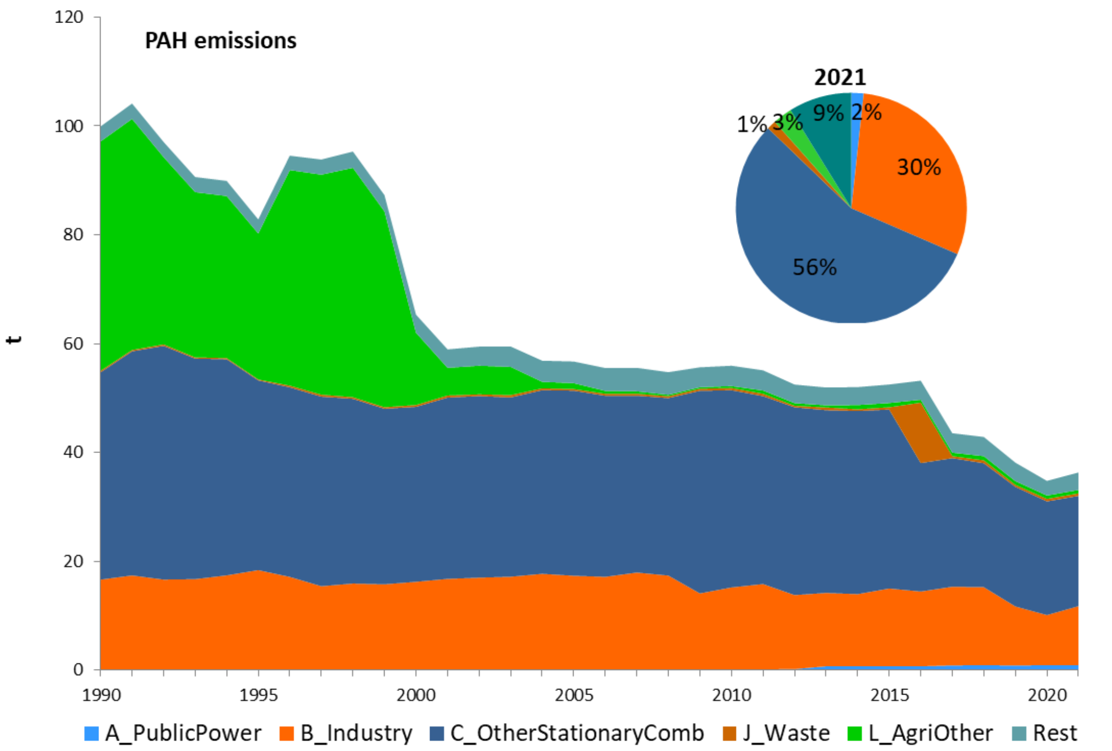


Figure 2.1.16 Evolution of PAHs emissions by category and distribution in year 2021

The trend of global PAHs emissions between 1990 and 2021 (decrease of -64%) is essentially ruled by the behaviour of emissions from L_AgriOther sector, that experiences a sharp decrease as from 2000, due to the abandonment of the practice of field burning (3F), restricted by forest fire prevention legislation and conditionality of CAP payments.

In the Small Stationary Combustion (C_OtherStationaryComb) category, there is a decrease of -47% in PAH emissions in 2021 when compared to 1990, in which predominates the declining use of coal over the increasing use of biomass (PAH emission factors for combustion of coal in small and uncontrolled combustion devices are higher than those of biomass).

B_Industry sectors show a decrease of -35% in PAH emissions between 1990 and 2021, owing to the decreasing use of coal as a fuel.

Although not relevant in the total amounts, the A_PublicPower sector shows an enormous increase in PAH emissions, due to the use of biomass, which was almost residual at the begining of the time series.

In 2016 there is an uptick regarding the emissions of PAHs under J_Waste, linked to an accidental tyre fire reported under Other waste (5E), that therefore can be considered as a singularity in the time series.

2.1.12. Polychlorinated biphenyls (PCBs)

In 2021, approximately 451 t of polychlorinated biphenyls were emitted in Spain (excluding the Canary Islands).

The PCBs emissions in 2021 decreased by -79.4% when compared to 1990, and slightly increased by 1.7%, when compared to 2020.

As can be seen in he table below, the paramount GNFR aggregated sector contributing to PCBs emissions is Industries (B_Industry) which accounted for 99.2% of total PCBs emissions in 2021, and 99.8% in 1990.

Table 2.1.12 PCBs emissions by sector (t)

	1990	2005	2010	2019	2020	2021	Share 2021	2021/ 1990	2021/ 2020
A_PublicPower	0.2	0.0	0.0	0.0	0.0	0.1	0.0%	-67.3%	31.7%
B_Industry	2180.1	1438.1	719.0	483.8	439.9	447.3	99.2%	-79.5%	1.7%
C_OtherStationaryComb	2.9	2.1	1.9	1.1	1.0	0.9	0.2%	-68.8%	-11.8%
D_Fugitive	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	-	-
E_Solvents	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	-	-
F_RoadTransport	1.4	3.8	3.9	2.5	2.0	2.2	0.5%	59.8%	11.9%
G_Shipping	0.2	0.1	0.1	0.2	0.1	0.1	0.0%	-34.2%	20.6%
H_Aviation	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	-	-
I_Offroad	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	-53.1%	0.0%
J_Waste	0.5	0.2	0.3	0.3	0.3	0.3	0.1%	-37.3%	-2.5%
K_AgriLivestock	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	-	-
L_AgriOther	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	-	-
Total (Canary Islands not included)	**2185.3**	**1444.3**	**725.2**	**488.0**	**443.4**	**451.0**	**100.0%**	**-79.4%**	**1.7%**

Detailed emission data of the Spanish Inventory are available from the MITECO-SEI website WebTable.

2.1.12.1. Trend assessment

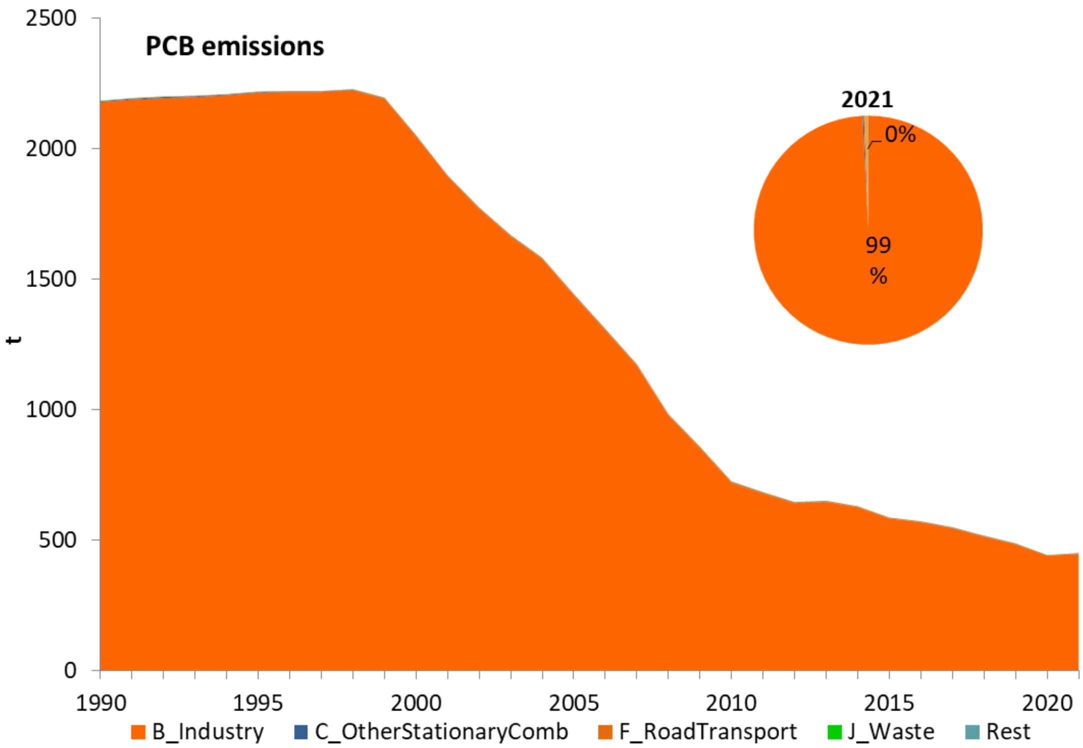


Figure 2.1.17 Evolution of PCBs emissions by category and distribution in year 2021

The trend of global PAHs emissions between 1990 and 2021 (decrease of -79%) is essentially ruled by the behaviour of emissions from B_Industry sector, namely by the 2K category (use of POPs in electrical equipment), which decreased its emissions by -81% between 1990 and 2021, due to the enforcement of Directive 96/59/EC on the disposal of polychlorinated biphenyls and polychlorinated terphenyls (PCB/PCT) and Regulation (EC) 850/2004 on persistent organic pollutants.

2.2. Analysis by activity category

The latest estimates of the emissions by major NFR activity category, as well as the trends in these emissions along the studied time series (1990-2021) are analysed and discussed in this section.

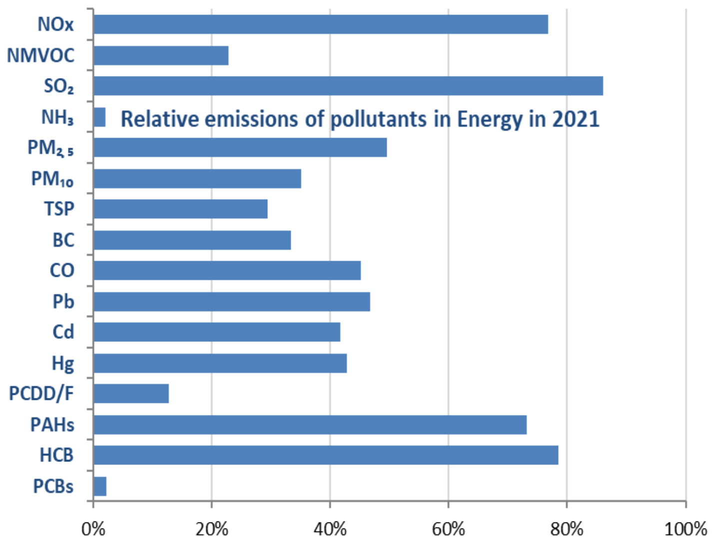
The considered activity categories are:

- Energy (NFR 1A, 1B)
- Industrial Processes and Product Use, IPPU (NFR 2)
- Agriculture (NFR 3)
- Waste (NFR 5)

Each of these activity categories is covered in detail in the following chapters.

2.2.1. Energy (NFR 1)

Energy emissions stand out for their relative weight with respect of the total of the Inventory for most pollutants, especially with respect to SO_2, HCB, PAHs, and NOx.



Emissions 2021		INV Total	ENER	%
NOx	kt	620.5	476.5	77%
NMVOC	kt	549.4	125.3	23%
SO_2	kt	122.9	105.7	86%
NH_3	kt	478.8	10.4	2%
$PM_{2.5}$	kt	135.0	66.9	50%
PM_{10}	kt	215.3	75.6	35%
TSP	kt	297.1	87.7	30%
BC	kt	46.2	15.4	33%
CO	kt	1,636.7	739.3	45%
Pb	t	100.7	47.2	47%
Cd	t	6.8	2.9	42%
Hg	t	2.9	1.3	43%
PCCD/F	g	477.0	61.4	13%
PAHs	t	36.4	26.6	73%
HCB	kg	2.1	1.6	79%
PCBs	kg	451.0	10.4	2%

Figure 2.2.1 Relative emissions of pollutants (Energy vs. total emissions, excluding Canary Islands) in 2021

Along the last two decades, the Inventory shows drastic emission reductions in the energy sector, with most of the pollutants showing reductions higher than 40% in 2021 compared to 1990 levels (year 2000 in case of Particulate Matter). NH_3 and HCB, on the contrary, showed increases in this sector.

	Emission 2021/base year	
	INV Total	ENER
NOx	-53%	-59%
NMVOC	-46%	-73%
SO_2	-94%	-95%
NH_3	-2%	29%
$PM_{2.5}$	-27%	-40%
PM_{10}	-27%	-44%
TSP	-27%	-46%
BC	-13%	-46%
CO	-60%	-74%
Pb	-97%	-98%
Cd	-74%	-85%
Hg	-72%	-77%
PCDD/F	-18%	-71%
PAHs	-64%	-39%
HCB	-96%	-16%
PCBs	-79%	22%

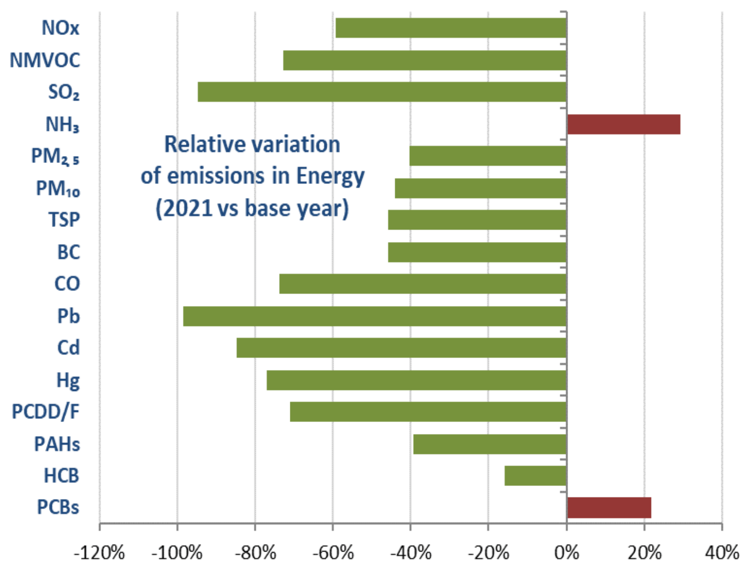
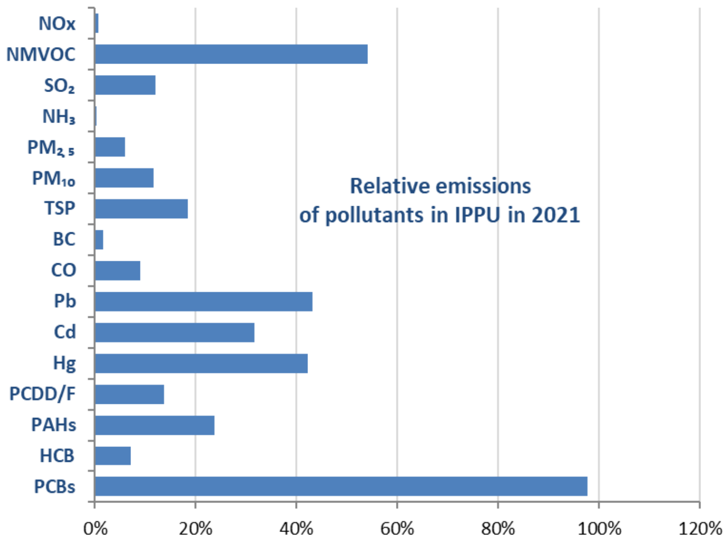


Figure 2.2.2 Relative variation of emissions in Energy (2021 vs. base year, excluding Canary Islands)

2.2.2. Industrial Processes and Product Use: IPPU (NFR 2)

With a wide variety of industrial activities, installations, plants and uses of products in Spain, IPPU sector contributed by 98% of the total PCBs emissions in 2021 and contributed to 54% of the total NMVOC emissions in Spain (excluding the Canary Islands). To a lesser extent, IPPU activities also had a high share to Heavy Metals and PAH emissions.



Emissions 2021		INV Total	IPPU	%
NOx	kt	620.5	3.7	1%
NMVOC	kt	549.4	297.4	54%
SO_2	kt	122.9	14.7	12%
NH_3	kt	478.8	1.5	0%
$PM_{2.5}$	kt	135.0	8.0	6%
PM_{10}	kt	215.3	25.1	12%
TSP	kt	297.1	54.9	18%
BC	kt	46.2	0.8	2%
CO	kt	1,636.7	148.5	9%
Pb	t	100.7	43.4	43%
Cd	t	6.8	2.2	32%
Hg	t	2.9	1.2	42%
PCDD/F	g	477.0	65.4	14%
PAHs	t	36.4	8.6	24%
HCB	kg	2.1	0.1	7%
PCBs	kg	451.0	440.3	98%

Figure 2.2.3 Relative emissions of pollutants (IPPU vs. total emissions, excluding Canary Islands) in 2021

Significant reduction in pollutant emissions has taken place between 1990 and 2021 in the IPPU sector (base year: 2000 in case of Particulate Matter). Emissions reductions of NOx, Hg and PCBs are particularly significant. On the contrary, emissions of Black Carbon and Cd have increased since 1990/2000.

	Emission 2021/base year	
	INV Total	IPPU
NOx	-53%	-65%
NMVOC	-46%	-29%
SO_2	-94%	-20%
NH_3	-2%	-51%
$PM_{2.5}$	-27%	-7%
PM_{10}	-27%	-33%
TSP	-27%	-40%
BC	-13%	109%
CO	-60%	-19%
Pb	-97%	-19%
Cd	-74%	31%
Hg	-72%	-61%
PCDD/F	-18%	-15%
PAHs	-64%	-36%
HCB	-96%	34%
PCBs	-79%	-80%

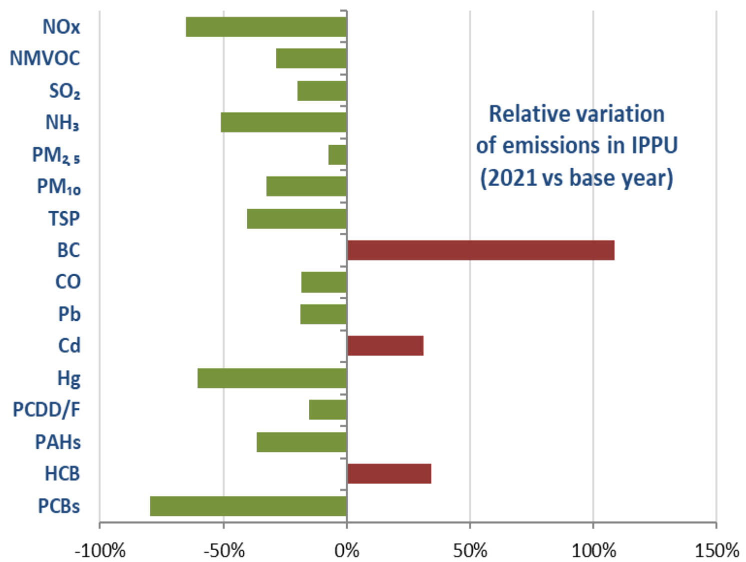
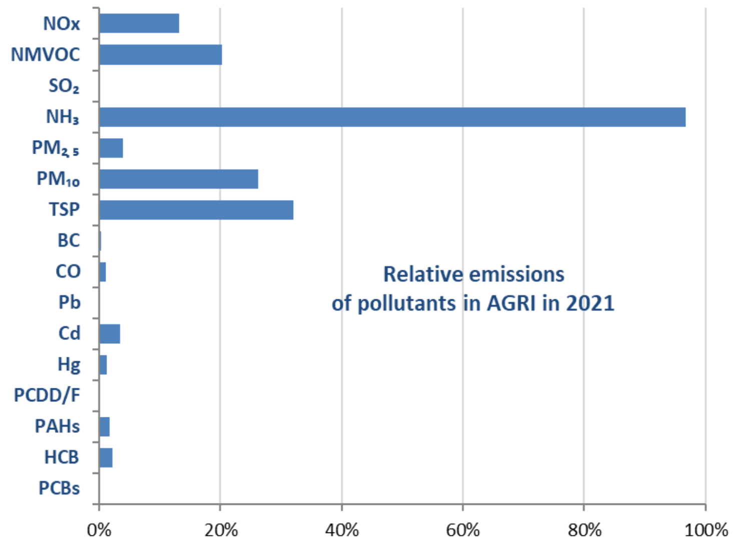


Figure 2.2.4 Relative variation of emissions in IPPU (2021 vs. base year, excluding Canary Islands)

2.2.3. Agriculture (NFR 3)

Taking into account the importance of this primary sector, Agriculture accounts for 97% of NH_3 total emissions in Spain (excluding the Canary Islands).



Emissions 2021		INV Total	AGRI	%
NOx	kt	620.5	82.1	13%
NMVOC	kt	549.4	111.6	20%
SO_2	kt	122.9	0.1	0%
NH_3	kt	478.8	463.3	97%
$PM_{2.5}$	kt	135.0	5.2	4%
PM_{10}	kt	215.3	56.4	26%
TSP	kt	297.1	95.2	32%
BC	kt	46.2	0.1	0%
CO	kt	1,636.7	18.1	1%
Pb	t	100.7	0.0	0%
Cd	t	6.8	0.2	3%
Hg	t	2.9	0.0	1%
PCDD/F	g	477.0	0.1	0%
PAHs	t	36.4	0.6	2%
HCB	kg	2.1	0.0	2%
PCBs	kg	451.0	0.0	0%

Figure 2.2.5 Relative emissions of pollutants (Agriculture vs. total emissions, excluding Canary Islands) in 2021

When comparing 2021 to 1990 (2000 in case of Particulate Matter), every pollutant experienced decreases. The strong decrease observed in SO_2, CO, BC, Heavy Metals, PAHs and PCDD/PCDF emissions is caused by the abandonment of the practice of field burning (3F), restricted by forest fire prevention legislation and conditionality of CAP payments.

	Emission 2021/base year	
	Total	AGRI
NOx	-53%	-16%
NMVOC	-46%	-17%
SO_2	-94%	-96%
NH_3	-2%	-1%
$PM_{2.5}$	-27%	-78%
PM_{10}	-27%	-29%
TSP	-27%	-12%
BC	-13%	-94%
CO	-60%	-97%
Pb	-97%	-95%
Cd	-74%	-95%
Hg	-72%	-96%
PCDD/F	-18%	-97%
PAHs	-64%	-99%
HCB	-96%	-
PCBs	-79%	-

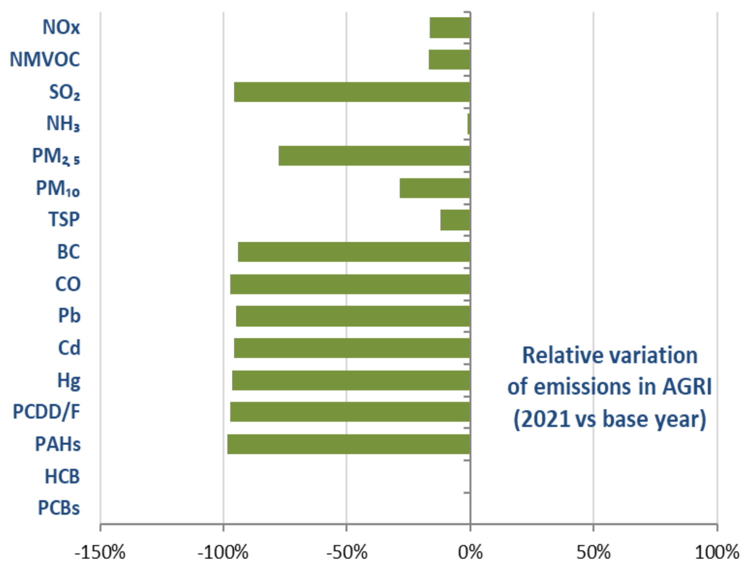
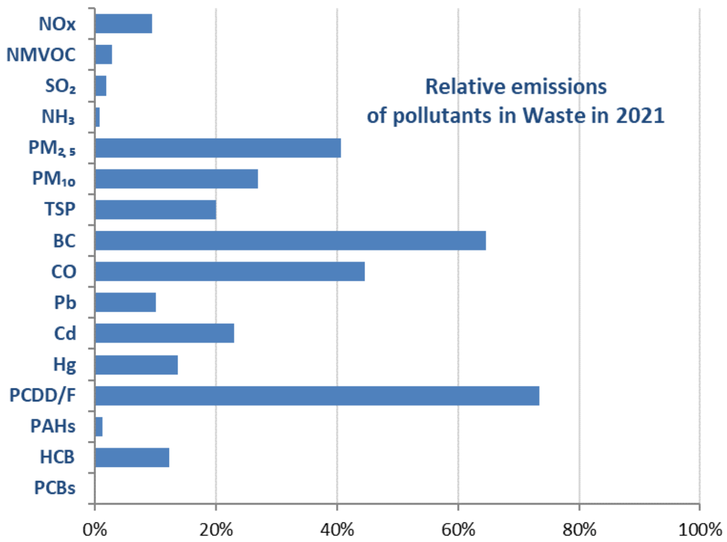


Figure 2.2.6 Relative variation of emissions in Agriculture (2021 vs. base year, excluding Canary Islands)

2.2.4. Waste (NFR 5)

The Waste sector contribution to the total emissions in Spain (excluding the Canary Islands) in 2021 is relatively low for the main pollutants, with the exception of $PM_{2.5}$. The shares increase when considering black carbon, CO, and dioxins and furans.



Emissions 2021		Total	WASTE	%
NOx	kt	620.5	58.2	9%
NMVOC	kt	549.4	15.1	3%
SO_2	kt	122.9	2.4	2%
NH_3	kt	478.8	3.5	1%
$PM_{2.5}$	kt	135.0	54.9	41%
PM_{10}	kt	215.3	58.2	27%
TSP	kt	297.1	59.3	20%
BC	kt	46.2	29.9	65%
CO	kt	1636.7	730.8	45%
Pb	t	100.7	10.1	10%
Cd	t	6.8	1.6	23%
Hg	t	2.9	0.4	14%
PCDD/F	g	477.0	350.1	73%
PAHs	t	36.4	0.5	1%
HCB	kg	2.1	0.3	12%
PCBs	kg	451.0	0.3	0%

Figure 2.2.7 Relative emissions of pollutants (Waste vs. total emissions, excluding Canary Islands) in 2021

Since 1990 (2000 in case of Particulate Matter), most pollutants have increased emissions in this sector. NOx, CO, Pb, Cd and PAHs have showed increase of more than 50%. Opposed to that, significant reductions are shown in NH_3, Hg, HCB and PCBs emissions.

	Emission 2021/base year	
	Total	WASTE
NOx	-53%	66%
NMVOC	-46%	24%
SO_2	-94%	30%
NH_3	-2%	-59%
$PM_{2.5}$	-27%	33%
PM_{10}	-27%	34%
TSP	-27%	33%
BC	-13%	36%
CO	-60%	67%
Pb	-97%	85%
Cd	-74%	106%
Hg	-72%	-45%
PCDD/F	-18%	22%
PAHs	-64%	69%
HCB	-96%	-87%
PCBs	-79%	-37%

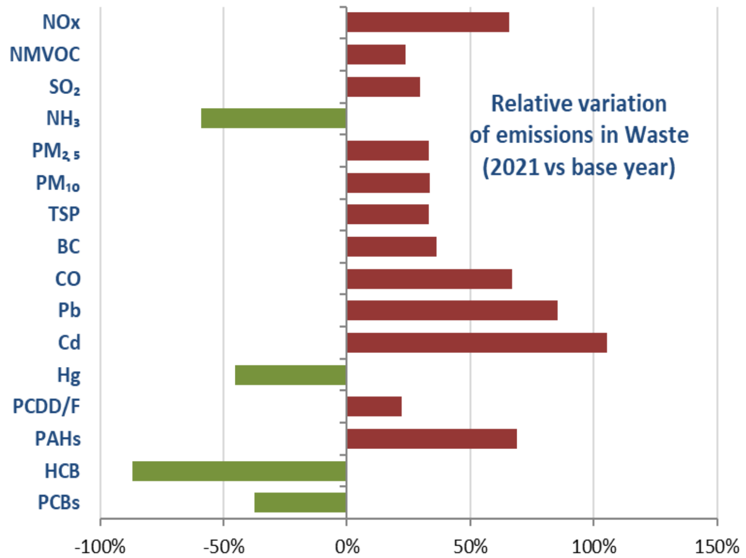


Figure 2.2.8 Relative variation of emissions in Waste (2021 vs. base year, excluding Canary Islands)

3. ENERGY (NFR 1)

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FIGURES

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3. ENERGY (NFR 1)

Chapter updated in March, 2023.

Sector Energy at a glance

Energy emissions stand out for their relative weight for almost every pollutant covered by the Spanish Inventory. As shown in Figure 3.1.1, in many cases Energy sector is responsible for more than 40% of the pollutants emissions in the Inventory. In general, Energy emissions have decreased since 1990 (since 2000 for $PM_{2.5}$ and BC) for most of the inventoried pollutants by more than 50%.

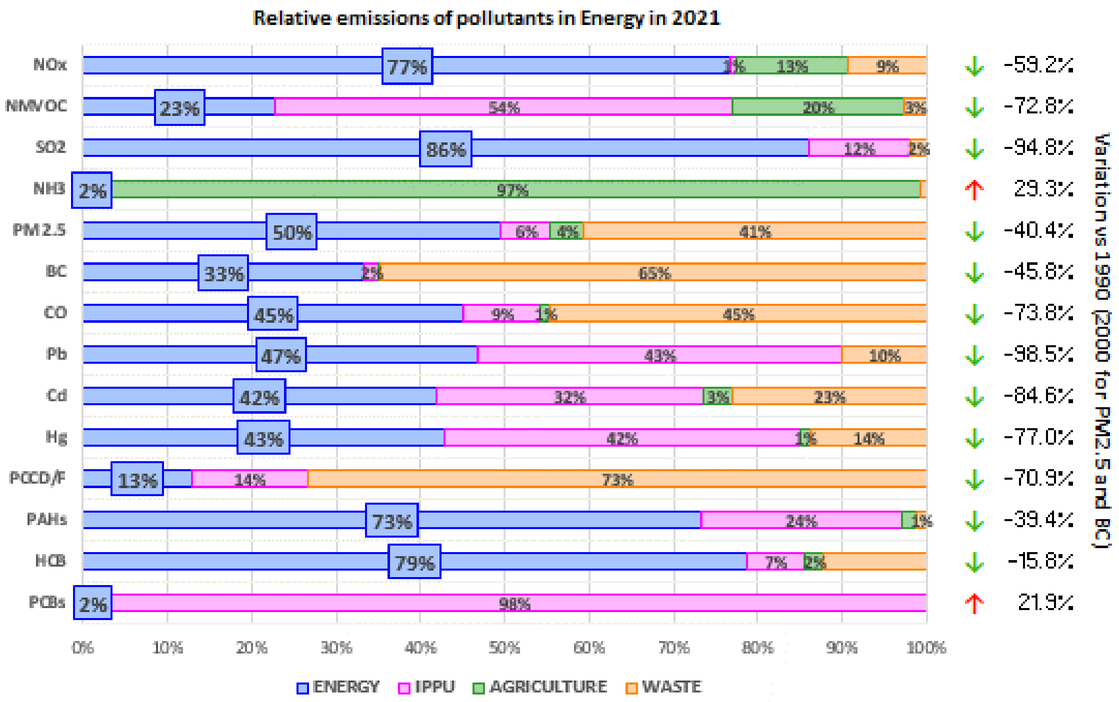


Figure 3.1.1 Relative emissions in Energy in 2021 and its relative variation (2021 vs. 1990)

In 2021, the Energy sector in Spain involved, among others, the activity of 53 large power thermal plants, 13 incineration plants with energy recovery, 9 refineries, 1 integrated steel plant with coke production, 2 plants of coke production, more than 800 installations covered by the EU ETS, 200 energy installations registered within the PRTR, more than 1.18 million of flights, 34 million of vehicles and almost 25 million of households (see Table 3.2.1).

Energy activities in 2021 produced 86% of the total emissions of SO_2, 79% of HCB emissions and 77% of NOx emissions. On the other hand, its contribution to ammonia and PCB emissions was minor (around 2%).

Along the last two decades, emission reduction measures have had a drastic effect on most of the pollutants with reduction rates higher than 50% in 2021 compared to 1990 levels (almost 99% in Pb and 95% in SO_2). The relative increase in NH_3 emissions is indicative of the growing weight of the use of biomass in energy production and the increase of road transport activity compared to the previous year. The relative increase of PCBs is mostly linked to combustion processes from metallurgical industry, in particular iron and steel production, combustion in non-metallic minerals industries, as well as in road transport (passenger cars).

3.1. Sector overview

The following table shows, per each NFR category, the pollutants coverage, methodology approach (Method) and consideration as key category (KC).

Table 3.1.1 Coverage of NFR category in 2021

<table>
<tr><th rowspan="3">NFR Code</th><th rowspan="3">NFR category</th><th colspan="4">Pollutants</th><th rowspan="3">Method</th><th rowspan="3">KC</th></tr>
<tr><th rowspan="2">Covered</th><th colspan="3">Exceptions</th></tr>
<tr><th>IE</th><th>NA</th><th>NE</th></tr>
<tr><td>1A1a</td><td>Public electricity and heat production</td><td>All</td><td>–</td><td>–</td><td>–</td><td>T1/T2</td><td>✓</td></tr>
<tr><td>1A1b</td><td>Petroleum refining</td><td>All</td><td>–</td><td>HCB, PCBs</td><td>NH3</td><td>T1/T2/T3</td><td>✓</td></tr>
<tr><td>1A1c</td><td>Manufacture of solid fuels and other energy industries</td><td>All</td><td>–</td><td>–</td><td>–</td><td>T1/T2</td><td>✓</td></tr>
<tr><td>1A2a</td><td>Stationary combustion in manufacturing industries and construction: Iron and steel</td><td>All</td><td>–</td><td>–</td><td>–</td><td>T1/T2/T3</td><td rowspan="9">✓</td></tr>
<tr><td>1A2b</td><td>Stationary combustion in manufacturing industries and construction: Non-ferrous metals</td><td>All</td><td>–</td><td>PCBs</td><td>–</td><td>T1/T2/T3</td></tr>
<tr><td>1A2c</td><td>Stationary combustion in manufacturing industries and constructions: Chemicals</td><td>All</td><td>–</td><td>–</td><td>–</td><td>T1/T2/T3</td></tr>
<tr><td>1A2d</td><td>Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print</td><td>All</td><td>–</td><td>–</td><td>–</td><td>T1/T2/T3</td></tr>
<tr><td>1A2e</td><td>Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco</td><td>All</td><td>–</td><td>–</td><td>–</td><td>T1/T2/T3</td></tr>
<tr><td>1A2f</td><td>Stationary combustion in manufacturing industries and construction: Non-metallic minerals</td><td>All</td><td>–</td><td>–</td><td>–</td><td>T1/T2/T3</td></tr>
<tr><td>1A2gvii</td><td>Mobile Combustion in manufacturing industries and construction</td><td>All</td><td>–</td><td>HCB, PCBs</td><td>Pb, Hg, As, PCDD/PCDF</td><td>T1/T2</td></tr>
<tr><td>1A2gviii</td><td>Stationary combustion in manufacturing industries and construction: Other</td><td>All</td><td>–</td><td>–</td><td>–</td><td>T1/T2/T3</td></tr>
<tr><td>1A3ai(i)</td><td>International aviation LTO (civil)</td><td>All</td><td>–</td><td>HCB, PCBs</td><td>NH_3, PCDD/PCDF</td><td>T1/T3</td><td rowspan="2"></td></tr>
<tr><td>1A3aii(i)</td><td>Domestic aviation LTO (civil)</td><td>All</td><td>–</td><td>HCB, PCBs</td><td>NH_3, PCDD/PCDF</td><td>T1/T3</td></tr>
<tr><td>1A3bi</td><td>Road transport: Passenger cars</td><td>All</td><td>–</td><td>HCB</td><td>–</td><td>T2/T3</td><td rowspan="5">✓</td></tr>
<tr><td>1A3bii</td><td>Road transport: Light duty vehicles</td><td>All</td><td>–</td><td>HCB</td><td>–</td><td>T2/T3</td></tr>
<tr><td>1A3biii</td><td>Road transport: Heavy duty vehicles and buses</td><td>All</td><td>–</td><td>HCB</td><td>–</td><td>T2/T3</td></tr>
<tr><td>1A3biv</td><td>Road transport: Mopeds & motorcycles</td><td>All</td><td>–</td><td>HCB</td><td>–</td><td>T2/T3</td></tr>
<tr><td>1A3bv</td><td>Road transport: Gasoline evaporation</td><td>NMVOC</td><td>–</td><td>Rest of pollutants</td><td>–</td><td>T3</td></tr>
</table>

NFR Code	NFR category	Pollutants				Method	KC
		Covered	Exceptions				
			IE	NA	NE		
1A3bvi	Road transport: Automobile tyre and brake wear	All	–	NOx, NMVOC, SO_2, NH_3, CO, PCDD/PCDF, HCB, PCBs	Hg, IcP	T1/T2	
1A3bvii	Road transport: Automobile road abrasion	All	–	NOx, NMVOC, SO_2, NH_3, CO, PCDD/PCDF, HCB, PCBs	Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, BaP, BbF, BkF, IcP	T1/T2	
1A3c	Railways	All	–	HCB, PCBs	Pb, Hg, As	T1	
1A3di(ii)	International inland waterways	NO					✓
1A3dii	National navigation (shipping)	All	–	–	–	T1/T2	
1A3ei	Pipeline transport	All	–	NH_3	–	T1/T2	
1A3eii	Other	NO					
1A4ai	Commercial/institutional: Stationary	All	–	–	-	T1/T2	
1A4aii	Commercial/institutional: Mobile	All	–	HCB, PCBs	Hg, As, PCDD/PCDF	T1	✓
1A4bi	Residential: Stationary	All	–	–	–	T1/T2	
1A4bii	Residential: Household and gardening (mobile)	IE (under 1A4bi)					
1A4ci	Agriculture/Forestry/Fishing: Stationary	All	–	–	-	T1/T2	
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	All	–	HCB, PCBs	Pb, Hg, As, PCDD/PCDF	T1/T2	✓
1A4ciii	Agriculture/Forestry/Fishing: National fishing	All	–	–	–	T1/T2	
1A5a	Other stationary (including military)	IE (under 1A3 and 1A4)					
1A5b	Other mobile	All	–	–	–	T1/T2/T3	
1B1a	Coal mining and handling	All	–	NOx, SO_2, NH_3, CO, PCDD/PCDF, PAHs, HCB, HCH	NMVOC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, BC	T2	
1B1b	Solid fuel transformation	All	Pb, Cd, Hg	PCDD/PCDF, HCB, PCBs	As, Cr, Cu, Ni, Se, Zn, BC	T2	
1B1c	Other fugitive emissions from solid fuels	NO					
1B2ai	Fugitive emissions oil: Exploration, production, transport	NMVOC	–	NOx, CO, NH_3, TSP, PM_{10}, $PM_{2.5}$, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCBs, PAHs, HCB	SO_2, PCDD/PCDF	T2	✓
1B2aiv	Fugitive emissions oil: Refining /storage	All	–	PAHs, HCB, PCBs	–	T1/T2/T3	
1B2av	Distribution of oil products	NMVOC	–	NOx, CO, NH_3, TSP, PM_{10}, PM2., Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCBs, PAHs, HCB	SO_2, PCDD/PCDF	T2	

NFR Code	NFR category	Pollutants				Method	KC
		Covered	Exceptions				
			IE	NA	NE		
1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)	NMVOC	–	NOx, CO, NH_3, TSP, PM_{10}, $PM_{2.5}$, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCBs, PAHs, HCB	SO_2, PCDD/PCDF	T2	
1B2c	Venting and flaring (oil, gas, combined oil and gas)	All	–	HCB, PCBs	NH_3,Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, PAHs	T1/T2/T3	
1B2d	Other fugitive emissions from energy production	NO					

IE: included elsewhere; NA: not applicable NE: not estimated; NO: not occurring.

To a large extent, the emissions of SO_2, NOx and PM (sometimes CO, NMVOC) are estimated using data from continuous emission monitoring systems (CEMS), especially in large combustion plants (LCPs) belonging to NFR categories 1A1 and 1A2.

According to Spain's Orden PRA/321/2017, Annex II, Section A, referred to Large Combustion Plants (LCPs) that require continuous measurements, the "validated average values" must include the subtraction of the specific confidence interval depending on the pollutant, and are to be used solely to assess the compliance with emission limit values (ELV-art. 7). However, article 6 of Annex II sets the criteria to determine "average emission values". No subtraction of the confidence interval is required in this case. The calculation must be performed in accordance with UNE/EN standards (transposition of CEN standards in Spain) and the start-up and shut-down periods must be disregarded.

According to article 9 of Orden PRA/321/2017, "average emission values" are those reported to the European Pollutant Emission Register and to the National Inventory of emissions.

Therefore, the Spanish Inventory considers that no underestimation is taking place when including emissions reported by operators using CEMS data and assuming that every operator complies with the current legislation in force.

More information on emission estimations, processes and abatement techniques are available in Introductory factsheet A General description of combustion processes that generate emissions, Introductory factsheet B General description of emission reduction techniques and Introductory factsheet C Methodologies for estimating combustion emissions.

3.2. Sector analysis

Main features of the Energy sector in Spain in 2021 are listed in the following table for reference. These main features do not consider the Canary Islands, as their territory is not under the EMEP grid.

For further information on methodology applied to non-key categories, links to the methodology factsheets published in MITECO-SEI website are included below. For key categories, links to the available factsheets have been included in the corresponding methodology section.

Table 3.2.1 Sector analysis

NFR Code	NFR category	Main features (2021)	Main sources of activity data
1A1a	Public electricity and heat production	- 53 large thermoelectric power plants. - 47,796 GWh/year of electricity produced in thermal power plants. - 390,524 TJ in fossil fuels consumption. - 14 Incineration plants with energy production (1 out of order). - 12 significant district heating networks (>10 MWt). - 270 kt biogas for energy recovery use.	IQ from main power generation plants (LPS), MITECO (small power plants and solar thermal plants). National census of DH plants from IDAE-MITECO.
1A1b	Petroleum refining	- 9 Refineries. - 60.7·10^6 tonnes of crude oil processed. - 164,143 TJ in fossil fuels consumption.	IQ from refineries.
1A1c	Manufacture of solid fuels and other energy industries	- 1 integrated steel plant with coke production. - 2 plants of coke production. - 16,378 TJ in fossil fuels consumption.	IQ from large plants, MITECO (other energy industries).
1A2	Stationary combustion in manufacturing industries and construction	- More than 60 industrial activities, including: · Cement production: 32 facilities (17,302 kt of clinker manufactured). · Lime production: 17 facilities (2,183 kt produced). · Glass production: more than 25 facilities (4,823 kt of glass). · Steel production: 27 facilities (14,151 kt) - 781,974 TJ in fossil fuels consumption.	IQ Entrepreneurial associations.
1A3a	Transport: aviation (Methodology factsheet: Aviation)	- 46 airports - 0.39·10^6 domestic flights - 40.89·10^6 passengers in domestic flights - 1.18·10^6 total flights - 94.89·10^6 total passengers	National Statistics from Air Navigation Agency (AENA) and MITMA.
1A3b	Transport: road (Methodology factsheets: Road transport: combustion, evaporative emissions, tyre and brake wear and road abrasion emissions)	- 161,242 km not urban road network - 23.9·10^6 passengers cars (58% diesel/42% gasoline) - 3.73·10^6 heavy duty vehicles and buses (92% diesel/8% gasoline) - 220,012·10^6 vehicles x km not urban pattern	National statistics from Traffic Department and MITMA.
1A3c	Transport: railways (Methodology factsheet: Railways)	- 15,301 km railway network of them 64.1% electrified.	National statistics from MITMA.
1A3d	Transport: navigation (Methodology factsheet: Navigation)	- 26 national ports. - 11.70·10^6 domestic passengers (incl. regional ports). - 74.36·10^6 tonnes domestic freights (incl. regional ports).	National statistics from MITMA.
1A3e	Pipeline transport (Methodology factsheet: Pipeline transport)	- More than 12,000 km of high-pressure gas pipelines. - More than 4,000 km of oil pipelines.	ENAGÁS, Exolum (previously called CLH).
1A4	Commercial/Institutional Residential Agriculture, forestry and fishing	- 24.91·10^6 households. - 2.73·10^6 tonnes of diesel oil for agricultural machinery. - 7,825 fishing ships.	MITMA, MITECO, MAPA.
1B	Fugitives	- 5 abandoned underground mines. - 5,815 tonnes crude oil extracted. - 439,949 GW/h Gas produced. - 1,111,920.4 t of coke produced.	MITECO, SEDIGÁS, ENAGÁS. IQ from coke plants.

3.2.1. Key categories

Identified key categories within the Energy sector in 2021, according to the information provided in section 1.5 of the IIR and Annex 1, are listed in the following table.

Table 3.2.2 Assignation of KC

NFR	NFR Category	NOx	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	PCDD /PCDF	PAHs	HCB	PCBs
1A1a	Public electricity and heat production	L-T	L-T	L-T	-	L-T	L-T	L-T	-	L	-	L	L-T	T	L-T	L-T	-
1A1b	Petroleum refining	L	-	T	-	-	-	-	-	-	-	-	-	-	-	-	-
1A1c	Manufacture of solid fuels and other energy industries	-	-	-	-	T	T	T	T	-	-	-	-	-	-	-	-
1A2	Manufacturing Industries and Construction	L-T	L	L-T	-	L-T	L-T	L-T	L-T	L-T	L-T	L-T	L-T	-	L-T	L-T	T
1A3b	Road transport	L-T	L-T	T	T	L-T	L-T	L-T	L-T	L-T	L-T	L-T	L-T	T	L-T	-	-
1A3d	Navigation	T	-	L	-	-	-	-	-	-	-	-	-	-	-	L	-
1A4a + 1A4b	Commercial / institutional / residential	L-T	L-T	L-T	T	L-T	L-T	L-T	L-T	L-T	-	L-T	L-T	L-T	L-T	L-T	-
1A4c	Agriculture / Forestry / Fishing	L-T	-	-	-	L-T	L-T	T	L-T	L	-	-	-	-	-	-	-
1B	Fugitive Emissions from Fuels	-	L	L-T	-	-	-	-	-	-	-	-	-	-	-	-	-

L: level; T: trend

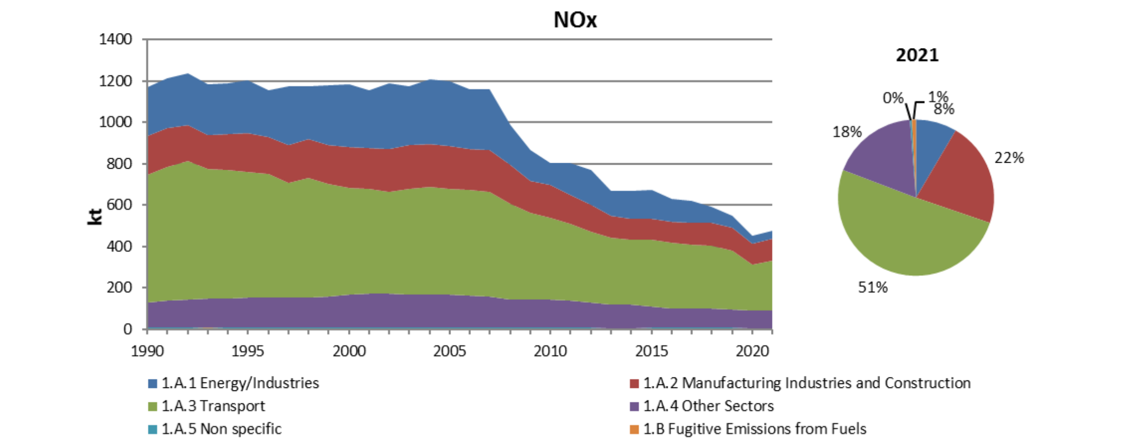
3.2.2. Analysis by pollutant

Charts of the time series by pollutants and NFR categories are shown next. Each pollutant is represented independently, broken down by main NFR categories within the sector. Additionally, a pie chart showing weight distribution of the main categories for year 2021 is included.

Explanation boxes are included beside the graphs, providing specific details on the pollutant emissions in year 2021 and main drivers and trends during the time series. Emissions from the Canary Islands are not considered, as their territory is not under the EMEP grid.

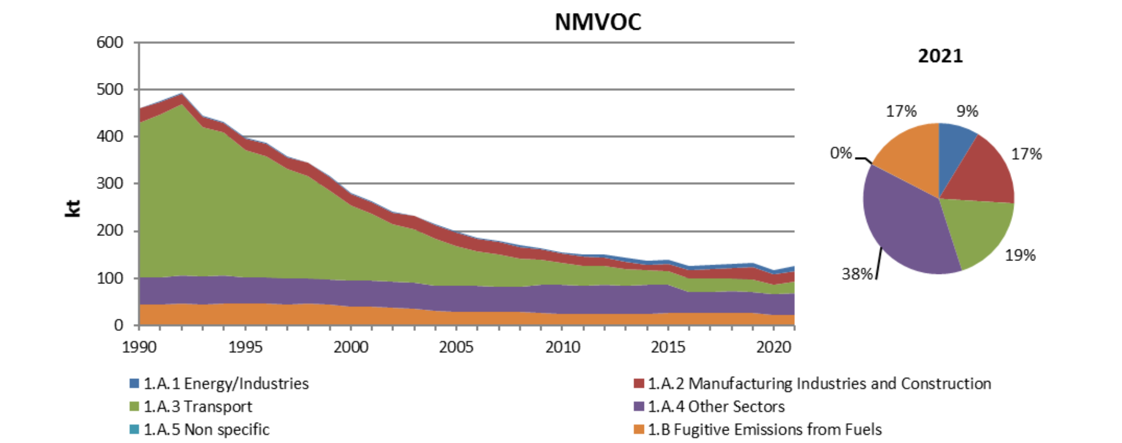
Detailed emission data of the Spanish Inventory are available from the MITECO-SEI website WebTable.

Main Pollutants



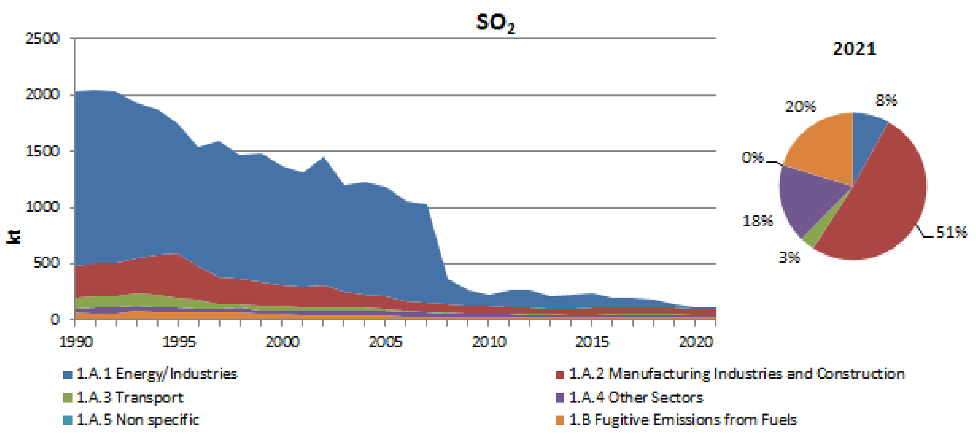
NOx	476.47 kt emitted in 2021 76.8% of the total NOx emissions of the Inventory in 2021	
	1990-2005	Stability
	2005-2010	Significant decline in 2008-2010 driven by: (i) Technological advances (EURO technologies) adopted in vehicle fleets (1A3b). (ii) Growth in combined-cycle power stations (1A1), with lower NOx emission ratios. (iii) Dissemination of NOx abatement and energy efficiency measures in conventional coal-fired power stations (1A1) and in other industrial combustion sectors (1A2).
	2010-2021	Minor growth in 2011 and 2012 in the activity of coal-fired power stations (1A1). Drop in 2013 and 2020 due to reduction in conventional electricity production (1A1a) and the change in the energy mix dominated by the decrease in consumption of coal. Continuous decline of emissions from heavy duty vehicles (1A3biii), with a sharp drop in 2020 (in the entire 1A3 category) as a consequence of COVID-19 pandemic, and recovery in 2021.

Figure 3.2.1 Evolution of NOx emissions by category and distribution in year 2021



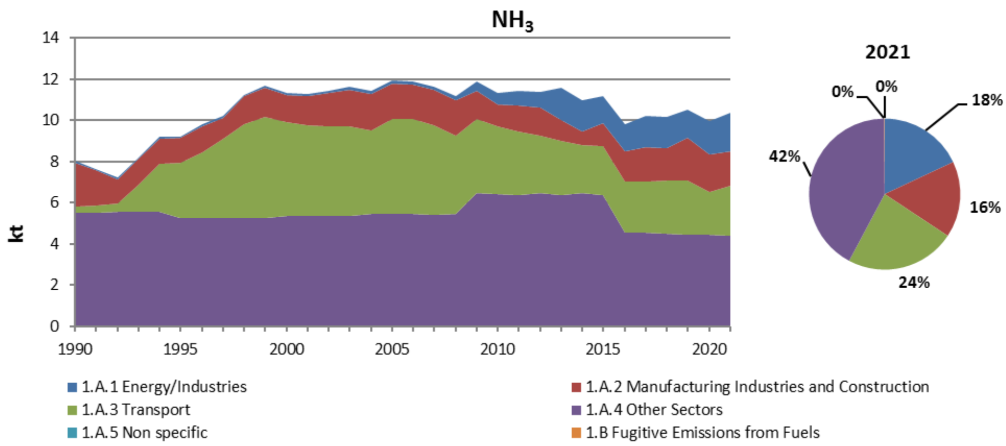
NMVOC	125.33 kt emitted in 2021 22.8% of the total NMVOC emissions of the Inventory in 2021	
	1990-1992	Growing trend.
	1992-2021	Decrease in emissions from Transport activities (1A3) as result of restrictions imposed on vehicle exhaust emissions of pollutants and the evaporative emissions from petrol-driven vehicles (successive introduction of EURO technologies). Emissions increase since 2010 in power generation sector (1A1a), mainly due to the growing activity of industrial waste incineration and biomass energy plants.

Figure 3.2.2 Evolution of NMVOC emissions by category and distribution in year 2021



SO_2	105.71 kt emitted in 2021 86.0% of the total SO_2 emissions of the Inventory in 2021	
	1990-2008	Downward trend.
	2008-2010	Significant decreasing pattern driven by: (i) The change in the structure of the electricity sector (1A1) with the installation of combined cycle power stations and the smaller influence of coal. (ii) The closure of the last brown coal mine in 2008 and stop in using this fuel at conventional power plants; evolution of consumption in favour of fuels with lower sulphur content, together with limiting regulations on fuel sulphur content. (iii) The introduction of secondary desulphurization techniques.
	2010-2021	Slight downward trend with a steeper decline in 2019 and 2020, driven by the decrease in consumption of coal in electricity generation (1A1a).

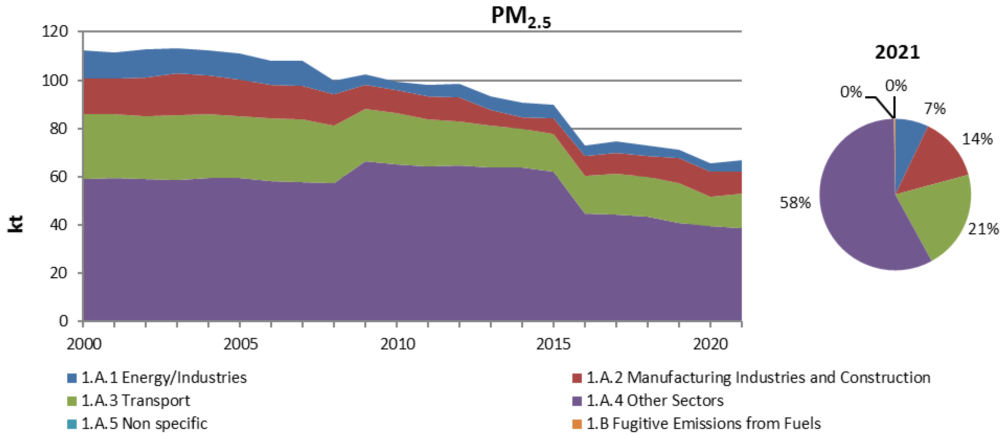
Figure 3.2.3 Evolution of SO_2 emissions by category and distribution in year 2021



NH_3	10.38 kt emitted in 2021 2.2% of the total NH_3 emissions of the Inventory in 2021	
	1990-1992	Decrease in emissions from category 1A2.
	1992-2000	A continue growth in the emissions is observed in road transport (1A3), due to the successive introduction of catalytic technologies EURO I and EURO II.
	2000-2021	Emissions decrease as technologies EURO III and later are entering into force in road transport (1A3). Significant emissions increase from 2008 onwards in Other sectors (1A4) as a consequence of the promotion of biomass in RCI sectors in Spain, with a drastic fall in 2016 due to reduction in consumption of biomass. Since 2013 a noticeable increase is also seen in power generation sector (1A1a), mainly due to proliferation of biomass burning plants.

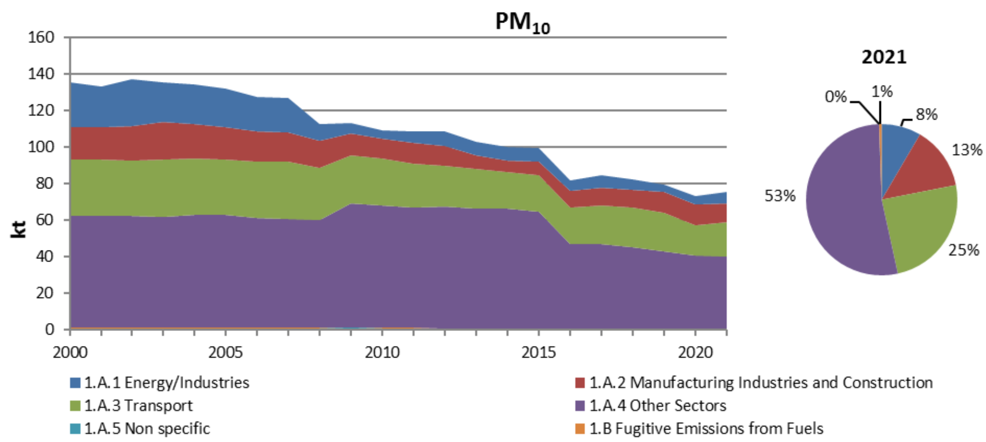
Figure 3.2.4 Evolution of NH_3 emissions by category and distribution in year 2021

Particulate Matter



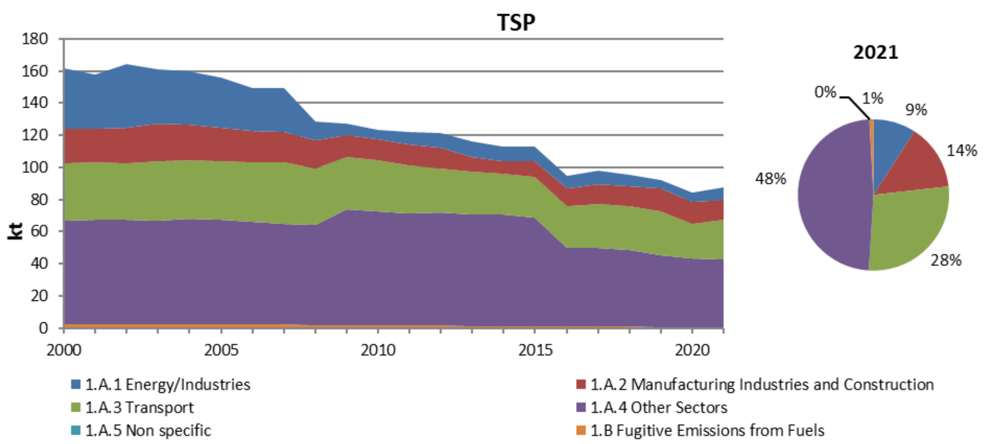
PM2.5	66.93 kt emitted in 2021 49.6% of the total $PM_{2.5}$ emissions of the Inventory in 2021	
	2000-2007	Moderate decline.
	2007-2015	Increase of the slope, motivated by: (iv) Decrease of journeys in road transport together with the fall in national navigation (1A3). (v) Reduction in activity at coal-fired power station (1A1), albeit with a moderate increase in 2011 and 2012 compared with 2010. (vi) Variation of the fuel mix: increase of natural gas consumption, notable drop of coal in 2008-2010 (last brown coal mine closed in 2008) and decrease in certain oil-derived products (such as residual oil). (vii) Introduction of abatement techniques in certain industries (such as the cement industry). (viii) Increase of emissions from Other Sectors (1A4) in 2009, linked to the promotion of biomass consumption in RCI sectors in Spain.
	2015-2021	Drops in 2016, due to reduction in biomass consumption under category 1A4, and in 2020, as a consequence of COVID-19 pandemic on transport activity (1A3).

Figure 3.2.5 Evolution of $PM_{2.5}$ emissions by category and distribution in year 2021



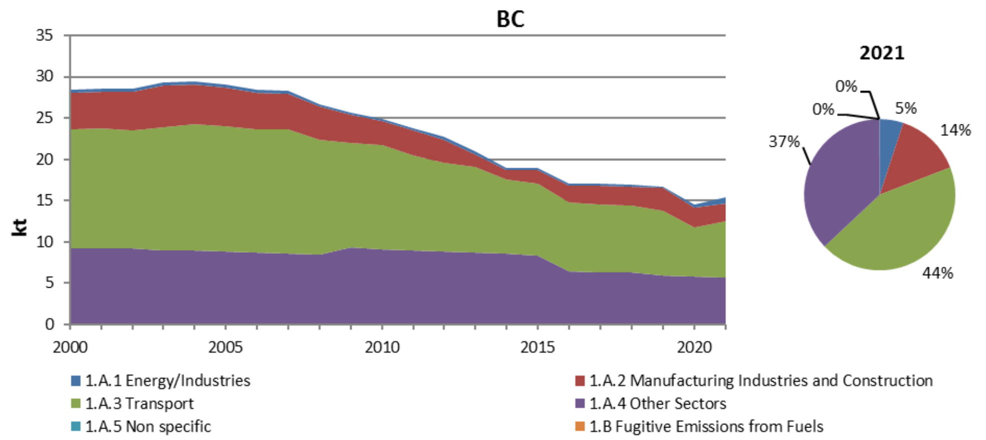
PM10	75.61 kt emitted in 2021 35.1% of the total PM_{10} emissions of the Inventory in 2021	
	2000-2007	Moderate decline.
	2007-2021	The trends are very similar to those already described for $PM_{2.5}$.

Figure 3.2.6 Evolution of PM_{10} emissions by category and distribution in year 2021



TSP	87.71 kt emitted in 2021 29.5% of the total TSP emissions of the Inventory in 2021	
	2000-2007	Moderate decline.
	2007-2021	Evolution very similar to that already described for $PM_{2.5}$.

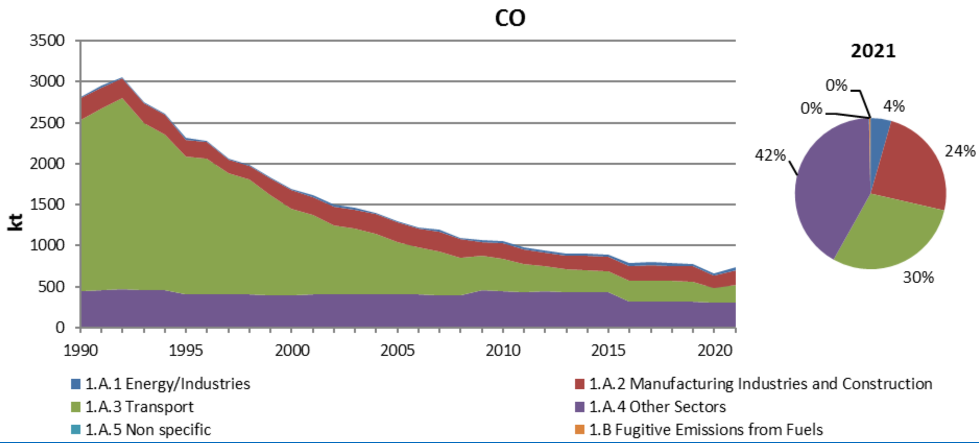
Figure 3.2.7 Evolution of TSP emissions by category and distribution in year 2021



BC	15.42 kt emitted in 2021 33.4% of the total BC emissions of the Inventory in 2021	
	2000-2007	Stability.
	2007-2015	Downward trend, mainly motivated by reduction in emission levels from Transport (1A3) and Manufacturing Industries and Construction (1A2). Increase of emissions from Other Sectors (1A4) in 2009, linked to biomass consumption.
	2015-2021	Drops in 2016, due to reduction in biomass consumption under category 1A4, and in 2020, as a consequence of COVID-19 pandemic on transport activity (1A3).

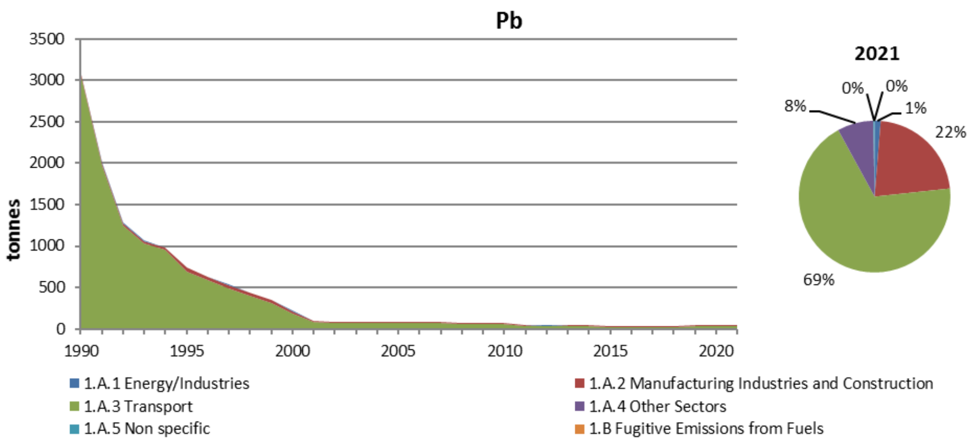
Figure 3.2.8 Evolution of BC emissions by category and distribution in year 2021

CO and Priority Heavy Metals



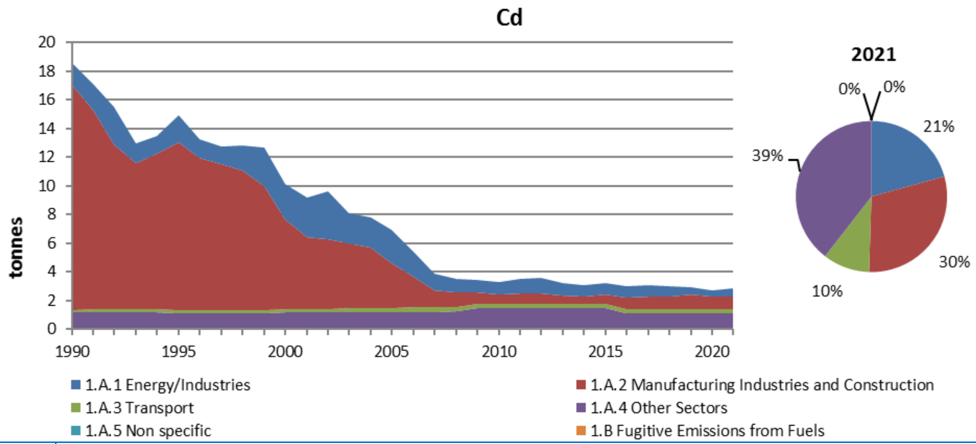
CO	739.29 kt emitted in 2021 45.2% of the total CO emissions of the Inventory in 2021	
	1990-1992	Upward trend.
	1992-2015	Downward pattern, determined by the reduction in transport emission levels (1A3): (i) The new vehicles fleets have been equipped with engine technologies and more effective abatement techniques designed to reduce CO (EURO technologies). (ii) The structure of vehicle fleets by fuel type reveals a decrease in the contribution of petrol driven vehicles to the total fleet in favour of diesel vehicles. In 2009, increase from categories 1A4 and 1A1a, linked to biomass consumption.
	2015-2021	Drops in 2016, due to reduction in biomass consumption under category 1A4, and in 2020, as a consequence of COVID-19 pandemic on transport activity (1A3).

Figure 3.2.9 Evolution of CO emissions by category and distribution in year 2021



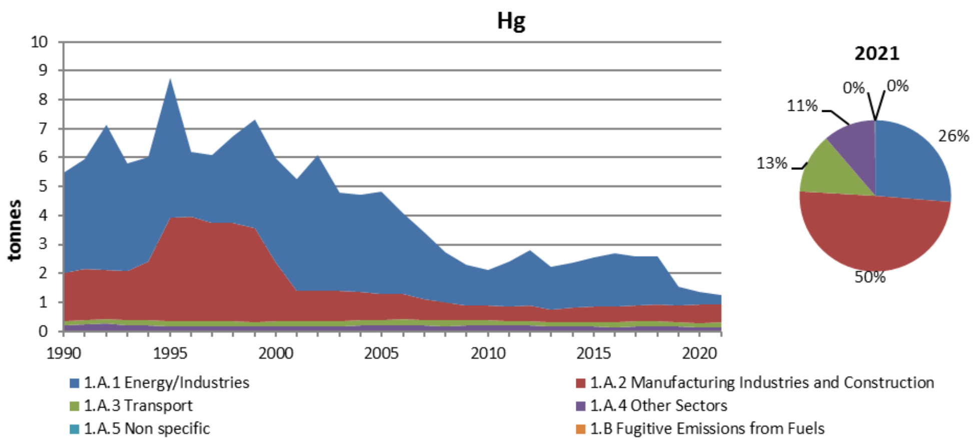
Pb	47.16 tonnes emitted in 2021 46.8% of the total Pb emissions of the Inventory in 2021	
	1990-2002	Strong decrease as a consequence of the progressive decline and disappearance of leaded petrol consumption in road transport: (i) 1990-1992: continued reduction in the maximum lead content allowed in petrol. (ii) Starting in 1993: new petrol-driven vehicles use unleaded fuels (EURO technologies); at the same time, the number of diesel vehicles increases, whereas petrol-driven vehicles have been decreasing continuously. (iii) From 2001 onwards, sales of leaded petrol are prohibited.
	2002-2021	Stability.

Figure 3.2.10 Evolution of Pb emissions by category and distribution in year 2021



Cd	2.86 tonnes emitted in 2021 41.8% of the total Cd emissions of the Inventory in 2021	
	1990-2013	Energy sector is a significant emission source within the inventory through the whole period despite the decline in its relative contribution. This decrease is due to the change in the mix of fuels used, mainly in Manufacturing Industries and Construction (1A2) -lower coal and residual oil consumption- but also in power plants (1A1a); efficient TSP abatement techniques have a direct impact on the reduction of heavy metals emissions.
	2013-2021	Stability with drop in 2020 mainly linked to the fall in coal consumption for electricity generation (1A1a).

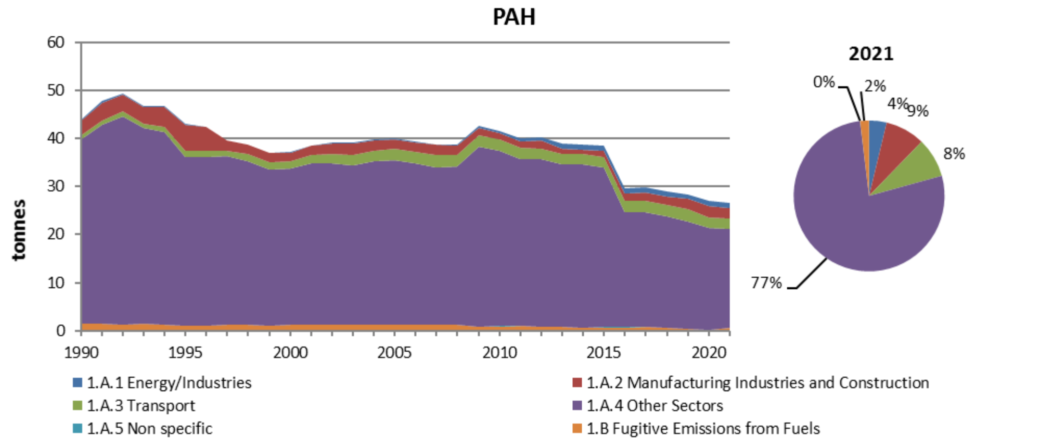
Figure 3.2.11 Evolution of Cd emissions by category and distribution in year 2021



Hg	1.26 tonnes emitted in 2021 42.8% of the total Hg emissions of the Inventory in 2021	
	1990-2005	Energy industries, basically thermal power stations and refining plants, as well as the cement industry (category 1A2f) and non-specific combustion in industries, are the main Hg emitters. The irregular profile of the series is linked to the evolution of emissions in energy industries, subject in turn to annual variations in the use of potentially emitting fuels, residual oil or coal.
	2005-2010	Energy sector is a significant emission source within the inventory through the whole period in spite of the decline in its relative contribution. This decrease is due to the change in the mix of fuels used in power plants (1A1a) and refineries (1A1b) —increased consumption of natural gas—, and in Manufacturing Industries and Construction —lower coal and residual oil consumption—. Efficient TSP abatement techniques also imply a reduction on heavy metals emissions.
	2010-2018	Slight upward trend due to the increment in coal consumption in 1A1 category.
	2019-2021	Strong decline by activity reduction in coal-fired power plants (1A1a).

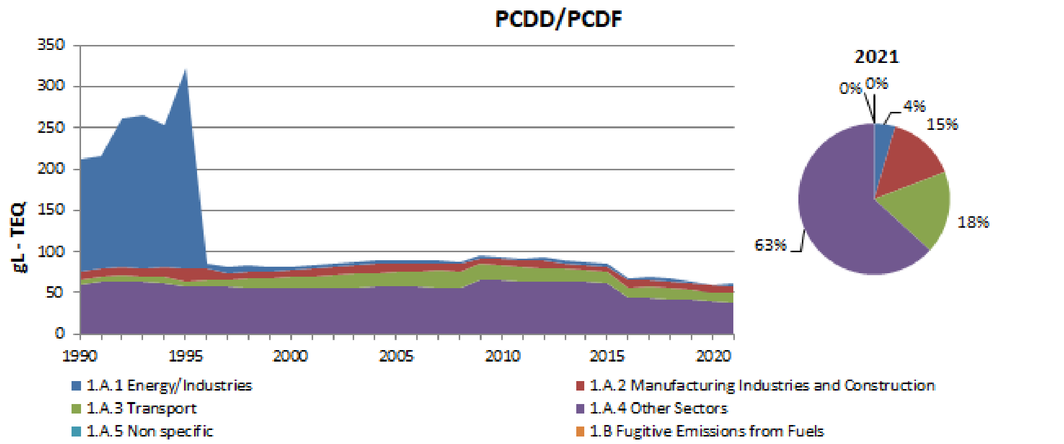
Figure 3.2.12 Evolution of Hg emissions by category and distribution in year 2021

POPs



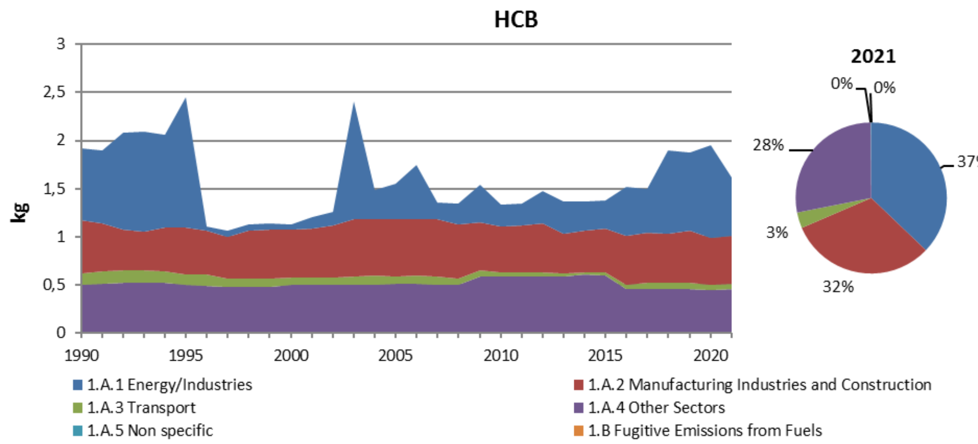
PAHs	26.63 tonnes emitted in 2021 73.2% of the total PAHs emissions of the Inventory in 2021	
	1990-1992	Upward trend due to the growth in coal consumption within Residential sector (1A4bi).
	1993-1999	Decrease. Reduction of emissions in Manufacturing Industries and Construction (1A2) is significant.
	2000-2015	Slight upward trend until year 2008. Emissions in Energy/Industries (1A1) increase their share since 2009 as indicative of the increase of wood wastes burned in boilers at biomass power plants. In Commercial/institutional and Residential sectors (1A4) the decline in the use of coal is counterbalanced by an increase in the use of biomass in small combustion devices.
	2015-2021	Strong drop in 2016, due to reduction in biomass consumption under category 1A4, whitin the overall downward trend.

Figure 3.2.13 Evolution of PAHs emissions by category and distribution in year 2021



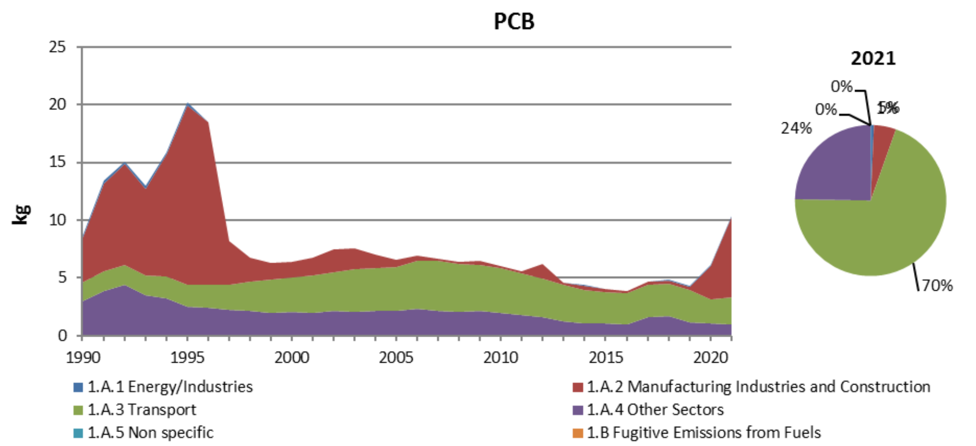
PCDD/ PCDF	61.39 g I - TEQ emitted in 2021 12.9% of the total PCDD/PCDF emissions of the Inventory in 2021	
	1990-1995	Upward trend. Emissions linked to MSW incineration plants with energy recovery.
	1996	Sudden drop due to new legislative requirements affecting MSW incineration plants with energy recovery.
	1997-2021	Stability. Slight decline in the steel production activities in 2009. Slight upward trend since 2009, mainly driven by Other Sectors (1A4), with a further fall in emissions in 2016 linked to reduction in biomass consumption.

Figure 3.2.14 Evolution of PCDD/PCDF emissions by category and distribution in year 2021



HCB	1.61 kg emitted in 2021 78.6% of the total HCB emissions of the Inventory in 2021	
	1990-1995	Upward trend. Emissions linked to MSW incineration plants with energy recovery.
	1996	Sudden drop due to abatement techniques in MSW incineration plants with energy recovery.
	1997-2021	New MSW incineration plants implement energy recovery from 2002 onwards (2003 emissions based on measurements carried out by the plants). Slight upward trend in Other Sectors (1A4) since 2009; further fall in emissions in 2016 linked to reduction in biomass consumption.

Figure 3.2.15 Evolution of HCB emissions by category and distribution in year 2021



PCBs	10.35 kg emitted in 2021 2.3% of the total PCB emissions of the Inventory in 2021	
	1990-1997	The main contribution is from Manufacturing Industries and Construction, especially Stationary combustion: Non-metallic minerals (1A2f), followed by Other Sectors basically by Residential: Stationary (1A4bi).
	1997-2019	Sudden drop in 1997 due to a change in fuels consumption in Manufacturing Industries and Construction: in 1997, the consumption of coal in Non-ferrous metals (1A2b) reduced over 72%. Transport (1A3) results to be the main contributor.
	2020-2021	Marked increase leaded by category 1A2, in particular from iron and steel production.

Figure 3.2.16 Evolution of PCB emissions by category and distribution in year 2021

3.2.3. Condensable component of PM_{10} and $PM_{2.5}$

As detailed in Annex V, indication of whether the emission estimates and emission factors for PM_{10} and $PM_{2.5}$ in the Energy sector include or exclude the condensable component can be found in the table below:

Table 3.2.3 Condensable component of PM_{10} and $PM_{2.5}$ in Energy sector

NFR	Source/sector name	PM emissions: the condensable component is		EF reference and comments
		included	excluded	
1A1a	Public electricity and heat production		X	<u>LPS</u>: continuous stack measurements of TSP (mainly opacimeters, calibrated by gravimetry and isokinetic sampling); $PM_{2.5}$ and PM_{10} fractions based in CEPMEIP (2000), from TSP data. <u>Area sources</u>: default EF from CEPMEIP Database (2000).
1A1b	Petroleum refining		X	Varying degrees of complexity; in majority emission factors represent filterable PM emissions.
1A1c	Manufacture of solid fuels and other energy industries		X	LPS (coke plants): country specific TSP and PM_{10} EF; $PM_{2.5}$ fraction based in CEPMEIP. <u>Area sources</u>: mainly default EF from CEPMEIP Database (2000), but also from EEA/EMEP Guidebook (2019) where most of the EF used represents only filterable PM emissions.
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	Mostly excluded but unclear		Varying degrees of complexity: in majority emissions factors represent filterable PM emissions, but it may not be clear whether only the filterable part or the total part is represented (EMEP/EEA Guidebook (2019); TSP (mainly opacimeters, calibrated by gravimetry and isokinetic sampling); $PM_{2.5}$ and PM_{10} fractions based in CEPMEIP (2000), from TSP data. Periodic measurements (between one time a week and once a year).
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous Metals	Mostly excluded but unclear		Varying degrees of complexity: in majority emissions factors represent filterable PM emissions, but it may not be clear whether only the filterable part or the total part is represented (EMEP/EEA Guidebook (2019); TSP (mainly opacimeters, calibrated by gravimetry and isokinetic sampling); $PM_{2.5}$ and PM_{10} fractions based in CEPMEIP (2000), from TSP data. Periodic measurements (between one time a month and once a year).
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	Mostly excluded but unclear		Varying degrees of complexity: in majority emissions factors represent filterable PM emissions, but it may not be clear whether only the filterable part or the total part is represented (EMEP/EEA Guidebook (2019).

NFR	Source/sector name	PM emissions: the condensable component is		EF reference and comments
		included	excluded	
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	Mostly excluded but unclear		Varying degrees of complexity: in majority emissions factors represent filterable PM emissions, but it may not be clear whether only the filterable part or the total part is represented (EMEP/EEA Guidebook (2019). Periodic measurements (between once a month and more than once a year).
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	Mostly excluded but unclear		Varying degrees of complexity: in majority emissions factors represent filterable PM emissions, but it may not be clear whether only the filterable part or the total part is represented (EMEP/EEA Guidebook (2019).
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	Mostly excluded but unclear		Varying degrees of complexity; in majority emission factors represent filterable PM emissions (EMEP/EEA Guidebook (2019), OFICEMEN).
1A2gvii	Mobile combustion in manufacturing industries and construction	X		EF from EEA/EMEP Guidebook (2019).
1A2gviii	Stationary combustion in manufacturing industries and construction: Other		X	$PM_{2.5}$ and PM_{10} fractions based in CEPMEIP (2000), from TSP data. Periodic measurements (between once a week and once a year).
1A3ai(i)	International aviation LTO (civil)	X		EF from FEIS model (EUROCONTROL).
1A3aii(i)	Domestic aviation LTO (civil)	X		
1A3bi	Road transport: Passenger cars	X		EF from EEA/EMEP Guidebook (2019): The measurement procedure regulated for vehicle exhaust PM mass characterisation requires that samples are taken at a temperature lower than 52°C. At this temperature, PM contains a large fraction of condensable species. Hence, PM mass emission factors in this sector are considered to include both filterable and condensable material.
1A3bii	Road transport: Light duty vehicles	X		
1A3biii	Road transport: Heavy duty vehicles and buses	X		
1A3biv	Road transport: Mopeds & motorcycles	X		
1A3bv	Road transport: Gasoline evaporation	NA		
1A3bvi	Road transport: Automobile tyre and brake wear	X		EF from EEA/EMEP Guidebook (2019).
1A3bvii	Road transport: Automobile road abrasion	X		EF from EEA/EMEP Guidebook (2019).
1A3c	Railways	X		Default T1 EF from EEA/EMEP Guidebook (2019).
1A3di(ii)	International inland waterways	NO		
1A3dii	National navigation (shipping)	X		EF from EEA/EMEP Guidebook (2019).
1A3ei	Pipeline transport		X	Default EF from CEPMEIP Database (2000).
1A3eii	Other	NO		
1A4ai	Commercial/Institutional: Stationary	Depending on category and fuel		EF from EEA/EMEP Guidebook (2019), Chapter 1A4, Small combustion.

NFR	Source/sector name	PM emissions: the condensable component is		EF reference and comments
		included	excluded	
				Boilers – solid and liquid fuels: It is unclear whether PM emissions include or not the condensable component. Boilers – gaseous fuels: Condensable component excluded. Boilers – biomass: Condensable component included. Turbines – all fuels: It is unclear whether PM emissions include or not the condensable component. Stationary engines – lliquid fuels: Condensable component excluded. Stationary engines – gaseous fuels: It is unclear whether PM emissions include or not the condensable component.
1A4aii	Commercial/Institutional: Mobile	X		Default EF from EEA/EMEP Guidebook (2019), Chapter 1A4 Non-road mobile machinery, table 3-1.
1A4bi	Residential: Stationary	Depending on category and fuel		EF from EEA/EMEP Guidebook (2019), Chapter 1A4, Small combustion. Boilers – solid fuels: Condensable component excluded. Boilers – gas oil: Condensable component excluded. Boilers – rest of liquid fuels: It is unclear whether PM emissions include or not the condensable component. Boilers – gaseous fuels: It is unclear whether PM emissions include or not the condensable component. All appliances – biomass: Condensable component included.
1A4bii	Residential: Household and gardening (mobile)	IE		
1A4ci	Agriculture/Forestry/Fishing: Stationary	Depending on category and fuel		EF from EEA/EMEP Guidebook (2019), Chapter 1A4, Small combustion. Boilers – solid and liquid fuels: It is unclear whether PM emissions include or not the condensable component. Boilers – gaseous fuels: Condensable component excluded. Boilers – biomass: Condensable component included. Stationary engines – gas oil: Condensable component excluded. Stationary engines – rest of liquid fuels: It is unclear whether PM emissions include or not the condensable component.
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	X		EF from EEA/EMEP Guidebook (2019).
1A4ciii	Agriculture/Forestry/Fishing: National fishing	X		EF from EEA/EMEP Guidebook (2019).
1A5a	Other stationary (including military)	IE		
1A5b	Other, Mobile (including military, land based and recreational boats)	X		Aggregated methodology from 1A3a, 1A3b, 1A3dii (see categories above).

NFR	Source/sector name	PM emissions: the condensable component is		EF reference and comments
		included	excluded	
1B1a	Fugitive emission from solid fuels: Coal mining and handling	No information available		EF from EEA/EMEP Guidebook (2019).
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	No information available		EF from EEA/EMEP Guidebook (2019).
1B1c	Other fugitive emissions from solid fuels	NO		
1B2ai	Fugitive emissions oil: Exploration, production, transport	NA		
1B2aiv	Fugitive emissions oil: Refining and storage	No information available		EMEP/EEA Guidebook (2019). Continuous measurements.
1B2av	Distribution of oil products	NA		
1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)	NA		
1B2c	Venting and flaring (oil, gas, combined oil and gas)	No information available		Continuous measurements.
1B2d	Other fugitive emissions from energy production	NO		

3.3. Major changes

In the present edition, the Spanish Inventory has made several major changes that are summarized in the table below.

Those referred to the recommendations made by the TERT in the 2022 NECD review[1] (pursuant to Directive (EU) 2016/2284), and to the recommendations made by the ERT in the Spanish Stage 3 centralised Review Report (2022) of the UNECE LRTAP[2], have been marked with an asterisk (*).

Table 3.3.1 Major changes in the Energy sector in Inventory edition 2023

NFR Category	Activities included	Pollutant	Type of change
Public electricity and heat production (**1A1a**)	- Electicity production (1A1ai)	All	New activity data and data corrections
	- District heating networks (1A1aiii)	All	Activity data update
Petroleum refining (**1A1b**)	- Ethylene production	All	Activity data correction
Manufacture of solid fuels and other energy industries (**1A1c**)	- Coke ovens (1A1ci)	All	EF corrections
	- Other energy industries (1A1cii, 1A1ciii, 1A1civ)	All (except PCBs)	Fuel balance recalculation
Stationary combustion in manufacturing industries	- Alumina production	PAHs, BaP, BbF, BkF, IcP	New estimation according to EMEP/EEA Guidebook (2019)

[1] Final Review Report available in: https://environment.ec.europa.eu/topics/air/reducing-emissions-air-pollutants/emissions-inventories_en

[2] Stage 3 Review Report available in: https://www.ceip.at/status-of-reporting-and-review-results/2022-submission

NFR Category	Activities included	Pollutant	Type of change
and construction: Non ferrous metal **(1A2b)**		NMVOC, HM, PCDD/PCDF	No emissions estimation according to EMEP/EEA Guidebook (2019)
Stationary combustion in manufacturing industries and construction: Non metallic mineral **(1A2f)**	- Magnesites	All	EF update according to EMEP/EEA Guidebook (2019)
	- Bricks and tiles	All	Reallocation of two subactivities from 1A2gviii
Stationary combustion in manufacturing industries and construction **(1A2gviii)**	- Bricks and tiles	All	Reallocation of two misplaced subactivities to 1A2f
Road transport (**1A3b**) (*)	- Exhaust emissions	NMVOC, CO, NOx, PM	EF update according to EMEP/EEA Guidebook (2019, Oct 2021)
National navigation (**1A3d**)	- National navigation	CO, NOx, NMVOC, PM, BC, Cu, Se, As	EF update according to EMEP/EEA Guidebook (2019, Dic 2021)
Commercial/Institutional sector (**1A4a**)	- Stationary	All	Activity data update
Commercial/Institutional sector (**1A4a**) (*)	- Stationary. Biomass consumption	NH_3	New estimates
Residential sector (**1A4b**)	- Stationary	All	Activity data update
Residential sector (**1A4b**) (*)	- Stationary. Biomass consumption	All	Activity data update (new split of biomass appliances)
Agriculture, forestry and fishing sector (**1A4ci**)	- Stationary	All	Activity data update
Agriculture, forestry and fishing sector (**1A4ci**) (*)	- Stationary. Biomass consumption	NH_3	New estimates
Agriculture, forestry and fishing sector (**1A4ci**)	- Stationary. Natural gas consumption	All	New estimates
Agriculture, forestry and fishing sector (**1A4cii**)	- Mobile machinery (agriculture, forestry, fishing)	All	Activity data update
Agriculture, forestry and fishing sector (**1A4ciii**)	- Mobile machinery (fishing)	CO, NOx, NMVOC, PM, BC, Cu, Se, As	EF update according to EMEP/EEA Guidebook (2019, Dic 2021)
Distribution of oil products (1B2av)	- Gasoline distribution	NMVOC	Activity data update Update to EMEP/EEA Guidebook (2019)

3.4. Key categories analysis

Within this sector, the following categories have been identified as key (Table 3.2.2 for reference).

A. Public electricity and heat production - 1A1a
B. Petroleum refining - 1A1b
C. Manufacture of solid fuels and other energy industries - 1A1c
D. Manufacturing industries and construction - 1A2

E. Road transport - 1A3b

F. National navigation - 1A3d

G. Combustion in other sectors - 1A4

H. Fugitive emissions from fuels - 1B

It is worth mentioning that Air traffic at airports (1A3a) is not a key category in the present Inventory edition, thus is not included in the current chapter. The decline in fuel consumption suffered in this category since 2020 has been caused by the COVID-19 pandemic.

Activity data sources, methodologies and a general assessment for each category are provided.

A. Public electricity and heat production (1A1a)

This category includes Public service heat and power generation plants (NFR 1A1a) and it constitutes one of the main contributors to the emissions in the Inventory as a whole. It is considered a key category for:

- NOx, NMVOC, SO_2, $PM_{2.5}$, PM_{10}, TSP, Hg, PAHs and HCB for level and trend reasons;
- CO and Cd for level reasons;
- PCDD/PCDF for trend reasons.

The dominant types of installations in the power plants are gas turbines (combined cycles) and boilers, and among the latter, those with power ratings in excess of 300 MWt. Facilities using stationary engines are particularly significant within the extra-peninsular electrical system. The presence of district heating networks in Spain is not very significant, although this activity has been experiencing a relatively important growth in recent years.

In the current edition of the Inventory, some significant changes in activity data have been performed under 1A1a category:

- Activity data corrections in two combined cycle power stations (LPS), in year 2020;
- New data from one MSW incineration plant (LPS) and one biomass power plant (AS) not previously accounted for (both in operation since2020);
- Activity data updates within sub-category 1A1aiii (District heating), for years 2019 and 2020.

Descriptions of these changes, along with other minor ones, are shown in section 3.6 (Recalculations) and in Chapter 8 (Recalculations and planned improvements).

A.1. Activity variables

The following table summarises the main activities considered within this category, as well as the main activity data and their corresponding sources of information.

Table 3.4.1 Summary of activity variables, data and information sources for category 1A1a

Activities included	Activity data	Source of information
Public service heat and power generation plants	- Fuel consumption. - Fuel characteristics: LHV, contents in carbon, sulphur, ash, etc. - Type of installation and thermal power installed. - Other parameters required for the application of emission estimation algorithms.	- 1990-1993: OFICO-MINER. - 1994-2021: IQ to thermal power stations (Large Point Sources). - 1990-2021: information on fuel consumption and location of small power plants (Area Sources) provided by MITECO. - 2009-2021: information on fuel consumption and location of solar thermal plants (Area Sources) provided by the Spanish Office of Climate Change at MITECO. - 1990-2012: information on district heating (Area Sources) from FEMP / ADHAC. - 2013-2021: national census of district heating plants provided by IDAE at MITECO.

Activities included	Activity data	Source of information
Biogas from solid waste landfills in power plants	- Amounts of waste and biogas burnt. - Other parameters required for the application of emission estimation algorithms.	- 1990-2008: IQ. - 2009-2021: information provided by national focal point (Subdirectorate General of Circular Economy at MITECO). - 2009-2021: IQ to non-municipal facilities.
Municipal and industrial incineration plants with heat or electricity production	- Quantities of waste burnt. - Composition of the waste. - Other parameters required for the application of emission estimation algorithms.	- IQ to incineration plants.

A.2. Methodology

Table 3.4.2 Summary of methodologies applied in category 1A1a

Pollutants	Tier	Methodology applied	Observations
Boilers (Methodology factsheet: Public electricity production)			
SO_2	T2	Direct emissions measurement. Stoichiometric balance. EMEP/EEA Guidebook (2019) Part B, Chapter 1.A.1.a. Chapter 1.A.4.	Data provided by installations via IQ. In absence of direct measurements. In absence of data: default EF. Tables 3-4, 3-5, 3-9 to 3-16. Tables 3-10, 3-25, 3-27 and 3-45.
NOx	T2	Direct emissions measurement. EMEP/EEA Guidebook (2019) Part B, Chapter 1.A.1.a. Chapter 1.A.4.	Data provided by installations via IQ. In absence of data: default EF. Tables 3-4, 3-5, 3-9 to 3-16. Tables 3-10, 3-25, 3-27 and 3-45.
$PM_{2.5}$, PM_{10}, TSP BC	T1/T2 T1	Mixed methodology based on direct emissions measurement and default EF from CEPMEIP. EMEP/EEA Guidebook (2019) Part B, Chapter 1.A.1.a.	Data (TSP) provided by installations via questionnaire; distribution of $PM_{2.5}$ and PM_{10} fractions based on CEPMEIP Database. In absence of data: CEPMEIP default EF. Default EF: % of the $PM_{2.5}$. Tables 3-3, 3-6, 3-9 to 3-16.
Cd, Hg, Pb	T1/T2	For coals: CS (country specific) EF from a national study. EMEP/CORINAIR Guidebook (2007) Part B, Chapter 111. EMEP/EEA Guidebook (2019) Part B, Chapter 1.A.4.	EF obtained from publication: "*Heavy metal emissions in ENDESA's Coal Power Stations*". For other fuels or data absence: default EF Table 31, DBB. Area Sources - district heating: default EF. Tables 3-25, 3-27 and 3-45.
PCDD/PCDF	T1	OSPARCOM-HELCOM-UNECE (1995). EMEP/EEA Guidebook (2019) Part B, Chapter 1.A.4.	EF for maximum abatement techniques. Table 4.5.1. Area Sources - district heating: default EF. Tables 3-9, 3-25, 3-27 and 3-45.
PAHs	T1	EMEP/EEA Guidebook (2019) Part B, Chapter 1.A.1.a. Chapter 1.A.4.	Default EF. Tables 3-4 to 3-6 and 3-9 to 3-16. Tables 3-8 to 3-10, 3-25, 3-27 and 3-45.
PCBs	T1	EMEP/EEA Guidebook (2019) Part B, Chapter 1.A.1.a. Chapter 1.A.4.	Default EF. Tables 3-4 to 3-6 and 3-9 to 3-16. Table 3-18 and 3-45.
NMVOC	T1/T2	Direct emissions measurement. EMEP/EEA Guidebook (2019) Part B, Chapter 1.A.1.a. Chapter 1.A.4.	Data provided by installations via IQ. In absence of data: default EF Tables 3-4, 3-5, 3-9 to 3-16. Tables 3-10, 3-25, 3-27 and 3-45.

Pollutants	Tier	Methodology applied	Observations
CO	T1/T2	Direct emissions measurement. EMEP/EEA Guidebook (2019) Part B, Chapter 1.A.1.a Chapter 1.A.4.	Data provided by installations via IQ. In absence of data: default EF. Tables 3-4, 3-5, 3-9 to 3-16. Tables 3-10, 3-25, 3-27 and 3-45.
NH_3	T1/T2	Direct emissions measurement. EMEP/EEA Guidebook (2019) Part B, Chapter 1.A.4.	LPS: data provided by installations via IQ. Area Sources: default EF. Tables 3-10 and 3-45.
Gas turbines and stationary engines (Methodology factsheet: Public electricity production)			
SO_2	T2	Direct emissions measurement. Stoichiometric balance. EMEP/EEA Guidebook (2019) Part B, Chapter 1.A.1.a.	Data provided by installations via IQ. In absence of direct measurements. In absence of data: default EF. Tables 3-5, 3-17 to 3-20.
NOx	T2	Direct emissions measurement. EMEP/EEA Guidebook (2019) Part B, Chapter 1.A.1.a.	Data provided by installations via IQ. In absence of data: default EF. Tables 3-5, 3-17 to 3-20.
$PM_{2.5}$, PM_{10}, TSP BC	T1/T2 T1	Mixed methodology based on direct emissions measurement and default EF from CEPMEIP. EMEP/EEA Guidebook (2019) Part B, Chapter 1.A.1.a.	Data (TSP) provided by installations via questionnaire; distribution of $PM_{2.5}$ and PM_{10} fractions based on CEPMEIP Database. In absence of data: CEPMEIP default EF. Default EF: % of the $PM_{2.5}$. Tables 3-5, 3-17 to 3-20.
Cd, Hg, Pb	T1	EMEP/CORINAIR Guidebook (2007) Part B, Chapter 111.	Default EF. Table 31, DBB.
PAHs	T1	EMEP/EEA Guidebook (2019) Part B, Chapter 1.A.1.a. Chapter 1.A.4.	Default EF. Tables 3-5, 3-6 and 3-17 to 3-20. Tables 3-9, 3-28, 3-31.
PCBs	T1	EMEP/EEA Guidebook (2013) Part B, Chapter 1.A.1.a.	Default EF. Table 3-19.
NMVOC	T1/T2	Direct emissions measurement. EMEP/EEA Guidebook (2019) Part B, Chapter 1.A.1.a.	Data provided by installations via IQ. In absence of data: default EF. Tables 3-5, 3-17 to 3-20.
CO	T1/T2	Direct emissions measurement. EMEP/EEA Guidebook (2019) Part B, Chapter 1.A.1.a.	Data provided by installations via IQ. In absence of data: default EF. Tables 3-5, 3-17 to 3-20.
MSW incineration plants (with energy recovery) (Methodology factsheet: MSW incineration power plants)			
Main Pollutants, PM, BC, Heavy Metals, PCDD/PCDF, PAHs, HCB, PCBs	T1/T2	Direct emissions measurement. EMEP/EEA Guidebook (2019) Part B, Chapter 5.C.1.a.	Emission data and abatement techniques provided by installations via IQ. In absence of data: default EF by tonne of waste table 3-2 (1990-1995, it was assumed only “Particle Abatement” as control techniques) and table 3-1 (1996-2015, it is considered as a minimum “Particle Abatement + acid gas abatement”).
Industrial waste incineration plants (with energy recovery) (Methodology factsheet: IW incineration power plants)			
Main Pollutants, PM, BC, HM, PCDD/PCDF, PAHs, HCB	T1	EMEP/EEA Guidebook (2019) Part B, Chapters 5.C.1.bi, 5.C.1.bii, 5.C.1.biv.	Default EF by tonne of waste. Table 3-1.

Pollutants	Tier	Methodology applied	Observations
Combustion in managed landfills with biogas capture; Combustion in biogas facilities; Combustion in domestic wastewater handling plants with biogas capture (Methodology factsheet: Managed landfills) (Methodology factsheet: Biomethanization) (Methodology factsheet: Domestic wastewater handling)			
NOx, CO, PM	T1	US EPA AP-42 - 5th Edition (1998) Chapter 2.4.	Default EF. Table 2.4-4.

A.3. Assessment

According to Red Eléctrica de España (REE) data[3], the demand for electricity in Spain during 2021 showed an increase of 2.6% compared to 2020, this being the first year of growth after two consecutive years of declining demand. The peninsular electricity system demand (just over 94% of total demand nationwide) was 2.4% higher, which contrasts with the 5% decline recorded in 2020, but remains impacted by the prolonged effects of the COVID-19 crisis in year 2021 and pre-pandemic values have not yet been recovered. In terms of electricity generation, there was a new all-time high in peninsular renewable generation with a 48.4% share of the total electricity generation mix as a result of an increase in wind power and solar photovoltaic production. The share of non-renewable generation stood at 51.6%, a decrease of 2.9 percentage points compared to the previous year. This decrease in non-renewable generation on the Spanish mainland is mainly due to the lower production of nuclear and combined cycle power stations (3.1% and 2% less than in 2020, respectively).

The Inventory reflects this behavior of the Spanish electricity system. Thereby, fuel consumption recorded under category 1A1a increased by 2.8% in 2021 compared to 2020 mostly due to the growth in the consumption of natural gas (+2.0%), the current main fuel used in electricity generation; biomass (+12.5%), which for first time reaches consumption values higher than coals; and the consumption of wastes (+12.2%), particularly MSW.

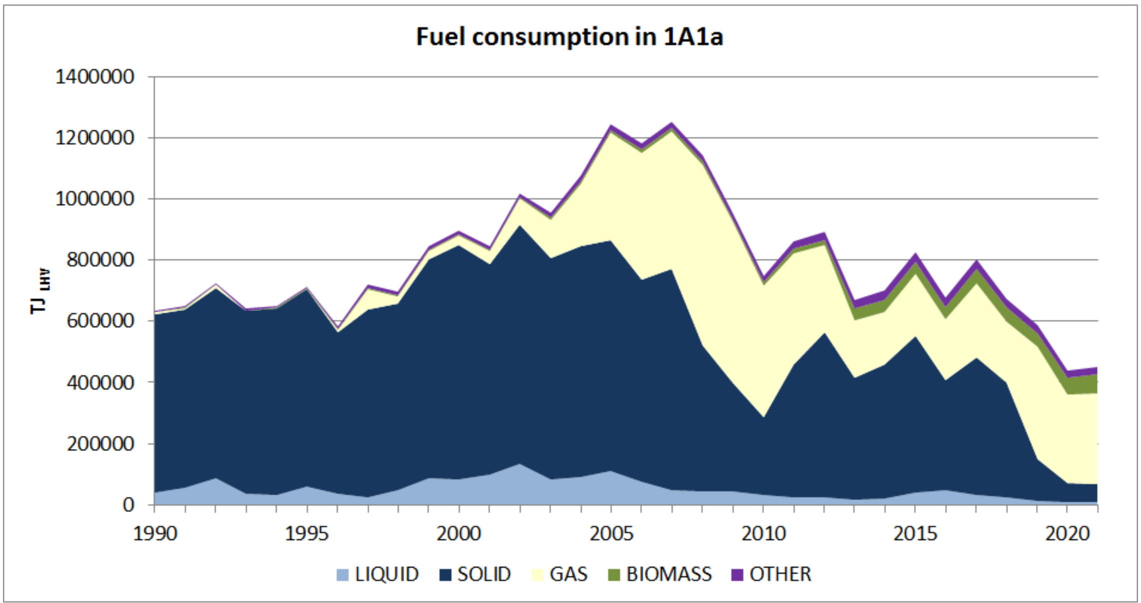


Figure 3.4.1 Evolution of fuel consumption in category 1A1a

[3] REE Spanish Electricity System 2021 Report

Regarding the whole time series (Figure 3.4.1), even though solid fuels have historically been the predominant type of fuel used for electricity generation, since 2019 coal use has clearly ceased in favour of natural gas, due to the cessation of coal mining in Spain -year 2018- and the progressive closure of coal-fired power plants. Consumption level of solids in 2021 remains similar than in 2020 only thanks to the increasing use of blast furnace gas. The graph also shows the influence of the economic downturn in Spain in this sector since 2007.

Furthermore, the only IGCC plant in Spain was closed at the end of 2015, so 'Gas works gas' is no longer used in electricity generation.

Among liquid fuels, as the following table shows, the main consumption corresponds to residual oil, with a complementary contribution of gas oil. As of 2006, there was a significant decrease in the consumption of residual oil, as a result of the cessation of activity of several thermal plants. In the years 2015 and 2016, there was a remarkable increase in petroleum coke burned at coal-fired thermal plants, although this trend changed in 2017 until reaching zero consumption in 2021.

Table 3.4.3 Fuel consumption in category 1A1a (Amounts in TJ_{LHV})

TYPE	1990	2005	2010	2015	2019	2020	2021
LIQUID	***39,928***	***109,650***	***30,632***	***40,793***	***12,944***	***9,082***	***8,448***
GAS OIL	2,203	14,719	14,456	5,066	4,223	2,765	2,673
LPG	-	-	-	0	0	0	0
PETROLEUM COKE	-	26,081	363	26,774	797	471	-
RESIDUAL OIL	37,726	68,790	15,776	8,936	7,925	5,847	5,775
OTHER LIQUID FUELS	-	59	37	17	-	-	-
SOLID	***581,240***	***755,577***	***254,251***	***510,772***	***135,441***	***60,330***	***57,962***
BLAST FURNACE GAS	4,784	9,922	7,672	11,374	10,350	6,406	11,031
BROWN COAL / LIGNITE	114,539	61,976	-	-	-	-	-
BROWN COAL BRIQ.	5,860	-	-	-	-	-	-
COKE OVEN GAS	944	2,410	530	-	-	-	-
GAS WORKS GAS	-	6,466	8,179	6,135	-	-	-
STEAM COAL	401,951	625,694	224,266	460,453	114,510	51,500	45,914
SUB-BITUMINOUS COAL	53,162	49,109	13,604	32,809	10,580	2,424	1,017
GAS	***7,450***	***351,556***	***430,686***	***203,329***	***366,733***	***292,911***	***298,667***
NATURAL GAS	7,450	351,556	430,686	203,329	366,733	292,911	298,667
BIOMASS	***1,346***	***9,499***	***13,317***	***38,868***	***46,269***	***54,445***	***61,249***
AGRICULTURAL WASTES	-	1,080	2,777	9,373	13,460	16,586	19,397
BIOGAS	1,340	3,542	4,597	6,806	6,633	6,982	7,220
GAS FROM WASTE TIPS	6	4,427	4,877	4,123	4,670	3,952	3,878
WOOD WASTES	-	451	1,065	18,566	21,506	26,924	30,754
OTHER	***3,103***	***18,568***	***19,384***	***31,826***	***25,977***	***22,686***	***25,447***
INDUSTRIAL WASTES	-	590	618	8,848	4,086	3,650	3,905
MUNICIPAL WASTES	3,103	15,598	17,426	22,213	20,862	18,057	20,757
WASTE GAS	-	2,379	1,339	766	1,029	980	785
TOTAL	**633,068**	**1,244,849**	**748,270**	**825,587**	**587,363**	**439,455**	**451,773**

With regard to gaseous fuels, the entry into operation of the Maghreb gas pipeline in 1996 was an important milestone, connecting Spain with the natural gas fields of Algeria and beginning the widespread use of this fuel throughout the country, and for electricity generation in particular. The increase in natural gas consumption is remarkable since 2002 owing to new combined cycle power stations. 2011 onwards there is a general decline in the use of natural gas, which changes dramatically in 2019.

Within the biomass consumption, the trend would be linked to the actions developed by the Administration for the promotion of biomass in different productive sectors, such as the Renewable Energy Plan (PER) 2005-2010 and its subsequent regulatory developments. Until 2012 the main fuel corresponds to biogas in the landfills and biomethanization plants. In 2013, the consumption of wood wastes together with agricultural wastes begins to gain relevance and continues its growth until 2021. This is explained by the proliferation of biomass power plants in recent years in Spain.

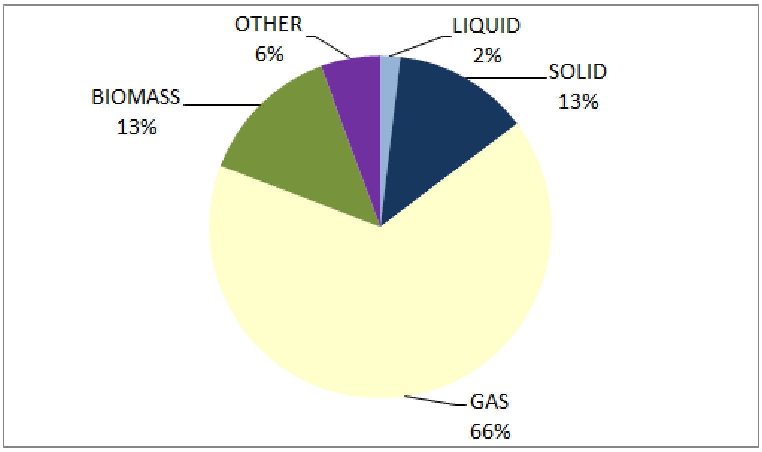


Figure 3.4.2 Distribution of fuel consumption in category 1A1a (2021)

Finally, regarding the fuels included in 'Other', the general growing trend changed in 2018 due to the slight drop in MSW consumption. This downward trend continued, accompanied by the drop in industrial waste consumption, until year 2020. In contrast, in 2021 the consumption of 'other fuels' grows again, partly due to the operation of a new MSW incineration plant in northern Spain.

B. Petroleum refining (1A1b)

This NFR category 1A1b includes refineries performing many different processes. It is considered a key category for Cd for level and trend reasons, for SO_2 for trend reasons and for NOx for level reason.

In Spain (without Canary Islands), there are nine refineries with very diverse processes, ages, capacities and configurations.

Figure 3.4.3 Distribution of refineries in Spain

B.1. Activity variables

The following table summarises the main activities considered within this category as well as the main activity data and their corresponding sources of information.

Table 3.4.4 Summary of activity variables, data and information sources for category 1A1b

Activities included	Activity data	Source of information
Combustion processes in Refineries · Boilers, gas turbines, stationary engines. · Contactless processing furnaces: distillation, catalytic reforming, hydrotreatment, catalytic cracking, alkylation, hydrocracking*	**Fuel Consumption** - Fuel characteristics: LHV, contents in carbon, sulphur, ash, etc.	- IQ sent to each of the nine existing refineries

* Regarding the emissions of pollutants, consideration is given exclusively to those gases coming from the combustion carried out in the furnaces; the emissions that these furnaces might generate through non-combustible processes taking place inside them are included within category 1B2aiv. Additionally, the emissions from waste gas flaring are included in category 1B2c2i.

B.2. Methodology

Table 3.4.5 Summary of methodologies applied in category 1A1b

Pollutants	Tier	Methodology applied	Observations
Boilers, gas turbines, stationary engines and process furnaces (Methodology factsheets: Combustion in oil refining plants)			
SO_2	T3/T2	IQ	Direct emissions measurements, when available via IQ. Mass balance when measurements were not available.
NOx	T3/T2/T1	IQ EMEP/EEA Guidebook (2019), Chapter 1.A.1	Direct emissions measurements, when available via IQ. Default EF, tables 3-4, 3-5, 3-6, 3-17, 3-18, 4-2, 4-4, 4-5 and 4-6.
NMVOC	T1/T2	EMEP/EEA Guidebook (2019), Chapter 1.A.1.	Default EF, tables 3-4, 3-5, 3-6, 3-17, 3-18, 4-2, 4-4, 4-5 and 4-6.
$PM_{2.5}$, PM_{10}, TSP, BC	T1/T2	IQ EMEP/EEA Guidebook (2019), Chapter 1.A.1.	Direct emissions measurements, when available via IQ. With TSP measurement (generally) an in absence of PM_{10} and $PM_{2.5}$ CEPMEIP Database default emission factors. Default EF, tables 3-4, 3-5, 3-6, 3-17, 3-18, 4-2, 4-4, 4-5 and 4-6.
Cd, Pb, Hg, As, Cr, Cu, Ni, Se, Zn	T1/T2	EMEP/EEA Guidebook (2019), Chapter 1.A.1.	Default EF, tables 3-4, 3-5, 3-6, 3-17, 3-18, 4-2, 4-4, 4-5 and 4-6.
PCDD/PCDF	T1/T2	EMEP/EEA Guidebook (2019), Chapter 1.A.1.	Default EF, Tables 3-4, 3-5, 3-6, 4-4.

B.3. Assessment

There is a change in the relative share of liquid fuels between residual oil and refinery gas, particularly in the last years of the Inventory period. Thus, residual oil shows a downward trend from 2004 on, going from representing 49% of the consumption of liquid fuels in 1990 to 1.6% in 2021, and refinery gas shows an upward trend since 2010. Regarding the whole time series, this fuel varies from a 51% share of liquid fuels in 1990 to represent 97.3% in 2021.

The increase observed in natural gas consumption throughout the Inventory period is remarkable, as a consequence of the progressive installation of cogeneration units (gas turbines) in oil refinery plants.

Finally, mention should be made about the inclusion of various fuel gases (off-gas) used in oil refinery plants within 'Other' category with a low representativeness.

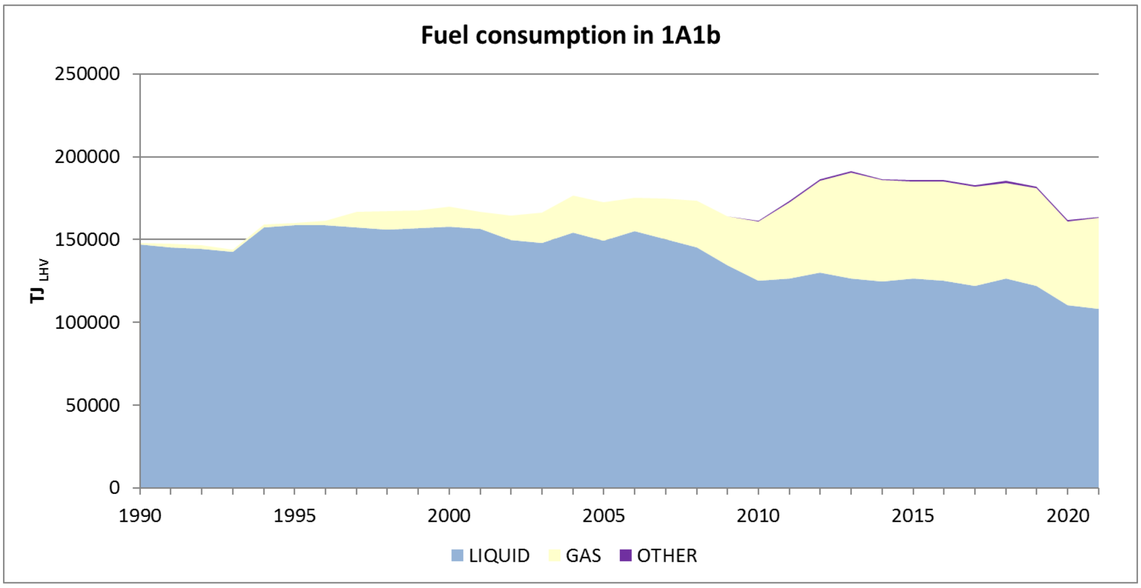


Figure 3.4.4 Evolution of fuel consumption in category 1A1b

Table 3.4.6 Fuel consumption (Amounts in TJ_{LHV})

TYPE	1990	2005	2010	2015	2019	2020	2021
LIQUID	***147,059***	***149,396***	***124,957***	***126,580***	***121,816***	***110,361***	***108,284***
GAS OIL	369	1,674	66	14	-	-	-
KEROSENE	-	22	2	-	-	-	-
LPG	-	172	143	115	117	-	-
NAPHTA	195	-	-	-	-	-	-
OTHER PETROLEUM PRODUCTS	-	1,390	884	1,461	1,845	1,714	1,799
REFINERY GAS	74,573	77,058	79,618	118,066	118,762	107,862	105,321
RESIDUAL OIL	71,922	69,079	44,245	6,923	1,092	786	1,165
GAS	***820***	***23,259***	***36,188***	***58,653***	***59,046***	***50,460***	***54,807***
NATURAL GAS	820	23,259	36,188	58,653	59,046	50,460	54,807
OTHER	-	-	***46***	***883***	***960***	***1,009***	***724***
WASTE GAS	-	-	46	883	960	1,009	724
TOTAL	***147,879***	***172,654***	***161,191***	***186,115***	***181,821***	***161,829***	***163,816***

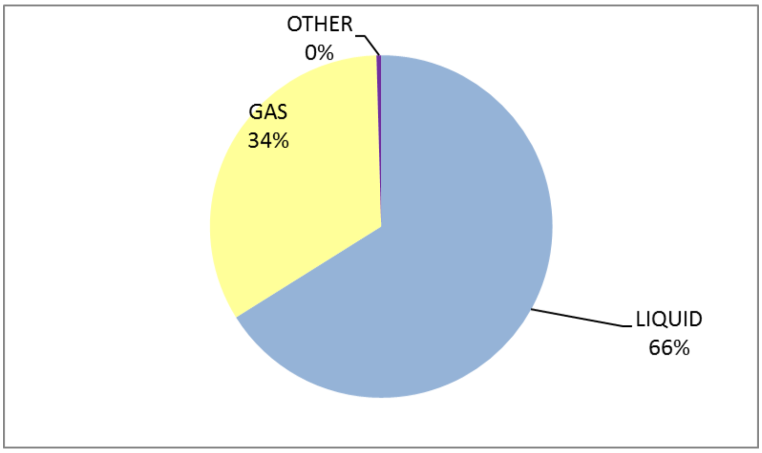


Figure 3.4.5 Distribution of fuel consumption in category 1A1b (2021)

Except for natural gas, the fuels used at the refineries are produced onsite. Therefore, their physical and chemical characteristics vary from one plant to another and even from one year to another in the same refinery. The characteristics (ranges) for the fuels used throughout the period of the Inventory are the following:

Table 3.4.7 Fuel characteristics

FUEL	% SULPHUR	% CARBON	LHV	
			kcal/kg	GJ/t
GAS/DIESEL OIL	0 – 0.872	82.70 – 87.47	9,542 – 10,548	39.76 – 43.95
INDUSTRIAL WASTE	0 – 6.8	0.07 – 74.05	60 – 16,344	0.25 – 68.9
LPG	0 – 0.03	73.30 – 81.85	10,548 – 11,347	43.95 – 46.58
NAPHTA	0	81.36	10,723 – 11,352	44.68 – 47.3
NATURAL GAS	0 – 0.12	69.32 – 78.50	10,728 – 12,550	44.7 – 52.29
OTHER (*)	-	-	-	-
OTHER KEROSENE	0.035 – 0.3	84.80 – 86.48	10,270 – 10,632	42.79 – 44.3
REFINERY GAS	0 – 5.7	0 – 87.77	7,152 – 14,124	29.8 – 58.85
RESIDUAL OIL	0 – 4.49	82.91 – 90.35	9,326 – 10,109	38.86 – 42.12

(*) No characteristics are given in the table for "Other" in view of the wide range of variation in the specifications of this gas and because no information is available regarding its characteristics in some refineries

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

This category deals with emissions generated in the transformation of solid fuels (coke ovens) as well as emissions generated at non-specific combustion installations both in the fuel transformation sector and in other energy industries (coal mining, oil and natural gas production).

It is considered a key category for $PM_{2.5}$, PM_{10}, TSP and BC, for trend reasons.

In the present edition, some changes in activity data have been performed under 1A1c category. An updating of base information from international questionnaires (IntQ), and a whole fuel balance recalculation (1990-2020) has affected fuel consumptions (mainly 1A1civ but also 1A1cii and 1A1ciii sub-categories). Within 1A1ci sub-category, the only coke oven belonging to an integrated steel plant, active since year 2013, ceased operation in 2020, and at the same time the refurbished installation of the other coke oven, that ceased operation in 2013, was put back into operation.

Additionally, the emission factors related to coke ovens have been corrected for the year 2020.

Descriptions of these changes, along with other minor ones, are shown in section 3.6 (Recalculations) and in Chapter 8 (Recalculations and planned improvements).

C.1. Activity variables

The following table summarises the main activities considered within this category, as well as the main activity data and their corresponding sources of information.

Table 3.4.8 Summary of activity variables, data and information sources for category 1A1c

Activities included	Activity data	Source of information
Transformation of solid fuels (coke ovens)	- Fuel consumption. - Fuel characteristics.	- IQ from integrated iron and steel plants. - IQ from plants not located in the integrated iron and steel plants.
Non-specific combustion installations: - Fuel transformation sector - Other energy industries	- Fuel consumption.	- IQ from the natural gas regasification, underground storage plants and gas pressure Regulating and Metering Stations (RMS) of natural gas pipeline network. - IntQ: Energy balance from International Questionnaires elaborated by MITECO.

C.2. Methodology

Table 3.4.9 Summary of methodologies applied in category 1A1c

Pollutants	Tier	Methodology applied	Observations
Coke oven furnaces: integrated iron and steel plants			
NOx, NMVOC	T2	EMEP/EEA Guidebook (2019) Part B, Chapter 1.A.1	Table 5-2.

Pollutants	Tier	Methodology applied	Observations
SO_2	T1/T2	1990-2018: IQ 2019-2021: EMEP/EEA Guidebook (2019) Part B, Chapter 1.A.1	Direct emissions measurements, when available via IQ. Mass balance when measurements were not available and no default emission factor had been applied. Table 5-2.
NH_3, PM_{10}, TSP, HM, PAHs	T2	1990-2018: Implicit emission factors obtained from one integrated plant in 2003 2019-2021: EMEP/EEA Guidebook (2019) Part B, Chapter 1.A.1	EF using 2003 data. Table 5-2.
$PM_{2.5}$	T1	1990-2018: CITEPA 2019-2021: EMEP/EEA Guidebook (2019) Part B, Chapter 1.A.1	Ratio derived from the default emission factors. Table 5-2.
BC	T2	EMEP/EEA Guidebook (2019) Part B, Chapter 1.A.1	Table 5-2.
CO	T1 T2	1990-2018:EMEP/CORINAIR Guidebook (2007) Part B, Chapter 146 2019-2021: EMEP/EEA Guidebook (2019) Part B, Chapter 1.A.1	Default EF. Table 5-2.
Coke oven furnaces: not integrated in steel plants			
ALL (except SO_2 and NH_3)	T1/T2	Implicit emission factors obtained from one integrated plant in 2003	It was used due to the similarities in the fuels consumed (coke oven gas).
SO_2	T2	Country specific methodology	Mass balance based on the characteristics (sulphur contents) of coke oven gas attributed to these plants.
Boilers, gas turbines and stationary engines (Methodology factsheet: Combustion in other energy industries)			
CO, NMVOC, NOx, SO_2, NH_3, HM, PAHs, HCB, PCBs	T1	EMEP/EEA Guidebook (2019) Part B, Chapter 1.A.4	Default EF. Tables 3-21, 3-25, 3-27 to 3-31 and 3-45.
TSP, $PM_{2.5}$, PM_{10} BC	T1	CEPMEIP Database EMEP/EEA Guidebook (2019) Part B, Chapter 1.A.4 Chapter 1.A.1.a	Default EF from CEPMEIP. Default EF: % of the $PM_{2.5}$. Tables 3-21, 3-27 to 3-31 and 3-45. Table 3-11.
PCDD/PCDF	T1	OSPARCOM-HELCOM-UNECE (1995)	EF based on abatement techniques. Table 4.5.1.

C.3. Assessment

Overall, fuel consumption in category 1A1c is currently somewhat lower than in the first years of the series. Peak values were reached in the years 2006-2008 and are related to the consumption of natural gas as an energy source prior to the economic crisis (see Figure 3.4.6). The sharp decline in 2020 is closely linked to the general downturn in Spanish economic activity caused by the COVID-19 pandemic. However, it should be noted that the fuel consumption data provided by the energy statistics are, in some cases, incomplete up to 2005, as explained below.

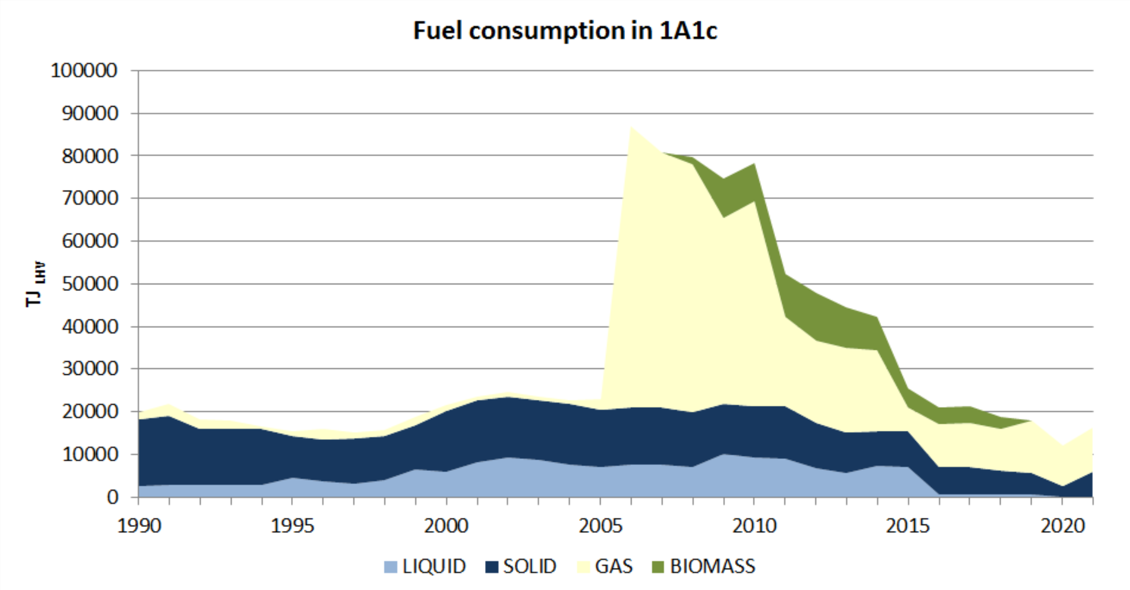


Figure 3.4.6 Evolution of fuel consumption in category 1A1c

The main fuels used in this category are natural gas (gaseous fuels), coke oven gas (solid fuels), petroleum coke (liquid fuels), and wood wastes (biomass).

For some fuels (especially in the case of natural gas), there are notable fluctuations and discontinuities in the evolution of the series, which are directly related to the source of the underlying data. Most of the energy consumption of natural gas in category 1A1c (sub-categories 1A1cii, 1A1ciii and 1A1civ) comes from the international Gas Energy Questionnaire, prepared by MITECO for submission to IEA-EUROSTAT. Specifically, the evolution of natural gas is a consequence of the consumption profile in the section '*Energy Sector - Not elsewhere specified (Energy)*'. The explanation for the jump in natural gas consumption between 2005 and 2006 lies in the fact that MITECO only began to include it in this section when the reporting of this type of consumption to the Administration became compulsory in Spain. On the other hand, this source does not complete the historical series backwards, but collects in the international questionnaires only the information available, which is the one used for the Inventory, so the information gap prior to 2006 remains.

Table 3.4.10 Fuel consumption in category 1A1c (Amounts in TJ_{LHV})

TYPE	1990	2005	2010	2015	2019	2020	2021
LIQUID	***2,554***	***7,143***	***9,365***	***6,949***	***572***	***105***	***130***
GAS OIL	1,950	1	24	519	572	105	130
LPG	-	9	-	-	-	-	-
PETROLEUM COKE	-	7,076	9,341	6,431	-	-	-
RESIDUAL OIL	603	57	-	-	-	-	-
SOLID	***15,776***	***13,430***	***11,930***	***8,430***	***5,172***	***2,481***	***5,762***
BLAST FURNACE GAS	4,116	1,927	1,527	-	-	431	208
COKE OVEN GAS	7,534	8,694	7,449	6,384	5,172	2,051	5,554
GAS WORKS GAS	10	-	-	-	-	-	-
STEAM COAL	4,102	2,809	2,954	2,046	-	-	-

TYPE	1990	2005	2010	2015	2019	2020	2021
SUB-BITUMINOUS COAL	13	-	-	-	-	-	-
GAS	***1,624***	***2,350***	***48,078***	***5,580***	***12,165***	***9,529***	***10,486***
NATURAL GAS	1,624	2,350	48,078	5,580	12,165	9,529	10,486
BIOMASS	***-***	***-***	***8,957***	***4,563***	***-***	***-***	***-***
WOOD WASTES	-	-	8,957	4,563	-	-	-
TOTAL	**19,953**	**22,924**	**78,329**	**25,522**	**17,910**	**12,116**	**16,378**

In general, the trend in fuel consumption in category 1A1c has been downward since 2006. Of particular note is the sharp drop in 2015, of around 40% compared to 2014, mainly due to the sharp decline in natural gas and biomass consumption. In 2017, the trend of recent years was reversed, with consumption increasing by 1.5% compared to the previous year, almost exclusively due to natural gas. In 2020, total fuel consumption in category 1A1c fell sharply by 32% compared to 2019, with a generalised drop for all types, but particularly significant for gas (-22%) and coke oven gas (-60%). The year 2021 sees some recovery to pre-COVID-19 pandemic levels of consumption.

Natural gas has been the most consumed fuel in category 1A1c since 2006, when it replaced solids in importance, although its consumption has declined significantly since then, having fallen sharply twice, in 2011 and 2015. After significant growth in 2019, the sharp decline in 2020 was partly due to the general decline in economic activity in various energy sectors, but also to the drop in natural gas consumption in the solid fuel transformation sector (coke ovens), where it has been partially replaced by blast furnace gas.

Among the solid fuels, the consumption of coke oven gas predominates over the period inventoried, followed by steel gases (blast furnace gas). The closure in 2014 of the coke oven at the only integrated steel plant that still used blast furnace gas as fuel for the coke ovens means that it is no longer consumed in category 1A1c. In 2020, consumption of blast furnace gas is recorded again, due to the reopening of the coke oven at this facility. As this installation is progressively raising its coke production, an increase in coke oven gas consumption is observed in 2021, replacing blast furnace gas as fuel.

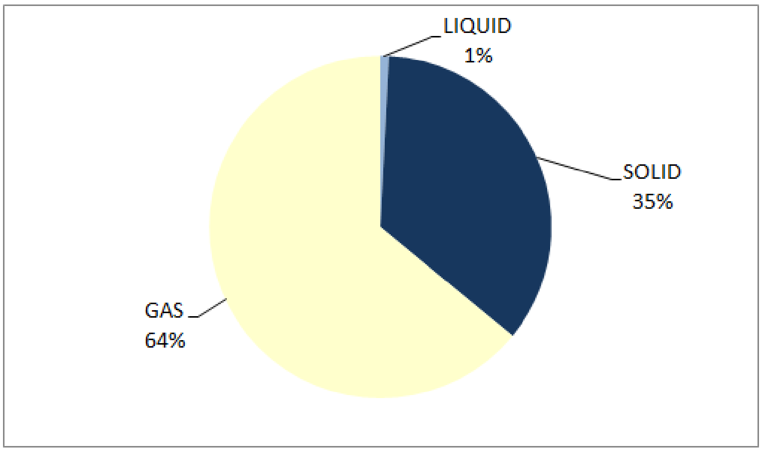


Figure 3.4.7 Distribution of fuel consumption in category 1A1c (2021)

The data on biomass consumption in category 1A1c come from the IEA-EUROSTAT Renewable Energy Questionnaire, prepared by MITECO. This broad category groups very heterogeneous combustion activities, where the growing trend in biomass consumption, which started in 2008, is most probably linked to the actions developed by the Administration for the promotion of biomass in different productive sectors (as well as in the residential and services sector), such as the Renewable Energy Plan (PER) 2005-2010 and its subsequent regulatory developments. In 2019, biomass disappears from the statistical records linked to category 1A1c, coinciding with the definitive cessation of coal mining in Spain, where it was used as a fuel in small boilers (<50 MWt).

In the current Inventory edition, an updating of base information from IntQ, and a recalculation for the Inventory fuel balance has been performed for the whole time series. This has caused slight variations in the consumption of certain fuels and in the corresponding emission estimates under 1A1c.

D. Combustion in industry (1A2)

This category encompasses a set of activities related to industrial combustion. Depending on the device used and the type of process, the Spanish Inventory data compilation is performed differentiating the following four groups:

1. Non-specific stationary industrial combustion: this group includes the emissions from non-specific industrial combustion in boilers, gas turbines and stationary engines whose purpose is the production of electricity and/or the generation of heat. Within the boilers, the Spanish Inventory compiles the emissions differentiating the ranges of rated thermal input capacity (combustion plants: RTI ≥300 MWt; combustion plants: 300 MWt > RTI ≥ 50 MWt; combustion plants: RTI <50 MWt).
2. Industrial combustion in furnaces without contact: this group includes the emissions from furnaces in which neither the flames nor the combustion gases come into contact with the products that are processed. Within this group, the Inventory compiles the emissions from blast furnaces, plaster furnaces and other type of processes.
3. Industrial combustion in furnaces with contact: this group includes the emissions from furnaces in which the flames and/or the combustion gases come into contact with the products that are processed.
4. Industrial mobile machinery: includes emissions of exhaust gases from vehicles and mobile machinery operating in open spaces, essentially in mining, construction and public works.

The Spanish Inventory assigns the emissions from each industrial sector in two different categories (emissions from combustion of fuels in NFR category 1A2, SNAP group 03 and specific emissions of the industrial process in NFR category 2, SNAP group 04).

The combustion in industry is a key category for its contribution to the level and the trend of the emissions of NOx, NMVOC, SO_2, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, PAHs and HCB; for PCBs for trend reasons.

Spanish Inventory compiles more than 60 combinations of activities and fuels from more than 70 different sources (both area and large point sources) included in industrial combustion. For this reason, all the particularities of every activity/pollutant are not fully detailed in the following tables. The main characteristics of the activity variables and the methodology are explained in the following sections.

D.1. Activity variables

Table 3.4.11 Summary of activity variables, data and information sources for category 1A2

Activities included	Activity data	Source of information
Combustion in industry (**1A2**)	Fuel consumption and LHV by category.	AQs: Energy balance from international questionnaires elaborated by DGPEM (MITECO).
Stationary combustion in manufacturing industries and construction: Iron and steel (**1A2a**)	Fuel consumption by process. Fuel characteristics: LHV, contents in carbon, sulphur, ash, etc. Other parameters required for the estimation of NFR 2 emissions: production, type of process, inputs used, etc.	IQ from the two existing integrated iron and steel plants. For non-integrated iron and steel sector, the Inventory uses data from: - MINER for 1990-1993, - UNESID for 1994-2021 - FEAF.

Activities included	Activity data	Source of information
Stationary combustion in manufacturing industries and construction: Nonferrous metals (**1A2b**)	Fuel consumption by process. Fuel characteristics: LHV, contents in carbon, sulphur, ash, etc. Other parameters required for the estimation of NFR 2 emissions: production, type of process, inputs used, etc.	- Primary Aluminium: IQ from the only existing production plant of electrolytic aluminium. - Primary copper: IQ from the only existing plant. - Primary zinc: IQ from the only existing plant. For industries listed below an estimate of fuel consumption is made based on energy requirements (GJ/tonne produced) obtained from the IPCC non-ferrous metal industry BREF. Information on production has been obtained from the following sources: - Primary lead: MINER. - Secondary lead: IQ from five plants, UNIPLOM and MITYC. - Secondary Aluminium: SGIBPMINER, ASERAL, MITYC and INE data. - Secondary Zinc: SGIBP-MINER and U.S. Geological Survey Mineral Yearbook (2014). - Secondary copper: SGIBP-MINER, MITYC, UNICOBRE and U.S. Geological Survey Mineral Yearbook (2014).
Stationary combustion in manufacturing industries and construction: Chemicals (**1A2c**)	Fuel consumption by process.	IQ from production plants.
Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print (**1A2d**)	Fuel consumption by process. Fuel characteristics: LHV, contents in carbon, sulphur, ash, etc. Other parameters required for the estimation of NFR 2 emissions: production, type of process, inputs used, etc.	IQ from 9 production plants. ASPAPEL
Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco (**1A2e**)	Fuel consumption and LHV by category.	IQ from 5 sugar plants.
Stationary combustion in manufacturing industries and construction: Non-metallic minerals (**1A2f**)	Fuel consumption by process. Fuel characteristics: LHV, contents in carbon, sulphur, ash, etc. Other parameters required for the estimation of NFR 2 emissions: production, type of process, inputs used, etc.	Cement: OFICEMEN. Asphalt concrete plants: "Asphalt in figures", EAPA. Lime: ANCADE. Glass: Vidrio España, ANFFEC. Brick and tiles: HISPALYT. Fine ceramics: ASCER. IQ from 2 magnesite plants
Mobile Combustion in manufacturing industries and construction (**1A2gvii**)	1993-1996: fuel consumption estimation constructed from those two aspects. Remaining years: fuel consumption series, extended from 1993-1996 series by means of the socio-economic variables.	1993-1996: expert's judgments on specialized sectorial documentation, about: machinery fleet and activity parameters. Remaining years: representative variables of the main socio-economic sector, in relation with the sectorial evolution: - < 1993: cost for building and civil engineering works, available (until 2005) in the "Ministry of Public Works' Statistical Yearbook". >1996: gross fixed capital formation (GFCF) in the construction sector, published by INE.
Stationary combustion in manufacturing industries and construction (**1A2gviii**)	1993-1996: fuel consumption estimation constructed from those two aspects.	1993-1996: expert's judgments on specialized sectorial documentation, about: machinery fleet and activity parameters.

Activities included	Activity data	Source of information
	Remaining years: fuel consumption series, extended from 1993-1996 series by means of the socio-economic variables.	Remaining years: representative variables of the main socio-economic sector, in relation with the sectorial evolution: - < 1993: cost for building and civil engineering works, available (until 2005) in the "Ministry of Public Works' Statistical Yearbook". >1996: gross fixed capital formation (GFCF) in the construction sector, published by INE.

The information coming from direct sources in 1A2 represents 56% of the entire information for the last year reported. The remaining data (44%) come from the national energy statistics, provided by the Spanish Ministry for the Ecological Transition and Demographic Challenge (MITECO). Therefore, the contribution of energy statistics to 1A2 emission estimates is quite significant.[4]

D.2. Methodology

The methodological approach for all industrial combustion activities is similar. The following table summarizes the general approach followed for estimating all activities as well as the methodology of activities with distinct approaches within this 1A2 category.

Table 3.4.12 Summary of methodologies applied in category 1A2

Pollutants	Tier	Methodology applied	Observations
General approach	T1/T2	IQ	Within the IQ, the plants provide measured emissions, specific emission factors or default emission factors.
		Entrepreneurial associations.	The collaboration of the Inventory with associations of reference in different sectors derives in certain cases in national specific emission factors.
		EMEP/EEA Guidebook (2019) & EMEP/CORINAIR Guidebooks. CEPMEIP. PARCOM-ATMOS etc.	In the cases that the Inventory cannot obtain national specific information, the best available generic combustion factors by type of device.
Non-specific industrial combustion (Methodology factsheets: Non - specific industrial stationary combustion)			
NOx, NMVOC, CO, SO_2, NH_3, PM, CO, HM, PCDD/PCDF, PAHs, HCB, PCBs	T3/T2/T1	EMEP/EEA Guidebook (2016) & EMEP/CORINAIR Guidebooks.	
Iron and steel (1A2a) (Methodology factsheet: Sintering plants (combustion); Blast furnace cowpers; Combustion in other furnaces without contact; Reheating furnaces)			

[4] See Appendix 3.1: Inventory energy balance (IEB).

Pollutants	Tier	Methodology applied	Observations
NOx, NMVOC, SO_2, PM, CO, HM, PCDD/PCDF, PAHs, HCB, PCBs	T3/T2/ T1	IQ. EMEP/EEA Guidebook (2019) Chapter 1.A.1, 1.A.2, 1.A.4. EMEP/CORINAIR Guidebooks Chapters B333. CEPMEIP. PARCOM-ATMOS.	Information from IQ from integrated steel plants has been obtained for several pollutants and years. As this information is not homogeneous and sustained over the years, the Spanish Inventory completes the information from measurements with the best available emission factors.
Non-Ferrous Metals (1A2b) (Methodology factsheet: Combustion in other furnaces without contact; Non ferrous metal production (combustion))			
NOx, NMVOC, SO_2, PM, CO, HM, PCDD/PCDF, PAHs, HCB, PCBs	T2/T1	IQ. EMEP/EEA Guidebook (2019) Chapters 1A1, 1A2 and 1A4. CEPMEIP.	Mass balance (SO_2). EF
Chemicals (1A2c)			
NOx, NMVOC, SO_2, NH_3, PM, CO, HM, PCDD/PCDF, PAHs, HCB, PCBs	T3/ T2	IQ. EMEP/EEA Guidebook (2019) Chapter 1.A.2.	Information from IQ. EF
Pulp, Paper and Print (1A2d)			
NOx, NMVOC, SO_2, NH_3, PM, CO, HM, PCDD/PCDF, PAHs, HCB, PCBs	T2/T1	IQ EMEP/EEA Guidebook (2019) Chapter 1A1, 1A2. EMEP/CORINAIR Guidebooks Chapters B111, B321. OSPARCOM-HELCOM-UNECE (1995). CEPMEIP.	Mass balance (SO_2). EF
Food Processing, Beverages and Tobacco (1A2e)			
NOx, NMVOC, SO_2, NH_3, PM, CO, HM, PCDD/PCDF, PAHs, HCB, PCBs	T2	EMEP/EEA Guidebook (2019) Chapter 1.A.2.	EF
Cement (under 1A2f)			
NO_X, NMVOC, SO_2, NH_3, PM, HM, PCDD/PCDF, PCBs	T2	OFICEMEN	EF OFICEMEN 1990 – 2005: OFICEMEN estimated the expected evolution of the incorporation of reduction technologies, as well as their impact on the emissions of the pollutants considered. OFICEMEN 2005: OFICEMEN provided EFs as an average of the values measured within the Environmental Benchmarking programme for 2003. OFICEMEN 2013: OFICEMEN provided representative EFs based on a measurement program developed during the years 2007-2011. OFICEMEN 2014: OFICEMEN provided representative EFs based on a measurement program developed during the years 2009-2013.

Pollutants	Tier	Methodology applied	Observations
			OFICEMEN 2017: OFICEMEN provided representative EFs based on a measurement program developed during the years 2011-2015. OFICEMEN 2020: OFICEMEN provided representative EFs based on a measurement program developed during the years 2014-2018.
Non-metallic Minerals (except Cement) (1A2f)			
NOx, NMVOC, SO_2, NH_3, PM, CO, HM, PCDD/PCDF, PAHs, HCB, PCBs	T2	EMEP/EEA Guidebook (2016, 2019) Chapter 1.A.2. EMEP/CORINAIR Guidebooks Chapters B112. OSPARCOM-HELCOM-UNECE (1995). CEPMEIP.	EF
Other (1A2gvii) Mobile Combustion in manufacturing industries and construction (Methodology factsheet: Mobile machinery)			
NOx, NMVOC, SO_2, NH_3, PM, HM (except Pb, Hg, As), PAHs	T2/T1	EMEP/EEA Guidebook (2019) Chapter 1.A.4	EF
Other (1A2gviii) Other:			
NOx, NMVOC, SO_2, NH_3 , PM, CO, HM, PCDD/PCDF, PAHs, HCB, PCBs	T2	EMEP/CORINAIR Guidebooks Chapters B111, B112. EMEP/EEA Guidebook (2019) Chapter 1.A.2. OSPARCOM-HELCOM-UNECE (1995). CEPMEIP.	EF

In those cases where the information registered by the Inventory does not fully cover all the sectors, information is completed with the official energy statistics.[5]

D.3. Assessment

The consumption of liquid and gaseous fuels in 1A2 shows opposite trends along the Inventory period. While liquid fuels show a downward trend, representing 45% of the total consumption in 1990 and 12% in 2021, gaseous fuels increase their share from 25% in 1990 to 69% in 2021. Whereas biomass fuels shows a steady trend over the whole period.

The most representative fuels for 2021 besides natural gas (69%) are wood wastes (7%), petroleum coke (6%), diesel oil (4%), black liquor (3%) and residual oil (2%).

[5] See Appendix 3.1.

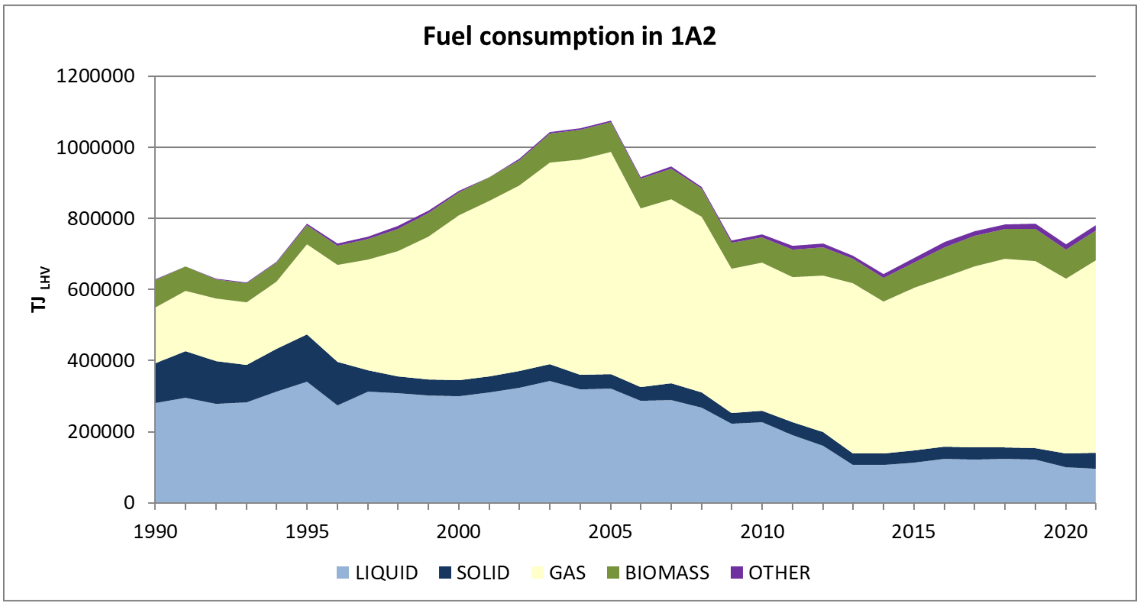


Figure 3.4.8 Evolution of fuel consumption in category 1A2

Table 3.4.13 Fuel consumption (Amounts in TJ_{LHV})

TYPE	1990	2005	2010	2015	2019	2020	2021
LIQUID	***281,532***	***321,666***	***226,676***	***113,534***	***121,434***	***100,088***	***97,315***
BITUMEN	-	-	34	42	127	10	76
CRUDE OIL	-	-	-	181	-	-	
DIESEL OIL ROAD TRANSPORT	50,489	57,038	44,042	21,922	30,845	26,307	28,574
GAS OIL	424	8,220	3,858	372	603	557	797
LPG	13,283	10,819	3,260	552	558	552	3,992
OTHER LIQUID FUELS	-	-	788	709	1,628	1,662	1,130
PETROLEUM COKE	57,027	135,800	126,262	55,596	57,855	47,987	43,453
REFINERY AND PETROCHEM, GAS	1,344	-	-	-	-	-	
RESIDUAL OIL	158,965	110,121	48,518	34,161	29,818	23,021	19,293
SOLID	***110,714***	***41,011***	***33,566***	***35,119***	***32,841***	***39,640***	***43,565***
BLAST FURNACE GAS	16,501	8,189	6,963	8,501	8,739	6,892	8,856
COKE OVEN COKE	16,850	9,280	7,402	6,712	6,963	21,341	17,796
COKE OVEN GAS	15,057	7,690	6,634	3,883	2,632	1,063	2,899
GAS WORKS GAS	80						
STEAM COAL	60,830	14,460	11,068	14,574	13,485	9,596	13,008
STEEL PLANT FURNACE GAS	732	1,393	1,359	1,329	1,022	748	1,006
SUB-BITUMINOUS COAL	664		140	118			
BIOMASS	***78,127***	***83,753***	***69,271***	***71,448***	***89,968***	***81,891***	***83,932***
AGRICULTURAL WASTES		18	17	329	584	688	845
ANIMAL MEAL		1,033	835	1,165	1,408	1,271	999
BIOGAS	363	490	891	1,044	1,153	1,015	1,035
BLACK LIQUOR	18,217	32,106	30,897	31,613	21,425	21,070	26,392
CELLULOSE			25				
SEWAGE SLUDGE		315	823	399	257	324	267
WOOD WASTES	59,547	49,791	35,782	36,900	65,141	57,523	54,395

TYPE	1990	2005	2010	2015	2019	2020	2021
GAS	***157,084***	***623,915***	***416,528***	***456,121***	***526,838***	***491,758***	***542,106***
NATURAL GAS	157,084	623,915	416,528	456,121	526,838	491,758	542,106
OTHER	***838***	***5,310***	***9,383***	***11,807***	***13,624***	***13,124***	***15,057***
INDUSTRIAL WASTES	838	2,015	7,171	4,510	6,988	6,320	6,573
OTHER LIQUID WASTES		1,284	474	1,011	123	148	26
REFUSE DERIVED FUELS			438	5,682	5,986	6,123	8,073
WASTE GAS		921					
WASTE SOLVENTS		1,089	1,299	605	527	533	385
TOTAL	***628,296***	***1,075,656***	***755,424***	***688,028***	***784,705***	***726,501***	***781,974***

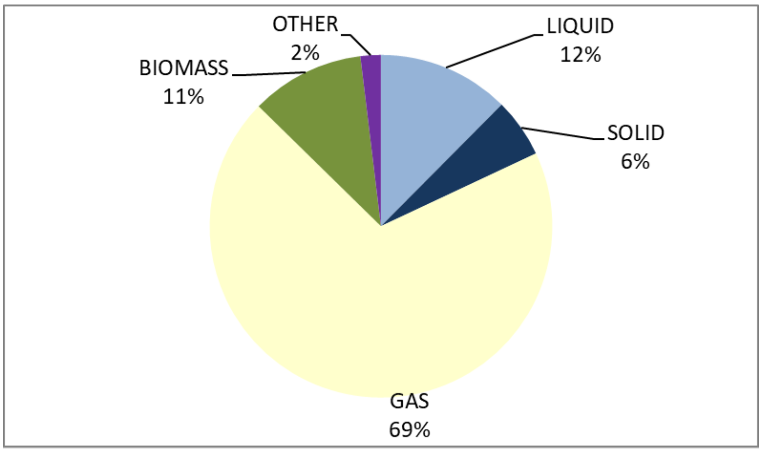


Figure 3.4.9 Distribution of fuel consumption in category 1A2 (2021)

E. Road Transport (1A3b)

This subcategory encompasses pollutant emissions from traffic of vehicles whose main purpose is the road transportation of passengers or freight. Self-propelled vehicles that are classified and used as industrial or agricultural-forestry machinery are included in categories 1A2 and 1A4.

In the last Inventory Edition the methodology of road transport was updated, including both activity data and emission calculations. An emission calculation tool was implemented, according to the guidelines of EMEP/EEA Guidebook (2019), which was validated comparing with software COPERT 5.4.36.

In the present Inventory Edition, emission factors of pollutants affected have been updated according to the latest version of EMEP/EEA 2019 Guidebook (October 2021), following the recommendation made by the ERT in the Spanish Stage 3 centralised Review Report (2022) of the UNECE LRTAP Convention[6]. New calculate equations of cold exhaust PM have been implemented in the calculation tool, in line with the updates made in software COPERT 5.5.1 (September 2021). Non-exhaust emission of electric vehicles have also been calculated in the present Inventory Edition. Also, natural gas consumption between years 2018 and 2020 has been updated, due to more accurate information available. In addition, LCV of LPG has been updated according to new information available.

Road transport is one of the main contributors to the emissions in the whole Spanish inventory, therefore is a key category for its contribution to the level and trend of the emissions of NOx, NMVOC, Particulate Matter, Black Carbon, CO, Pb, Cd, Hg, and PAHs. In addition, is a key category for its contribution to the trend of the emissions of SO_2, NH_3 and PCDD/PCDF.

E.1. Activity variables

Table 3.4.14 Summary of activity variables, data and information sources for category 1A3b

Activities included	Activity data	Source of information
Road transport	**Fuel consumption**	- AQs: National energy balances elaborated by MITECO, and sent to IEA and EUROSTAT. - “Oil-derived Product Consumption Statistics” by the Sub-Directorate-General for Hydrocarbons at MITECO.

[6] Stage 3 Review Report available in: https://www.ceip.at/status-of-reporting-and-review-results/2022-submission

Activities included	Activity data	Source of information
	Vehicle fleets Number of registered vehicles classified by type: - Vehicle category, - Fuel type, - Engine capacity or maximum authorised mass, - Year of registration	- 2007 – 2021: Statistics elaborated by the DGT (Spanish Traffic Department) of the Ministry of Interior. Remaining years: Estimation based on "Anuario Estadístico General" ("General Statistical Yearbook") published by the DGT (Spanish Traffic Department) of the Ministry of Home Affairs. In order to ensure consistency between the two data sets, the available disaggregated information of vehicle type by year of registration (from 1900 to 2006) of year 2007 was used to extrapolate trends and complete the missing information of the older statistics, which is classified in wider groups. Thus, the same detail level was achieved for all years inventoried. This explanation has been included following the recommendation made by the ERT in the Spanish Stage 3 centralised Review Report (2022) of the UNECE LRTAP Convention[7].
	Distances travelled - Journeys including the National Road Network (Red de Carreteras del Estado), Regional Community networks and Provincial networks, broken down by vehicle category and driving patterns (interurban and rural routes). - Distances travelled in urban driving pattern.	- Statistics from General Directorate for Roads (Ministry of Transport, Mobility and Urban Agenda). - Study of annual distances travelled by vehicles subject of Thecnical Inspection of Vehicles (ITV) in 2017 (DGT of Ministry of Home Affairs)
	Distribution of vehicle journeys - Distribution of the journeys for each vehicle category into driving patterns (interurban, rural and urban routes), depending on the fuel type, cylinder capacity, max. authorised mass and year of registration, prepared by the inventory team based on the referred information.	- Statistics from General Directorate for Roads (Ministry of Transport, Mobility and Urban Agenda). - Studies of road sampling carried out in the city of Madrid during the years 2008/2009, 2013 and 2017 (General Directorate of Sustainability and Environmental Control of Madrid City Council) -"Standing Survey of Road Freight" EPTMC, prepared by DGC (Subdirectorate-General for Statistics and Surveys at the Directorate-General for Economic Programming, of the Ministry of Transport, Mobility and Urban Agenda).

[7] Stage 3 Review Report available in: https://www.ceip.at/status-of-reporting-and-review-results/2022-submission

E.2. Methodology

Table 3.4.15 Summary of methodologies applied in category 1A3b

Pollutants	Tier	Methodology applied	Observations
Passenger cars (1A3bi), Light goods vehicles (1A3bii), Heavy duty vehicles (1A3biii) and motorcycles (1A3biv) (Methodology factsheet: Road transport: combustion)			
SO_2, HM	T1, T3	EMEP/EEA Guidebook 2019 (October 2021). Chapter 1.A.3.b.i, 1.A.3.b.ii, 1.A.3.b.iii, 1.A.3.b.iv	EF: - Emissions dependent on fuel consumption, assuming that all the sulphur and heavy metals content into fuel are emitted to the atmosphere. - Lubricants*: HM emissions are estimated assuming that they come only from engine wear.
CO, NOx, NMVOC, PM[8]	T3	EMEP/EEA Guidebook 2019 (October 2021). Chapter 1.A.3.b.i, 1.A.3.b.ii, 1.A.3.b.iii, 1.A.3.b.iv	EF: - Specific for each vehicle category, fuel and engine size. - Two types of emissions considered: - hot emissions (speed dependent) in three different driving patterns (see table 3.4.15 below). - additional cold emissions during transient thermal engine operation, related to meteorological conditions.
NH_3	T3	EMEP/EEA Guidebook 2019 (October 2021). Chapter 1.A.3.b.i, 1.A.3.b.ii, 1.A.3.b.iii, 1.A.3.b.iv	EF: - Related to vehicle mileage and fuel sulphur content.
PAHs, POPs, PCDD/PCDF, PCBs	T3	EMEP/EEA Guidebook 2019 (October 2021). Chapter 1.A.3.b.i, 1.A.3.b.ii, 1.A.3.b.iii, 1.A.3.b.iv	EF: - Values provided for all vehicle categories.
BC	T3	EMEP/EEA Guidebook 2019 (October 2021). Chapter 1.A.3.b.i, 1.A.3.b.ii, 1.A.3.b.iii, 1.A.3.b.iv	EF: - % of $PM_{2.5}$
Evaporative emissions (1A3bv) (Methodology factsheet: Road transport: evaporative emissions)			
NMVOC	T3	EMEP/EEA Guidebook 2019. Chapter 1.A.3.b.v	EF: - Emission factors depending on the temperature profile and the driving and parking pattern over the day, for uncontrolled and canister equipped vehicles.
Tyre and brake wear (1A3bvi) and road abrasion (1A3bvii) (Methodology factsheet: Road transport: tyre and brake wear and road abrasionemissions)			
PM, HM, PAHs	T2	EMEP/EEA Guidebook 2019. Chapter 1.A.3.b.vi, 1.A.3.b.vii	EF: - Emissions dependent on travelled distances (1.A.3.b.vi, 1.A.3.b.vii) and speed (1.A.3.b.vi) - EF given in section 1.A.3.b.vi/vii.
BC	T1	EMEP/EEA Guidebook 2019. Chapter 1.A.3.b.vi, 1.A.3.b.vii	EF: - % of PST

* Regarding the ES-1A3b-2017-0004 recommendation made by the TERT in the 2017 NECD review (pursuant to Directive (EU) 2016/2284), related to lubricant consumption, Heavy metals emissions are estimated based on the apparent emission factors from EMEP/EEA Guidebook 2019 (table 3-87) assuming that these emissions come exclusively from engine wear. The Spanish Inventory does not specifically estimate SO_2, NOx, NH_3, NMVOC nor $PM_{2.5}$ emissions due to lubricant consumption since these are assumed to be included within the fuel consumption emission factors and EMEP/EEA Guidebook does not provide emission factors for this subcategory. Therefore, emissions are all reported under 1A3b category but there is no point in reporting consumption as activity data.

[8] Regarding Particulate Matter, it is assumed that all of the emission is concentrated in $PM_{2.5}$

The following table describes in more detail the parameters used in the methodology.

Table 3.4.16 Methodological issues

Parameter	Description	Explanation
Vehicle classification	European regulations introducing common requirements for emissions from motor vehicles (EURO standards).	Those regulations have been considered taking into account the year of registration of the vehicles as an indicator of the vehicles' environmental characteristics, thus allowing the creation of a correspondence between the age of the fleet and the categories defined in EMEP/EEA Guidebook 2019.
Driving patterns	Three driving patterns defined by EMEP/EEA Guidebook 2019: - *highway driving (I)*, - *rural driving (R)*, and - *urban driving (U)*.	A distinction has been made between vehicle categories before determining average speeds, taking into account the different characteristics of the vehicles.
Running fleet	Distribution of the total distance travelled for each vehicle type: category, fuel type, segment (engine capacity or max. authorised mass) and EURO standars by driving pattern.	The distribution of the running fleet has been estimated by the inventory team based on road sampling studies carried out in the city of Madrid in years 2008/2009, 2013 and 2017 (General Directorate of Sustainability and Environmental Control of Madrid City Council) and the fleet characterization of each year, ensuring the temporal coherence along the inventory period. In the case of highway and rural driving patterns, the distribution of heavy duty trucks is estimated based on EPTMC surveys ("Standing Survey of Road Freight") prepared by DGC.
Other variables and parameters information	- Fuel Characteristics according to measured values, reported under the fuel quality Directive 98/70/EC. - Average length of journey: the value of 12 km has been assumed in accordance with EMEP/EEA Guidebook (2019). - Monthly minimum and maximum average temperatures (°C). (AEMET (Meteorology Statal Agency) of MITECO)	The estimation method includes parameters that qualify or constrain emission factors.

E.3. Assessment

The registered vehicle fleet in Spain has experienced notable growth over the years since 1990, doubling its number. Following the recommendation made by the ERT in the Spanish Stage 3 centralised Review Report (2022) of the UNECE LRTAP Convention[9], the trends in the fleet composition by fuel and Euro Standard by type of vehicle have been included, which can be observed in the following figures.

The distances travelled under the three driving patterns considered (interurban, rural and urban routes) have also experienced a similar increase, but the effect of the COVID-19 pandemic on transport activity has diminished the rising trend, resulting in an increase of 94% in 2021 compared to 1990.

[9] Stage 3 Review Report available in: https://www.ceip.at/status-of-reporting-and-review-results/2022-submission

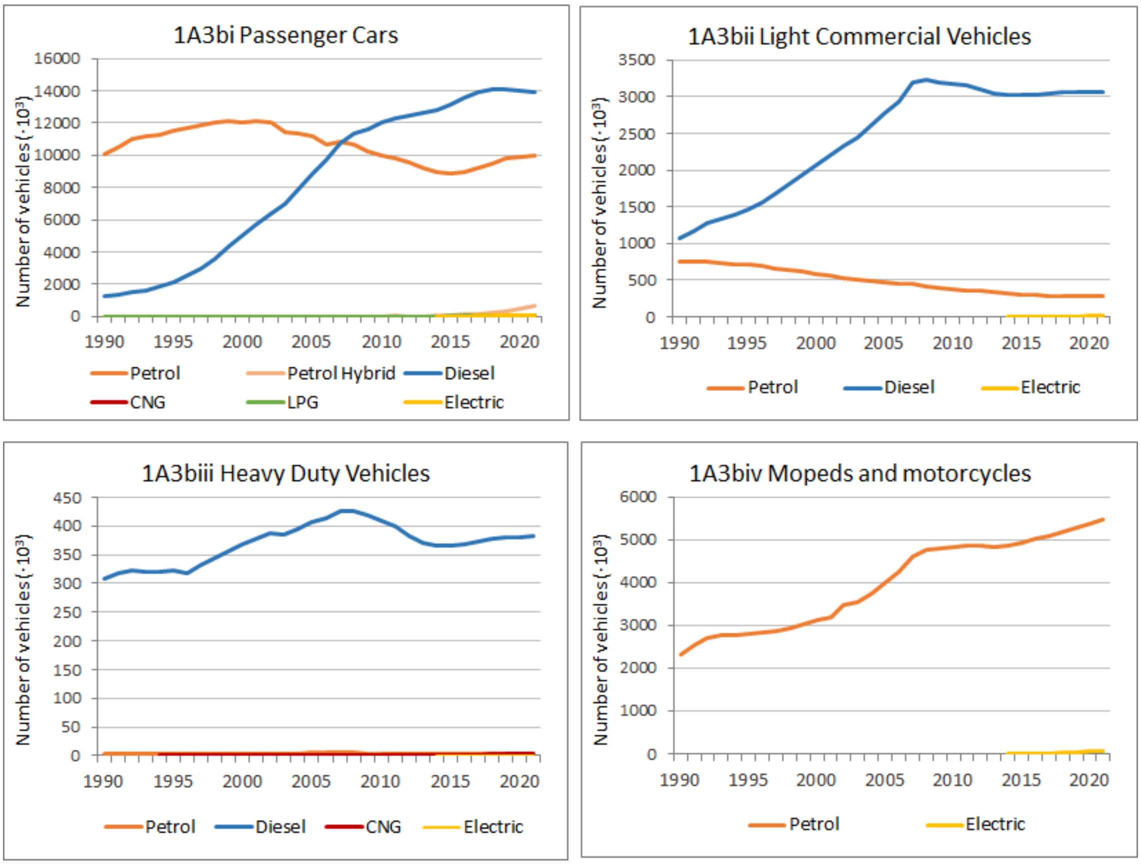


Figure 3.4.10 1A3b Fleet evolution by fuel

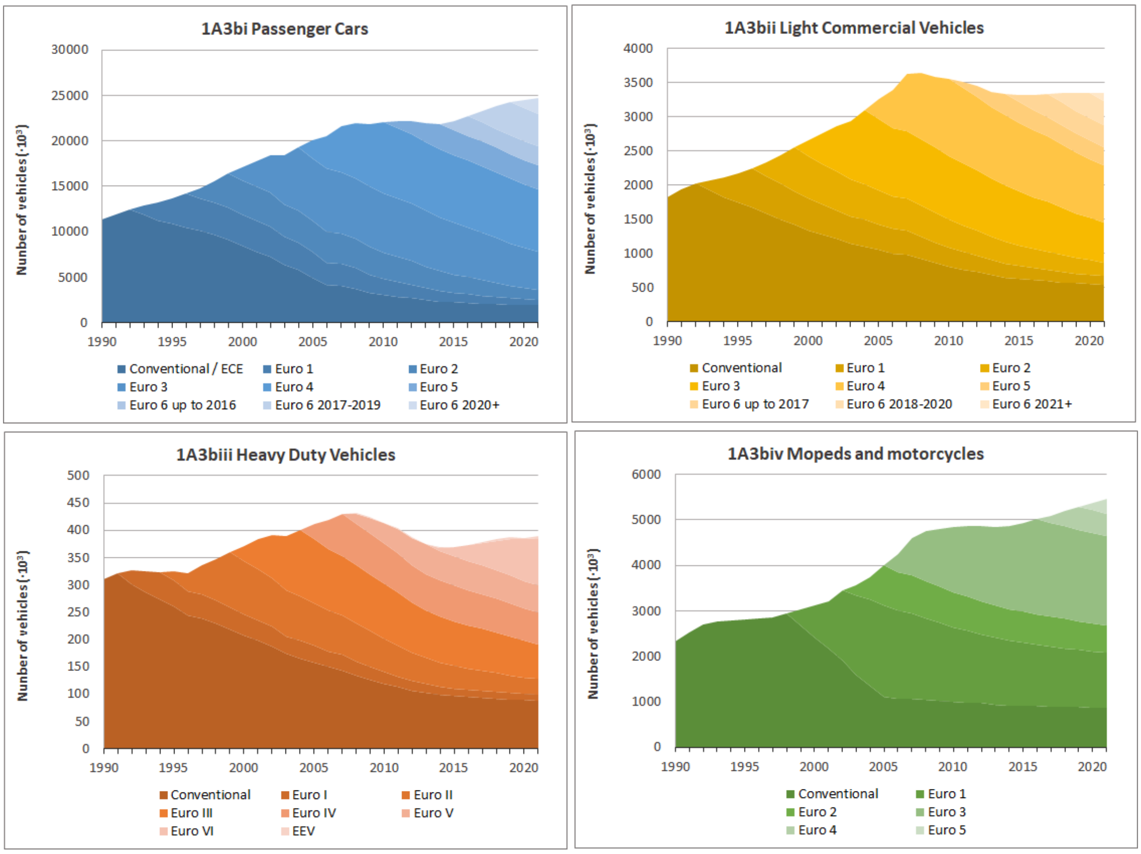


Figure 3.4.11 1A3b Fleet evolution by Euro Standard

Figures below illustrate the time-based index (taking 1990 as base 100, and year 2000 for $PM_{2.5}$) of the emissions of main pollutants in road transport category (1A3b), and priority heavy metals emissions evolution.

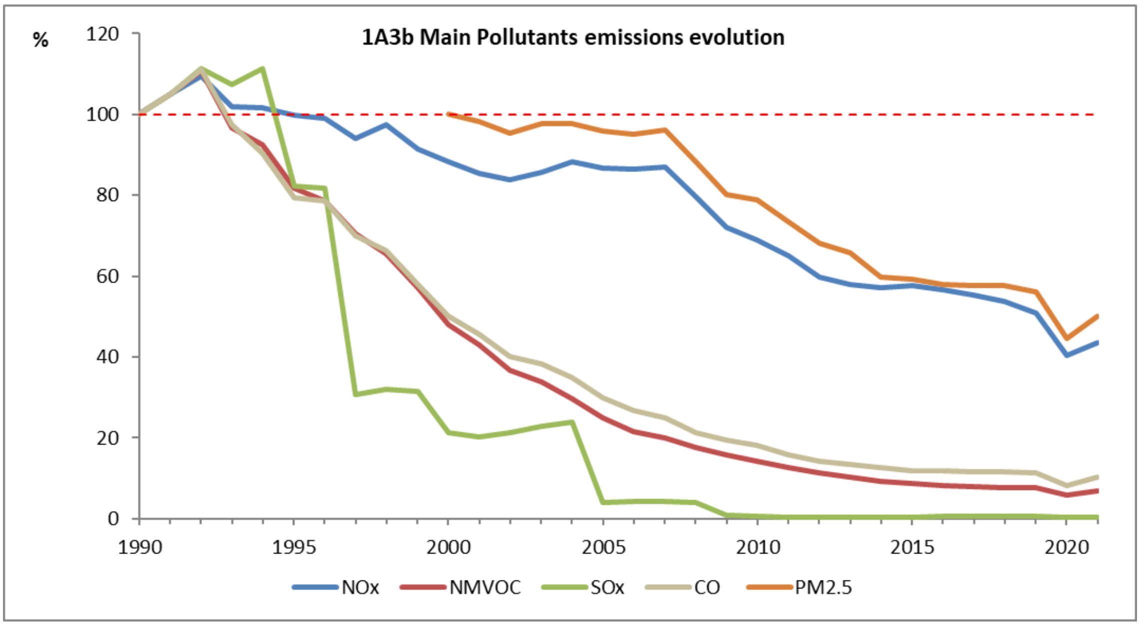


Figure 3.4.12 1A3b Main Pollutants, CO and $PM_{2.5}$ emissions evolution in percentage (1990 base 100)

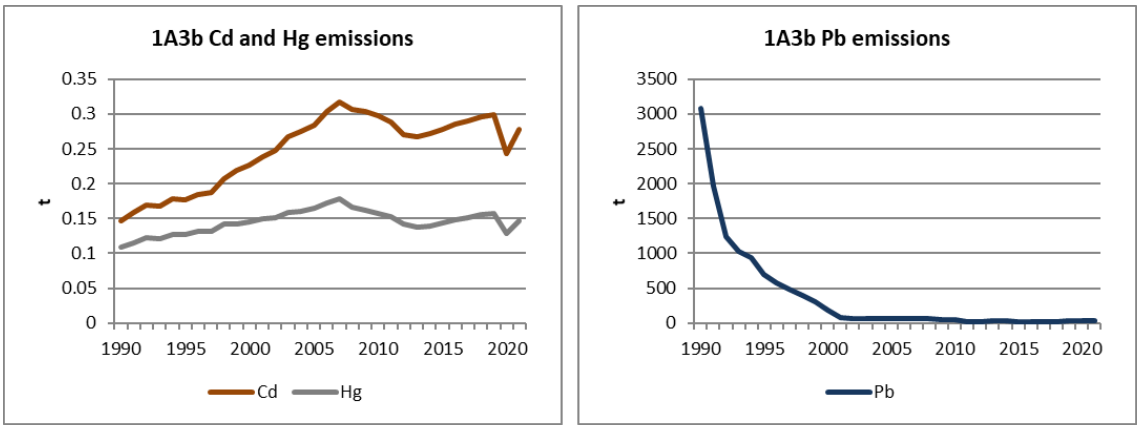


Figure 3.4.13 1A3b Priority heavy metal emissions evolution

The main contributor to NOx and SO_2 emissions is Passenger cars category (1A3bi) followed by Heavy duty vehicles and buses category (1A3biii). With respect to NMVOC, major contributors are Passenger cars category (1A3bi) and mopeds and motorcycles category (1A3biv). For the rest of pollutants, the main contributor is unquestionably, Passenger cars category. This category has experienced the most noticeable increase over the whole series both in vehicle fleet and in mileage for the three driving patterns. Despite this increase in activity, most pollutants have experienced strong decreases due to the enforcement of more stringent emission regulations.

EURO regulations entered into force in 1991 for the first time with the aim of limiting as much as possible the negative impact of road vehicles on the environment. These requirements are particularly focused on nitrogen oxides and Particulate Matter, but also show effects on other pollutants such as carbon monoxide (CO) and non-methane volatile organic compounds (NMVOC). Different emission limits have been established for each category of pollutants and for the different types of vehicles. Successive EURO regulations have been approved and their influence on the affected pollutant emissions is noticeable in the figures above.

Regarding heavy metals emissions, the graphs above reflect how road transport emissions of cadmium and mercury follow a similar trend to the pattern of fuel consumption in 1A3b category. On the other hand, Pb emissions suffer a drastic fall from the beginning of the series to reach negligible values since the prohibition of leaded gasoline in 2002.

The Inventory covers pollutant emissions coming from all kinds of fuels, all vehicle categories and the three different driving patterns (highway, rural and urban routes). The road transport NOx emissions in 2021 in Spain can be split in the following manner:

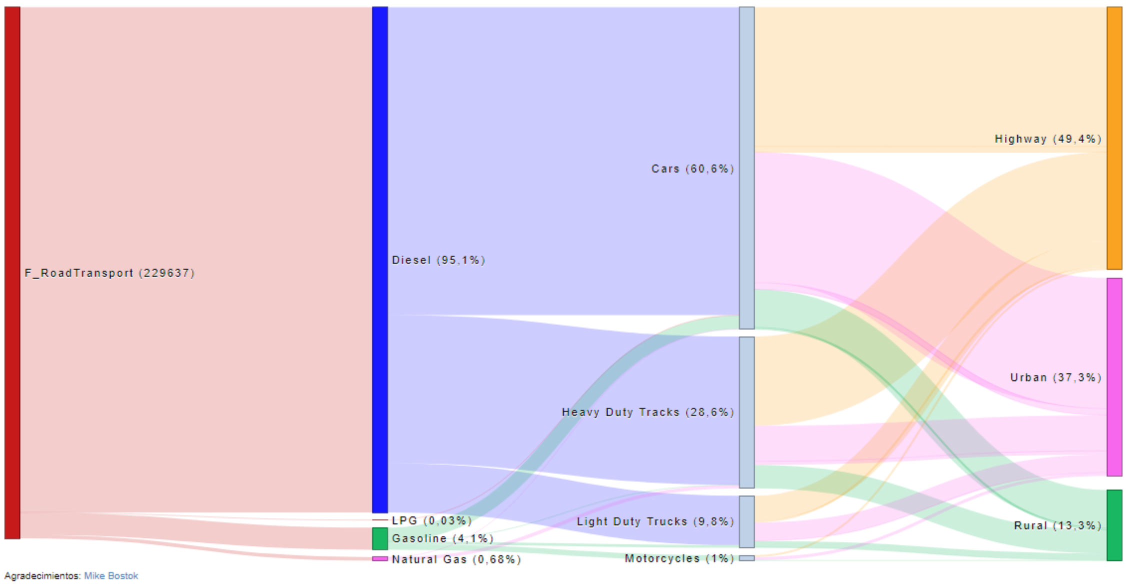


Figure 3.4.14 Road transport NOx emissions split in 2021 (tonnes)

The figure above clearly shows that most of the Road transport NOx emissions come from diesel passenger cars (1A3bi) in both urban and highway patterns. In highway pattern, as mentioned above, traffic of heavy duty vehicles (1A3biii) also has an important weight.

As far as fuel consumption is concerned, this activity data has experienced a sustained growth along the Inventory period in category 1A3b. After 2007, consumption has decreased according to the economic downturn in Spain. New sustained growth can be observed from 2012 onwards, until the sharp drop suffered in 2020 because of the COVID-19 pandemic. In 2021, fuel consumption experiments an increase of 13.8% with respect to 2020, but in which only gaseous fuels consumption show an increase with respect to pre-COVID levels.

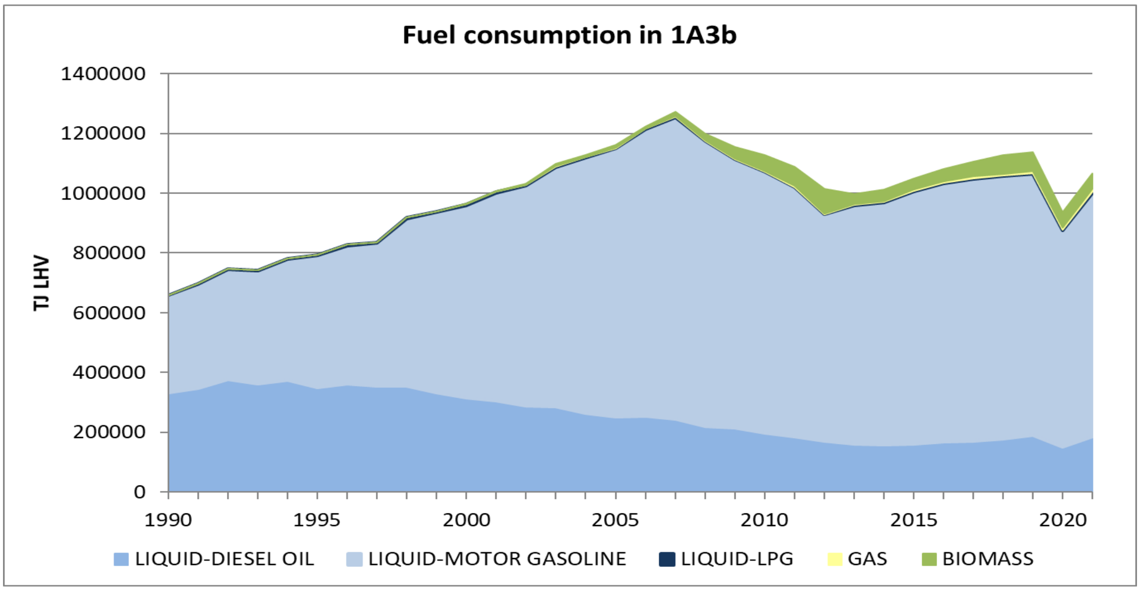


Figure 3.4.15 Evolution of fuel consumption in 1A3b

Table 3.4.17 Fuel consumption (Amounts in TJ_{LHV})

TYPE	1990	2005	2010	2015	2019	2020	2021
LIQUID	***659,589***	***1,151,007***	***1,071,850***	***1,007,616***	***1,066,944***	***877,578***	***1,004,931***
MOTOR GASOLINE	331,488	251,815	196,669	159,641	190,241	151,353	184,838
GAS/DIESEL OIL	326,906	897,122	874,308	846,003	872,787	723,218	816,307
LPG	1,195	2,069	874	1,973	3,915	3,006	3,786
OTHER	-	***306***	***2,573***	***1,222***	***2,680***	***2,467***	***2,401***
FOSSIL PART BIODIESEL	-	306	2,573	1,222	2,680	2,467	2,401
GAS	-	***972***	***2,572***	***3,673***	***6,643***	***7,110***	***9,205***
NATURAL GAS	-	972	2,572	3,673	6,643	7,110	9,205
BIOMASS	-	***9,169***	***52,722***	***38,599***	***63,062***	***52,175***	***51,970***
OTH. LIQ. BIOMASS	-	9,169	52,722	38,599	63,062	52,175	51,970
TOTAL	**659,589**	**1,161,453**	**1,129,717**	**1,051,110**	**1,139,329**	**939,329**	**1,068,507**

By type of fuel, the relative distribution of diesel fuel versus gasoline maintains a very similar ratio since 2013 but, for the last years, is noteworthy the slight increase of the gasoline share. In 2021, petrol consumption increases 22%, whereas in the case of diesel the consumption increases 13%.

“Other liquid biomass” includes bioethanol and biodiesel (FAME) that are marketed after mixture with petrol and diesel, respectively. Their consumptions grow significantly until 2012 and, after a pronounced decrease in 2013, similar consumptions are observed in 2014 and 2015 with a significant 13% increase in 2016 consumption that doubles in 2018 (28%). Since 2019, the trend changes, experiencing a slightly decrease in part aggravated by the drop of fossil fuels during the COVID-19 pandemic. For consistency with the Spanish greenhouse gases inventory, the fossil part of FAME (that coming from fossil methanol) is shown separately in the table, in “Other”.

F. National navigation (1A3d)

This category includes domestic maritime traffic, thus voyages between domestic ports, despite the vessel´s nationality or flag.

National navigation (1A3d) is a key category for its contribution to the level of the emissions of SO_2 and HCB, and to the trend of the emissions of NOx.

International navigation is reported as “Memo item” in the NFR reporting tables for informative purposes.

In this Inventory edition, the following emission factors have been updated according to the latest December 2021 version of EMEP/EEA Guidebook (2019): Tier 1 emission factors of CO, NMVOC, PST, PM_{10}, BC, Cu, Se (in both gasoil and fueloil) and As (in gasoil); Tier 2 emission factors of NOx, PST, PM_{10}, $PM_{2.5}$; emission factors of CO, NMVOC and BC have been updated from Tier 1 to Tier 2, when available.

Since 2020, lower sulphur content has been applied to fueloil consumption, according to the application of the International Maritime Organization (IMO) stricter limits for marine fuels used in territorial seas and exclusive economic zones (Directive 2016/802 amending Directive 2012/33/EU and Council Directive 1999/32/EC as regards the sulphur content of marine fuels).

F.1. Activity variables

Table 3.4.18 Summary of activity variables, data and information sources for category 1A3d

Activities included	Activity data	Source of information
National navigation	- Fuel consumption series.	Oil international questionnaires (AQAOS), elaborated by MITECO and sent to IEA and EUROSTAT.
	- Number and gross tonnage of vessels in the main ports by type of vessel.	“Anuario de Puertos del Estado” (“National Ports Yearbook”) published by National Port Authorities of the Ministry of Transport, Mobility and Urban Agenda.

F.2. Methodology

Table 3.4.19 Summary of methodologies applied in category 1A3d

Pollutants	Tier	Methodology applied	Observations
National navigation (Methodology factsheet: Navigation)			
SO_2	T1	EMEP/EEA Guidebook (2019, update Dec 2021) Chapter 1A3d.	EF: - Derived from mass balance based on the sulphur content in marine fuels, established by international regulations.
HM, PCDD/PCDF, HCB, PCBs	T1	EMEP/EEA Guidebook (2019, update Dec 2021) Chapter 1A3d.	EF: - Default value from tables 3-1, 3-2.
NMVOC, CO, BC	T1/T2	EMEP/EEA Guidebook (2019, update Dec 2021) Chapter 1A3d.	EF: - T1: Default value from tables 3-1, 3-2 (turbines). - T2: Tables 3-5, 3-6 and 3-7 (diesel motors).

Pollutants	Tier	Methodology applied	Observations
NOx, TSP, PM_{10}, $PM_{2.5}$	T2	EMEP/EEA Guidebook (2019, update Dec 2021) Chapter 1A3d.	EF: -Tables 3-5, 3-6 and 3-7.
NH_3	T1	EMEP CORINAIR Manual (1992).	EF: - Table VI, 10-1 (Updated EMEP guidelines do not provide NH_3 EF for maritime transport).
PAHs	T1	EMEP/EEA Guidebook (2019, Oct 2020) Chapter 1A3d.	EF - Default value from tables 3-1, 3-2. (Updated EMEP guidelines do not provide PAHs EF for maritime transport).

F.3. Assessment

Fuel consumption throughout the Inventory period shows a decreasing trend since 2006 with a minimum in 2014. Drastic descent in fuel supply to domestic navigation activities is likely due to a combination of sector development, activity evolution during the economic downturn in Spain and market and geographical factors. Nonetheless, since 2014 there has been a change in trend with a sustained upturn in maritime fuel consumption (see figure below), which grows progressively starting from an increase of 37% in 2015 and reaching a maximum increase of 62% in 2017. In 2020 fuel consumption suffered a decrease of 34% due to the COVID-19 pandemic, whereas in 2021 has increased 22% with regard to 2020.

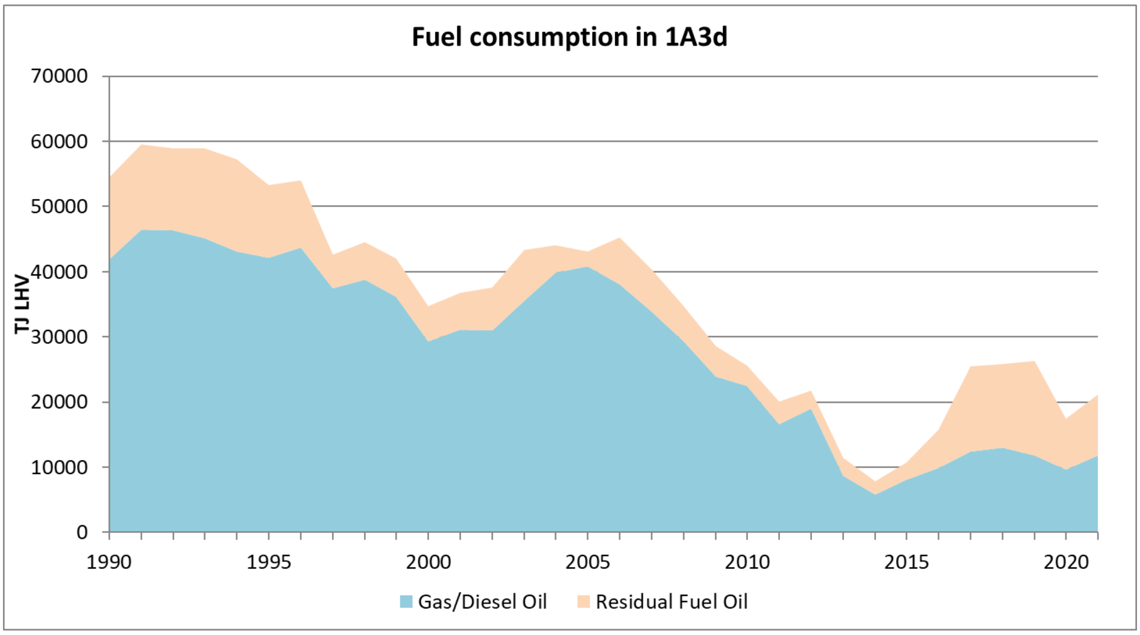


Figure 3.4.16 Evolution of fuel consumption in 1A3d

Drastic rise in fuel oil supply to domestic navigation activities is again likely due to a combination of factors. On one hand, new market strategies for one of the main operators in the sector have been recently observed. On the other hand, new technology introduced in residual fuel oil ships, created to adapt the engines to the legislation regarding sulphur content in marine fuels could also be playing a role. The modification of the International Maritime Organization to the MARPOL 78/78 convention established, as of 2015, lower limits of sulphur content in fuels consumed by ships travelling through Emission Control Areas (ECA). European Union has gone beyond the IMO, extending in 2020 the application of the stricter limits to the waters of its exclusive economic zone (Directive 2016/802 amending Directive 2012/33/EU and Council Directive 1999/32/EC as regards the sulphur content of marine fuels). As an alternative, a new technology is being deployed consisting of installation of scrubber equipment in the residual fuel oil vessels, cleaning the combustion gases before going out into the atmosphere. The installation of scrubbers thus could be directly related to the increase in residual fuel oil consumption.

G. Combustion in other sectors (1A4)

This category 1A4 includes the following subcategories:

- Combustion in mobile and stationary equipment in commercial and institutional activities (1A4a).
- Combustion in mobile and stationary equipment in residential activities (1A4b).
- Combustion in machinery used in agriculture, forestry and fishing activities (1A4c).

These subcategories have consideration of key category:

- 1A4a (Commercial/Institutional sector) and 1A4b (Residential sector), for its contribution to the level and the trend of the emissions of NOx, NMVOC, SO_2, Particulate Matter, Black Carbon, CO, Cd, Hg, PCDD/PCDF, PAHs and HCBs; and for its contribution to the trend of the emissions of NH_3.
- 1A4c (Agriculture, forestry and fishing sector) for its contribution to the level and the trend of the emissions of NOx, $PM_{2.5}$, PM_{10} and BC; for its contribution to the level of the emissions of CO; and for its contribution to the trend of the emissions of TSP.

In this Inventory edition, all pollutant emissions have been recalculated due to the update by the information source of fuel-activity allocation for the whole inventory period. This update is specifically noticeable in natural gas consumption since 2015 reallocated among different activities.

In addition, following the recommendations ES1A4a-2022-0001 and ES1A4c-2022-0001 made by the TERT in the Final Review Report 2022 (Review of National Air Pollutant Emission Inventory Data 2022 under Directive (EU) 2016/2284)[10], new estimates of NH_3 emissions from biomass have been included in 1A4a and 1A4c categories according to the emission factors from EMEP 2019 Guidebook.

Also in this Inventory edition and following the recommendation made in the Spanish Stage 3 Review Report (2022)[11], new estimates of residential combustion emissions have been carried out by dissagregating total biomass consumption according to different existing fuels and appliances. This methodology has been developed with information data from TIMES model, EMEP/EEA 2019 Guidebook and a national Study of biomass heating technologies and their breakdown for estimation of emissions from the residential sector carried out by IDAE (MITECO).

And last, in the present Inventory edition and for stationary fishing activities (1A4ci) new emissions from natural gas consumption have been estimated considering new data from the international questionnaires elaborated by MITECO and sent to IEA and EUROSTAT. Also, for 1A4ciii category (Fishing), the following emission factors have been updated according to the latest December 2021 version of EMEP/EEA Guidebook (2019): Tier 1 emission factors of CO, NMVOC, PST, PM_{10}, BC, Cu, Se and As; Tier 2 emission factors of NOx, PST, PM_{10}, $PM_{2.5}$; emission factors of CO, NMVOC and BC have been updated from Tier 1 to Tier 2, when available.

[10] Final Review Report available in: https://environment.ec.europa.eu/topics/air/reducing-emissions-air-pollutants/emissions-inventories_en#review-of-national-emission-inventories

[11] Stage 3 Review Report available in: https://www.ceip.at/status-of-reporting-and-review-results/2022-submission

G.1. Activity variables

Table 3.4.20 Summary of activity variables, data and information sources for category 1A4

Activities included	Activity data	Source of information
Commercial/Institutional sector (**1A4a**)	- Annual electricity production, broken down by energy demand sectors, generation mode (autoproduction vs. co-generation) and fuel type.	- Questionnaires from MITECO and IDAE.
	- Final energy fuel use.	- International questionnaires elaborated by MITECO and sent to IEA and EUROSTAT.
Residential sector (**1A4b**)	- Annual electricity production, broken down by energy demand sectors, generation mode (autoproduction vs. co-generation) and fuel type.	- Questionnaires from MITECO and IDAE.
	- Annual biomass consumption, broken down by different combustion appliances and fuel type.	- Study of biomass heating technologies in Spain (IDAE, 2021) - TIMES model data from 2015 to 2020 - EMEP/EEA Guidebook 2019, Chapter 1A4, tables 3-36 to 3-38 (Appliance type split according IIASA GAINS model)
	- Final energy fuel use.	- International questionnaires elaborated by MITECO and sent to IEA and EUROSTAT. - Spanish association for energy recovery of biomass (AVEBIOM).
Stationary combustion in the agricultural sector (**1A4ci**)	- Assigned amounts of fossil fuels; with the exception of diesel, which is estimated proportionality to the value of mobile agricultural machinery.	- AQs: Energy balance from International questionnaires elaborated by MITECO and sent to IEA and EUROSTAT.
	- Fuel consumption for agricultural irrigation engines, based on published: • diesel consumption ratios per hectare of irrigation • irrigation surface area	- “Energy Saving and Efficiency Strategy – E4” for the agricultural sector. - “Statistical Yearbook” by MAPA.
	- Fuel consumption for stationary fishing activities	- International questionnaires elaborated by MITECO and sent to IEA and EUROSTAT.
Agricultural machinery (**1A4cii**)	- Power installed in active vehicles by type of machinery.	- Directorate-General for Agricultural Production and Markets at MAPA.
	- Other parameters: effective hours/year of each type of machinery, energy requirements per standard hour of operation and per unit of rated power.	- Expert judgement.
Forestry machinery (**1A4cii**)	- Socio-economic data relating to forestry: reforested surface area, volume of wood harvested, etc.	- “Statistical Yearbook” prepared by MITECO.
	- Additional activity variables (length of prepared forest trails, surface area of firewalls…); characteristics of machinery by class of operation.	- Expert judgement.
Sea fishing (**1A4ciii**)	- Values for parameters referring to specific fuel consumption per fishing ground calculated from sailing days per year and fishing vessels population.	- Directorate-General for Fisheries at MAPA.

G.2. Methodology

Table 3.4.21 Summary of methodologies applied in category 1A4

Pollutants	Tier	Methodology applied	Observations
Commercial/Institutional sector (1A4a): Combustion plants <50 MW (Boilers) (Methodology factsheet: Other stationary combustion)			
NOx, NMVOC, CO, SO_2, NH_3, PM, PCBs, HCB, PCDD/PCDF	T1/T2	EMEP/EEA Guidebook (2019) Chapter 1A4.	EF: - Tables 3-9, 3-10, 3-21, 3-25, 3-27 and 3-46.
BC	T1/T2	EMEP/EEA Guidebook (2019) Chapter 1A4.	EF: - Tables 3-10, 3-21, 3-25, 3-27 and 3-46, % of $PM_{2.5}$.
HM , PAHs	T1	EMEP/EEA Guidebook (2019) Chapter 1A4.	EF: - Tables 3-7, 3-21, 3-25 and 3-46.
Commercial/Institutional sector (1A4a): Stationary gas turbines (Methodology factsheet: Other stationary combustion)			
NOx, NMVOC, CO, SO_2, PM, PCDD/PCDF	T2	EMEP/EEA Guidebook (2019) Chapter 1A4.	EF: - Tables 3-28 and 3-29.
BC	T2	EMEP/EEA Guidebook (2019) Chapter 1A4.	EF: - Tables 3-28, 3-25, % of $PM_{2.5}$.
Rest of pollutants	T1	EMEP/EEA Guidebook (2019) Chapter 1A4.	EF: - Tables 3-9, 3-28 and 3-29.
Commercial/Institutional sector (1A4a): Stationary engines (Methodology factsheet: Other stationary combustion)			
NOx, NMVOC, CO, SO_2, PM, PCBs, HCB, PCDD/PCDF	T2	EMEP/EEA Guidebook (2019) Chapter 1A4.	EF: - Tables 3-30 and 3-31.
BC	T2	EMEP/EEA Guidebook (2019) Chapter 1A4.	EF: - Tables 3-30 and 3-31, % of $PM_{2.5}$.
Rest of pollutants	T2	EMEP/EEA Guidebook (2019) Chapter 1A4.	EF: - Tables 3-30 and 3-31.
Commercial/Institutional sector (1A4a): Mobile machinery			
NOx, NMVOC, CO, SO_2, PM, BC, NH_3, HM, PAHs	T1	EMEP/EEA Guidebook (2019) Chapter 1A4.	EF: - Table 3-1.
Residential sector (1A4b): Combustion plants <50 MW (Boilers) (Methodology factsheet: Other stationary combustion)			
NOx, NMVOC, CO, SO_2, PM, BC, PCBs, HCB, PCDD/PCDF, NH_3, HM, PAHs	T1/T2	EMEP/EEA Guidebook (2019) Chapter 1A4.	EF: - Tables 3-4, 3-5, 3-6, 3-15, 3-16, 3-18, 3-42, 3-43 and 3-44.

Pollutants	Tier	Methodology applied	Observations
Residential sector (1A4b): Residential -Other equipment (stoves, fireplaces, cooking,...)			
NOx, NMVOC, CO, SO_2, PM, BC, PCBs, HCB, PCDD/PCDF, NH_3, HM, PAHs	T2	EMEP/EEA Guidebook (2019) Chapter 1A4.	EF: - Tables 3-39, 3-40, 3-41, 3-42 and 3-44
Residential sector (1A4b): Combustion plants <50 MW (Medium Boilers)			
NOx, NMVOC, CO, SO_2, PM, BC, PCBs, HCB, PCDD/PCDF, NH_3, HM, PAHs	T1/T2	EMEP/EEA Guidebook (2019) Chapter 1A4.	EF: - Tables 3-47 and 3-48
Stationary machinery in agriculture, forestry and fishing activities (1A4ci): Combustion plants <50 MW (Boilers) (Methodology factsheet: Other stationary combustion)			
NOx, NMVOC, CO, SO_2, NH_3, PM, BC, PCBs, HCB, PCDD/PCDF, HM, PAHs	T1/T2	EMEP/EEA Guidebook (2019) Chapter 1A4.	EF: - Tables 3-7, 3-10, 3-21, 3-25, 3-27 and 3-46.
Stationary machinery in agriculture, forestry and fishing activities (1A4ci): Stationary engines (Methodology factsheet: Other stationary combustion)			
NOx, NMVOC, CO, SO_2, PM, BC, PCBs, HCB, PCDD/PCDF, HM, PAHs	T1/T2	EMEP/EEA Guidebook (2019) Chapter 1A4.	EF: - Tables 3-9 and 3-31.
Mobile machinery in agriculture and forestry activities (1A4cii) (Methodology factsheet: Mobile machinery)			
NOx, NMVOC, CO, SO_2, NH_3, PM, BC	T2	EMEP/EEA Guidebook (2019) Chapter 1A4.	EF: - Annual emission factors according to annual fleet structure (1.A.4 Non-road mobile machinery Annex: distribution by age and technology).
Rest of pollutants	T1	EMEP/EEA Guidebook (2019) Chapter 1A4.	EF: Table 3-1.
Mobile machinery in fishing activities (1A4ciii) (Methodology factsheet: Fishing activities)			
SO_2	T1	EMEP/EEA Guidebook (2019, update Dec 2021) Chapter 1A3d.	EF: - Derived from mass balance based on the sulphur content in marine fuels, established by international regulations.
HM, PCDD/PCDF, HCB, PCBs	T1	EMEP/EEA Guidebook (2019, update Dec 2021) Chapter 1A3d.	EF: - Default value from table 3-2.

Pollutants	Tier	Methodology applied	Observations
NMVOC, CO, TSP, PM_{10}, BC	T1/T2	EMEP/EEA Guidebook (2019, update Dec 2021) Chapter 1A3d.	EF: - Default value from table 3-2
NOx, $PM_{2.5}$	T2	EMEP/EEA Guidebook (2019, update Dec 2021) Chapter 1A3d.	EF: -Tables 3-5, 3-6 and 3-7.
NH_3	T1	EMEP CORINAIR Manual (1992).	EF: - Table VI, 10-1 (Updated EMEP guidelines do not provide NH_3 EF for maritime transport).
PAHs	T1	EMEP/EEA Guidebook (2019, update Oct 2020) Chapter 1A3d.	EF - Default value from tables 3-1, 3-2. (Updated EMEP guidelines do not provide PAHs EF for maritime transport).

* Summary tables of emission factors for 1A4, mobile sources, have been included in the methodology factsheet for Mobile machinery (updated May 2019).

G.3. Assessment

Within 1A4 category, the Residential sector (1A4b) is still the main driver in the evolution of fuel consumption, due to its relative weight within the entire category (48.8% of the total fuel consumption in 1A4 for 2021).

The figure below shows the trend of fuel consumption under 1A4, showing the effect of the economic downturn in Spain, that is intertwined with meteorological inputs.

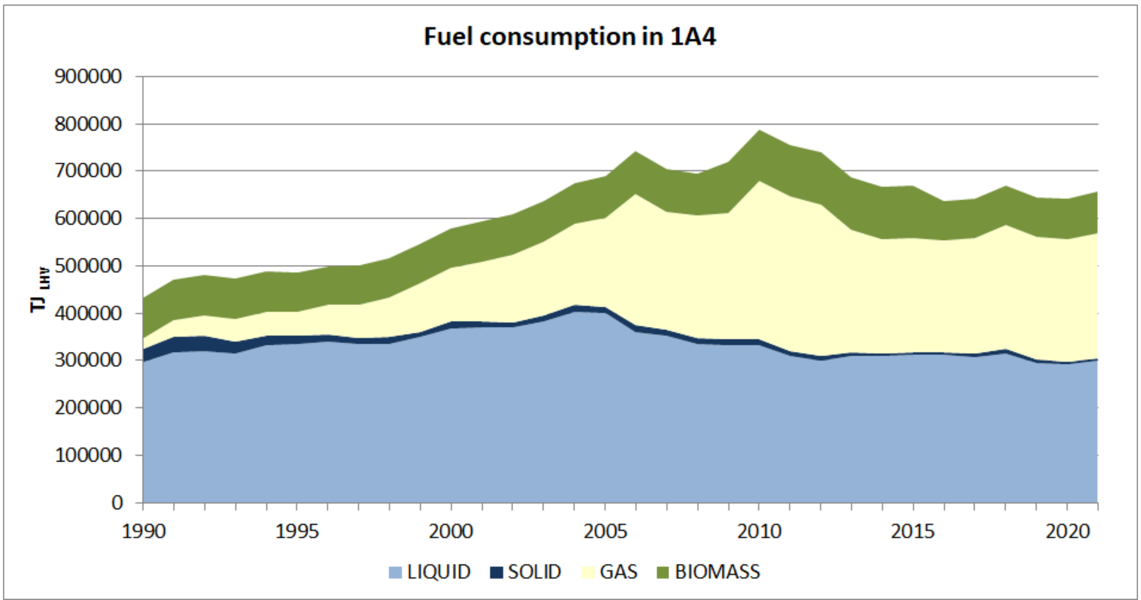


Figure 3.4.17 Evolution of fuel consumption in 1A4 category

Despite their loss of relative importance, liquid fuels continue to be the predominant type of fuel burned under 1A4, most of it consumed in Agriculture, forestry and fishing sector; this consumption remains almost constant for recent years showing a slight decrease in 2019. Consumption of solid fuels is minor and constantly decreases throughout the period to become negligible since 2015.

Biomass consumption maintains a small but steady growth along the Inventory period, increasing its representativeness due to promotion measures developed by the Spanish administration.

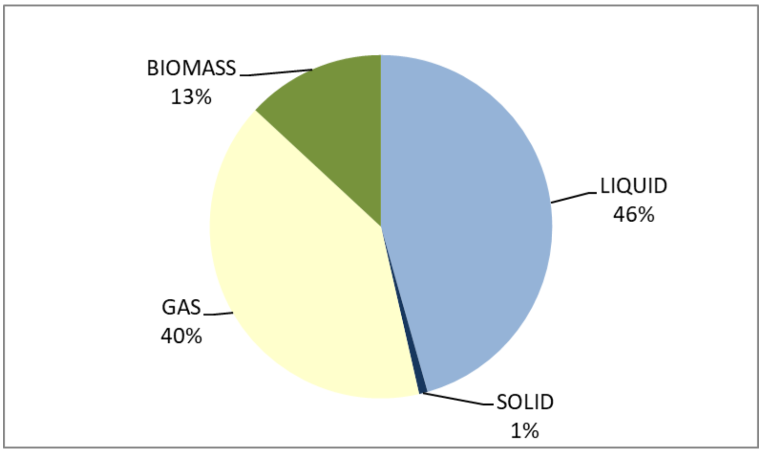


Figure 3.4.18 Distribution of fuel consumption 1A4 (2021)

Following figures show the evolution of fuel consumption in the various subcategories that constitute the category Combustion in other sectors (1A4).

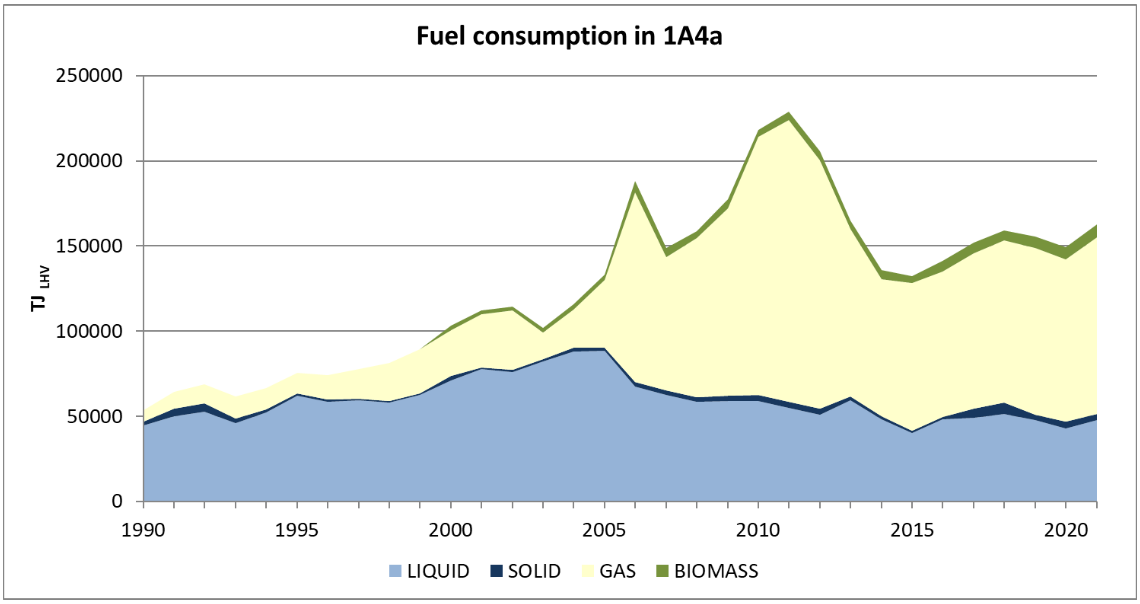


Figure 3.4.19 Evolution of fuel consumption in Commercial and Institutional sector (1A4a)

The evolution of natural gas consumption in Commercial and Institutional sector (1A4a) shows more pronounced peaks and valleys than its observed evolution in the category 1A4 as a whole, due to the already mentioned meteorological inputs, affecting mainly the gas natural consumption. However, from 2015 onwards, natural gas consumption seems to be more stable showing a slightly increasing trend except for a small drop in 2020 defined as the warmest year in Spain since records exists[12]. This fact, together with the decrease and even cessation of activity of many institutions and businesses during the lockdown due to the COVID-19 pandemic crisis, clearly explains this decline which recovers its growing trend in 2021. With regard to liquid

[12] The climate summary report of 2020 is available at: http://www.aemet.es/documentos/es/datos_abiertos/Estadisticas/Vigilancia_Clima/resumenclima_2020.pdf

fuels, estimates of mobile combustion in commercial and institutional sector (1A4aii subcategory) represent in 2021 almost the 4% of total liquid consumption in 1A4a category.

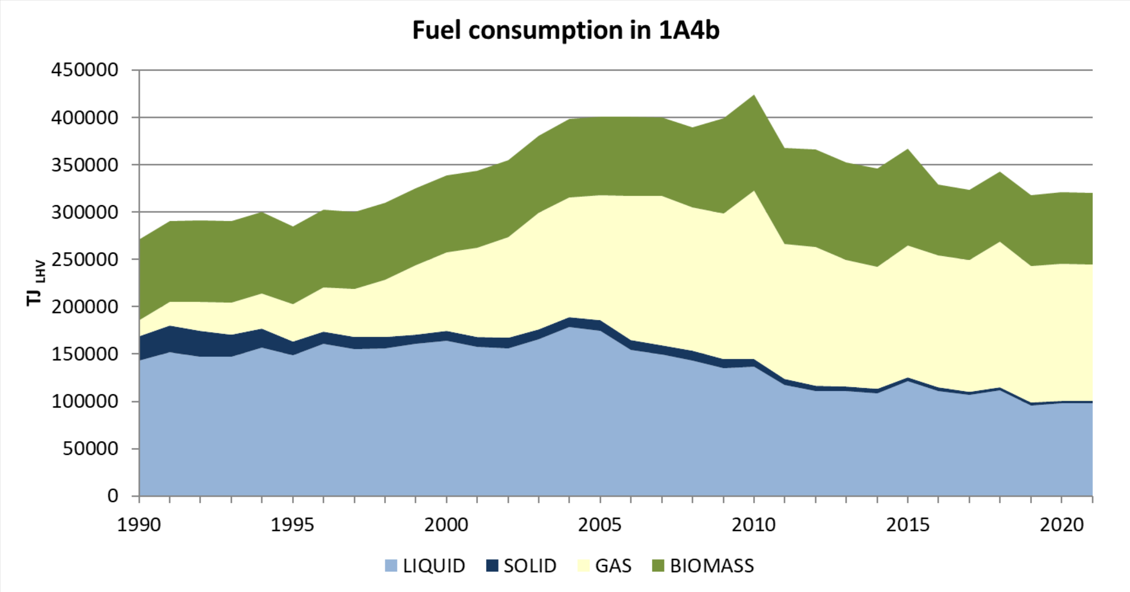


Figure 3.4.20 Evolution of fuel consumption in Residential Sector (1A4b)

The general trend in the residential sector (1A4b) reflects the population increase and the effect of the economic downturn, with yearly variations due to the meteorological factors. Gas natural consumption increased noticeably until the early 2000s and it remains virtually unchanged for the last three years. Beyond this particular fact, distribution of biomass, liquid and gaseous fuels maintains relatively similar proportions during the recent years.

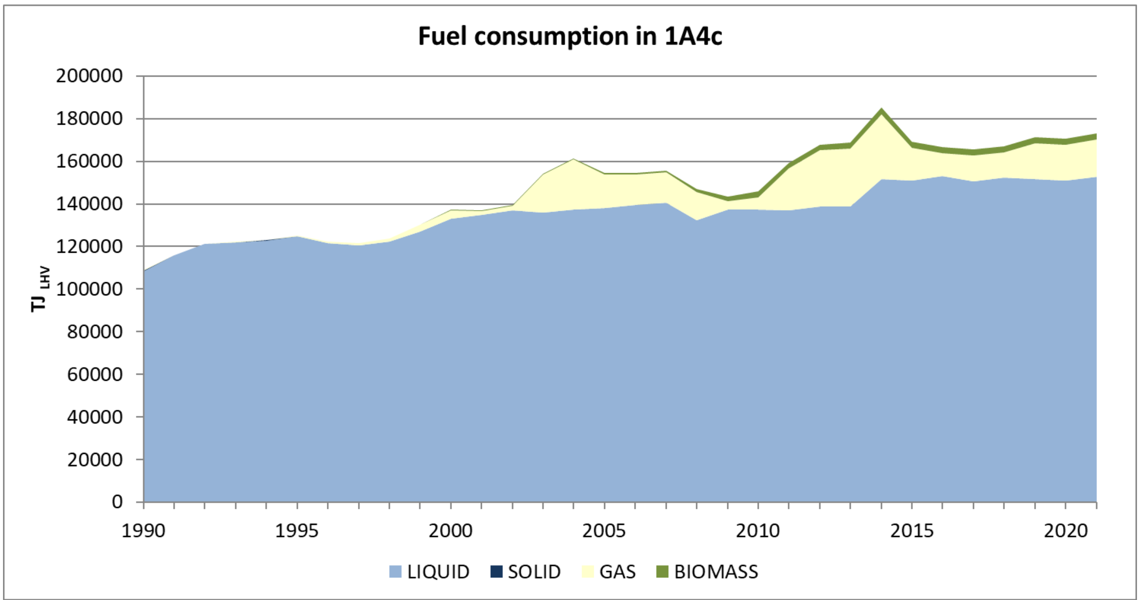


Figure 3.4.21 Evolution of fuel consumption in Agriculture, forestry and fishing sector (1A4c)

Gasoil continues to be the most consumed fuel in the Agriculture, forestry and fishing sector (1A4c category, see figure above), remaining almost constant since 2014.

The following tables include detailed information regarding fuel consumption in 1A4 subcategories.

Table 3.4.22 Fuel consumption (Amounts in TJ_{LHV})

1A4a Commercial / institutional sector

TYPE	1990	2005	2010	2015	2019	2020	2021
LIQUID	*44,543*	*88,278*	*58,933*	*40,023*	*47,735*	*42,943*	*47,990*
GAS OIL	26,734	70,893	47,828	32,470	39,778	36,115	39,927
LPG	7,196	7,871	7,451	5,986	5,949	3,736	4,367
MOTOR GASOLINE	-	-	-	442	1,324	1,284	1,891
PETROLEUM COKE	163	163	130	-	-	-	-
RESIDUAL OIL	10,450	9,352	3,524	1,125	683	1,808	1,806
SOLID	*2,128*	*2,150*	*3,715*	*1,353*	*3,318*	*3,730*	*3,388*
COKE OVEN COKE	-	-	-	282	2,256	2,820	2,538
GAS WORKS GAS	1,234	633	1,287	9	-	-	-
STEAM COAL	880	1,517	2,427	1,062	1,062	910	850
SUB-BITUMINOUS COAL	13	-	-	-	-	-	-
GAS	*6,878*	*39,847*	*151,638*	*87,075*	*97,819*	*95,628*	*103,736*
NATURAL GAS	6,878	39,847	151,638	87,075	97,819	95,628	103,736
BIOMASS	-	*3,117*	*3,661*	*3,972*	*6,600*	*6,931*	*7,755*
BIOGAS	-	974	1,147	730	2,528	2,513	3,037
WOOD WASTES	-	2,144	2,513	3,242	4,072	4,419	4,718
TOTAL	53,549	133,392	217,946	132,423	155,472	149,233	162,869

1A4b Residential sector

TYPE	1990	2005	2010	2015	2019	2020	2021
LIQUID	*143,163*	*174,312*	*136,502*	*121,219*	*95,708*	*98,389*	*98,433*
GAS OIL	53,424	105,940	77,193	79,483	61,141	66,144	64,112
LPG	88,811	66,449	54,598	41,093	34,366	32,124	34,197
PETROLEUM COKE	325	195	130	-	-	-	-
RESIDUAL OIL	603	1,728	4,581	643	201	121	124
SOLID	*25,850*	*11,150*	*8,317*	*4,248*	*3,186*	*2,276*	*1,881*
GAS WORKS GAS	10,600	1,138	126	-	-	-	-
PATENT FUELS	152	-	-	-	-	-	-
STEAM COAL	14,563	10,012	8,192	4,248	3,186	2,276	1,881
SUB-BITUMINOUS COAL	536	-	-	-	-	-	-
GAS	*16,572*	*132,483*	*178,090*	*138,895*	*144,347*	*145,066*	*144,527*
NATURAL GAS	16,572	132,483	178,090	138,895	144,347	145,066	144,527
BIOMASS	*85,251*	*82,897*	*100,782*	*102,840*	*74,890*	*75,094*	*75,340*
CHARCOAL	-	-	1,130	1.130	461	461	461
NUT SHELL	-	-	472	463	317	317	312
OLIVE PITS	-	-	1,730	1,694	1,162	1,162	1,143
SAWDUST AND WOOD SHAVINGS	-	-	296	290	199	199	196
WOOD CHIPS	-	-	433	424	291	291	286
WOOD PELLETS	-	-	178	4,279	7,488	7,666	9,003

TYPE	1990	2005	2010	2015	2019	2020	2021
WOOD WASTES	85,251	82,897	96,543	94,560	64,972	64,998	63,939
TOTAL	**270,836**	**400,842**	**423,692**	**367,202**	**318,131**	**320,824**	**320,181**

1A4c Agriculture, forestry and fishing sector

TYPE	1990	2005	2010	2015	2019	2020	2021
LIQUID	***108,502***	***137,896***	***137,424***	***150,798***	***151,486***	***151,069***	***152,815***
GAS OIL	105,443	134,580	135,053	148,511	148,738	148,684	150,622
KEROSENE	1,263	-	-	-	-	-	9
LPG	960	2,480	1,653	1,827	2,306	2,132	1,911
MOTOR GASOLINE	249	212	54	225	247	214	214
RESIDUAL OIL	587	625	664	234	195	39	60
SOLID	***365***	-	-	-	-	-	-
SUB-BITUMINOUS COAL	365	-	-	-	-	-	-
GAS	***112***	***15,886***	***5,752***	***15,548***	***16,889***	***16,778***	***17,251***
NATURAL GAS	112	15,886	5,752	15,548	16,889	16,778	17,251
BIOMASS	-	***622***	***2,579***	***2,836***	***2,895***	***2,896***	***2,898***
BIOGAS	-	3	182	55	139	143	199
WOOD WASTES	-	619	2,398	2,781	2,756	2,753	2,700
TOTAL	**108,979**	**154,404**	**145,755**	**169,183**	**171,270**	**170,743**	**172,965**

H. Fugitive emissions from fuels (1B)

This category includes emissions generated during prospection, extraction, storage, transportation, processing or disposal of fossil fuels (coal, oil, oil-derived fuels or natural gas) where there is no energy recovery from the fuel. Thus, activities such as flaring of petroleum or natural gas are included here, but not combustion activities intended for the provision of energy in extractive or transformation processes.

This category is considered a key category for SO_2 for level and trend reasons, NMVOC for level and TSP for trend.

Table 3.4.23 Contents of 1B

1B	Includes
Solid fuel (**1B1**)	**Coal mining and handling (1B1a)**: dust emissions associated with production and storage processes in coal mines.
	Solid fuel transformation (1B1b): Fugitive emissions of residual raw gases and powdery materials generated during the opening of doors of coke ovens and coke cooling. Production of solid semi-coke is not included as this activity does not occur in Spain.
Oil and natural gas and other emissions from energy production (**1B2**)	**Oil – Exploration, production, transport (1B2ai)**: Evaporative emissions of volatile organic compound (NMVOC) losses during operation in prospection and production platforms and marine terminals, including crude oil supply to refineries.
	Fugitive emissions oil – Refining/storage (1B2aiv): fugitive emissions associated with the processing or combustion generated by activities in refining plants (excluding those related to combustion processes for energy purposes): processing of oil derived products, sulphur recovery, storage and handling of intermediate and final products, vacuum distillation, coke calcination, fluid catalytic cracking (FCC) and catalytic reforming units. All of these can be included in separation processes, conversion, treating and blending.
	Distribution of oil products (1B2av): emissions from hydrocarbons in the distribution network of petroleum derived products outside the refineries premises.
	Natural gas (1B2b): hydrocarbon losses during the different stages of the operation in prospection, production and supply process: production in extractive facilities (marine or inland platforms), firs treatment, loading, transportation and supply to consumer sectors.
	Venting and flaring (1B2c): intentional gas losses that, for safety reasons, take place at refining plants or natural gas supply systems, by means of direct gas venting or flaring.

H.1. Activity variables

Table 3.4.24 Summary of activity variables, data and information sources for category 1B

Activities included	Activity data	Source of information
Coal, natural gas and oil extraction activities (Coal 1B1a, natural gas **1B2b**, oil **1B2ai**)	**Internal production (gross) of different primary fuels** (coal, crude oil and natural gas).	- National statistics on hydrocarbon prospection and production. MITECO. - National statistics on hydrocarbon production. MITECO (CORES)
Opening and extinction of coke oven furnaces (**1B1b**)	**Production of metallurgical coke in coke oven furnaces**.	- For integrated steel plants: IQ. - For plants located outside integrated steelworks plants (Area source level): · Historically: IEA and EUROSTAT or in national statistics from MITECO ("Statistics on Coking Paste Manufacture, Coke Ovens and Blast Furnace Gas"). · 2008-2020: Individualized information at plant level (IQ).

Activities included	Activity data	Source of information
Loading-unloading operations of tank vessels and crude oil storage in marine terminals (**1B2ai**)	**The acquisition (imports) of crude oil by refineries**.	- "Energy Statistics of OECD countries", IEA. - National Energy Statistics by MITECO (AQ-AOS).
Refining activities (**1B2aiv**, **1B2c**)	**Processed crude oil** acts as a proxy variable. **Process feed**. **Storage of products**.	- IQ from refineries.
Gasoline and biofuels distribution (**1B2av**)	**Exported petrol**	- IQ from refineries.
	Imported petrol	- IQ from refineries.
	Amount of gasoline dispatched from the refinery supply stations to the national logistics circuit.	- IQ from refineries.
	Flows of gasoline at the refineries.	- IQ from refineries.
	Flows of gasoline at the national logistics circuit.	- IQ from Exolum.
	Gasoline consumption	- National statistics on hydrocarbon production. MITECO (CORES)
	Temperatures in summer and winter.	- State agency of meteorology (AEMET).
	Data on biofuels.	- Annual data (from 2006 to 2021) via IQ from major sector entity ("Refining association, Association of Renewable Energy Producers, storage facilities and logistic operators' managers").
	Means of transport, loading techniques and technologies for reducing evaporative emissions.	- Evolution of the national logistics circuit of gasoline.
Natural gas transport (**1B2b**, **1B2c**)	**Emissions leaked, vented or amounts incinerated in natural gas transport facilities**	IQ (ENAGAS and gas transportation companies) with information on: - Natural gas losses in regulation plants, transport network, compression stations, underground storage and regulation stations and measures. - Amount of gas vented in regulation plants, transport network, compression stations and underground storage. - Burned quantities in regulation plants and underground storage.
Natural gas distribution system facilities (**1B2b**)	**Natural gas losses**.	IQ SEDIGAS (Spanish Gas Association from gas distribution companies) with information on: - Kg CH_4 losses in distribution networks.
Exploration-drilling (**1B2c**)	**Production of crude oil and gas**.	- National statistics on hydrocarbon production. (CORES).

H.2. Methodology

Table 3.4.25 Summary of methodologies applied in category 1B

Pollutants	Tier	Methodology applied	Observations
Fugitive emissions from fuel (1B)			
In general	T1/T2	EMEP/EEA Guidebook (2019) Chapters 1B2ai,1B2b, 1B2aiv, 1B2av and 1B2c.	Default EF.
PM, BC	T1/T2	CEPMEIP Database. EMEP/EEA Guidebook (2019).	Default EF.
Coal mining and handling (1B1a) (Methodology factsheet: Fugitive emissions in coal mining)			
TSP, $PM_{2.5}$, PM_{10}	T2	EMEP/EEA Guidebook (2019) Chapter 1B1a.	Table 3-2.
Solid fuel transformation (1B1b) (Methodology factsheet: Coke oven (door leakage and extinction))			
Main Pollutants	T2	EMEP/EEA Guidebook (2019) Chapter 1B1b.	Default EF: Tables 3.2/3.3/3.5 (considering wet coal charging, door leak and coke pushing operations).
CO	T2	EMEP/EEA Guidebook (2019) Chapter 1B1b.	Default EF: Tables 3.2/3.3/3.5 (considering wet coal charging, door leak and quenching operations).
TSP, $PM_{2.5}$, PM_{10}	T2	EMEP/EEA Guidebook (2019) Chapter 1B1b.	Default EF: Tables 3.2/3.3/3.4/3.5/3.6 (considering wet coal charging, door leak, off-take leaks, quenching and coke pushing operations).
PAHs	T1	"Atmospheric Emission Inventory Guidelines for Persistent Organic Pollutants (POPs)".	Default EF.
Oil – Exploration, production, transport (1B2ai) (Methodology factsheets: Oil-In Shore exploration, production, transport, Oil-Off Shore exploration, production, transport and Natural gas distribution networks)			
NMVOC	T2/T3	EMEP/EEA Guidebook (2019) Chapter 1B2ai.	Exploration Table 3-3 and table 3-4. Transport Table 3-16.
Fugitive emissions from natural gas (1B2b) (Methodology factsheets: Natural gas-In shore exploration, production, transport and Natural gas-Off shore exploration, production, transport)			
NMVOC	T2	EMEP/EEA Guidebook (2019) Chapter 1B2b.	Exploration Table 3-5 and table 3-6.
		Direct emissions measurement.	Data on measured/estimated gas emissions furnished by facilities within the network via individualised questionnaire, data provided by transport or supply companies/association together with annual gas characteristics.
Fugitive emissions from oil – refining/ storage (1B2aiv) (Methodology factsheets: Fugitive emissions from processes in the refining industry)			
NOx	T2	Mixed methodology based on direct emissions measurements or estimates. EMEP/EEA Guidebook (2019) Chapter 1B2aiv.	FCC regeneration and Sulphur recovery. Table 3-2.
NMVOC	T2	EMEP/EEA Guidebook (2019) Chapter 1B2aiv.	Table 3-2, 3-7. Storage and handling (Inventory team judgement).

Pollutants	Tier	Methodology applied	Observations
SO_2	T2/ T3	Mixed methodology based on direct emissions measurements or estimates (mass balance).	Coking calcination, FCC regeneration, sulphur recovery and catalytic reforming units.
NH_3, PM, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PAHs	T2	EMEP/EEA Guidebook (2019) Chapter 1B2aiv.	Table 3-2, 3-7.
CO	T2	Country specific factors based on direct emissions. EMEP/EEA Guidebook (2019) Chapter 1B2aiv.	FCC regeneration. Catalytic reforming units Table 3-3.
PCDD/PCDF	T2	EMEP/EEA Guidebook (2019) Chapter 1B2aiv.	Catalytic reforming units Table 3-3.
Distribution of oil products (1B2av)			
NMVOC	T2	EMEP/EEA Guidebook (2019) Chapter 1B2av.	Table 3-2, 3-3, 3-4, 3-5, 3-6, 3-8, 3-9. Directive 2009/126/EC.
Venting and flaring (1B2c) (Methodology factsheets: Oil-In Shore exploration, production, transport, Oil-Off Shore exploration, production, transport, Natural gas-In shore exploration, production, transport, Natural gas-Off shore exploration, production, transport and Flaring in oil refining plants)			
NOx, NMVOC, CO, SO_2	T1/ T2	EMEP/EEA Guidebook (2019) Chapter 1B2c.	Flaring Table 3-1, 3-2. Venting Table 3-8.
PM, BC	T3/ T1	Mixed methodology based on direct emissions measurements or estimates (EMEP/EEA Guidebook (2019) Chapter 1A1).	IQ from refineries table 4-7.

H.3. Assessment

This category stands out as a moderate emitting source in the Inventory for certain main pollutants (particularly, NMVOC and SO_2). The contribution of the remaining pollutants, namely NOx, NH_3, CO, Particulate Matter and PAHs is marginal.

Activity data and NMVOC emission factors available for 1B2ai (Oil exploration, production and transport) are shown below.

Table 3.4.26 Activity data of 1B2ai

	1990	2005	2010	2015	2019	2020	2021
Production (10^3 m^3)	901	259	138	346	46	32	7
Transport (10^3 m^3)	65,094	75,927	86,263	79,751	82,185	67,842	69,012

Production figures cover offshore and onshore oil extraction in Spain. On the other hand, Transport figures refer to oil transport in pipelines and oil pumping at maritime terminals.

Table 3.4.27 NMVOC emission factors from EMEP/EEA Guidebook (2019) 1B2ai

	EF	Unit	Table
Production	0.10	Kg /Mg oil	3-3
	0.40	Kg /Mg oil	3-4
Transport	0.27	Kg/Mg	3-16

As can be seen in the following figure, emissions from oil transport are much higher than emissions from oil production.

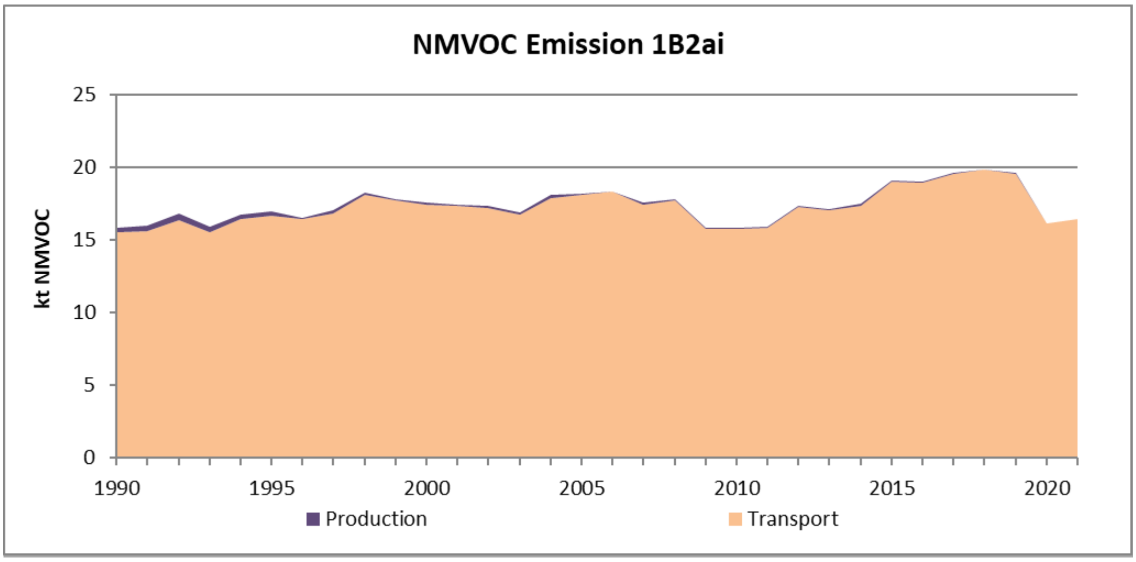


Figure 3.4.22 Evolution of NMVOC emissions in category 1B2ai

The SO_2 implied emission factor for 1B2aiv (Fugitive emissions from oil refining and storage) is displayed in the figure below.

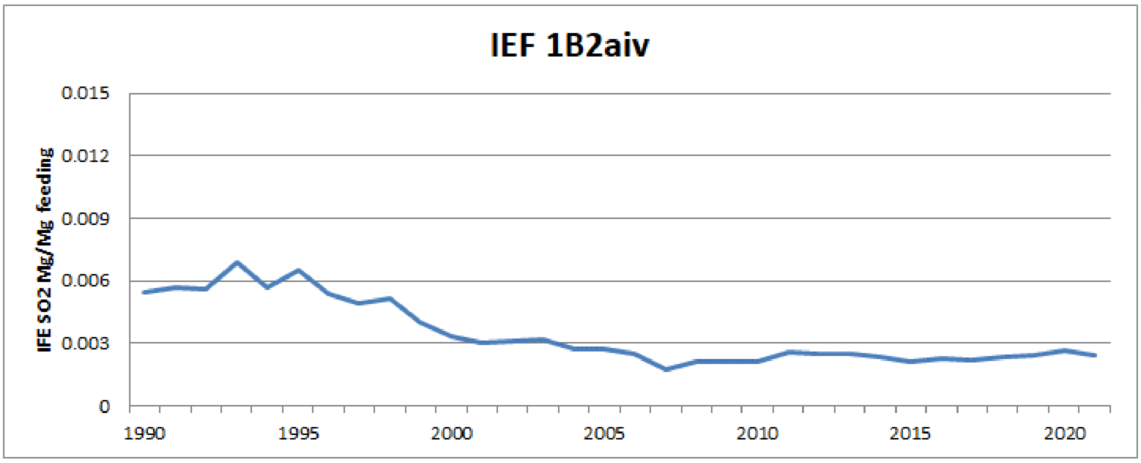


Figure 3.4.23 Evolution of SO_2 Implied emission factor in category 1B2aiv

The category 1B2aiv includes different processes in petroleum industries as petroleum products processing, fluid catalytic cracking, sulphur recovery plants, catalytic reforming unit and storage and handling of petroleum products in refineries. Every process has different emission factors and, in some cases, emissions are estimated based on direct measurements.

Therefore, it is not feasible to show the whole amount of data associated. The SO_2 implied emission factor trend shown is mainly linked to the activity of sulphur recovery, followed by the fluid catalytic cracking process.

Finally, NMVOC emissions from Coal mining and handling activities are under the threshold of significance and, therefore, considered as negligible (see Annex 6 - Expert Judgement).

3.5. Memo items

The United Nations Economic Commission for Europe (UNECE) Convention on Long-Range Transboundary Air Pollution (CLRTAP) excludes the cruising phases (both domestic and international segments) in air traffic category and the international maritime traffic. These categories and their figures are not included in the totals of the Spanish Inventory, but are reported as "Memo items" in the NFR reporting tables for informative purposes.

Estimation of emissions in these categories is analogous to what has been previously described in the correspondent inventory categories in the present chapter, in particular in the item "G National Navigation". This correspondence can be seen below:

Table 3.5.1 Air traffic: Inventory items / Memo Items

AIR TRAFFIC	LTO	Cruise
International aviation	1A3ai(i): Inventory	1A3ai(ii): Memo item
Domestic aviation	1A3aii(i): Inventory	1A3aii(ii): Memo item

Table 3.5.2 Maritime traffic: Inventory items / Memo Items

MARITIME TRAFFIC	
International navigation	1A3di(i): Memo item
International inland waterways	1A3di(ii): Inventory (Not Occurring)
National navigation (shipping)	1A3dii: Inventory

3.6. Recalculations

In the current edition of the Spanish Inventory, there have been several recalculations within the Energy sector due to different reasons such as methodological improvements —including updates of emission factors to EMEP/EEA Guidebook (2019)—, availability of new data, adjusting in the calculations and correction of found errors.

The most relevant recalculations performed in Energy are shown in the following table.

Table 3.6.1 Recalculation by pollutants – Energy

Pollutants affected	Recalculation
1A1a Public electricity and heat production	
District heating plants: - All pollutants	Activity data correction in year 2019 and data update in year 2020.
Power generation plants: - All pollutants	Update of base information on fuel consumption in two power plants in year 2020; new data from one MSW incineration plant and one biomass power plant, in operation since 2020.
Power generation plants: - NOx, CO, SO_2, TSP, NMVOC	Correction on measured emissions in three different power plants and one incineration plant in year 2011 (NOx), year 2013 (CO, SO_2), year 2015 (TSP) and years 2019-2020 (NMVOC), respectively.
Power generation plants (LPS): - $PM_{2.5}$, PM_{10}, BC	Adjustements on CEPMEIP fractions distribution procedure for period 1990-2020.
Biogas facilities: - All pollutants	New data from biomethanization plants (2015-2020); update on amount of waste treated in year 2020.

Pollutants affected	Recalculation
Domestic wastewater handling: - All pollutants	Correction of biogas burned in motors for period 2015-2017.
1A1b Petroleum refining	
Ethylene production: - All pollutans	Data corrections and update for period 1998-2020. Elimination of double counting in ethylene production in refineries.
1A1c Manufacture of solid fuels and other energy industries	
Coke ovens: - All pollutants	Correction of erroneous EFs for the year 2020.
All categories (except coke plants): - All pollutants (except PCBs)	Update on fuel consumption (from IntQ); fuel balance recalculation for consistency with international energy statistics.
1A2 Combustion in manufacturing industries and construction	
All categories: - All pollutants	Fuel balance recalculation for consistency with international energy statistics.
1A2b Stationary Combustion in Manufacturing Industries and Construction: Non ferrous metals	
Alumina production: - PAH and their species - NMVOC, HM, PCDD/PCDF	New estimation according to EMEP/EEA Guiebook 2019. Deletion of pollutants according to EMEP/EEA Guiebook 2019.
1A2f Stationary Combustion in Manufacturing Industries and Construction: Non metallic minerals	
Magnesites: - All pollutants	EF update to EMEP/EEA Guidebook (2019).
Bricks and tiles: - NMVOC, NOx, BC, CO, PCDD/PCDF, Hg - All pollutants	Correction of erroneous EF in 2020. Reallocation of two subactivities that were misplaced in category 1A2gviii.
1A2gviii Stationary Combustion in Manufacturing Industries and Construction:	
Bricks and tiles: - All pollutants	Reallocation of two misplaced subactivities to category 1A2f.
1A3b Road transport	
- NMVOC, CO, NOx, PM	EF and PM equations have been updated according to the Oct 2021 version of EMEP/EEA Guidebook (2019).
- All pollutants	Update of LPG LCV. Update of CNG consumption and correction of CNG characteristics in 2020. Small adjusts in activity data (fleet data).
1A3d Maritime navigation	
- CO, NOx, NMVOC, PM, BC, Cu, Se, As	EFs have been updated according to the Dic 2021 version of EMEP/EEA Guidebook (2019).
- All pollutants	Update of activity data in 2019 and 2020.
- SO_2	EF correction in 2020.
1A4ai Stationary combustion in commercial and institutional activities	
- NH_3	Estimates of NH_3 emissions from biomass have been included.
- All pollutants	Update of fuel-activity allocation for the whole series. Update of natural gas consumption since 2015. Emission factors update and minor corrections.
1A4bi Stationary combustion in residential activities	
- All pollutants	Disaggregation of biomass consumption. Update of fuel-activity allocation for the whole series. Update of natural gas consumption since 2015.

Pollutants affected	Recalculation
1A4ci Stationary combustion in agriculture, forestry and fishing activities	
- NH_3	Estimates of NH_3 emissions from biomass have been included.
- All pollutants	Update of natural gas consumption since 2015. New estimation of natural gas emissions from stationary fishing facilities.
1A4cii Mobile machinery in agriculture and forestry activities	
- All pollutants	Activity data updated for year 2020.
1A4ciii Mobile machinery in fishing activities	
- CO, NOx, NMVOC, PM, BC, Cu, Se, As	EFs have been updated according to the Dic 2021 version of EMEP/EEA Guidebook (2019).
- All pollutants	Update of activity data in 2019 and 2020.
1A5b Military transport	
- All pollutants	The emission series of military road traffic and maritime activities have been updated as a consequence of the update of activity 1A3b and 1A3d.
1B2aiv Fugitive emissions oil: Refining and storage	
- BC	Data update by source.
1B2av Fugitive emissions oil: Distribution of oil	
- NMVOC	Improvement in data collection.
1B2b Natural Gas-Exploration, production, transport	
- NMVOC	Data update by source.

1A1a Public electricity and heat production. Main Pollutants and CO emissions

The main changes in activity rates performed in the present edition (data updates within district heating activity; two new power stations -one incinerator and one biomass power plant-; and downward data corrections in two combined cycles) have affected 1A1a emissions in the last two years of the series, as is shown in the following pictures.

Activity data of category 1A1aiii has been revised (downwards) in the years 2019 and 2020. But the most significant recalculations are a consequence of updating the base information on fuel consumption (downwards) from two combined cycle power stations, and the new data from one incineration plant not previously accounted for, both in 2020.

Emissions of SO_2, NOx, CO and PM are estimated using data from continuous emission monitoring systems (CEMS) in combined cycles (LPS), so the corrections do not affect these parameters in the two mentioned power stations.

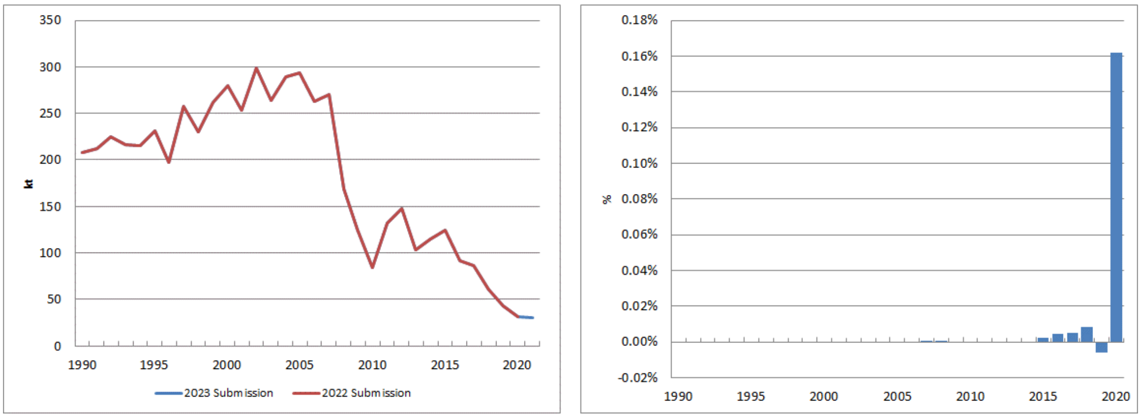


Figure 3.6.1 Evolution of the difference in 1A1a NOx emissions

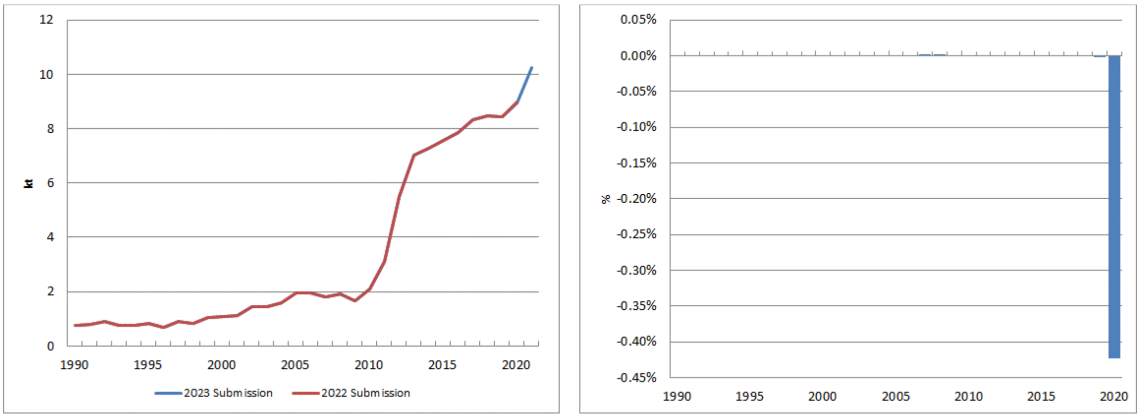


Figure 3.6.2 Evolution of the difference in 1A1a NMVOC emissions

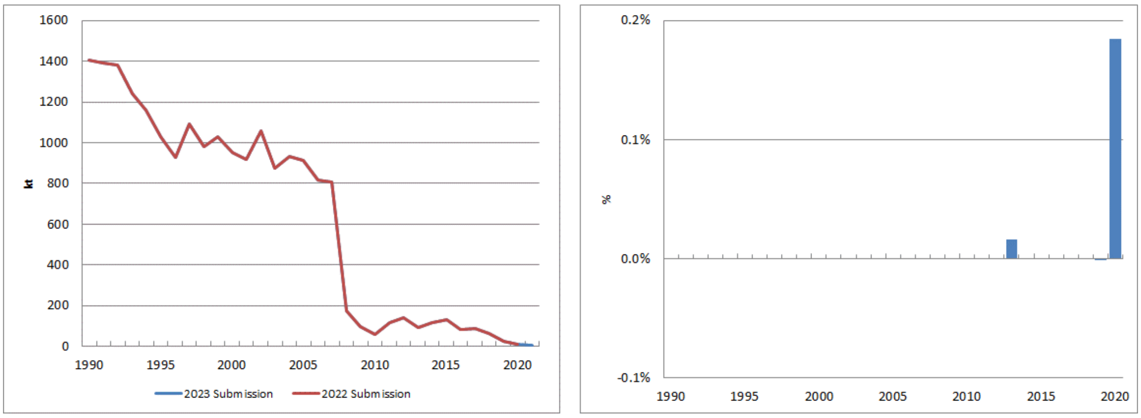


Figure 3.6.3 Evolution of the difference in 1A1a SO_2 emissions

Differences in NH_3 emissions are directly related to update of biomass combustion in DH plants and one biomass plant in 2020.

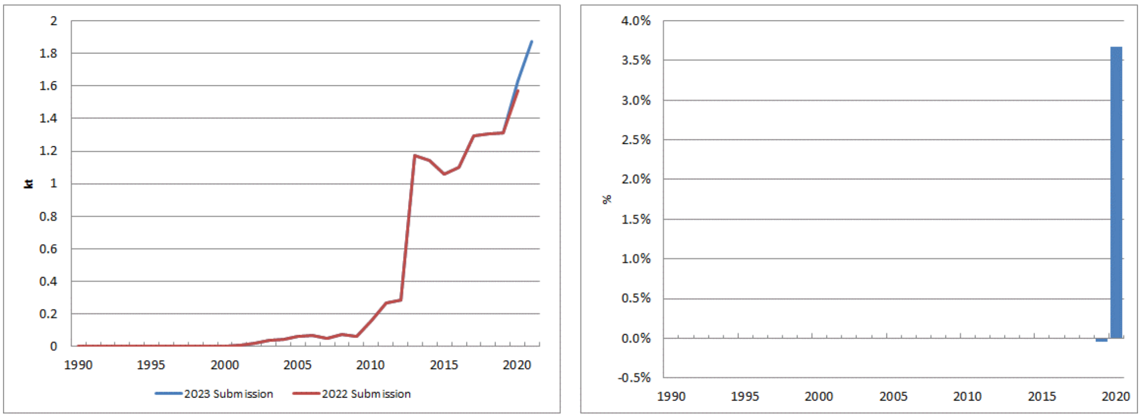


Figure 3.6.4 Evolution of the difference in 1A1a NH_3 emissions

The result of the corrections on measured emissions—data provided by CEMS— of pollutants (NOx, CO, SO_2, TSP, NMVOC) in several power plants in years 2011, 2013, 2015 and 2019-2020 respectively, is clearly shown in the following figure (for year 2013).

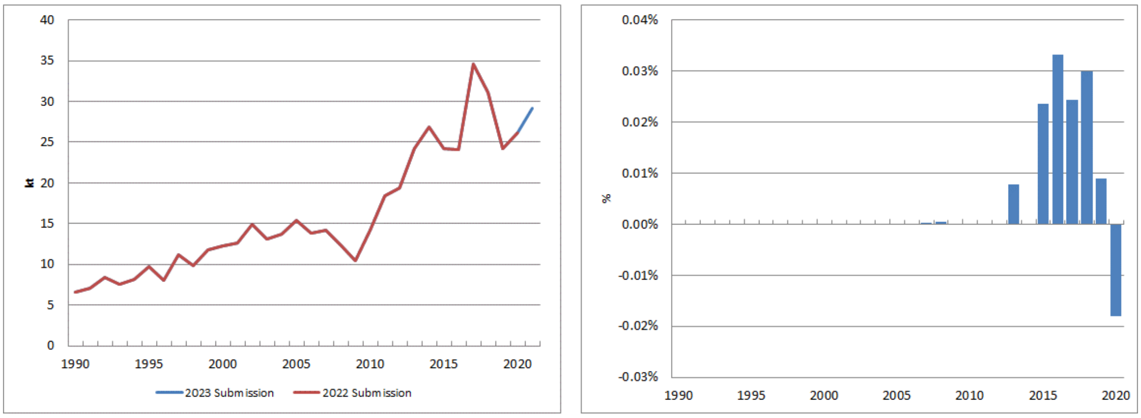


Figure 3.6.5 Evolution of the difference in 1A1a CO emissions

1A1a Public electricity and heat production. Particulate Matter, Heavy Metals and POPs emissions

As result of adjustements on distribution procedure of CEPMEIP fractions of PM, several inconsistencies have been revised in LPS emissions. These corrections have only affected the distribution of the $PM_{2.5}$ and PM_{10} fractions and those emissions belonging to BC, but not the total emitted particulate matter (TSP) whose emissions data are from CEMS.

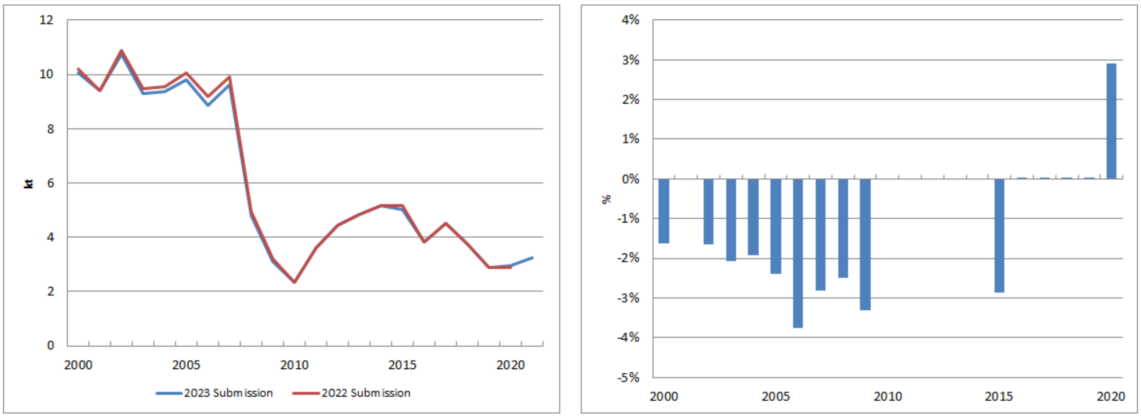


Figure 3.6.6 Evolution of the difference in 1A1a $PM_{2.5}$ emissions

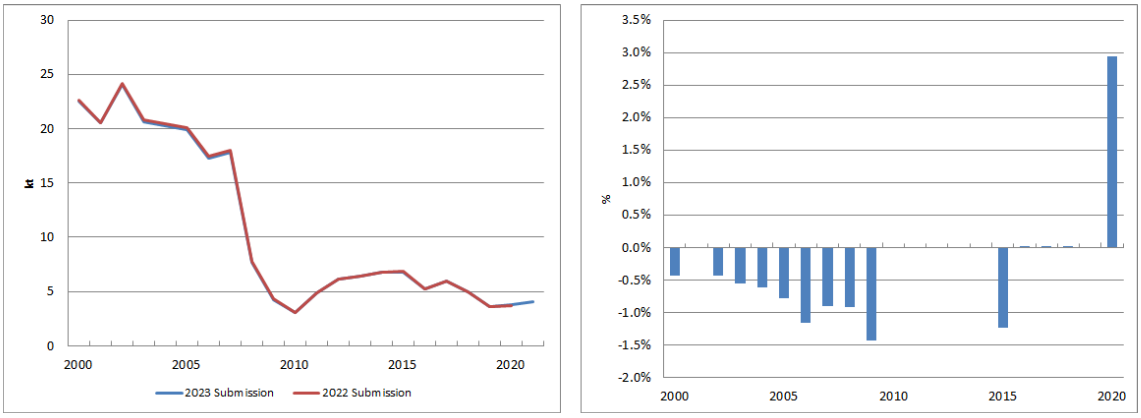


Figure 3.6.7 Evolution of the difference in 1A1a PM_{10} emissions

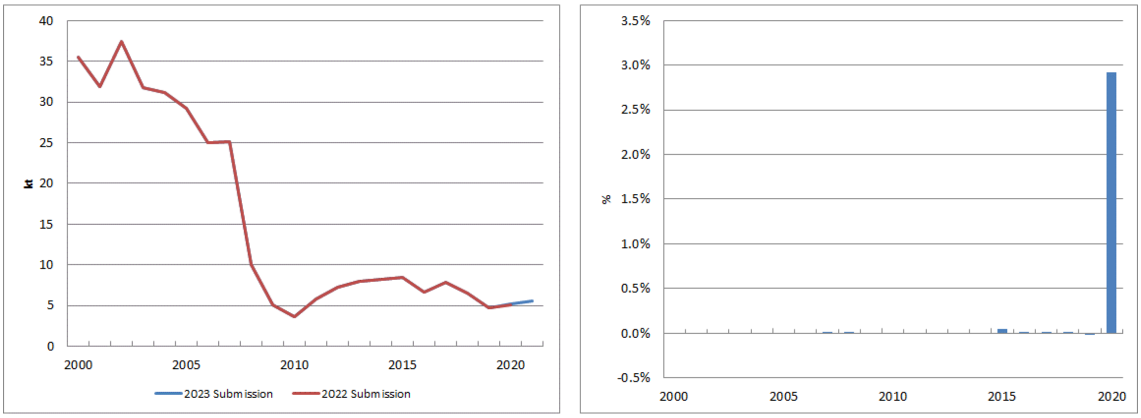


Figure 3.6.8 Evolution of the difference in 1A1a TSP emissions

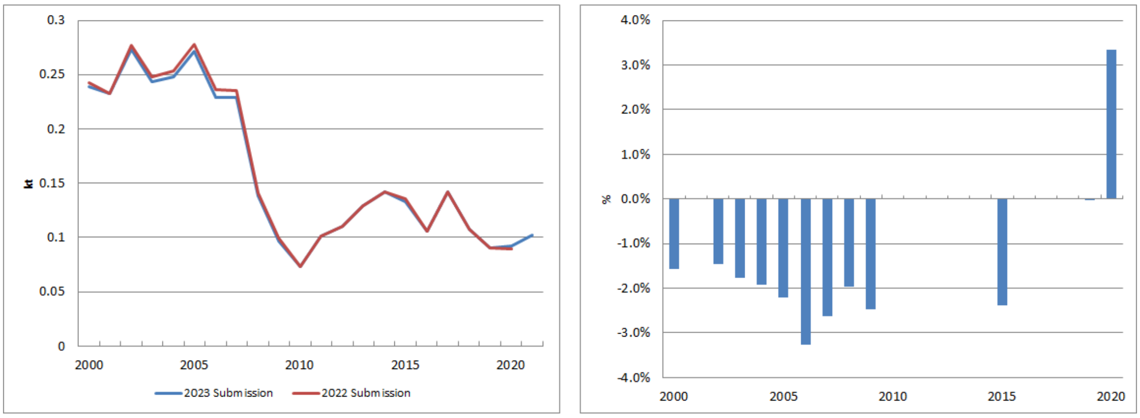


Figure 3.6.9 Evolution of the difference in 1A1a BC emissions

The most significant recalculations on Heavy metals and Persistent Organic Pollutants emissions are consequence of updating the activity data from two power stations in 2020, and from DH plants in the years 2019 and 2020.

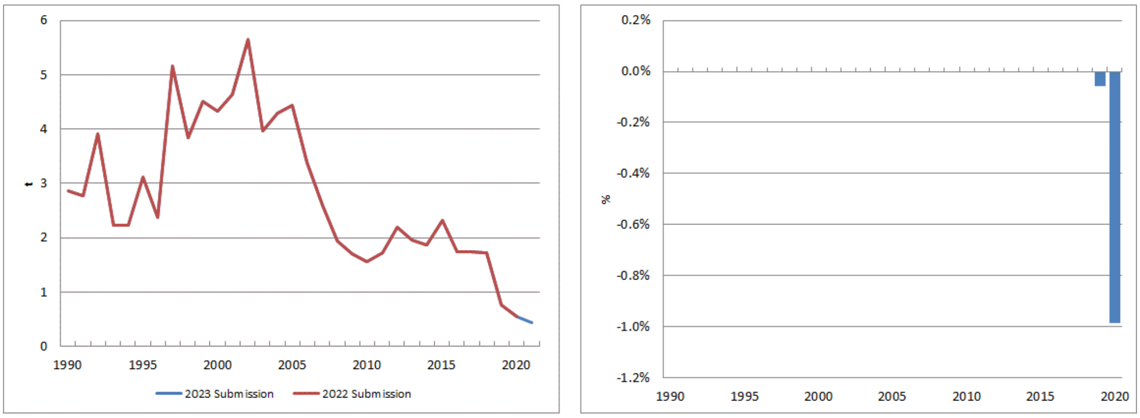


Figure 3.6.10 Evolution of the difference in 1A1a Pb emissions

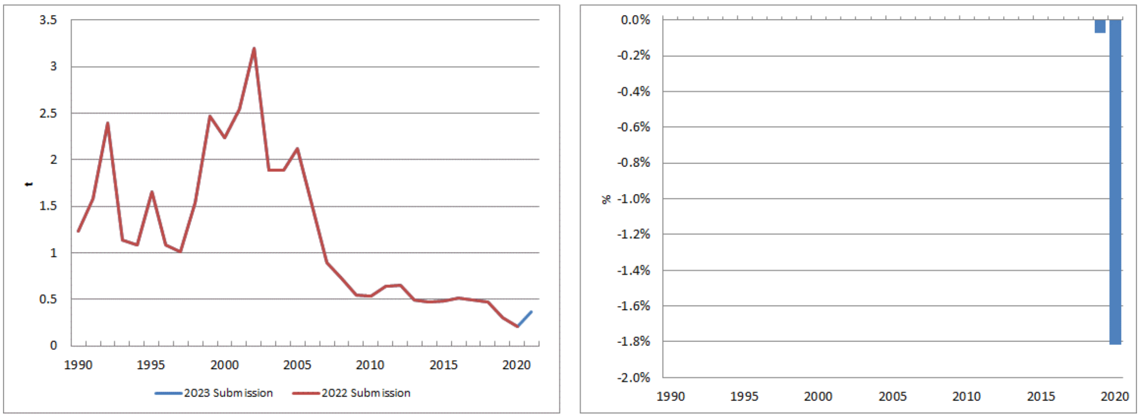


Figure 3.6.11 Evolution of the difference in 1A1a Cd emissions

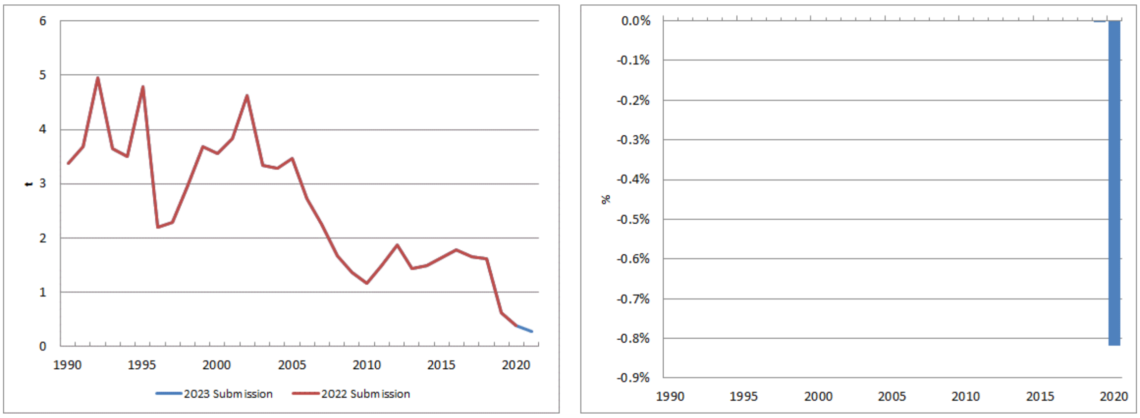


Figure 3.6.12 Evolution of the difference in 1A1a Hg emissions

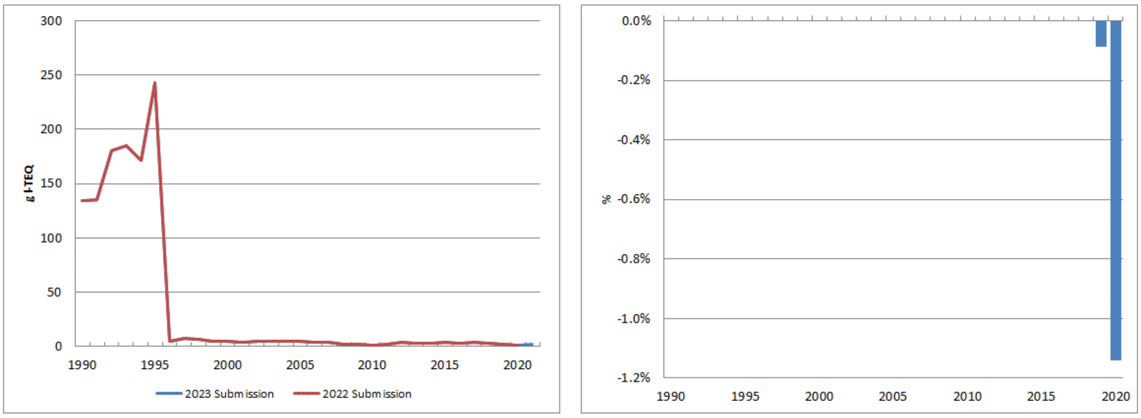


Figure 3.6.13 Evolution of the difference in 1A1a PCDD/PCDF emissions

PAHs emissions under 1A1a Public electricity and heat production

Emissions of PAHs totals under 1A1a were updated to EMEP/EEA Guidebook (2019) for both Large Point Sources (LPS) and small power plants (Area Sources) in previous editions of the Inventory. This recalculation included all type of fuels used in power generation plants and incineration plants.

The changes in activity rates performed in the present edition (mainly corrections within district heating activity in years 2019 and 2020, with high proportion of biomass plants) have affected PAHs emissions, as is shown in the following picture.

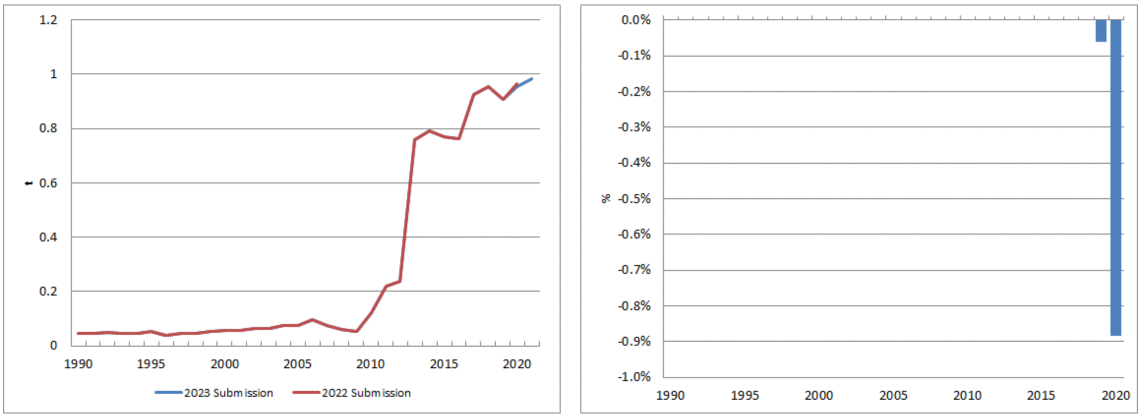


Figure 3.6.14 Evolution of the difference in 1A1a PAHs emissions

The main driver in PAHs emissions at the beginning of the Inventory period is the amount of MSW burned at incineration plants with energy recovery. From 1996 onwards, information regarding abatement techniques in MSW incineration plants became available, and PAHs emissions decreased between the years 1995 and 1996 (as can also be seen more clearly in the evolution of PCDD/PCDF and HCB emissions), despite the increase in the municipal waste incineration. Taking into consideration historical data on control devices installed in Spanish incineration plants, in years 1990-1995 PAHs Tier 2 EF in Table 3-2 (EMEP/EEA 2019 GB, Chapter 5.C.1.a) are used (uncontrolled abatement technologies). From 1996 onwards, Tier 1 EFs in Table 3-1 are used (default abatement technologies considered). After this, between 2009 and 2010 a significant rise in agricultural wastes consumption at biomass plants implies an increase in PAHs emissions. Finally, the consumption of wood wastes (together with agricultural wastes), begins to gain relevance in 2013. Small power plants (mainly biomass power plants but also DH networks) have multiplied in recent years in Spain (e.g. 8 biomass power plants in 2011 vs. 30 plants in 2021) that means a significant increase of wood wastes burned in boilers, which have a direct correlation with PAHs emissions.

1A1b Petroleum refining. All pollutants

This recalculation has been made due to the double counting detected in the parts of the refineries where ethylene production takes place. Said production is reported in the IPPU sector. To this end, said double accounting is corrected in the two refineries where ethylene is produced.

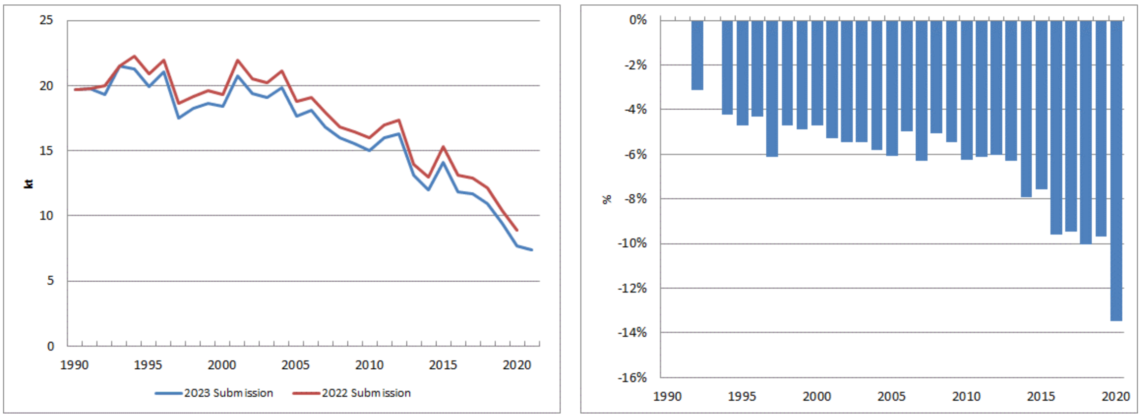


Figure 3.6.15 Evolution of the difference in 1A1b NOx emissions

1A1c Manufacture of solid fuels and other energy industries. All pollutants (except PCBs)

The main recalculations are related to updating of base information from international questionnaires (IntQ) for the whole time series, in particular on non-specific consumption of natural gas in coke plants (1A1civ sub-category) and on other fuels like biomass consumption (wood/wood wastes) in coal mines (1A1ciii sub-category).

Other recalculations are due to the correction of emission factors related to coke ovens (1A1ci sub-category) for the year 2020. These EFs from EMEP Guidebook 2019 were introduced with an error in the 2022 edition of the Inventory.

Changes related to the recalculation of the fuel balance are barely noticeable within the whole 1A1c category.

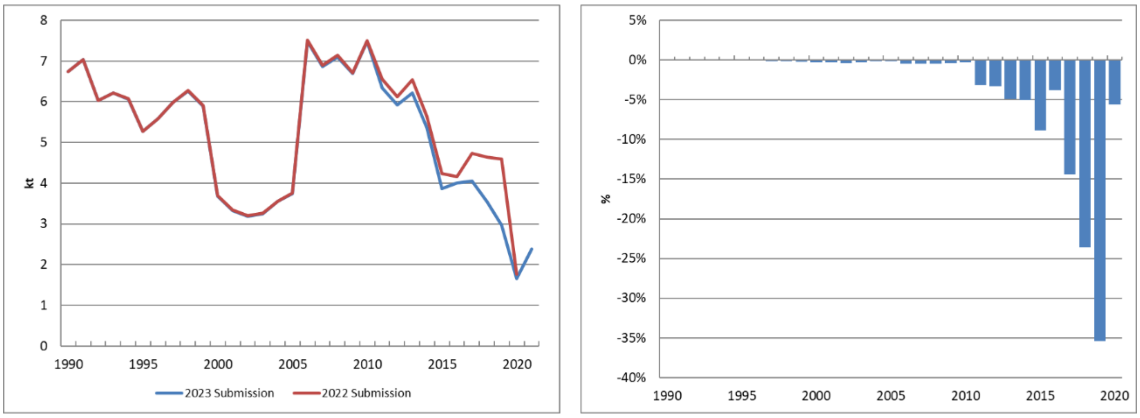


Figure 3.6.16 Evolution of the difference in 1A1c NOx emissions

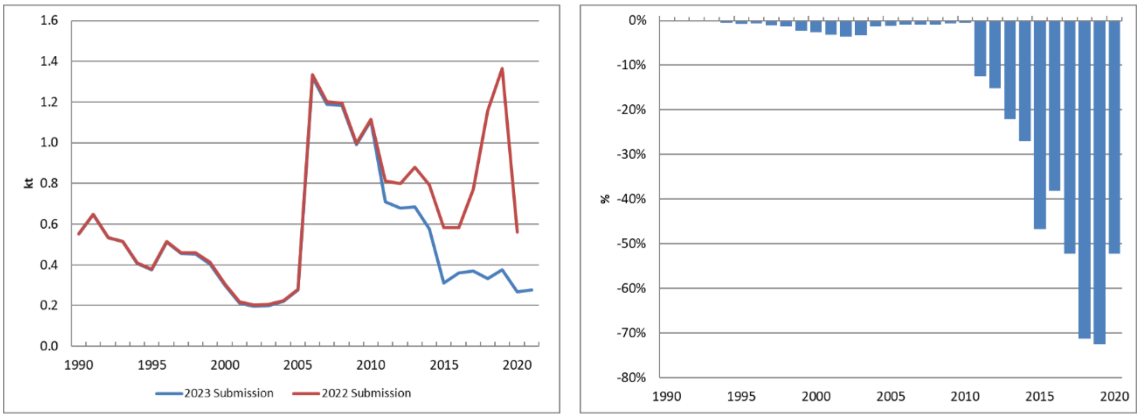


Figure 3.6.17 Evolution of the difference in 1A1c NMVOC emissions

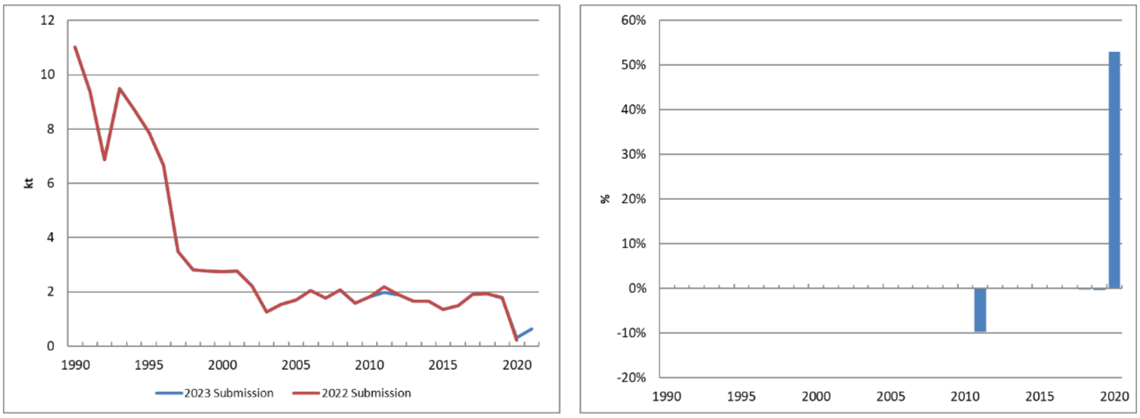


Figure 3.6.18 Evolution of the difference in 1A1c SO_2 emissions

Differences in NH_3 emissions are directly related to update of biomass consumption from international questionnaires (IntQ).

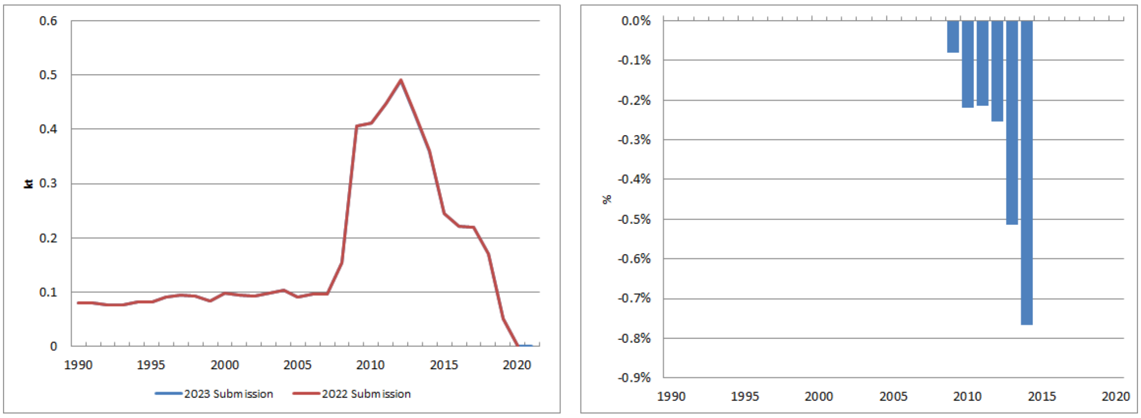


Figure 3.6.19 Evolution of the difference in 1A1c NH_3 emissions

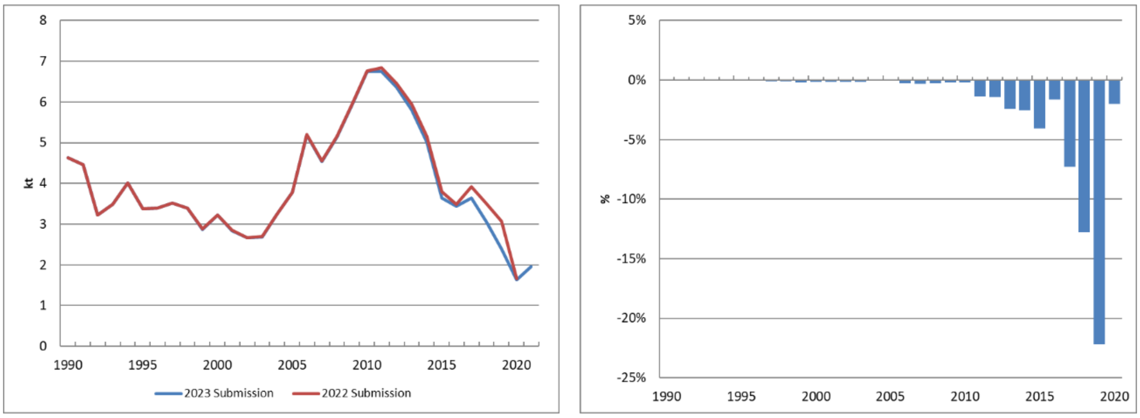


Figure 3.6.20 Evolution of the difference in 1A1c CO emissions

The most significant recalculations on TSP are consequence of the correction of EFs related to coke ovens for the year 2020.

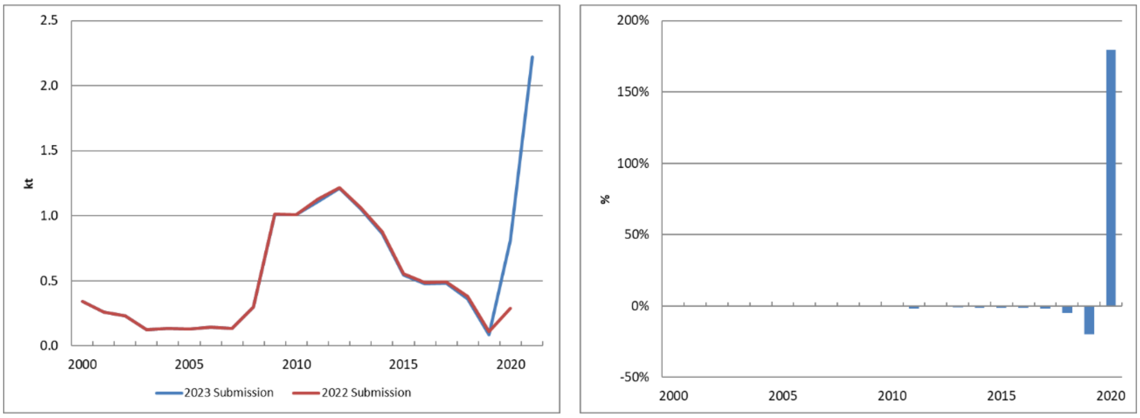


Figure 3.6.21 Evolution of the difference in 1A1c TSP emissions

Differences in $PM_{2.5}$ and PM_{10} emissions are very similar to those of TSP.

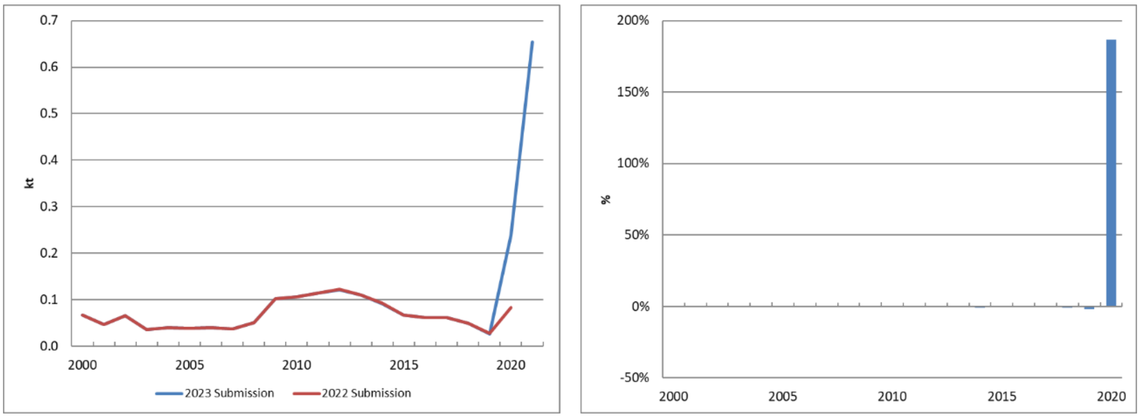


Figure 3.6.22 Evolution of the difference in 1A1c BC emissions

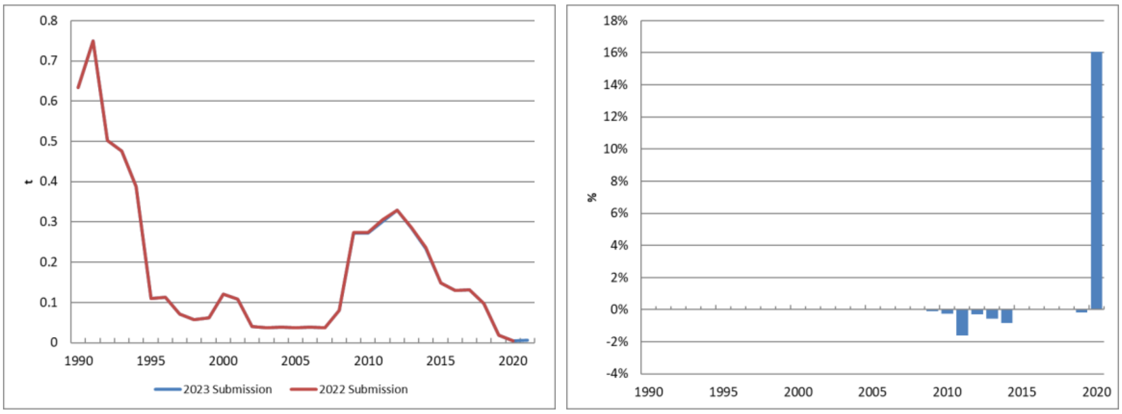


Figure 3.6.23 Evolution of the difference in 1A1c Pb emissions

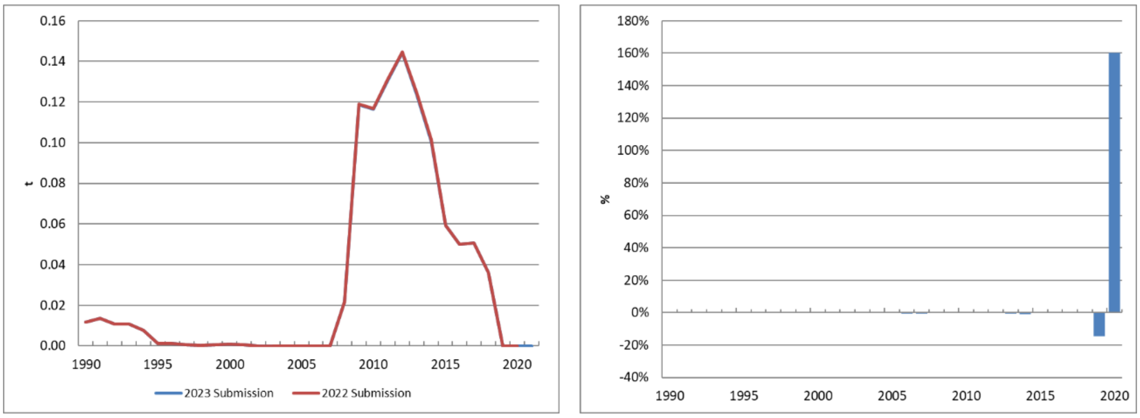


Figure 3.6.24 Evolution of the difference in 1A1c Cd emissions

Recalculations on Hg are directly related to update of natural gas combustion from IntQ.

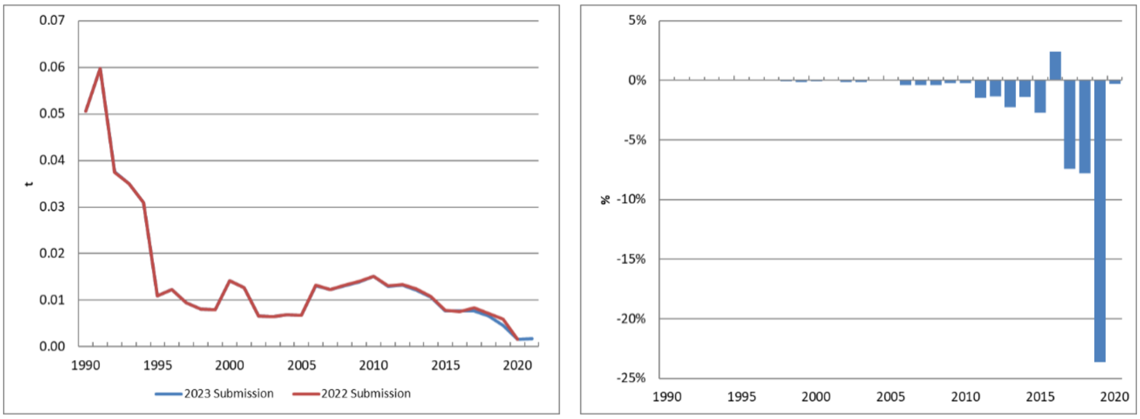


Figure 3.6.25 Evolution of the difference in 1A1c Hg emissions

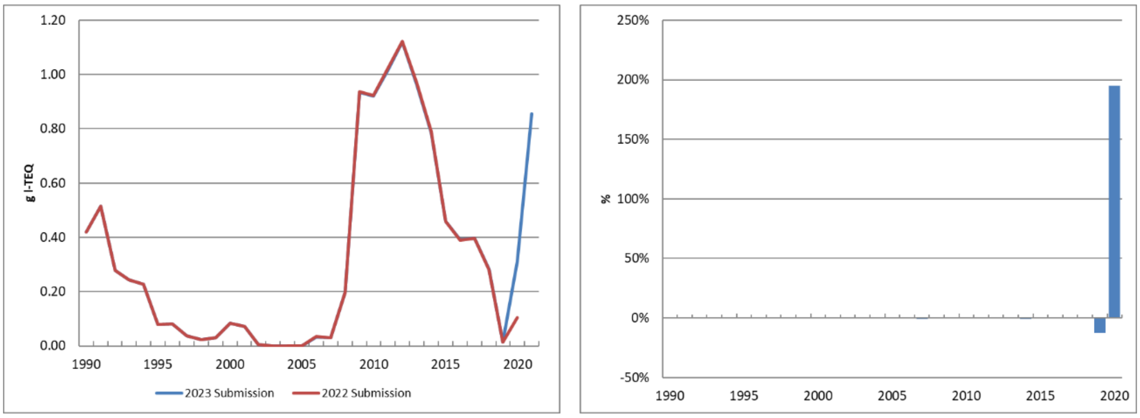


Figure 3.6.26 Evolution of the difference in 1A1c PCDD/PCDF emissions

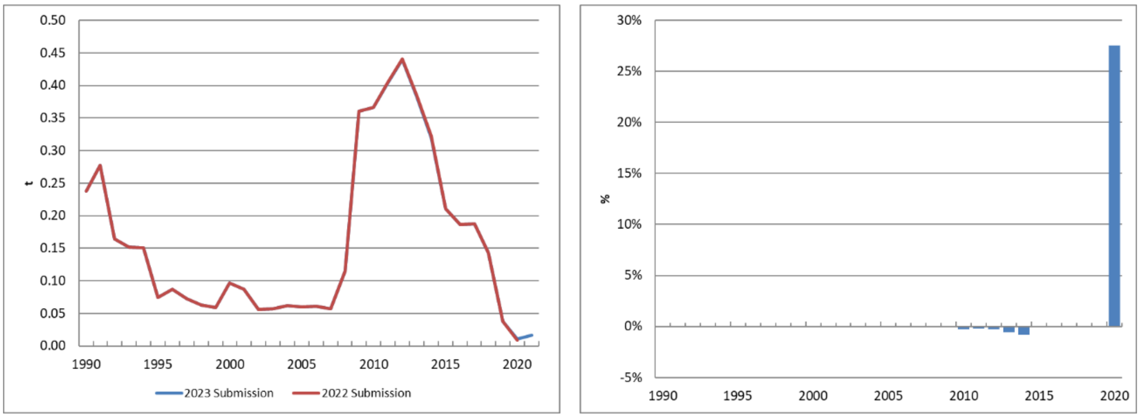


Figure 3.6.27 Evolution of the difference in 1A1c PAH emissions

1A2 Stationary combustion in manufacturing industries and construction. All pollutants

Recalculations caused by the update of the fuel balance for consistency with international energy statistics, have an impact on all subcategories and pollutants. This effect is added to the ones specified in Table 3.6.1 for each subcategory.

In this edition, most of the total recalculation on 1A2 is minor for most of the pollutants, so it has been deemed appropriate to include only the ones relevant.

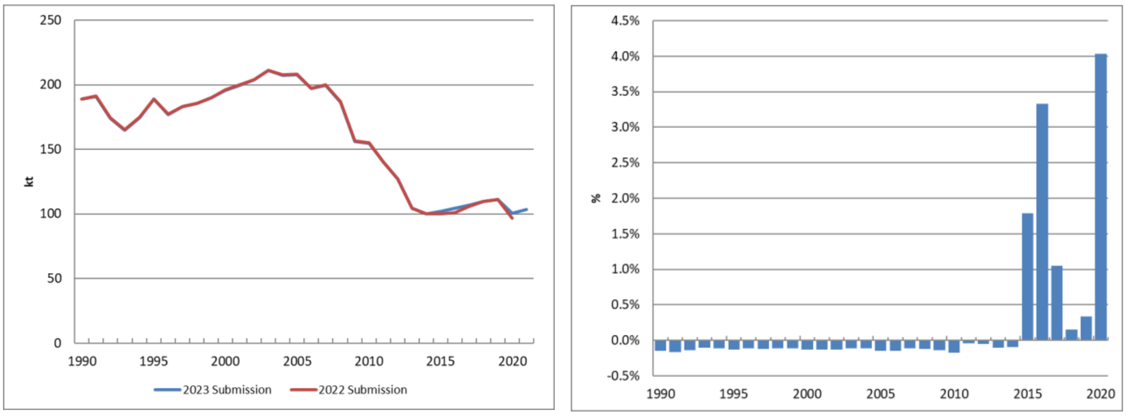


Figure 3.6.28 Evolution of the difference in 1A2 NOx emissions

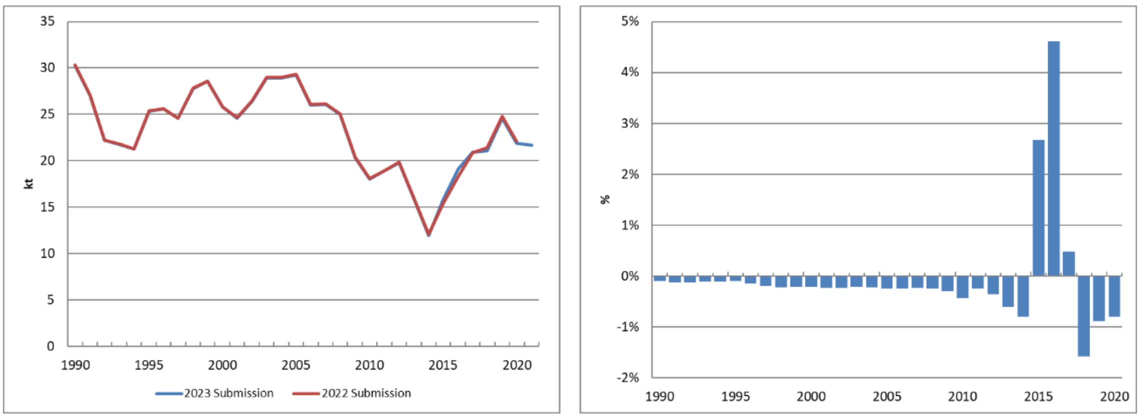


Figure 3.6.29 Evolution of the difference in 1A2 NMVOC emissions

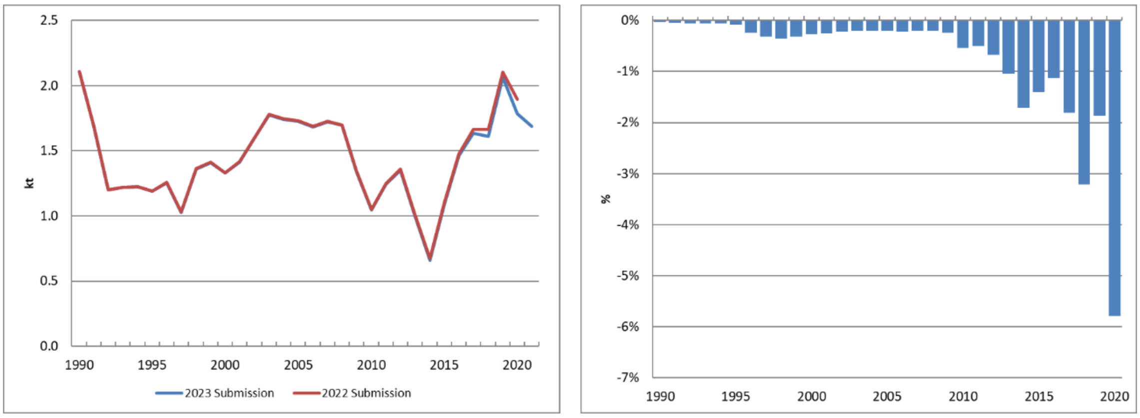


Figure 3.6.30 Evolution of the difference in 1A2 NH_3 emissions

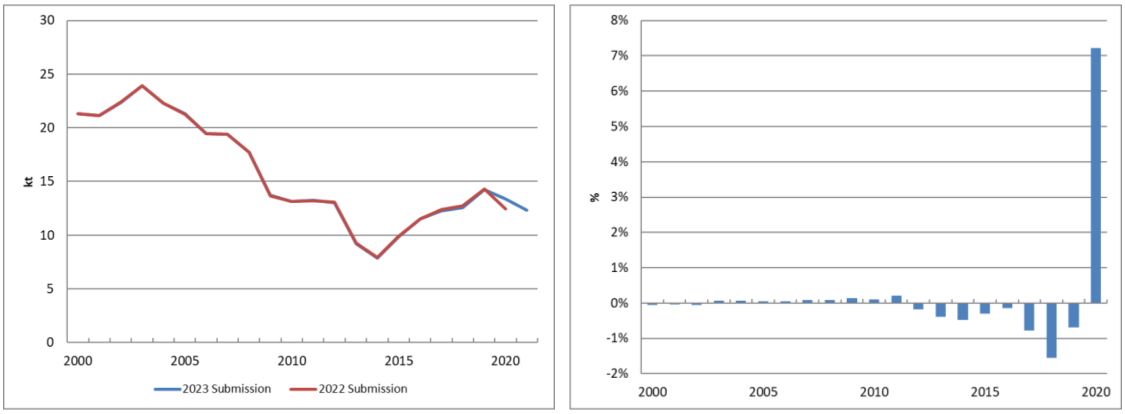


Figure 3.6.31 Evolution of the difference in 1A2 TSP emissions

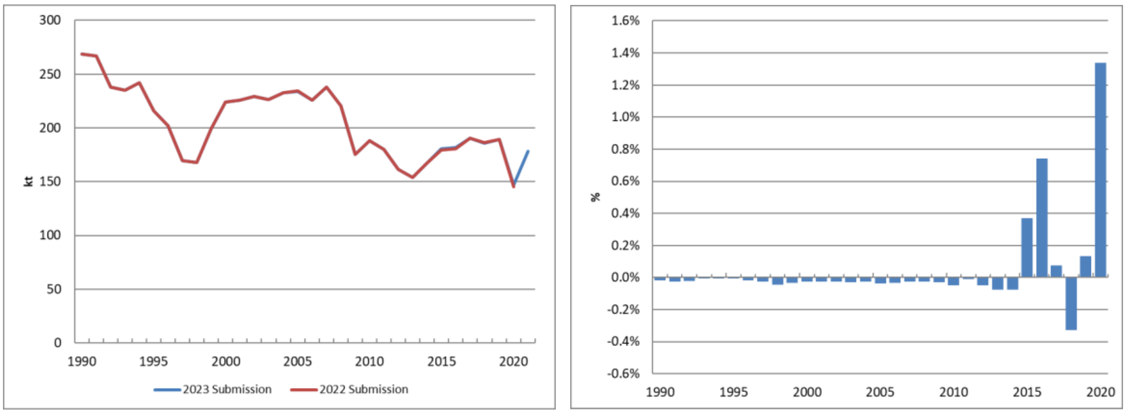


Figure 3.6.32 Evolution of the difference in 1A2 CO emissions

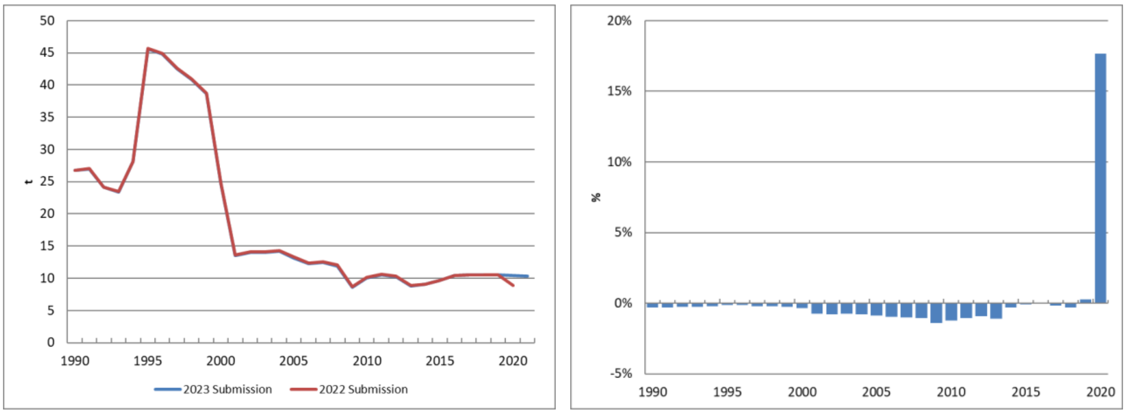


Figure 3.6.33 Evolution of the difference in 1A2 Pb emissions

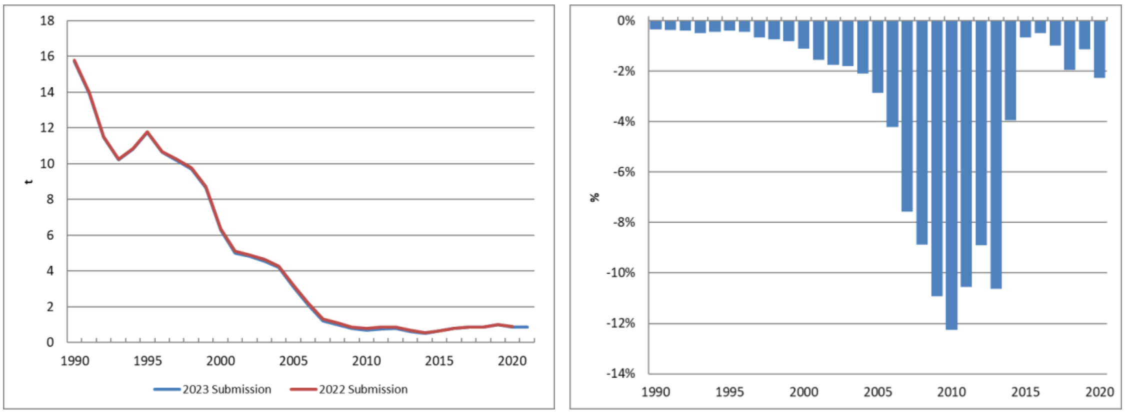


Figure 3.6.34 Evolution of the difference in 1A2 Cd emissions

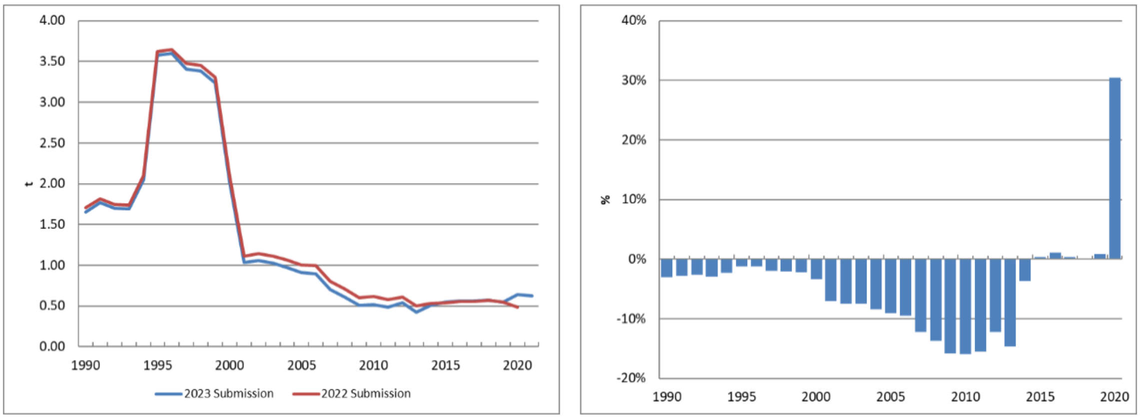


Figure 3.6.35 Evolution of the difference in 1A2 Hg emissions

1A3b Road transport. All pollutants

Recalculations made in road transport are caused by the following variations: update of emission factors according the latest version of EMEP/EEA 2019 Guidebook (october 2021), the update of calculation equations of cold exhaust PM, the update of LPG LCV, the update of CNG consumption from 2018 to 2020, the correction of CNG characteristics in 2020, and minor recalculations in all pollutants caused by small adjusts in vehicle fleet data (automation of the load process of the fleet dataset in the database)

Recalculations of main pollutants and priority heavy metals are shown below, although recalculations affect to all pollutants.

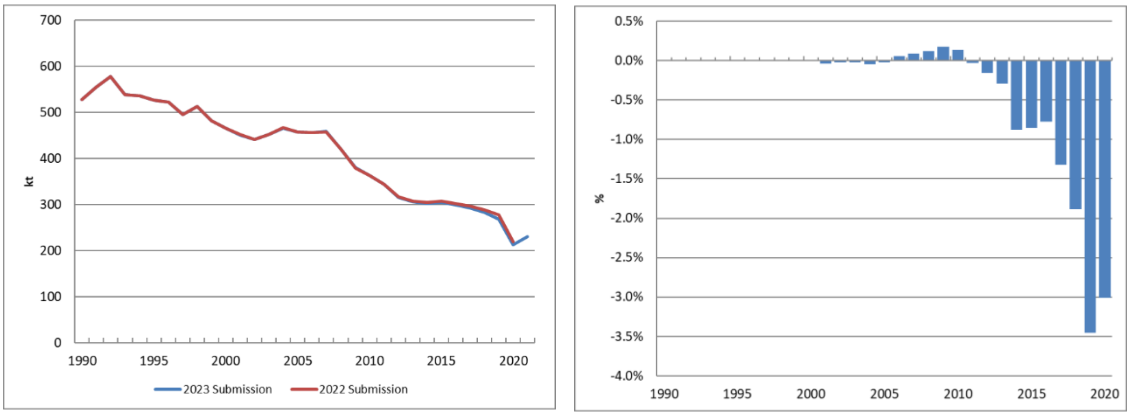


Figure 3.6.36 Evolution of the difference in 1A3b NOx emissions

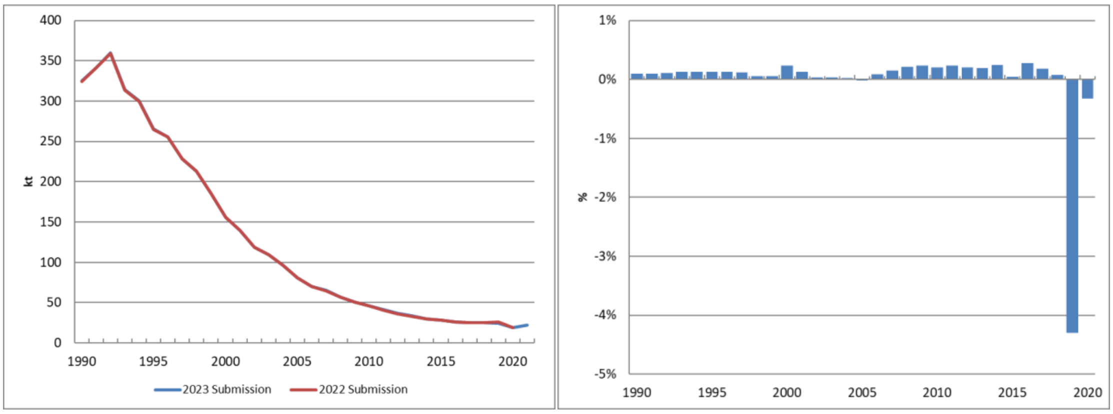


Figure 3.6.37 Evolution of the difference in 1A3b NMVOC emissions

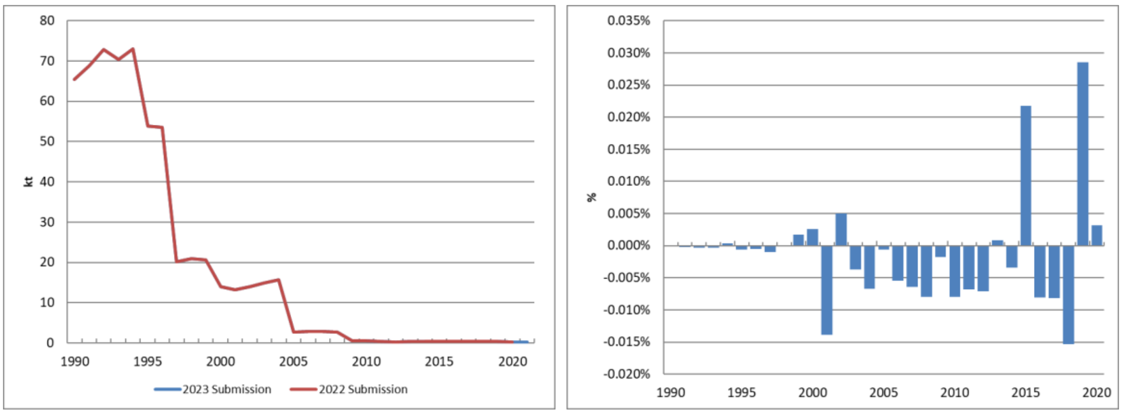


Figure 3.6.38 Evolution of the difference in 1A3b SO_2 emissions

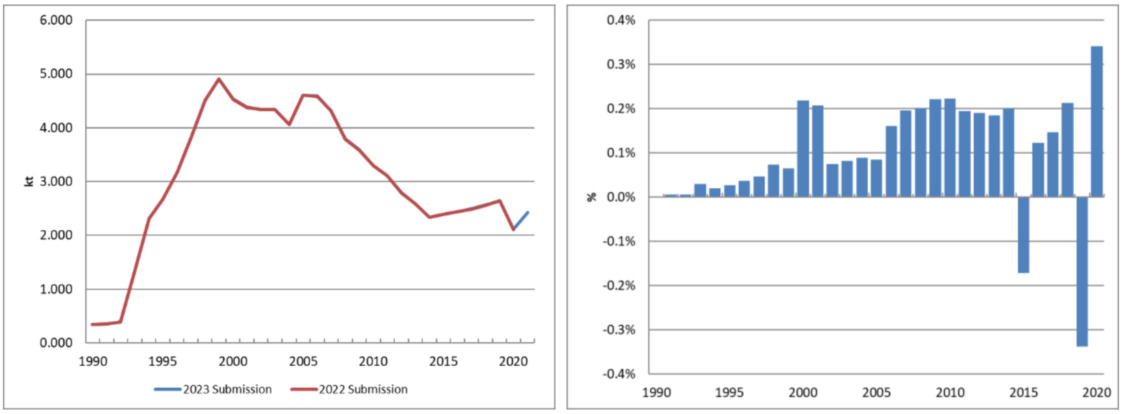


Figure 3.6.39 Evolution of the difference in 1A3b NH_3 emissions

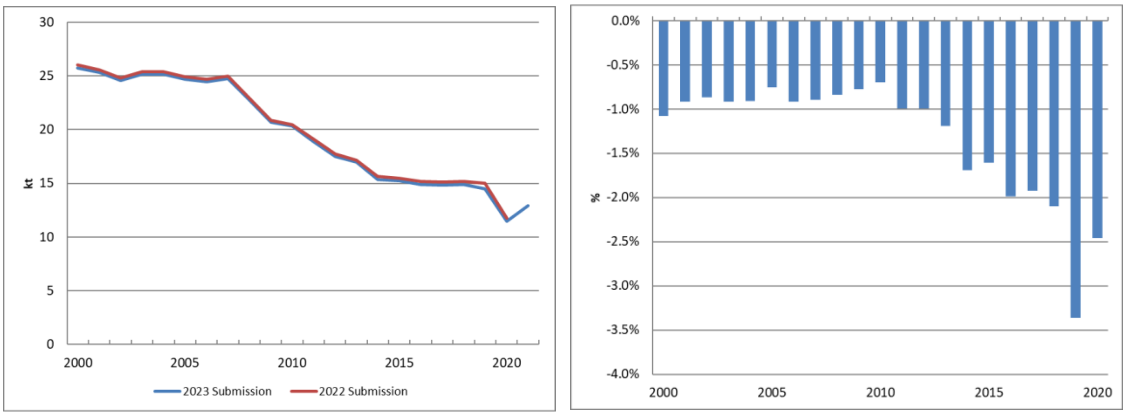


Figure 3.6.40 Evolution of the difference in 1A3b $PM_{2.5}$ emissions

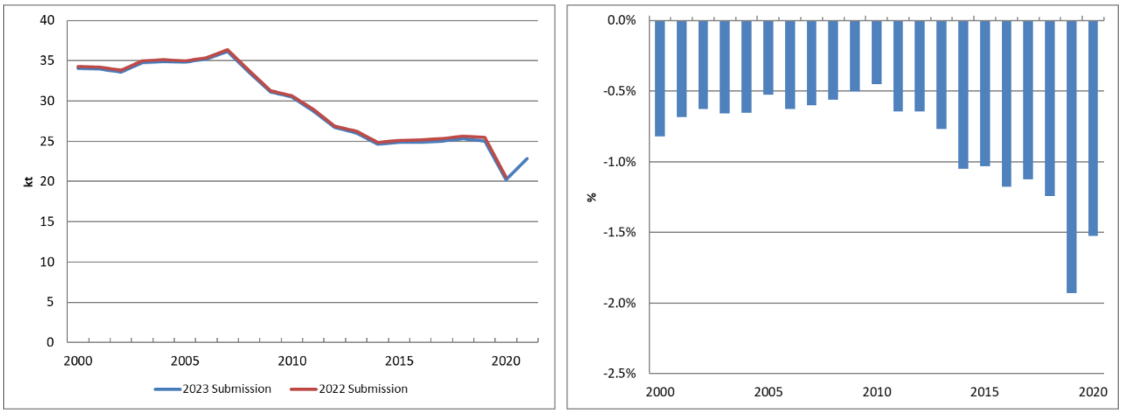


Figure 3.6.41 Evolution of the difference in 1A3b TSP emissions

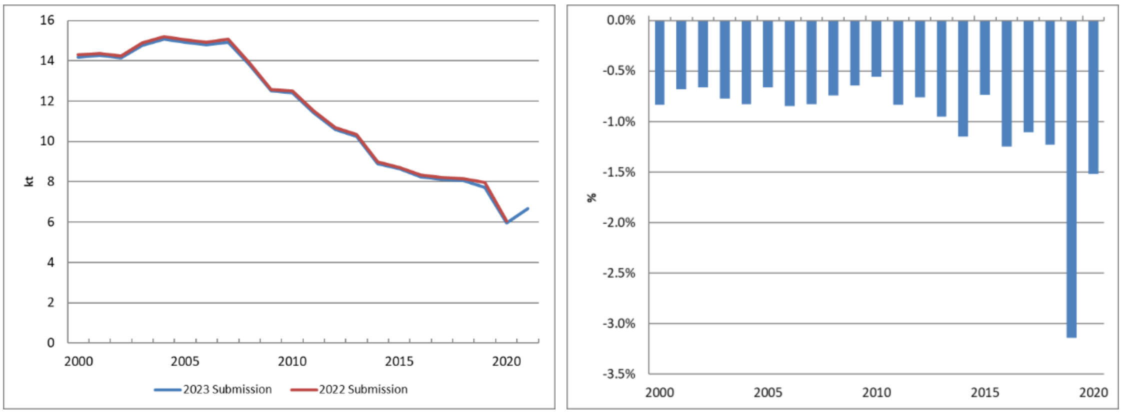


Figure 3.6.42 Evolution of the difference in 1A3b BC emissions

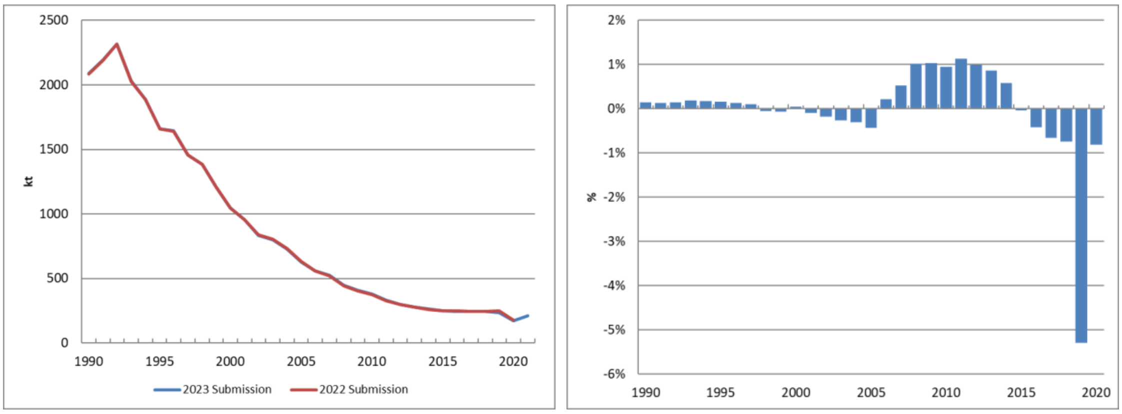


Figure 3.6.43 Evolution of the difference in 1A3b CO emissions

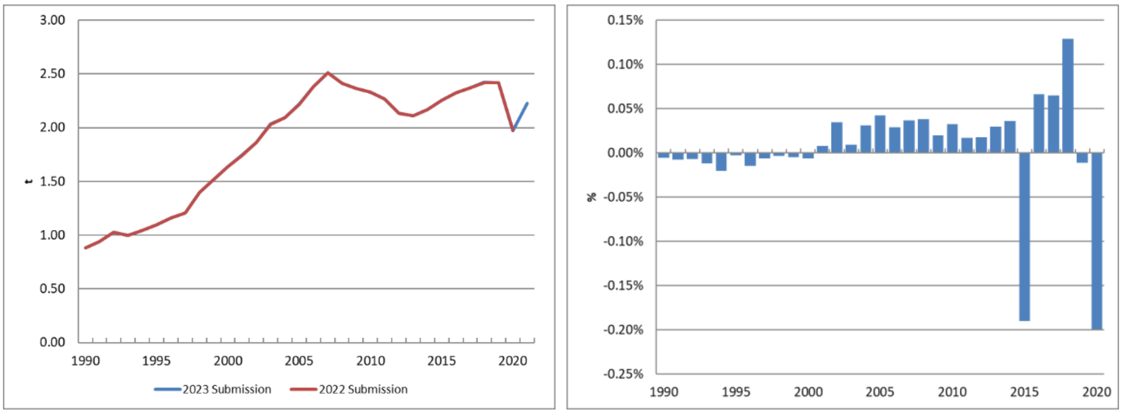


Figure 3.6.44 Evolution of the difference in 1A3b PAH emissions

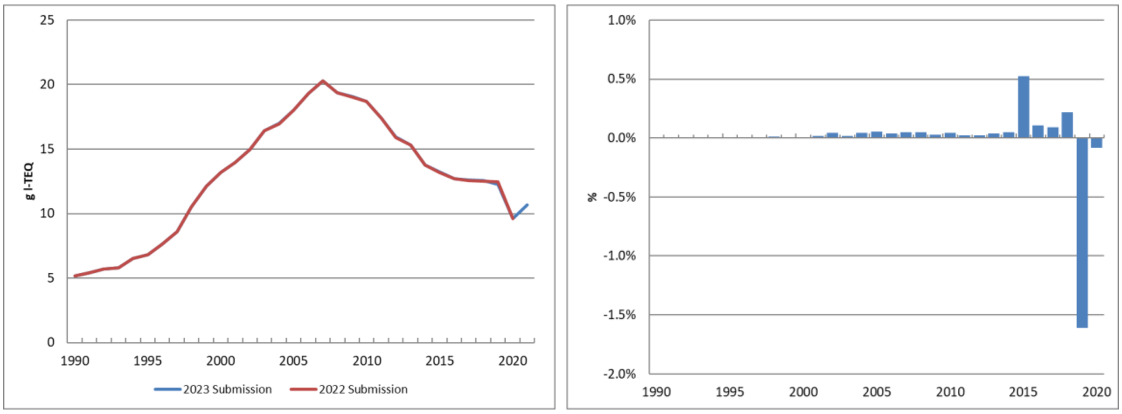


Figure 3.6.45 Evolution of the difference in 1A3b PCDD/PCDF emissions

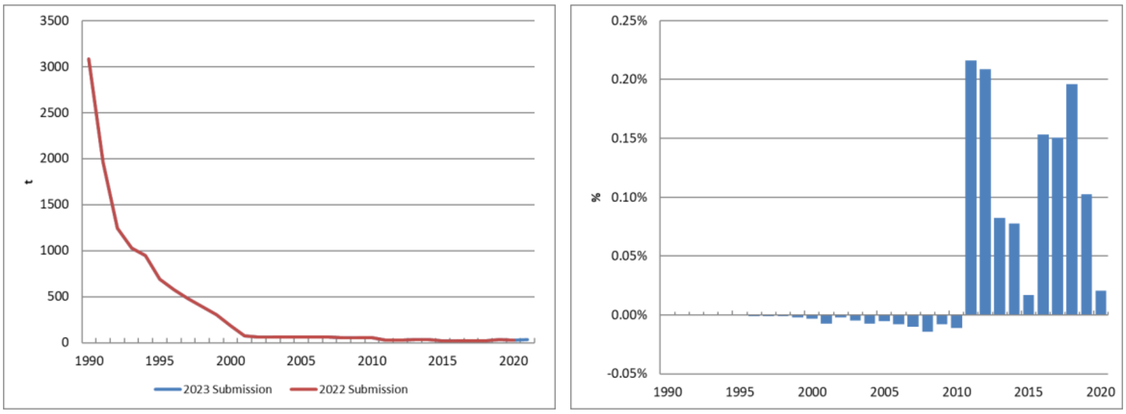


Figure 3.6.46 Evolution of the difference in 1A3b Pb emissions

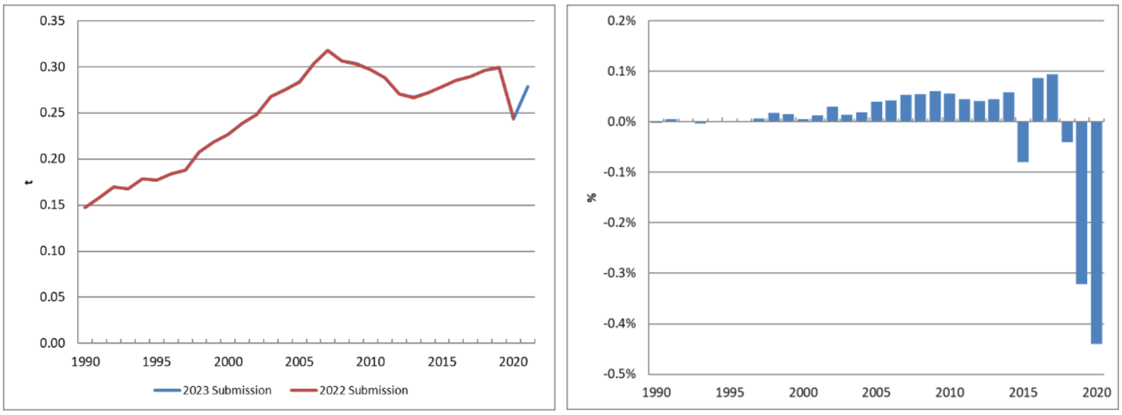


Figure 3.6.47 Evolution of the difference in 1A3b Cd emissions

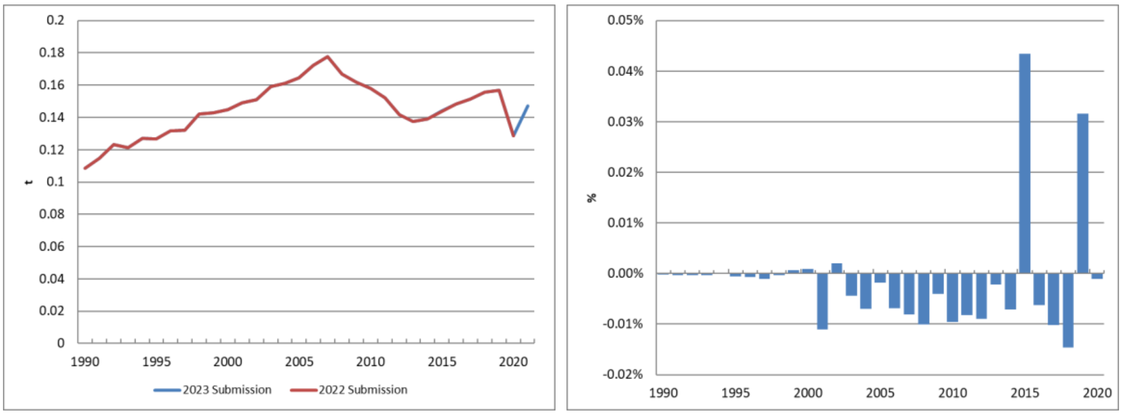


Figure 3.6.48 Evolution of the difference in 1A3b Hg emissions

1A3d National navigation

The recalculation in national navigation is caused by the update of emission factors of CO, NMVOC, NOx, PM, BC, Cu, Se and As according to the latest version of EMEP/EEA Guidebook (2019) in December 2021. Besides, provincial distribution data was updated for 2019 an 2020 (affecting total national consumption without Canary Islands). In addition, a correction of SO_2 emission factor was made in 2020.

The following figures show the emission trends of the pollutants and heavy metals more affected.

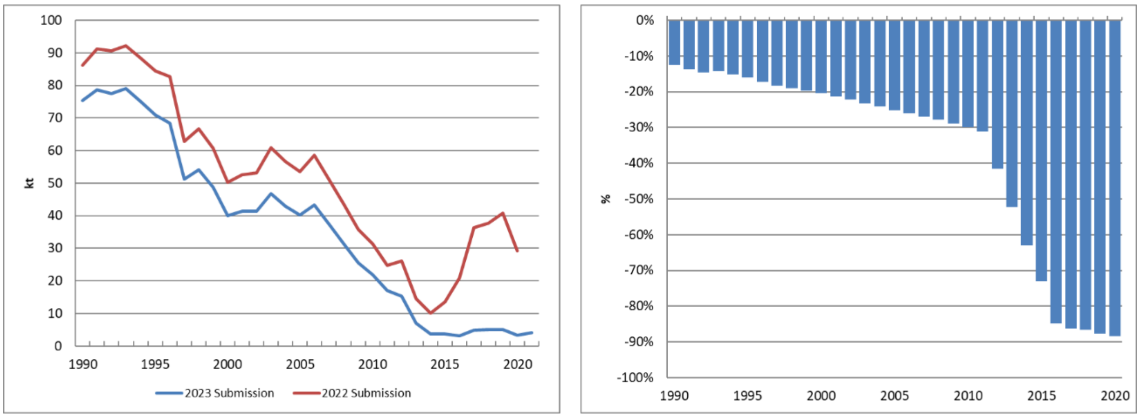


Figure 3.6.49 Evolution of the difference in 1A3d NOx emissions

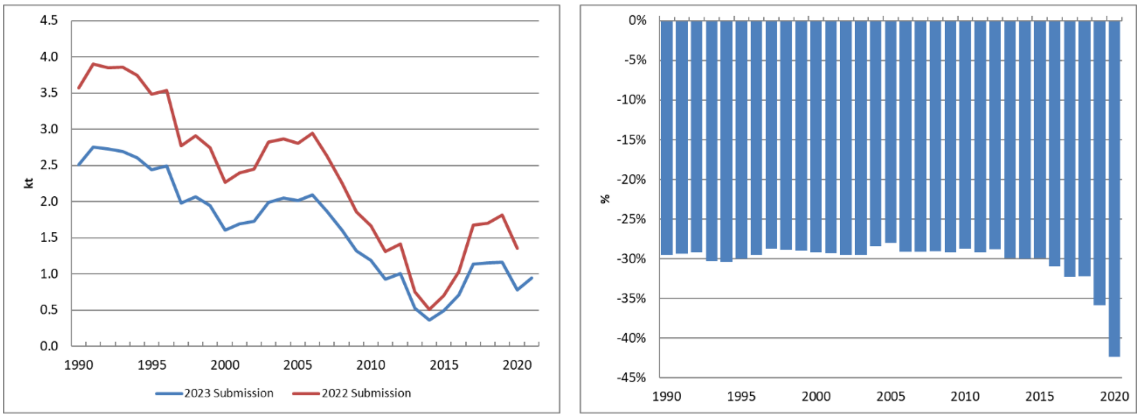


Figure 3.6.50 Evolution of the difference in 1A3d NMVOC emissions

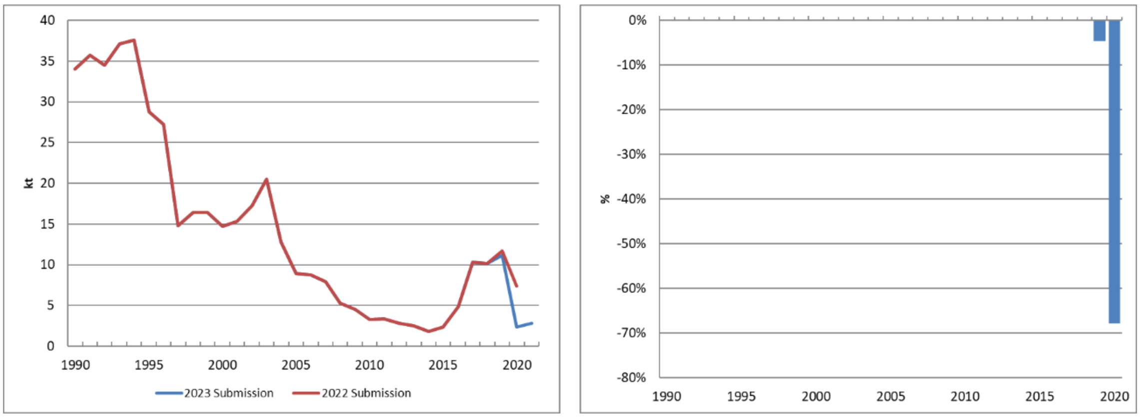


Figure 3.6.51 Evolution of the difference in 1A3d SO_2 emissions

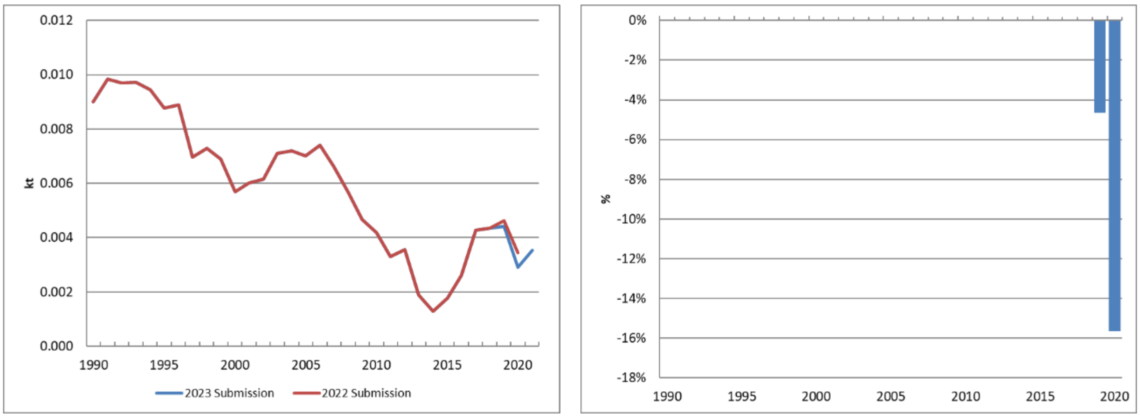


Figure 3.6.52 Evolution of the difference in 1A3d NH_3 emissions

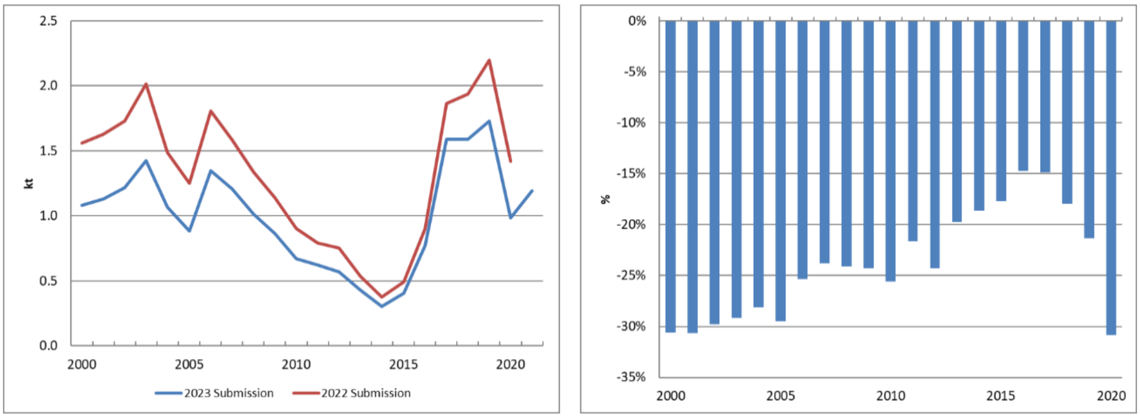


Figure 3.6.53 Evolution of the difference in 1A3d $PM_{2.5}$ emissions

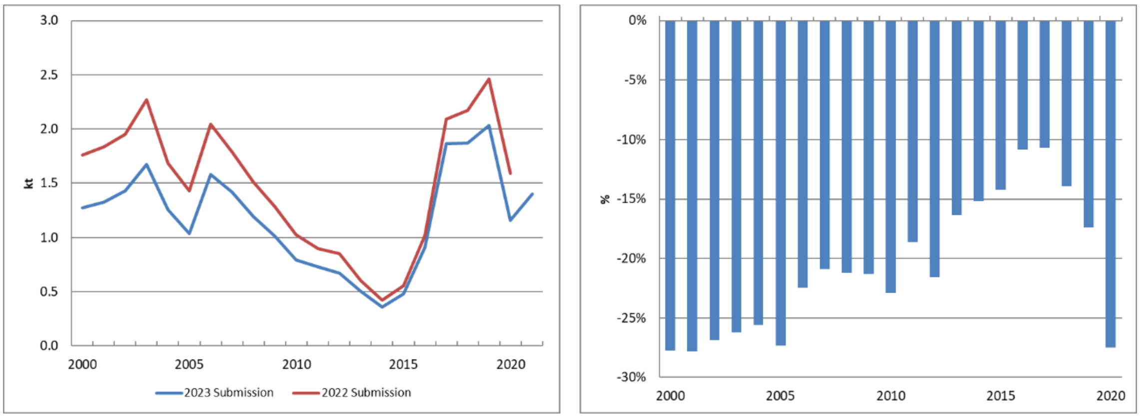


Figure 3.6.54 Evolution of the difference in 1A3d TSP emissions

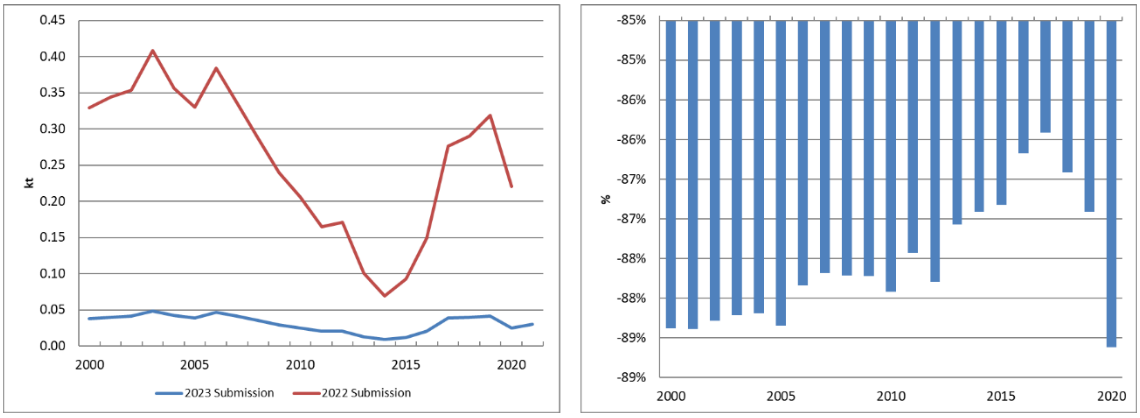


Figure 3.6.55 Evolution of the difference in 1A3d BC emissions

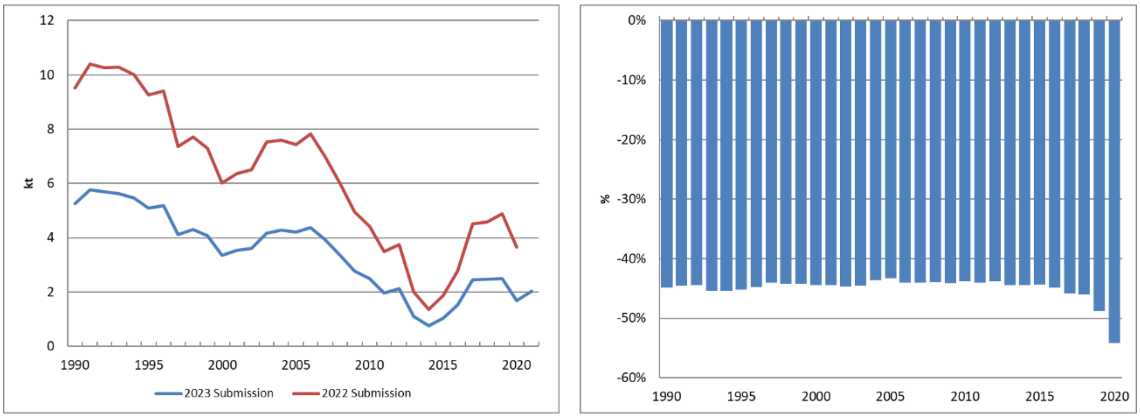


Figure 3.6.56 Evolution of the difference in 1A3d CO emissions

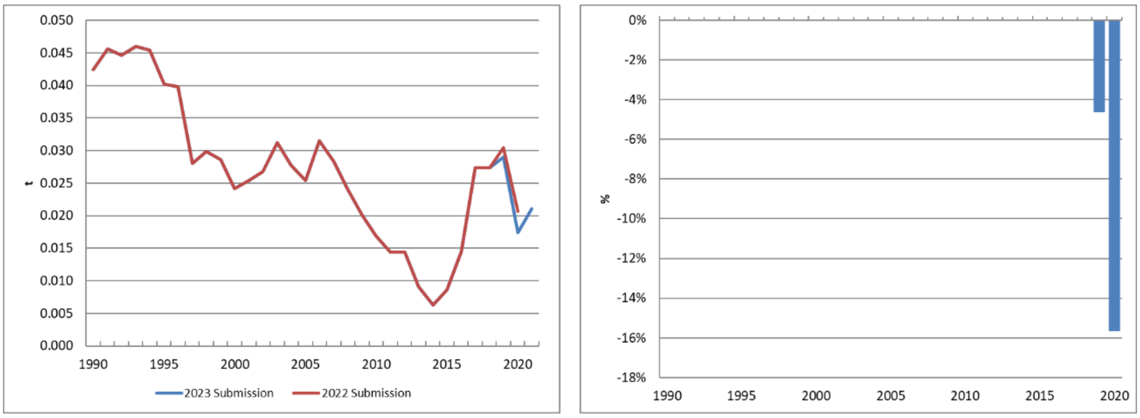


Figure 3.6.57 Evolution of the difference in 1A3d PAH emissions

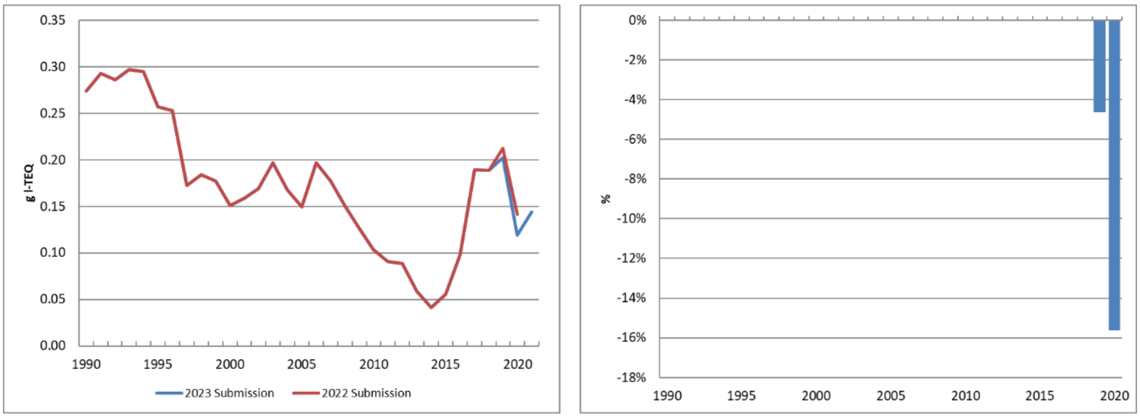


Figure 3.6.58 Evolution of the difference in 1A3d PCDD/PCDF emissions

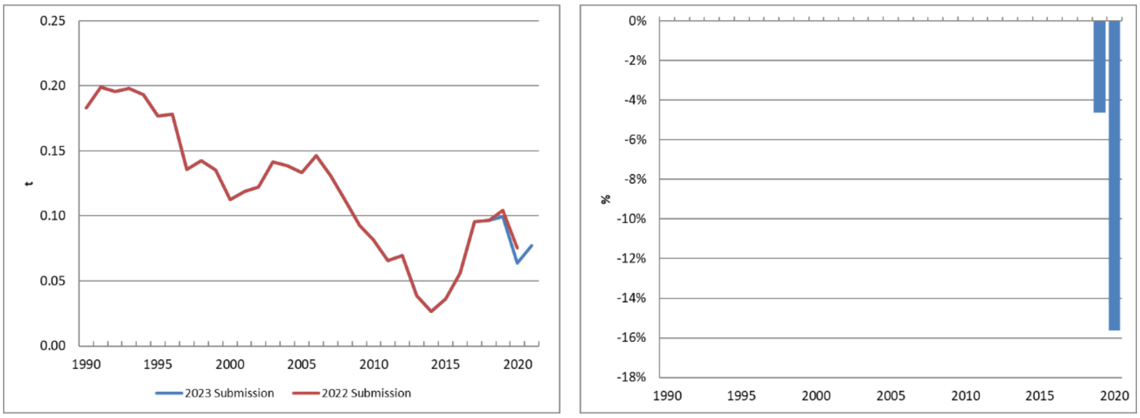


Figure 3.6.59 Evolution of the difference in 1A3d Pb emissions

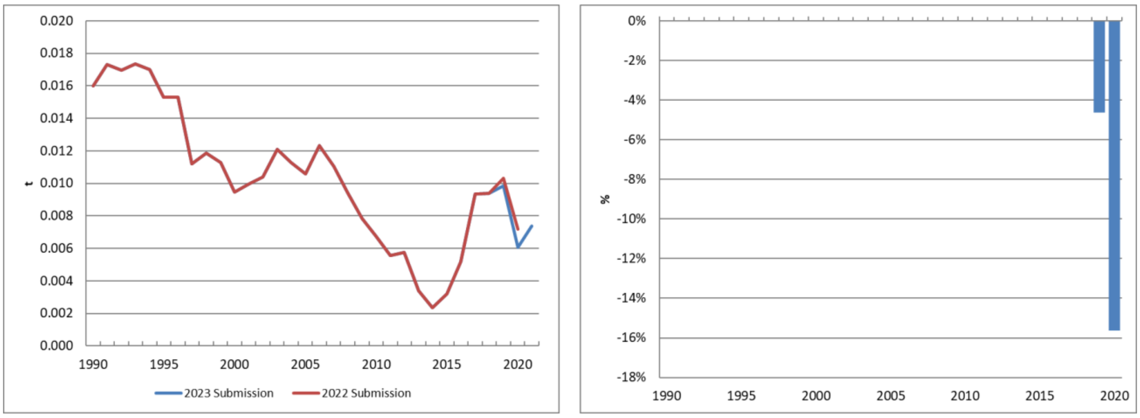


Figure 3.6.60 Evolution of the difference in 1A3d Cd emissions

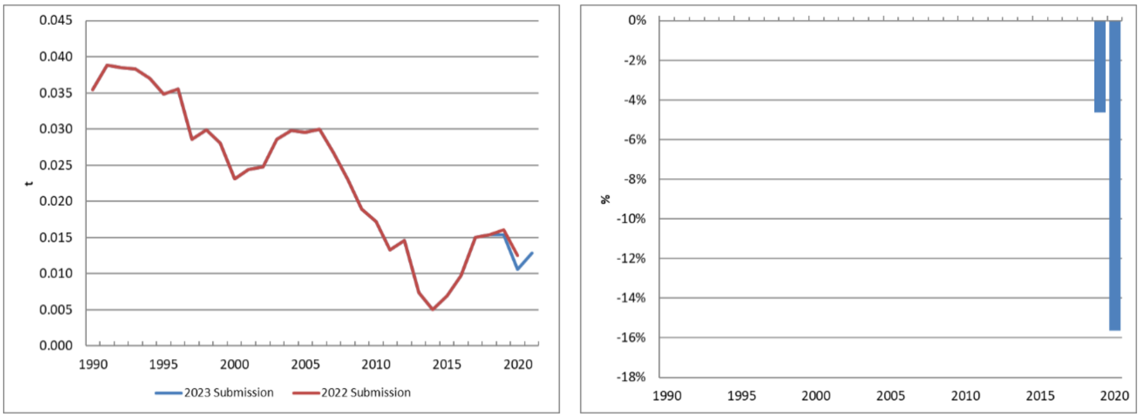


Figure 3.6.61 Evolution of the difference in 1A3d Hg emissions

1A4ai Stationary combustion in commercial and institutional sector

Recalculations in all pollutant emissions are due to the update by the information source of fuel-activity allocation for the whole inventory period. This update is specifically marked in natural gas consumption since 2015.

Besides, new estimates of NH_3 emissions from biomass have been included in 1A4a category according to the emission factors from EMEP/EEA 2019 Guidebook.

Finally, emission factors update and minor corrections have been carried out in this Inventory edition. This update responds to the unification of criteria among different inventory activities and is mainly noticeable in liquid fuels for pollutants such as TSP and BC.

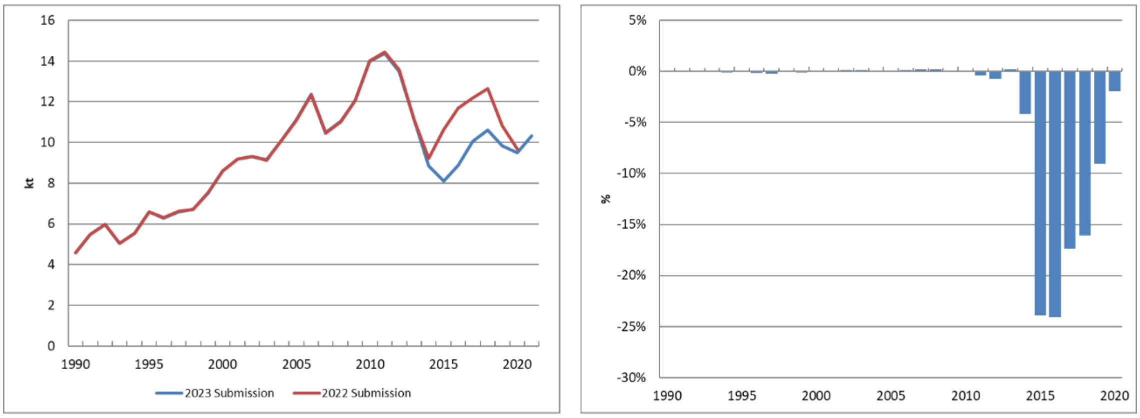


Figure 3.6.62 Evolution of the difference in 1A4ai NOx emissions

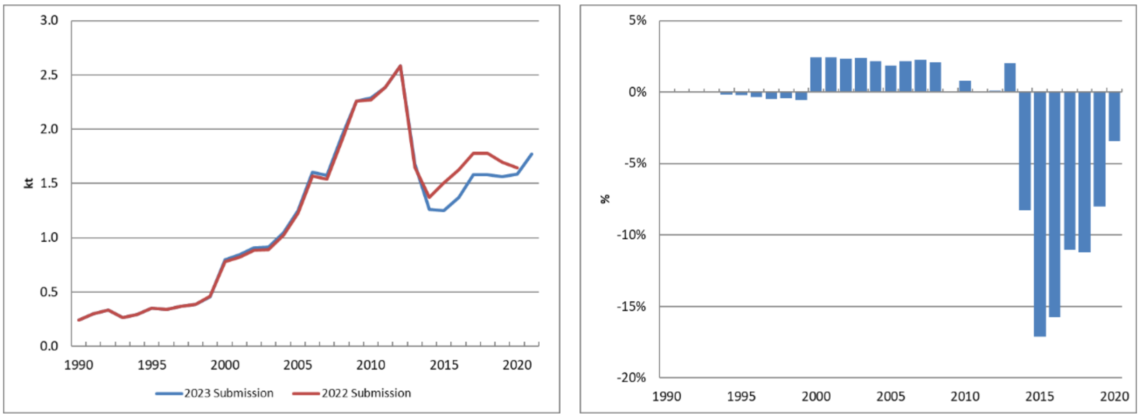


Figure 3.6.63 Evolution of the difference in 1A4ai NMVOC emissions

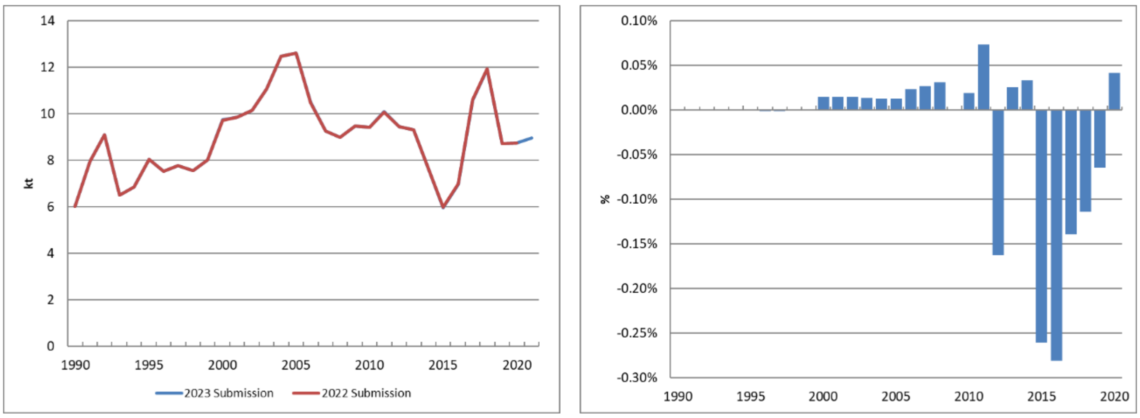
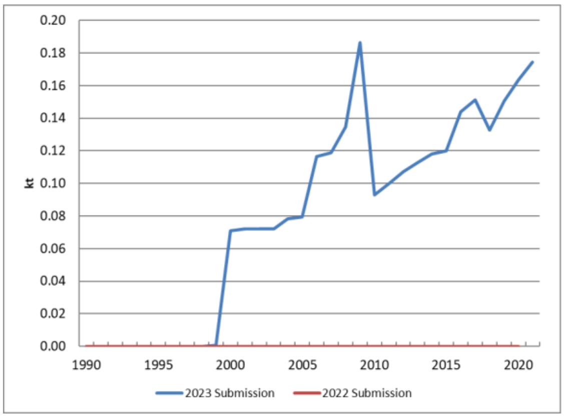


Figure 3.6.64 Evolution of the difference in 1A4ai SO_2 emissions



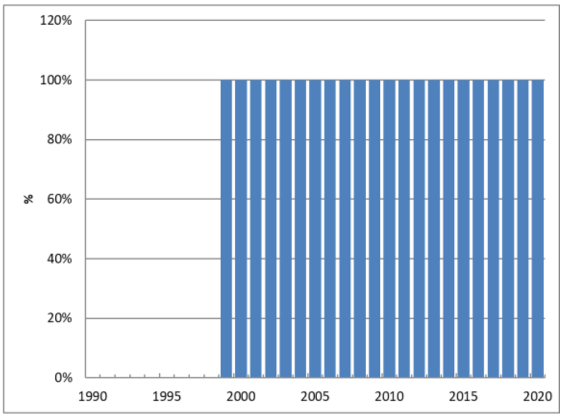
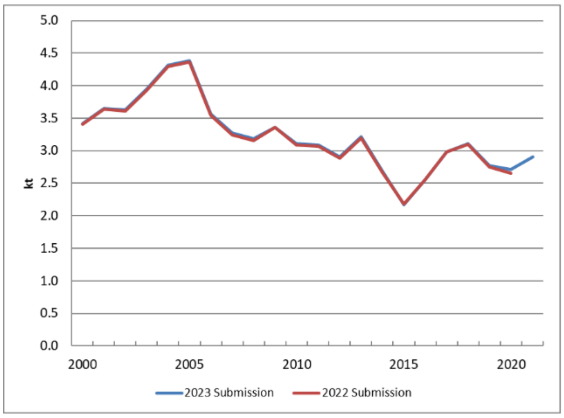


Figure 3.6.65 Evolution of the difference in 1A4ai NH_3 emissions



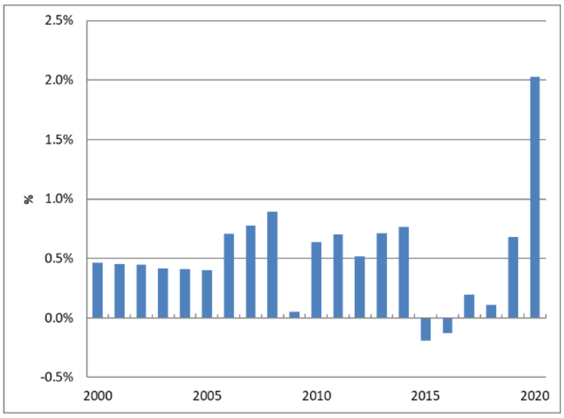
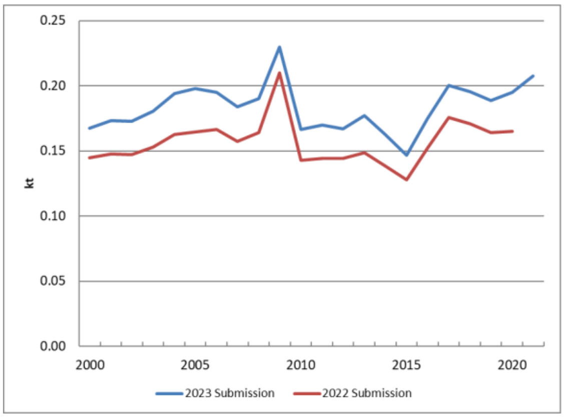


Figure 3.6.66 Evolution of the difference in 1A4ai TSP emissions



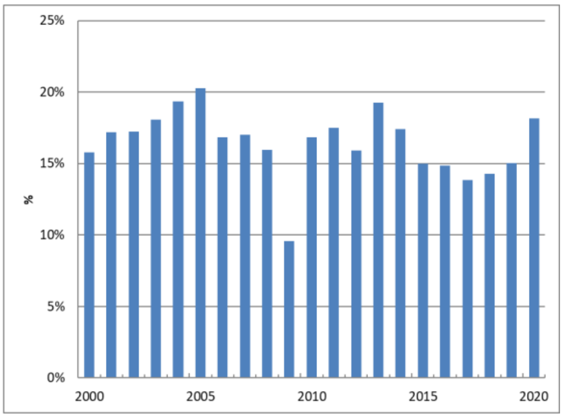


Figure 3.6.67 Evolution of the difference in 1A4ai BC emissions

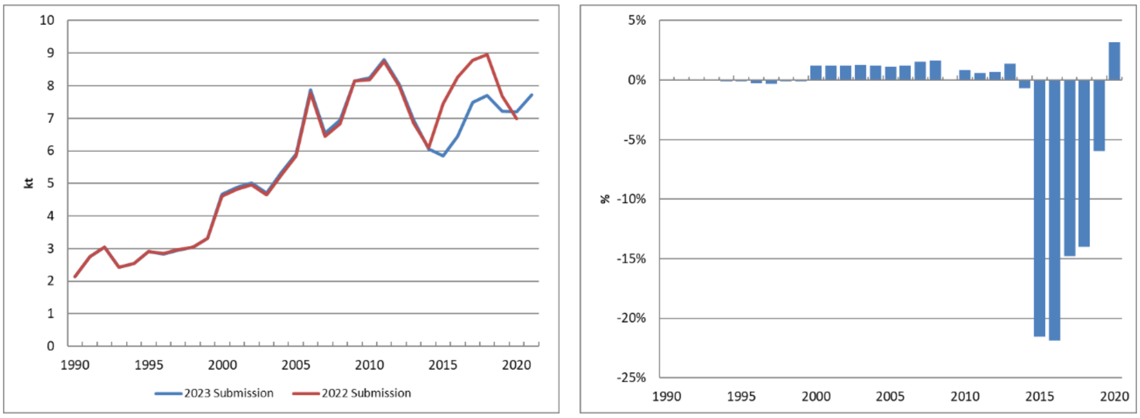


Figure 3.6.68 Evolution of the difference in 1A4ai CO emissions

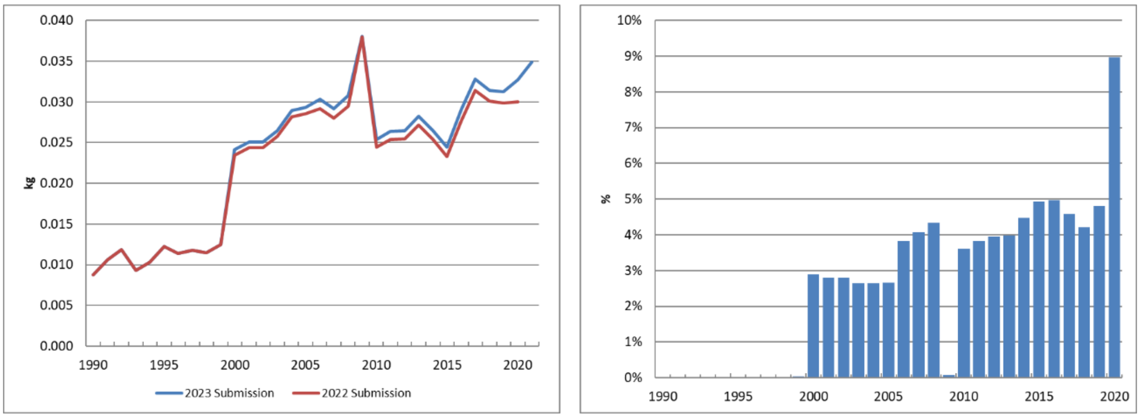


Figure 3.6.69 Evolution of the difference in 1A4ai HCB emissions

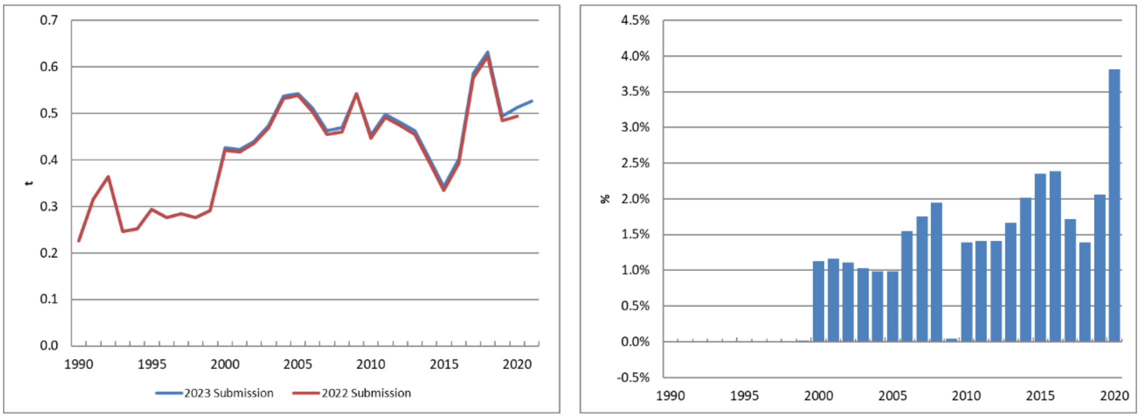


Figure 3.6.70 Evolution of the difference in 1A4ai PAH emissions

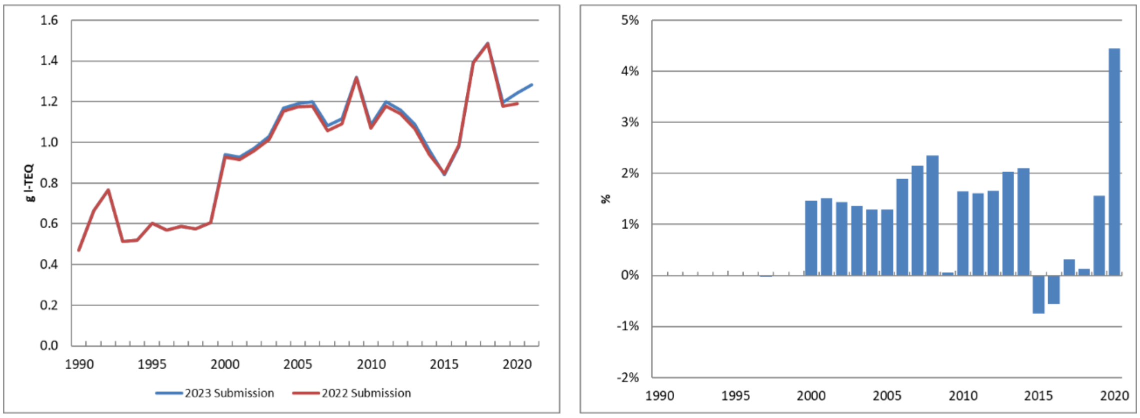


Figure 3.6.71 Evolution of the difference in 1A4ai PCDD/PCDF emissions

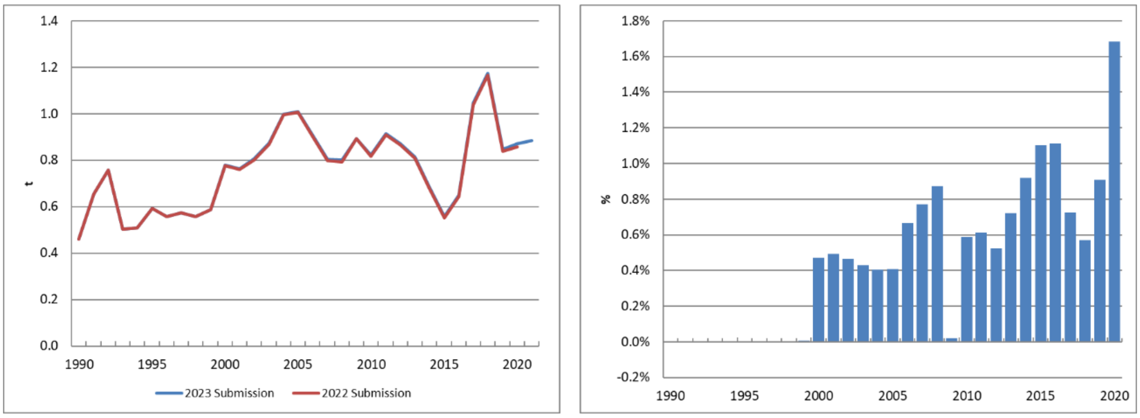


Figure 3.6.72 Evolution of the difference in 1A4ai Pb emissions

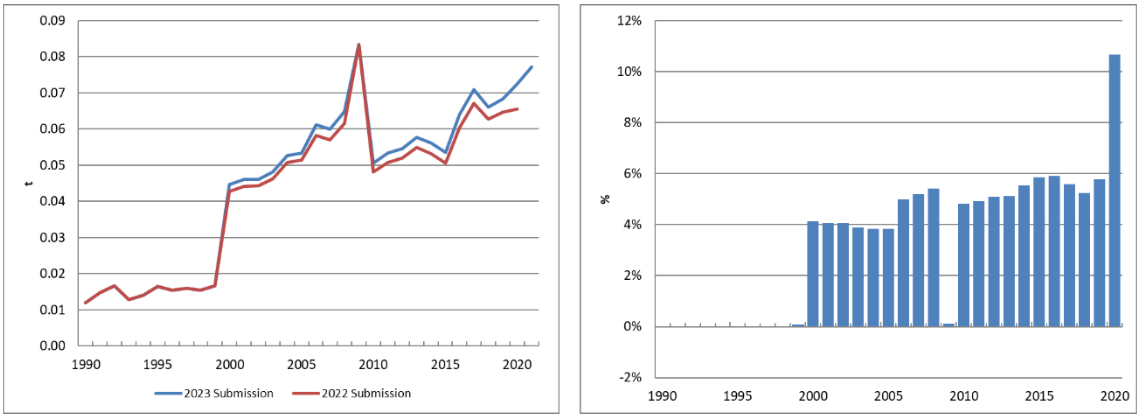


Figure 3.6.73 Evolution of the difference in 1A4ai Cd emissions

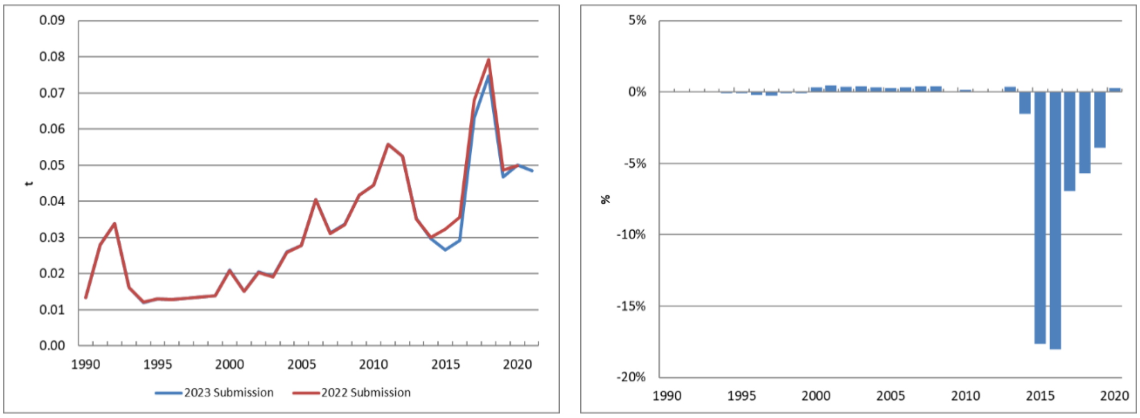


Figure 3.6.74 Evolution of the difference in 1A4ai Hg emissions

1A4bi Combustion in stationary equipment in residential sector

As in the previous category, recalculations in all pollutant emissions are caused by the update of fuel-activity allocation for the whole series, as well as by the reallocation of natural gas consumption since 2015.

However, the main driver in the recalculations of this category is the disaggregation of biomass consumption according to different fuels and stationary combustion appliances for the residential sector. This new estimate is based on a study of biomass, biogas and wastes for thermal uses in Spain (IDAE, 2021), and the appliance type split of EMEP/EEA Guidebook 2019, Chapter 1A4, tables 3-36 to 3-38 (fireplace, heating stove, single house boiler –automated/manual feed-, and medium boiler –automated/manual feed-) and affects pollutant emissions differently, so main variations are observed as a decrease in NOx, NH_3, CO and PAH while an increase is shown in NMVOC and TSP emissions for the whole series.

The following graphs show the trend of the main pollutants affected, PST, PAH and heavy metals.

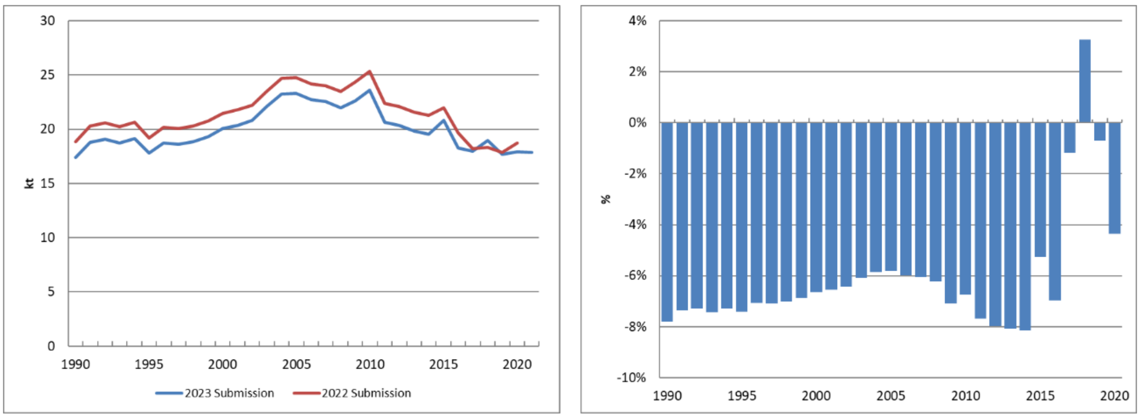


Figure 3.6.75 Evolution of the difference in 1A4bi NOx emissions

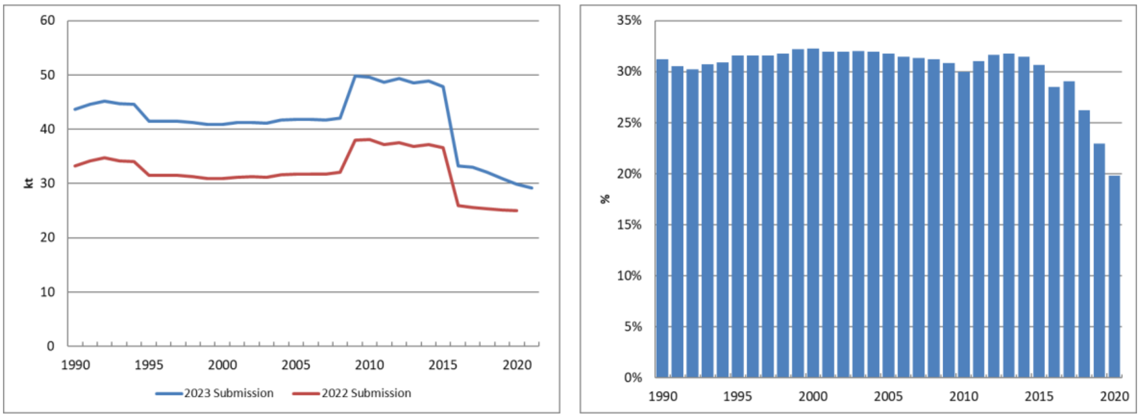


Figure 3.6.76 Evolution of the difference in 1A4bi NMVOC emissions

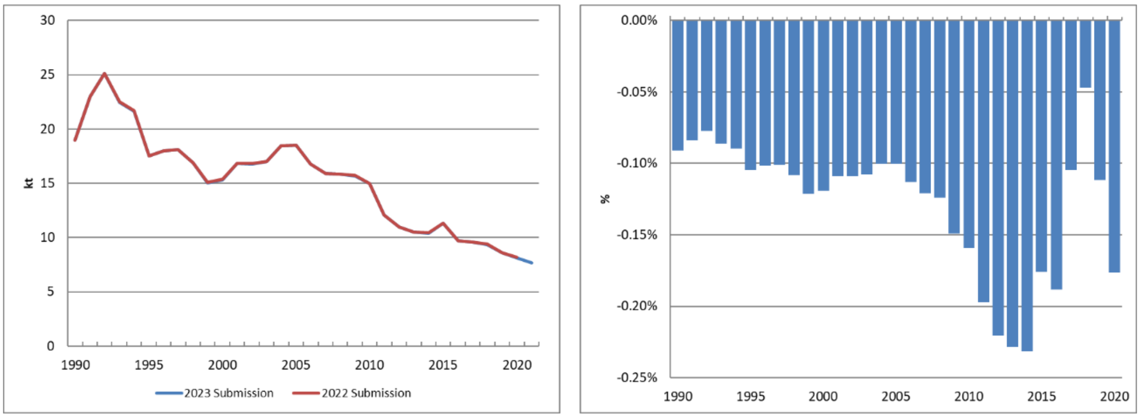


Figure 3.6.77 Evolution of the difference in 1A4bi SO_2 emissions

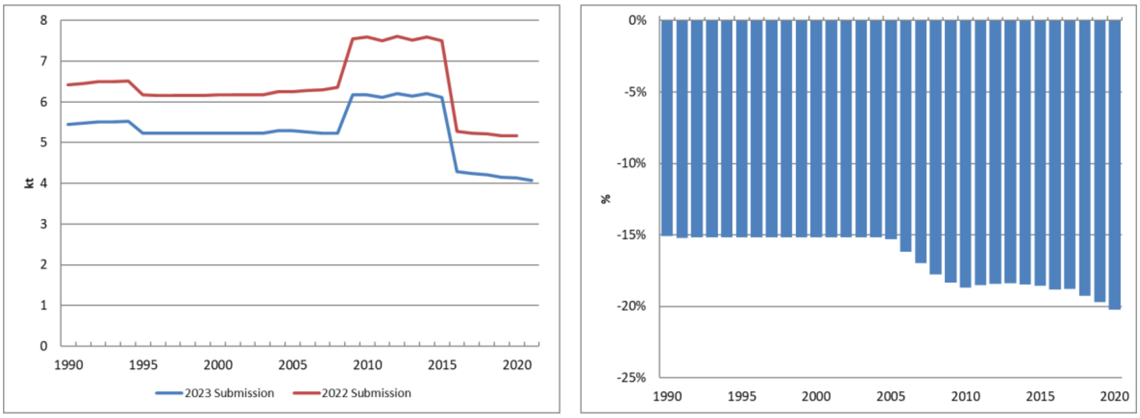
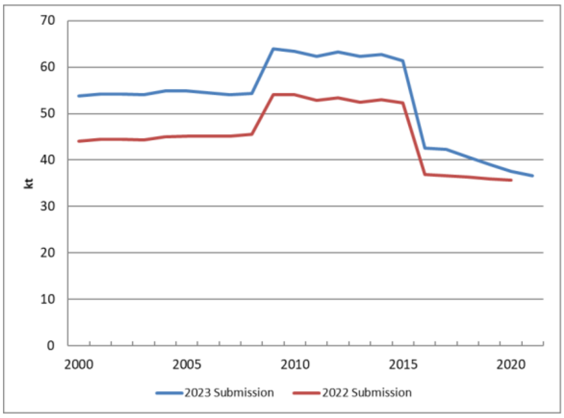


Figure 3.6.78 Evolution of the difference in 1A4bi NH_3 emissions



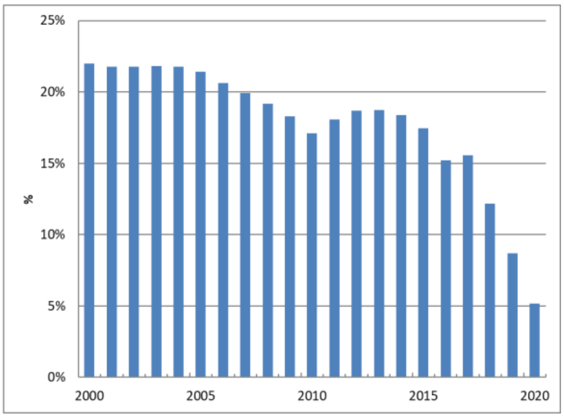
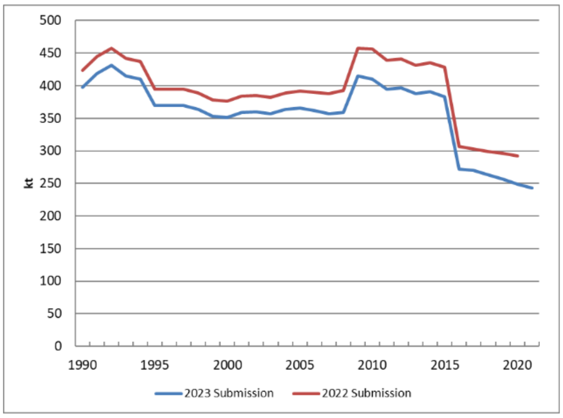


Figure 3.6.79 Evolution of the difference in 1A4bi TSP emissions



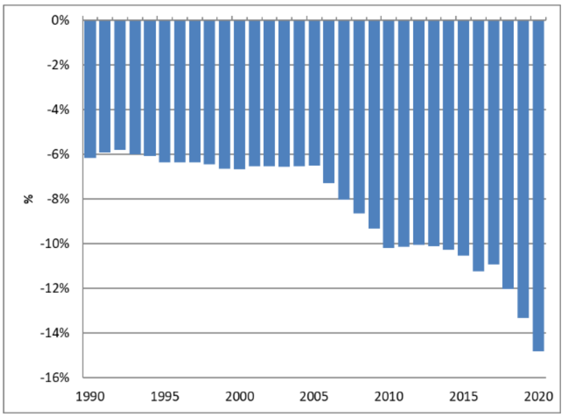
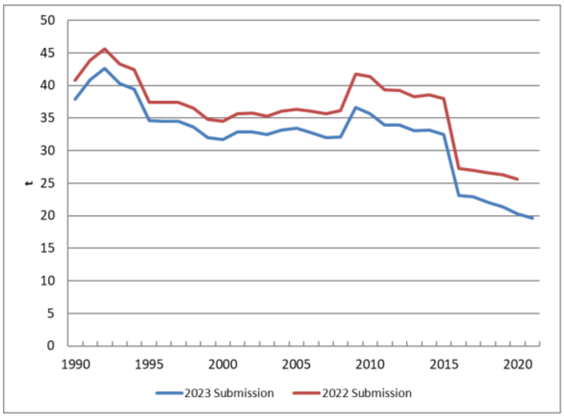


Figure 3.6.80 Evolution of the difference in 1A4bi CO emissions



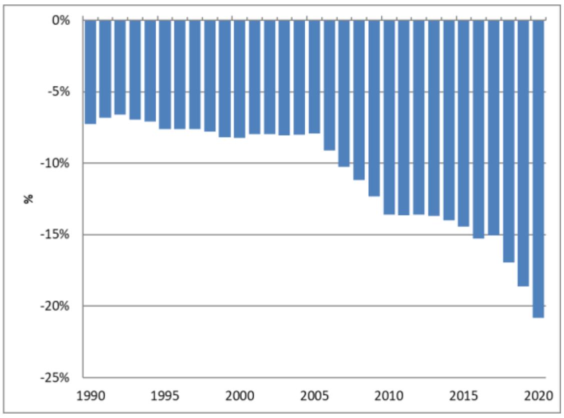


Figure 3.6.81 Evolution of the difference in 1A4bi PAH emissions

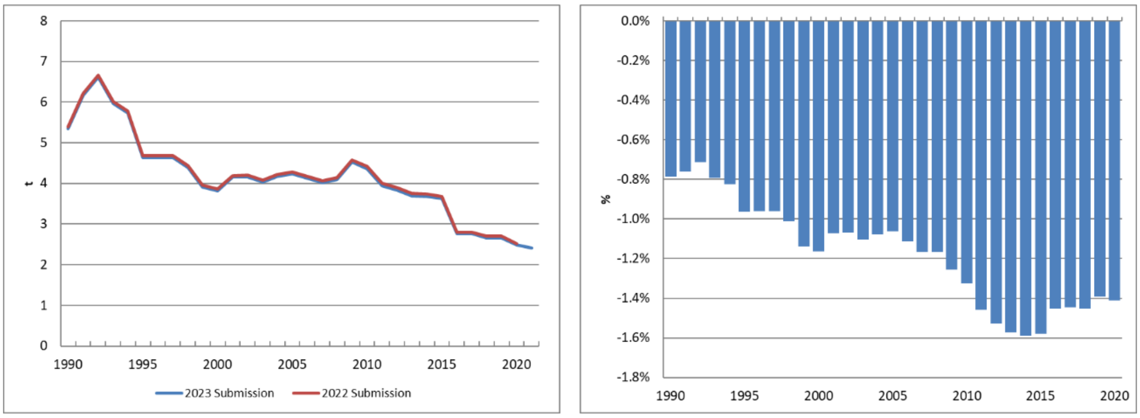


Figure 3.6.82 Evolution of the difference in 1A4bi Pb emissions

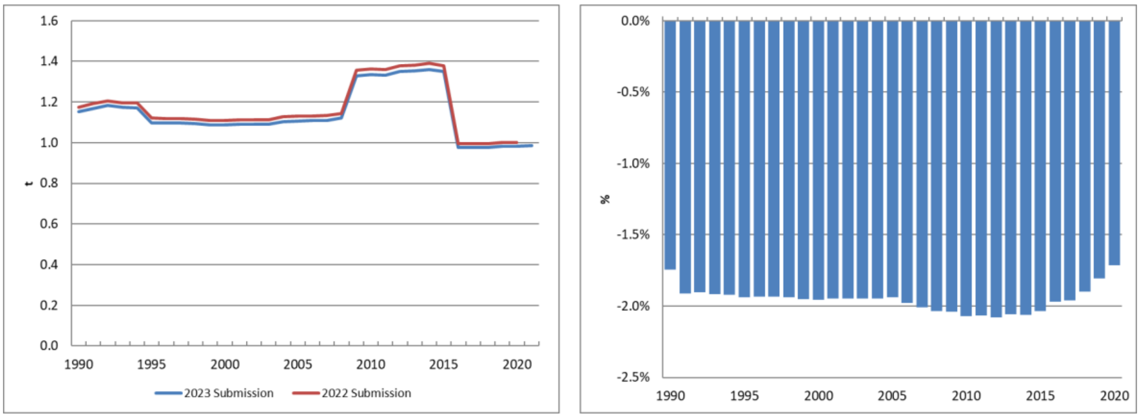


Figure 3.6.83 Evolution of the difference in 1A4bi Cd emissions

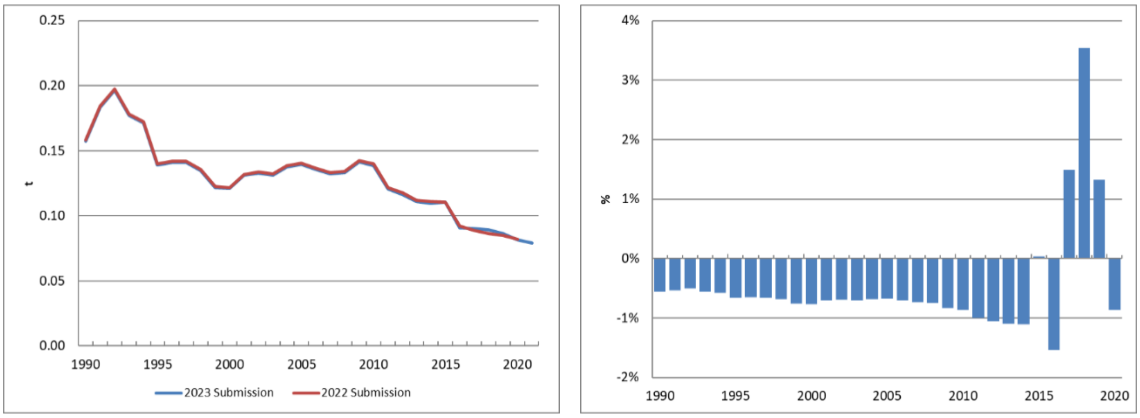


Figure 3.6.84 Evolution of the difference in 1A4bi Hg emissions

1A4ci Stationary combustion in agricultural, forestry and fishing sector

Again, as in activity 1A4ai, recalculations in all pollutant emissions are due to minor updates of fuel-activity allocation for the whole inventory period, as well as to the update of natural gas consumption since 2015.

Besides, and also as in previous activity 1A4ai, new estimates of NH_3 emissions from biomass have been included in 1A4c category according to the emission factors from EMEP/EEA 2019 Guidebook. In adition, new emission estimates for natural gas from stationary fishing facilities have been carried out since 2019.

The graphs with the recalculation of the main pollutants, TSP, BC, HCB, PCDD/PCDF, PAH and Heavy Metals emissions are shown below.

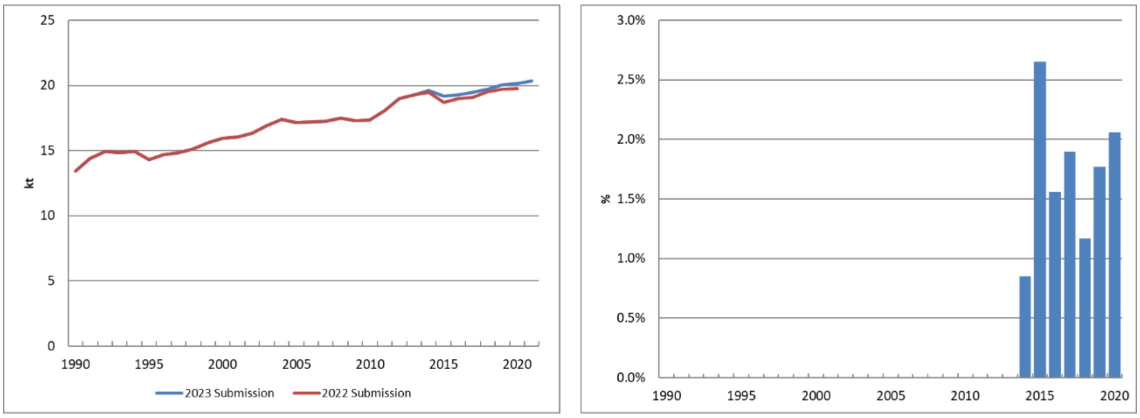


Figure 3.6.85 Evolution of the difference in 1A4ci NOx emissions

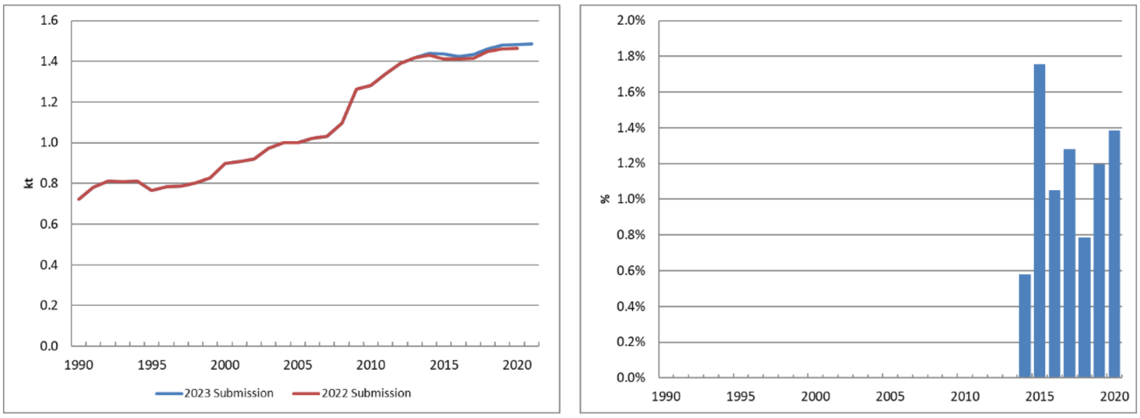


Figure 3.6.86 Evolution of the difference in 1A4ci NMVOC emissions

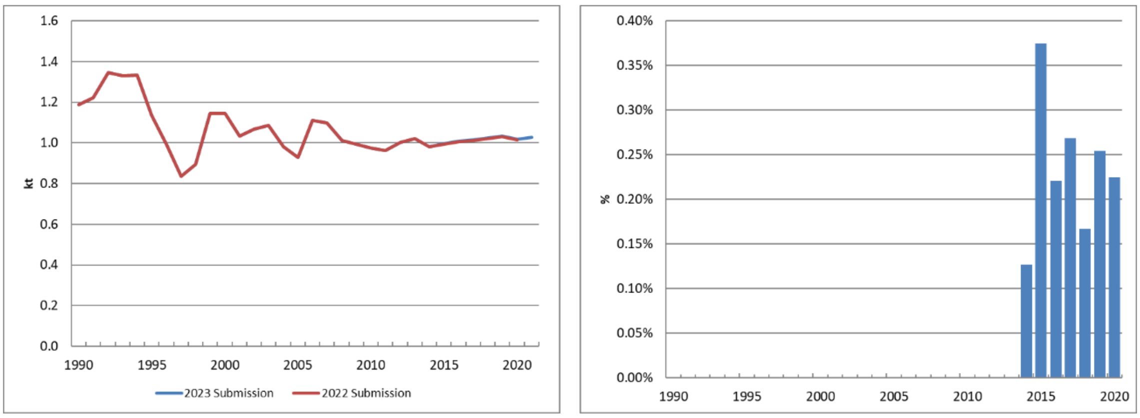


Figure 3.6.87 Evolution of the difference in 1A4ci SO_2 emissions

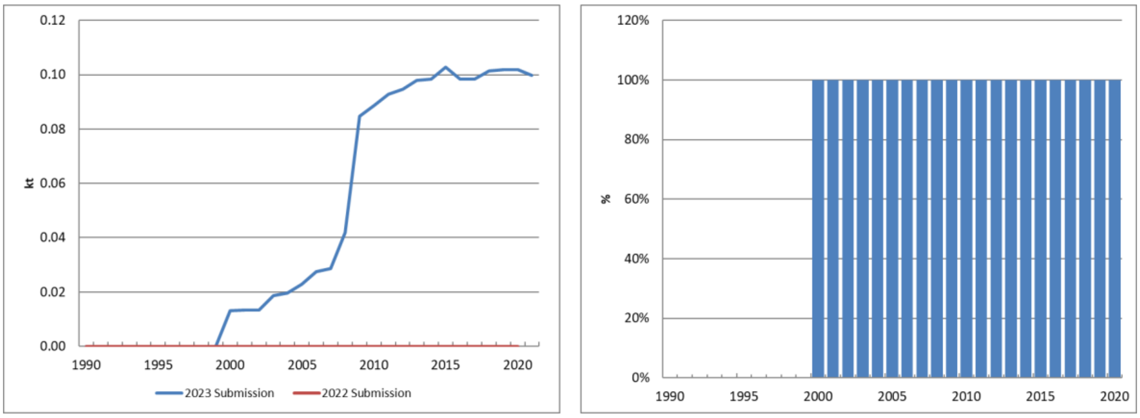


Figure 3.6.88 Evolution of the difference in 1A4ci NH_3 emissions

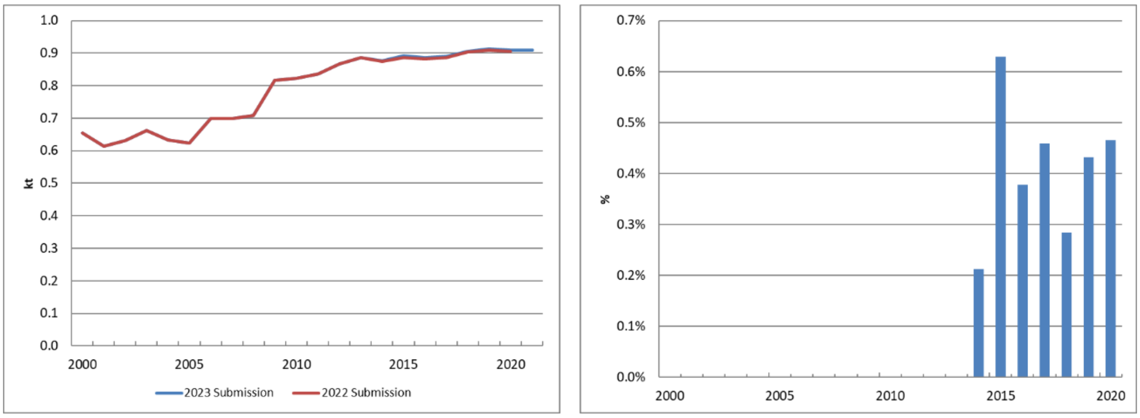


Figure 3.6.89 Evolution of the difference in 1A4ci TSP emissions

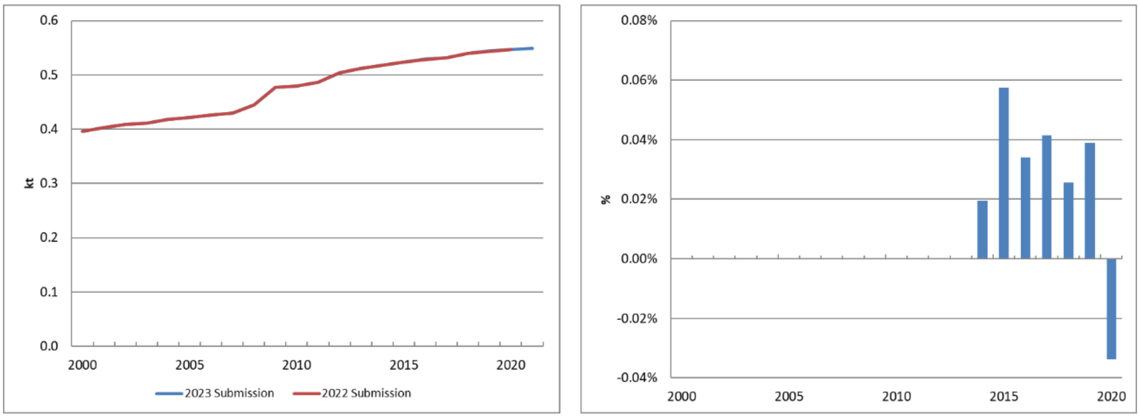


Figure 3.6.90 Evolution of the difference in 1A4ci BC emissions

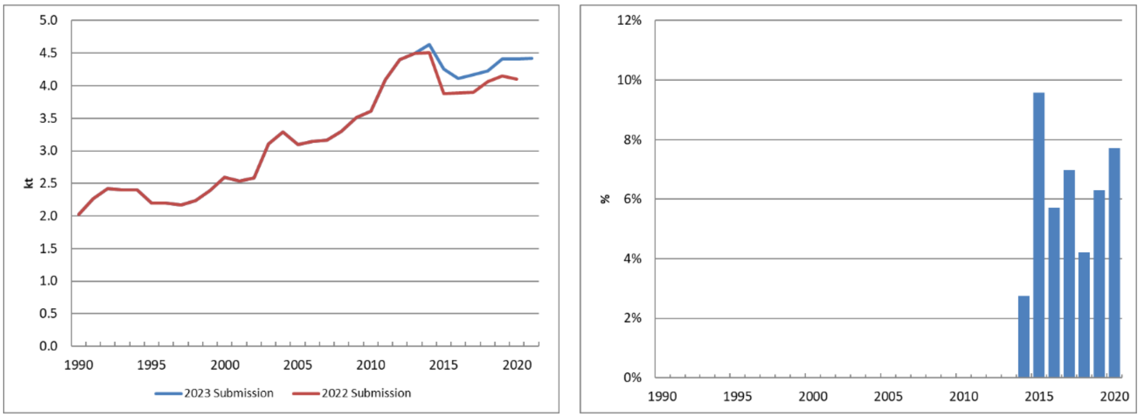


Figure 3.6.91 Evolution of the difference in 1A4ci CO emissions

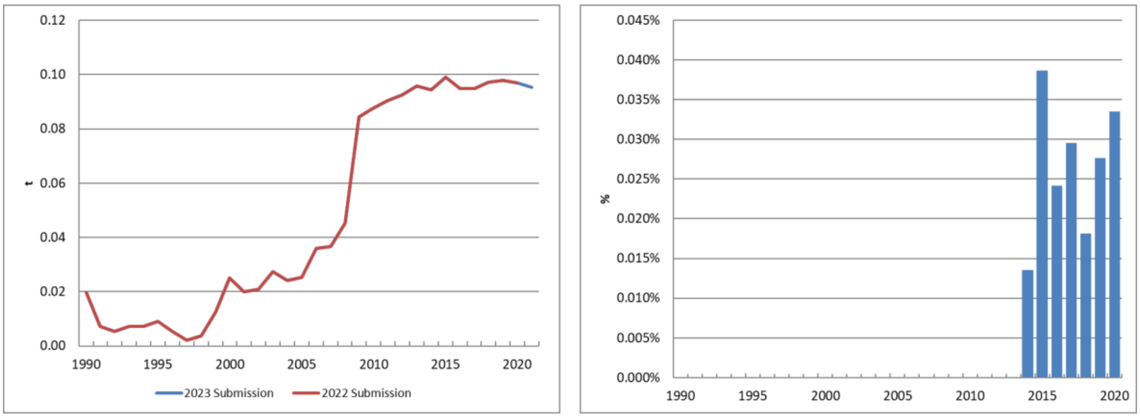


Figure 3.6.92 Evolution of the difference in 1A4ci PAH emissions

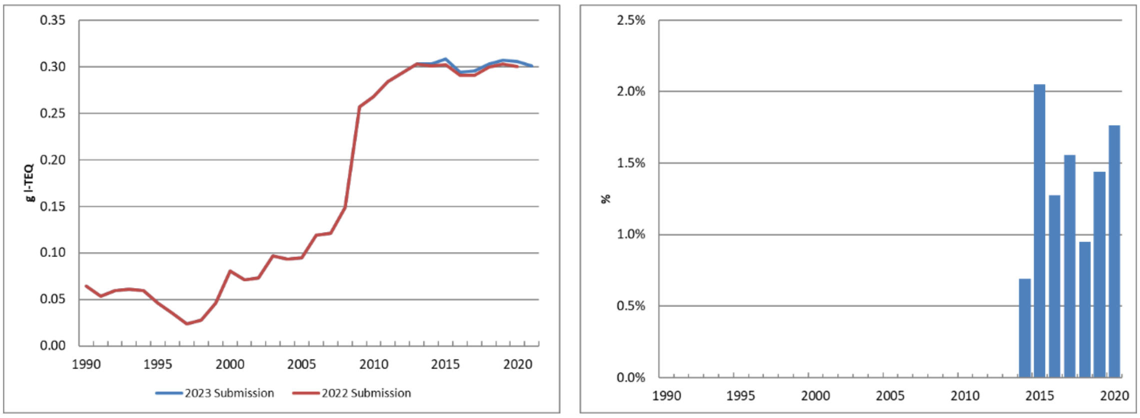


Figure 3.6.93 Evolution of the difference in 1A4ci PCDD/PCDF emissions

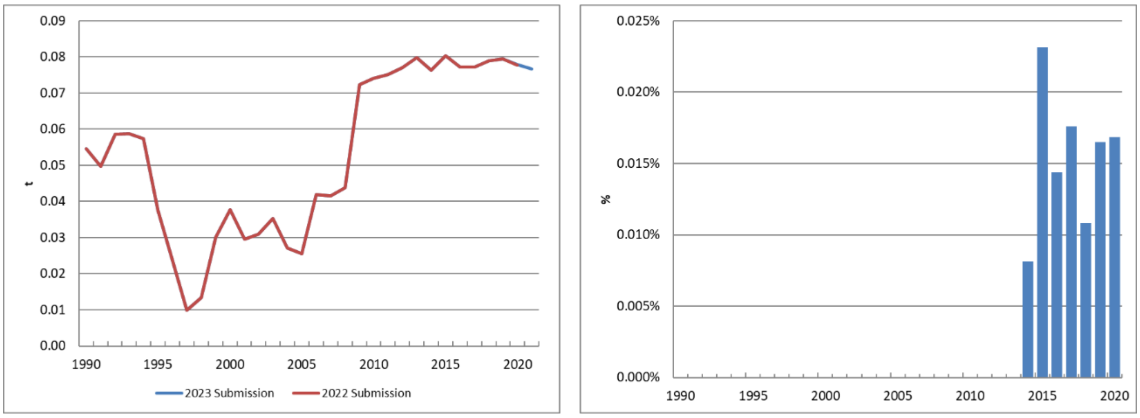


Figure 3.6.94 Evolution of the difference in 1A4ci Pb emissions

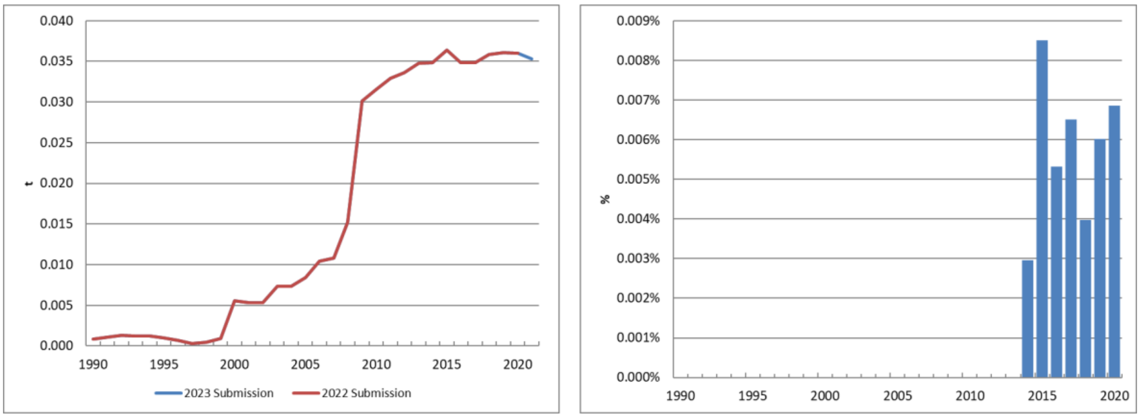


Figure 3.6.95 Evolution of the difference in 1A4ci Cd emissions

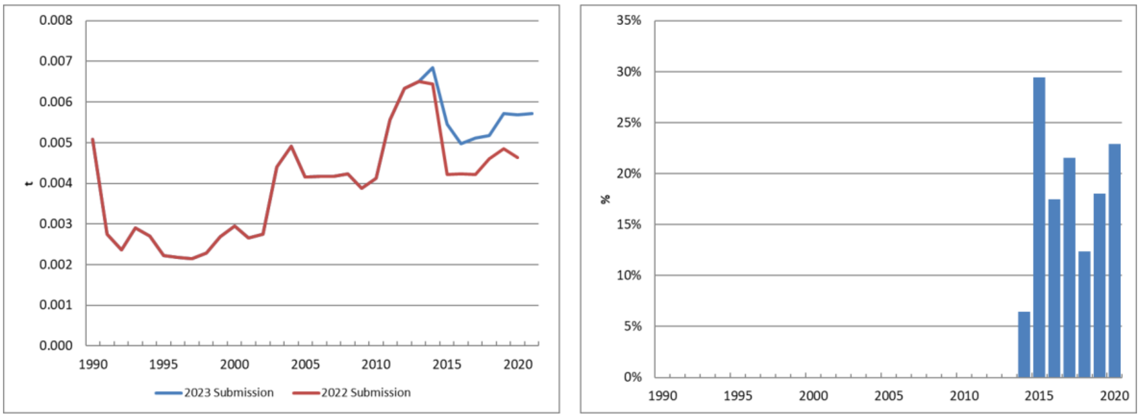


Figure 3.6.96 Evolution of the difference in 1A4ci Hg emissions

1A4cii and 1A4ciii Mobile machinery in agriculture, forestry and National fishing activities

Recalculations in these subcategories in 2020 are due to the update of activity data for this year.

In adittion, for Mobile machinery in fishing activities (1A4ciii), the recalculation for the whole series is caused by the update of emission factors of CO, NMVOC, NOx, PM, BC, Cu, Se and As according to the latest version of EMEP/EEA Guidebook (2019) in December 2021. Besides, provincial distribution data has been updated for 2019 an 2020.

The following graphs show the recalculation of main pollutants, TSP, BC, HCB, PCDD/PCDF, PAH and Heavy Metals emissions.

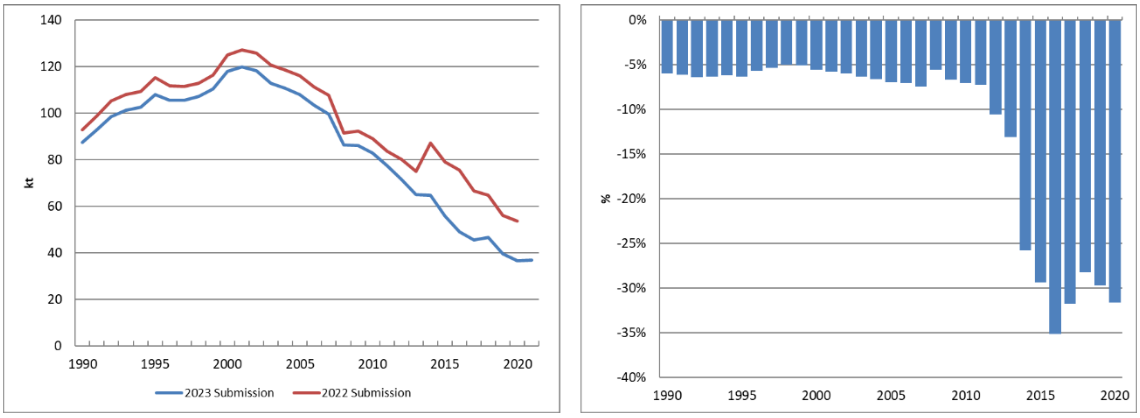


Figure 3.6.97 Evolution of the difference in 1A4cii and 1A4ciii NOx emissions

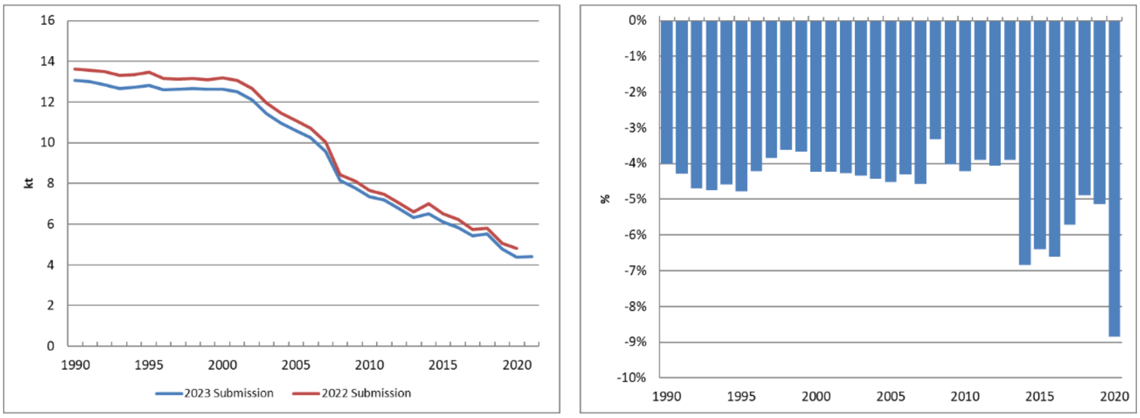


Figure 3.6.98 Evolution of the difference in 1A4cii and 1A4ciii NMVOC emissions

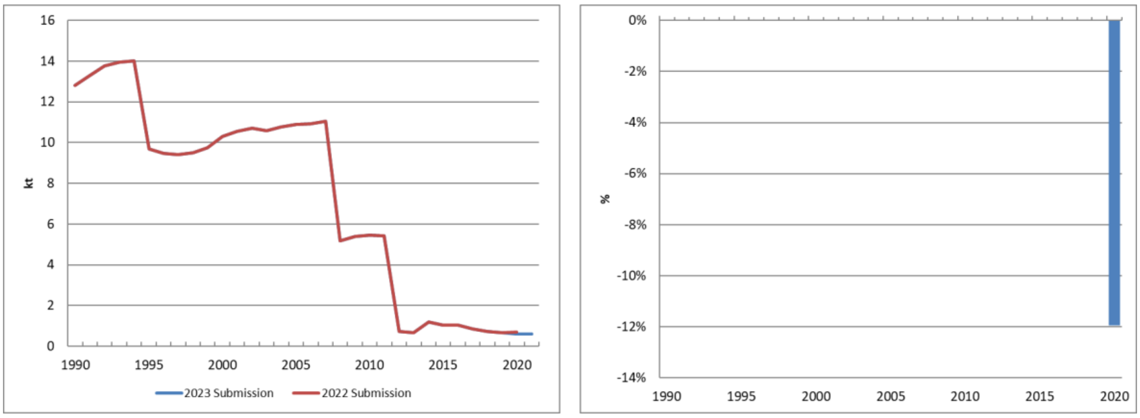


Figure 3.6.99 Evolution of the difference in 1A4cii and 1A4ciii SO_2 emissions

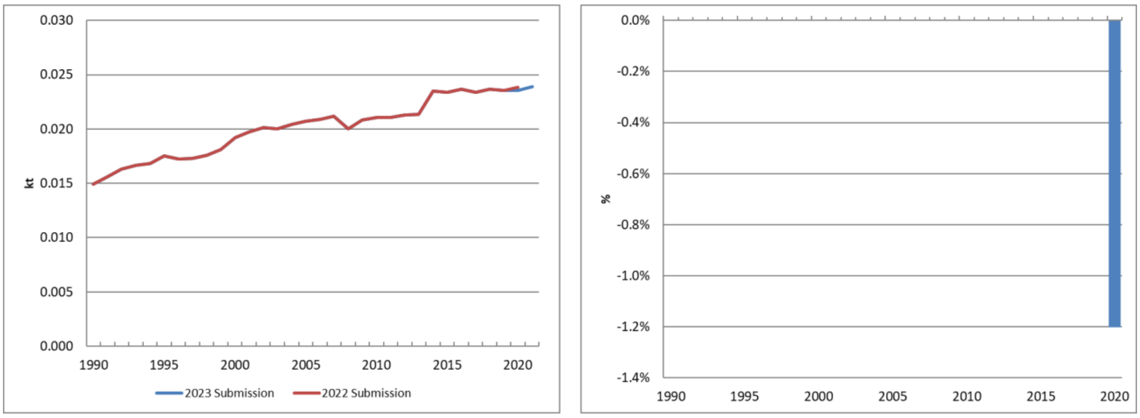


Figure 3.6.100 Evolution of the difference in 1A4cii and 1A4ciii NH_3 emissions

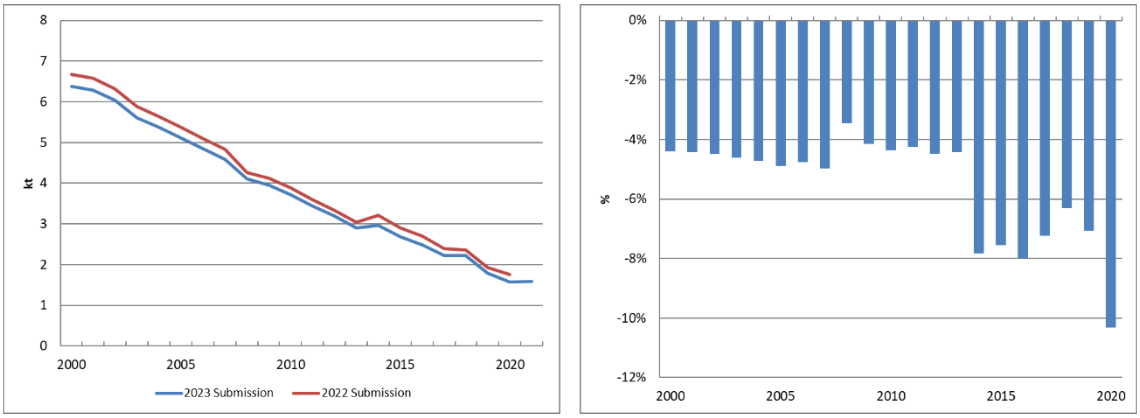


Figure 3.6.101 Evolution of the difference in 1A4cii and 1A4ciii TSP emissions

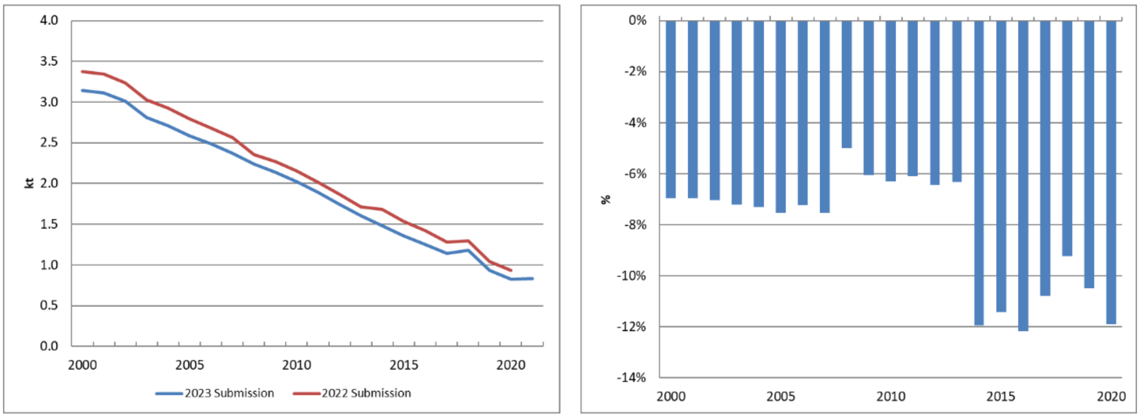


Figure 3.6.102 Evolution of the difference in 1A4cii and 1A4ciii BC emissions

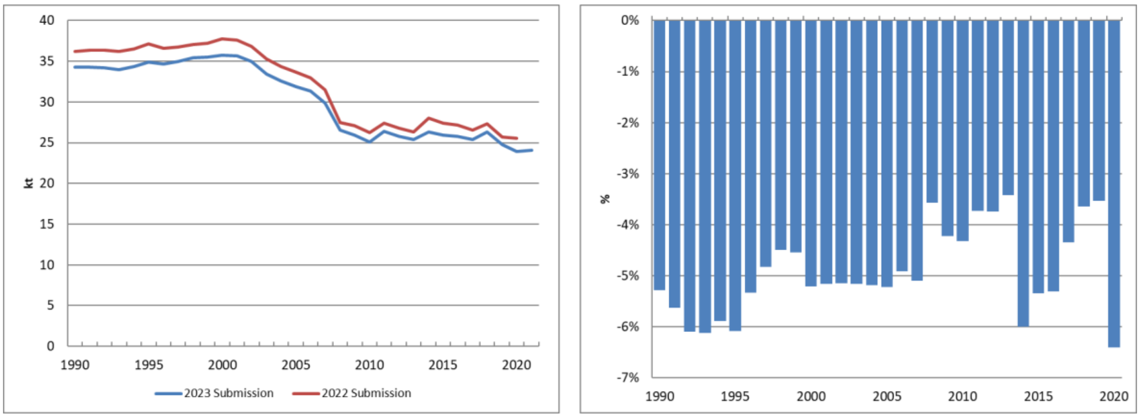


Figure 3.6.103 Evolution of the difference in 1A4cii and 1A4ciii CO emissions

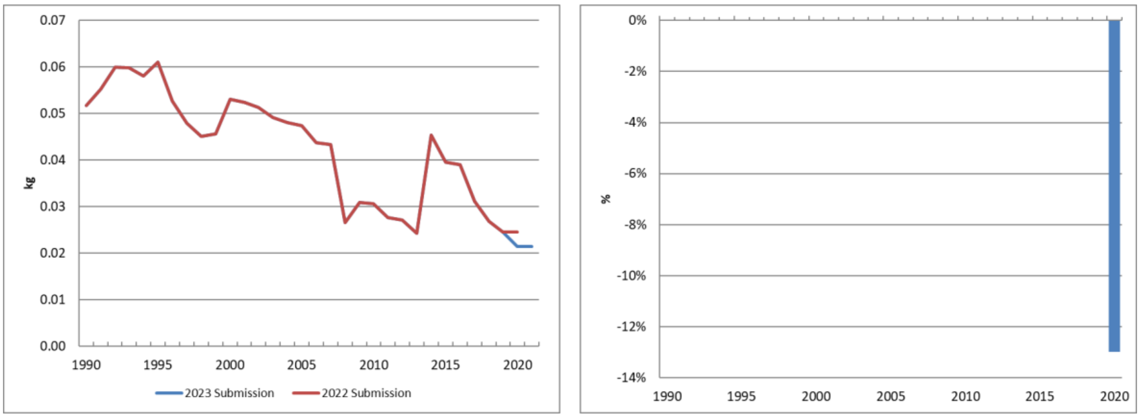


Figure 3.6.104 Evolution of the difference in 1A4cii and 1A4ciii HCB emissions

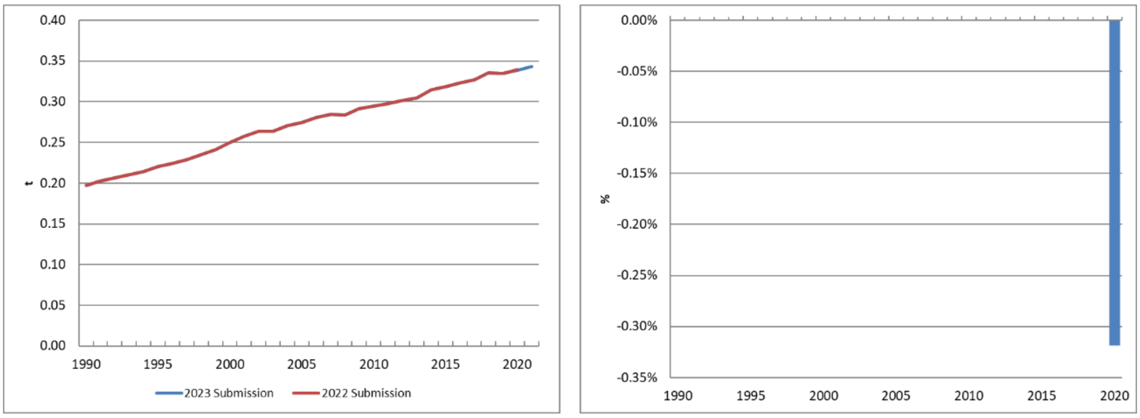


Figure 3.6.105 Evolution of the difference in 1A4cii and 1A4ciii PAH emissions

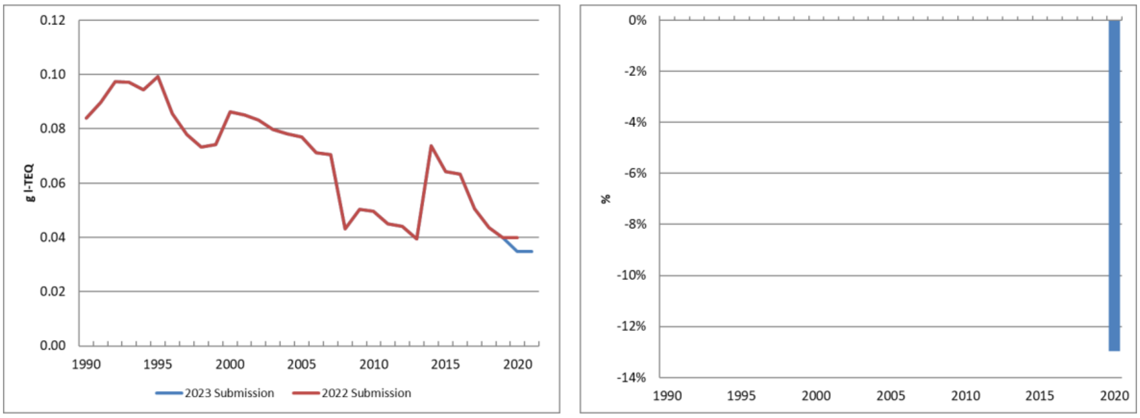


Figure 3.6.106 Evolution of the difference in 1A4cii and 1A4ciii PCDD/PCDF emissions

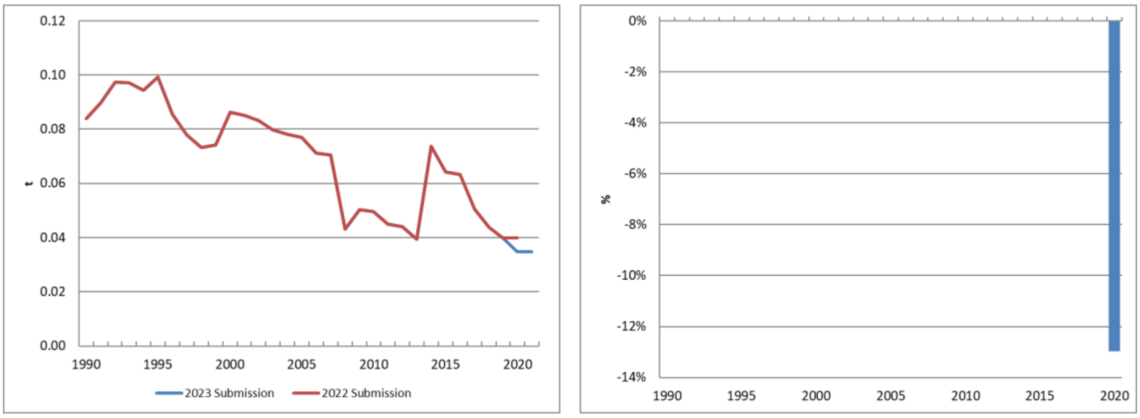


Figure 3.6.107 Evolution of the difference in 1A4cii and 1A4ciii Pb emissions

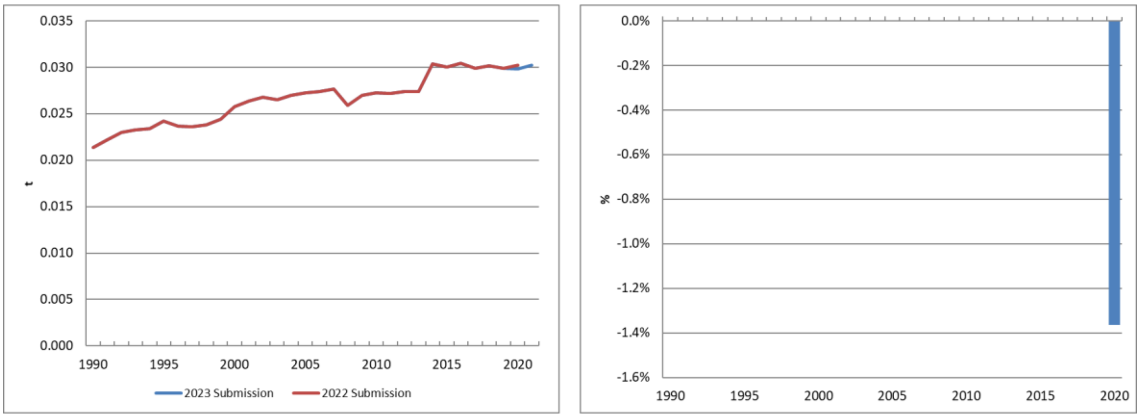


Figure 3.6.108 Evolution of the difference in 1A4cii and 1A4ciii Cd emissions

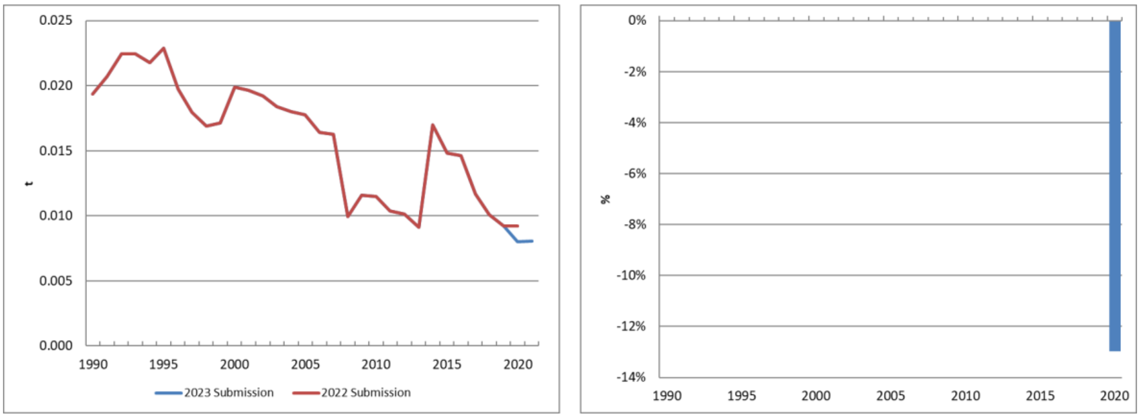


Figure 3.6.109 Evolution of the difference in 1A4cii and 1A4ciii Hg emissions

1B2aiv Fugitive emissions oil: Refining and storage. BC

The recalculation is due to an update of the information by the source.

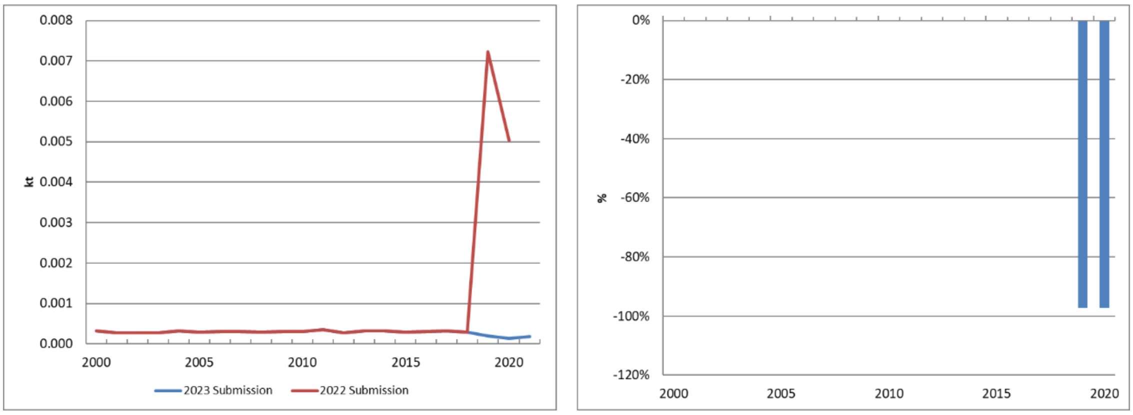


Figure 3.6.110 Evolution of the difference in 1B2aiv BC emissions

1B2av Fugitive emissions oil: Distribution of oil. NMVOC emissions

The recalculation is due to an improvement in data collection.

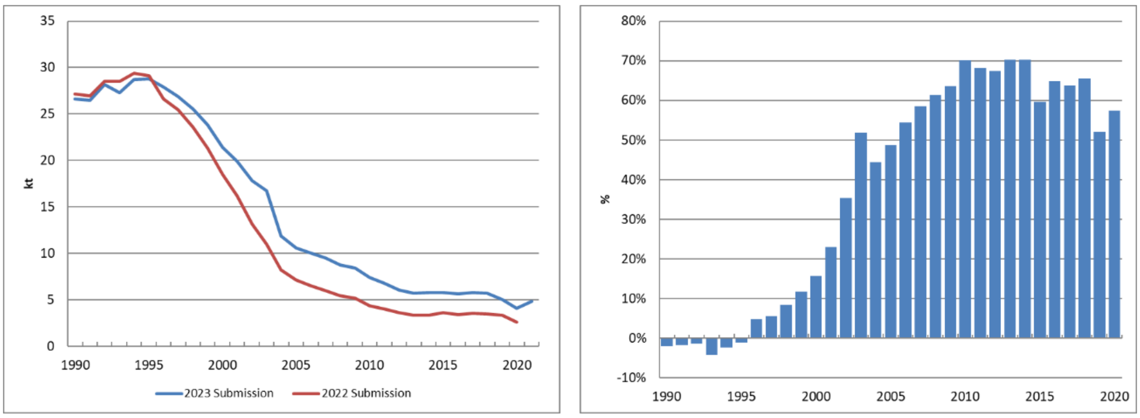


Figure 3.6.111 Evolution of the difference in 1B2av NMVOC emissions

1B2b Natural Gas-Exploration, production, transport. NMVOC emissions

Recalculatiosn are due to additional data from new Natural gas transport companies.

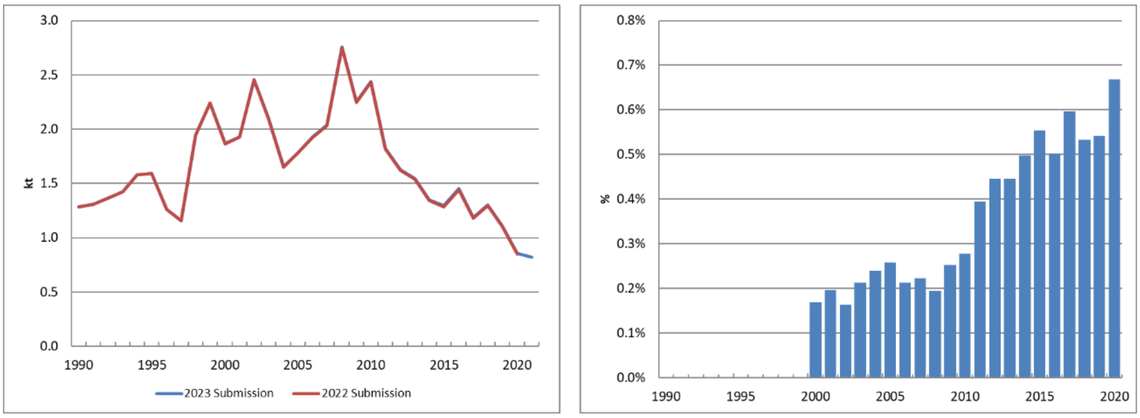


Figure 3.6.112 Evolution of the difference in 1B2b NMVOC emissions

3.7. Sector improvements

The review of the methodology for the elaboration of the fuel balance will continue, in collaboration with the relevant departments of the Secretary of State for Energy at MITECO. The collaboration with the IDAE-MITECO continues in the sense of providing specific information for the balance.

Minor improvements are progressively addressed in order to achieve full implementation of EMEP/EEA Guidebook (2019).

1A1a Public electricity and heat production

NH_3 data (measured or estimated) provided by large power plants are being collected and will be reviewed.

1A1c Manufacture of solid fuels and other energy industries

It will be carried out the segregation of RMS (Regulating and Metering Stations) belonging to the natural gas pipeline distribution network (low pressure pipelines), out from the Inventory fuel balance.

The process of collaboration with the General Subdirectorate of Energy Planning and Monitoring of MITECO will continue, in order to improve the information provided by this source and its correct adaptation to the Inventory.

1A2 Manufacturing industries and construction (combustion)

Review and standardise the emission factors.

1A3a Air traffic at airports

Continue alignment with the methodology established by EUROCONTROL, applying all the new adjustments and improvements proposed.

1A3b Road transport

Work will continue in road transport methodology with the aim to be aligned with the improvements proposed in further editions of EMEP/EEA Guidebook, paying special attention to the emission estimation of alternative modes of propulsion and new Euro Standards.

Carry on with the process of continuous improvement of activity variable data (vehicle fleet, mileage and driving patterns distribution) when more accurate information would be available.

1A3c Railways

Continue with the collaboration with the focal point on railways, National Network of Spanish Railways (RENFE), with the aim of improving background information on fuel consumption broken down by type of machinery.

1A4ai Commercial/Institutional: Stationary

Continue the search of reliable data for carrying out separate estimates for pellet stoves and boilers burning wood pellets for source category Stationary combustion in Commercial/Institutional sector.

Continue alignment with activity data source of information in order to update the whole fuel consumption series for stationary combustion sectors.

1A4bi Residential: Stationary

Following the recommendation made in the Spanish Stage 3 Review Report (2014)[13], planned improvements for this sector are focused on making separate estimates for Household and gardening mobile machinery subcategory (1A4bii) currently included in the stationary subcategory (1A4bi).

[13] Final Review Report available in: https://www.ceip.at/fileadmin/inhalte/ceip/00_pdf_other/2014_s3/spain_stage3_rr_2014.pdf

Appendix 3.1: Inventory Energy Balance (IEB)

This appendix complements the information in chapter "3. Energy" of this report by providing background detail on how fuel consumption data is obtained by the Inventory and its full consistency with the National energy balances elaborated by the Ministry for the Ecological Transition and Demographic Challenge (MITECO), and sent to IEA and EUROSTAT.

For the sake of consistency, two approaches (bottom-up and top-down) are combined. On the one hand, information is provided directly from the affected facilities or entrepreneurial sectors and those data prevails over statistics or any other source. This information includes the individualized questionnaires from different agents in the private sector and some public sources. Those are the data that Spanish Inventory considers as 'registered information'.

On the other side, following a top-down approach, all the registered information, once processed, is completed with the official energy statistics. Therefore, the total fuel consumption in the Spanish Inventory is tallied with the national fuel balance (EUROSTAT). This is because, in some cases, the registered information by the Inventory does not achieve a full coverage of all the sectors.

Following this methodology, fuel consumption is finally adjusted for categories 1A1 and 1A2. The result of this fuel balance is summarized in the figure below: the inner circle shows the percentage of information provided by the adjustment of the balance and the 'registered information' for category 1A1; the second circle refers to category 1A2; the third one corresponds to 1A1+1A2 categories and, finally, the outer circle represents the complete Inventory.

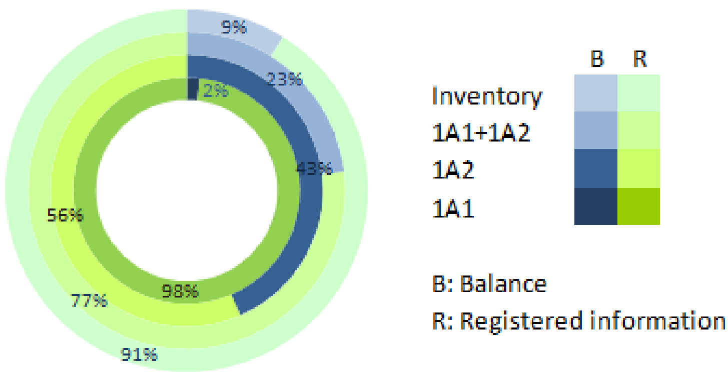


Figure 3.7.1 Percentage of fuel consumption provided by IEB and registered information for categories

This IEB involves a complex process that aims at ensuring full consistency between the fuel use considered by the Inventory and the total consumption figures from the national energy balance. The Inventory Energy Balance is performed with the national total consumption of fuels, that includes the whole Spanish territory (including the Canary Islands), and the results are then down-scaled to the EMEP domain, that does not include the Canary Islands.

The IEB always respect the consumptions pre-allocated by the National Inventory (consumption finally assigned to each sector and type of use must be equal or higher than the information registered by the National Inventory) and intends to minimize, for every fuel type, the differences with official energy statistics. Full coverage of the information in the National Inventory for the crossing of consumer sector, type of use and fuel occurs in those sectors where complete and direct information is available from the individual plant questionnaires.

As an example, next two first figures with the partial balances for natural gas in 1A1 and 1A2 categories show the way in which some categories are tallied over the figures from the statistics, while others are tallied under the statistics.

The third figure contains the categories affected by the adjustment (1A1 and 1A2) plus fugitive emissions in Energy sector (1B) given that this sector includes non-energy emissions that international statistics consider. Finally, the total national consumption of natural gas from the official energy statistics constitutes the upper limit for the adjustment of the whole Energy sector, as can be seen in the fourth figure that shows how the sectoral differences are compensated so that global fuel consumption in the Spanish Inventory is tallied with the national fuel balance (EUROSTAT).

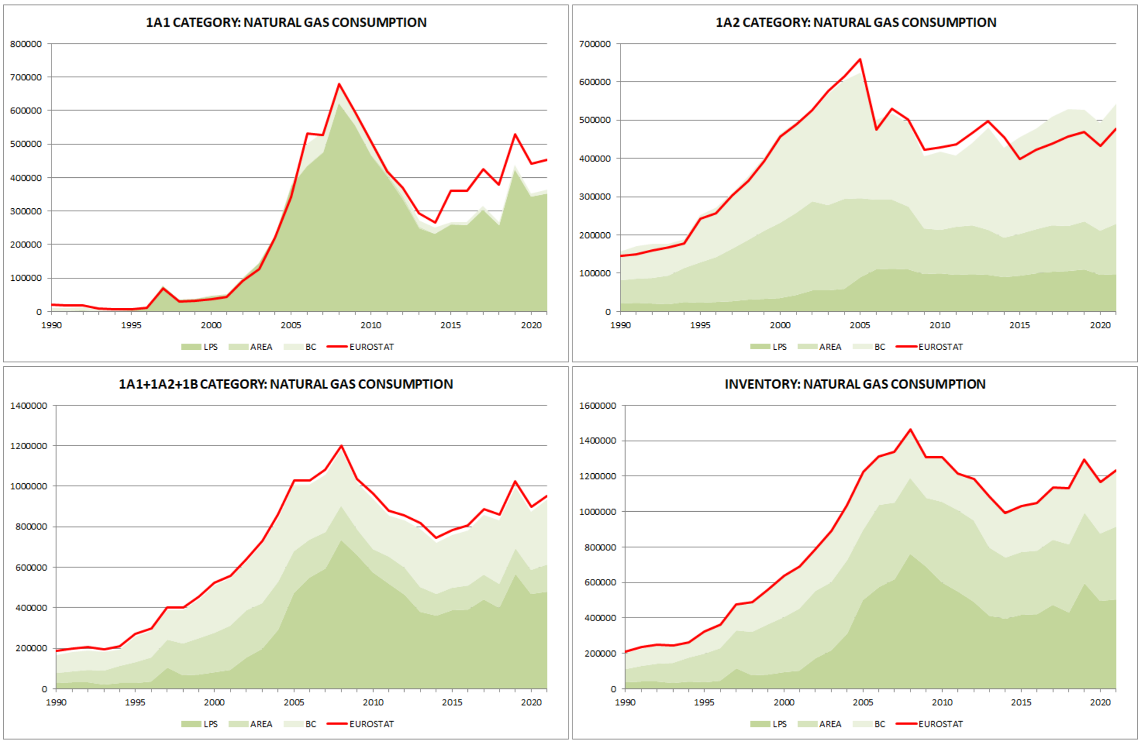


Figure 3.7.2 Adjustment of natural gas consumption (TJ) as registered by the Inventory and national statistics

For a better interpretation of the graphs, the meaning of the legend is specified below:

- EUROSTAT: national energy statistics from MITECO;
- LPS: information provided by plants to the Inventory;
- AREA: information provided by entrepreneurial associations to the Inventory;
- BC: amount to be allocated to each sector, ensuring that global fuel consumption is tallied with EUROSTAT.

The registered information by the Inventory includes the sum of LPS + AREA while total consumption considered by the Inventory includes the fuel consumption in each category (sum of LPS + AREA + BC).

4. IPPU (NFR 2)

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4. IPPU (NFR 2)

Chapter updated in March, 2023.

Sector IPPU at a glance

With a wide variety of industrial activities, facilities, plants and product uses, the IPPU sector accounts for a big share of the emissions of the Spanish Inventory for many pollutants. As shown in Figure 4.1.1, IPPU sector is the main responsible of the emissions of PCBs (with a 98%), followed by NMVOC (54%), Pb (43%), Hg (42%), Cd (32%) and PAHs (24%). The emissions of the rest of the pollutants are not so significant (less than 24%, and negligible in the case of NOx, and NH_3).

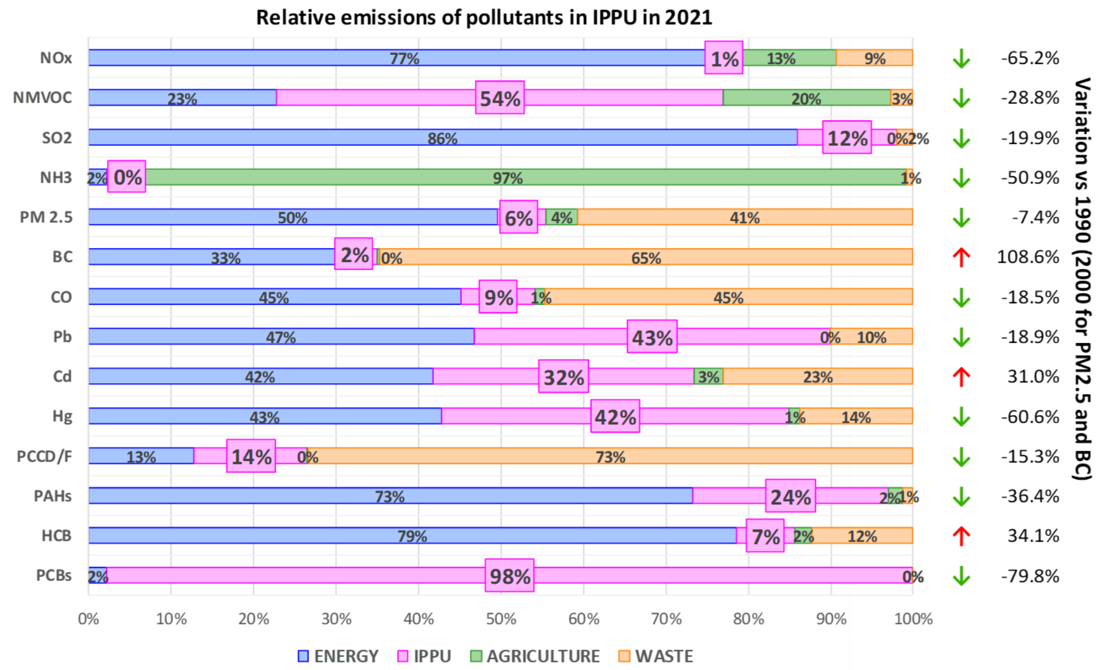


Figure 4.1.1 Relative emissions in IPPU in 2021 and its relative variation (2021 vs. 1990)

In 2021, the IPPU sector in Spain involved the activity of 27 iron and steel plants, 5 ferroalloys production plants, 1 aluminium production facility, 10 car factories, 8 paper pulp plants, several glass and lime production facilities, a big amount and variety of food and beverages industries, as well as the production of organic and inorganic chemicals, and all the related activities and use of products from these and other industries (see Table 4.2.1).

IPPU emissions have decreased since 1990 (2000 for particulate matter) for most of pollutants, due to the applied emission reduction measures. NOx emissions show a reduction of -65%, while PCBs and mercury have reductions of -80% and -61%, respectively. Other pollutants, such as BC, Cd and HCB show increases in percentage, with a special mention to the rise in BC in the IPPU sector (+109%) due to the increase in tobacco consumption over the analysed period.

4.1. Sector overview

Main issues regarding gas emissions reported for this sector are shown in the following table, in particular, NFR categories and pollutants coverage, methodology approach (method) and selection as key categories (KC).

Table 4.1.1 Coverage of NFR category in 2021

NFR Code	NFR category	Pollutants				Method	KC
		Covered	Exceptions				
			IE	NA	NE		
2A1	Cement production	–	$PM_{2.5}$, PM_{10}, TSP, BC	PCBs	Rest of pollutants	–	
2A2	Lime production	$PM_{2.5}$, PM_{10}, TSP, BC	–	Rest of pollutants	NOx, CO, NMVOC, SO_2, Pb, Cd, Hg	T2	
2A3	Glass production	Rest of pollutants	–	PCBs	NOx, SO_2, CO, PCDD/PCDF, PAHs, HCB	T2	
2A5a	Quarrying and mining of minerals other than coal	$PM_{2.5}$, PM_{10}, TSP	–	Rest of pollutants	–	T1	✓
2A5b	Construction and demolition	$PM_{2.5}$, PM_{10}, TSP	–	Rest of pollutants	–	T1	
2A5c	Storage, handling and transport of mineral products	$PM_{2.5}$, PM_{10}, TSP	–	Rest of pollutants	–	T2	
2A6	Other mineral products: Batteries manufacturing	Pb	–	Rest of pollutants	–	T1	
2B1	Ammonia production	–	NOx	Rest of pollutants(*)	$PM_{2.5}$	–	
2B2	Nitric acid production	NOx, NH_3	–	Rest of pollutants	$PM_{2.5}$	T2/T3	
2B3	Adipic acid production	NO					
2B5	Carbide production	$PM_{2.5}$, PM_{10}, TSP, BC, CO		NH_3, PCBs	Rest of pollutants	T2	
2B6	Titanium dioxide production	NOx, SO_2, $PM_{2.5}$, PM_{10},TSP, BC	–	–	Rest of pollutants	T2	
2B7	Soda ash production	NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO	–	Rest of pollutants	–	T3	✓
2B10a	Other chemical industry: Processes in organic and inorganic chemical industry except adipic acid	NOx, NMVOC, SO_2, NH_3, $PM_{2.5}$, PM_{10}, TSP,BC, CO	–	–	Rest of pollutants	T2/T3	
2B10b	Storage, handling and transport of chemical products	–	NMVOC, $PM_{2.5}$, PM_{10}, TSP	Rest of pollutants	–	–	
2C1	Iron and steel production	Rest of pollutants	BaP, BbF, BkF, IcP	–	NH_3	T2/T3	✓

NFR Code	NFR category	Pollutants				Method	KC
		Covered	Exceptions				
			IE	NA	NE		
2C2	Ferroalloys production	$PM_{2.5}$, PM_{10}, TSP, BC, Pb, Cd, As, Cr, Cu, Ni, Zn,		HCB, PCBs	NOx, NMVOC, SO_2, CO, NH_3, Hg, Se, PCDD/PCDF, PAHs, BaP, BbF, BkF, IcP	T1	
2C3	Aluminium production	Rest of pollutants	–	NMVOC, PCBs, HCB	NH_3, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn	T2/T3	
2C4	Magnesium production	NO					
2C5	Lead production	SO_2, $PM_{2.5}$, PM_{10}, TSP, Pb, Cd, As, Zn, PCDD/PCDF, PCBs			Rest of pollutants	T2	
2C6	Zinc production	SO_2, $PM_{2.5}$, PM_{10}, TSP, Pb, Cd, Hg, As, Zn, PCDD/PCDF, PCBs			Rest of pollutants	T2	
2C7a	Copper production	SO_2, $PM_{2.5}$, PM_{10}, TSP, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Zn, PCDD/PCDF, PCBs			Rest of pollutants	T2	
2C7b	Nickel production	NO					
2C7c	Silicon production	TSP, SO_2	–	NMVOC	Rest of pollutants	T1	
2C7d	Storage, handling and transport of metal products	–	$PM_{2.5}$, PM_{10}, TSP	Rest of pollutants	–	–	
2D3a	Domestic solvent use including fungicides	NMVOC, Hg	–	Rest of pollutants	$PM_{2.5}$	T2	
2D3b	Road paving with asphalt	NMVOC, $PM_{2.5}$, PM_{10}, TSP, BC		Rest of pollutants	NOx, SO_2, CO, PCDD/PCDF, PAHs, HCB	T2	
2D3c	Asphalt roofing	NMVOC, $PM_{2.5}$, PM_{10}, TSP, BC, CO	–	Rest of pollutants	NOx, Pb, Cd, Hg, PCDD/PCDF, PAHs, HCB	T1	✓
2D3d	Coating applications	NMVOC	–	Rest of pollutants	-	T2	
2D3e	Degreasing	NMVOC	–	Rest of pollutants	$PM_{2.5}$	T2	
2D3f	Dry cleaning	NMVOC	–	Rest of pollutants	$PM_{2.5}$	T2	
2D3g	Chemical products	NMVOC	–	Cd, As, Cr, Ni, Se, PAHs(*)	Rest of pollutants(**)	T1/T2	

NFR Code	NFR category	Pollutants					Method	KC
		Covered	Exceptions					
			IE	NA	NE			
2D3h	Printing	NMVOC	–	Rest of pollutants	$PM_{2.5}$, BC	T2	
2D3i	Other solvent use	NMVOC, BaP, BbF, BkF, IcP, PAH	–	PCBs	Rest of pollutants	T1/T2	
2G	Other product use: Other use of solvents and related activities	Rest of pollutants	–	–	Se, HCB, PCBs	T2	
2H1	Pulp and paper industry	NOx, NMVOC, SO_2, $PM_{2.5}$, PM_{10}, TSP, BC, CO		Heavy Metals, PCBs, PCDD/PCDF	NH_3, BaP, BbF, BkF, IcP, PAH, HCB	T2/T3	
2H2	Food and beverages industry	NMVOC	–	Rest of pollutants	$PM_{2.5}$, PM_{10}, TSP,BC	T1	
2H3	Other industrial processes	NO					
2I	Wood processing	TSP	–	Rest of pollutants	NOx, NMVOC, SO_2, NH_3, $PM_{2.5}$, PM_{10}, BC, CO, As, Cu	T1	✓
2J	Production of POPs and heavy metals	–	–	Rest of pollutants	NOx, NMVOC, SO_2, NH_3, CO, HCB, PCBs	–	
2K	Consumption of POPs and Heavy Metals	PCB	–	Rest of pollutants	Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, HCB	T3	
2L	Other production, consumption, storage, transportation or handling of bulk products: NH_3 consumption in refrigeration	NH_3	–	Rest of pollutants	–	T2	

IE: included elsewhere; NA: not applicable; NE: not estimated; NO: not occurring.

(*): Emissions for these pollutants are reported ad 'NA' because according to specific plant information for the ammonia process, processes that only use natural gas, as both feedstock and fuel, do not emit CO, NH_3 nor NMVOC.

(**): Polycyclic Aromatic Hydrocarbons (PAHs) are only produced by asphalt blowing activity into this category, but this process did not take place in any of the existing refineries in Spain during the Inventory period.

As a general rule, notation keys NE and NA are reported following the EMEP/EEA Guidebook (2019) according to the tables indicated within each chapter in the table summary of methodologies applied.

As for notation keys IE:

- 2A1: Emissions of particulate matter coming from cement production are included within the estimations of the associated combustion (1A2f), because they are estimated by measurements performed at the plants.

- 2B1: Emissions of NO_X within ammonia production are allocated under category 1A2c, and thus associated to combustion, because they are reported as end pipe measurements performed at the plants.

- 2B10b: NMVOC and particulate matter emissions are included, in process emissions within categories 2B1 to 2B10a.
- 2C1: PAHs emissions are included within category 1A2a.
- 2C7d: particulate matter emissions are included within categories 2C1 and 2C2.

4.2. Sector analysis

Main features of the Industrial Processes and Products Use Sector in Spain in 2021 are listed in the following table for reference.

These main features do not consider the Canary Islands, as their territory is not under the EMEP grid.

Table 4.2.1 Sector analysis

NFR Code	NFR category	Main features (2021)	Main sources of activity data
2A2	Lime production	- 17 facilities - 2,183 kt produced	- ANCADE (National Association of Manufacturers of Limes and Derivatives of Spain) - EU ETS data - IQ
2A3	Glass production	- More than 25 facilities - 4,823 kt of glass	- IQ - ANFFECC (Association of companies of Spanish ceramic frits, glazes and ceramic pigments producers)
2A5a	Quarrying and mining of minerals other than coal	- 190.272 Mt of material quarried	- IGME
2A5b	Construction and demolition	- 24,783,000 m^2 of floor space constructed/demolished - 2,984,040 m^2 of road constructed	- INE - Ministry of Public Works
2A5c	Storage, handling and transport of mineral products	- 51.55 Mt Port traffic: mineral products handled	- Spanish State ports website
2A6	Other mineral products: Batteries manufacturing	- 7 facilities - 15,900,000 units of lead batteries manufactured	- MINCOTUR
2B1	Ammonia production	- 2 facilities - 429 kt produced	- IQ
2B2	Nitric acid production	- 3 facilities - 666 kt produced	- IQ
2B5	Carbide production	- Silicon and calcium carbide production	- IQ
2B6	Titanium dioxide production	- 1 facility	- FEIQUE
2B7	Soda ash production	- 1 facility	- SOLVAY
2B10a	Other chemical industry: Processes in organic and inorganic chemical industry except adipic acid	- 7 subsectors of inorganic production included - 17 subsectors of organic production included	- IQ - FEIQUE
2C1	Iron and steel production	- 2 integrated iron and steel plants - 25 Non-integrated iron and steel plants - 14,151 kt manufactured	- IQ - UNESID

NFR Code	NFR category	Main features (2021)	Main sources of activity data
2C2	Ferroalloys production	- 4 production plants - 205 kt produced - Production of ferrosilicon, ferromanganese and silicomanganese	- IQ
2C3	Aluminium production	- Primary production: - Type of processes: central prebaked - 1 facility - Secondary production:	- IQ - SGIBP-MINER - Aseral (Spanish Association of Aluminium Refiners) - INE
2C5	Lead production	- Primary and secondary lead production - 202 kt produced	- IQ - Spanish Industry Report 1992 (MINER) - UNIPLOM - MITYC - “World Mineral Production” publication
2C6	Zinc production	- Primary and secondary zinc production	- IQ - SGIBP - U.S. Geological Survey Mineral Yearbook (2014)
2C7a	Copper production	- Primary and secondary copper production	- IQ - SGIBP - UNICOBRE - U.S. Geological Survey Mineral Yearbook (2014)
2D3a	Domestic solvent use including fungicides	- Estimations based on population data. 2021 Spain Population = 47.326.693	- INE - ESIG
2D3b	Road paving with asphalt	Two types of bituminous mixes compiled: - Hot bituminous mixtures - Cutback asphalt	- EAPA
2D3c	Asphalt roofing	- 208 tonnes of roofing material produced	- INE
2D3d	Coating applications	- 9 categories of emissions with information on solvent content in the product - 450.86 kt paint applied - Information on solvent used in manufacturing of automobiles from IQ	- ASEFAPI - Automobile industry
2D3e	Degreasing	- Information on solvent used in manufacturing of automobiles from IQ - Washing preparations and cleaning preparations, with or without soap, not packaged for retail sale (PRODCOM 20413270: 31,660 t)	- Automobile industry - EUROSTAT
2D3f	Dry cleaning	- Estimations of solvent consumption based on actual consumption in installations - 213 t of solvents consumed	- VOC consumption and emissions from installations under Royal Decree/117/2003
2D3g	Chemical products	- 11 compilation categories (activities within SNAP subgroup 06.03)	- INE - COFACO
2D3h	Printing	- 56.2 kt of inks estimated (paste inks, black new inks, publication inks, varnishes and sundries and other inks)	- ASEFAPI - CITEPA

NFR Code	NFR category	Main features (2021)	Main sources of activity data
2D3i	Other solvent use	- Heterogeneous group including 7 different activities (see Solvent use section for details)	- Statistical sources - AFOEX - ANEO - VOC consumption and emissions from installations under RD/117/2003
2G	Other product use	- Heterogeneous group including 4 different activities (see “Other” section for details)	- EUROSTAT - Spanish producers of anaesthesia
2H1	Pulp and paper industry	- 8 production plants - 1,691 kt of pulp manufactured	- ASPAPEL
2H2	Food and beverages industry	- 1,833,477 tonnes of bread manufactured - 530,659 tonnes of biscuits manufactured - 146,426 tonnes of coffee manufactured - 368,327 tonnes of sugar - 19,658,994 hl of white wine produced - 21,406,133 hl of red wine produced - 35,193,407 hl of beer - 96,433 hl of whisky - 666,175 hl of brandy - 540,363 hl of other spirits	- INE
2I	Wood processing	- 2,547 kt of wood board products	- FAOSTAT
2K	Consumption of POPs and Heavy Metals	- 7183 t of remaining dielectric fluid	- SGEC
2L	Other production, consumption, storage, transportation or handling of bulk products: NH_3 Consumption in refrigeration	- 1.549 tonnes of NH_3 consumed in refrigeration	- Spanish producers of ammonia for refrigeration use

4.2.1. Key categories

Identified Key Categories within the IPPU sector, according to the information provided in section 1.5 of the IIR and Annex 1 are listed in the following table.

Table 4.2.2 Assignation of KC

NFR	NFR Category	NOx	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	PCDD /PCDF	PAHs	HCB	PCBs
2A	Mineral products	–	–	–	–	L	L-T	L-T	–	–	L-T	L-T	–	–	–	–	–
2B	Chemical Industry	–	T	L	T	L	L	–	–	–	–	–	T	–	–	–	–
2C	Metal production	–	–	L-T	–	–	–	L	–	L-T	L-T	L-T	L-T	L	L-T	L-T	L-T
2D	Solvents and other product use	–	L-T	–	–	–	–	–	–	–	–	–	L	–	–	–	–
2G+ 2H+ 2I+2 J+2K +2L	Other industrial processes and product use	–	L-T	L-T	–	L-T	L-T	L	–	–	–	L-T	–	–	–	–	L-T

L: level; T: trend

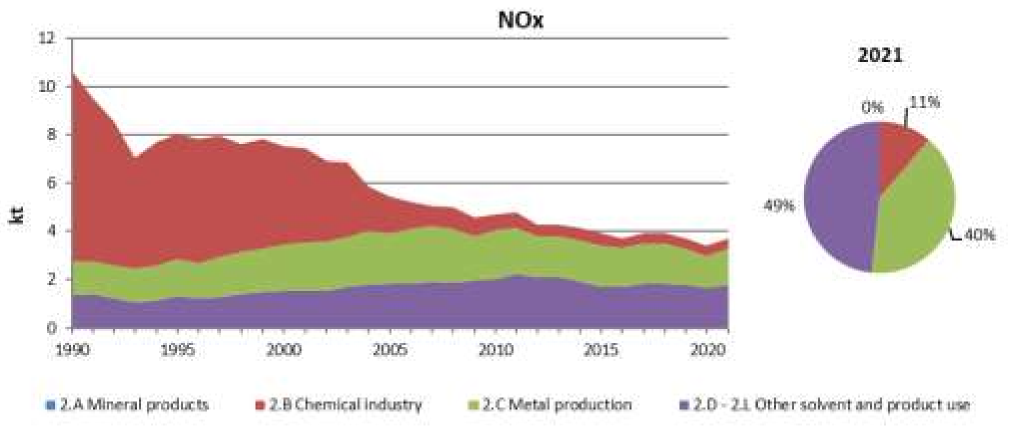
4.2.2. Analysis by pollutant

Charts of the time series by pollutants and NFR categories are shown next. Each pollutant is represented independently, broken down by main NFR categories within the sector. Additionally, a pie chart showing the weight distribution of the main categories for year 2021 is included.

In many of the activities under IPPU sector, during 2021 a partial recovery to emission levels previous to the COVID-19 pandemic, where many were decreased, are observed. Explanation boxes are included beside the graphs, providing specific details on the pollutant emissions in year 2021 and main drivers and trends during the time series. Emissions from the Canary Islands are not considered, as their territory is not under the EMEP grid.

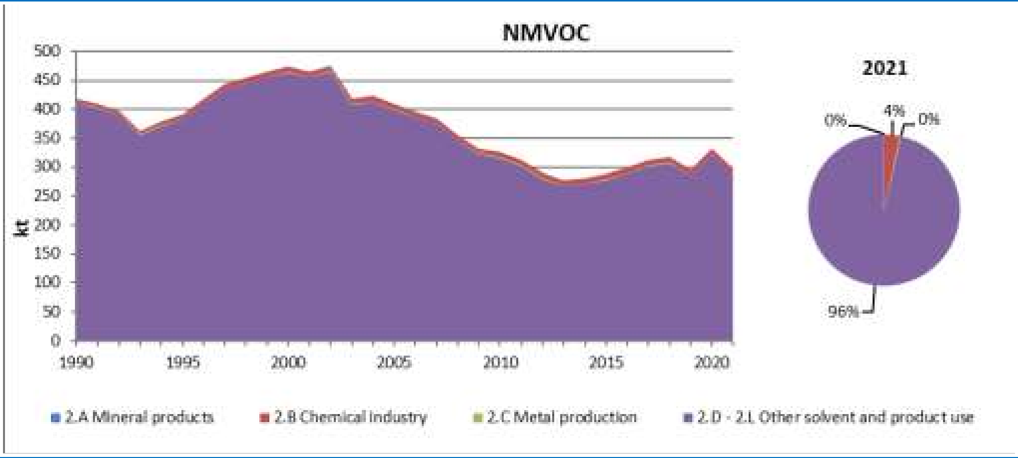
Detailed emission data of the Spanish Inventory are available from the MITECO-SEI website WebTable.

Main Pollutants



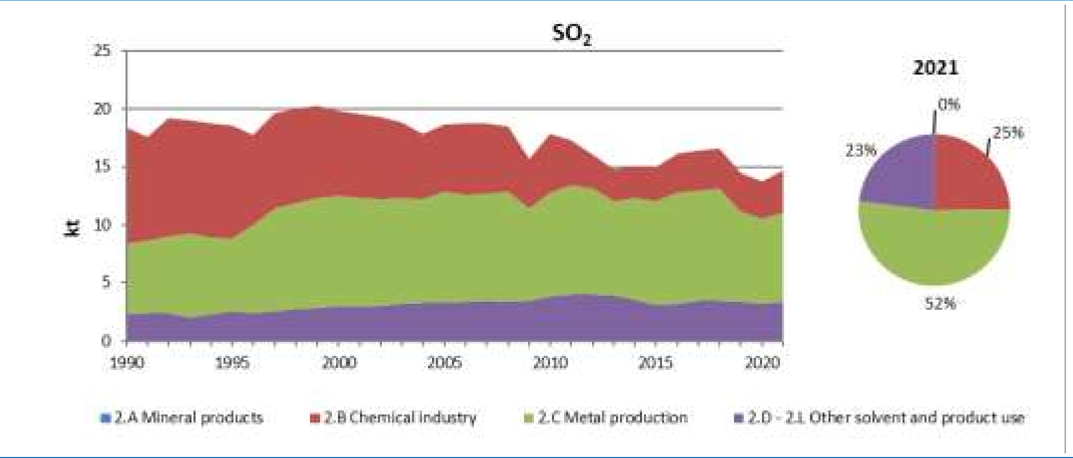
NOx	3.71 kt emitted in 2021 0.6% of the total NOx emissions of the Inventory in 2021	
	1990-1993	Reduction in the production of nitric acid and introduction of NOx abatement techniques.
	1994-2021	Trend remains steady till 2001 when a downward tendency starts, led by the chemical industry in general, with sharper decreases in 2004, 2009, 2012 and 2016, due to the combined action of nitric acid production (2B2), other chemical industry (2B10a), and iron and steel production (2C1).2021 shows a slight recovery to 2019 levels led by iron and steel production (2C1)

Figure 4.2.1 Evolution of NOx emissions by category and distribution in year 2021



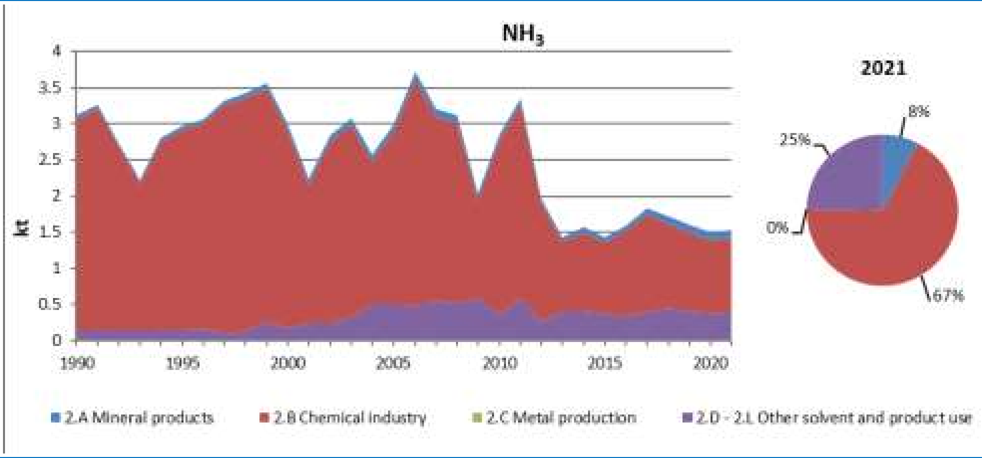
NMVOC	297.38 kt emitted in 2021 54.1% of the total NMVOC emissions of the Inventory in 2021	
	1990-1993	General descent mainly due to the decreasing consumption of certain products (Paint application, 2D3d) and in category Chemical products (2D3g).
	1994-2007	Upward trend attributable to the increase in solvent consumption, category 2D3.
	2008-2013	Progressive decrease owing to the effect of the reduction in the solvent content in painting products, the progressive penetration of abatement techniques and the economic downturn in Spain that led to less consumption.
	2014-2021	Slight increase due to an upturn in the industries under category 2D3g and to the use of hand sanitizers and other solvent-containing products related to the COVID19 pandemic (2D3a category) in 2020. 2021 shows a recovery to 2019 levels.

Figure 4.2.2 Evolution of NMVOC emissions by category and distribution in year 2021



SO_2	14.69 kt emitted in 2021 12.0% of the total SO_2 emissions of the Inventory in 2021	
	1990-2013	Steady fall with stages marked in 1991, 1996, 2004 and 2009 where more pronounced drops arise due to economic and industrial slowdowns in Spain that affected chemical industry (mainly Sulphuric acid production, 2B10a).
	2014-2021	Slight increase, sharper in 2016, due to an upturn of the production of sulphuric acid (2B10a) and aluminium (2C3). Since 2019 a drop in aluminium production (2C3) can be observed as a consequence of a significant slowdown in manufacturing activity. 2021 shows a recovery in metal production (2C) to 2019 levels.

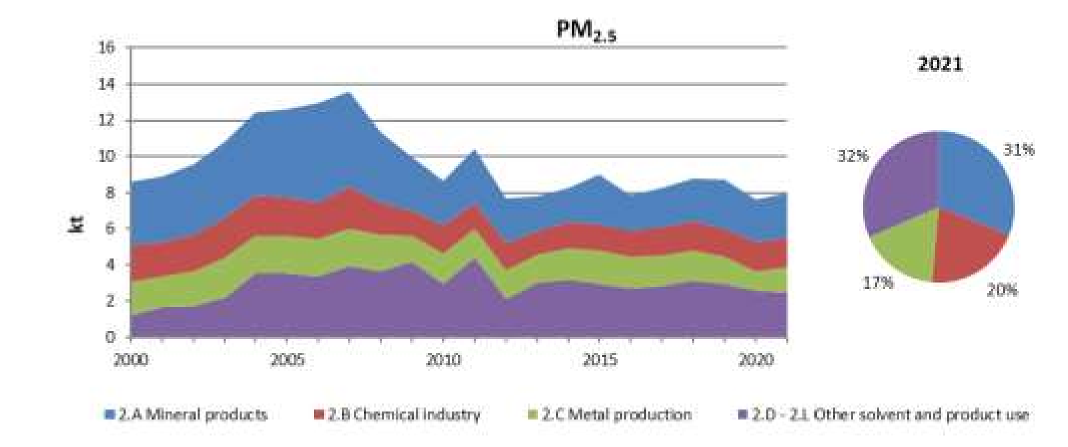
Figure 4.2.3 Evolution of SO_2 emissions by category and distribution in year 2021



NH_3	1.53 kt emitted in 2021 0.3% of the total NH_3 emissions of the Inventory in 2021	
	1990-2021	Trend fluctuates widely over time driven by the NPK fertilizer production until 2012 when soda ash production and use takes over leadership, both activities are under other chemical industries (2B10a). To be highlighted the increasing contribution to emissions in recent years from tobacco combustion under other product use (2G) and refrigeration products (2L).

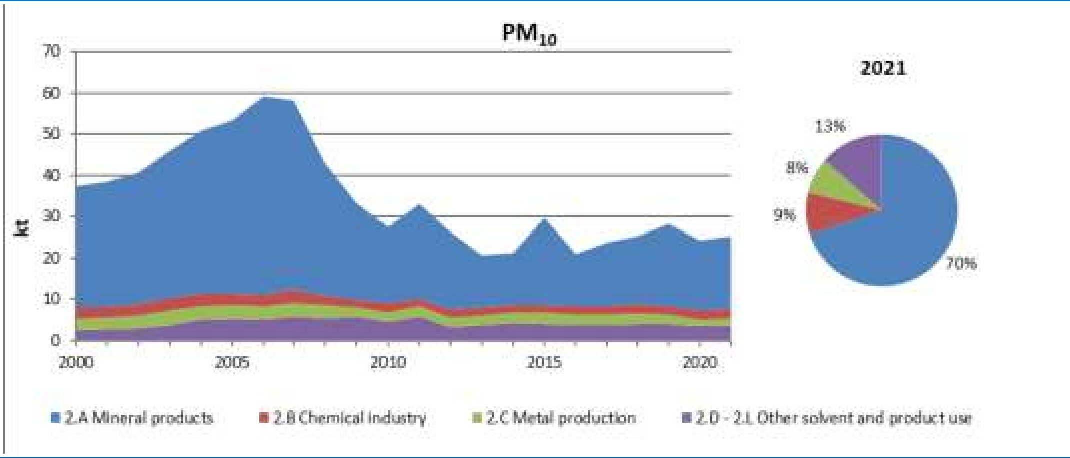
Figure 4.2.4 Evolution of NH_3 emissions by category and distribution in year 2021

Particulate Matter



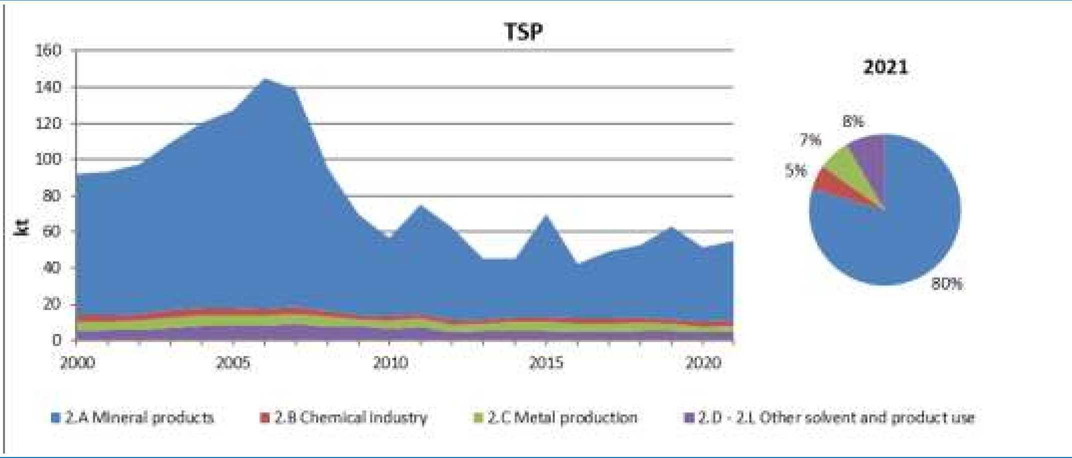
$PM_{2.5}$	7.97 kt emitted in 2021 5.9% of the total $PM_{2.5}$ emissions of the Inventory in 2021	
	2000-2006	Growing trend led by effect of quarrying and mining of minerals other than coal (2A5a).
	2007-2012	Decline of the trend due to the reduction of activity under 2A5a, mostly caused by the decrease of the construction activities in Spain, combined with a decrease in the production of NPK fertilizer under other chemical industries (2B10a). Peak in 2011 due to a rise in tobacco consumption.
	2013-2021	Trend levelled off over the period with a slight rise due to tobacco consumption (2G). 2021 presents a recovery to 2019 levels.

Figure 4.2.5 Evolution of $PM_{2.5}$ emissions by category and distribution in year 2021



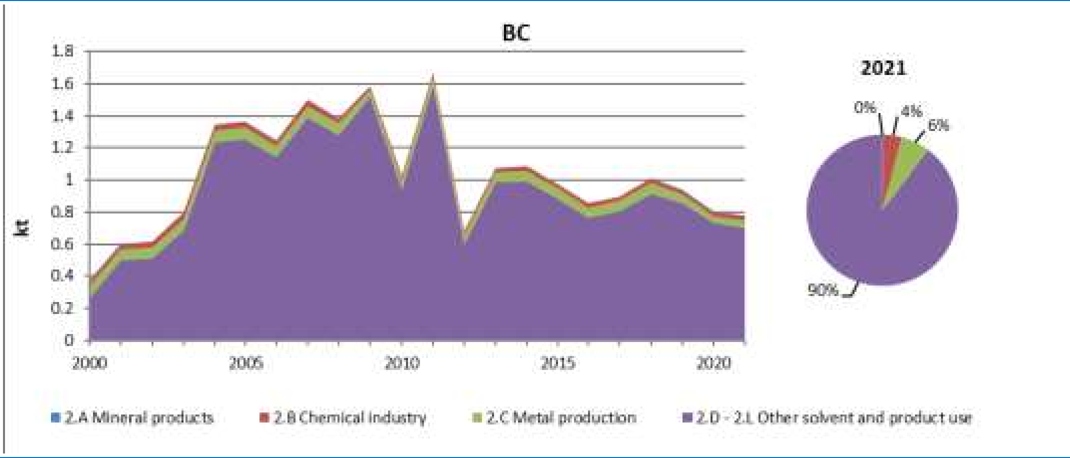
PM_{10}	25.14 kt emitted in 2021 11.7% of the total PM_{10} emissions of the Inventory in 2021	
	2000-2006	Growing trend mainly led by 2A5a and 2A5b source categories in the mineral products sector.
	2007-2013	Decline of the construction activities in Spain narrowly linked to the aforementioned mineral products sector. 2011 reaches a peak due to the category road construction (2A5b).
	2014-2021	Stable trend led by the contribution of the quarrying and mining of minerals (2A5a). 2015 and 2019 present peaks because of increases in road construction (2A5b).

Figure 4.2.6 Evolution of PM_{10} emissions by category and distribution in year 2021



TSP	54.85 kt emitted in 2021 18.5% of the total TSP emissions of the Inventory in 2021	
	2000-2006	Trend grows steadily driven by 2A5a and 2A5b source categories in the mineral products sector and the wood processing sector.
	2007-2012	Decline of the construction activities in Spain narrowly linked to the aforementioned mineral products sector. 2011 reaches a peak due to the category road construction (2A5b).
	2013-2021	Trend levels off with slight fluctuations due to a steady contribution from both mineral products sector, 2A5a and 2A5b. 2015 and 2019 present peaks because of increases in road construction (2A5b).

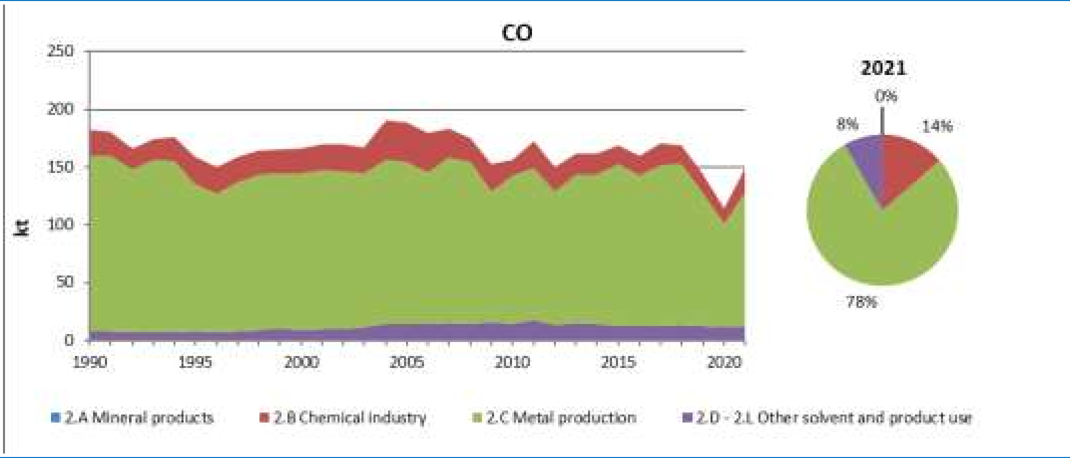
Figure 4.2.7 Evolution of TSP emissions by category and distribution in year 2021



BC	0.78 kt emitted in 2021 1.7% of the total BC emissions of the Inventory in 2021	
	2000-2021	Unsteady trend led by the tobacco consumption under other product use (2G).

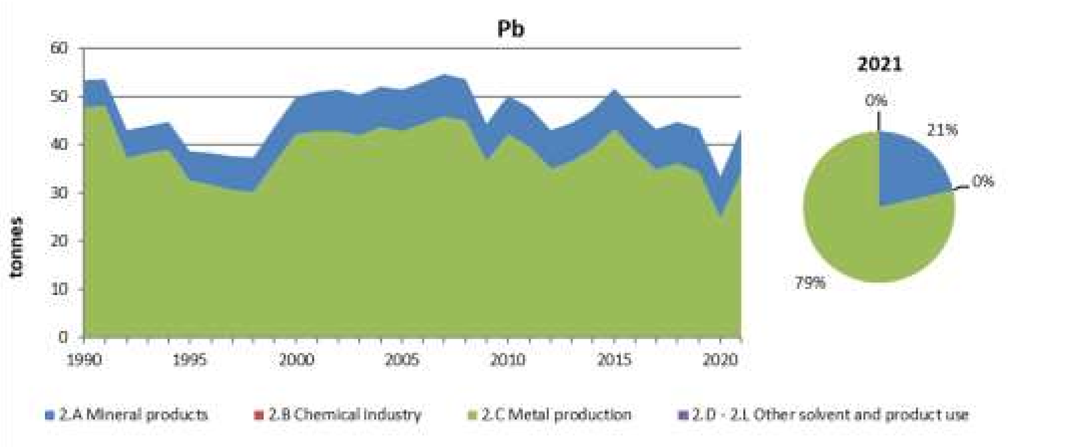
Figure 4.2.8 Evolution of BC emissions by category and distribution in year 2021

CO and Priority Heavy Metals



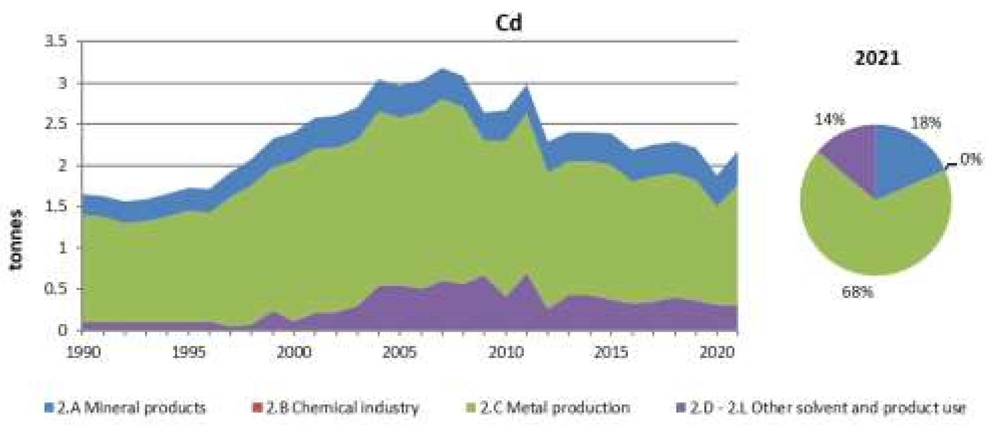
CO	148.51 kt emitted in 2021 9.1% of the total CO emissions of the Inventory in 2021	
	1990-2021	Trend fluctuates over time driven mostly by iron and steel production (2C1). 2021 presents a recovery to 2019 levels.

Figure 4.2.9 Evolution of CO emissions by category and distribution in year 2021



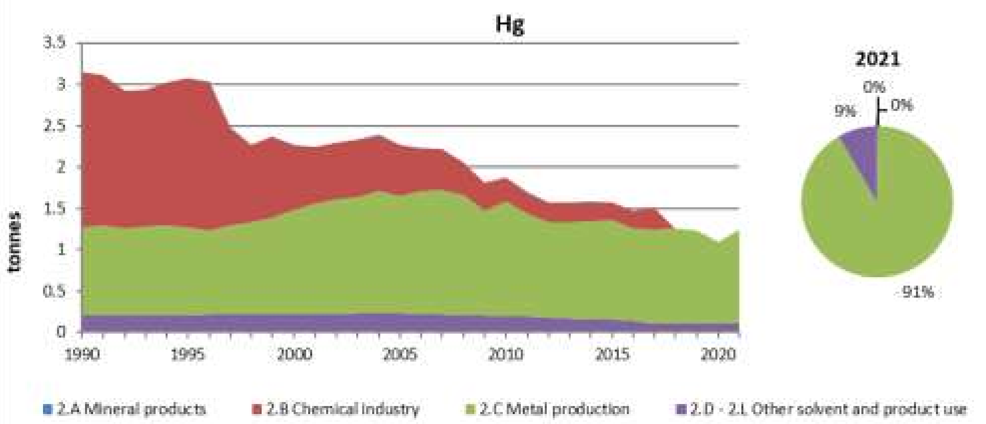
Pb	43.37 tonnes emitted in 2021 43.1% of the total Pb emissions of the Inventory in 2021	
	1990-1998	Downward trend led by iron and steel sector (2C1), sharper in 1995 due to a drop in sinter production as a result of the closure of one integrated iron and steel plant.
	1999-2008	Rising trend due to the iron and steel sector (2C1).
	2009-2021	Overall decreasing trend with fluctuations due to both production of steel in electric furnaces (2C1a) and sinter (2C1d). 2021 presents a recovery to 2019 levels.

Figure 4.2.10 Evolution of Pb emissions by category and distribution in year 2021



Cd	2.17 tonnes emitted in 2021 31.7% of the total Cd emissions of the Inventory in 2021	
	1990-2008	Growing trend over the period largely due to metal production, basically, to iron and steel production (2C1).
	2009-2021	Steady downward trend with fluctuations due to production of steel in electric furnaces (2C1) and tobacco consumption (2G). 2021 presents a recovery to 2019 levels.

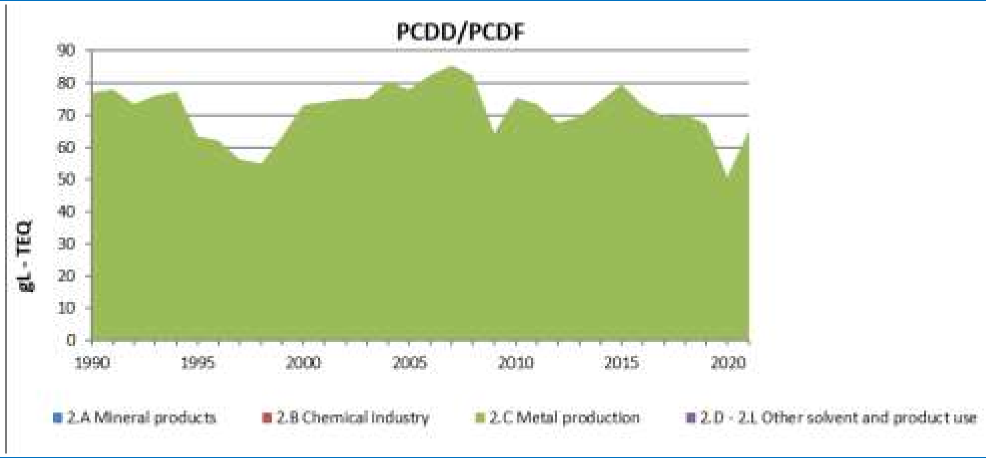
Figure 4.2.11 Evolution of Cd emissions by category and distribution in year 2021



Hg	1.24 tonnes emitted in 2021 42.2% of the total Hg emissions of the Inventory in 2021	
	1990-1996	Levelled off trend with slight fluctuations driven by the chemical industry, basically, chlorine manufacturing (2B10a).
	1997-2021	Decreasing trend due to technological improvements implemented in the chemical industry (Chlorine production, category 2B10a). Since 2018 no Hg emissions have been produced within this sector, as chlorine production with mercury process is no longer allowed, which results in the metal production leading the emissions. 2021 presents a recovery to 2019 levels.

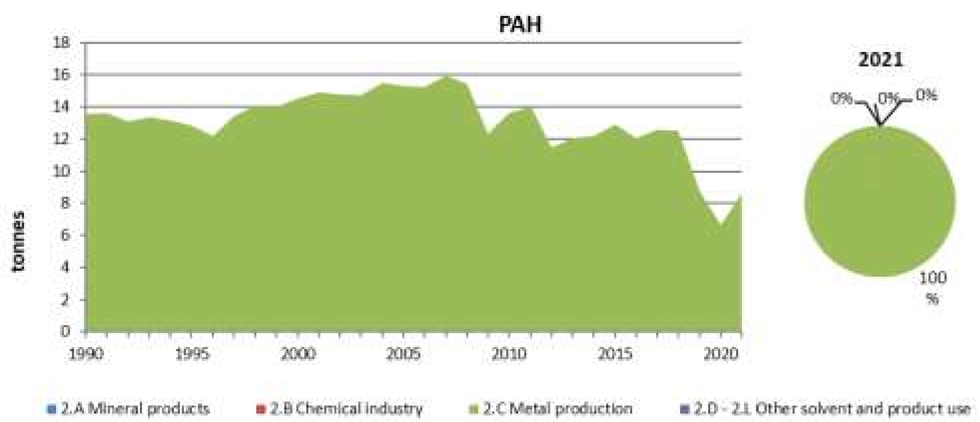
Figure 4.2.12 Evolution of Hg emissions by category and distribution in year 2021

POPs



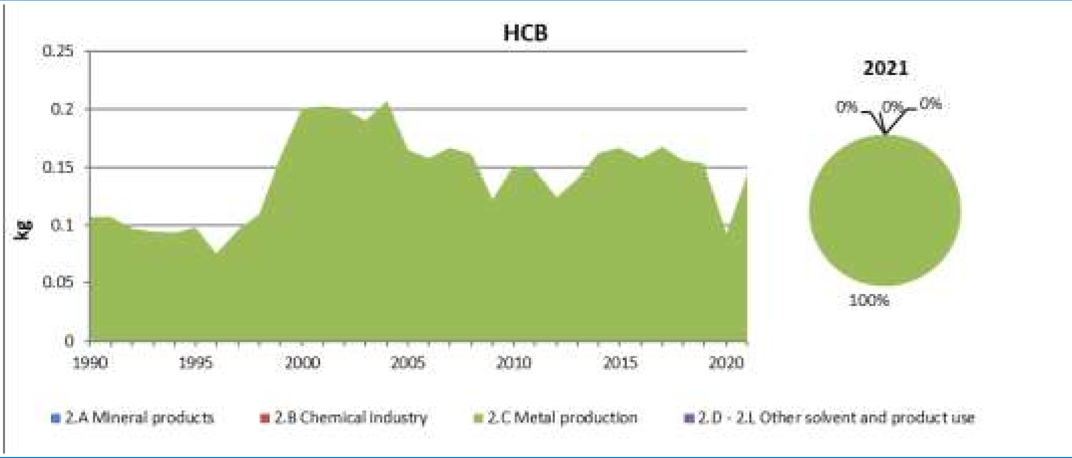
PCDD/PCDF	65.42 g I-TEQ emitted in 2021 13.7% of the total PCDD/PCDF emissions of the Inventory in 2021	
	1990-1998	Downward trend led by iron and steel production (2C1).
	1999-2007	Trend increases steadily driven by production of steel in electric furnaces (2C1).
	2008-2020	Fluctuations over the period with a downward trend driven mainly by the production of steel in electric furnaces (2C1) followed by the aluminium production (2C3). 2015 peak is due to a rise in sinter production (2C1). 2021 presents a recovery to 2019 levels.

Figure 4.2.13 Evolution of PCDD/PCDF emissions by category and distribution in year 2021



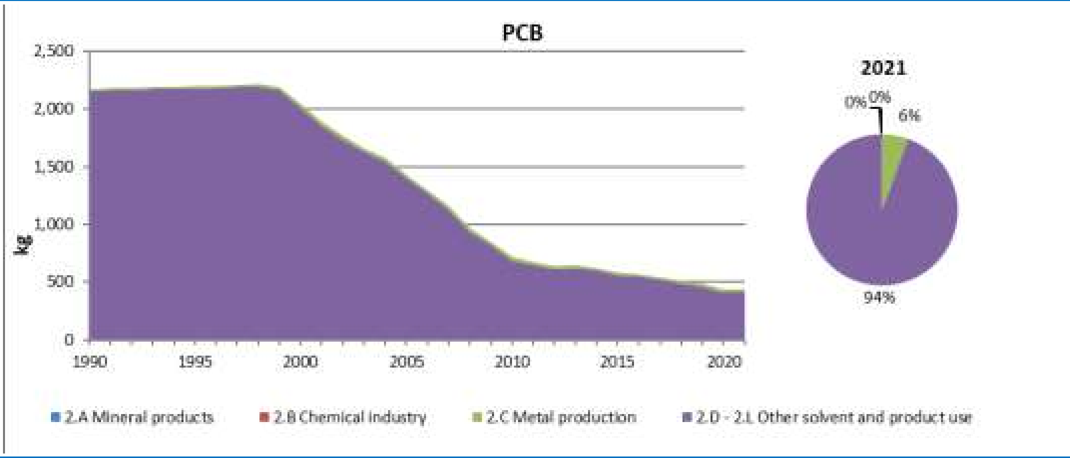
PAHs	8.64 tonnes emitted in 2021 23.8% of the total PAHs emissions of the Inventory in 2020	
	1990-2008	Upward trend with fluctuations, being both the production of Steel in electric furnaces and pig iron the main drivers (category 2C1).
	2009	Decrease due to a lower activity in the drivers aforementioned.
	2010-2021	Recovery of activity levels in the involved sectors, with a slight decrease in 2012 and 2016 caused by a reduction in production in Steel in electric furnaces as well as in pig iron production. (2C1).In 2019, a drop in aluminium production (2C3) explains the fall in the emissions. This trend continues in 2020 and is further boosted by the fall in steel production. 2021 presents a recovery to 2019 levels in 2C1.

Figure 4.2.14 Evolution of PAHs emissions by category and distribution in year 2021



HCB	0.14 kg emitted in 2021 7.0% of the total HCB emissions of the Inventory in 2021	
	1990-2021	Low emissions from the manufacture of sinter (2C1). 2021 presents a recovery to 2019 levels in 2C1.

Figure 4.2.15 Evolution of HCB emissions by category and distribution in year 2021



PCB	440.31 kg emitted in 2021 97.6% of the total PCBs emissions of the Inventory in 2021	
	1990-1999	Stable trend.
	2000-2021	Downward trend correlated with the evolution of the electrical equipment manufactured or contaminated with PCBs that have been destroyed (2K).

Figure 4.2.16 Evolution of PCBs emissions by category and distribution in year 2021

4.2.3. Condensable component of PM_{10} and $PM_{2.5}$

As detailed in Annex V, indication of whether the emission estimates and emission factors for PM_{10} and $PM_{2.5}$ in the IPPU sector include or exclude the condensable component can be found in the table below:

Table 4.2.3 Particulate matter emission factors per source category and information on condensable component

<table>
<tr><th rowspan="2">NFR</th><th rowspan="2" colspan="2">Source/sector name</th><th colspan="2">PM emissions: the condensable component is</th><th rowspan="2">EF reference and comments</th></tr>
<tr><th>Included</th><th>excluded</th></tr>
<tr><td>2A1</td><td colspan="2">Cement production</td><td colspan="2">IE</td><td></td></tr>
<tr><td>2A2</td><td colspan="2">Lime production</td><td colspan="2">No information available</td><td>EMEP/EEA GB 2019</td></tr>
<tr><td>2A3</td><td colspan="2">Glass production</td><td colspan="2">No information available</td><td>EMEP/EEA GB 2019</td></tr>
<tr><td>2A5a</td><td colspan="2">Quarrying and mining of minerals other than coal</td><td colspan="2">No information available</td><td>EMEP/EEA GB 2016</td></tr>
<tr><td>2A5b</td><td colspan="2">Construction and demolition</td><td colspan="2">No information available</td><td>EMEP/EEA GB 2019</td></tr>
<tr><td>2A5c</td><td colspan="2">Storage, handling and transport of mineral products</td><td colspan="2">No information available</td><td>EMEP/EEA GB 2019</td></tr>
<tr><td>2A6</td><td colspan="2">Other mineral products (please specify in the IIR)</td><td colspan="2">NA</td><td></td></tr>
<tr><td>2B1</td><td colspan="2">Ammonia production</td><td colspan="2">NE</td><td></td></tr>
<tr><td>2B2</td><td colspan="2">Nitric acid production</td><td colspan="2">NE</td><td></td></tr>
<tr><td>2B3</td><td colspan="2">Adipic acid production</td><td colspan="2">NO</td><td></td></tr>
<tr><td>2B5</td><td colspan="2">Carbide production</td><td colspan="2">No information available</td><td>EMEP/EEA GB 2019</td></tr>
<tr><td>2B6</td><td colspan="2">Titanium dioxide production</td><td colspan="2">No information available</td><td>EMEP/EEA GB 2019</td></tr>
<tr><td>2B7</td><td colspan="2">Soda ash production</td><td colspan="2">No information available</td><td>EMEP/EEA GB 2019</td></tr>
<tr><td>2B10a</td><td colspan="2">Chemical industry: Other (please specify in the IIR)</td><td colspan="2">No information available</td><td>EMEP/EEA GB 2019</td></tr>
<tr><td>2B10b</td><td colspan="2">Storage, handling and transport of chemical products (please specify in the IIR)</td><td colspan="2">IE</td><td></td></tr>
<tr><td rowspan="2">2C1</td><td rowspan="2" colspan="2">Iron and steel production</td><td colspan="2">No information available</td><td>Stack measurements of TSP and PM_{10}; $PM_{2.5}$ fractions based in CEPMEIP (2000) or EMEP/EEA GB 2019, from TSP data</td></tr>
<tr><td></td><td>X</td><td>EMEP/EEA GB 2019</td></tr>
<tr><td>2C2</td><td colspan="2">Ferroalloys production</td><td></td><td>X</td><td>EMEP/EEA GB 2019</td></tr>
<tr><td rowspan="2">2C3</td><td rowspan="2">Aluminium production</td><td>Primary production</td><td colspan="2">No information available</td><td>Stack measurements of TSP; $PM_{2.5}$ and PM_{10} fractions based in CEPMEIP (2000), from TSP data</td></tr>
<tr><td>Secondary production</td><td></td><td>X</td><td>EMEP/EEA GB 2019</td></tr>
<tr><td>2C4</td><td colspan="2">Magnesium production</td><td colspan="2">NO</td><td></td></tr>
<tr><td>2C5</td><td colspan="2">Lead production</td><td></td><td>X</td><td>EMEP/EEA GB 2019</td></tr>
<tr><td>2C6</td><td colspan="2">Zinc production</td><td></td><td>X</td><td>EMEP/EEA GB 2019</td></tr>
<tr><td>2C7a</td><td colspan="2">Copper production</td><td></td><td>X</td><td>EMEP/EEA GB 2019</td></tr>
</table>

NFR	Source/sector name	PM emissions: the condensable component is		EF reference and comments
		Included	excluded	
2C7b	Nickel production	NO		
2C7c	Other metal production (Silicon)	NA		
2C7d	Storage, handling and transport of metal products (please specify in the IIR)	NE		
2D3a	Domestic solvent use including fungicides	NE		
2D3b	Road paving with asphalt	X		EMEP/EEA GB 2019
2D3c	Asphalt roofing	No information available		EMEP/EEA GB 2019
2D3d	Coating applications	NA		
2D3e	Degreasing	NE		
2D3f	Dry cleaning	NE		
2D3g	Chemical products	NE		
2D3h	Printing	NE		
2D3i	Other solvent use (please specify in the IIR)	NE		
2G	Other product use (please specify in the IIR)	No information available		EMEP/EEA GB 2019
2H1	Pulp and paper industry	No information available		EMEP/EEA GB 2019
2H2	Food and beverages industry	NE		
2H3	Other industrial processes (please specify in the IIR)	NO		
2I	Wood processing	NE		
2J	Production of POPs	NA		
2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)	NA		
2L	Other production, consumption, storage, transportation or handling of bulk products (please specify in the IIR)	NA		

4.3. Major changes

The table below summarizes the major changes performed in the IPPU sector in the current Inventory edition. Those referred to the recommendations made by the TERT in the 2022 NECD review (pursuant to Directive (EU) 2016/2284), have been marked with an asterisk (*).

Further details of new estimations and recalculations can be found in sections 4.4 (Key categories analysis) and 4.5 (Recalculations).

Table 4.3.1 Major changes in the IPPU sector in Inventory edition 2023

NFR Category	Activities included	Pollutant	Type of change
(*)Construction and demolition (**2A5b**)	- Construction and demolition of housing and roads	TSP, PM_{10}, $PM_{2.5}$	New estimation from roads construction EF update
Storage, handling and transport of mineral product (**2A5c**)	- Storage, handling and transport of mineral product	TSP, PM_{10}, $PM_{2.5}$	Recalculation
Other chemical industry (**2B10a**)	- Production of persistent organic pollutants	NMVOC, HCB	Not estimated
(*)Silicon production (**2C7c**)	- Silicon production	SO_2, TSP	New estimation
(*)Storage, handling and transport of metal products (**2C7d**)	- Storage, handling and transport of metal products	TSP, PM_{10}, $PM_{2.5}$	Notation keys updated
(*)Domestic solvents use (**2D3a**)	- Use of detergents, cosmetics, cleaning and hygiene products, within the domestic sphere.	NMVOC	Recalculation
(*)Degreasing (**2D3e**)	- Metal degreasing	NMVOC	Recalculation
(*)Consumption of POPs and heavy metals (**2K**)	- Electrical equipment manufactured or contaminated with PCB	PCB	New estimation

4.4. Key categories analysis

Within this sector, the following categories have been identified as key (see table Assignation of KC for reference):

A. Mineral Industry - 2A

B. Chemical Industry - 2B

C. Metal production - 2C

D. Solvent use - 2D

E. Other industrial processes and product use – 2G+2H+2I+2J+2K+2L

Activity data sources, methodologies and a general assessment for each category are provided.

A. Mineral industry (2A)

Mineral industry is a key category for its contribution to the level and the trend of the emissions of PM_{10}, TSP, Pb and Cd, as well as for its contribution to the level of the emission of $PM_{2.5}$.

Emissions of Particulate Matter in this sector are mainly due to activities 2A5b (Construction and demolition) followed by 2A5a (Quarrying and mining of minerals other than coal) and 2A3 (glass production). As for the heavy metals emissions (Pb and Cd) are largely due to glass production activity (2A3). Emissions from 2A1 (Cement production) are allocated under 1A2f (see section 4.1).

A.1. Activity variables

Table 4.4.1 Summary of activity variables, data and information sources for category 2A

Activities included	Activity data	Source of information
Lime production (**2A2**)	- Production of lime.	- 1990-2021: IQ. - 1990-2021: EU ETS DATA. - 1990-2006: ANCADE.
Glass production (**2A3**)	- Production of glass.	- 1990-2021: IQ. - 1990-2021: ANFFECC.
Quarrying and mining of minerals other than coal (**2A5a**)	- Production of construction aggregates.	- 1991–2014: “Panorama minero (Mining overview)”. IGME. - 2015-2021: “Estadística minera de España (Mining statistic)”. MITECO. - 1990: subrogated data from the most recent year available.
Construction and demolition (**2A5b**)	- Municipal construction authorizations (square metres authorized for housing construction or demolition)	- 1990–2000: Ministry of Public Works - 2000-2021: INE.
	- Square metres of road construction	- 2011-2021: Ministry of Transport, Mobility and Urban Agenda (MITMA)
Storage, handling and transport of mineral products (**2A5c**)	Tonnes of material handled: - Cement and clinker. - Construction materials. - Other non metallic minerals.	- 2002-2021: Spanish State ports website.
Other mineral products – Batteries manufacturing (**2A6**)	- Number of batteries produced. - Amount of metal used per battery.	- 1993-1996: MITYC. - 2005-2007: MITYC. - 1997-2004: lineal interpolation. - 1990-1992: subrogated data (1993). - 2008-2021: subrogated data (2007). - 1990-2021: EPA. AP-42.

A.2. Methodology

Table 4.4.2 Summary of methodologies applied in category 2A

Pollutants	Tier	Methodology applied	Observations
Lime production (2A2)			
$PM_{2.5}$, PM_{10}, TSP, BC	T2	EMEP/EEA Guidebook (2019). Chapter 2A2.	EF: - Table 3.3: default Tier 2 emission factors by tonne of lime.

Pollutants	Tier	Methodology applied	Observations
Glass production (2A3) (Methodological factsheets: Glass manufacturing)			
NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn	T2	EMEP/EEA Guidebook (2019). Chapter 2A3. US EPA AP-42. Chapter 11.14 Frit Manufacturing.	EF (emission factors by tonne of glass): - Stone glass: CS, except for BC Table 3.5 (default T2). - Wool glass: Table 3.5 (default T2). - Container glass: Table 3.3 (default T2). - Flat glass: Table 3.2 (default T2). - Other glasses: for BC table 3.6 and 3.7. Rest of pollutants: Table 14-1,14-2 (default US EPA).
Quarrying and mining of minerals other than coal (2A5a)			
PM	T1	EMEP/EEA Guidebook (2019). Chapter 2A5a.	EF: - Table 3.1: default Tier 1 emission factors by tonne of mineral quarried.
Construction and demolition (2A5b)			
PM	T1	EMEP/EEA Guidebook (2019). Chapter 2A5b.	EF: - Tables: 3.2, 3.4: default Tier 1 emission factors.
Storage, handling and transport of mineral products (2A5c)			
PM	T2	EMEP/EEA Guidebook (2019). Chapter 2A5c.	EF: - Table 3.4: default Tier 2 emission factors by tonnes of mineral products handled.
Other mineral products – Batteries manufacturing (2A6)			
Cd, Pb	T1	PARCOM – ATMOS (1992). Section 2.9.6.	EF: - Emissions factor by tonne of metal used in the manufacturing of batteries. - For Ni-Cd batteries, the lowest value of EF has been chosen assuming abatement techniques installed in factories.

A.3. Assessment

Activities 2A5a and 2A5b are narrowly related to each other and both linked to the construction sector. The production of aggregates grows along with the surface to be constructed. As shown in the next figure, from 1996 to 2006 the production of aggregates suffered a steep rise as did the authorized surface for construction. In 2007, just in the prelude of the Spanish economic downturn, activity variables start a sharp fall until 2010, when trend softens, recovering a light increase from 2014 onwards.

Following the recommendation ES-2A5b-2022-001 made by the TERT in the 2022 NECD review (pursuant to Directive (EU) 2016/2284) the area of constructed roads has been included under category 2A5b.

In addition, update of activity data have been carried out for categories 2A5a and 2A5c.

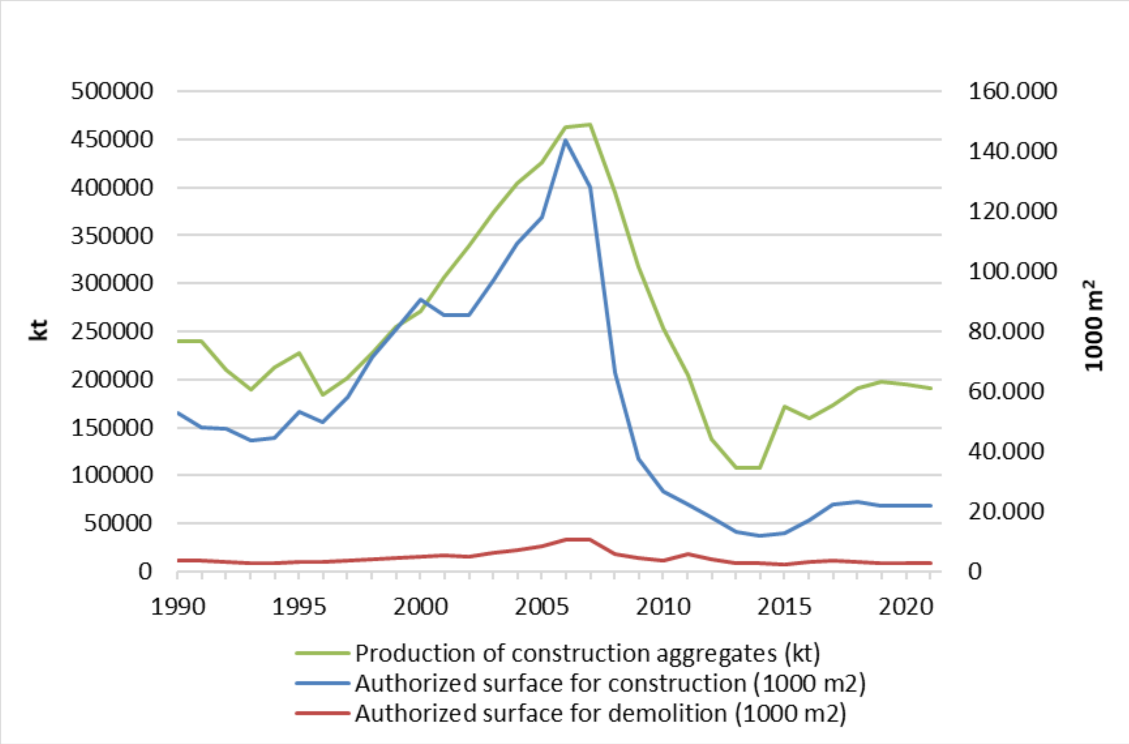


Figure 4.4.1 Evolution of activity data in 2A5a and 2A5b

Emissions from activity 2A3 are driven by the fluctuations of productivity inherent to the glass sector.

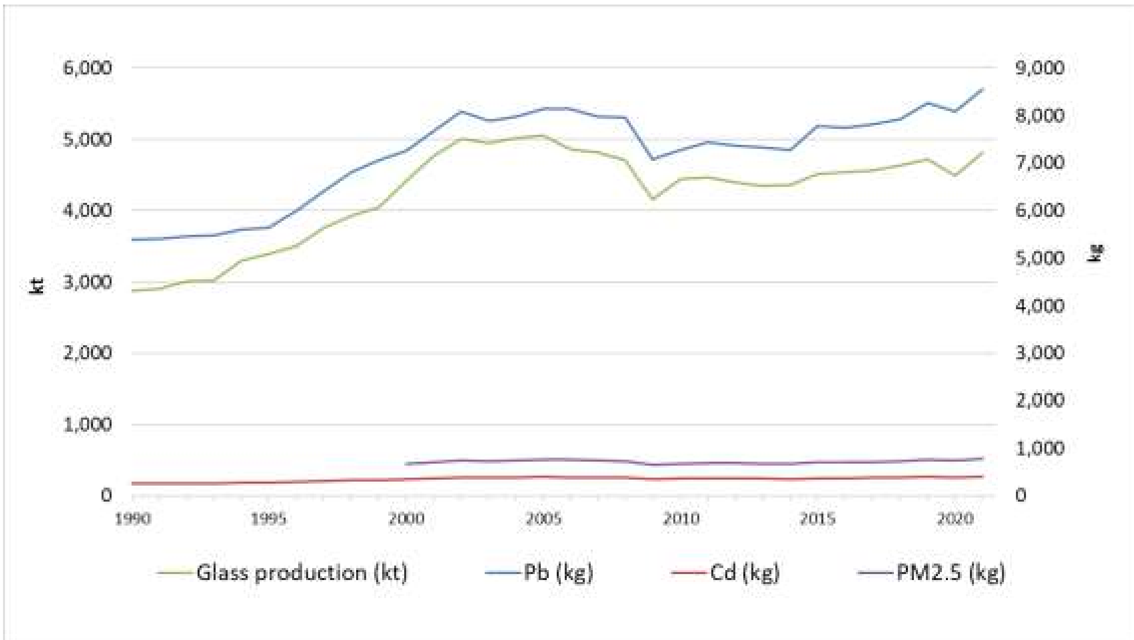


Figure 4.4.2 Evolution of activity data vs Pb, Cd and $PM_{2.5}$ emissions in 2A3

B. Chemical industry (2B)

The chemical industry is a key category for its contribution to the level of the emissions of SO_2, PM_{10} and $PM_{2.5}$, and to the trend of NMVOC, NH_3 and Hg.

B.1. Activity variables

Table 4.4.3 Summary of activity variables, data and information sources for category 2B

Activities included	Activity data	Source of information
Nitric acid (**2B2**)	- Nitric acid production by type of process (low pressure, medium pressure and high pressure).	- 1990: IQ from the production plants. - 1991-2000: Ministry of Industry and FEIQUE. - 2001-2007: IQ from the production plants and FEIQUE. - 2008-2021: IQ from the production plants.
Carbide production (**2B5**)	- Production of silicon and calcium carbide.	- 1990–2021: IQ from the production plants for the production of silicon carbide. - 1990-2002: publication “The chemical industry in Spain” for calcium carbide. - 2003-2004: publication “Chemistry engineering yearbook” for calcium carbide. - 2005-2021: IQ from the production plants for the production of calcium carbide.
Titanium dioxide production (**2B6**)	- Production of titanium dioxide.	- 1990-2002: publication “The chemical industry in Spain”. - 2003-2007: MINCOTUR. - 2008-2021: FEIQUE.
Soda ash production (**2B7**)	- Production of soda ash.	- 1990-2021: IQ from the production plant.
Manufacture of sulphuric acid (**2B10a**)	- Sulphuric acid production.	- 1990-2021: IQ from the production plants. - 1990-2021: FEIQUE.
Ammonium sulphate (**2B10a**)	- Ammonium sulphate production	- 1990-2002: publication “The chemical industry in Spain”. - 2003-2007: DG of Industry (MITYC) - 2008-2021: INE’s Industrial Survey
Ammonium nitrate (**2B10a**)	- Ammonium nitrate production	- 1990-2000:Sub-Directorate General for Basic and Processing Industries at the Ministry of Industry and Energy. - 2001-2002: publication “The chemical industry in Spain”; IQ from the production plants. - 2003-2007: DG of Industry (MITYC); IQ from the production plants - 2008-2021: IQ from the production plants.
Ammonium phosphate (**2B10a**)	- Ammonium phosphate production	- 1900: IQ from the production plants. - 1991-2001: publication “The chemical industry in Spain”. - 2001-2013: IQ from the production plants; FEIQUE.

Activities included	Activity data	Source of information
NPK fertilisers (**2B10a**)	- NPK fertilisers production	- 1990-2000: publication "The chemical industry in Spain". - 2001-2002: publication "The chemical industry in Spain"; IQ from the production plants. - 2003-2007: DG of Industry (MITYC); IQ from the production plants. - 2008-2021: INE's Industrial Survey; IQ from the production plants.
Urea (**2B10a**)	- Urea production	- 1990-2021: IQ from the production plants.
Carbon black (**2B10a**)	- Production of carbon black.	- 1990-2021: IQ from the plant.
Production of chlorine (**2B10a**)	- Data on production capacity with mercury cells.	- 1990–1997: Chemical Engineering Annual Report. - 1998-2004: ANE. - 2005–2012: IQ from the production plants. - 2013-2017: MITECO (Data from the Spanish Chlor-Alkali industry reported under OSPAR Convention).
Phosphate fertilisers (**2B10a**)	- Phosphate fertilisers production	- 1990-2005: Chemical Engineering Annual Report; publication "The chemical industry in Spain". - 2006-2021: INE's Industrial Survey.
Ethylene (**2B10a**)	- Ethylene production	- 1990-2002: publication "The chemical industry in Spain". - 2003-2021: IQ from the production plants.
Propylene (**2B10a**)	- Propylene production	- 1990-2002: publication "The chemical industry in Spain"; Sub-Directorate General for Basic and Processing Industries at the Ministry of Industry and Energy; FEIQUE; National Encyclopaedia of Oil, Petrochemistry and Gas, OILGAS - 2002-2021: FEIQUE; IQ from production plants.
Vinylchloride (**2B10a**)	- Vinyl chloride production	- 1990-2002: publication "The chemical industry in Spain". - 2003-2008: FEIQUE. - 2009-2021: FEIQUE; IQ from production plant.
Polyethylene low density (**2B10a**)	- Polyethylene low density production	- 1990-2002: publication "The chemical industry in Spain". - 2003: publication "The plastics in Spain" (ANAIP) - 2004-2005: ANAIP - 2006-2021: FEIQUE; IQ from production plant.
Polyethylene high density (**2B10a**)	- Polyethylene high density production	- 1990-2002: publication "The chemical industry in Spain". - 2003: publication "The plastics in Spain" (ANAIP) - 2004-2005: ANAIP - 2006-2021: FEIQUE; IQ from production plant.
Polyvinylchloride (**2B10a**)	- Polyvinylchloride production	- 1990-2021: FEIQUE; IQ from production plant.

Activities included	Activity data	Source of information
Polypropylene (**2B10a**)	- Polypropylene production	- 1990-2002: publication "The chemical industry in Spain". - 2003: publication "The plastics in Spain" (ANAIP) - 2004-2005: ANAIP - 2006-2021: FEIQUE; IQ from production plant.
Styrene (**2B10a**)	- Styrene production	- 1990-2002: publication "The chemical industry in Spain". - 2003-2007: National producer - 2008-2021: IQ from production plant
Polystyrene (**2B10a**)	- Polysterene production	- 1990-2002: publication "The chemical industry in Spain". - 2003: publication "The plastics in Spain" (ANAIP) - 2004-2005: ANAIP - 2006-2019: FEIQUE; IQ from production plant.
Styrene butadiene (**2B10a**)	- Styrene butadiene production	- 1990-2002: publication "The chemical industry in Spain". - 2003-2006: FEIQUE. - 2007-2021: IQ from production plants.
Styrene-butadiene latex (**2B10a**)	- Styrene-butadiene latex production	- 1990-2002: publication "The chemical industry in Spain". - 2003-2005: Chemical Engineering Yearbook - 2006-2021: subrogated data (2005)
Styrene-butadiene rubber (SBR) (**2B10a**)	- Styrene-butadiene rubber (SBR) production	- 1990-2002: publication "The chemical industry in Spain". - 2003-2021: IQ from production plant.
Acrylonitrile butadiene styrene (ABS) resins (**2B10a**)	- Acrylonitrile butadiene styrene (ABS) resins production	- 1990-2002: publication "The chemical industry in Spain". - 2003: publication "The plastics in Spain" (ANAIP) - 2004-2005: ANAIP - 2006-2021: FEIQUE
Ethylene oxide (**2B10a**)	- Ethylene oxide production	- 1990-2002: publication "The chemical industry in Spain". - 2003-2021: FEIQUE.
Formaldehyde (**2B10a**)	- Formaldehyde production	- 1990-2002: publication "The chemical industry in Spain". - 2003-2021: FEIQUE.
Ethylbenzene (**2B10a**)	- Ethylbenzene production	- 1990-1995: Chemical Engineering Yearbook. - 1996-2012: FEIQUE - 2013-2021: IQ from production plant.
Phtalic anhydride (**2B10a**)	- Phtalic achydride production	- 1990-1996: publication "The chemical industry in Spain". - 1997-2017: FEIQUE - 2018-2021: IQ from production plant.
Acrylonitrile (**2B10a**)	- Acrylonitrile production	- 1990-2002: publication "The chemical industry in Spain". - 2003-2005: FEIQUE. - 2006-2009: IQ from production plant.

B.2. Methodology

Table 4.4.4 Summary of methodologies applied in category 2B

Pollutants	Tier	Methodology applied	Observations
Nitric acid production (2B2) (Methodological factsheet: Nitric acid production)			
NOx	T3/T2	- EMEP/EEA Guidebook (2019). Chapter 2B.	EF: - For those plants that provide measured emissions, whenever the information was not available, an implicit emission factor has been applied, estimated either from 1990 data or from 2008 data, depending on the plant's activity period. - Default emission factors were used when no information from plants was available. Tables 3.9 – 3.12.
NH_3	T3/T2	- Country specific emission factors - EMEP/CORINAIR Guidebook (2007). Chapter B-442.	Emission measurements and information on abatement techniques since 2001 for certain plants. Default emission factors were used when no information from plants was available. Table 2.
Carbide production (2B5)			
CO $PM_{2.5}$, PM_{10}, TSP, BC	T1 T2	- Emission factor used by Norway. - EMEP/EEA Guidebook (2019). Chapter 2B.	EF: - Provided in a technical communication of the CORINAIR group. EF: - Table 3.18. - Table 3.1.
Titanium dioxide production (2B6)			
NOx, SO_2,TSP $PM_{2.5}$, PM_{10}, BC	T2	- EMEP/EEA Guidebook (2019). Chapter 2B.	EF: - Table 3.20 (sulphate process). - Table 3.1.
Soda ash production (2B7)			
NH_3, TSP, CO $PM_{2.5}$, PM_{10}, BC	T3	- Country specific Emission Factors. - EMEP/EEA Guidebook (2019). Chapter 2B.	EF: - Information provided by plant. - Table 3.1.
Manufacture of sulphuric acid (2B10a)			
SO_2	T3	- Country specific Emission Factors, for each manufacturing process.	EF: - Implied emission factor for each plant based on measured emissions. It is applied whenever emissions are not available. Emissions (three different methods): - Measured emissions since 2001 for the majority of the plants. - Measured emissions declared to the PRTR. - Measured emissions declared on environmental statements.
Ammonium sulphate (2B10a) (Methodological factsheets: Production of NPK fertilisers, ammonium nitrate, ammonium sulphate, ammonium phosphate and urea)			
TSP PM_{10}, $PM_{2.5}$, BC	T2	- EMEP/EEA Guidebook (2019). Chapter 2B. - EMEP/EEA Guidebook (2019). Chapter 2B.	EF: - Table 3.26. - Abatement efficiencies Table 6.62. - Table 3.1.

Pollutants	Tier	Methodology applied	Observations
Ammonium nitrate (2B10a) (Methodological factsheets: Production of NPK fertilisers, ammonium nitrate, ammonium sulphate, ammonium phosphate and urea)			
NH_3, TSP, PM_{10}, $PM_{2.5}$, BC	T3	- Country specific Emission Factors.	EF: - 1990-2000, implied emission factors based on plant measurements. Emissions measurements provided by plant from 2001 onwards.
Ammonium phosphate (2B10a) (Methodological factsheets: Production of NPK fertilisers, ammonium nitrate, ammonium sulphate, ammonium phosphate and urea)			
NH_3, TSP, PM_{10}, $PM_{2.5}$, BC	T3	- Country specific Emission Factors.	EF: - 1990-2001, implied emission factors based on plant measurements. - Emissions measurements provided by plant for the years 2002,2004,2007,2009, 2011 and 2013.
NPK fertilisers (2B10a) (Methodological factsheets: Production of NPK fertilisers, ammonium nitrate, ammonium sulphate, ammonium phosphate and urea)			
NH_3, TSP, PM_{10}, $PM_{2.5}$, BC	T3	- Country specific Emission Factors.	EF: - 1990-2000, implied emission factors based on plant measurements over the period 2001-2010. Emissions measurements provided by plant from 2001 onwards.
Urea (2B10a) (Methodological factsheets: Production of NPK fertilisers, ammonium nitrate, ammonium sulphate, ammonium phosphate and urea)			
NH_3, TSP, PM_{10}, $PM_{2.5}$, BC	T3	- Country specific Emission Factors.	EF: - 1990-2000, implied emission factors based on plant measurements over the period 2001-2009. Emissions measurements provided by plant from 2001 onwards.
Carbon black production (2B10a)			
NOx, SO_2, $PM_{2.5}$, PM_{10}, TSP, BC	T3	- Country specific Emission Factors.	EF: - 1990-2006, implied emission factor based on plant measurements. Emissions measurements provided by plant from 2007 onwards.
NMVOC, CO	T2	- EMEP/EEA Guidebook (2019). Chapter 2B.	EF: - Table 3.30.

Pollutants	Tier	Methodology applied	Observations
Chlorine production (2B10a)			
Hg	T2	- 1990 – 1997: PARCOM – ATMOS. - 1998 – 2004: OSPAR Commission report "Mercury Losses from the Chlor-Alkali Industry 2004"). - 2005 – 2011: IQ from the 7 existent production plants framed in the Voluntary Agreement for the environmental protection and control of emissions of the Spanish Chlor-alkali industry. - 2012 ANE (Electrochemical National Association). - 2013-2017: MITECO (Emission factors from the Spanish Chlor-Alkali industry reported under OSPAR Convention).	EF: - 1990-1997: emission factors by production capacity with mercury cells from PARCOM – ATMOS. - 1998-2017: emission factors by production capacity provided by each of the production plants using mercury cells for the different sources of information described before.
Phosphate fertilisers (2B10a)			
TSP, PM_{10}, $PM_{2.5}$ BC	T2	- EMEP/EEA Guidebook (2019). Chapter 2B	EF: - Table 3.35 - Table 3.1
Ethylene (2B10a)			
NMVOC	T2	- EMEP/EEA Guidebook (2019). Chapter 2B	EF: - Table 3.36
Propylene (2B10a)			
NMVOC	T2	- EMEP/EEA Guidebook (2019). Chapter 2B	EF: - Table 3.36
Vinylchloride (2B10a)			
NMVOC	T2	- EMEP/EEA Guidebook (2019). Chapter 2B	EF: - Table 3.37
Polyethylene low density (2B10a) (Methodological factsheets: Production of polymers **)**			
NMVOC, TSP $PM_{2.5}$, PM_{10}, BC	T2	- EMEP/EEA Guidebook (2019). Chapter 2B**.**	EF: - Table 3.39 - Table 3.1.
Polyethylene high density (2B10a) (Methodological factsheets: Production of polymers **)**			
NMVOC, TSP $PM_{2.5}$, PM_{10}, BC	T2	- EMEP/EEA Guidebook (2019). Chapter 2B**.**	EF: - Table 3.40 - Table 3.1.
Polyvinylchloride (2B10a) (Methodological factsheets: Production of polymers **)**			
NMVOC, TSP, $PM_{2.5}$, PM_{10} BC	T2	- EMEP/EEA Guidebook (2019). Chapter 2B**.**	EF: - Table 3.41 - Table 3.42 - Table 3.1.

Pollutants	Tier	Methodology applied	Observations
Polypropylene (2B10a) (Methodological factsheets: Production of polymers)			
NMVOC, TSP $PM_{2.5}$, PM_{10}, BC	T2	- EMEP/EEA Guidebook (2019). Chapter 2B. .	EF: - Table 3.43. - Table 3.1.
Styrene (2B10a)			
NMVOC	T2	- EMEP/EEA Guidebook (2019). Chapter 2B.	EF: - Table 3.44.
Polystyrene (2B10a) (Methodological factsheets: Production of polymers)			
NMVOC, TSP $PM_{2.5}$, PM_{10}, BC	T2	- EMEP/EEA Guidebook (2019). Chapter 2B.	EF: - Table 3.45. - Table 3.1
Styrene butadiene (2B10a) (Methodological factsheets: Production of polymers)			
NMVOC	T2	- EMEP/EEA Guidebook (2019). Chapter 2B.	EF: - Table 3.48.
Styrene-butadiene latex (2B10a) (Methodological factsheets: Production of polymers)			
NMVOC	T2	- EMEP/EEA Guidebook (2019). Chapter 2B.	EF: - Table 3.49.
Styrene-butadiene rubber (SBR) (2B10a) (Methodological factsheets: Production of polymers)			
NMVOC	T2	- EMEP/EEA Guidebook (2019). Chapter 2B.	EF: - Table 3.50.
Acrylonitrile butadiene styrene (ABS) resins (2B10a) (Methodological factsheets: Production of polymers)			
NMVOC	T2	- EMEP/EEA Guidebook (2019). Chapter 2B.	EF: - Table 3.51.
Ethylene oxide (2B10a)			
NMVOC	T2	- BAT Reference Document for the Production of LVOC (2017). Chapter 7.	EF: - Table 7.4.
Formaldehyde (2B10a)			
NMVOC, CO, TSP $PM_{2.5}$, PM_{10}, BC	T2	- EMEP/EEA Guidebook (2019). Chapter 2B.	EF: - Table 3.55. - Table 3.1
Ethylbezcene (2B10a)			
NMVOC	T2	- EMEP/EEA Guidebook (2019). Chapter 2B.	EF: - Table 3.56.
Phtalic anhydride (2B10a)			
NMVOC	T2	- EMEP/EEA Guidebook (2019). Chapter 2B.	EF: - Table 3.57.
Acrylonitrile (2B10a)			
NMVOC	T2	- EMEP/EEA Guidebook (2019). Chapter 2B.	EF: - Table 3.59.

B.3. Assessment

This category includes processes for both organic and inorganic chemical industries, though in the light of the total share of emissions in the category, the most representative is the subcategory 2B10a, which is the one responsible for the key category status.

The following table shows in red the activities included under subcategory 2B10a (Chemical industry: other) which share more than 18% of the emissions for each pollutant in 2021 within the IPPU sector. In blue are highlighted those pollutants for which the category is key.

Table 4.4.5 Main drivers for activity and pollutant in subcategory 2B10a for 2021

Industry	Activity	NOx	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
Inorganic chemical industry	Sulfuric acid	–	–	X	–	–	–	–	–	–
	Ammonium sulphate	–	–	–	–	X	X	X	X	–
	Ammonium nitrate	–	–	–	X	–	–	–	–	–
	Ammonium phosphate	–	–	–	–	–	–	–	–	–
	NPK fertilisers	–	–	–	–	–	–	–	–	–
	Urea	–	–	–	X	–	–	–	–	–
	Carbon black production	X	–	X	–	–	–	–	–	X
	Chlorine production	–	–	–	–	–	–	–	–	–
	Phosphate fertilizers	–	–	–	–	–	–	–	–	–
Organic chemical industry	Ethylene	–	–	–	–	–	–	–	–	–
	Propylene	–	–	–	–	–	–	–	–	–
	Vinylchloride	–	–	–	–	–	–	–	–	–
	Polyethylene low density	–	–	–	–	–	–	–	–	–
	Polyethylene high density	–	–	–	–	–	–	–	–	–
	Polyvinylchloride	–	–	–	–	–	–	–	–	–
	Polypropylene	–	X	–	–	X	X	X	X	–
	Styrene	–	–	–	–	–	–	–	–	–
	Polystyrene	–	–	–	–	–	–	–	–	–
	Styrene butadiene	–	–	–	–	–	–	–	–	–
	Styrene-butadiene latex	–	–	–	–	–	–	–	–	–
	Styrene-butadiene rubber (SBR)	–	–	–	–	–	–	–	–	–
	Acrylonitrile butadiene styrene (ABS) resins	–	–	–	–	–	–	–	–	–
	Ethylene oxide	–	–	–	–	–	–	–	–	–
	Formaldehyde	–	–	–	–	–	–	–	–	–
	Ethylbenzene	–	–	–	–	–	–	–	–	–
	Phthalic anhydride	–	–	–	–	–	–	–	–	–
	Acrylonitrile	–	–	–	–	–	–	–	–	–

The following figure illustrates the evolution of the five most significant activity variables, taking the data from 1990 as base year.

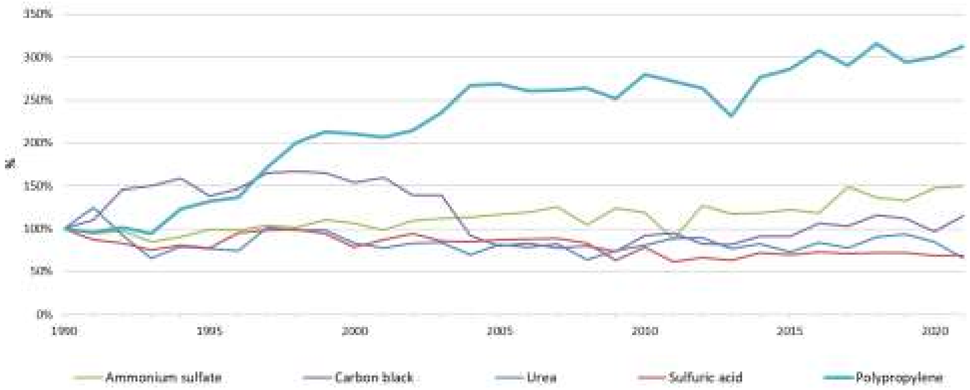


Figure 4.4.3 Evolution index of production (base year 1990) for main activities under 2B10a

Within this category, an update in the activity data for ammonium sulphate by the National Statistics Institution (INE) for 2020, results in a minor recalculation. In previous Inventory editions, emissions factors for NMVOC and HCB emissions due to the production of persistent organic pollutants were wrongly applied to some solvent production data, so in this edition their NMVOC and HCB estimations have been removed from 2B10a.

It is important to note that from 2018 onwards within chlor-alkali industry in Spain, no mercury cell facilities operate, pursuant the Best Available Technique (BAT) conclusions applicable to chlor-alkali (Implementing Decision 2013/732/EU adopted under the Directive 2010/75/EU on industrial emissions) which states that the mercury-cell process is not BAT, so that mercury-cell technique cannot be used after 11 December 2017. Therefore no Hg emissions are reported since.

In 2020, the production of polystyrene in Spain was suspended.

Regarding ammonia emissions for CO, NH_3 and NMVOC, are reported with the notation key 'NA' (not applicable) due to specific plant information for the ammonia process, as they state that the processes that only use natural gas, as both feedstock and fuel, do not emit CO, NH_3 nor NMVOC.

C. Metal Production (2C)

The Metal Production industry is a key category for its contribution to the level and the trend of the emissions of SO_2, CO, Pb, Cd, Hg, PAHs, PCBs and HCB. It is also a key category for its contribution to the level of the emissions of TSP and PCDD/PCDF

In the following pages further details are given regarding activities which are main drivers within this sector:

- The sinter production
- The pig iron production (blast furnace charging and pig iron tapping)
- The steel production (both basic oxygen and electric furnaces)
- The steel rolling (both hot and cold processes)
- The manufacturing of ferroalloys
- The aluminium production (both primary and secondary)
- The lead production (both primary and secondary)
- The zinc production (both primary and secondary)
- The copper production (both primary and secondary)
- The silicon production

C.1. Activity variables

Table 4.4.6 Summary of activity variables, data and information sources for category 2C

Activities included	Activity data	Source of information
Sinter production (**2C1**)	- Sinter production from integrated iron and steel plants (information individually treated as large point sources).	- 1990–2021: IQ.
Pig iron production (**2C1**)	- Pig iron production by plant.	- 1990–2021: IQ.
Steel production-Basic oxygen furnaces (**2C1**)	- Steel production from integrated iron and steel plants (information individually treated as large point sources).	- 1990–2021: IQ from the two existent integrated iron and steel plants.
Steel production-Electric furnaces (**2C1**)	- Steel production from non-integrated iron and steel sector (information individually treated as large point sources).	- 1990–1993: Data from MINETAD. - 1994–2021: Data from UNESID.
Steel rolling (**2C1**)	- Amounts of steel submitted to the processes of hot and cold lamination. Information from integrated and non-integrated iron and steel plants, individually treated as large point sources.	- 1990–2021: IQ from the two existent integrated iron and steel plants. - For non-integrated iron and steel sector, the Inventory uses data from: · MINETAD for 1990-1993. · UNESID for 1994-2021.
Ferroalloys production (**2C2**)	- Production by type of ferroalloy. - Carbon content of the inputs and outputs of the process.	- 1990–2021: IQ from the five existing production plants.

Activities included	Activity data	Source of information
Aluminium production (**2C3**)	- Primary production by type of process (prebaked anodes: side worked, central worked or Söderberg anodes).	Primary aluminium: 1990–2021: IQ from three existing production plants of electrolytic aluminium.
	- Secondary production.	Secondary aluminium: - 1990: Employer´s association. - 1991-1994: SGIBP-MINER. - 1995-2009: ASERAL. 2010-2021: National institute of Statistics industry product survey.
Lead production (**2C5**)	- Primary production.	Primary lead: - 1990-1991:"Spanish Industry Report 1992".
	- Secondary production.	- 1990-2014: Data from UNIPLOM, MITYC and "World Mineral Production" publication. 2015-2021: IQ from five existing production plants of secondary lead.
Zinc production (**2C6**)	- Primary production.	- 1990-2008: IQ from the existing plants and data from SGIBP. - 2009-2019: IQ from the only existing plant.
	- Secondary production.	1990-2021: IQ from one of the plants and data from U.S. Geological Survey Mineral Yearbook (2014).
Copper production (**2C7a**)	- Primary production.	- 1990-2019: IQ from the only existing plant.
	- Secondary production.	1990-2021: Data from SGIBP, UNICOBRE and U.S. Geological Survey Mineral Yearbook (2014).
Silicon production (**2C7c**)	- Silicon production	1990–2021: IQ from the only existing plant.

C.2. Methodology

Table 4.4.7 Summary of methodologies applied in category 2C

Pollutants	Tier	Methodology applied	Observations
Steel production-Sinter production (2C1) (Methodology factsheet: Sinter production)			
NMVOC	T2	- 1990–2002: EMEP/EEA Guidebook (2019) Chapter 2C1. - 2003: Measurements of emissions from the only existing plant. - 2004–2021: Derived from the measurements of 2003.	EF: - EMEP/EEA Guidebook (2019) Chapter 2C1. Table 3.2. - National derived emission factors using 2003 data.
HM (Heavy Metals)	T2/ T3	- 1990–2002: Derived from the measurements of 2003 in one of the plants/ EMEP/EEA Guidebook (2019) Chapter 2C1 for the other two plants. - 2003: Measurements of emissions from the only existing plant. - 2004–2021: Derived from the measurements of 2003.	EF: - EMEP/EEA Guidebook (2019) Chapter 2C1. Table 3.2. - National derived emission factors using 2003 data.

Pollutants	Tier	Methodology applied	Observations
TSP/PM_{10}	T2/ T3	- 1990–1997: EMEP/EEA Guidebook (2019) Chapter 2C1 for two plants. - 2000-2002: Derived from the measurements of 2003 in the only existing plant. - 2003: Measurements of emissions from the only production plant. - 2004–2021: Derived from the measurements of 2003.	EF: - EMEP/EEA Guidebook (2019) Chapter 2C1. Table 3.2. - National derived emission factors using 2003 data.
$PM_{2.5}$	T2	- 1990–1997: EMEP/EEA Guidebook (2019) Chapter 2C1 for two plants. - 2000-2021: CEPMEIP database for particles.	EF: - EMEP/EEA Guidebook (2019) Chapter 2C1. Table 3.2. - CEPMEIP data has been used to calculate the ratio between $PM_{2.5}$ and PM_{10} emissions
BC	T2	- EMEP/EEA Guidebook (2019) Chapter 2C1.	EF: - Table 3.2.
PCBs	T2	- EMEP/EEA Guidebook (2019) Chapter 2C1.	EF: - Table 3.2.
PCDD/PCDF	T2/ T3	- 1990–2002: Derived from the measurements of 2003 in one of the plants/ EMEP/EEA Guidebook (2019) Chapter 2C1. Table 3.2 for two plants. - 2003: Measurements of emissions from the only existing plant. - 2004–2021: Derived from the measurements of 2003.	- National derived emission factors using 2003 data. - EMEP/EEA Guidebook (2019) Chapter 2C1. Table 3.2
PAHs	T3	- 1990–2002: Derived from the measurements of 2003 in one of the plants. - 2003: Measurements of emissions from the only existing plant. - 2004–2021: Derived from the measurements of 2003.	- National derived emission factors using 2003 data.
Steel production-Pig iron production (2C1) (Methodology factsheet: Pig iron production)			
SO_2	T3	- 1990–2002: Derived from the measurements of 2003. - 2003: Measurements of emissions from the only existing plant. - 2004–2021: Derived from the measurements of 2003.	EF: - National derived emission factors using 2003 data.
TSP, PM_{10}, $PM_{2.5}$, BC	T3	- 2000–2002: Derived from the measurements of 2003. - 2003: Measurements of emissions of PM_{10} and TSP from the only existing plant. - 2004–2021: Derived from the measurements of 2003.	EF: - National derived emission factors for PM_{10} and TSP using 2003 data.
HM	T3	- 1990–2002: Derived from the measurements of 2003. - 2003: Measurements of emissions from the only existing plant. - 2004–2021: Derived from the measurements of 2003.	EF: - National derived emission factors using 2003 data.
PAHs	T1	- EMEP/CORINAIR Guidebook 2006.	EF: - Table 8.2.

Pollutants	Tier	Methodology applied	Observations
Steel production-Basic oxygen furnaces (2C1) (Methodology factsheet: Basic oxygen furnaces in steel plants)			
NOx, NMVOC	T2/ T3	- 1990–2002: Derived from the measurements of 2003 of one of the production plants. - 2003: Measurements of emissions from one of the existing plants. - 2004–2021 - : Derived from the measurements of 2003 of one of the existing plants.	EF: - National derived emission factors using 2003 data from one of the existing plants.
SO_2	T2/ T3	- 1990–2002: Derived from the measurements of 2003 of one of the existing plants. - 2003–2021: Measurements of emissions of SO_2 from one of the existing plants/ Derived from the measurements of 2003 for the other plants.	EF: - National derived emission factors using 2003 data from one of the existing plants.
TSP, PM_{10}	T2/ T3	- 1990–2002: Derived from the measurements of 2003. - 2003: Measurements of emissions from both existing plants. - 2004–2021: Derived from the measurements of 2003.	EF: - National derived emission factors using data from 2003.
$PM_{2.5}$, BC	T2	- CEPMEIP database for particles.	EF: CEPMEIP data has been used to calculate the ratio between: - $PM_{2.5}$ and PM_{10} emissions. - BC and $PM_{2.5}$ emissions.
CO	T3	- 1990–2002: Derived from the measurements of 2003. - 2003: Measurements of emissions from one of the existing plants. - 2004–2021: Derived from the measurements of 2003.	EF: - National derived emission factors using data from 2003.
HM	T2	- 1990–2002: Derived from the measurements of 2003. - 2003: Measurements of emissions from both existing plants. - 2004–2021: Derived from the measurements of 2003.	EF: - National derived emission factors using data from 2003.
PAHs	T3	- 1990–2002: Derived from the measurements of 2003. - 2003: Measurements of emissions from one of the existing plants. - 2004–2021: Derived from the measurements of 2003.	EF: - National derived emission factors using data from 2003.
Steel production-Electric furnaces (2C1) (Methodology factsheet: Electric arc furnaces)			
MP, PM, BC, CO, HM, PCDD/PCDF, PAHs, PCBs	T2	- EMEP/EEA Guidebook (2019) Chapter 2C1.	EF: - Table 3.19.

Pollutants	Tier	Methodology applied	Observations
Steel production-Steel rolling (2C1) (Methodology factsheet: Rolling mills)			
Hot rolling mills			
NMVOC	T2	- EMEP/EEA Guidebook (2019) Chapter 2C1.	EF: - Tables 3.22.
TSP	T2	Integrated iron and steel plants: - 1990–2002: Derived from the measurements of 2003. - 2003: Measurements of emissions. - 2004–2021: Derived from the measurements of 2003. Non-integrated iron and steel plants: - EMEP/EEA Guidebook (2019) Chapter 2C1.	EF: - National derived emission factors using data from 2003. - Table 3.22.
PM_{10}, $PM_{2.5}$	T2	Integrated iron and steel plants: - 1990–2002: Derived from the measurements of 2003. - 2003: Measurements of emissions. - 2004–2021: Derived from the measurements of 2003. Non-integrated iron and steel plants: - EMEP/EEA Guidebook (2019) Chapter 2C1.	EF: - National derived emission factors using data from 2003. Table 3.1 has been used to calculate the ratio between: - PM_{10} and TSP emissions. - $PM_{2.5}$ and PM_{10} emissions.
HM	T3	- 1990–2002: Derived from the measurements of 2003. - 2003: Measurements of emissions from one of the existing plants. - 2004–2021: Derived from the measurements of 2003**.**	EF: - National derived emission factors using data from 2003.
Cold rolling mills			
TSP	T2	- EMEP/EEA Guidebook (2019) Chapter 2C1.	EF: - Table 3.21.
PM_{10}, $PM_{2.5}$	T2	- EMEP/EEA Guidebook (2019) Chapter 2C1.	Table 3.1 has been used to calculate the ratio between: - PM_{10} and TSP emissions. - $PM_{2.5}$ and PM_{10} emissions.
Ferroalloys production (2C2) (Methodology factsheet: Ferroalloys production)			
PM, BC	T1	- EMEP/EEA Guidebook (2019) Chapter 2C2.	EF: Table 3.1.
HM	T1	- "Experiences with the Heavy Metals Inventory in Slovakia".	- Best available default emission factors.
Aluminium production (2C3) (Methodology factsheet: Aluminium production)			
Primary production			
NOx, SO_2, PM, BC, CO, PAHs	T2/ T3	- Measurements provided by each production plant.	EF: - For SO_2 and PM: national emission factors derived from the data provided by the production plants. When no information was available, the implicit emission factor of the closest year for

Pollutants	Tier	Methodology applied	Observations
		- EMEP/EEA Guidebook (2019) Chapter 2C3.	which information was available was applied. - The remaining pollutants have been estimated by default emission factors: Tables 3.2, 3.3.
Secondary production			
PM, BC, PCDD/PCDF	T2/ T3	- EMEP/EEA Guidebook (2019) Chapter 2C3.	EF: - Table 3.4.
Lead production (2C5) (Methodology factsheet: Lead production)			
Primary production			
PM, As, Cd, Hg, Pb, Zn, PCDD/PCDF, PCBs	T2	- EMEP/EEA Guidebook (2019) Chapter 2C5.	EF: - Tables 3.2.
Secondary production			
SO_2, PM, As, Cd, Pb, Zn, PCDD/PCDF, PCBs	T2	- EMEP/EEA Guidebook (2019) Chapter 2C5.	EF: - Tables 3.5.
Zinc production (2C6) (Methodology factsheet: *Zinc production*)			
Primary production			
SO_2 , PM, Cd, Hg, Pb, Zn, PCDD/PCDF, PCBs	T2	- EMEP/EEA Guidebook (2019) Chapter 2C6.	EF: - Tables 3.3.
Secondary production			
SO_2, PM, As, Cd, Hg, Pb, Zn, PCDD/PCDF, PCBs	T2	- EMEP/EEA Guidebook (2019) Chapter 2C6.	EF: - Tables 3.5.
Copper production (2C7a) (Methodology factsheet: Copper production)			
Primary production			
SO_2, PM, As, Cd, Cu, Hg, Ni, Pb, Zn	T2/T3	- 1990-2008: Derived from measurements in the period 2009-2011 - 2009-2020: Measurements provided by the plant.	EF: - National derived emission factors using data from 2009-2011
BC, Cr, PCDD/PCDF	T2	- EMEP/EEA Guidebook (2019) Chapter 2C7a.	EF: Tables 3.2.
Secondary production			
SO_2, PM, BC As, Cd, Cu, Ni, Pb, PCDD/PCDF, PCBs	T2	- EMEP/EEA Guidebook (2019) Chapter 2C7a.	EF: - Tables 3.3.

Pollutants	Tier	Methodology applied	Observations
Silicon production (2C7c)			
SO_2, TSP	T1	- EMEP/EEA Guidebook (2019) Chapter 2C7c.	EF: Tables 3.1.

C.3. Assessment

Following the recommendation ES-2-2022-001 made by the TERT in the 2022 NECD review (pursuant to Directive (EU) 2016/2284) SO_2 and TSP emissions have been included under category 2C7c (Silicon production).

Also notation keys have been updated for particulate matter under category 2C7d, following the recommendation ES-2C7d-2022-001 made by the TERT in the 2022 NECD review (pursuant to Directive (EU) 2016/2284).

The following figure illustrates the evolution of the most important activity variables (production) included within NFR category 2C1.

Figure 4.4.4 Evolution index of activity variables of subcategory 2C1 (1990=100)

Both pig iron casting and sinter process, which have a close relationship, have suffered important variations over the time series, with the only exception in 1997 when the closure of the sinter production line in one of the two existing integrated iron and steel plants led to a rough decrease of production. In 2020 a sharp drop in production caused by the Covid-19 pandemic is noticeable: pig iron production fell by 26.5% and sinter production by 39.4%. In 2021, however, production shows a recovery back to pre-pandemic levels.

Steel production, that includes both basic oxygen and electric arc furnaces, has also undergone important variations throughout the time series, where it is worth highlighting a significant decrease since 2008, corresponding with the economic and industrial slowdowns in Spain. In 2020, because of Covid-19, there is a significant further drop by 18.8%, which reverses in 2021 when production returns to pre-pandemic values.

In addition, it is important to point out that steel production in electrical arc furnaces is the main driver of PCBs emissions within metal production industry. These estimates are based on default emissions factor from EMEP/EEA Guidebook 2019 (table 3.19, Chapter 2.C.1). Nevertheless, the Spanish Inventory has gathered measured emissions from some production plants which yield an IEF several times lower than default values, this suggesting a possible overestimation.

However, the default emission factor of EMEP/EEA Guidebook 2019 has still been used for the estimations, as currently there is no complete information on measured emissions.

Regarding the non-ferrous metallurgical industry (2C3, 2C5, 2C6 and 2C7a), the next figure shows the trend of its production.

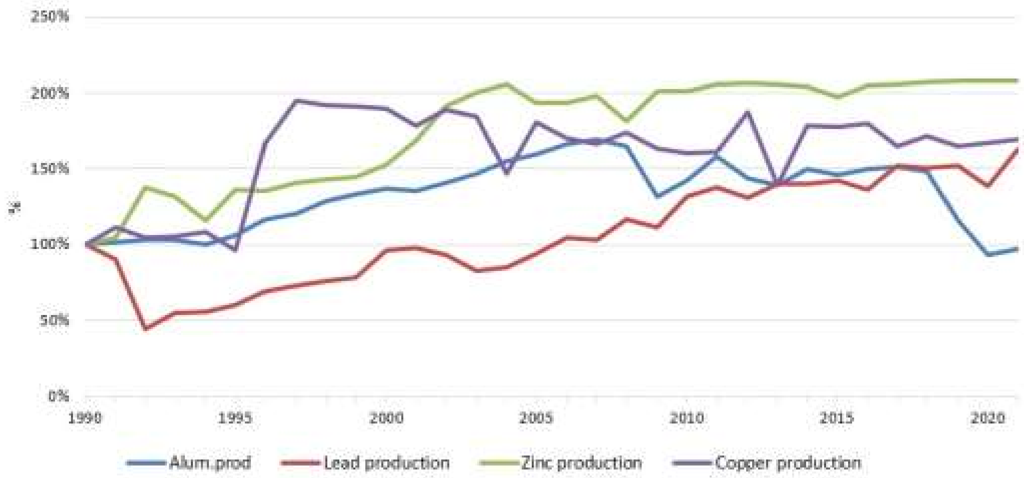


Figure 4.4.5 Evolution index of activity variables of subcategory 2C3, 2C5, 2C6 and 2C7a (1990=100)

It can be seen that aluminium production shows a progressive increase until 2007 when the trend is reversed due to the economic and industrial slowdowns in Spain. From 2011 onwards, production recovers an increasing trend. However, from 2018 a slight decline begins which becomes drastic from 2019 onwards (- 22%) when the closure of two of the production plants takes place. In 2021, a slight upturn in production is observed in the only remaining plant.

As for zinc and lead production, both present a similar trend, showing a gradual growth over time, with the exception that lead drastically decreased its production in 1992 when primary production was completely abandoned. It is also noticeable the upturn in lead production in 2021, after suffering a decrease in 2020 caused by the COVID-19 pandemic.

Finally, in terms of the evolution of copper, a strong increase has been observed since 1995, for which primary production is responsible. Since then, great variations have been observed throughout the Inventory period.

D. Solvent use (2D)

Solvent use sector is a key category for its contribution to the level and the trend of the emissions of NMVOC and for its contribution to the level of Hg. It represents 45.2 % of the total of Non-Methane Volatile Organic Compounds Inventory emissions in 2021.

During 2021, a recovery to previous NMVOC levels has been observed after the increase due to the use of hydroalcoholic gel during the COVID-19 pandemic.

D.1. Activity variables

Table 4.4.8 Summary of activity variables, data and information sources for category 2D

Activities included	Activity data	Source of information
Domestic solvents use including fungicides (**2D3a**)	- Spanish population	- 1990-2021: INE - 2015-2021: ESIG
Road paving with asphalt (**2D3b**)	- Consumption of hot bituminous mixtures and cutback asphalt.	- 2001, 2006-2021: “Asphalt in figures”. EAPA. - 1990-2005: estimation by interpolation based on information from ASEFMA. - 1990-2021: ratio cutback asphalt/ Cold Bituminous mixtures estimated based on ASEFMA information.
Asphalt roofing (**2D3c**)	- Bitumen products in roll.	- 1990-2021: INE.
Paint application in construction and buildings (deco-paint) Other industrial paint application (**2D3d**)	- Annual paint consumption disaggregated by sector of consumption, VOC content, density, water quantity and evolution of these characteristics by type of paint and share between water-based vs. solvent-based paint.	- 1990-2021: ASEFAPI. - 1990, 2000 and 2010: European Council of the Paint, Printing Ink and Artists Colours Industry (CEPE). - 2005, 2009: % VOC from a Spanish producer of industrial and anticorrosive coatings.
Paint application in automobiles (**2D3d**)	- Annual paint consumption for the whole sector disaggregated by subsector of consumption.	- 1990-1996: ASEFAPI. - From 1997 this information is complemented by ten IQ provided by automobile manufacturers.
Metal degreasing (**2D3e**)	- Consumption of washing and cleaning preparations, excluding those for use as soap, surface-active preparations - Solvents consumed for metal degreasing in the production processes of automobiles.	- 1990-1995: “Gross Domestic Product”. INE - 1995-2021: PRODCOM Statistics. Eurostat - From 1997 this information is complemented by ten IQ provided by automobile manufacturers.
Dry cleaning (**2D3f**)	- Solvents consumed in the installations.	- Official data in compliance with Royal Decree 117/2003-transposition of the VOC solvents emissions directive.
Chemical products (**2D3g**)	- Polyester processed in Spain.	- 1990-2008: “Gross Domestic Product”. INE - 2008-2021: INE (Industrial Product Survey).
	- Polyvinylchloride processed.	- 1990-2002: INE (Industrial Product Survey). - 2002-2005: ANAIP. - 2006-2011: National Encyclopaedia of Oil, Petrochemistry and Gas, OILGAS. - 2003-2021: FEIQUE. - 2012-2021: Catalan Statistical Institute.

Activities included	Activity data	Source of information
	- Polyurethane foam processed.	- 1990-2005: ANAIP. - 2005-2021: PRODCOM Statistics.
	- Polystyrene foams.	- 1990-2021: ANAPE.
	- Rubber manufactured.	- 1990-2021: COFACO.
	- Solvents used in the pharmaceutical sector.	- 1990-2006: Extrapolation based on annual variation of number of pharmaceutical sector employees. - 2007-2021: Official data in compliance with Royal Decree 117/2003 transposition of the VOC solvents emissions directive.
	- Paints, inks and glues manufactured.	- 1990-2021: INE (Industrial survey of companies). - 2007-2021: Official data in compliance with Royal Decree 117/2003 transposition of the VOC solvents emissions directive.
	- Leather tanning.	- 1990-2006: Extrapolation based on previous data of tanned leather (m^2) from the Spanish tanner council and other publications. - 2007-2021: Official data in compliance with Royal Decree 117/2003- transposition of the VOC solvents emissions directive.
Printing industry (**2D3h**)	- Sales of the different types of inks (paste inks, black new inks, gravure publication inks, other liquid inks, other printing inks and varnishes and sundries).	- 1990-2021: ASEFAPI - 1990, 2000, 2010, 2019 percentage of distribution of ink uses between the different printing techniques. CITEPA (France).
Other solvent use (**2D3i**)	- Glass and mineral wool production.	- 1990-1996: MINETAD statistics. - 1997-2021: IQs glass manufacturing plants.
	- Solvents consumed in sunflower, rapeseed, soy and olive oil production. - Amount of oil produced.	- 1990-2021: AFOEX. - 1990-2021: ANEO and AICA.
	- Creosote and organic solvents used in the treatment of wood.	- 1990-1998: AITIM. - 1999-2021: ANEPROMA.
	- Number of vehicles manufactured.	- IQ from vehicles manufacturing plants.
	- Glues application	- 1990-2021: INE (Industrial survey of companies).

D.2. Methodology

Table 4.4.9 Summary of methodologies applied in category 2D

Pollutants	Tier	Methodology applied	Observations
Domestic solvent use including fungicides (2D3a) (Methodological factsheets of a part of the category: Domestic solvent use **;** Mercury emission from lamps)			
NMVOC, Hg	T2	Inventory Team expert judgment and EMEP/EEA Guidebook (2019). Chapter 2D3a.	EF (expressed by habitant): NMVOC - 2015 and 2018-2021: Country-specific emission factor provided by ESIG. Ethanol is included and only 30% of data corresponding to the coating applications have been included, as agreed with the TERT during the NECD 2022 Inventory review. - 2006-2014 and 2016-2017: Weighting between years with data estimated by ESIG. - 1990-2005: Average EF per capita from ESIG data for the years 2015, 2018 and 2019. AD used is the population from Spain (excluding the Canary islands). This is the reason why It is represented as NA in

Pollutants	Tier	Methodology applied	Observations
			NECD Annex I tables. It is not possible to relate it with activity units in the NFR tables (kt of solvents used). Hg - 1990-2004: EMEP/EEA 2016,Table 3.6 - 2005-2021: Country specific factor from AMBILAMP.
Road paving with asphalt (2D3b) (Methodological factsheets of a part of the category: Road paving with asphalt)			
$PM_{2.5}$, PM_{10}, TSP, BC, NMVOC	T2	EMEP/EEA Guidebook (2019). Chapter 2D3b.	EF: - Tables 3.2, 3.3 and 3.4. Abatement: - Tables 3.5, 3.6.
Asphalt roofing (2D3c) (Methodological factsheets of a part of the category: Manufacture of asphalt roofing for waterproofing)			
$PM_{2.5}$, PM_{10}, TSP, BC, NMVOC	T1	EMEP/EEA Guidebook (2019). Chapter 2D3c.	EF: - Table 3.1.
Other industrial paint application (2D3d) (Methodological factsheets of a part of the category: Paint application in car manufacturing; Paint application in coil coating; Paint application in shipbuilding**;** Paint application in car repairing and Paint application in wood**)**			
NMVOC	T2	Inventory Team expert judgment and EMEP/EEA Guidebook (2019). Chapter 2D3d.	EF: - Estimation made by the Inventory team based on default values progressively reduced along the time series according to threshold VOC concentrations established by the Royal Decree 227/2006, information from CEPE on distribution of the consumption by type of paint and VOC contents for each type and degree of penetration of abatement techniques assumed for every year. - Tables 3.8, 3.9 and 3.15. Abatement: - Tables 3.20.
Paint application in construction and buildings (deco-paint) (2D3d)			
NMVOC	T2	Inventory Team expert judgment.	EF: - Estimation made by the Inventory team based on threshold VOC concentrations established by the Royal Decree 227/2006, information from CEPE on distribution of the consumption by type of paint and VOC contents for each type, and share between water-based vs. solvent-based paint. The percentage of ecolabel volatile content between 2010 and 2020 has been incorporated to the EF.
Paint application in the manufacture of automobiles (2D3d)			
NMVOC	T2	Solvent balance from 12 IQ.	Emissions: - Emission calculated by a solvent balance (solvent consumed – solvent recovery).
Metal degreasing (2D3e)			
NMVOC	T2	- Inventory Team expert judgment. - From 1997 IQ to automobiles manufacturers.	EF: Threshold VOC concentrations established by the Royal Decree 227/2006 AD: - PRODCOM EUROSTAT data
Dry cleaning (2D3f) (Methodological factsheets of a part of the category: Dry cleaning)			
NMVOC	T2	Inventory Team expert judgment.	Official data in compliance with Royal Decree 117/2003-transposition of the VOC solvents emissions directive.

Pollutants	Tier	Methodology applied	Observations
Chemical products (2D3g) (Methodological factsheets of a part of the category: Use of solvents in the manufacture or treatment of chemical products; Solvents use in pharmaceutical products manufacturing; Solvents use in leather tanning)			
Chemical products (2D3g) Polyester processing			
NMVOC	T1	EMEP/EEA Guidebook (2019). Chapter 2D3g.	EF: - Table 3-1.
Chemical products (2D3g) Polyvinylchloride processing			
NMVOC	T1	EMEP/EEA Guidebook (2019). Chapter 2D3g.	EF: - Table 3-1.
Chemical products (2D3g) Polyurethane foam processing			
NMVOC	T2	EMEP/EEA Guidebook (2019). Chapter 2D3g.	EF: - Table 3-3.
Chemical products (2D3g) Rubber processing			
NMVOC	T2	EMEP/EEA Guidebook (2019). Chapter 2D3g.	EF: - Tables 3-5 and 3-6. Abatement: - Table 3-21 from 1999 and 2003 onwards, VOC solvents Directive and Royal Decree 117/2003 dates of entry into force (Process optimization and new processes).
Chemical products (2D3g) Pharmaceutical products manufacturing			
NMVOC	T2	Inventory Team expert judgment.	Official data in compliance with Royal Decree 117/2003-transposition of the VOC solvents emissions directive.
Chemical products (2D3g) Paints, inks and glues manufacturing			
NMVOC	T2	EMEP/EEA Guidebook (2019). Chapter 2D3g.	EF: - Table 3-11. Abatement: - Table 3-20 from 2003 onwards, Royal Decree 117/2003 dates of entry into force (Use of good practices). - Abatement techniques applied to paint manufactures (Table 3-20) from 2007 onwards, Royal Decree 227/2006 dates of entry into force and reduction evidence based on Royal Decree 117/2003-transposition of the VOC solvents emissions directive data collection (Improved production mix).
Chemical products (2D3g) Leather tanning			
NMVOC	T2	Inventory Team expert judgment.	Official data in compliance with Royal Decree 117/2003-transposition of the VOC solvents emissions directive.
Chemical products (2D3h) Printing industry (Methodological factsheets of a part of the category: Solvent use in printing industry)			
NMVOC	T2	- ASEFAPI. - EMEP/EEA Guidebook (2019). Chapter 2D3g.	EF: - EMEP/EEA Guidebook (2019) Tables 3-2, to 3-6 from 1990 to 2002. Onwards, EF based on threshold VOC concentrations established by the Royal Decree 117/2003-transposition of the VOC solvents emissions directive.
Other solvents use (2D3i) Glass and mineral wool enduction (Methodological factsheets of a part of the category: Solvents use in glass and mineral wool enduction)			
NMVOC	T2	EMEP/EEA Guidebook (2019). Chapter 2D3i, 2G.	EF: - Tables 3-2 and Table 3-3.

Pollutants	Tier	Methodology applied	Observations
Other solvents use (2D3i) Fat, edible and non-edible oil extraction (Methodological factsheets of a part of the category: Extraction of fats and oils)			
NMVOC	T2	Country specific emission factors based on solvents consumed and tonnes of seeds treated.	EF expressed in kg NMVOC/tonnes of seeds. For chemical extraction of olive-pomace oil, EF 2003 onwards based on threshold VOC concentrations established by the Royal Decree 117/2003-transposition of the VOC solvents emissions directive and its data collection.
Other solvents use (2D3i) Preservation of wood			
NMVOC, BaP, BbF, BkF, IcP, PAH	T2	Inventory Team expert judgment and EMEP/EEA Guidebook (2019). Chapter 2D3i, 2G.	EF: - Estimation made by the Inventory team using data from ANEPROMA.
Other solvents use (2D3i) Underseal treatment and conservation of vehicles			
NMVOC	T2	Mass balance.	- Mass balance based on solvents consumed in IQs from vehicles manufacturing plants.
Application of glues and adhesives (2D3i)			
NMVOC	T2	EMEP/EEA Guidebook (2019). Chapter 2D3i.	EF: - Estimation made by the Inventory team based on default values (Table 3-11) which are progressively reduced along the time series according to threshold VOC concentrations established by the Royal Decree 227/2006 and the degree of penetration of abatement techniques assumed for every year.

D.3. Assessment

Following the recommendation ES-2D3a-2022-0001 made by the TERT during the 2022 NECD review (pursuant to Directive (EU) 2016/2284), in this edition the revised estimate for category 2D3a Domestic solvent use that was agreed with the Technical Expert Review Team has been incorporated. 2D3a estimations include ethanol all over the series, and only include 30% of coating data provided by ESIG (following the Annex 1 Mapping table of the EMEP/EEA Guidebook 2019). This has resulted in a major recalculation, becoming 2D3a the main activity, representing 20.67% of the total NMVOC emissions of the inventory in 2021.

On the other hand, as described in the previous edition of the IIR, there was a potential overestimation of NMVOC emissions from the polyester industry (SNAP 6-3-1) within the 2D3g sub-activity. This overestimation was due to the fact that the AD used was based on data from the survey of the Chemical Industry of Spain (1990-2005) and the industrial products survey from INE (2008 onwards). However, the way data were added and reported by INE followed changing criteria, and had gaps in several years due to confidentiality reasons, and thus the interpolation made was incorrect and led to an overestimation of the AD. Data for PET, the main polyester, has been used to reconstruct the series.

Furthermore, following the recommendation ES-2D3f-2021-0001 made by the TERT during the 2022 NECD review (pursuant to Directive (EU) 2016/2284), the 2D3f activity methodology has been updated from T1 to T2 producing a small recalculation into estimates with little relevance.

Anyway, a slowdown compared to 2018 NMVOC emissions level can be observed with the 2020 peak exception due to hydrogel use into the pandemic context.

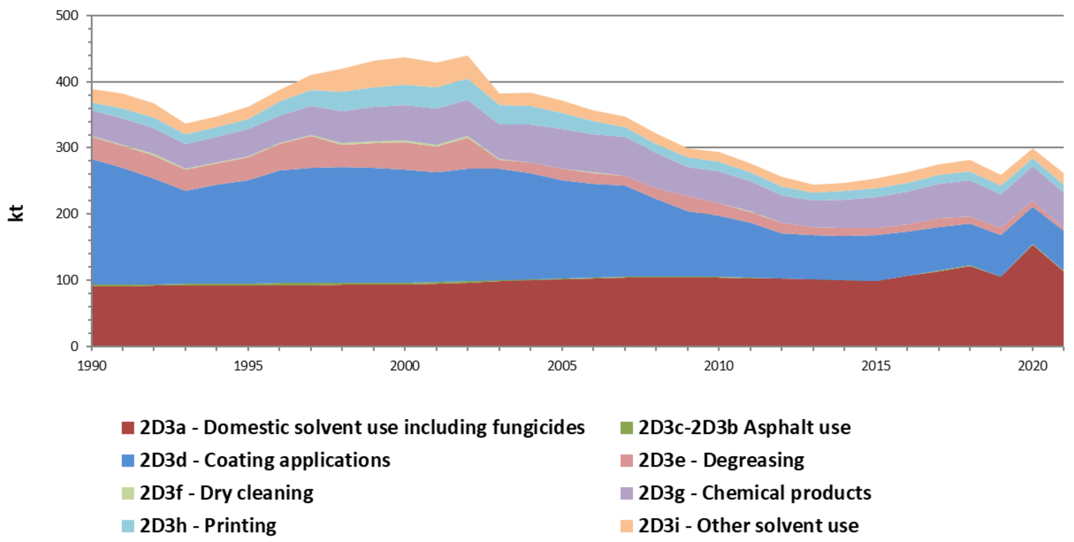


Figure 4.4.6 Distribution of NMVOC emissions in subcategories 2D

The following figure illustrates more clearly the new balance of each subcategory under 2D for the year 2021.

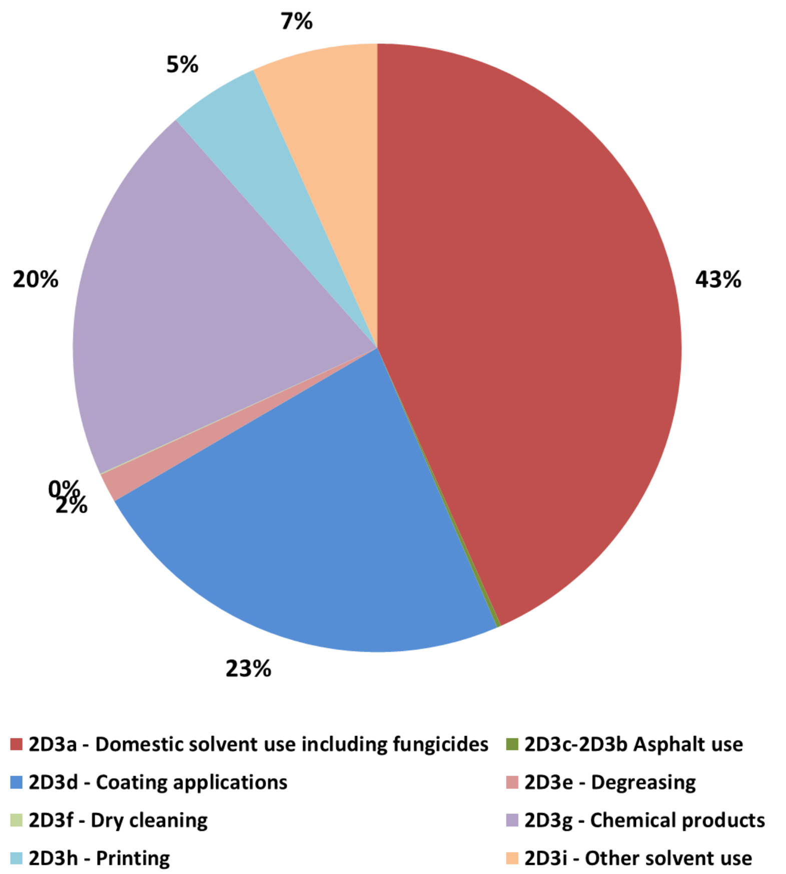


Figure 4.4.7 Distribution of NMVOC emissions in 2D for the year 2021

Because of 2D3a technical correction, a notable recalculation in the entire NMVOC series corresponding to activity 2D can be seen, which has affected all the aforementioned sub-activities (See section 4.5 Recalculations).

E. Other industrial processes and product use (2G+2H+2I+2J+2K+2L)

This group of NFR categories is significant for its emissions of NMVOC, SO_2, $PM_{2.5}$, PM_{10}, Cadmium and PCB, being key category for its contribution to the level and the trend. It is as well key category to the level of TSP emissions. The main activities encompassed within this category are:

- Tobacco consumption
- Fireworks
- Manufacturing of paper pulp and paperboard.
- Fermentation processes in the food and beverage industry (bread, biscuits, sugar, coffee roasting, wine, and spirits).
- Consumption of POPs and heavy metals

E.1. Activity variables

Table 4.4.10 Summary of activity variables, data and information sources for category 2G+2H+2I+2J+2K+2L

Activities included	Activity data	Source of information
Tobacco (**2G**)	- Total tobacco consumption.	- Eurostat data.
Fireworks (**2G**)	- Fireworks used in Spain.	- Eurostat data.
Chipboard (**2H1**)	- Chipboard production.	- 1991-1996: Sub-Directorate General for Basic and processing Industries at the Ministry of Industry and Energy. - Rest of years in the time series: ASPAPEL.
Paper pulp production (**2H1**)	- Paper pulp production by type of process (kraft process, acid sulphite process, neutral sulphite and semi-chemical process).	- IQ from 8 production plants. - 2021 cease production of acid sulphite process
Manufacture of bread and other food products (**2H2**)	- Production of bread, biscuits, sugar and coffee roasting.	Bread, Biscuits - 1990-1994: Overlap technique following the trend published in “La Alimentación en España” (MITECO). - 1995-2021: INE’s Industrial Survey. Coffee roasting: - 1990-2021: INE’s Industrial Survey. Sugar: - 1990-2009: INE’s Industrial Survey. - 2010-2021: IQ from production plants.
Manufacture of wine, beer and spirits (**2H2**)	- Production of wine (white, red and rose), beer and spirits (whisky, brandy, others).	- 1990-1994: Overlap technique following the trend published in Statistical Yearbook of MITEC or “La Alimentación en España” (MITECO). - 1995 -2021: INE’s Industrial Survey.
Wood processing (**2I**)	- Wood-board processed products.	- FAOSTAT. - Data provided by sector facilities.
Consumption of POPs and heavy metals (**2K**)	- Electrical equipment manufactured or contaminated with PCBs that have been destroyed	- 1990-1997: Spanish Population (INE) - 1998-2021: Data of electrical equipment with PCBs and amount of dielectric fluid, and amounts yearly decontaminated or disposed of,

Activities included	Activity data	Source of information
and Heavy Metals **(2J)**		provided by SGEC pursuant to Royal Decree 1378/1999.
Refrigeration products (**2L**)	- Tonnes of NH_3 used in refrigerating industry.	- Data provided by sector facilities.

E.2. Methodology

Table 4.4.11 Summary of methodologies applied in category 2G+2H+2I+2J+2K+2L

Pollutants	Tier	Methodology applied	Observations
Tobacco (2G) (Methodological factsheets of a part of the category: Tobacco combustion)			
NOx, NMVOC, NH_3, PM, BC, CO, Cd, Cu, Ni, Zn, PCDD/PCDF, PAHs	T2	- EMEP/EEA Guidebook (2019). Chapter 2.D3.i.	EF: - Table 3.15.
Fireworks (2G) (Methodological factsheets of a part of the category: Use of pyrotechnical products)			
NOx, SO_2, PM, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Zn	T2	- EMEP/EEA Guidebook (2019). Chapter 2.D3.i.	EF: - Table 3.14.
Chipboard (2H1)			
NMVOC	T2	- EMEP/EEA Guidebook (2019). Chapter 2H1.	EF: - Table 3.4.
Paper pulp production (2H1)			
NOx, NMVOC, SO_2, PM	T2	- EMEP/EEA Guidebook (2019). Chapter 2H1.	EF: - Table 3.2, 3.3.
Manufacture of bread and other food products (2H2)			
NMVOC	T2	- EMEP/EEA Guidebook (2019). Chapter 2H2.	EF: - Table 3.11, 3.18, 3.20, 3.23.
Manufacture of wine, beer and spirits (2H2)			
NMVOC	T2	- EMEP/EEA Guidebook (2019). Chapter 2H2.	EF: - Table 3.25, 3.26, 3.27, 3.29, 3.31, 3.32.
Wood processing (2I)			
TSP	T2	- EMEP/EEA Guidebook (2019). Chapter 2I.	- Emission factors derived from information on measurements provided by the production plants for 2016 (lineal extrapolation for the rest of the years).
Consumption of POPs and heavy metals (2K)			
PCB	T3	- EMEP/EEA Guidebook (2019). Chapter 2K.	EF: - Table 3.4
Other production, consumption, storage, transportation or handling of bulk products (2L) (Methodological factsheets of a part of the category: Use of products different from halogenated hydrocarbons for refrigeration)			

Pollutants	Tier	Methodology applied	Observations
NH_3	T2	- Inventory Team expert judgment.	- Emission factors derived from Central purchasing and services of refrigeration (ASOFRIO) based on measurements provided by the production plants.

E.3. Assessment

The main driver for NMVOC emissions is the category Food and beverage industry (2H2), as illustrated in the following figure. This subcategory is a mixture of many activities with different emissions factors, so the fluctuations in emissions are conditioned by changes in the share of each product in the total production.

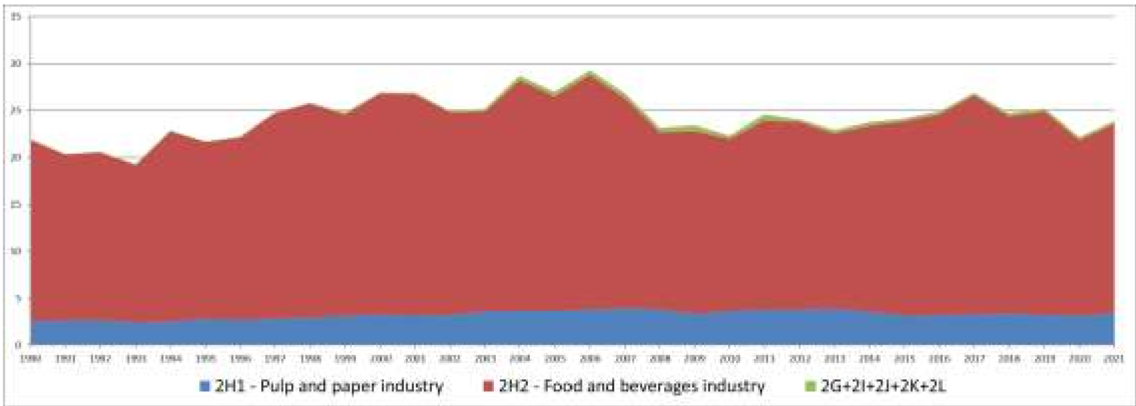


Figure 4.4.8 NMVOC emissions in categories 2H1, 2H2 and 2G+2I+2J+2K+2L

Some recalculations have taken place caused by updated data by providers for categories: 2H1 and 2H2.

Over the 2022 NECD review (pursuant to Directive (EU) 2016/2284), the TERT made some recommendations:

Regarding particulate matter emissions within category 2H2, page 9 of the EMEP/EEA 2019 Guidebook gives background emission factors that are taken from an earlier version of the Guidebook, whose original reference is not always clear, and recommends the use of default emission factors based on products, for food as well as for drinks, which is the approach followed by Spain.

Regarding SO_2 emissions within category 2H1, the method used is the Tier 2 default EF from the 2019 EMEP/EEA Guidebook (Chapter 2H1, Table 3.2) where abatement technologies considered are scrubber and electrostatic precipitator. Increase the accuracy of the method used does not seem achievable due to the fact that not all facilities provide measured emissions, and when provided they are end-of-pipe emissions and thus impossible to distinguish between combustion and process.

Regarding PCB emissions within category 2K, after consulting the SGEC, they sent an inventory of electric equipment which are produced, polluted or could containing PCB. After applying a T3 methodology to this AD, new estimates of this pollutant and category have been added to the Inventory.

4.5. Recalculations

The next table shows the main recalculations carried out in this Inventory edition, specifying pollutants affected and the reason for recalculation.

Table 4.5.1 Recalculation by pollutants – IPPU

Pollutants affected	Recalculation
2A2 Lime production	
$PM_{2.5}$, PM_{10}, TSP, BC	Recalculations due to error correction in some facilities for 2020
2A5a Quarrying and mining of minerals other than coal	
$PM_{2.5}$, PM_{10}, TSP	Recalculations due to Activity Data update from 2015 onwards from National Statistics.
2A5b Construction and demolition	
$PM_{2.5}$, PM_{10}, TSP	Recalculations due to update to EMEP/EEA GB 2019 as well as data enhancement with AD from road construction
2A5c Storage, handling and transport of mineral product	
$PM_{2.5}$, PM_{10}, TSP	Recalculations due to Activity Data update for the whole time series from National Statistics.
2B7 Soda ash production	
NH_3	Recalculations due to updating measured emissions for 2020 provided by data supplier.
2B10a Chemical industry: Other	
NMVOC, $PM_{2.5}$, PM_{10}, TSP, BC, HCB	Emissions recalculation due to: - Ammonium sulphate production: updating Activity Data information from National Statistics for 2020, which affects particulate matter emissions. - Removal of NMVOC and HCB emissions calculated with EF for production of persistent organic pollutants, wrongly applied to solvents.
2C7c Other metal production	
SO_2, TSP	New estimation according to EMEP/EEA GB 2019
2D3a Domestic solvent use	
NMVOC	Recalculation due to revised estimate after NECD 2022 review
2D3b Road paving with asphalt	
NMVOC, $PM_{2.5}$, PM_{10}, TSP, BC	Recalculations due to last year updating.
2D3d Coating applications	
NMVOC	Correction of the last year AD supplied by information focal point.
2D3e Metal Degreasing	
NMVOC	*Recalculation due to methodological change*
2D3f Dry cleaning	
NMVOC	Recalculations due to update of the information supplied by RD 117/2003
2D3g Chemical products	
NMVOC	Recalculations due to new polyester AD
2D3i Other solvent use	
NMVOC	Correction in the percentage of the market share of the sunflower oil extraction data provided by the focal point of information
2H2 Food and beverages industry	
NMVOC	Recalculations due to Activity Data update for 2020 from National Statistics.
2I Wood processing	
TSP	Update of AD for 2020
2K Consumption of POPs and Heavy Metals	
PCB	New estimate included after NECD 2022 review recommendation

As described above, major differences found between 2023 and 2022 editions for sector NFR 2 affect a wide range of pollutants. Next figures show recalculations in absolute values and in relative terms respectively for categories where either recalculation have been carried out for methodological reasons or have a significant weight within IPPU sector. Impacts of these changes have already been explained in this Chapter.

2A2 Lime production. $PM_{2.5}$, PM_{10}, TSP, BC

New estimates for 2020 caused by activity data error correction.

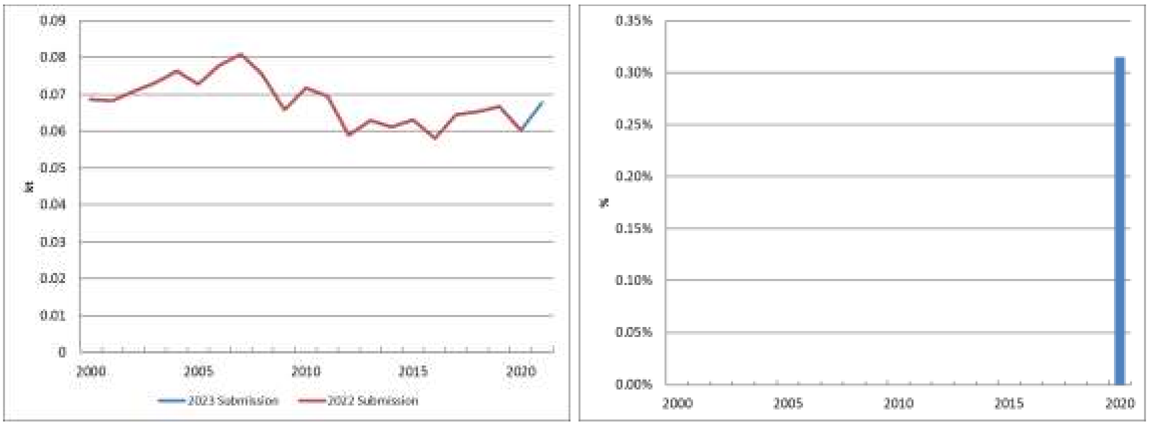


Figure 4.5.1 Evolution of the difference in 2A2 $PM_{2.5}$ emissions

2A5a Quarrying and mining of minerals other than coal. $PM_{2.5}$, PM_{10}, TSP

Activity Data update from 2015 onwards from National Statistics.

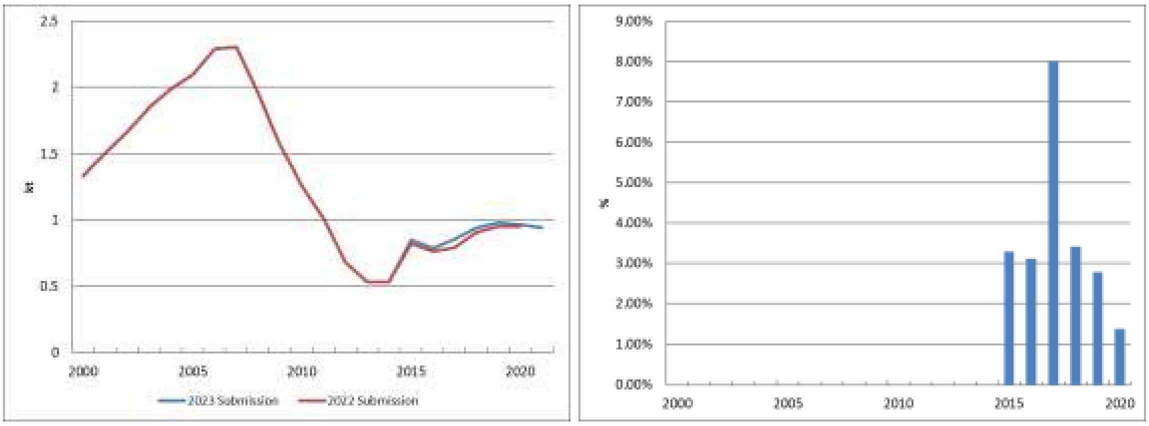


Figure 4.5.2 Evolution of the difference in 2A5a $PM_{2.5}$ emissions

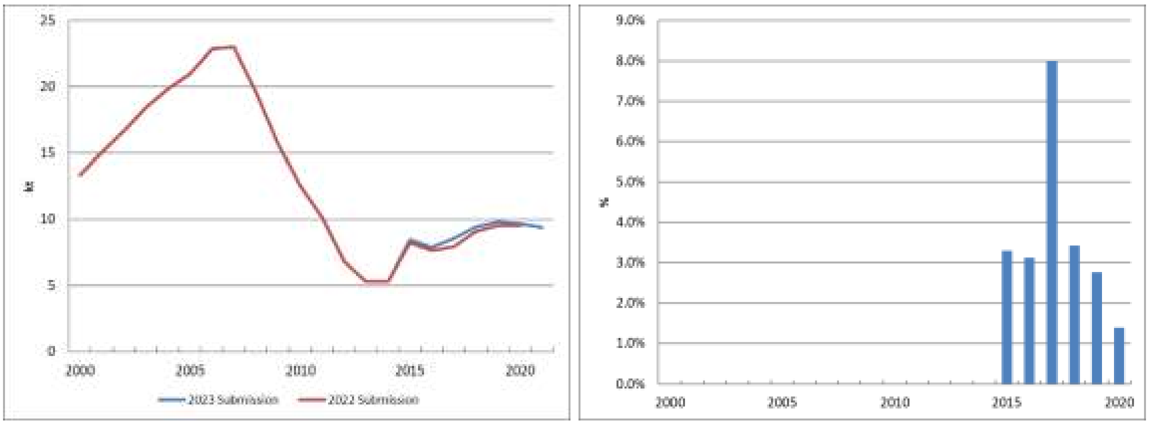


Figure 4.5.3 Evolution of the difference in 2A5a PM_{10} emissions

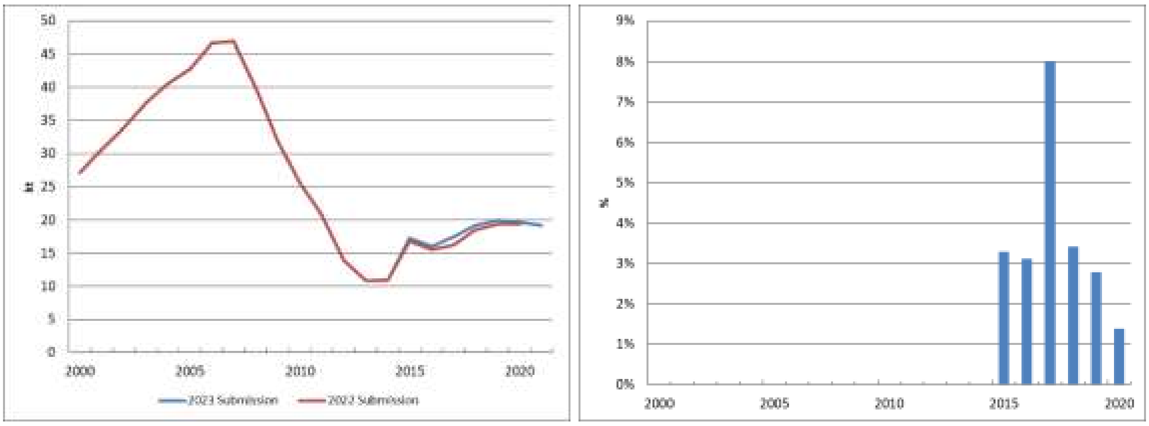


Figure 4.5.4 Evolution of the difference in 2A5a TSP emissions

2A5b Construction and demolition. $PM_{2.5}$, PM_{10}, TSP

Recalculations due to the update of EF to the EMEP/EEA GB 2019, as well as the incorporation of road construction area to Activity Data.

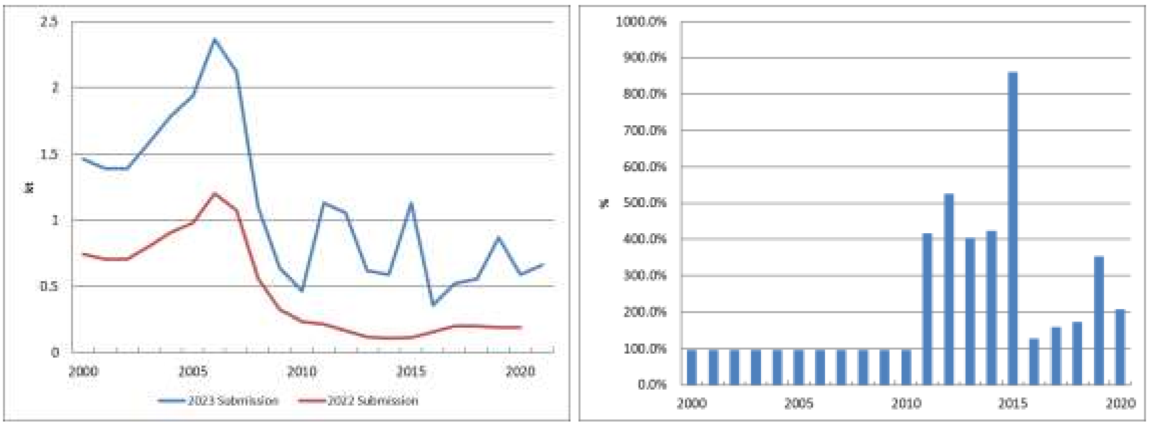


Figure 4.5.5 Evolution of the difference in 2A5b $PM_{2.5}$ emissions

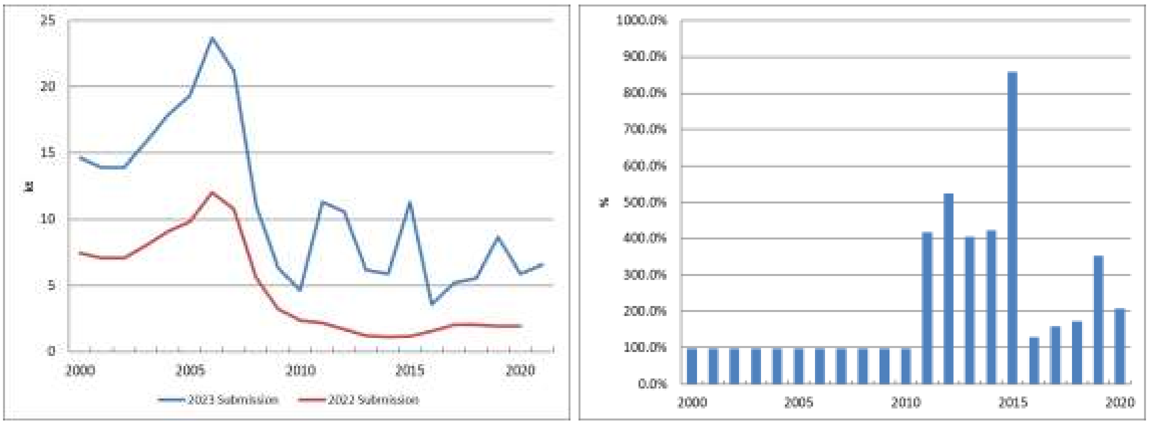


Figure 4.5.6 Evolution of the difference in 2A5b PM_{10} emissions

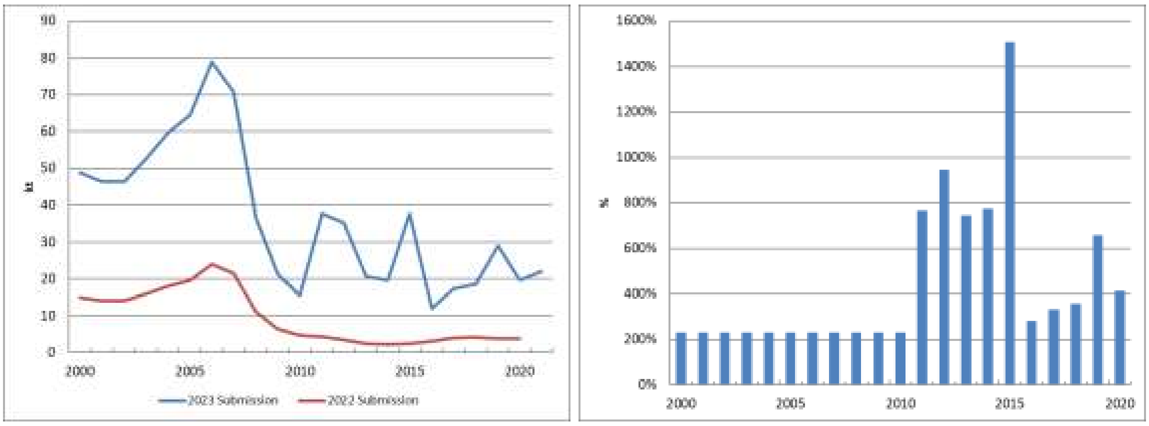


Figure 4.5.7 Evolution of the difference in 2A5b TSP emissions

2A5c Storage, handling and transport of mineral product. $PM_{2.5}$, PM_{10}, TSP

Recalculations due to Activity Data update for the whole time series from National Statistics.

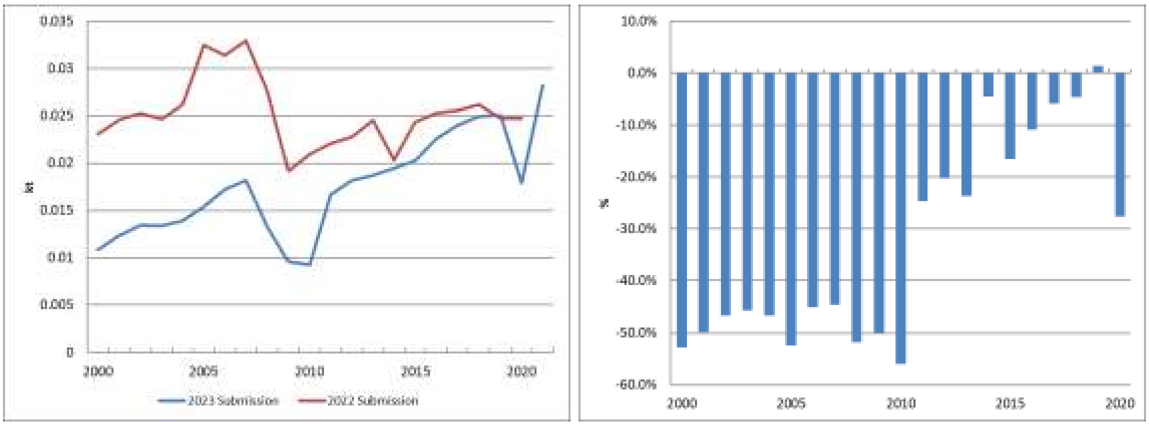


Figure 4.5.8 Evolution of the difference in 2A5c $PM_{2.5}$ emissions

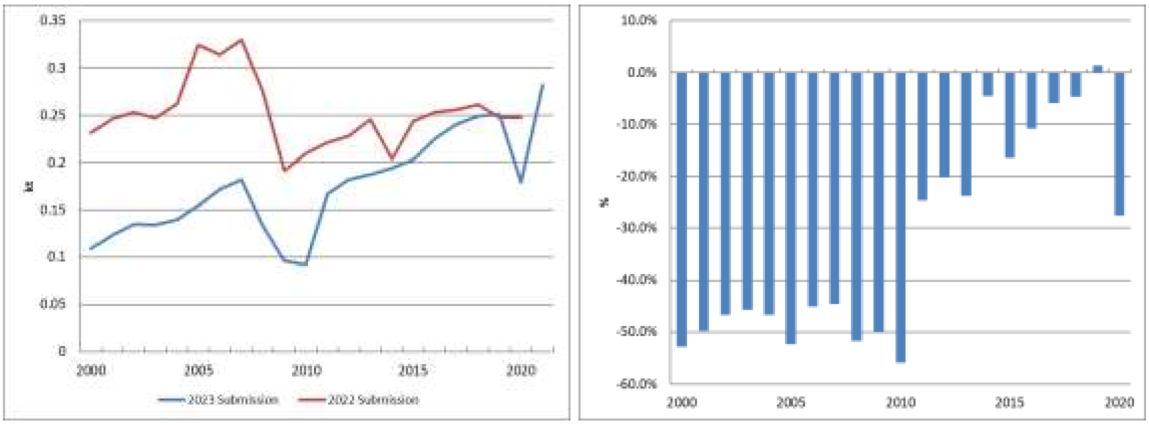


Figure 4.5.9 Evolution of the difference in 2A5c PM_{10} emissions

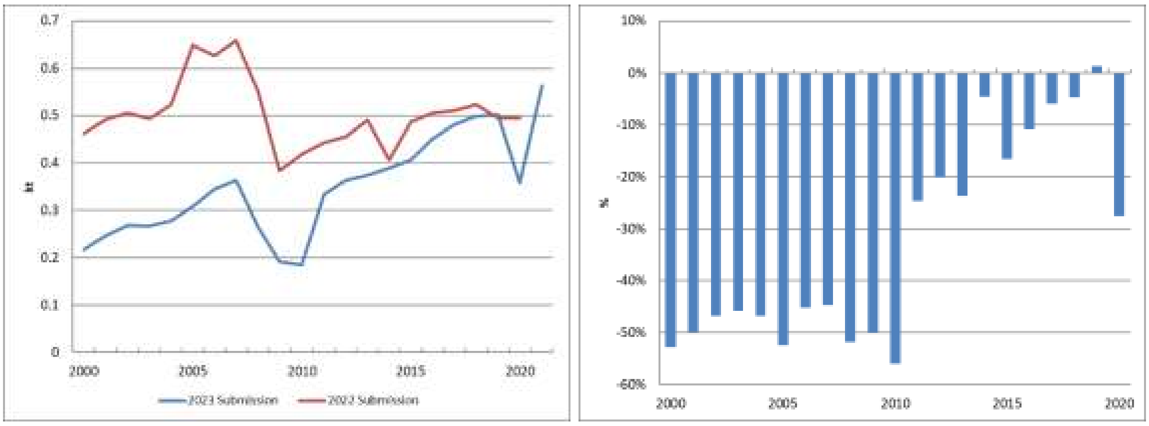


Figure 4.5.10 Evolution of the difference in 2A5c TSP emissions

2B7 Soda ash production. NH_3

New estimates for 2020 caused by measured emissions update from data provider.

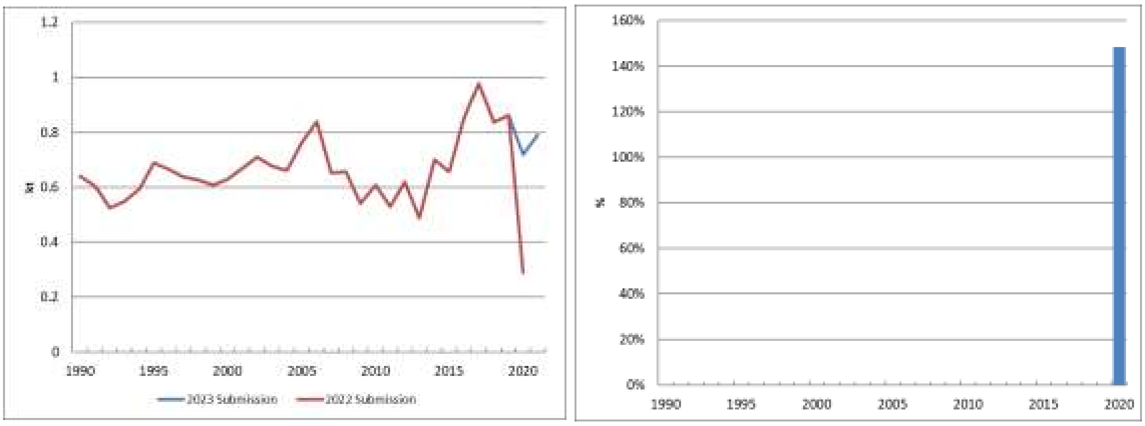


Figure 4.5.11 Evolution of the difference in 2B7 NH_3 emissions

2B10a Chemical industry: Other. NMVOC, $PM_{2.5}$, PM_{10}, TSP, BC, HCB

New estimates caused by a variety of reasons in some of the processes included within this category (see table 4.5.1 for more detail).

Due to the minor impact over emissions, it has been deemed to show only those graphs with a major relevance.

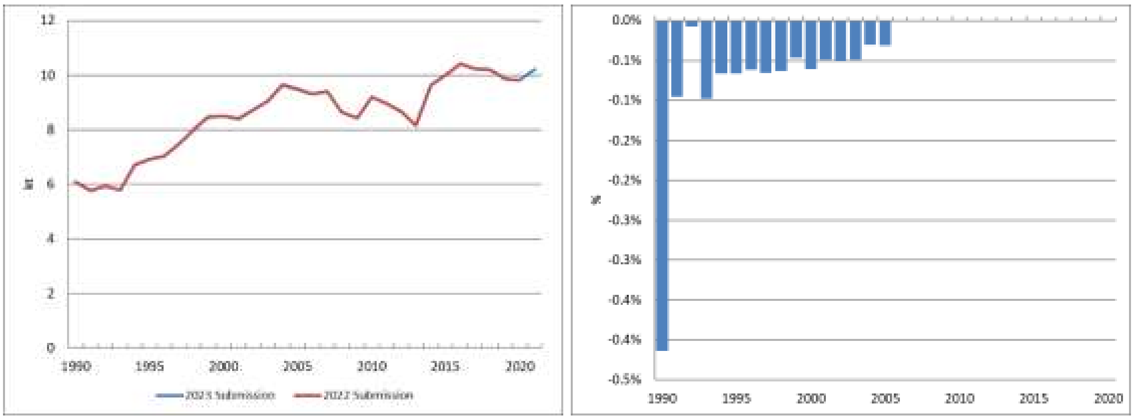


Figure 4.5.12 Evolution of the difference in 2B10a NMVOC emissions

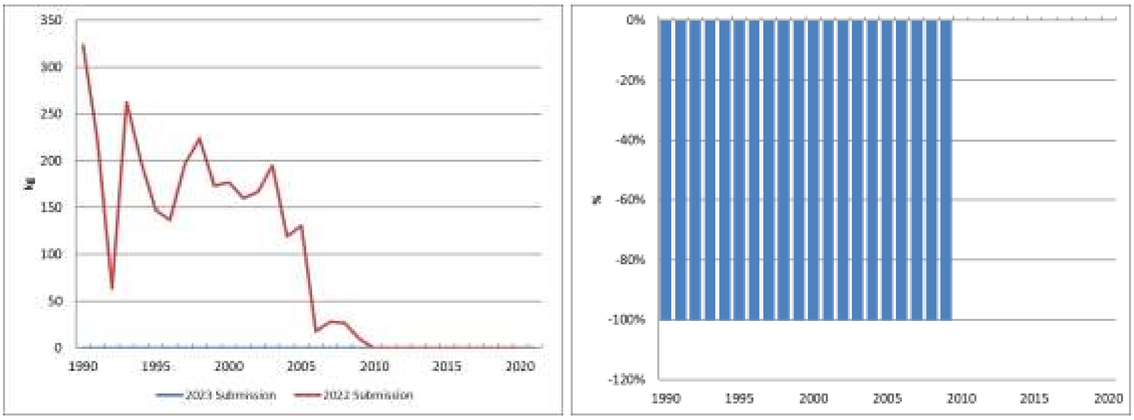


Figure 4.5.13 Evolution of the difference in 2B10a HCB emissions

2C7c Silicon production SO_2, TSP

New estimation of SO_2 and TSP according to EMEP/EEA GB 2019.

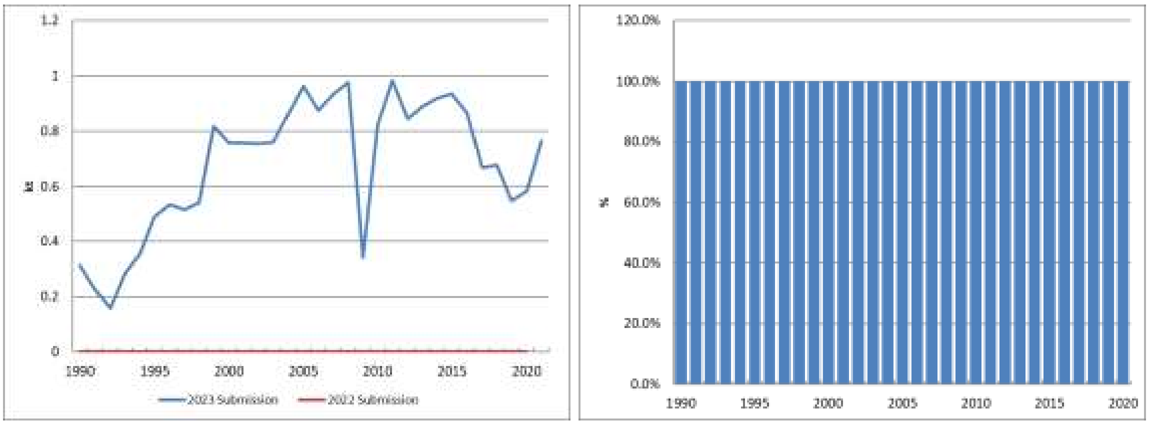


Figure 4.5.14 Evolution of the difference in 2C7c SO_2 emissions

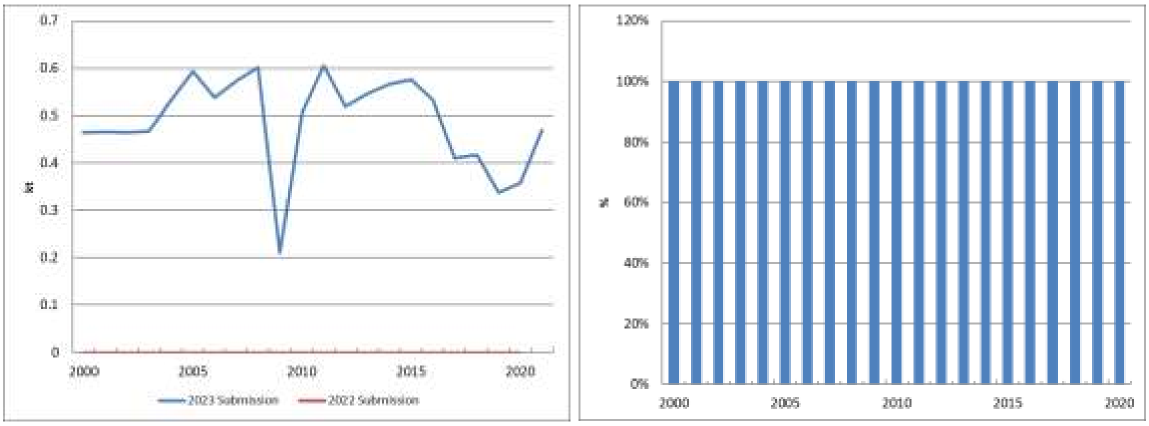


Figure 4.5.15 Evolution of the difference in 2C7c TSP emissions

2D3a Domestic solvents use. NMVOC

After a technical correction suggested by NECD review team, the Inventory has recalculated its estimates, based on ESIG country-specific emission factor.

The following figure represents the change:

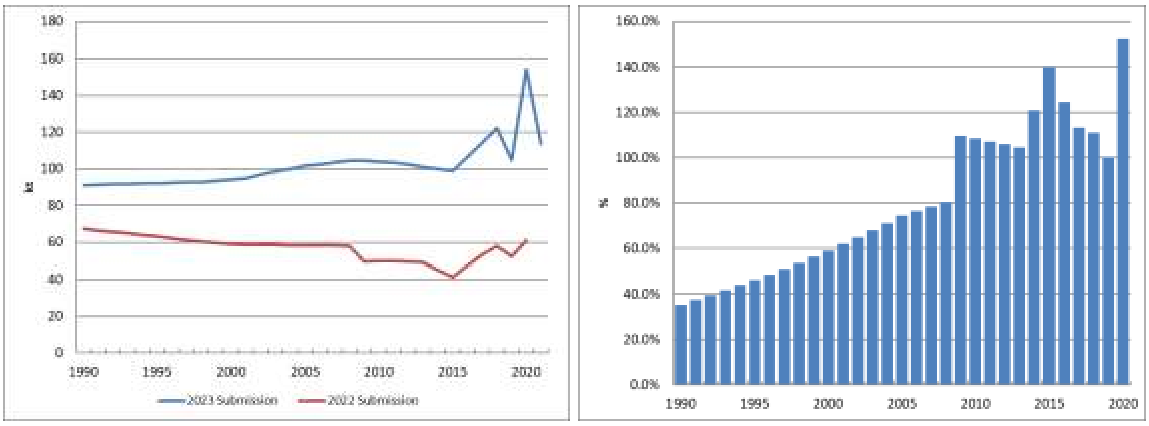


Figure 4.5.16 Evolution of the difference in 2D3a NMVOC emissions

2D3b Road paving with asphalt. NMVOC, $PM_{2.5}$, PM_{10}, TSP, BC

Recalculation into this activity due to an update of the AD provided from the focal point

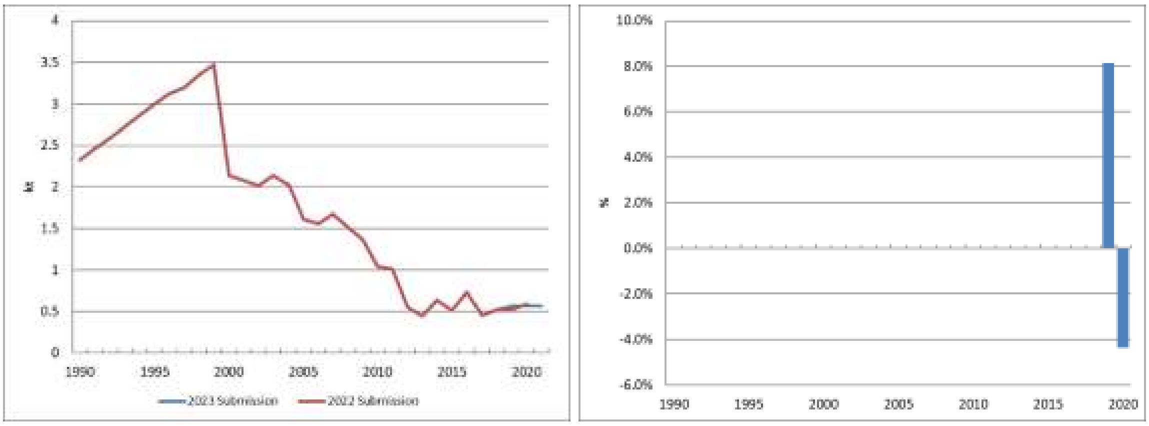


Figure 4.5.17 Evolution of the difference in 2D3b NMVOC emissions

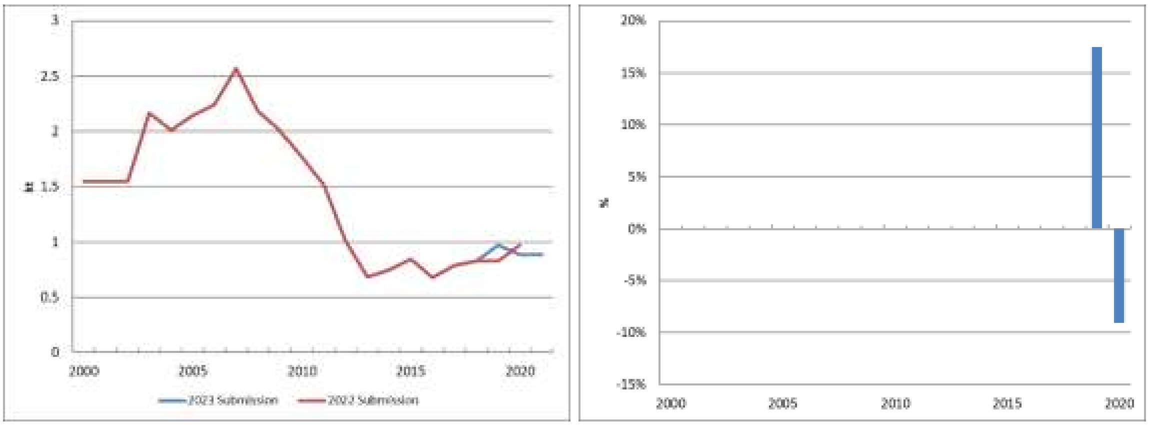


Figure 4.5.18 Evolution of the difference in 2D3b TSP emissions

2D3d Coating application. NMVOC

Recalculation into this activity due to an update of the AD provided from the focal point

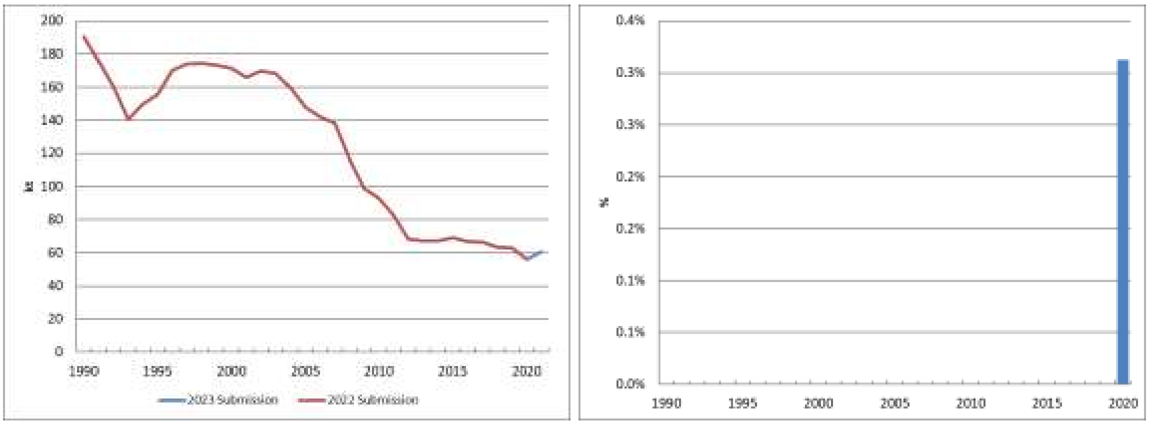


Figure 4.5.19 Evolution of the difference in 2D3d NMVOC emissions

2D3e Metal degreasing. NMVOC

This sub-activity was calculated with old activity data and methodology. The NECD review recommended to update it to Tier 2 EMEP Methodology so the entire series has been corrected.

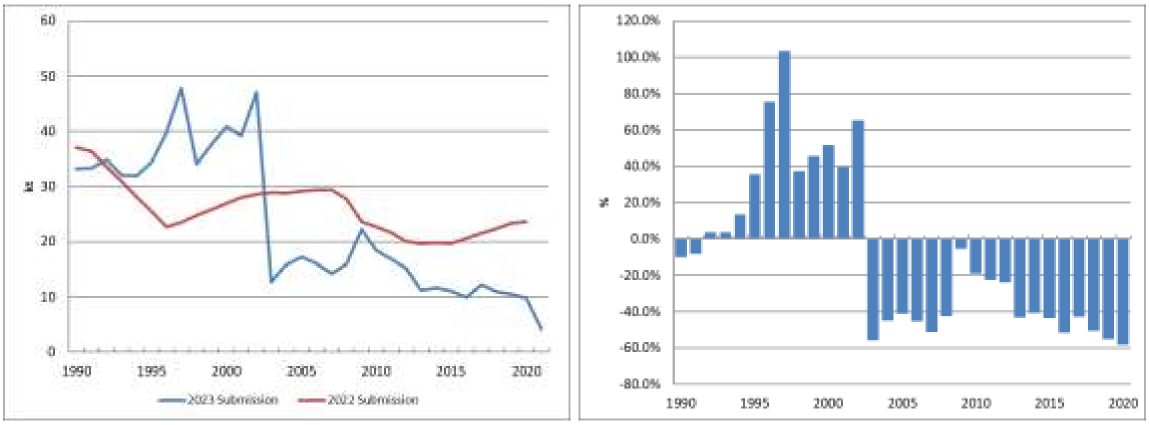


Figure 4.5.20 Evolution of the difference in 2D3e NMVOC emissions

2D3f Dry cleaning. NMVOC

Information updating from the focal point

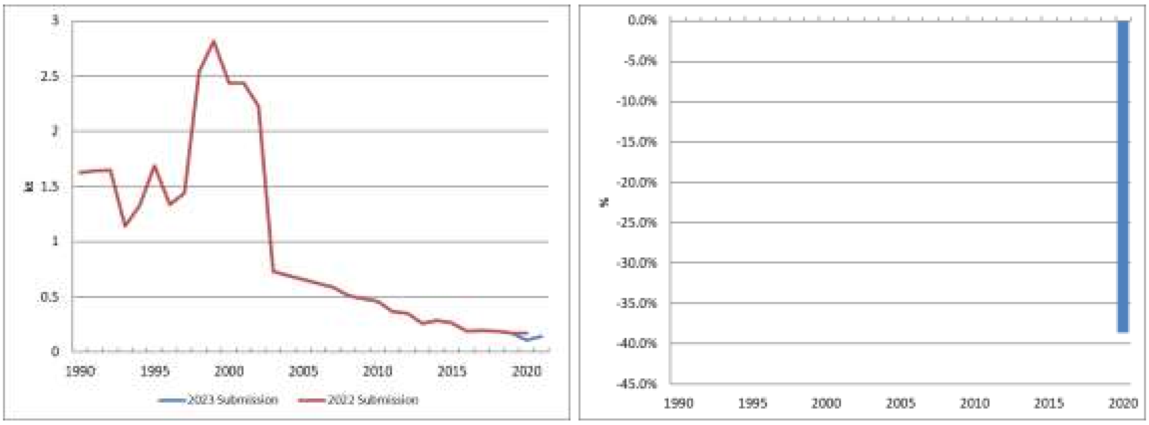


Figure 4.5.21 Evolution of the difference in 2D3f NMVOC emissions

2D3g Chemical products. NMVOC

Recalculation mainly due to change into polyester process emission methodology, because the AD was overestimated from incomplete statistic data from 2005 ahead. It is been a new methodology from the new statistical data of the 2008-2021 series.

The following figure represents the change:

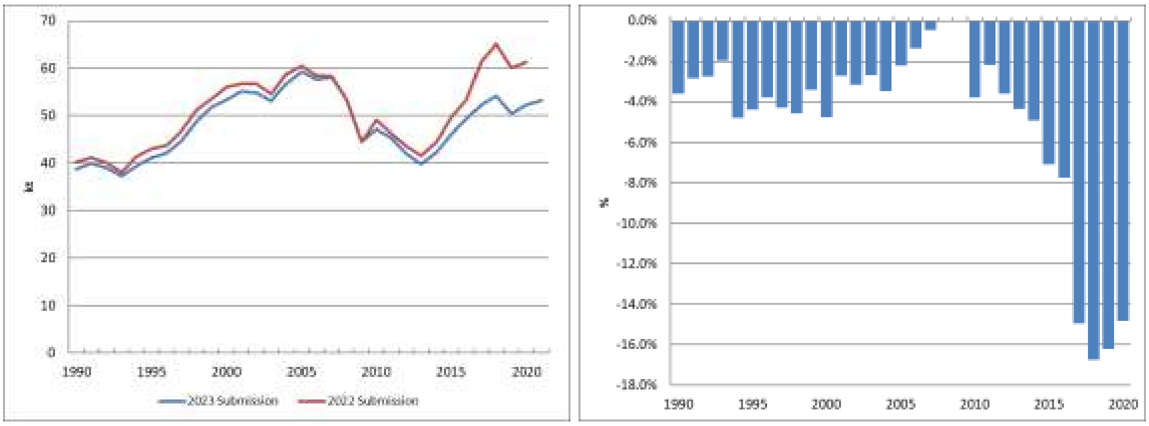


Figure 4.5.22 Evolution of the difference in 2D3g NMVOC emissions

2D3i Other solvent use. NMVOC

Recalculation due to update of the sunflower oil market share represented by the association that provides the AD.

Next figure represents the change:

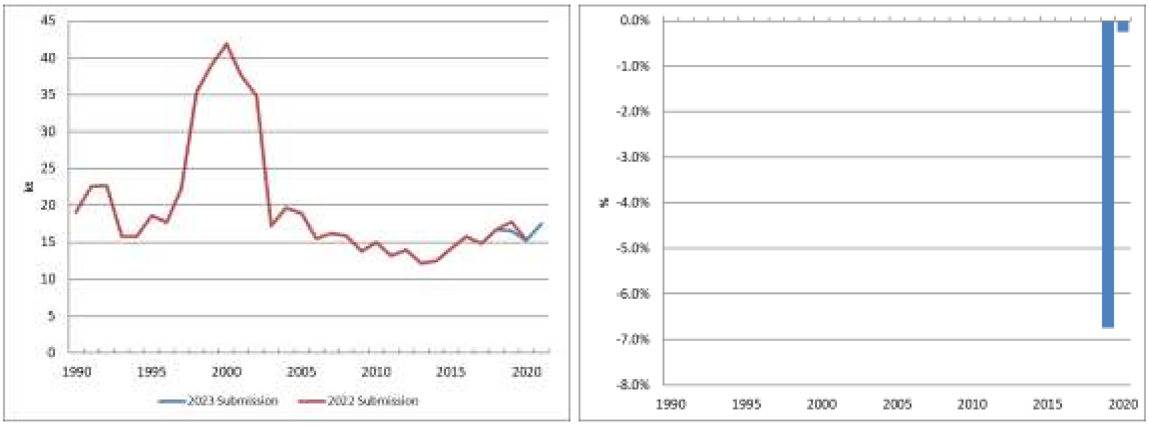


Figure 4.5.23 Evolution of the difference in 2D3i NMVOC emissions

2H2 Food beverages industry. NMVOC

Recalculations for 2020 caused by activity data update from National Statistics.

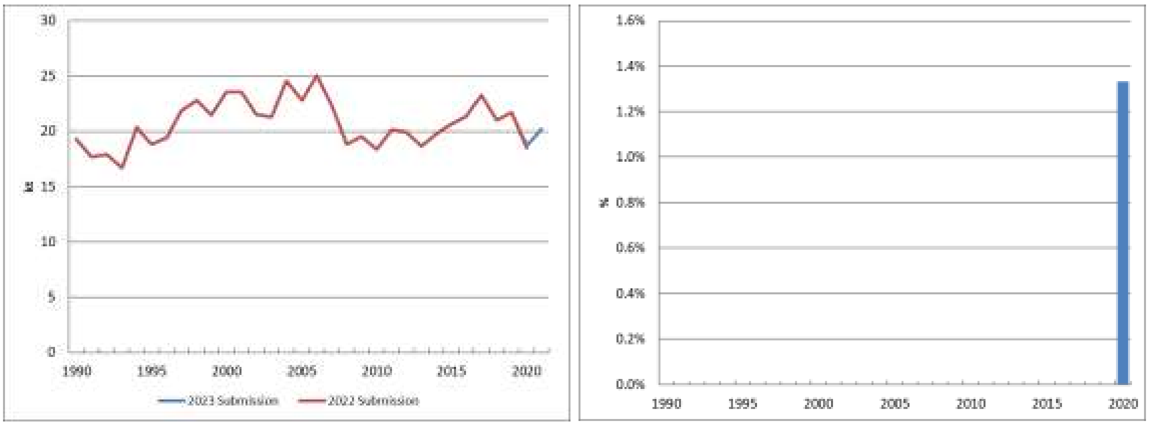


Figure 4.5.24 Evolution of the difference in 2H2 NMVOC emissions

2I Wood processing TSP

Recalculations in 2020 caused by activity data update from Statistics.

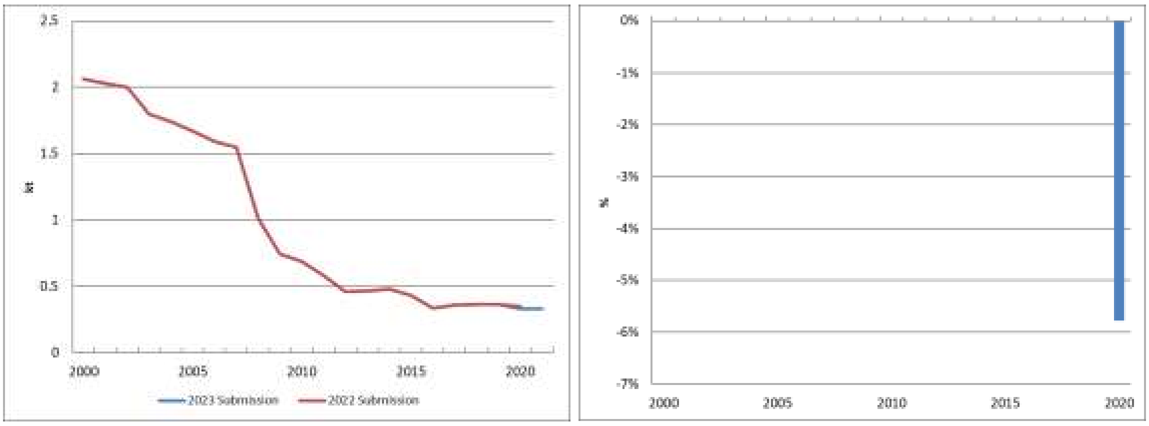


Figure 4.5.25 Evolution of the difference in 2I TSP emissions

2K Consumption of POPs and Heavy Metal. PCB

Recalculation due to review recommendation suggesting to include PCB estimates.

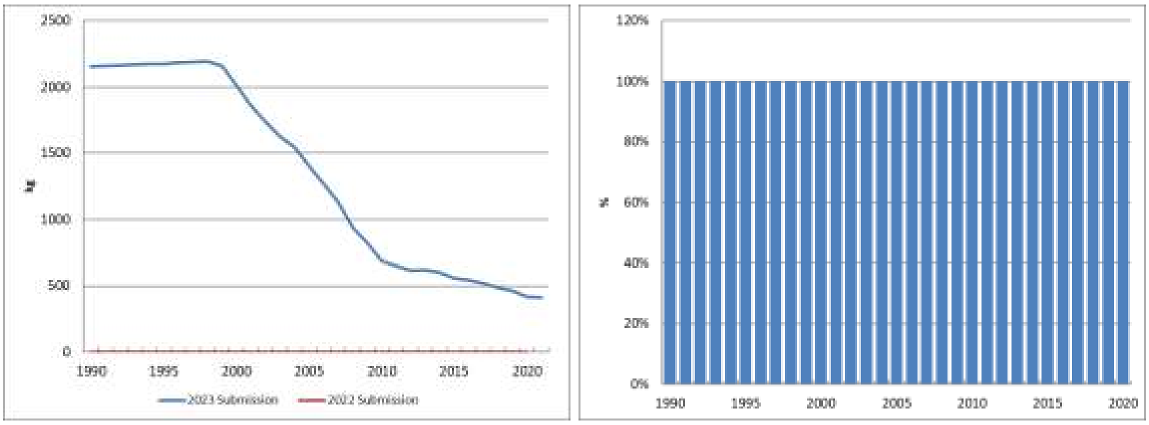


Figure 4.5.26 Evolution of the difference in 2K PCB emissions

4.6. Sector improvements

The main improvements planned for this sector are:

- 2A5b: More comprehensive data on road surface area built will continue to be gathered in order to complete activity data for the whole time series.

5. AGRICULTURE (NFR 3)

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5. AGRICULTURE (NFR 3)

Chapter updated in March, 2023.

Sector Agriculture at a glance

Agriculture sector mainly accounts for 97% of NH_3, 20% of NMVOC and 13% of NO_X inventoried emissions as expected due to the magnitude of the primary sector in Spain.

In 2021, this sector (without Canary Islands) involved 7.4 millions of cattle and equine animals heads breeding, 17.4 millions of small livestock, 33.4 millions of swine, 153.7 millions of poultry, 7.6 millions of rabbits, 17.5 million of hectares of crops susceptible to emit pollutants and 2.0 millions of tonnes of N inorganic and organic fertilizers applied to soils.

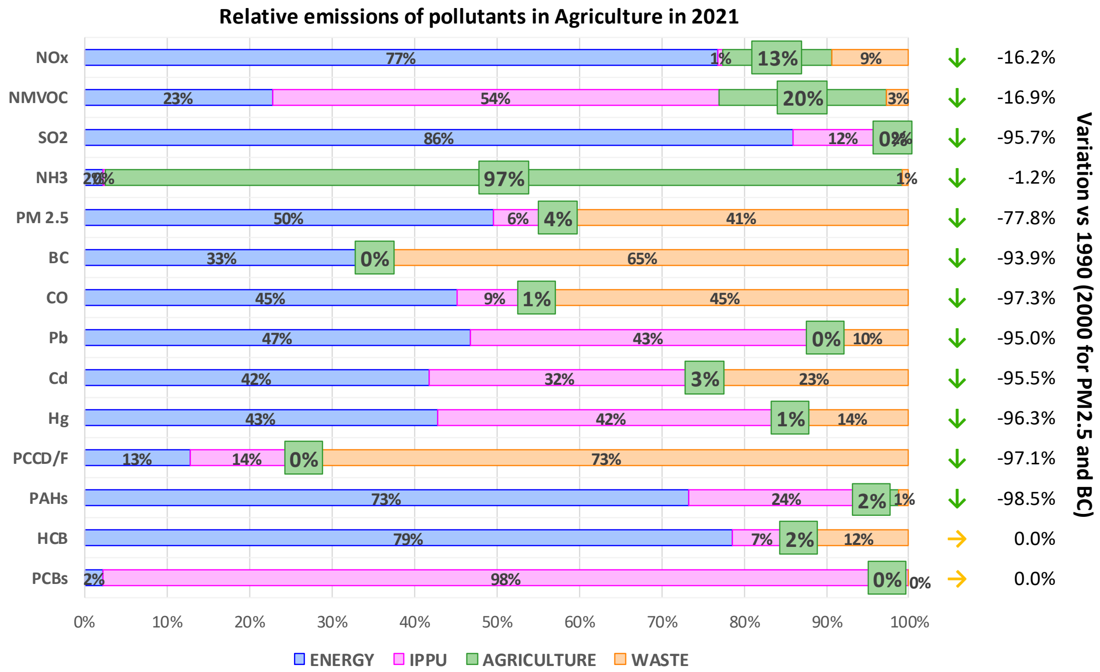


Figure 5.1.1 Relative emissions in Agriculture in 2021 and its relative variation (2021 vs. 1990)

Additionally, agriculture activities in 2021 produced 2% of the total emissions of HCB, linked to HCB impurities in pesticides use (activity 3Df), 4% of $PM_{2.5}$, 3% of Cd and 2% of PAHs emissions.

When comparing 2021 to 1990 results (2000 in case of Particulate Matter), most of the emissions trends show a clear reduction along the time series (around -80 or -90%) directly linked to the progressive abandonment of burning agricultural residues on field. Only NH_3 emissions record a downward trend of small magnitude since 1990, due to evolution of livestock and fertilization and the great importance of the agricultural sector in the country.

5.1. Sector overview

Main issues regarding gas emissions reported for this sector are shown in the following table, in particular, NFR categories and pollutants coverage, methodology approach (Method) and selection as key categories (KC).

Table 5.1.1 Coverage of NFR category in 2021

NFR Code	NFR category	Pollutants				Method	KC
		Covered	Exceptions				
			IE	NA	NE		
3B1a	Dairy cattle	NOx, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP	–	Rest of pollutants	–	T1/T2	
3B1b	Non-dairy cattle	NOx, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP	–	Rest of pollutants	–	T1/T2	
3B2	Sheep	NOx, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP	–	Rest of pollutants	–	T1/T2	
3B3	Swine	NOx, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP	–	Rest of pollutants	–	T1/T2	
3B4a	Buffalo	NO					
3B4d	Goats	NOx, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP	–	Rest of pollutants	–	T1/T2	
3B4e	Horses	NOx, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP	–	Rest of pollutants	–	T1/T2	✓
3B4f	Mules and asses	NOx, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP	–	Rest of pollutants	–	T1/T2	
3B4gi	Laying hens	NOx, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP	–	Rest of pollutants	–	T1/T2	
3B4gii	Broilers	NOx, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP	–	Rest of pollutants	–	T1/T2	
3B4giii	Turkeys	NOx, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP	–	Rest of pollutants	–	T1/T2	
3B4giv	Other poultry	NOx, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP	–	Rest of pollutants	–	T1/T2	
3B4h	Other animals-Rabbits	NOx, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP	–	Rest of pollutants	–	T1/T2	
3Da1	Inorganic N-fertilizers (also includes urea application)	NOx, NH_3	–	Rest of pollutants	–	T1/T2	
3Da2a	Animal manure applied to soils	NOx, NH_3	–	Rest of pollutants	–	T1/T2	
3Da2b	Sewage sludge applied to soils	NOx, NH_3	–	Rest of pollutants	–	T1	
3Da2c	Other organic fertilizers applied to soils (including compost)	NOx, NH_3	–	Rest of pollutants	–	T1	
3Da3	Urine, dung deposited by grazing animals	NOx, NH_3	–	Rest of pollutants	–	T1/T2	
3Da4	Crop residues applied to soils	–	–	Rest of pollutants	NH_3	–	✓
3Db	Indirect emissions from managed soils	NA					
3Dc	Farm-level agricultural operations including storage, handling, transport of agricultural products	$PM_{2.5}$, PM_{10}, TSP	–	Rest of pollutants	–	T2	
3Dd	Off-farm storage, handling, transport of bulk agricultural products	NA					
3De	Cultivated crops	NMVOC	–	Rest of pollutants	NH_3	T2	

NFR Code	NFR category	Pollutants				Method	KC
		Covered	Exceptions				
			IE	NA	NE		
3Df	Use of pesticides	HCB	–	Rest of pollutants	–	T1	
3F	Field burning of agricultural residues	NOx, NMVOC, SO_2, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, HM, PAHs, PCDD/PCDF	–	Rest of pollutants	–	T2	✓

IE: included elsewhere; NA: not applicable; NE: not estimated; NO: not occurring.

5.2. Sector analysis

Main features of Agriculture sector in Spain in 2021 are listed in the following table for reference. These main features do not consider the Canary Islands, as their territory is not under the EMEP grid.

Table 5.2.1 Sector analysis

NFR Code	NFR category	Main features (2021)	Main sources of activity data
3B1	Cattle	- 6.73 million (M) of cow heads.	- Zootechnical document[1] - Livestock Surveys[2]
3B2	Sheep	- 15.04 M of sheep heads.	- Zootechnical document[1]. - Livestock Surveys[2].
3B3	Swine	- 33.39 M of swine heads.	- Zootechnical document[1]. - Livestock Surveys[2].
3B4d	Goats	- 2.39 M of goats heads.	- Zootechnical document[1]. - Livestock Surveys[2].
3B4e **3B4f**	Equidae	- 0.64 M of equidae heads.	- Zootechnical document[1]. - REGA[3] (Livestock Farm Registry). - RIIA[3] (Animal Individual Identification Registry).
3B4g	Poultry	- 153.74 M of poultry.	- Zootechnical document[1]. - MAPA's Statistical Yearbook[4]. - REGA[3] (Livestock Farms Registry).
3B4h	Other animals-Rabbits	- 7.61 M of rabbits.*	- MAPA's Statistical Yearbook[4].
3Da1	Inorganic N-fertilizers (also includes urea application)	- 1.02 M tonnes of N inorganic fertilizers applied to soil.	- MAPA's Statistical Yearbook[4]. - Husbandry Surveys. - Nitrogen and Phosphorous Balance in Spanish Agriculture (BNPAE) Yearbook. - Zootechnical document[1]. - National Sewage Register (MITECO). - SG Circular Economy information (MITECO).
3Da2a	Animal manure applied to soils	- 0.48 M tonnes of N manure applied to soil.	
3Da2b	Sewage sludge applied to soils	- 0.02 M tonnes of N compost applied to soil.	
3Da2c	Other organic fertilizers applied to soils (compost)	- 0.02 M tonnes of N sewage sludge applied to soil.	
3Da3	Urine and dung deposited by grazing animals	- 0.32 M tonnes of N manure by grazing animals applied to soil.	

[1] See Table 5.4.3.

[2] Livestock Surveys (May and November): https://www.mapa.gob.es/es/estadistica/temas/estadisticas-agrarias/ganaderia/encuestas-ganaderas/

[3] http://www.mapa.gob.es/es/ganaderia/temas/trazabilidad-animal/registro/

[4] Ministry for Agriculture, Fisheries and Food Statistical Yearbook: http://www.mapa.gob.es/es/estadistica/temas/publicaciones/anuario-de-estadistica/

NFR Code	NFR category	Main features (2021)	Main sources of activity data
3Da4	Crop residues applied to soils	- 0.19 M tonnes of N crop residues applied to soil.*	
3Dc	Farm-level agricultural operations	- 17.55 M hectares of crops Surface susceptible to emit PM.*	- MAPA's Statistical Yearbook. - Nitrogen and Phosphorous Balance in Spanish Agriculture (BNPAE) Yearbook.
3De	Cultivated crops	- 10.30 M hectares of crops surface susceptible to emit NMVOC.*	- MAPA's Statistical Yearbook.
3Df	Use of pesticides	- 17.86 tonnes of active substances with HCB impurities.	- MAPA (Ministry for Agriculture, Fisheries and Food).
3F	Field burning of agricultural residues	- 271.50 kilotonnes of dry matter burnt.*	- MAPA's Statistical Yearbook. - Nitrogen and Phosphorous Balance in Spanish Agriculture (BNPAE) Yearbook.

* Data of areas of agricultural soils are provided by MAPA's Statistics Yearbook to BNPAE technical team with two-year lag compared with inventory report. In these cases, the Inventory replicates the x-2 year values published in the Yearbook, into x-1 year, the last year inventoried. This edition has updated the values of 2020 according to the yearbook and has replicated them into 2021.

5.2.1. Key categories

Identified key categories within the Agriculture sector, according to the information provided in section 1.5 of the IIR and Annex 1, are listed in the following table.

Table 5.2.2 Assignation of KC

NFR	NFR Category	NOx	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	PCDD /PCDF	PAHs	HCB	PCBs
3B	Manure management	L-T	L-T	–	L-T	L	L-T	L-T	–	–	–	–	–	–	–	–	–
3D	Crop production and agricultural soils	L-T	L-T	–	L	L	L-T	L-T	–	–	–	–	–	–	–	T	–
3F	Field burning of agricultural residues	T	T	–	T	L-T	T	T	T	T	–	L-T	T	–	L-T	–	–

L: level T: trend

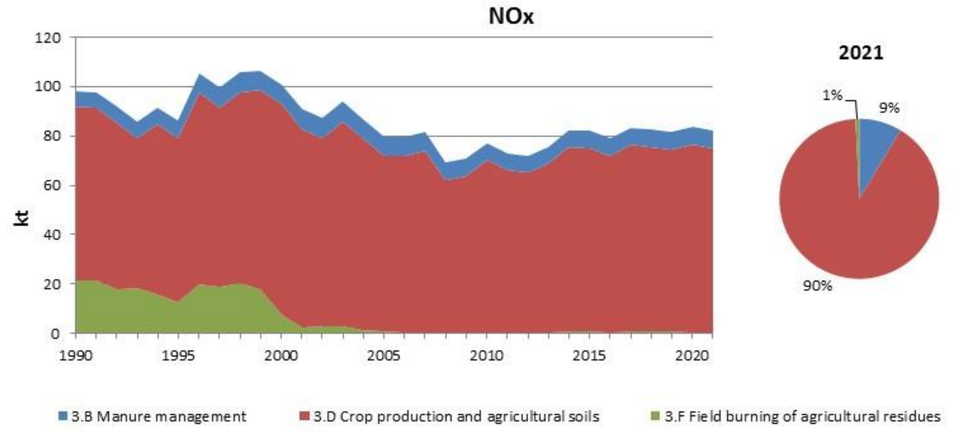
5.2.2. Analysis by pollutant

Featured below are the charts of the time series by pollutants and NFR categories. Each pollutant is represented independently, broken down by main NFR categories within the sector. Additionally, a pie chart showing the weight distribution of the main categories for the year 2021 is included.

Explanation boxes below the graphs provide specific details on the pollutant emissions for the year 2021, as well as main drivers and its trends during the time series. Emissions from the Canary Islands are not considered, as their territory is not under the EMEP grid.

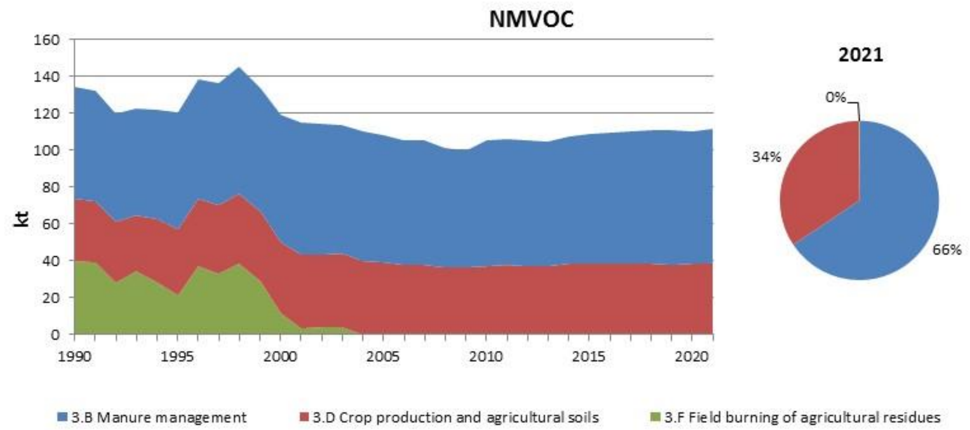
Detailed emission data of the Spanish Inventory are available from the MITECO-SEI website WebTable.

Main Pollutants



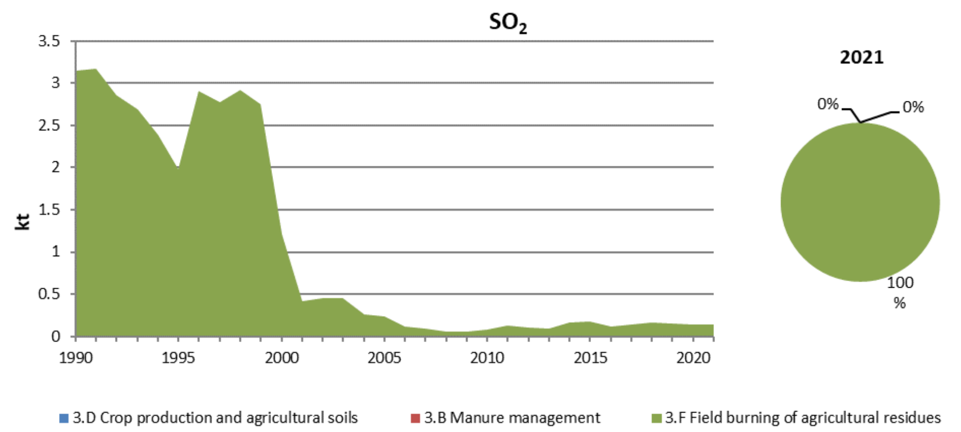
NOx	82.09 kt emitted in 2021 13.23% of the total NOx emissions of the Inventory in 2021	
	1990-1999	The emission fall from 1990 to 1993 is due to the economic recession of the early 1990s, 1993 worst year considered. From then on, NOx emissions regained base level until 1999 year.
	2000-2021	NOx emissions due to field of agricultural residues burning in Spain dropped drastically after year 2000: progressive abandonment of this practice is, from then on, only allowed in limited cases under authorization by public authorities. Forest fire preventive legislation and conditionality of Common Agricultural Policy payments discourage this practice. Emissions fluctuate irregularly coupled to the trade and use of fertilizers (3D). Manure management emissions (3B) evolve in correlation with livestock heads.

Figure 5.2.1 Evolution of NOx emissions by category and distribution in year 2021



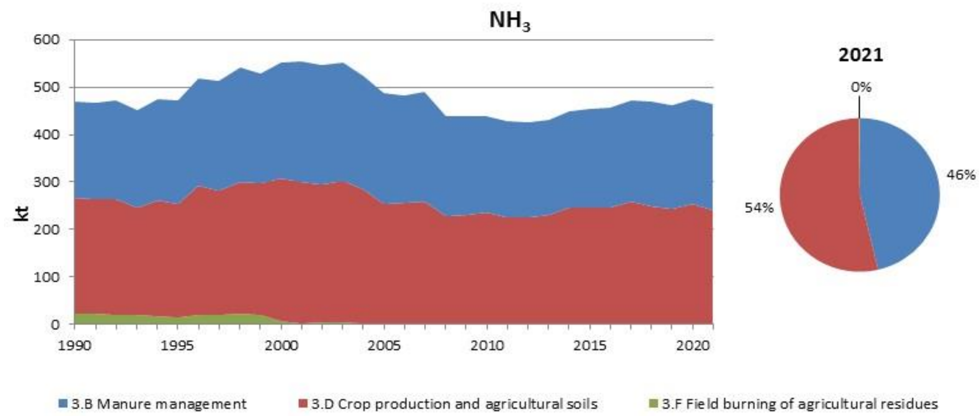
NMVOC	111.61 kt emitted in 2021 20.31% of the total NMVOC emissions of the Inventory in 2021	
	1990-2021	Within the Agriculture sector, around 35% of the emissions of this pollutant are due to category 3B (Manure management), being the rest produced by Crop production and agricultural soils (3D). Showing a general increasing tendency, there are only a couple of years of marked decrease matching the two last economic crises in 1993 and 2009. From 2000 on, withdrawal in inventorying category 3F is due to restriction by public authorities who have limited the situations to benefit from a residues burning authorization.

Figure 5.2.2 Evolution of NMVOC emissions by category and distribution in year 2021



SO_2	0.14 kt emitted in 2021 0.11% of the total SO_2 emissions of the Inventory in 2021	
	1990-1999	In the Agriculture sector, SO_2 emissions exclusively come from category 3F. From the base year until 1999, the activity keep remains constant, with the exception of a gap in 1995 due to lower agricultural productivity.
	2000-2021	Withdrawal in inventorying this category is due to restriction by public authorities who have limited the situations to benefit from a residue burning authorization.

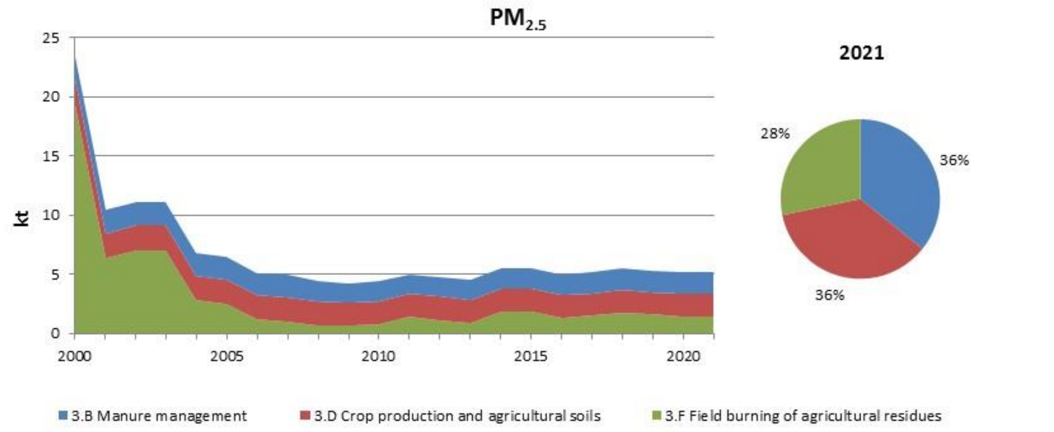
Figure 5.2.3 Evolution of SO_2 emissions by category and distribution in year 2021



NH_3	463.32 kt emitted in 2021 96.77% of the total NH_3 emissions of the Inventory in 2021	
	1990-1994	Ammonia emissions decrease from 1990 to 1994. Economic crisis in early 1990s and a marked drought period affected fertilizers trade and crop production (3D).
	1995-2003	Emissions rise in agreement with both drivers, livestock effectives and nitrogen amount applied to soils as fertilizer. The NH_3 emissions of burnings in open field of agricultural waste followed the tendency explained in previous boxes. Just before 2004, 3F emissions dropped drastically from 2000 to 2002 as a result of abandonment of this practice restricted by forest fire preventive legislation and conditionality of Common Agricultural Policy payments.
	2004-2021	Ammonia emissions decrease from 2004 to 2011, possibly related to another marked drought period followed by a deep economic crisis that flattened the sector. From 2013 on, recovery is noticeably, with a slight increase in recent years despite the considerable increase in population; this is due to all along the time series, ammonia emissions evolve in parallel with the variable of activity, livestock population, but from 2005 onwards, Spanish inventory has taken into account abatement measures implemented in 3B and 3D.

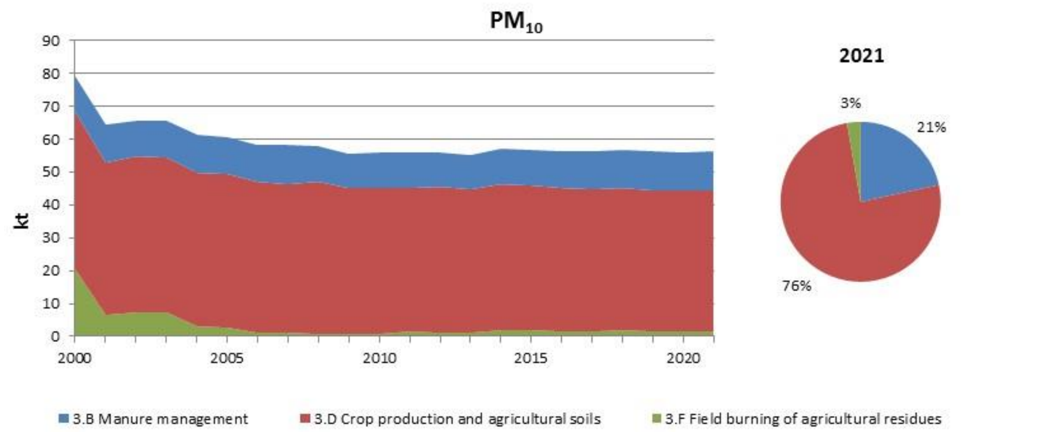
Figure 5.2.4 Evolution of NH_3 emissions by category and distribution in year 2021

Particulate Matter



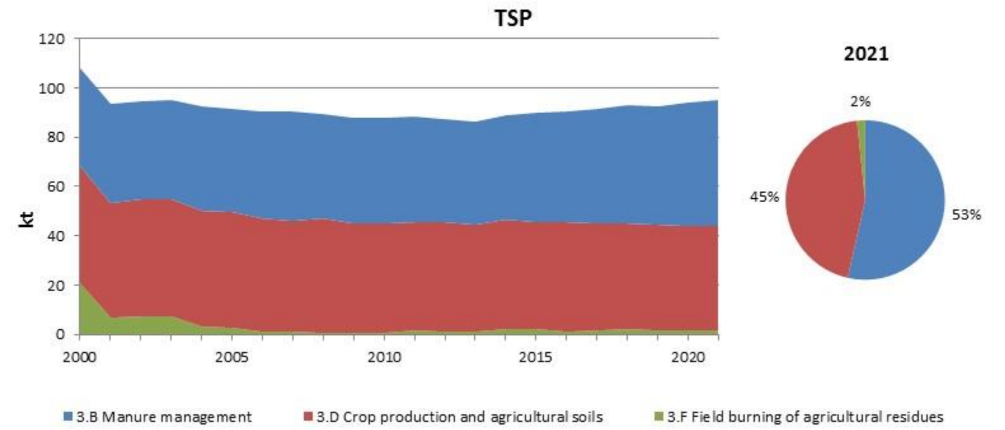
$PM_{2.5}$	5.19 kt emitted in 2021 3.85% of the total $PM_{2.5}$ emissions of the Inventory in 2021	
	2000-2003	Remarkable decrease in the first year of the series is due to category 3F. In the frame of forest fire preventive legislation and conditionality of Common Agricultural Policy payments, public authorities ruled field burning of crop residues in a restricted way allowing it only in limited cases. After 2003 only flowers and cotton crop residues are burnt in open field.
	2004-2021	From 2004 onwards, emissions evolve with the fluctuations of livestock heads, crop surface and agricultural productivity.

Figure 5.2.5 Evolution of $PM_{2.5}$ emissions by category and distribution in year 2021



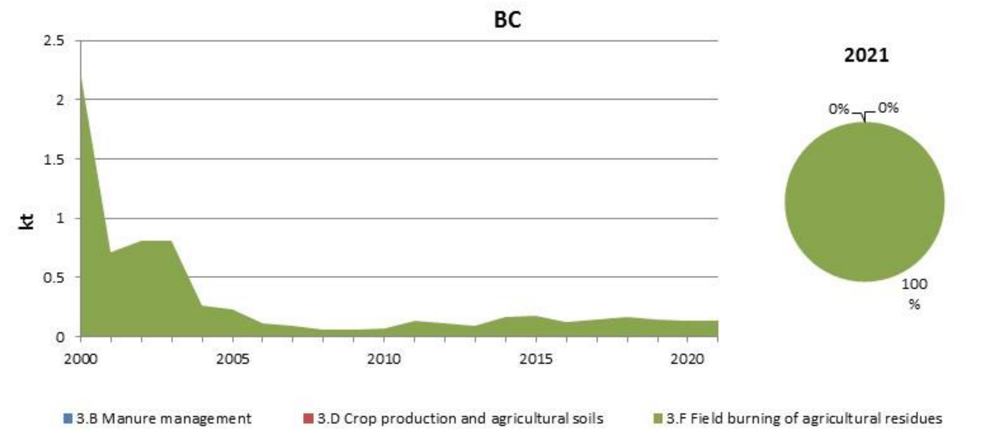
PM_{10}	56.39 kt emitted in 2021 26.19% of the total PM_{10} emissions of the Inventory in 2021	
	2000-2003	3F emissions dropped drastically as a result of abandonment of this practice restricted by forest fire preventive legislation and conditionality of Common Agricultural Policy payments. Contributions of Crop production and Manure Management shield the effect of 3F decrease on total emissions.
	2004-2021	From 2004 onwards, emissions evolve with the fluctuations of livestock heads, crop surface and agricultural productivity.

Figure 5.2.6 Evolution of PM_{10} emissions by category and distribution in year 2021



<table>
<tr><td rowspan="3">TSP</td><td colspan="2">95.20 kt emitted in 2021
32.05% of the total TSP emissions of the Inventory in 2021</td></tr>
<tr><td>2000-2003</td><td>3F emissions dropped drastically as a result of abandonment of this practice restricted by forest fire preventive legislation and conditionality of Common Agricultural Policy payments. Contributions of Crop production and Manure Management shield the effect of 3F decrease on total emissions.</td></tr>
<tr><td>2004-2021</td><td>From 2004 onwards, emissions evolve with the fluctuations of livestock heads, crop surface and agricultural productivity.</td></tr>
</table>

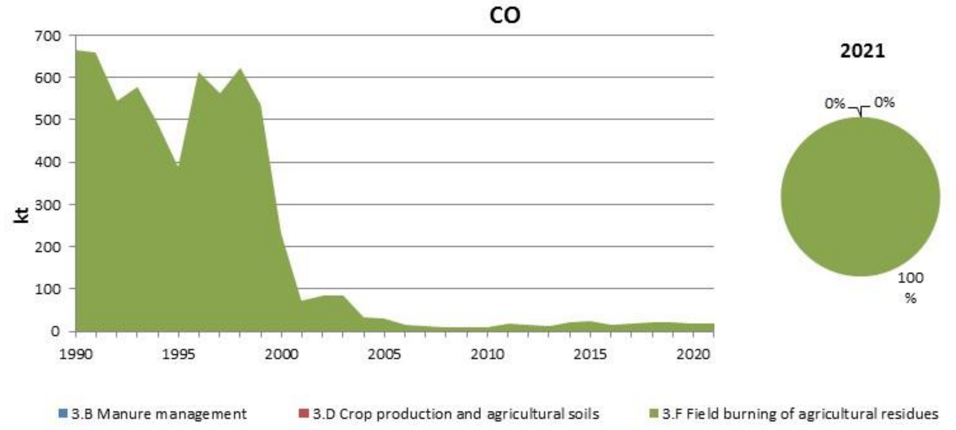
Figure 5.2.7 Evolution of TSP emissions by category and distribution in year 2021



<table>
<tr><td rowspan="3">BC</td><td colspan="2">0.14 kt emitted in 2021
0.29% of the total BC emissions of the Inventory in 2021</td></tr>
<tr><td>2000-2003</td><td>BC emissions exclusively come from category 3F whose fall in 2001 is explained in previous boxes. In this case, effects on relative emissions are remarkable because of the lack of any other contributor.</td></tr>
<tr><td>2004-2021</td><td>From 2004 onwards, BC emissions present slight variations in absolute terms, in line mainly with annual cotton production and its consequent burning of residues.</td></tr>
</table>

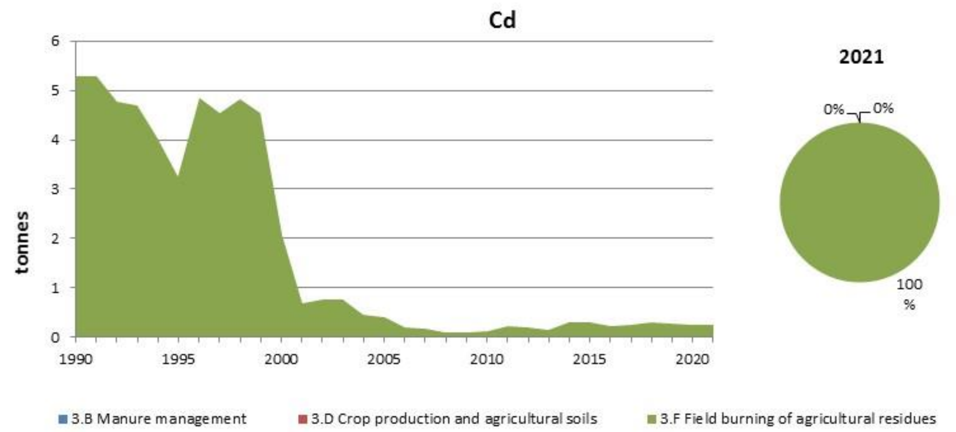
Figure 5.2.8 Evolution of BC emissions by category and distribution in year 2021

CO and Priority Heavy Metals



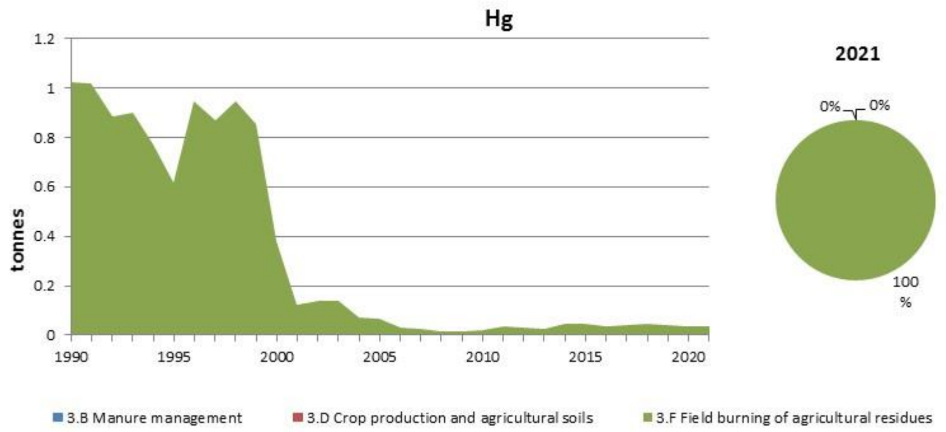
CO	18.11 kt emitted in 2021 1.11% of the total CO emissions of the Inventory in 2021	
	1990-2003	CO emissions exclusively come from category 3F whose fall in 2000-2003 is due to restriction by public authorities who have limited the situations to benefit from a residue burning authorization. In this case, effects on relative and absolute emissions are remarkable because of the lack of any other contributor. From 1990 until 1999, the activity evolves with the agricultural productivity.
	2004-2021	From 2004 onwards, CO emissions present slight variations in absolute terms, in line mainly with annual cotton production and its consequent burning of residues.

Figure 5.2.9 Evolution of CO emissions by category and distribution in year 2021



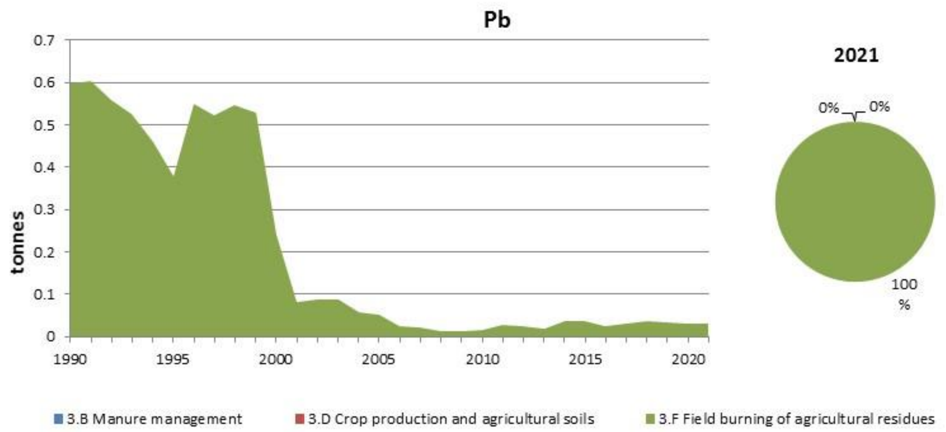
Cd	0.24 kt emitted in 2021 3.49% of the total Cd emissions of the Inventory in 2021	
	1990-2003	Cd emissions exclusively come from category 3F whose fall in 2000-2003 is explained in the previous boxes. From 1990 until 1999, the activity evolves with the agricultural productivity.
	2004-2021	From 2004 onwards, Cd emissions present slight variations in absolute terms, in line mainly with annual cotton production and its consequent burning of residues.

Figure 5.2.10 Evolution of Cd emissions by category and distribution in year 2021



Hg	0.04 kt emitted in 2021 1.29% of the total Hg emissions of the Inventory in 2021	
	1990-2003	Hg emissions exclusively come from category 3F whose fall in 2000-2003 is explained in the previous boxes. In this case, effects on relative and absolute emissions are remarkable because of the lack of any other contributor. From 1990 until 1999, the activity evolves with the agricultural productivity.
	2004-2021	From 2004 onwards, Hg emissions present slight variations in absolute terms, in line mainly with annual cotton production and its consequent burning of residues.

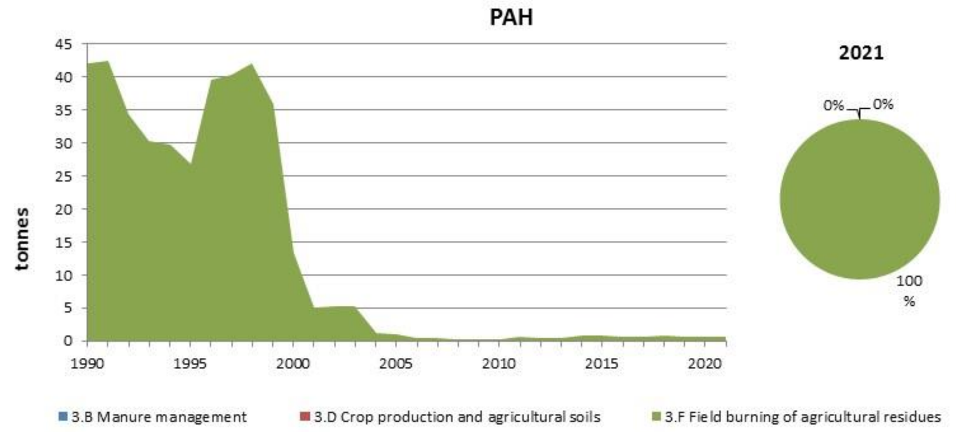
Figure 5.2.11 Evolution of Hg emissions by category and distribution in year 2021



Pb	0.03 kt emitted in 2021 0.03% of the total Pb emissions of the Inventory in 2021	
	1990-2003	Pb emissions exclusively come from category 3F whose fall in 2000-2003 is explained in the previous boxes. In this case, effects on relative and absolute emissions are remarkable because of the lack of any other contributor. From 1990 until 1999, the activity evolves with the agricultural productivity.
	2004-2021	From 2004 onwards, Pb emissions present slight variations in absolute terms, in line mainly with annual cotton production and its consequent burning of residues.

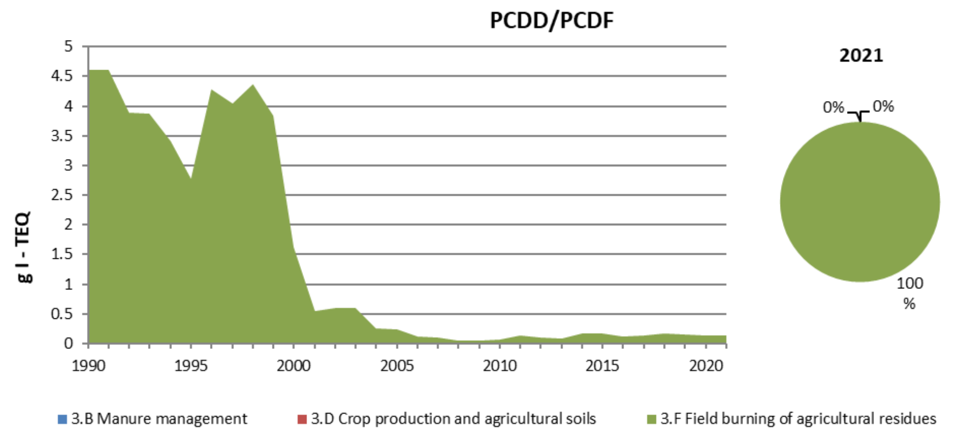
Figure 5.2.12 Evolution of Pb emissions by category and distribution in year 2021

POPs



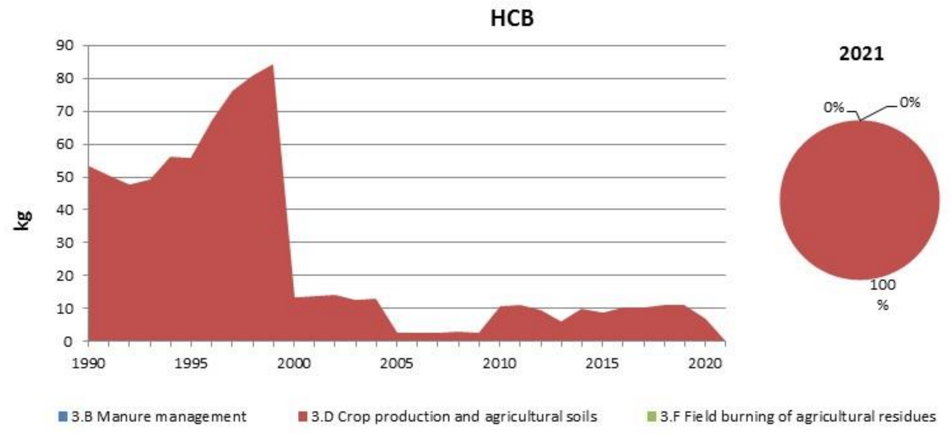
<table>
<tr><td rowspan="3">PAHs</td><td colspan="2">0.62 tonnes emitted in 2021
1.71% of the total PAHs emissions of the Inventory in 2021</td></tr>
<tr><td>1990-2003</td><td>PAHs emissions exclusively come from category 3F whose fall in 2000-2003 is explained in the previous boxes. In this case, effects on relative and absolute emissions are remarkable because of the lack of any other contributor. From 1990 until 1999, the activity evolves with the agricultural productivity.</td></tr>
<tr><td>2004-2021</td><td>From 2004 onwards, PAHS emissions present slight variations in absolute terms, in line mainly with annual cotton production and its consequent burning of residues.</td></tr>
</table>

Figure 5.2.13 Evolution of PAHs emissions by category and distribution in year 2021



<table>
<tr><td rowspan="3">PCDD/F</td><td colspan="2">0.14 g I-TEQ emitted in 2021
0.03% of the total PCDD/PCDF emissions of the Inventory in 2021</td></tr>
<tr><td>1990-2003</td><td>PCDD/PCDF emissions exclusively come from category 3F whose fall in 2000-2003 is explained in the previous boxes. In this case, effects on relative and absolute emissions are remarkable because of the lack of any other contributor. From 1990 until 1999, the activity evolves with the agricultural productivity.</td></tr>
<tr><td>2004-2021</td><td>From 2004 onwards, PCDD/PCDF emissions present slight variations in absolute terms, in line mainly with annual cotton production and its consequent burning of residues.</td></tr>
</table>

Figure 5.2.14 Evolution of PCDD/PCDF emissions by category and distribution in year 2021



HCB	0.04 kg emitted in 2021 2.17% of the total HCB emissions of the Inventory in 2021	
	1990-2021	HCB emissions exclusively come from category 3Df, whose fall in 1999-2001 is due to prohibition use of lindane and change in HCB-concentration (impurity factor) for chlorothalonil. The prohibition use of simazine was applied in 2005 and clopyralid began to use in 2007. The prohibition use of chlorothalonil has been applied in 2020. Currently, only active substance with HCB impurities clopyralid is used.

Figure 5.2.15 Evolution of HCB emissions by category and distribution in year 2021

5.2.3. Condensable component of PM_{10} and $PM_{2.5}$

As detailed in Annex V, indication of whether the emission estimates and emission factors for PM_{10} and $PM_{2.5}$ in the Agriculture sector include or exclude the condensable component can be found in the table below:

Table 5.2.3 Information on condensable component of PM

NFR	Source/sector name	PM emissions: the condensable component is		EF reference and comments
		included	excluded	
3B1a	Dairy Cattle	No information available		EF from EEA/EMEP Guidebook (2019)
3B1b	Non-Dairy Cattle	No information available		EF from EEA/EMEP Guidebook (2019)
3B2	Sheep	No information available		EF from EEA/EMEP Guidebook (2019)
3B3	Swine	No information available		EF from EEA/EMEP Guidebook (2019)
3B4d	Goats	No information available		EF from EEA/EMEP Guidebook (2019)
3B4e	Horses	No information available		EF from EEA/EMEP Guidebook (2019)
3B4f	Mules and Asses	No information available		EF from EEA/EMEP Guidebook (2019)
3B4gi	Laying Hens	No information available		EF from EEA/EMEP Guidebook (2019)
3B4gii	Broilers	No information available		EF from EEA/EMEP Guidebook (2019)
3B4giii	Turkeys	No information available		EF from EEA/EMEP Guidebook (2019)
3B4giv	Other Poultry	No information available		EF from EEA/EMEP Guidebook (2019)
3B4h	Other animals-Rabbits	No information available		EF from EEA/EMEP Guidebook (2019)

NFR	Source/sector name	PM emissions: the condensable component is		EF reference and comments
		included	excluded	
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	No information available		EF from EEA/EMEP Guidebook (2019)
3F	Field burning of agricultural residues	No information available		EF from EEA/EMEP Guidebook (2019)

5.3. Major changes

The chapter on agriculture was thoroughly reviewed in the 2017 edition of the inventory to adapt it to EMEP/EEA Guidebook (2016). Subsequent editions of the inventory have been adapted to the new requirements.

The table below summarizes the major changes performed in the Agriculture sector in the current Inventory edition (Ed.2023) (see table 5.5.1). Those changes resulting from the 2022 NECD review (pursuant to Directive (EU) 2016/2284) have been marked with an asterisk (*).

Table 5.3.1 Major changes in Agriculture sector in Inventory edition 2023

NFR Category	Activities included	Pollutant	Type of change
3B (All categories) (*)	- Manure management / All animals	NMVOC,	Recalculation (*).
3B1a (Dairy cattle), **3B3** (Swine), **3B4gi** (Laying hens)	- Manure management / Dairy cattle, Swine, Laying hens.	NOx, NH_3	Recalculation.
3B1b (Non-dairy cattle), **3B4gii** (Broilers)	- Manure management / Non-dairy cattle, Broilers.	NOx, NH_3, $PM_{2.5}$, PM_{10}, TSP	Recalculation.
3B4giii (Turkeys)	- Manure management / Turkeys	NOx, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP	Desegregation of 3B4giii from 3B4giv.
3B4giv (Other poultry)	- Manure management / Other poultry	NOx, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP	Desegregation of 3B4giii from 3B4giv.
3B4h (Rabbits)	- Manure management / Rabbits	NOx, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP	New category.
3Da2a (Animal manure applied to soils)	- Animal manure applied to soils.	NMVOC,	Recalculation (*).
3Da2a (Animal manure applied to soils)	- Animal manure applied to soils.	NOx, NH_3	Recalculation.
3Dc (Farm-level agricultural operations)	- Farm-level agricultural operations including storage, handling and transport of agricultural products.	$PM_{2.5}$, PM_{10}, TSP	Recalculation (*).
3Da2b, 3Da2c, 3De, 3Df, 3F (sewage sludge and compost applied to soils, cultivated crops, use of pesticides and field burning of agricultural residues)	- Sewage sludge applied to soils, Other organic fertilizers applied to soils (including compost), Cultivated crops, Use of pesticides, Field burning of agricultural residues.	NOx, NMVOC, SO_2, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, PAHs	Updating values of the penultimate year of the VA.

5.4. Key categories analysis

Within this sector, the following categories have been identified as key (check table 5.2.2 for reference):

A. Manure management - 3B

B. Crop production and agricultural soils - 3D

C. Field burning of agricultural residues - 3F

Activity data sources, methodologies and a general assessment for each category are provided in the following paragraphs.

A. Manure management (3B)

Category 3B "Manure management" is considered as a key category for its contribution to the level of $PM_{2.5}$ emissions and for its contribution to the level and the trend of emissions of the following pollutants NOx, NMVOC, NH_3, PM_{10}, and TSP.

A.1. Activity variables

Activity variables mainly consist on livestock census and its derived variable "Annual Average Population", per species and homogeneous categories in terms of emissions. Data from new zootechnical documents, updated REGA and Husbandry and slaughterhouse surveys, performed under European Regulation nº 1165/2008, are compiled by the Statistical Office (MAPA). Results are available in the official web of the Ministry of Agriculture, Fishing and Food.

Table 5.4.1 Summary of activity variables, data and information sources for category 3B (Manure management)

Activities included	Activity data	Source of information
Manure management / - Dairy cattle (3B1a) - Non-dairy cattle (3B1b) - Sheep (3B2) - Swine (3B3) - Goats (3B4d)	- Annual census and provincial distribution.	- Zootechnical document[5] - Official Husbandry Surveys[6] - MAPA's Statistic Yearbook[7]
Manure management / - Horses (3B4e) - Mules and asses (3B4f)	- Annual census and provincial distribution.	- Zootechnical document[7] - REGA[8] (General Registry of Livestock Farming). - RIIA (Registry of Individual Animal Identification).
Manure management / - Laying hens (3B4gi) - Broilers (3B4gii) - Turkeys (3B4giii) - Other poultry (3B4giv)	- Monthly sacrificed livestock heads in national territory. - Annual census and provincial distribution.	- Zootechnical document[7] - MAPA's Statistic Yearbook[9] - REGA (General Registry of Livestock Farming)[10]
Manure management / - Rabbits (3B4h)	- Annual sacrificed livestock and provincial distribution.	- MAPA's Statistic Yearbook[9]

A.2. Methodology

The following table summarises the methodologies applied in this chapter. Methodology level and sources are provided for reference.

Table 5.4.2 Summary of methodologies applied in category 3B (Manure management)

Pollutants	Tier	Methodology applied	Observations
Cattle (3B1a-3B1b)			
NOx	T2	- Country specific methodology.	- Total and ammoniacal N-excreted and pasture distribution.

[5] See Table 5.4.3.

[6] Official statistical information from husbandry can be consulted at: http://www.mapa.gob.es/es/estadistica/temas/estadisticas-agrarias/ganaderia/

[7] http://www.mapa.gob.es/es/estadistica/temas/publicaciones/anuario-de-estadistica/

[8] http://www.mapa.gob.es/es/ganaderia/temas/trazabilidad-animal/registro/

Pollutants	Tier	Methodology applied	Observations
			- Manure management system from 2010 onwards, with progressive implementation since 1990(***).
		- IPCC Reference Manual 2006.	- Manure manag. system (Annex 10A.2-Chapter 10-Vol 4) from 1990 to 2009, with progressive dis-implementation.
		- EMEP/EEA Guidebook (2019).	- EF (3.B Manure management-section 3.4 —Tier 2 technology specific approach— pg. 20, Table 3.10) (N-mass balance). - Detailed methodological factsheets (MITECO)(*)
NMVOC	T2	- Country specific methodology.	- Feed intake, silage feeding and pasture distribution. - Manure management system from 2010 onwards, with progressive implementation since 1990(***).
		- IPCC Reference Manual 2006.	- Manure manag. system (Annex 10A.2-Chapter 10-Vol 4) from 1990 to 2009, with progressive dis-implementation.
		- EMEP/EEA Guidebook (2019).	- NMVOC EF (3.B Manure management-Table 3.11). - NH_3 emissions (3.B Manure management). - Fraction of silage store. - Detailed methodological factsheets (MITECO)(*).
NH_3	T2	- Country specific methodology.	- Total and ammoniacal N-excreted and pasture distribution. - Manure management system from 2010 onwards, with progressive implementation since 1990(***). - BATs from 2010 MAPA surveys(***), with progressive implementation since 2003.
		- IPCC Reference Manual 2006.	- Manure management system (Annex 10A.2-Chapter 10-Vol 4) from 1990, with progressive dis-implementation between 1991 and 2009.
		- EMEP/EEA Guidebook (2019).	- EF (3.B Manure management- section 3.4 – Tier 2 technology-specific approach, Table 3.9) (N-mass balance). - Detailed methodological factsheets (MITECO)(*).
$PM_{2.5}$, PM_{10}, TSP	T1	- Country specific methodology.	- Housing period.
		- EMEP/EEA Guidebook (2019).	- EF (3.B Manure management-Table 3.5).
Sheep (3B2)			
NOx	T2	- Country specific methodology.	- Total and ammoniacal N-excreted. - Manure management system and pasture distribution.
		- EMEP/EEA Guidebook (2019).	- EF (3.B Manure management- section 3.4 – Tier 2 technology-specific approach, Table 3.10) (N-mass balance). - Detailed methodological factsheets (MITECO)(*).
NMVOC	T2	- Country specific methodology.	- VS excreted, silage feeding, pasture distribution and manure management system.
		- EMEP/EEA Guidebook (2019).	- NMVOC EF (3.B Manure management-Table 3.12). - NH_3 emissions (3.B Manure management). - Fraction of silage store. - Detailed methodological factsheets (MITECO)(*).
NH_3	T2	- Country specific methodology.	- Total and ammoniacal N-excreted. - Manure management system and pasture distribution.
		- EMEP/EEA Guidebook (2019).	- EF (3.B Manure management- section 3.4 – Tier 2 technology-specific approach, Table 3.9) (N-mass balance). - Detailed methodological factsheets (MITECO)(*).
$PM_{2.5}$, PM_{10}, TSP	T1	- Country specific methodology.	- Housing period.
		- EMEP/EEA Guidebook (2019).	- EF (3.B Manure management-Table 3.5).
Swine (3B3)			
NOx	T2	- Country specific methodology.	- Total and ammoniacal N-excreted (zootechnical document (1990-2020) and ECOGAN(**) (2021) for white swine and only zootechnical document for Iberian swine.

Pollutants	Tier	Methodology applied	Observations
			- Manure management system from 2015 onwards, with progressive implementation since 1990. - Pasture distribution for Iberian swine.
		- IPCC Reference Manual 2006.	- Manure management system (Annex 10A.2-Chapter 10-Vol 4), with progressive dis-implementation between 1991 and 2014.
		- EMEP/EEA Guidebook (2019).	- EF (3.B Manure management- section 3.4 – Tier 2 technology-specific approach, Table 3.10) (N-mass balance). - Detailed methodological factsheets (MITECO)(*).
NMVOC	T2	- Country specific methodology.	- VS excreted, silage feeding, pasture distribution and manure management system from 2015 onwards.
		- IPCC Reference Manual 2006.	- Manure management system (Annex 10A.2-Chapter 10-Vol 4), with progressive dis-implementation between 1991 and 2014.
		- EMEP/EEA Guidebook (2019).	- NMVOC EF (3.B Manure management-Table 3.12). - NH_3 emissions (3.B Manure management). - Fraction of silage store. - Detailed methodological factsheets (MITECO)(*).
NH_3	T2	- Country specific methodology.	- Total and ammoniacal N-excreted (zootechnical document (1990-2020) and ECOGAN(**) (2021) for white swine and only zootechnical document for Iberian swine. - Manure management system from 2015 onwards, with progressive implementation since 1990. - Pasture distribution for Iberian swine. - BATs from 2015 surveys, with progressive implementation since 2003 and progressive dis-implementation between 2015 and 2020; BATs from ECOGAN(**) data from 2021, with progressive implementation since 2015.
		- IPCC Reference Manual 2006.	- Manure management system (Annex 10A.2-Chapter 10-Vol 4), with progressive dis-implementation between 1991 and 2014.
		- EMEP/EEA Guidebook (2019).	- EF (3.B Manure management- section 3.4 – Tier 2 technology-specific approach, Table 3.9) (N-mass balance). - Detailed methodological factsheets (MITECO)(*).
$PM_{2.5}$, PM_{10}, TSP	T1	- Country specific methodology.	- Housing period.
		- EMEP/EEA Guidebook (2019).	- EF (3.B Manure management-Table 3.5).
Goats (3B4d)			
NOx	T2	- Country specific methodology.	- Total and ammoniacal N-excreted. - Manure management system and pasture distribution.
		- EMEP/EEA Guidebook (2019).	- EF (3.B Manure management- section 3.4 - Tier 2 technology-specific approach, Table 3.10) (N-mass balance). - Detailed methodological factsheets (MITECO)(*).
NMVOC	T2	- Country specific methodology.	- VS excreted, silage feeding, pasture distribution and manure management system.
		- EMEP/EEA Guidebook (2019).	- NMVOC EF (3.B Manure management-Table 3.12). - NH_3 emissions (3.B Manure management). - Fraction of silage store. - Detailed methodological factsheets (MITECO)(*).
NH_3	T2	- Country specific methodology.	- Total and ammoniacal N-excreted. - Manure management system and pasture distribution.
		- EMEP/EEA Guidebook (2019).	- EF (3.B Manure management- section 3.4 – Tier 2 technology-specific approach, Table 3.9) (N-mass balance). - Detailed methodological factsheets (MITECO)(*).
	T1	- Country specific methodology.	- Housing period.

Pollutants	Tier	Methodology applied	Observations
$PM_{2.5}$, PM_{10}, TSP		- EMEP/EEA Guidebook (2019).	- EF (3.B Manure management-Table 3.5).
Horses (3B4e), Mules and Assess (3B4f)			
NOx	T2	- Country specific methodology.	- Total and ammoniacal N-excreted. - Manure management system and pasture distribution.
		- EMEP/EEA Guidebook (2019).	- EF (3.B Manure management- section 3.4 - Tier 2 technology-specific approach, Table 3.10) (N-mass balance). - Detailed methodological factsheets (MITECO)(*).
NMVOC	T2	- Country specific methodology.	- VS excreted, silage feeding, pasture distribution and manure management system.
		- EMEP/EEA Guidebook (2019).	- NMVOC EF (3.B Manure management-Table 3.12). - NH_3 emissions (3.B Manure management). - Fraction of silage store. - Detailed methodological factsheets (MITECO)(*).
NH_3	T2	- Country specific methodology.	- Total and ammoniacal N-excreted. - Manure management system and pasture distribution.
		- EMEP/EEA Guidebook (2019).	- EF (3.B Manure management- section 3.4 – Tier 2 technology-specific approach, Table 3.9) (N-mass balance). - Detailed methodological factsheets (MITECO)(*).
$PM_{2.5}$, PM_{10}, TSP	T1	- Country specific methodology.	- Housing period.
		- EMEP/EEA Guidebook (2019).	- EF (3.B Manure management-Table 3.5).
Laying hens (3B4gi)			
NOx	T2	- Country specific methodology.	- Total and ammoniacal N-excreted. - Manure management system(***).
		- EMEP/EEA Guidebook (2019).	- EF (3.B Manure management- section 3.4 - Tier 2 technology-specific approach, Table 3.10) (N-mass balance). - Detailed methodological factsheets (MITECO)(*).
NMVOC	T2	- Country specific methodology.	- VS excreted. - Manure management system(***).
		- EMEP/EEA Guidebook (2019).	- NMVOC EF (3.B Manure management-Table 3.12). - NH_3 emissions (3.B Manure management). - Detailed methodological factsheets (MITECO)(*).
NH_3	T2	- Country specific methodology.	- Total and ammoniacal N-excreted. - Manure management system(***). - BATs from 2010 MAPA surveys(***), with progressive implementation since 2003.
		- EMEP/EEA Guidebook (2019).	- EF (3.B Manure management- section 3.4 - Tier 2 technology-specific approach, Table 3.9) (N-mass balance). - Detailed methodological factsheets (MITECO)(*).
$PM_{2.5}$, PM_{10}, TSP	T1	- Country specific methodology.	- Housing period.
		- EMEP/EEA Guidebook (2019).	- EF (3.B Manure management-Table 3.5).
Broilers (3B4gii)			
NOx	T2	- Country specific methodology.	- Total and ammoniacal N-excreted. - Manure management system.
		- EMEP/EEA Guidebook (2019).	- EF (3.B Manure management- section 3.4 - Tier 2 technology-specific approach, Table 3.10) (N-mass balance). - Detailed methodological factsheets (MITECO)(*).
NMVOC	T2	- Country specific methodology.	- VS excreted and manure management system.
		- EMEP/EEA Guidebook (2019).	- NMVOC EF (3.B Manure management-Table 3.12). - NH_3 emissions (3.B Manure management). - Detailed methodological factsheets (MITECO)(*).

Pollutants	Tier	Methodology applied	Observations
NH_3	T2	- Country specific methodology.	- Total and ammoniacal N-excreted. - Manure management system.
		- EMEP/EEA Guidebook (2019).	- EF (3.B Manure management- section 3.4 – Tier 2 technology-specific approach, Table 3.9) (N-mass balance). - Detailed methodological factsheets (MITECO)(*).
$PM_{2.5}$, PM_{10}, TSP	T1	- Country specific methodology.	- Housing period.
		- EMEP/EEA Guidebook (2019).	- EF (3.B Manure management-Table 3.5).
Turkeys (3B4giii), Other poultry (3B4giv)			
NOx	T2	- Country specific methodology.	- Total and ammoniacal N-excreted. - Manure management system.
		- EMEP/EEA Guidebook (2019).	- EF (3.B Manure management- section 3.4 - Tier 2 technology-specific approach, Table 3.10) (N-mass balance). - Detailed methodological factsheets (MITECO)(*).
NMVOC	T2	- Country specific methodology.	- VS excreted and manure management system.
		- EMEP/EEA Guidebook (2019).	- NMVOC EF (3.B Manure management-Table 3.12). - NH_3 emissions (3.B Manure management). - Detailed methodological factsheets (MITECO)(*).
NH_3	T2	- Country specific methodology.	- Total and ammoniacal N-excreted. - Manure management system.
		- EMEP/EEA Guidebook (2019).	- EF (3.B Manure management- section 3.4 – Tier 2 technology-specific approach, Table 3.9) (N-mass balance). - Detailed methodological factsheets (MITECO)(*).
$PM_{2.5}$, PM_{10}, TSP	T1	- Country specific methodology.	- Housing period.
		- EMEP/EEA Guidebook (2019).	- EF (3.B Manure management-Table 3.5).
Rabbits (3B4h)			
NOx	T1/ T2	- IPCC Reference Manual 2006 (Refinement 2019).	- N excreted. - Manure management system.
		- Country specific methodology.	- Manure management system.
		- EMEP/EEA Guidebook (2019).	- EF and TAN (3.B Manure management- section 3.4 - Tier 2 technology-specific approach, Table 3.9) (N-mass balance).
NMVOC	T1/ T2	- IPCC Reference Manual 2006 (Refinement 2019).	- VS excreted (Table 10.15). - Manure management system.
		- Country specific methodology.	- Manure management system.
		- EMEP/EEA Guidebook (2019).	- NMVOC EF (3.B Manure management-Table 3.12). - NH_3 emissions (3.B Manure management).
NH_3	T1/ T2	- IPCC Reference Manual 2006 (Refinement 2019).	- N excreted. - Manure management system.
		- Country specific methodology.	- Manure management system.
		- EMEP/EEA Guidebook (2019).	- EF and TAN (3.B Manure management- section 3.4 - Tier 2 technology-specific approach, Table 3.9) (N-mass balance).
$PM_{2.5}$, PM_{10}, TSP	T1	- Country specific methodology.	- Housing period.
		- EMEP/EEA Guidebook (2019).	- EF (3.B Manure management-Table 3.5).

(*) Detailed methodological factsheets (MITECO)[9]
(**) ECOGAN[10]
(***) MAPA surveys and descriptive studies[11]

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9 https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/sistema-espanol-de-inventario-sei-/SEI-Metodologias.aspx

10 https://www.mapa.gob.es/es/ganaderia/temas/ganaderia-y-medio-ambiente/calculo-emisiones/default.aspx

11 https://www.mapa.gob.es/es/ganaderia/publicaciones/Bovino%20cebo_tcm30-105325.pdf
https://www.mapa.gob.es/es/ganaderia/publicaciones/Bovino%20leche_tcm30-105326.pdf
https://www.mapa.gob.es/es/ganaderia/publicaciones/AVES%20DE%20PUESTA_tcm30-105324.pdf

The following table summarises the country specific zootechnical information provided by the collection of documents “Bases Zootécnicas para el cálculo del balance alimentario de nitrógeno y de fósforo”[12] whose parameters are applied in emission calculations.

Table 5.4.3 Country specific technical information and zootechnical documents

Animal	Zootechnical document – Country specific technical information
Dairy cattle	Document completed and published. Bases zootécnicas para el cálculo del balance alimentario de nitrógeno y fósforo en bovino.
Non-dairy cattle	Document completed and published. Bases zootécnicas para el cálculo del balance alimentario de nitrógeno y fósforo en bovino.
Sheep	Document completed and published. Bases zootécnicas para el cálculo del balance alimentario de nitrógeno y fósforo en ovino.
White swine	Document completed and published. Bases zootécnicas para el cálculo del balance alimentario de nitrógeno y fósforo en porcino blanco.
Iberian swine	Document completed and published. Bases zootécnicas para el cálculo del balance alimentario de nitrógeno y fósforo en porcino ibérico.
Goats	Document completed and published. Bases zootécnicas para el cálculo del balance alimentario de nitrógeno y fósforo en caprino.
Horses	Document completed and published. Bases zootécnicas para el cálculo del balance alimentario de nitrógeno y fósforo en équidos.
Mules and asses	Document completed and published. Bases zootécnicas para el cálculo del balance alimentario de nitrógeno y fósforo en équidos.
Laying hens	Document completed and published. Bases zootécnicas para el cálculo del balance alimentario de nitrógeno y fósforo en aves de puesta.
Broilers	Document completed and published. Bases zootécnicas para el cálculo del balance alimentario de nitrógeno y fósforo en aves de carne.
Turkeys and other poultry	Document completed. Publication planned for the 2nd semester of 2023. Bases zootécnicas para el cálculo del balance alimentario de nitrógeno y fósforo en pavos y patos.
Rabbits	MAPA information (Ministry for Agriculture, Fisheries and Food)[13].

A.3. Assessment

From the base year, population of swine, horses, mules-asses, non-dairy cattle, and poultry have increased in number of heads, while dairy cattle, sheep-goats and rabbits steadily decrease.

[12] https://www.mapa.gob.es/es/ganaderia/temas/ganaderia-y-medio-ambiente/balance-de-nitrogeno-e-inventario-de-emisiones-de-gases/default.aspx%20%20

[13] https://www.mapa.gob.es/es/ministerio/servicios/informacion/plataforma-de-conocimiento-para-el-medio-rural-y-pesquero/observatorio-de-tecnologias-probadas/sistemas-prodnut-animal/cunicultura.aspx

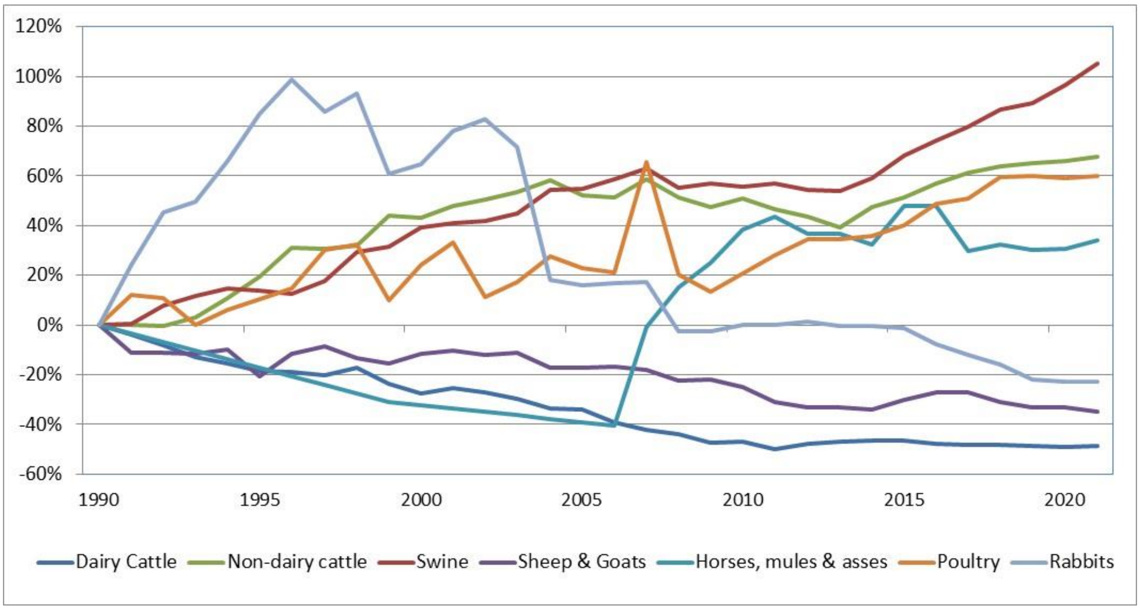

Figure 5.4.1 Variation in animal number from 1990 (%)

In the following table, the values of livestock numbers, N excretion rates, TAN fraction and use of MMS by animal (cattle and swine subcategories included) for the time series are provided[14].

Disaggregated values have been included for swine subcategories (Iberian and white)[15].

Table 5.4.4 Values of livestock numbers, N excretion rates and use of MMS by animal

	1990	2005	2010	2015	2019	2020	2021
Dairy Cattle (3B1a)							
Population (1000s)	**1,575.4**	**1,036.2**	**834.7**	**842.3**	**808.3**	**804.3**	**811.8**
N excr (kg/head/year)	84.5	100.0	112.0	113.3	113.5	113.4	113.5
TAN (Fraction)	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Total N excr (ton/year)	**133,054.8**	**103,638.0**	**93,506.4**	**95,462.9**	**91,703.1**	**91,244.0**	**92,125.6**
N excretion per MMS							
Anaerobic lagoon	0.0	4,990.2	6,003.1	6,128.7	5,887.3	5,857.9	5,914.5
Liquid system	59,375.7	43,458.8	38,371.3	39,174.1	37,631.2	37,442.9	37,804.6
Daily spread	11,642.3	2,267.1	0.0	0.0	0.0	0.0	0.0
Solid storage and dry lot	61,205.2	44,924.4	39,705.8	40,536.6	38,940.0	38,745.1	39,119.4
Pasture	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Digesters	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other	831.6	7,997.7	9,426.3	9,623.5	9,244.5	9,198.2	9,287.1
Non-Dairy Cattle (3B1b)							
Population (1000s)	**3,528.7**	**5,367.5**	**5,323.5**	**5,346.6**	**5,832.7**	**5,851.7**	**5,917.5**
N excr (kg/head/year)	56.7	58.7	56.7	57.4	57.2	57.2	57.4
TAN (Fraction)	0.6	0.7	0.6	0.7	0.7	0.7	0.7
Total N excr (ton/year)	**200,201.1**	**314,835.1**	**301,808.8**	**306,656.2**	**333,477.9**	**334,835.2**	**339,923.1**
N excretion per MMS							
Anaerobic lagoon	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Liquid system	32,356.2	13,299.0	1,774.1	1,921.9	2,122.7	2,088.5	2,154.6
Daily spread	2,311.2	830.9	0.0	0.0	0.0	0.0	0.0
Solid storage and dry lot	50,075.0	90,020.9	76,654.8	83,042.4	91,718.6	90,239.9	93,097.4
Pasture	112,890.8	189,280.8	201,581.2	198,076.6	213,554.1	216,844.7	218,196.4

[14] Recommendation made by the ERT in the 2019 NECD Final Review Report.

[15] Recommendation made by the ERT in the 2020 NECD Final Review Report.

	1990	2005	2010	2015	2019	2020	2021
Digesters	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other	2,567.9	21,403.5	21,798.7	23,615.2	26,082.5	25,662.0	26,474.6
Sheep (3B2)							
Population (1000s)	24,021.7	22,635.3	18,471.3	15,970.3	15,435.5	15,399.2	15,042.7
N excr (kg/head/year)	4.3	5.1	5.6	5.4	5.3	5.4	5.3
TAN (Fraction)	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Total N excr (ton/year)	**102,524.0**	**115,325.4**	**103,537.0**	**86,497.2**	**82,384.1**	**82,590.0**	**80,478.6**
N excretion per MMS							
Anaerobic lagoon	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Liquid system	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Daily spread	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Solid storage and dry lot	12,968.6	12,804.3	14,109.2	12,463.0	11,202.0	11,227.2	10,772.5
Pasture	71,982.0	85,170.2	70,308.7	57,145.9	56,002.4	56,149.0	55,108.6
Digesters	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other	17,573.5	17,350.9	19,119.1	16,888.4	15,179.7	15,213.8	14,597.6
Goats (3B4d)							
Population (1000s)	**3,525.9**	**2,511.9**	**2,569.9**	**2,574.1**	**2,454.2**	**2,450.3**	**2,385.8**
N excr (kg/head/year)	9.3	9.5	9.7	9.0	9.2	9.3	9.4
TAN (Fraction)	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Total N excr (ton/year)	**32,932.9**	**23,819.7**	**24,800.2**	**23,097.5**	**22,689.8**	**22,898.7**	**22,348.2**
N excretion per MMS							
Anaerobic lagoon	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Liquid system	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Daily spread	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Solid storage and dry lot	2,626.0	4,536.9	6,469.5	5,331.6	6,282.2	6,657.8	6,524.8
Pasture	26,748.4	13,135.0	9,564.0	10,541.1	7,894.7	7,219.1	6,981.7
Digesters	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other	3,558.5	6,147.8	8,766.8	7,224.8	8,512.9	9,021.8	8,841.7
Iberian&White Swine (Sows) (3B3)							
Population (1000s)	**1,984.7**	**2,665.6**	**2,601.2**	**2,455.0**	**2,577.6**	**2,618.5**	**2,696.0**
N excr (kg/head/year)	19.4	19.8	18.5	18.7	18.5	18.6	19.1
TAN (Fraction)	0.691	0.722	0.733	0.730	0.730	0.729	0.729
Total N excr (ton/year)	**38,547.0**	**52,816.6**	**48,042.8**	**45,885.6**	**47,683.7**	**48,697.7**	**51,615.7**
N excretion per MMS							
Anaerobic lagoon	3,199.2	1,669.2	780.2	0.0	0.0	0.0	0.0
Liquid system	0.0	6,665.5	8,308.1	10,049.4	10,404.4	10,685.1	11,317.9
Daily spread	735.4	786.7	681.6	607.5	628.9	645.9	684.2
Solid storage and dry lot	5,037.8	3,756.8	2,634.9	1,700.9	1,761.0	1,808.5	1,915.6
Pasture	1,774.7	4,849.9	3,201.8	2,494.5	2,759.8	2,561.7	2,747.5
Digesters	0.0	279.2	348.0	420.9	435.8	447.5	474.0
Other (mainly pit stor.)	27,799.8	34,809.4	32,088.2	30,612.4	31,693.8	32,548.9	34,476.5
Iberian&White Swine (Finishing/fattening pigs) (3B3)							
Population (1000s)	**14,305.0**	**22,513.0**	**22,752.0**	**24,951.1**	**28,232.0**	**29,418.0**	**30,699.0**
N excr (kg/head/year)	10.9	10.5	8.3	8.4	8.5	8.6	7.9
TAN (Fraction)	0.721	0.717	0.735	0.728	0.729	0.728	0.728
Total N excr (ton/year)	**155,533.6**	**236,711.0**	**189,737.9**	**210,262.7**	**240,872.6**	**252,825.3**	**241,694.1**
N excretion per MMS							
Anaerobic lagoon	12,954.6	7,523.7	3,194.7	0.0	0.0	0.0	0.0
Liquid system	0.0	30,043.1	34,018.1	46,274.5	52,490.7	55,331.3	52,656.0
Daily spread	2,978.1	3,545.7	2,790.8	2,797.2	3,173.0	3,344.7	3,183.0
Solid storage and dry lot	20,399.7	16,932.7	10,788.6	7,832.3	8,884.4	9,365.2	8,912.4
Pasture	6,630.6	20,511.6	6,134.2	10,459.2	14,228.6	13,916.5	14,336.5
Digesters	0.0	1,258.3	1,424.8	1,938.1	2,198.4	2,317.4	2,205.4
Other	112,570.7	156,895.9	131,386.9	140,961.4	159,897.3	168,550.2	160,400.8

	1990	2005	2010	2015	2019	2020	2021
Iberian Swine (Sows) (partial 3B3)							
Population (1000s)	**93.6**	**245.2**	**367.9**	**316.6**	**372.7**	**333.6**	**366.0**
N excr (kg/head/year)	20.7	20.2	18.3	18.5	18.3	18.8	18.4
TAN (Fraction)	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Total N excr (ton/year)	**1,933.1**	**4,948.0**	**6,738.3**	**5,846.0**	**6,807.2**	**6,269.5**	**6,716.0**
N excretion per MMS							
Anaerobic lagoon	13.8	3.4	61.5	0.0	0.0	0.0	0.0
Liquid system	0.0	13.6	655.2	776.2	937.4	858.7	919.1
Daily spread	3.2	1.6	53.8	46.9	56.7	51.9	55.6
Solid storage and dry lot	21.7	7.7	207.8	131.4	158.7	145.3	155.6
Pasture	1,774.7	4,849.9	3,201.8	2,494.5	2,759.8	2,561.7	2,747.5
Digesters	0.0	0.6	27.4	32.5	39.3	36.0	38.5
Other (mainly pit stor.)	119.7	71.2	2,530.7	2,364.5	2,855.4	2,615.8	2,799.7
Iberian Swine (Finishing/fattening pigs) (partial 3B3)							
Population (1000s)	**621.3**	**1,897.8**	**2,039.3**	**2,293.6**	**2,973.7**	**2,963.8**	**3,064.5**
N excr (kg/head/year)	12.0	11.0	9.9	11.0	11.5	11.3	11.3
TAN (Fraction)	0.8	0.8	0.7	0.8	0.8	0.8	0.8
Total N excr (ton/year)	**7,465.9**	**20,939.4**	**20,109.1**	**25,190.9**	**34,273.3**	**33,451.4**	**34,676.9**
N excretion per MMS							
Anaerobic lagoon	72.7	14.9	243.2	0.0	0.0	0.0	0.0
Liquid system	0.0	59.4	2,589.3	3,411.9	4,642.4	4,524.3	4,710.8
Daily spread	16.7	7.0	212.4	206.2	280.6	273.5	284.8
Solid storage and dry lot	114.4	33.5	821.2	577.5	785.8	765.8	797.3
Pasture	6,630.6	20,511.6	6,134.2	10,459.2	14,228.6	13,916.5	14,336.5
Digesters	0.0	2.5	108.4	142.9	194.4	189.5	197.3
Other	631.5	310.4	10,000.4	10,393.2	14,141.6	13,781.9	14,350.2
White Swine (Sows) (partial 3B3)							
Population (1000s)	**1,891.1**	**2,420.4**	**2,233.2**	**2,138.4**	**2,205.0**	**2,284.9**	**2,330.0**
N excr (kg/head/year)	19.4	19.8	18.5	18.7	18.5	18.6	19.3
TAN (Fraction)	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Total N excr (ton/year)	**36,613.9**	**47,868.6**	**41,304.6**	**40,039.5**	**40,876.6**	**42,428.2**	**44,899.7**
N excretion per MMS							
Anaerobic lagoon	3,185.4	1,665.8	718.7	0.0	0.0	0.0	0.0
Liquid system	0.0	6,651.8	7,652.9	9,273.2	9,467.0	9,826.4	10,398.8
Daily spread	732.3	785.0	627.8	560.6	572.3	594.0	628.6
Solid storage and dry lot	5,016.1	3,749.1	2,427.1	1,569.5	1,602.4	1,663.2	1,760.1
Pasture	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Digesters	0.0	278.6	320.5	388.4	396.5	411.6	435.5
Other (mainly pit stor.)	27,680.1	34,738.2	29,557.5	28,247.9	28,838.4	29,933.1	31,676.8
White Swine (Finishing/fattening pigs) (partial 3B3)							
Population (1000s)	**13,683.7**	**20,615.2**	**20,712.8**	**22,657.5**	**25,258.3**	**26,454.2**	**27,634.5**
N excr (kg/head/year)	10.8	10.5	8.2	8.2	8.2	8.3	7.5
TAN (Fraction)	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Total N excr (ton/year)	**148,067.8**	**215,771.6**	**169,628.8**	**185,071.8**	**206,599.2**	**219,373.9**	**207,017.2**
N excretion per MMS							
Anaerobic lagoon	12,881.9	7,508.9	2,951.5	0.0	0.0	0.0	0.0
Liquid system	0.0	29,983.6	31,428.8	42,862.6	47,848.4	50,807.0	47,945.2
Daily spread	2,961.4	3,538.7	2,578.4	2,591.0	2,892.4	3,071.2	2,898.2
Solid storage and dry lot	20,285.3	16,899.2	9,967.4	7,254.8	8,098.7	8,599.5	8,115.1
Pasture	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Digesters	0.0	1,255.8	1,316.3	1,795.2	2,004.0	2,127.9	2,008.1
Other	111,939.2	156,585.4	121,386.4	130,568.1	145,755.8	154,768.3	146,050.7
Horses (3B4e)							
Population (1000s)	**243.3**	**263.8**	**622.1**	**663.8**	**584.6**	**587.3**	**602.4**

	1990	2005	2010	2015	2019	2020	2021
N excr (kg/head/year)	54.1	54.8	54.2	52.4	53.4	53.5	53.8
TAN (Fraction)	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Total N excr (ton/year)	**13,171.9**	**14,467.4**	**33,692.5**	**34,801.7**	**31,228.3**	**31,426.0**	**32,388.3**
N excretion per MMS							
Anaerobic lagoon	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Liquid system	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Daily spread	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Solid storage and dry lot	4,699.4	5,347.6	10,766.6	11,512.3	12,233.1	12,332.6	13,360.3
Pasture	7,772.9	8,323.6	21,323.3	21,576.4	17,175.0	17,258.6	17,040.6
Digesters	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other	699.6	796.1	1,602.5	1,713.0	1,820.1	1,834.9	1,987.5
Mules and Asses (3B4f)							
Population (1000s)	**200.0**	**26.9**	**42.2**	**45.2**	**40.1**	**40.2**	**40.2**
N excr (kg/head/year)	34.8	31.5	31.3	31.1	31.6	31.6	31.5
TAN (Fraction)	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Total N excr (ton/year)	**6,953.4**	**848.2**	**1,319.9**	**1,407.6**	**1,269.0**	**1,270.1**	**1,267.6**
N excretion per MMS							
Anaerobic lagoon	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Liquid system	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Daily spread	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Solid storage and dry lot	2,835.1	269.4	353.5	421.6	417.7	412.2	405.5
Pasture	3,694.7	538.5	913.6	923.0	788.8	796.3	801.5
Digesters	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other	423.6	40.3	52.8	63.0	62.4	61.6	60.6
Poultry (Laying hens) (3B4gi)							
Population (1000s)	**46,366.5**	**49,307.9**	**49,343.2**	**46,432.9**	**46,361.4**	**48,941.7**	**47,692.5**
N excr (kg/head/year)	0.7	0.6	0.6	0.6	0.6	0.6	0.6
TAN (Fraction)	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Total N excr (ton/year)	**31,124.2**	**31,805.4**	**30,429.6**	**27,943.8**	**28,183.3**	**30,778.9**	**30,024.1**
N excretion per MMS							
Liquid system	1,428.6	1,459.9	1,396.7	1,282.6	1,293.6	1,412.8	1,378.1
Solid poultry manure	3,736.4	3,818.2	3,653.0	3,354.6	3,383.4	3,695.0	3,604.4
Poultry (Broilers) (3B4gii)							
Population (1000s)	**64,892.5**	**76,086.7**	**75,419.4**	**78,944.1**	**88,862.8**	**84,009.4**	**82,118.3**
N excr (kg/head/year)	0.8	0.7	0.7	0.6	0.6	0.6	0.6
TAN (Fraction)	0.8	0.8	0.7	0.7	0.7	0.7	0.7
Total N excr (ton/year)	**49,736.3**	**51,428.0**	**49,427.9**	**49,306.5**	**55,501.5**	**53,887.4**	**52,674.4**
N excretion per MMS							
Solid poultry manure	49,736.3	51,428.0	49,427.9	49,306.5	55,501.5	53,887.4	52,674.4
Poultry (Turkeys) (3B4giii)							
Population (1000s)	**3,562.7**	**4,633.9**	**5,797.0**	**8,333.9**	**10,390.3**	**10,364.5**	**10,071.6**
N excr (kg/head/year)	1.5	1.2	1.5	1.3	1.3	1.3	1.3
TAN (Fraction)	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Total N excr (ton/year)	**5,171.2**	**5,576.1**	**8,511.2**	**10,999.3**	**13,713.3**	**12,967.5**	**12,601.0**
N excretion per MMS							
Solid poultry manure	5,171.2	5,576.1	8,511.2	10,999.3	13,713.3	12,967.5	12,601.0
Poultry (Other poultry (ducks and other)) (3B4giv)							
Population (1000s)	**15,933.9**	**19,964.4**	**13,878.4**	**11,704.3**	**10,581.6**	**10,642.9**	**12,854.6**
N excr (kg/head/year)	1.4	1.2	1.5	1.3	1.3	1.2	1.2
TAN (Fraction)	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Total N excr (ton/year)	**23,022.1**	**23,946.2**	**20,224.6**	**15,353.2**	**13,861.6**	**13,249.7**	**16,011.7**

	1990	2005	2010	2015	2019	2020	2021
N excretion per MMS							
Solid poultry manure	23,022.1	23,946.2	20,224.6	15,353.2	13,861.6	13,249.7	16,011.7
Rabbits (3B4gh)(*)							
Population (1000s)	**9,839.4**	**11,396.9**	**9,821.8**	**9,698.9**	**7,665.9**	**7,613.1**	**7,613.1**
N excr (kg/head/year)	8.1	8.1	8.1	8.1	8.1	8.1	8.1
TAN (Fraction)	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Total N excr (ton/year)	**79,699.0**	**92,314.5**	**79,556.9**	**78,560.9**	**62,094.1**	**61,665.8**	**61,665.8**
N excretion per MMS							
Solid storage and dry lot	79,699.0	92,314.5	79,556.9	78,560.9	62,094.1	61,665.8	61,665.8

(*) 2021 rabbits data have been replicated from 2020.

Distribution pattern of manure management for dairy cattle, non-dairy cattle and laying hens were estimated based on descriptive studies[16] (MARM, 2010) produced by the Ministry of Agriculture, Fisheries and Food (MAPA) and national producers associations for cattle and laying hens.

The changes in zootechnical variables for swine category between 2004 and 2006 are due to the combination of animal diets and relevant legislative changes in 2005, which led to a drastic change in the use of raw materials used in animal feeding, with significantly lower methane emissions rates. This trend has been maintained in the subsequent period. The same situation occurs with cattle, where certain effects of changes in feeding and advances in technology in the sector with strong impulses in certain years generate changes in certain zootechnical coefficients, such as between 2009 and 2010. Full details of the criteria and formulas used can be found in the zootechnical reports (see table 5.4.3).

Furthermore, significant changes occurred in animal feeding as from 2005 for white swine. Specifically, the use of growth-promoting antibiotics in animal feeding was banned altogether, resulting in a radical change in feeding conditions. Raw materials with lowest digestibility were removed and trends were modified, mainly carbohydrates (products difficult to digest as cassava were eliminated from diets, and replaced by cereals). In terms of protein intake, the soybean 47 replaced the soybean 44 in a systematic way, seeking a higher digestibility and quality protein supply. Also, affordable synthetic amino acids and digestive enzymes were systematically introduced. In addition, during the same year, the regulation on additives used in animal feeding was published, forcing the withdrawal of products that were being used to date, in order to facilitate the digestion of other diet components. White swine breeding is particularly intensive and homogeneous.

On the other hand, it is important to note regarding iberian swine that its breeding in Spain has been developing an intensification process since 2005, which manifests a clear decrease in grazing system in contrast to an increase in manure management systems with storage, typical of intensive facilities, such as slurry storage or pit storage under the animal.

[16] https://www.mapa.gob.es/es/ganaderia/publicaciones/Bovino%20cebo_tcm30-105325.pdf
https://www.mapa.gob.es/es/ganaderia/publicaciones/Bovino%20leche_tcm30-105326.pdf
https://www.mapa.gob.es/es/ganaderia/publicaciones/AVES%20DE%20PUESTA_tcm30-105324.pdf

Nitrogen excreted values for white swine in 2021 is obtained from ECOGAN[17] (computerized system), which is a new calculation application based on the methodology explained in the zootechnical document for this animal[18], but in which certain input parameters, such as the configuration of the rations, the way of feeding the animals or BATs used, are entered by the farmers themselves through registration. The annual results are presented in a report that can be consulted on the MAPA website[19].

All along the time series, ammonia emissions evolve in parallel with the variable of activity, livestock population, except for animals for which information on abatement measures is available. From 2005 onwards, Spanish inventory has taken into account abatement measures implemented for manure management in swine farms. The measure penetration rate and the distribution pattern of manure management were estimated based on surveys for white swine performed during 2015-2016 (results are not published but they are available in case of need).

For swine, BATs penetration rate applied have been estimated through surveys performed during 2015-2016 for white swine (results are not published but they are available in case of need) and the other hand with data from ECOGAN register for white&iberian swine for the year 2021. For this overlap, BATs from 2015 surveys, with progressive implementation since 2003 and progressive dis-implementation between 2015 and 2020, have been implemented join with BATs from ECOGAN data from 2021, with progressive implementation since 2015. 2021 has been the first year of operation of ECOGAN, as well as of the aforementioned BATs annual report, so the population universe accommodates only a fraction of the census population of these animals; for this reason, and as a conservative criterion, ECOGAN BATs data have been proportionally reduced to this fraction.

Table 5.4.5 Reduction of 3B ammonia emissions for swine (ECOGAN 2021)

	Building(*)	Storage(*)
White swine (sows)	9.68%	20.51%
White swine (fattening)	10.65%	18.14%
Iberian swine (sows)	3.71%	7.68%
Iberian swine (fattening)	4.09%	7.64%

(*) Conservative criterion data

Next graphics show the progression of the two main drivers linked to ammonia emissions in category 3B where can see a difference between a non-dairy cattle category for whose BATs there are not yet available ECOGAN data and swine category for which BATs are considered.

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17 ECOGAN - National electronic support that facilitates the calculation, monitoring and notification of the emissions of each farm, as well as the notification to the General Registry of BATs available in the web of the Ministry of Agriculture, Fisheries and Food (MAPA). It is currently available for swine, the rest of livestock species will be incorporated as the corresponding management regulations are implemented.
https://www.mapa.gob.es/es/ganaderia/temas/ganaderia-y-medio-ambiente/calculo-emisiones/default.aspx

18 Zootechnical documents - https://www.mapa.gob.es/es/ganaderia/temas/ganaderia-y-medio-ambiente/balance-de-nitrogeno-e-inventario-de-emisiones-de-gases/default.aspx

19 Swine BATs 2021 report - https://www.mapa.gob.es/es/ganaderia/temas/ganaderia-y-medio-ambiente/informeimplantacionmtdsporcinointensivo2021env_tcm30-636072.pdf

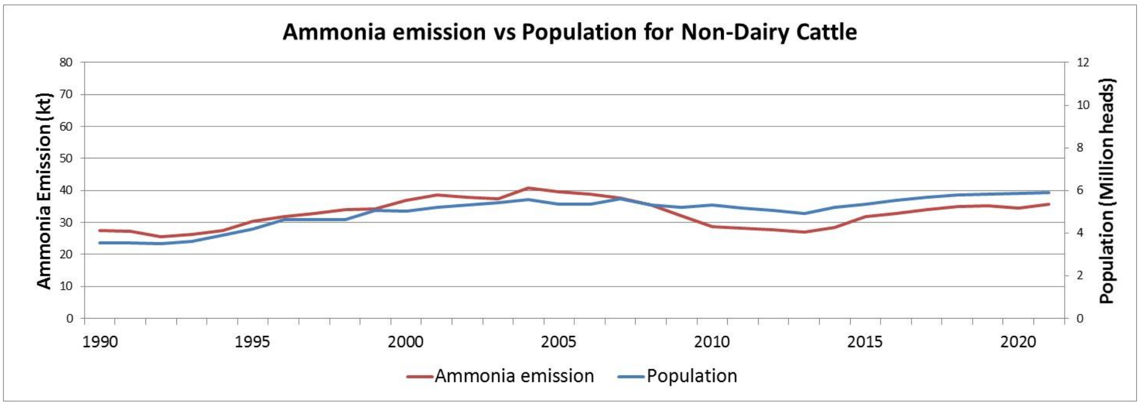


Figure 5.4.2 Variation of NH_3 emissions for Non-Dairy Cattle (3B1b)

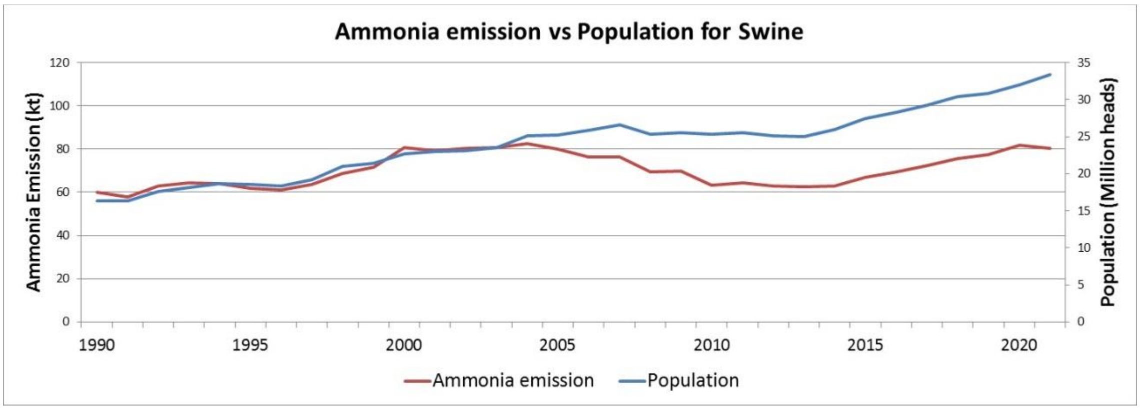


Figure 5.4.3 Variation of NH_3 emissions for Swine (White swine & Iberian swine) (3B3)

In addition, it should be mentioned that for dairy-cattle, milk yield per capita has increased while there is a decrease in the populations of this livestock species and milk production is maintained and, consequently, although the Nex (excreted nitrogen) and TAN (total ammoniacal nitrogen) per head increases (table 5.4.4), a reduction in the emission rate per quantity of milk obtained is achieved. This is due to the increase in the production efficiency of animals, as a result of genetic selection and improvement of farm management, as can be seen in the following graphics.

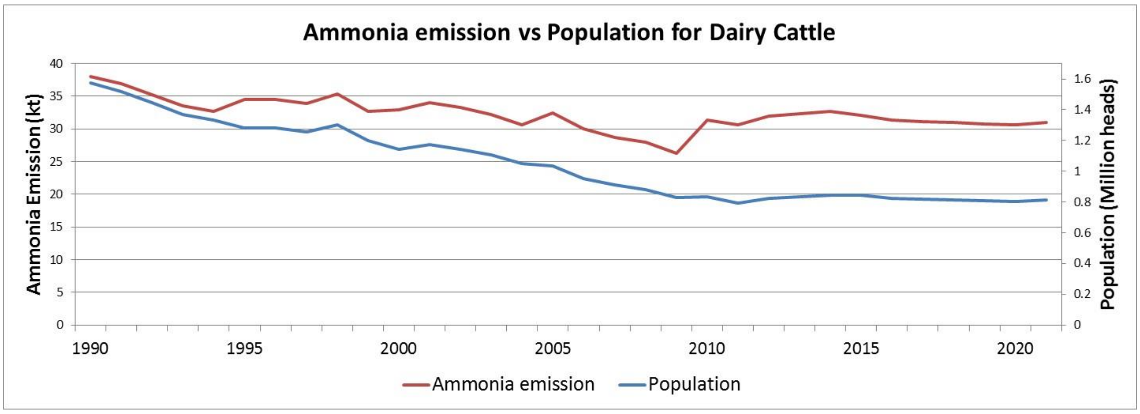


Figure 5.4.4 Ammonia emission vs population for Dairy Cattle

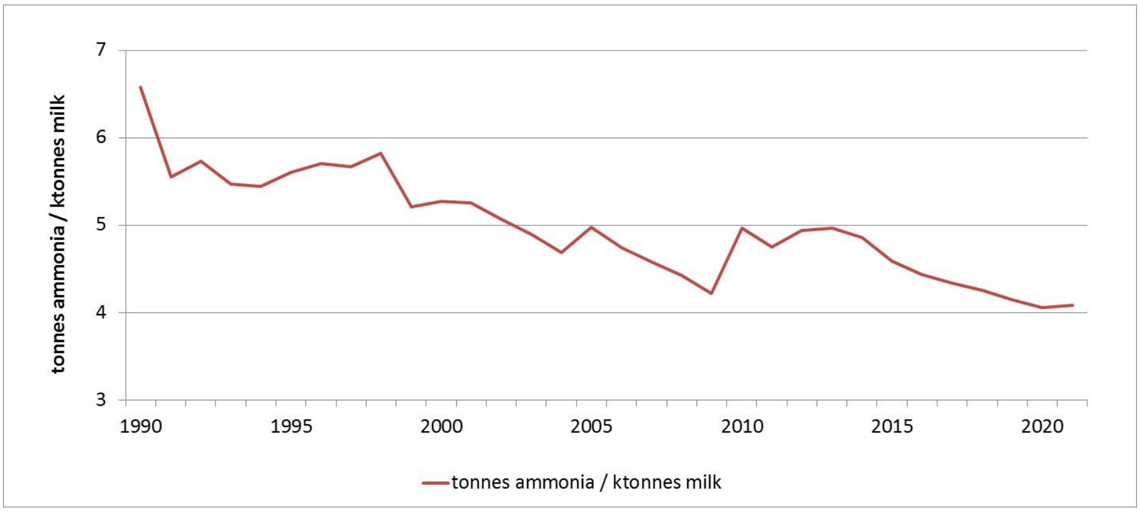


Figure 5.4.5 Emission rate per quantity of milk obtained for Dairy Cattle

Emissions of nitrogen compounds by agricultural N-fertilization activity and manure management in 2021 are shown in a Sankey diagram (see figure 5.4.13).

Relative contributions to ammonia emissions by animal category in 2021, is shown in the following chart.

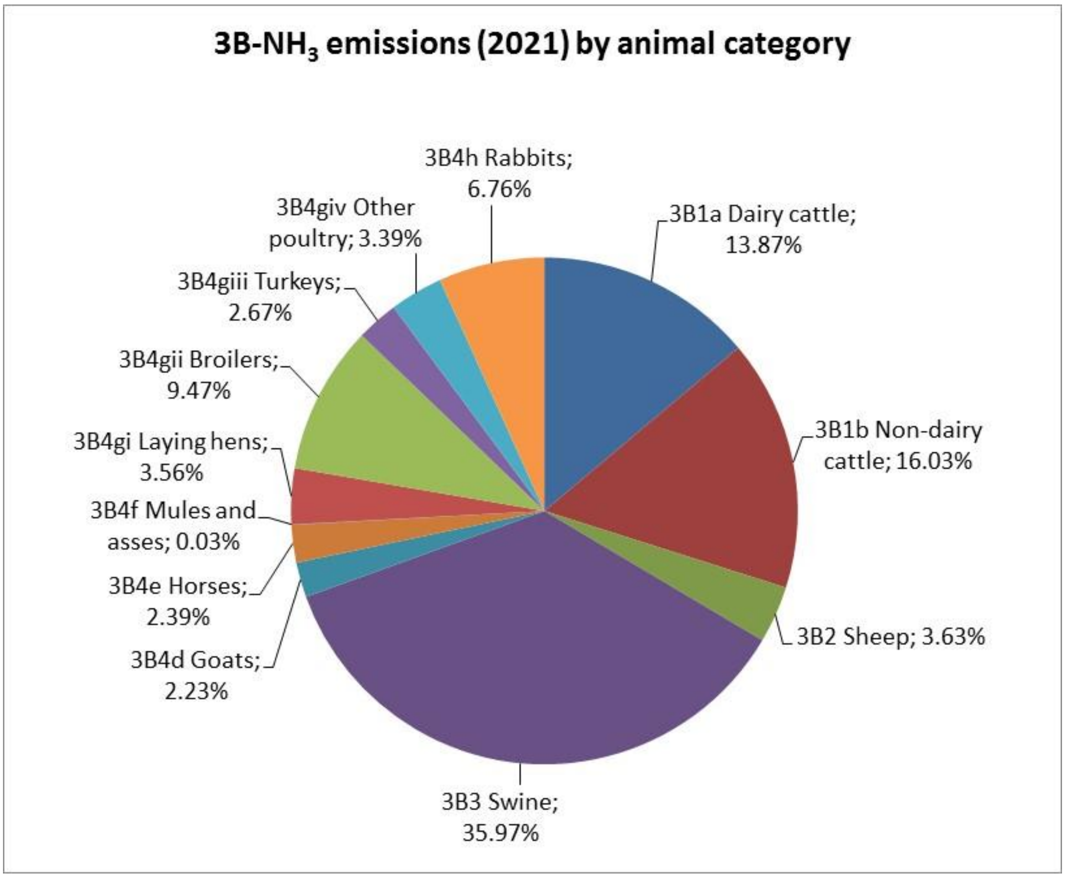


Figure 5.4.6 3B-NH_3 emissions (2021) by animal category

On the other hand, in the following table and chart, values of housing days by animal for the time series are provided[20]. These data are used to calculate NMVOC, $PM_{2.5}$, PM_{10} and TSP emissions.

Table 5.4.6 Housing days by animal

	1990	2005	2010	2015	2019	2020	2021
Dairy cattle	365	365	365	365	365	365	365
Non-dairy cattle	156	132	120	127	129	127	127
Sheep	99	81	96	105	102	101	100
Goats	91	165	218	194	236	247	248
Iberian swine (sows)	37	8	212	222	230	229	229
Iberian swine (fattening)	40	9	270	238	238	238	238
White swine (sows)	365	365	365	365	365	365	365
White swine (fattening)	365	365	365	365	365	365	365
Poultry (Laying hens)	365	365	365	365	365	365	365
Poultry (Broilers)	365	365	365	365	365	365	365
Poultry (Turkeys)	365	365	365	365	365	365	365
Poultry (other poultry)	365	365	365	365	365	365	365
Horses	136	142	120	125	151	151	160
Mules	219	215	182	211	226	225	229
Asses	61	66	52	58	68	67	65
Rabbits	365	365	365	365	365	365	365

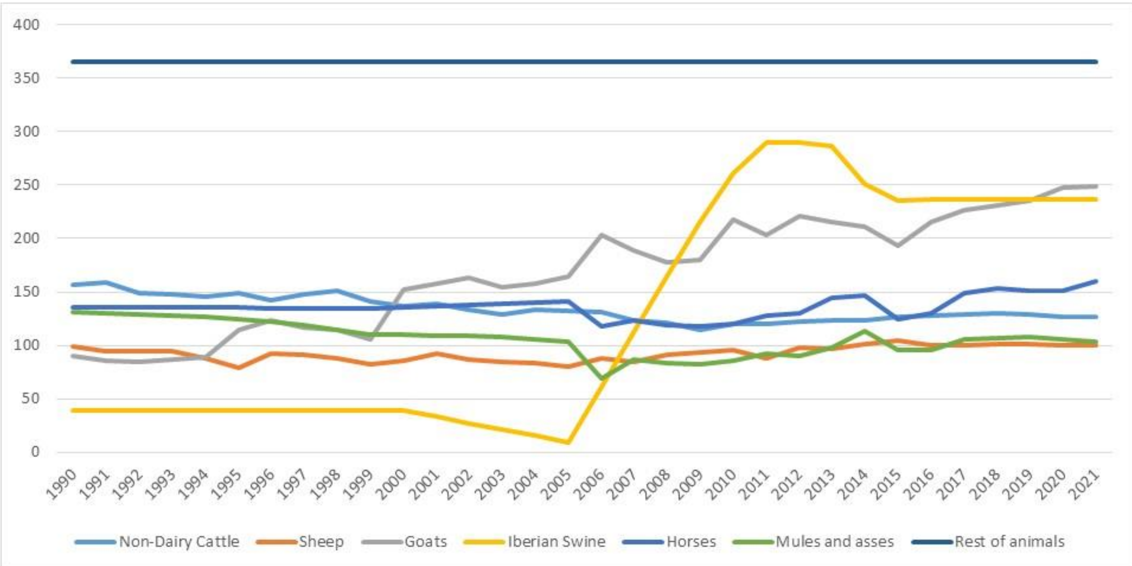


Figure 5.4.7 Housing days by animal (2021)

Further, in the following tables, values of gross energy intake, excreted VS (volatile solids), and fraction of silage feeding by animal for the time series are provided[21]. These data are used to calculate NMVOC.

[20] Recommendation made by the ERT in the 2019 and 2022 NECD Final Review Report

[21] Recommendation made by the ERT in the 2019 NECD Final Review Report

Table 5.4.7 Gross energy intake (MJ/head/day) by animal

	1990	2005	2010	2015	2019	2020	2021
Dairy cattle	200.43	250.54	275.27	292.61	293.21	293.16	293.30
Non-dairy cattle	147.94	145.51	148.24	146.20	145.51	145.91	147.10

Table 5.4.8 Excreted VS (kg/head/day) by animal

	1990	2005	2010	2015	2019	2020	2021
Sheep	0.32	0.38	0.41	0.38	0.38	0.38	0.38
Goats	0.44	0.43	0.41	0.39	0.37	0.37	0.37
Iberian swine (sows)	0.63	0.59	0.52	0.52	0.51	0.52	0.51
Iberian swine (fattening)	0.33	0.30	0.25	0.27	0.28	0.28	0.28
White swine (sows)	0.73	0.73	0.71	0.73	0.72	0.73	0.73
White swine (fattening)	0.40	0.42	0.33	0.33	0.33	0.34	0.34
Poultry (Laying hens)	0.01	0.01	0.01	0.01	0.01	0.02	0.02
Poultry (Broilers)	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Poultry (Turkeys)	0.03	0.03	0.04	0.04	0.04	0.03	0.03
Poultry (other poultry)	0.03	0.03	0.04	0.04	0.04	0.03	0.03
Horses	2.79	2.83	2.72	2.71	2.75	2.75	2.76
Mules and Asses	2.63	2.48	2.37	2.45	2.52	2.51	2.51
Rabbits	0.10	0.10	0.10	0.10	0.10	0.10	0.10

Table 5.4.9 Fraction of silage feeding by animal

	1990	2005	2010	2015	2019	2020	2021
Dairy cattle	0.44	0.41	0.50	0.53	0.53	0.53	0.53
Non-dairy cattle	0.09	0.07	0.07	0.06	0.05	0.05	0.05
Sheep	0	0	0	0	0	0	0
Goats	0	0	0	0	0	0	0
Swine	0	0	0	0	0	0	0
Horses, Mules and Asses	0	0	0	0	0	0	0

As a novelty in this 2023 edition of the IIR, rabbit emissions data are reported (3B4h).

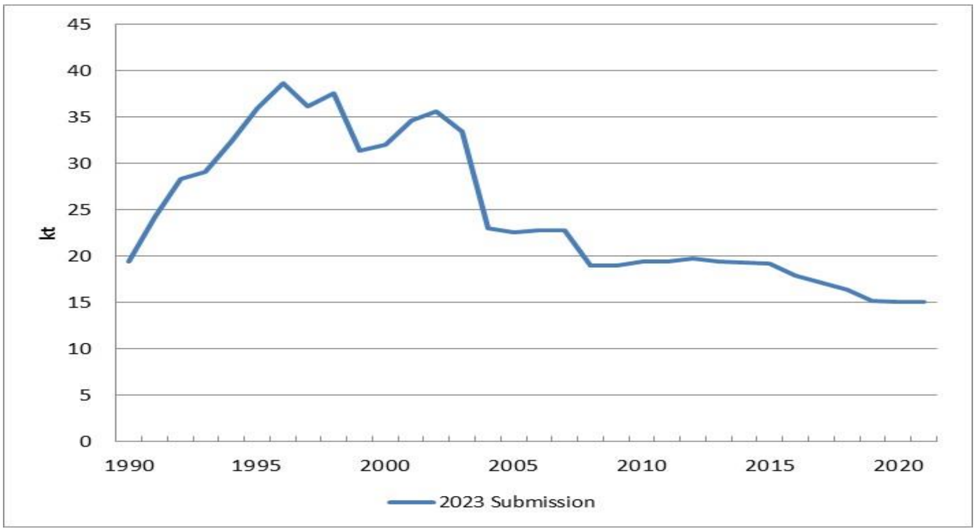


Figure 5.4.8 NH_3 emissions (1990-2021) from rabbits (3B4h)

In addition, emissions from turkeys (3B4giii) are reported separately, which until the last edition were included in the category of other poultry (3B4giv).

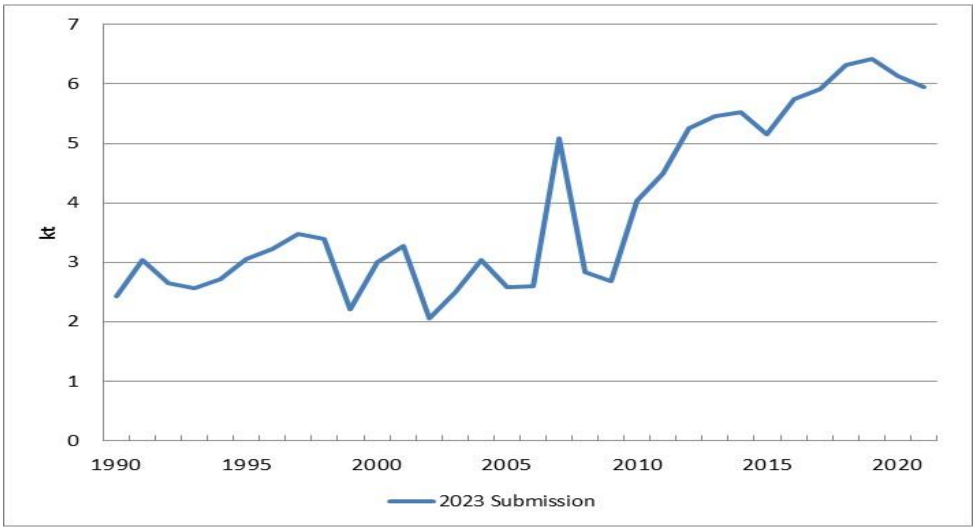


Figure 5.4.9 NH_3 emissions (1990-2021) from turkeys (3B4giii)

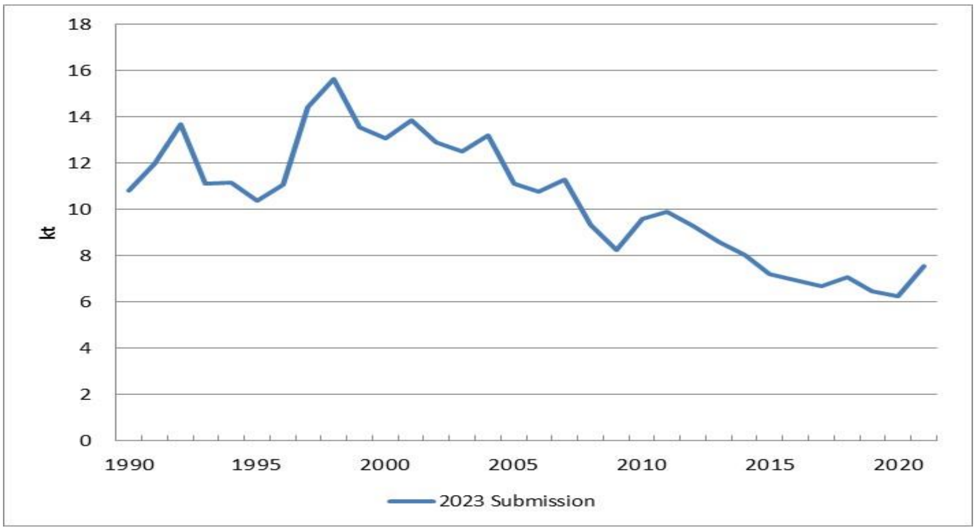


Figure 5.4.10 NH_3 emissions (1990-2021) from other poultry (3B4giv)

B. Crop production and agricultural soils (3D)

Category 3D “Crop Production and Agricultural Soils” is considered as a key category for its contribution to the level of NH_3 and $PM_{2.5}$ emissions, for its contribution to the trend of HCB emissions and for its contribution to the level and the trend of emissions of the following pollutants NOx, NMVOC, PM_{10} and TSP.

B.1. Activity Variables

Table 5.4.10 Summary of activity variables, data and information sources for category 3D (Crop production and agricultural soils)

Activities included	Activity data	Source of information
Inorganic N-fertilizers (includes urea application) (**3Da1**)	- Fertilizer sales (by N-fertilizer type at a national level). - % of N-fertilizer applied to cultivated areas is disaggregated by N-fertilizer type, crop species and irrigation system at a provincial level (region).	- MAPA´s Statistic Yearbook. - ESYRCE[22] (Crop Yield and Cultivated Areas Survey) Report on irrigation in Spain. - Nitrogen and Phosphorous Balance in Spanish Agriculture Book (BNPAE), several years[23].
Animal manure applied to soils (**3Da2a**)	- Amount of N excreted from manure by animal species, by productive category, by breeding system at a provincial level. - % of N excreted aimed at fertilization.	- Documentation cited in category 3B to estimate N excreted by livestock.
Sewage sludge applied to soils (**3Da2b**)	- Sewage sludge applied to soils as fertilizer.	- 1990-1992- Interpolation between data of 1989 provided by “The Environment in Spain” (MOPT, 1991) and data of 1993 provided by “Study on treatment and final disposal of urban wastewater sewage sludge” (CADIC, S.A., 1993). - 1993-1996-Interpolation between the MOPT study and the first available year from “National Sewage Register” (MITECO). - 1997-2020. “National Sewage Register” (MITECO). - 2021. 2020 “National Sewage Register” data is replicated due to lack of consolidated information from this year on.
	- Nitrogen contained in sludge.	- Nitrogen contained in sludge (0.0395 (kg N /kg sludge residues) Sludge composition provided by “National Sewage Register” (MITECO). “Caracterización de los lodos de depuradoras generados en España” MAPAMA 2009. Pag. 29.
	- Provincial distribution of sludge application to soils.	- Provincial proportion of national total sludge application to soil is provided by BNPAE.
Other organic fertilizers applied to soils (including compost) (**3Da2c**)	- Amount of organic waste intended to compost. - Nitrogen contained in compost production.	- Information of composting facilities and waste amount entering the composting process, provided by the SG Circular Economy.
Urine and dung deposited by grazing animals (**3Da3**)	- Amount of N excreted from grazing.	- Documentation cited in category 3B to estimate N excreted by livestock (3B Manure Management).
Farm-level agricultural operations (**3Dc**)	- Cultivated surface.	- MAPA´s Statistic Yearbook. - BNPAE.

[22] https://www.mapa.gob.es/es/estadistica/temas/estadisticas-agrarias/agricultura/esyrce/

[23] BNPAE results are annually submitted to EUROSTAT Nitrogen Balance database.

Activities included	Activity data	Source of information
Cultivated crops (**3De**)	- Cultivated Surface.	- MAPA´s Statistic Yearbook. - BNPAE.
Use of pesticides (**3Df**)	- Amount of active substances with HCB impurities.	- MAPA (Ministry for Agriculture, Fisheries and Food).

B.2. Methodology

The following table summarises the methodologies applied in this chapter. Methodology level and sources are provided for reference.

Table 5.4.11 Summary of methodologies applied in category 3D (Crop production and agricultural soils)

Pollutants	Tier	Methodology applied	Observations
Inorganic N-fertilizers (3Da1)			
NH_3	T2	- EMEP/EEA Guidebook (2019).	- EF (3D Crop production and agricultural soils- Table 3-2). - Reduction Factors applied according to “Options for ammonia mitigation. Guidance from the UNECE Task Force on Reactive Nitrogen” (Chapter 8: Fertilizer application)[24]. - Methodology factsheet: (Direct emissions by mineral nitrogen fertilizers application to soil)[25].
NOx	T1	- EMEP/EEA Guidebook (2019).	- EF (3D Crop production and agricultural soils- Table 3-1). - Methodology factsheet: (Direct emissions by mineral nitrogen fertilizers application to soil).
Animal manure applied to soils (3Da2a)			
NH_3	T2	- EMEP/EEA Guidebook (2019).	- N-mass balance methodology (3B Manure management section 3.4 - Tier 2 technology-specific approach, Table 3.9). - EF (3B Manure management- section 3.4 - Tier 2 technology specific approach, Table 3.9). - Reduction Factors applied according to “Options for ammonia mitigation. Guidance from the UNECE Task Force on Reactive Nitrogen” (Chapter 7: Manure application techniques). - BATs from 2010 MAPA surveys(***), with progressive implementation since 2003 for cattle and laying hens. BATs from 2010 surveys, with progressive implementation since 2003 and progressive dis-implementation between 2015 and 2020; BATs from ECOGAN(**) data from 2021, with progressive implementation since 2015 for swine. - Methodology factsheets from MITECO
NOx	T1	- EMEP/EEA Guidebook (2019).	- N-mass balance methodology (3B Manure management section 3.4 - Technology-specific approach, Table 3.9). - EF (3D Crop production and agricultural soils- section 3.3.2, Table 3.1). - Methodology factsheets from MITECO
NMVOC	T2	- EMEP/EEA Guidebook (2019).	- Algorithm for NMVOC emissions (3.B Manure management). - EF (3.B Manure management-Tables 3.11 and 3.12). - Relations of NH_3 emissions. - Methodology factsheet (NMVOC emissions during manure management, manure fertilization, and grazing).
Sewage sludge applied to soils (3Da2b)			
NH_3	T1	- EMEP/EEA Guidebook (2019).	- EF (3D Crop production and agricultural soils- section 3.3.2, Table 3.1).

[24] “Options for Ammonia Mitigation. Guidance from the UNECE Task Force on Reactive Nitrogen”, 2014 https://www.clrtap-tfrn.org/sites/clrtap-tfrn.org/files/documents/AGD_final_file.pdf.

[25] Recommendation made by the ERT in the 2019 NECD Final Review Report.

Pollutants	Tier	Methodology applied	Observations
NOx	T1	- EMEP/EEA Guidebook (2019).	- EF (3D Crop production and agricultural soils- section 3.3.2, Table 3.1).
Other organic fertilizers applied to soils (including compost) (3Da2c)			
NH_3	T1	- EMEP/EEA Guidebook (2019).	- EF (3D Crop production and agricultural soils- section 3.3.2, Table 3.1).
NOx	T1	- EMEP/EEA Guidebook (2019).	- EF (3D Crop production and agricultural soils- section 3.3.2, Table 3.1).
Urine and dung deposited by grazing animals (3Da3)			
NH_3	T2	- EMEP/EEA Guidebook (2019).	- N-mass balance methodology (3B Manure management section 3.4 - Tier 2 technology-specific approach, Table 3.9). - EF (3B Manure management- section 3.4 - Tier 2 technology-specific approach, Table 3.9). - Methodology factsheets from MITECO
NOx	T1	- EMEP/EEA Guidebook (2019).	- N-mass balance methodology (3B Manure management section 3.4 - Technology-specific approach, Table 3.9). - EF (3D Crop production and agricultural soils- section 3.3.2, Table 3.1). - Methodology factsheets from MITECO
NMVOC	T2	- EMEP/EEA Guidebook (2019).	- Algorithm for NMVOC emissions (3.B Manure management). - EF (3.B Manure management-Tables 3.11 and 3.12). - Methodology factsheet (NMVOC emissions during manure management, manure fertilization, and grazing).
Farm-level agricultural operations (3Dc)			
$PM_{2.5}$, PM_{10}, TSP	T2	- EMEP/EEA Guidebook (2019).	- EF (3D Crop production and agricultural soils, Tables 3.5-3.8). - Methodology (T1) factsheet: (Farm-level agricultural operations PM emissions).
Cultivated crops (3De)			
NMVOC	T2	- EMEP/EEA Guidebook (2019).	- EF (3D Crop production and agricultural soils, Table 3.3). - Methodology factsheet: (Crops. NMVOC emissions).
Use of pesticides (3Df)			
HCB	T1	- EMEP/EEA Guidebook (2019).	- Impurity factor (3Df, 3I Agriculture other including use of pesticides) Table 3.

For the particular case of 3Da1 Inorganic N-fertilizers, to calculate nitrogen emissions (NH_3, NOx) from inorganic fertilized crops, the Spanish Inventory Team has proceeded the following way:

– Equivalence between nitrogen need according to annual yields (obtained from the 'Nitrogen and Phosphorous Balance in Spanish Agriculture Book' (BNPAE)) and nitrogen uptake by crop (presuming enough nitrogen availability) has been assumed. According to the nitrogen need by crop and province estimated by the BNPAE, a distribution pattern of nitrogen applied to soils has been designed for the total national territory, by species, by province. Due to the lack of enough information about the fertilizer type applied on every crop and province, this proportional allocation of every chemical form commercialized has been adopted.

– The "Informe sobre regadíos en España" (Spanish Irrigation Report) run by ESYRCE provides irrigation type and extension by main crops and Autonomous Communities. The Inventory crosses this information with the above paragraph results for estimation of implementation level of possible options for ammonia mitigation.

– Once the amount of nitrogen from every fertilizer type applied $\left(\frac{\mathrm{kg\ N_{fertilize-type}}}{\mathrm{year \times crop \times province}}\right)$ has been established, it is then multiplied by the appropriate emission factor taking into account the pH-soil and temperature characterization of every province in Spain (see table 5.4.13).

– Information about performance of Good Agricultural Practices of fertilizer application has been collected from a survey, whose results are published by the MAPA´s Statistic Yearbook. When the implemented extent of those practices has been determined, a reduction factor is assigned according to "Options for ammonia mitigation. Guidance from the UNECE Task Force on Reactive Nitrogen"[26]. If a range of reduction was available, the interval average was chosen (see table 5.4.14).

B.3. Assessment

The chart below shows the time series evolution of N-fertilizers applied to soils.

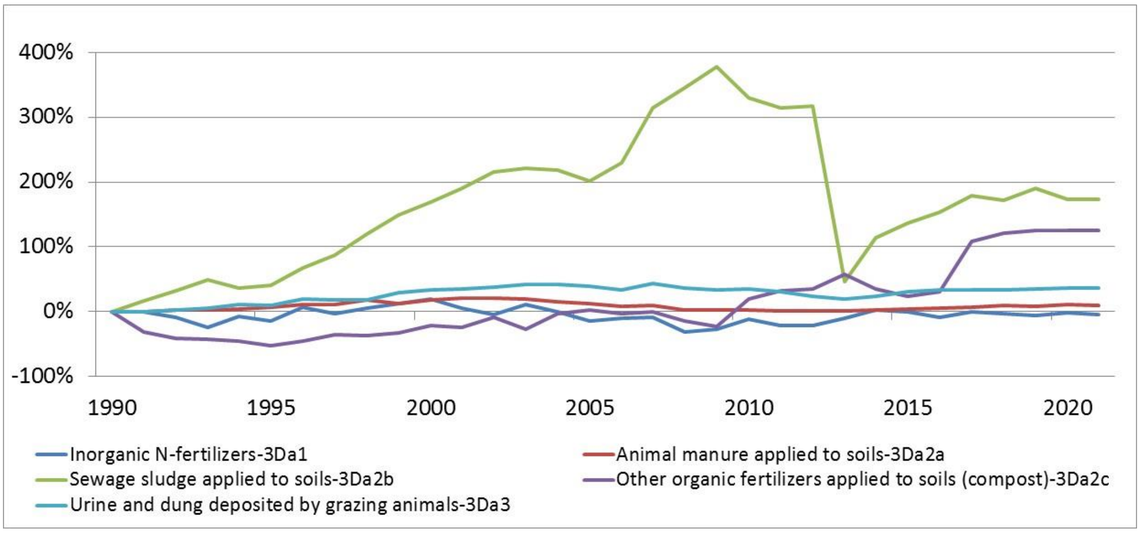


Figure 5.4.11 Variation ratio of N applied by fertilizers with respect to 1990

In relative terms, sewage sludge suffers a strong increase with respect to the base year, until 2012. From 2013 a significant decrease is observed following the entry into force of the Spanish Ministerial Order AAA/1072/2013, of 7 June, on the use of sewage sludge in the agriculture sector. Next graph shows the progression from 1990 and the impact of each subcategory on total N applied.

[26] "Options for Ammonia Mitigation. Guidance from the UNECE Task Force on Reactive Nitrogen", 2014.

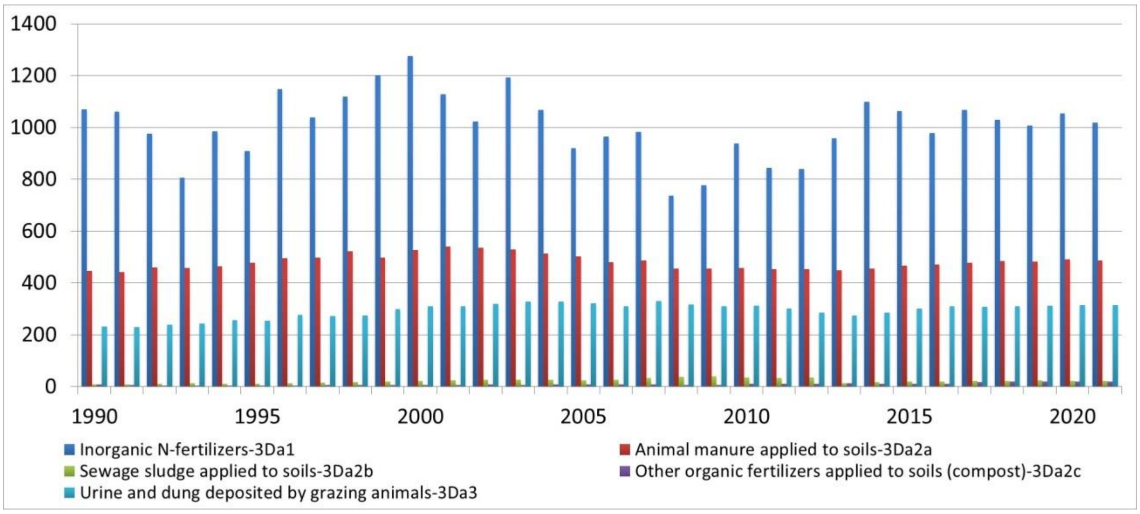


Figure 5.4.12 N applied by source (kt/year)

In the following table, the values of N applied to soil for the time series are provided in kt/year.

Table 5.4.12 N applied to soil by 3D category (kt/year)

	1990	2005	2010	2015	2019	2020	2021
3Da1	1,069.34	919.99	937.34	1,063.79	1,006.43	1,055.02	1,018.07
3Da2a	445.75	501.42	456.96	465.94	482.82	491.89	487.02
3Da2b	8.22	24.82	35.36	19.46	23.86	22.42	22.42
3Da2c	8.51	8.78	10.22	10.53	19.19	19.19	19.19
3Da3	231.49	321.81	313.03	301.22	312.40	314.75	315.21
Total	**1,763.31**	**1,776.82**	**1,752.91**	**1,860.94**	**1,844.70**	**1,903.27**	**1,861.91**

An approximate Sankey diagram of the nitrogen flows along the different agriculture sectors and pools (N-fertilization and manure management) and the corresponding emissions of nitrogen compounds in 2021 is shown in the following Sankey diagram.

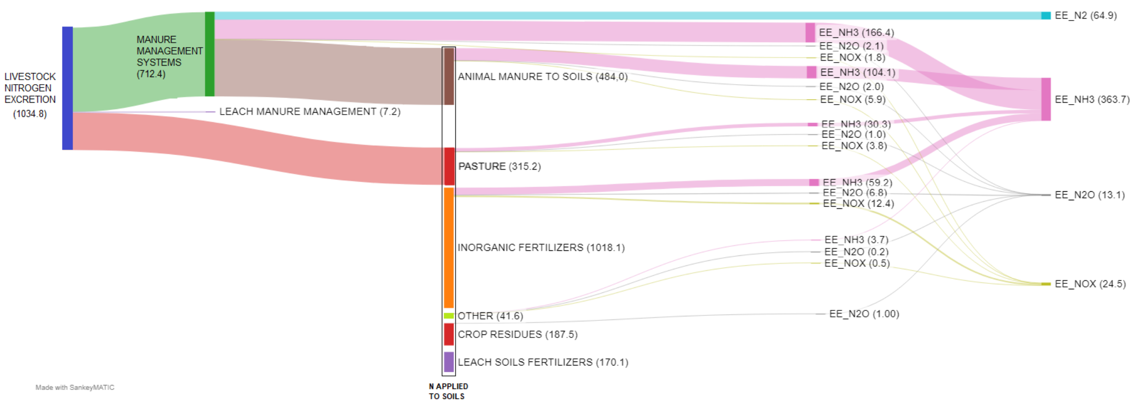


Figure 5.4.13 Emissions of nitrogen compounds by agricultural N-fertilization activity and manure management in 2021 (kt N)

The following pie chart displays the main relative contributions within category 3D in 2021 for NH_3 emissions.

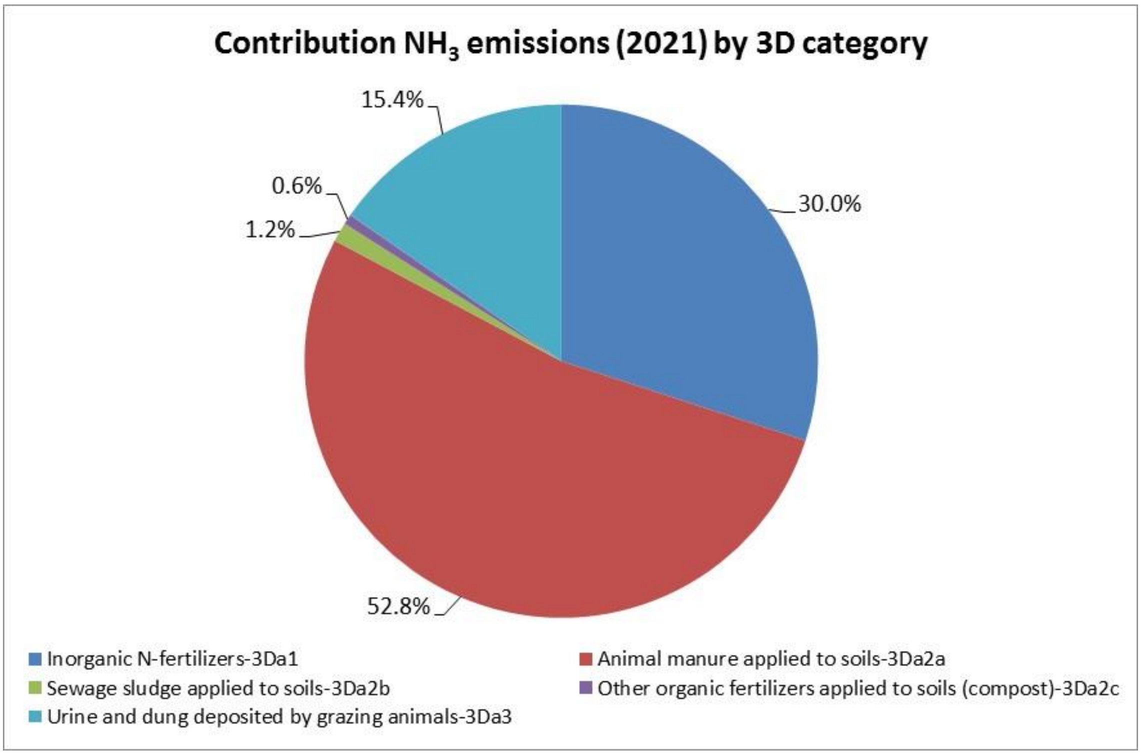


Figure 5.4.14 Contribution of NH_3 emissions (2021) by N applied to soil

Regarding 3Da1 category (Inorganic N-fertilizers), values of N applied to soil by type N-fertilizer and climate-pH provincial, as well as description of applied BATs are provided.[27]

Table 5.4.13 N applied to soil by type N-fertilizer and climate-pH provincial (t/year) in 2021(*)

Climate-pH provincial		1. Ammonium sulphate (AS)	2. Ammonium nitrosulphate (ANS)	3. Calcium ammonium nitrate (CAN)	4. Ammonium nitrate (AN)	5. Urea	6. Calcium nitrate (CN)
N applied in cool provinces	Normal pH	13,705.30	5,993.87	14,952.62	4,870.39	20,976.11	1,965.79
	High pH	47,360.48	20,712.60	51,670.80	16,830.30	72,485.76	6,793.05
N applied in temperate provinces	Normal pH	4,991.26	2,182.87	5,445.52	1,773.72	7,639.18	715.91
	High pH	48,685.79	21,292.21	53,116.72	17,301.27	74,514.16	6,983.14
TOTAL		**114,742.83**	**50,181.56**	**125,185.66**	**40,775.69**	**175,615.21**	**16,457.89**

[27] Recommendation made by the ERT in the 2019 NECD Review Final Review Report.

Climate-pH provincial		7. Chile nitrate	8. Anhydrous ammonia (AH)	9. Nitrogen solutions	10. NK, NPK, NP mixtures	11. Other straight N compounds	TOTAL
N applied in cool provinces	Normal pH	0.0	110.63	10,515.09	34,764.24	13,747.54	**121,601.59**
	High pH	0.0	382.31	36,336.30	120,132.49	47,506.47	**420,210.57**
N applied in temperate provinces	Normal pH	0.0	40.29	3,829.44	12,660.61	5,006.64	**44,285.44**
	High pH	0.0	393.01	37,353.12	123,494.22	48,835.87	**431,969.51**
TOTAL		**0.0**	**926.25**	**88,033.95**	**291,051.56**	**115,096.53**	**1,018,067.12**

(*) Data without Canary Islands.

Table 5.4.14 Description of applied BATs in 3Da1 (Inorganic N-fertilizers (includes urea application))

BAT id	Abatement measure	Fertilizer	Crops	Dry land/Irrigation	Regions (provinces)	Reduction (fraction)	Source
1	Irrigation with at least 5 mm water immediately following fertilizer application	All	All	Fertilization-Irrigation	All	0.55 (0.4-0.7)	(*)
2	Incorporation of fertilizer into the soil	Ammonium sulphate	All crops	All	Castilla y León provinces	0.65 (0.5-0.8)	(*)
3	Incorporation of fertilizer into the soil	Urea	Cereals and beans	All	Castilla y León provinces	0.65 (0.5-0.8)	(*)
4	Close-slot injection	Urea	Rice	Irrigation land	Cataluña provinces	0.8	(*)
5	Close-slot injection	Urea	Rice	Irrigation land	Valencia provinces	0.8	(*)
6	Incorporation of fertilizer into the soil	Ammonium nitrosulphate, Calcium ammonium nitrate, Urea, Nitrogen solutions, NK,NPK,NP mixtures, Other straight N compounds	Rice	Irrigation land	Andalucía provinces	0.65 (0.5-0.8)	(*)
7	Incorporation of fertilizer into the soil	Ammonium nitrate, Nitrogen solutions, Other straight N compounds	Rice	Irrigation land	Aragón provinces	0.65 (0.5-0.8)	(*)
8	Incorporation of fertilizer into the soil	Ammonium nitrosulphate, Calcium ammonium nitrate, Ammonium nitrate, Urea	Rice	Irrigation land	Navarra province	0.65 (0.5-0.8)	(*)
9	Incorporation of fertilizer into the soil	Calcium ammonium nitrate	Vineyard	All	Extremadura provinces	0.65 (0.5-0.8)	(*)

BAT id	Abatement measure	Fertilizer	Crops	Dry land/Irrigation	Regions (provinces)	Reduction (fraction)	Source
10	Incorporation of fertilizer into the soil	Urea	Olive grove	Dry land	Extremadura provinces	0.65 (0.5-0.8)	(*)

(*) "Options for ammonia mitigation. Guidance from the UNECE Task Force on Reactive Nitrogen", 2014.

In the following table, values of NH_3 emissions due to Inorganic N-fertilizers application (3Da1) by type N-fertilizer for the time series are provided in tonnes/year.

Table 5.4.15 Values of NH_3 emissions (tonnes) by type N-fertilizer (Inorganic N-fertilizers application (3Da1 category)).

	1990	2005	2010	2015	2019	2020	2021
Ammonium sulphate (AS)	15,822	8,865	7,911	9,690	7,292	8,068	15,015
Ammonium nitrosulphate (ANS)	2,168	1,096	1,719	2,476	2,346	2,599	4,013
Calcium ammonium nitrate (CAN)	3,174	3,219	2,924	2,674	2,564	2,234	1,684
Ammonium nitrate (AN)	3,573	1,308	1,120	969	1,162	1,012	1,052
Urea	43,441	29,859	38,581	39,974	35,517	42,867	23,769
Calcium nitrate (CN)	56	117	104	113	92	150	129
Chile nitrate	30	12	35				
Anhydrous ammonia (AH)	622	109	68	43	50	26	26
Nitrogen solutions	4,645	6,044	4,973	8,575	7,768	8,551	7,355
NK, NPK,NP mixtures	18,795	14,888	12,179	14,030	16,362	16,768	17,019
Other straight N compounds	-	317	388	1,047	532	466	1,805
TOTAL	**92,325**	**65,833**	**70,002**	**79,591**	**73,686**	**82,742**	**71,870**

Regarding 3Da2a category (Animal manure applied to soils), reduction of ammonia emissions was applied to swine, cattle and laying hens according to UNECE Task Force on Reactive Nitrogen Guidance of "Options for Ammonia Mitigation"). BATs implemented in farms were identified and assigned a reduction factor according to the JRC document what was applied to the default emission factor according to equation 57, pg. 33 of EMEP/EEA Guidebook (2019). A summary is provided in the following table[28] (5.4.16).

BATs penetration rate used during application manure to soils were estimated based on descriptive studies[29] (MARM, 2010) produced by the Ministry of Agriculture, Fisheries and Food (MAPA) and national producers associations for cattle and laying hens, with progressive implementation between 2003 and 2010 and constant values from 2010 onwards.

For white swine, BATs penetration rate used during application manure to soils were estimated based on surveys for this livestock performed during 2015-2016 (results are not published but they are available in case of need) and the other hand with data from ECOGAN[30] register for white and Iberian swine for the year 2021. For this overlap, BATs from 2015 surveys, with

[28] Recommendation made by the ERT in the 2019 NECD. Final Review Report.

[29] https://www.mapa.gob.es/es/ganaderia/publicaciones/Bovino%20cebo_tcm30-105325.pdf
https://www.mapa.gob.es/es/ganaderia/publicaciones/Bovino%20leche_tcm30-105326.pdf
https://www.mapa.gob.es/es/ganaderia/publicaciones/AVES%20DE%20PUESTA_tcm30-105324.pdf

[30] ECOGAN - National electronic support that facilitates the calculation, monitoring and notification of the emissions of each farm, as well as the notification to the General Registry of BATs available in the web of the Ministry of Agriculture, Fisheries and Food (MAPA). It is currently available for swine; the rest of livestock species will be incorporated as the corresponding management regulations are implemented.
https://www.mapa.gob.es/es/ganaderia/temas/ganaderia-y-medio-ambiente/calculo-emisiones/default.aspx

progressive implementation since 2003 and progressive dis-implementation between 2015 and 2020, have been implemented join with BATs from ECOGAN data from 2021, with progressive implementation since 2015. The year 2021 has been the first year of operation of ECOGAN, as well as of the BATs annual report[31] obtained from it, so the population universe accommodates only a fraction of the census population of these animals; for this reason, and as a conservative criterion, ECOGAN BATs data have been proportionally reduced to this fraction.

Table 5.4.16 BAT implementation and reduction of ammonia emissions during manure application to soils in 2021

Animal		BAT	Imple-ment (fraction)	Reduction (fraction) (**)
Dairy cattle	slurry	Soil incorp by ploughing <4h after applic, slurry	0.0766	0.700
	solid	Soil incorp by ploughing 4 - 12 h after applic, solid	0.0610	0.550
	slurry	Soil incorp by ploughing 4 - 12 h after applic, slurry	0.1004	0.550
	solid	Soil incorp by ploughing 12 - 24 h after applic, solid	0.4120	0.500
	slurry	Soil incorp by ploughing 12 - 24 h after applic, slurry	0.0922	0.300
	solid	Soil incorp by ploughing >24 h after applic, solid	0.2950	0.300
	slurry	Soil incorp by ploughing >24 h after applic, slurry	0.2314	0.300
Non-dairy cattle	solid	Soil incorp by ploughing 4 - 12 h after applic, solid	0.0358	0.550
	slurry	Soil incorp by ploughing 4 - 12 h after applic, slurry	0.0200	0.550
	solid	Soil incorp by ploughing 12 - 24 h after applic, solid	0.3866	0.500
	slurry	Soil incorp by ploughing 12 - 24 h after applic, slurry	0.0710	0.300
	solid	Soil incorp by ploughing >24 h after applic, solid	0.2932	0.300
	slurry	Soil incorp by ploughing >24 h after applic, slurry	0.3530	0.300
Laying hens	slurry	Soil incorp by ploughing 4 - 12 h after applic, slurry	0.9900	0.550
	solid	Soil incorp by ploughing 12 - 24 h after applic, solid	0.0260	0.500
	solid	Soil incorp by ploughing >24 h after applic, solid	0.9740	0.300
White swine (fattening)(*)	slurry	Acidification	0.0000	0.600
	slurry	Dilution slurry	0.0125	0.300
	slurry	Band spreading slurry	0.3758	0.325
	slurry	Superficial injection	0.0213	0.700
	slurry	Deep injection	0.0422	0.900
	solid	Soil incorp by ploughing <4h after applic, solid	0.0205	0.600
	slurry	Soil incorp by ploughing <4h after applic, slurry	0.0205	0.700
	solid	Soil incorp by ploughing 4 - 12 h after applic, solid	0.0068	0.550
	slurry	Soil incorp by ploughing 4 - 12 h after applic, slurry	0.0068	0.550
	solid	Soil incorp by ploughing 12 - 24 h after applic, solid	0.0185	0.500
	slurry	Soil incorp by ploughing 12 - 24 h after applic, slurry	0.0185	0.300
	solid	Soil incorp by ploughing >24 h after applic, solid	0.0081	0.300
	slurry	Soil incorp by ploughing >24 h after applic, slurry	0.0081	0.300
White swine (sows)(*)	slurry	Acidification	0.0000	0.600
	slurry	Dilution slurry	0.0020	0.300
	slurry	Band spreading slurry	0.3383	0.325

[31] Swine BATs 2021 report - https://www.mapa.gob.es/es/ganaderia/temas/ganaderia-y-medio-ambiente/informeimplantacionmtdsporcinointensivo2021env_tcm30-636072.pdf

Animal		BAT	Imple-ment (fraction)	Reduction (fraction) (**)
	slurry	Superficial injection	0.0225	0.700
	slurry	Deep injection	0.0459	0.900
	solid	Soil incorp by ploughing <4h after applic, solid	0.0058	0.600
	slurry	Soil incorp by ploughing <4h after applic, slurry	0.0058	0.700
	solid	Soil incorp by ploughing 4 - 12 h after applic, solid	0.0007	0.550
	slurry	Soil incorp by ploughing 4 - 12 h after applic, slurry	0.0007	0.550
	solid	Soil incorp by ploughing 12 - 24 h after applic, solid	0.0075	0.500
	slurry	Soil incorp by ploughing 12 - 24 h after applic, slurry	0.0075	0.300
	solid	Soil incorp by ploughing >24 h after applic, solid	0.0041	0.300
	slurry	Soil incorp by ploughing >24 h after applic, slurry	0.0041	0.300
Iberian swine (fattening)(*)	slurry	Acidification	0.0018	0.600
	slurry	Dilution slurry	0.0246	0.300
	slurry	Band spreading slurry	0.1817	0.325
	slurry	Superficial injection	0.0206	0.700
	slurry	Deep injection	0.0146	0.900
	solid	Soil incorp by ploughing <4h after applic, solid	0.0430	0.600
	slurry	Soil incorp by ploughing <4h after applic, slurry	0.0430	0.700
	solid	Soil incorp by ploughing 4 - 12 h after applic, solid	0.0024	0.550
	slurry	Soil incorp by ploughing 4 - 12 h after applic, slurry	0.0024	0.550
	solid	Soil incorp by ploughing 12 - 24 h after applic, solid	0.0627	0.500
	slurry	Soil incorp by ploughing 12 - 24 h after applic, slurry	0.0627	0.300
	solid	Soil incorp by ploughing >24 h after applic, solid	0.0351	0.300
	slurry	Soil incorp by ploughing >24 h after applic, slurry	0.0351	0.300
Iberian swine (sows)(*)	slurry	Acidification	0.0013	0.600
	slurry	Dilution slurry	0.0133	0.300
	slurry	Band spreading slurry	0.1713	0.325
	slurry	Superficial injection	0.0078	0.700
	slurry	Deep injection	0.0187	0.900
	solid	Soil incorp by ploughing <4h after applic, solid	0.0281	0.600
	slurry	Soil incorp by ploughing <4h after applic, slurry	0.0281	0.700
	solid	Soil incorp by ploughing 4 - 12 h after applic, solid	0.0040	0.550
	slurry	Soil incorp by ploughing 4 - 12 h after applic, slurry	0.0040	0.550
	solid	Soil incorp by ploughing 12 - 24 h after applic, solid	0.1149	0.500
	slurry	Soil incorp by ploughing 12 - 24 h after applic, slurry	0.1149	0.300
	solid	Soil incorp by ploughing >24 h after applic, solid	0.0426	0.300
	slurry	Soil incorp by ploughing >24 h after applic, slurry	0.0426	0.300

(*) Conservative criterion data for implementation
(**) "Options for ammonia mitigation. Guidance from the UNECE Task Force on Reactive Nitrogen", 2014.

In the following tables, values of NH_3 emissions by animal under 3Da2a category (animal manure applied to soils) and 3Da3 category (urine and dung deposited by grazing animals) for the time series are provided in tonnes/year.

Table 5.4.17 Values of NH_3 emissions (tonnes) by animal under 3Da2a category

	1990	2005	2010	2015	2019	2020	2021
Dairy Cattle	28,494	21,104	16,977	17,351	16,673	16,589	16,748
Non-Dairy Cattle	18,595	22,660	13,185	14,693	16,242	15,971	16,530
Sheep	3,674	4,223	4,613	4,068	3,651	3,666	3,512
Goats	1,123	1,837	2,609	2,186	2,564	2,723	2,667
Iberian Swine (Sows)	23	15	549	511	571	512	545
Iberian Swine (Finishing/fattening pigs)	189	99	3,287	3,419	4,324	4,135	4,235
White Swine (Sows)	5,268	7,301	6,585	6,256	5,814	5,892	6,083
White Swine (Finishing/fattening pigs)	31,857	47,644	39,053	42,062	43,839	45,722	42,628
Poultry (Laying hens)	6,915	6,404	4,671	4,285	4,323	4,642	4,528
Poultry (Broilers)	5,375	5,559	5,158	5,136	5,781	5,592	5,466
Turkeys	752	799	1,247	1,590	1,983	1,891	1,838
Poultry (Other poultry)	3,346	3,433	2,962	2,220	2,004	1,932	2,334
Rabbits	22,127	25,629	22,087	21,811	17,239	17,120	17,120
Horses	767	875	1,772	1,872	1,987	2,004	2,169
Mules	147	11	16	17	17	16	16
Asses	3	1	1	1	1	1	1
TOTAL	**128,656**	**147,593**	**124,771**	**127,476**	**127,013**	**128,408**	**126,419**

Table 5.4.18 Values of NH_3 emissions (tonnes) by animal under 3Da3 category

	1990	2005	2010	2015	2019	2020	2021
Dairy Cattle	-	-	-	-	-	-	-
Non-Dairy Cattle	11,423	19,927	21,160	20,973	22,752	23,069	23,069
Sheep	4,241	5,104	4,207	3,447	3,397	3,402	3,341
Goats	1,932	926	667	743	555	508	491
Iberian Swine (Sows)	509	1,396	929	720	796	738	793
Iberian Swine (Finishing/fattening pigs)	1,949	6,027	1,802	3,100	4,222	4,130	4,248
White Swine (Sows)	-	-	-	-	-	-	-
White Swine (Finishing/fattening pigs)	-	-	-	-	-	-	-
Poultry (Laying hens)	-	-	-	-	-	-	-
Poultry (Broilers)	-	-	-	-	-	-	-
Turkeys	-	-	-	-	-	-	-
Poultry (Other poultry)	-	-	-	-	-	-	-
Rabbits	-	-	-	-	-	-	-
Horses	2,148	2,298	5,908	5,966	4,752	4,776	4,717
Mules	250	20	39	33	27	27	24
Asses	366	65	114	114	96	98	100
TOTAL	**22,817**	**35,763**	**34,826**	**35,096**	**36,596**	**36,748**	**36,783**

C. Field burning of agricultural waste (3F)

Category 3F "Field burning of agricultural waste" is considered as a key category for its contribution to the trend of the following pollutants: NOx, NMVOC, NH_3, PM_{10}, TSP, BC, CO and Hg and for its contribution to the level and trend of the pollutants: $PM_{2.5}$, Cd and PAHs.

The practice of burning agricultural waste after crop harvesting has been soundly settled in Spanish agriculture before being excluded from the Good Agricultural Practice framework. From then on, it has been progressively restricted by forest fire preventive legislation and conditionality of CAP (Common Agricultural Policy) payments.

In fact, only residues of cotton crops are currently burnt (a minimal amount of ornamental flower residue is also burned). Residues of wooden crop pruning, such as olive or vineyards, are conveyed out of the crop field and burnt as waste in separated areas. For this reason, the emissions derived from burning the pruning residues are not included in category 3F but in category 5C2, in a coherent way to the EMEP report (see NFR 5.C.2 – Open burning of waste).

As mentioned, as from 2000, the forest fire prevention legislation (see next table[32]) has strongly/completely restricted the burnings in the field, which also include forest residues. Before that date, and due to the climatic characteristics of most of the Spanish territory and the extreme risk of burning wood in a forest, it is considered that this practice was not common either. Therefore, the estimations of 5C2 activity only include open controlled burning of orchard crops.

Table 5.4.19 Forest fire prevention legislation

Region	Legislation
ANDALUCÍA	Orden de 21 de mayo de 2009, por la que se establecen limitaciones de usos y actividades en terrenos forestales y zonas de influencia forestal.
ANDALUCÍA	Sección Segunda del Decreto 247/2001, de 13 de noviembre, por el que se aprueba el Reglamento de Prevención y Lucha contra los Incendios Forestales.
ANDALUCÍA	Orden de 22 de junio de 2009, por la que se establecen las normas de Condicionalidad (requisitos legales de gestión y buenas condiciones agrarias y medioambientales) que deben cumplir los agricultores y ganaderos que reciban pagos directos en el marco de la Política Agraria Común.
ARAGÓN	Orden de 14 de febrero de 2014, del Consejero de Agricultura, Ganadería y Medio Ambiente, sobre prevención y lucha contra los incendios forestales en la Comunidad Autónoma de Aragón para la campaña 2014/2015.
ARAGÓN	Orden de 4 de febrero de 2013, del Consejero de Agricultura, Ganadería y Medio Ambiente, sobre prevención y lucha contra los incendios forestales en la Comunidad Autónoma de Aragón para la campaña 2013/2014.
ASTURIAS	Resolución de 4 de junio de 2013, de la Consejería de Agroganadería y Recursos Autóctonos, por la que se aprueban medidas en materia de prevención de incendios forestales en el territorio del Principado de Asturias.
ASTURIAS	Resolución de 30 de enero de 2012, de la Consejería de Agroganadería y Recursos Autóctonos, por la que se aprueban las normas sobre quemas en el territorio del Principado de Asturias.
CANTABRIA	Orden DES/44/2007, de 8 de agosto, por la que se establecen normas sobre uso del fuego y medidas preventivas en relación con los incendios forestales.
CASTILLA Y LEÓN	ORDEN FYM/511/2013, de 26 de junio, por la que se fija la época de peligro alto de incendios forestales en la Comunidad de Castilla y León.

[32] Recommendation made by the ERT in the 2022 NECD Final Review Report for 5C2 category.

Region	Legislation
CASTILLA Y LEÓN	Orden FYM/510/2013, de 25 de junio, por la que se regula el uso del fuego y se establecen medidas preventivas para la lucha contra los incendios forestales en Castilla y León.
CASTILLA Y LEÓN	Orden FYM/335/2013, de 9 de mayo, por la que se determina el riesgo potencial, el número de guardias y el régimen de exenciones para el personal que ha de participar en el Operativo de Lucha contra Incendios Forestales de Castilla y León.
CASTILLA-LA MANCHA	Orden de 16/05/2006, de la Consejería de Medio Ambiente y Desarrollo Rural, por la que se regulan las campañas de prevención de incendios forestales.
CASTILLA-LA MANCHA	Orden de 26/09/2012, de la Consejería de Agricultura, por la que se modifica la Orden de 16/05/2006 de la Consejería de Medio Ambiente y Desarrollo Rural, por la que se regulan las campañas de prevención de incendios forestales.
CASTILLA-LA MANCHA	Corrección de errores de la Orden de 26/09/2012, por la que se modifica la Orden de 16/05/2006, de la Consejería de Medio Ambiente y Desarrollo Rural, por la que se regulan las campañas de prevención de incendios forestales.
CATALUÑA	Decreto 64/1995, de 7 de marzo por el que se establecen medidas de prevención de incendios forestales.
COMUNIDAD VALENCIANA	Resolución de 10 de marzo de 2014, de la Dirección General de Prevención, Extinción de Incendios y Emergencias, sobre reducción de los horarios aptos para la realización de quemas.
ESTATAL	Real Decreto 4/2001, de 12 de enero, por el que se establece un régimen de ayudas a la utilización de métodos de producción agraria compatibles con el medio ambiente.
ESTATAL	Real Decreto 1322/2002, de 13 de diciembre, sobre requisitos agroambientales en relación con las ayudas directas en el marco de la política agraria común.
ESTATAL	Real Decreto 486/2009, de 3 de abril, por el que se establecen los requisitos legales de gestión y las buenas condiciones agrarias y medioambientales que deben cumplir los agricultores que reciban pagos directos en el marco de la política agrícola común, los beneficiarios de determinadas ayudas de desarrollo rural, y los agricultores que reciban ayudas en virtud de los programas de apoyo a la reestructuración y reconversión y a la prima por arranque del viñedo.
EXTREMADURA	Orden de 14 de mayo de 2014 por la que se declara época de peligro medio de incendios forestales en todas las zonas de coordinación del Plan INFOEX y finalizada la misma, se declara época de peligro alto de incendios. (2014050101)
GALICIA	Ley 3/2007, de 9 de abril, de prevención y defensa contra los incendios forestales de Galicia.
ISLAS BALEARES	Artículo 7.1.d del Decreto 125/2007, de 5 de octubre, por el que se dictan normas sobre el uso del fuego y se regula el ejercicio de determinadas actividades susceptibles de incrementar el riesgo de incendio forestal.
ISLAS CANARIAS	Decreto 100/2002, de 26 de julio, por el que se aprueba el Plan Canario de Protección Civil y Atención de Emergencias por Incendios Forestales (INFOCA).
LA RIOJA	Orden 7/2013, de 28 de mayo, de la Consejería de Agricultura, Ganadería y Medio Ambiente, sobre prevención y lucha contra los incendios forestales en la Comunidad Autónoma de La Rioja para la campaña 2013/2014.
MADRID	Decreto 58/2009, de 4 de junio, del Consejo de Gobierno, por el que se aprueba el Plan de Protección Civil de Emergencia por Incendios Forestales en la Comunidad de Madrid (INFOMA).
MADRID	Orden 3816/2003, de 22 de mayo, de la Consejería de Economía e Innovación Tecnológica, por la que se establecen las normas sobre las autorizaciones para realizar quemas en tierras agrícolas.
MURCIA	Resolución de la Dirección General de Medio Ambiente por la que se amplía para el año 2014 el periodo de peligro y se suspende la vigencia y efectos de las autorizaciones para quemas emitidas de conformidad con la Orden de 24 de mayo de 2010, de la Consejería de Agricultura y Agua, sobre medidas de prevención de incendios forestales en la Región de Murcia para el año 2010.
MURCIA	Orden de 24 de mayo de 2010, de la Consejería de Agricultura y Agua, sobre medidas de prevención de incendios forestales en la Región de Murcia para el año 2010.
NAVARRA	Orden Foral 248/2013, de 5 de julio, del consejero de desarrollo rural, medio ambiente y administración local por la que se regula el uso del fuego en suelo no urbanizable y se establecen medidas de prevención de incendios forestales en navarra.

Region	Legislation
PAÍS VASCO	Orden Foral 558/2012, de 3 de diciembre que aprueba la normativa reguladora de las quemas de residuos agrícolas, en toda clase de terrenos rústicos del Territorio Histórico de Álava.

C.1. Activity variables

Table 5.4.20 Summary of activity variables, data and information sources for category 3F

Activities included	Activity data	Source of information
Field burning of agricultural residues (**3F**)	- Crop surface and crop yield.	- MAPA´s Statistic Yearbook. - Nitrogen and Phosphorous Balance in Spanish Agriculture Book (BNPAE).
	- Burnt fraction by crop.	- Nitrogen and Phosphorous Balance in Spanish Agriculture Book (BNPAE).
	- Annual N-amount of burnt crop residue.	- Nitrogen and Phosphorous Balance in Spanish Agriculture Book (BNPAE).
	- Nitrogen fraction by crop.	- Nitrogen fraction by crop (several authors); Ref. Man. & Good Pract. Guide IPCC; Martínez, X.; Roselló, J. and Domínguez, A. (2006); Harvest index. (2006); Krider J.N. et al.; Villalobos, F.J. *et al*. (2002); Wheeler, R.M. (2003); Energy Andalucia Agency (1999); Senovilla, L. and Antolín, G. (2005); La Cal, J.A. (2007).

C.2. Methodology

The following table summarises the methodologies applied in this chapter. Methodology level and sources are provided for reference.

Table 5.4.21 Summary of methodologies applied in category 3F

Pollutants	Tier	Methodology applied	Observations
Field burning of agricultural residues (3F)			
NOx, NMVOC, SO_2, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, HM, PCDD/PCDF, PAHs	T2	- EMEP/EEA Guidebook (2019).	- 3F Field burning of agricultural residues - section 3.3 – Methodological fundamentals. - EF default value (3.F Field burning of agricultural residues - Tables 3.3, 3.4, 3.5 y 3.6). - Calculation of PAH emissions has been carried out by pollutants: benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene.

C.3. Assessment

The emissions of Field burning of agricultural residues (3F) in 2021 are -97.1% lower than in 1990 due to progressive abandonment of this practice as explained above. The chart below shows the time series evolution of burnt crop area in Spain.

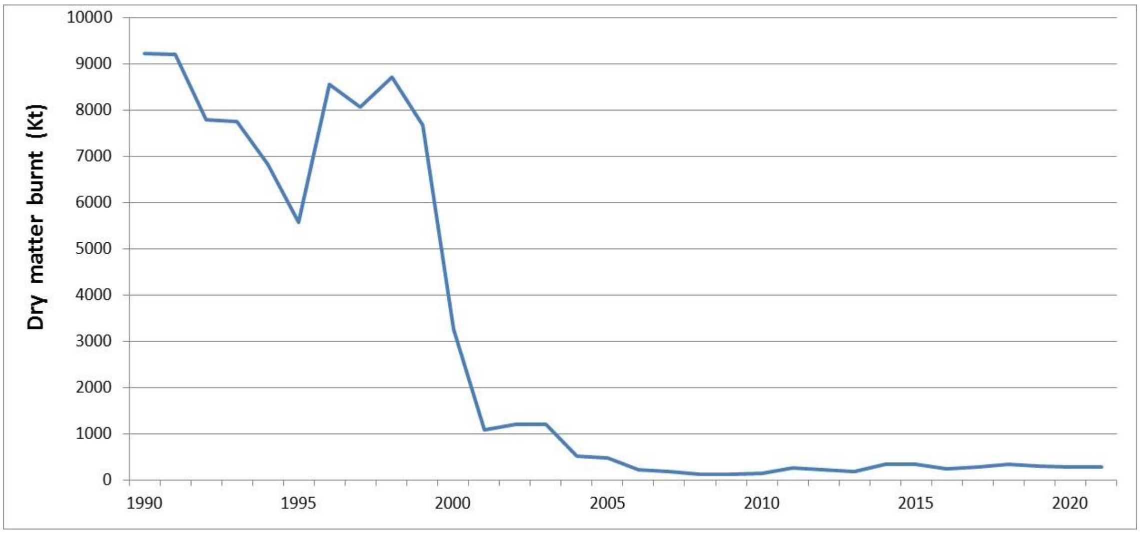


Figure 5.4.15 Dry matter burnt

This activity has been a common practice in Spain until the early 2000s. It generates emission of polluting gases without energy yield and can elicit other negative consequences such as risk of fires and erosion. For this reason, the practice has been limited to a few authorised situations within different law frameworks and the proportion of crops burnt has been significantly reduced, and subsequently the emissions derived from them. The evolution and forest fire prevention legislation can be seen in the following tables.

Table 5.4.22 Dry matter burnt evolution (kt)

	1990	2005	2010	2015	2019	2020	2021
CEREALS	6,403.5	-	-	-	-	-	-
PULSES	2.4	-	-	-	-	-	-
TUBERS AND ROOTS	1,455.1	-	-	-	-	-	-
SUGAR CANE	57.0	-	-	-	-	-	-
OTHERS	1,313.8	467.1*	146.9*	341.9*	296.0*	271.5*	271.5*
TOTAL	**9,231.8**	**467.1**	**146.9**	**341.9**	**296,0**	**271,5**	**271,5**

(*) Since 2004, only residues of cotton crops are burnt (a minimal amount of ornamental flower crop residue is also burned).

5.5. Recalculations

The changes have been incorporated and summarized in the following table.

Table 5.5.1 Recalculation by pollutants

Pollutants affected	Recalculation
3B Manure management (3B1a, 3B1b, 3B2, 3B3, 3B4d, 3B4e, 3B4f, 3B4gi, 3B4gii, 3Bgiii, 3B4giv and 3B4h)	
3B1a (Dairy Cattle)	
NOx, NH_3	Recalculation due to the incorporation progressive of data from new surveys on manure management systems from 1990 to 2010 and constant maintenance of values from 2010 onwards.
NMVOC	Recalculation due to methodology change for NMVOC emissions calculations based on NH_3 emissions ratio instead of NH_3 emission factors ratio.

Pollutants affected	Recalculation
3B1b (Non Dairy Cattle)	
NOx, NH_3	Recalculation due to the incorporation progressive of data from new surveys on manure management systems from 1990 to 2010 and constant maintenance of values from 2010 onwards, together with slight variations in the grazing animal distribution data throughout the time series.
NMVOC	Recalculation due to methodology change for NMVOC emissions calculations based on NH_3 emissions ratio instead of NH_3 emission factors ratio in addition to reasons cited for NH_3 and NOx.
$PM_{2.5}$, PM_{10}, TSP	Recalculation due to slight variations in the grazing animal distribution data throughout the time series.
3B2 (Sheep)	
NMVOC	Recalculation due to methodology change for NMVOC emissions calculations based on NH_3 emissions ratio instead of NH_3 emission factors ratio.
3B3 (Swine)	
NOx, NH_3	Recalculation by incorporating BAT data obtained from ECOGAN by progressive implantation from 2015 to 2021. N excretion values for white swine from ECOGAN for the year 2021.
NMVOC	Recalculation due to methodology change for NMVOC emissions calculations based on NH_3 emissions ratio instead of NH_3 emission factors ratio.
3B4d (Goats)	
NMVOC	Recalculation due to methodology change for NMVOC emissions calculations based on NH_3 emissions ratio instead of NH_3 emission factors ratio.
3B4e (Horses)	
NMVOC	Recalculation due to methodology change for NMVOC emissions calculations based on NH_3 emissions ratio instead of NH_3 emission factors ratio.
3B4f (Mules and Asses)	
NMVOC	Recalculation due to methodology change for NMVOC emissions calculations based on NH_3 emissions ratio instead of NH_3 emission factors ratio.
3B4gi (Laying hens)	
NOx, NH_3	Recalculation due to the incorporation of data from new surveys on manure management systems and the revision of zootechnical parameters, which has caused slight variations in these throughout the time series.
NMVOC	Recalculation due to methodology change for NMVOC emissions calculations based on NH_3 emissions ratio instead of NH_3 emission factors ratio.
3B4gii (Broilers)	
NOx, NH_3	Recalculation due to the revision of zootechnical parameters, which has caused slight variations in these throughout the time series.
NMVOC	Recalculation due to methodology change for NMVOC emissions calculations based on NH_3 emissions ratio instead of NH_3 emission factors ratio.
$PM_{2.5}$, PM_{10}, TSP	Recalculation due to slight variation in number of broilers in the year 2020.
3B4giii (Turkeys)	
NOx, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP	Incorporation as a new and independent category from the category “Other poultry” in addition recalculations cited for NMVOC.
3B4giv (Other poultry)	
NOx, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP	Recalculation due to Incorporation of a new category for Turkeys which was previously included into “Other poultry” in addition recalculations cited for NMVOC.
3B4h (Rabbits)	
NOx, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP	Incorporation as a new category.

Pollutants affected	Recalculation
3D Crop production and agricultural soils (3Da1, 3Da2a, 3Da2b, 3Da2c, 3Da3, 3Dc, 3De and 3Df)	
3Da1 (Inorganic N-fertilizers (also includes urea application)	
NH_3	Recalculation due to small nitrogen balance (BNPAE) alterations in all annual series due to implementation of recalculations of emissions during last edition of the inventory which were incorporated to the nitrogen balance the following year producing regional changes in the distribution of fertilizers whose emissions are affected by T and pH of the regions. These changes produce minimal variations in ammonia emissions.
3Da2a (Animal manure applied to soils)	
NOx, NH_3	Recalculation due the incorporation of data from new surveys on manure management systems and variations by incorporating BAT data obtained from ECOGAN cited for 3B categories that produce alterations in nitrogen balance calculations and nitrogen applied to soils from manure. Incorporation of new data for ammonia BATs from ECOGAN in relation to application of manure to soils.
NMVOC	Recalculation due to methodology change for NMVOC emissions calculations based on NH_3 emissions ratio instead of NH_3 emission factors ratio[33].
3Da2b (Sewage sludge applied to soils)	
NOx, NH_3	Sewage sludge amount applied to soils are provided by source ("National Sewage Register" (MITECO)) with several years lag. In this edition has updated the values of 2019 and 2020 according to values published, and 2020 value has been replicated them into 2021.
3Da2c (Other organic fertilizers applied to soils (including compost))	
NOx, NH_3	Compost amount applied to soils are provided by source with two-year lag. In these cases, the Inventory replicates the x-2 year values published, into x-1 year, the last year inventoried. This edition has updated the values of 2020 according to values published, and has replicated them into 2021.
3Da3 (Urine and dung deposited by grazing animals)	
NOx, NH_3	Recalculation due to slight variations in the grazing animal distribution data throughout the time series cited for non-dairy cattle.
3Dc (Farm-level agricultural operations including storage, handling and transport of agricultural products)	
$PM_{2.5}$, PM_{10}, TSP	Recalculations due to methodological changes carried out to pass this category to Tier 2[34]. Furthermore, data of areas of agricultural soils are provided by MAPA`s Statistics Yearbook to BNPAE technical team with two-year lag compared with inventory report. In these cases, the Inventory replicates the x-2 year values published in the Yearbook, into x-1 year, the last year inventoried. This edition has updated the values of 2020 according to the yearbook and has replicated them into 2021.
3De (Cultivated crops)	
NMVOC	Data of areas of agricultural soils are provided by MAPA`s Statistics Yearbook to BNPAE technical team with two-year lag compared with inventory report. In these cases, the Inventory replicates the x-2 year values published in the Yearbook, into x-1 year, the last year inventoried. This edition has updated the values of 2020 according to the yearbook and has replicated them into 2021. Furthermore, in this edition slight updates for data of some crops have been carried out for years 1995, 1997 and 2000.
3Df (Use of pesticides)	
HCB	Recalculation due to correction of variations in Activity Variable data for the year 2020.
3F (Field burning of agricultural residues)	
NOx, NMVOC, SO_2, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, PAHs	Data of areas of agricultural soils are provided by MAPA`s Statistics Yearbook to BNPAE technical team with two-year lag compared with inventory report. In these cases, the Inventory replicates the x-2 year values published in the Yearbook, into x-1 year, the last year inventoried. This edition has updated the values of 2020 according to the yearbook and has replicated them into 2021. The recalculation has been equivalent for all contaminants.

[33] Recommendation made by the ERT in the 2022 NECD. Final Review Report.

[34] Recommendation made by the ERT in the 2022 NECD. Final Review Report.

The following graphs display the evolution as a result of recalculations. The line chart shows emissions (kt) in absolute terms, while the bar chart displays the relative difference between emission values before and after recalculations.

3B Manure management (3B1a, 3B1b, 3B2, 3B3, 3B4d, 3B4e, 3B4f, 3B4gi, 3B4gii, 3Bgiii, 3B4giv and 3B4h)

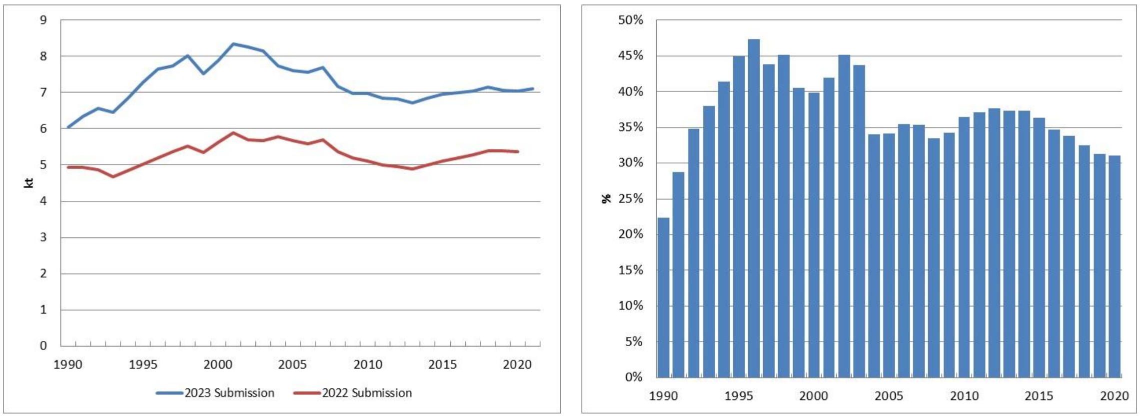


Figure 5.5.1 Evolution of the difference in 3B NOx emissions

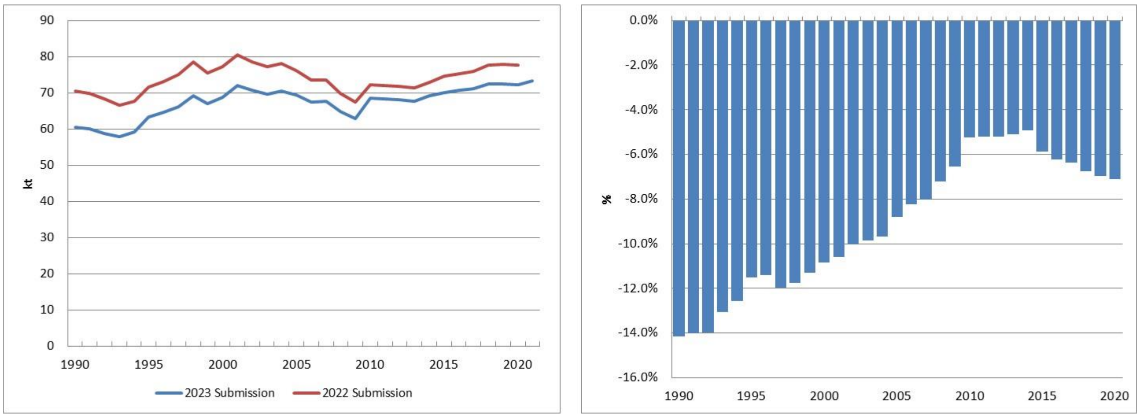


Figure 5.5.2 Evolution of the difference in 3B NMVOC emissions

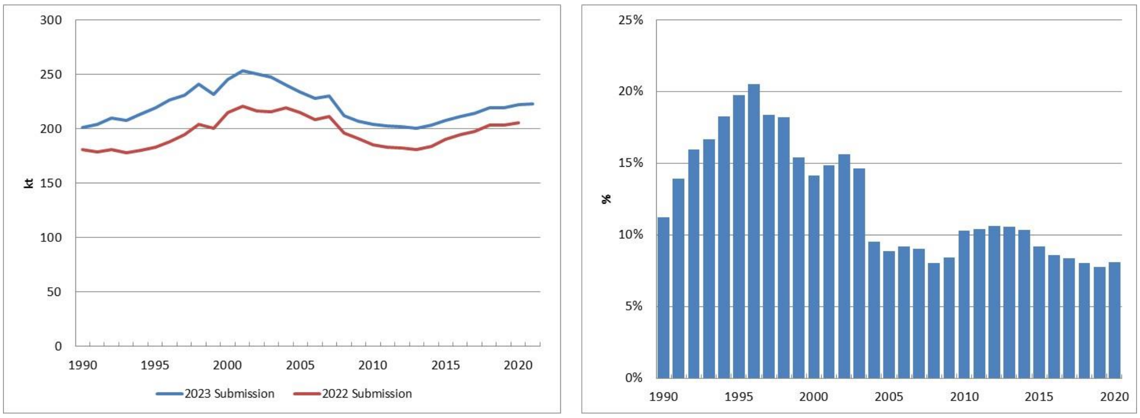


Figure 5.5.3 Evolution of the difference in 3B NH_3 emissions

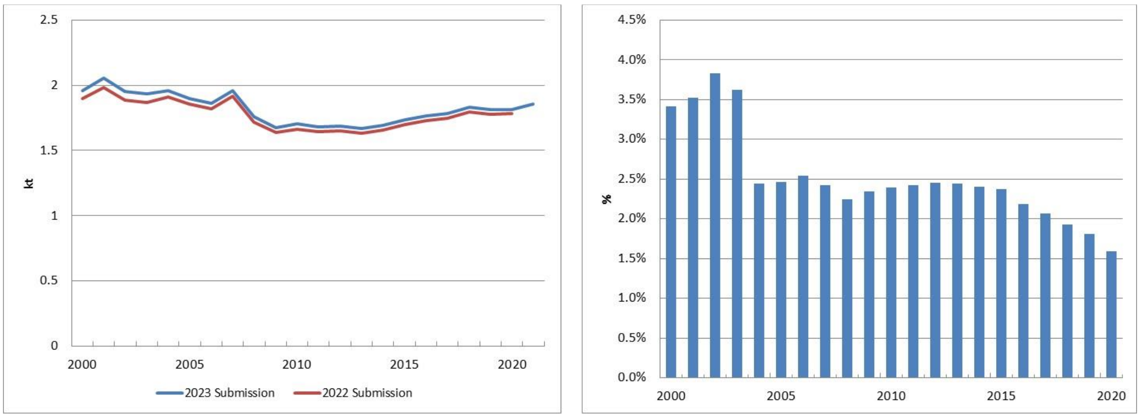


Figure 5.5.4 Evolution of the difference in 3B $PM_{2.5}$ emissions

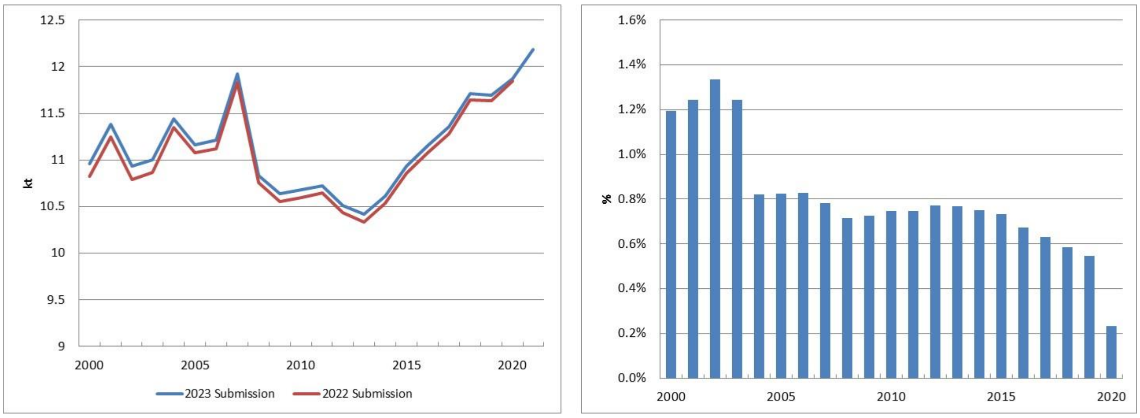


Figure 5.5.5 Evolution of the difference in 3B PM_{10} emissions

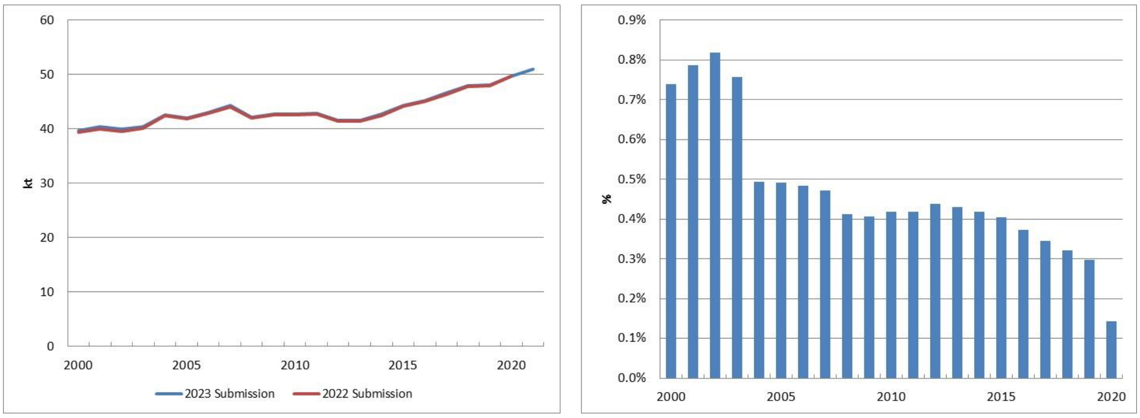


Figure 5.5.6 Evolution of the difference in 3B TSP emissions

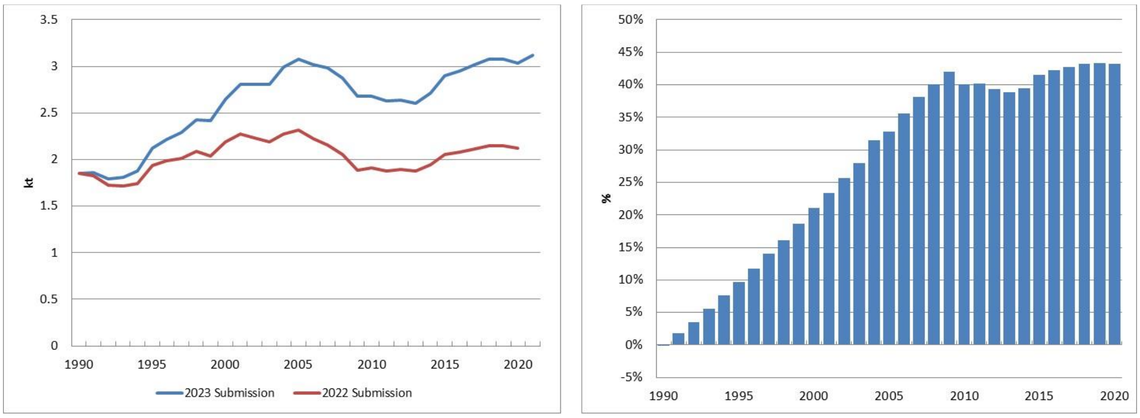


Figure 5.5.7 Evolution of the difference in 3B1 (Cattle) NO_X emissions

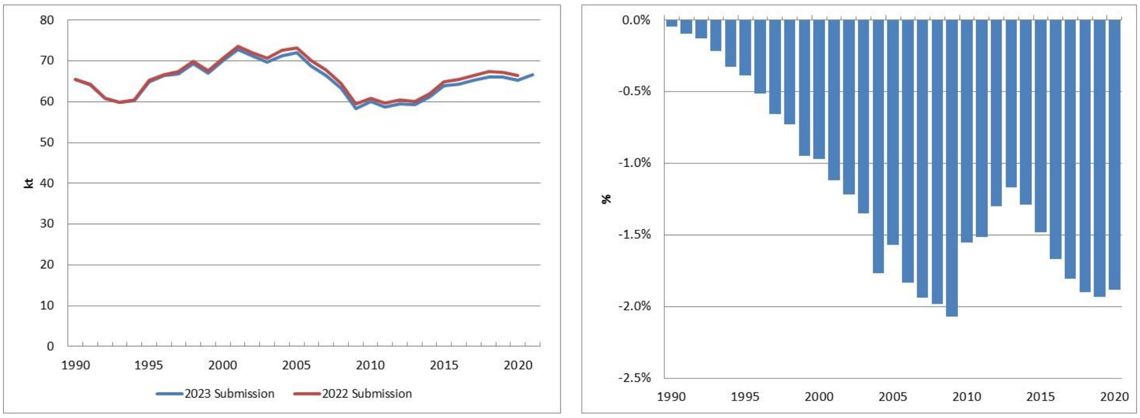


Figure 5.5.8 Evolution of the difference in 3B1 (Cattle) NH_3 emissions

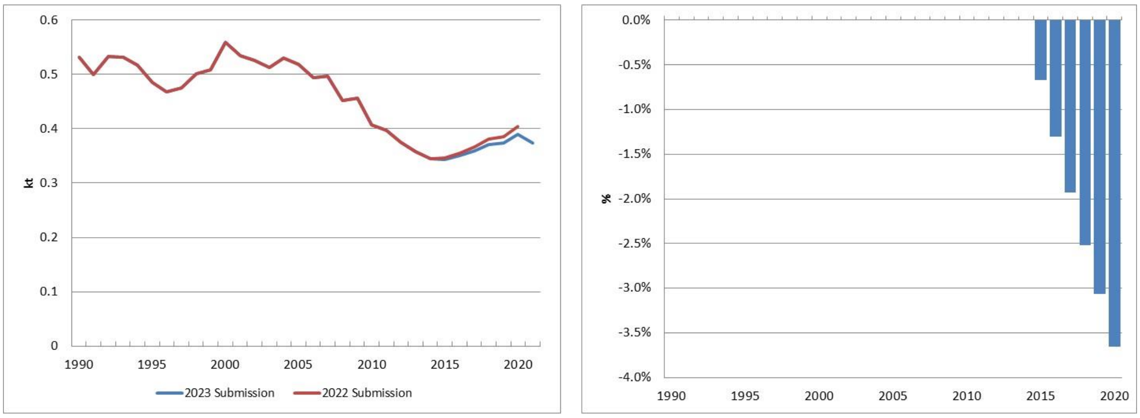


Figure 5.5.9 Evolution of the difference in 3B3 (Swine) NO_X emissions

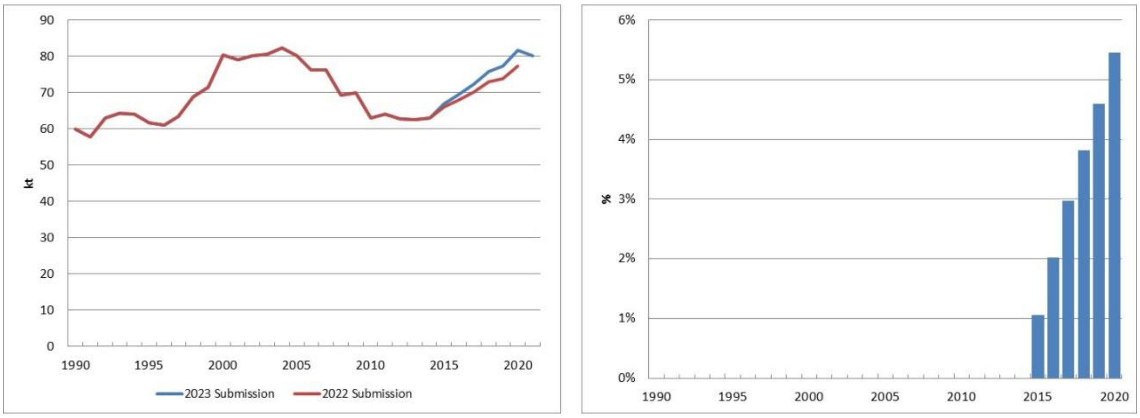


Figure 5.5.10 Evolution of the difference in 3B3 (Swine) NH_3 emissions

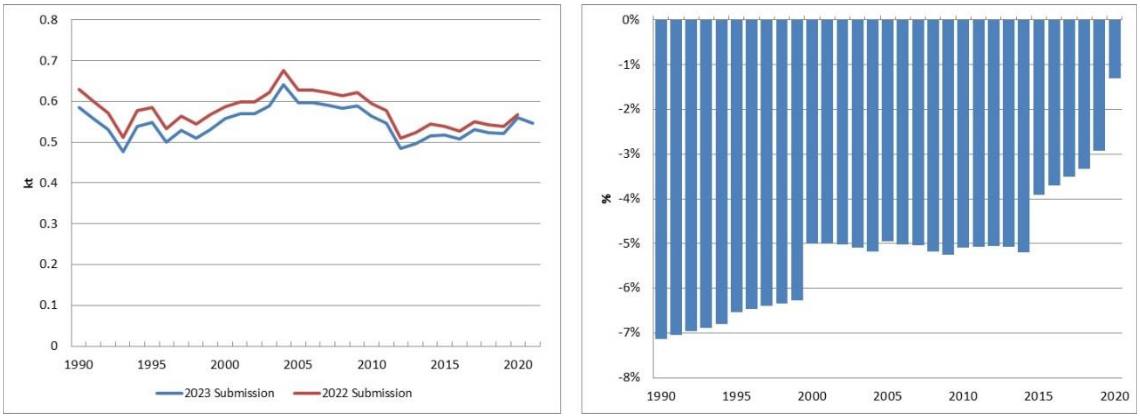


Figure 5.5.11 Evolution of the difference in 3B4gi (Laying hens) NO_X emissions

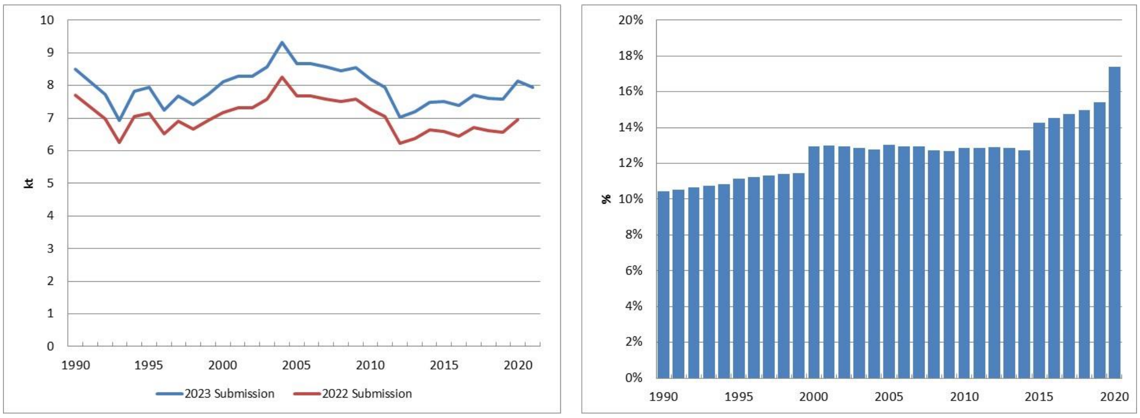


Figure 5.5.12 Evolution of the difference in 3B4gi (Laying hens) NH_3 emissions

3D Crop production and agricultural soils (3Da1, 3Da2a, 3Da2b, 3Da2c, 3Da3, 3Dc, 3De and 3Df)

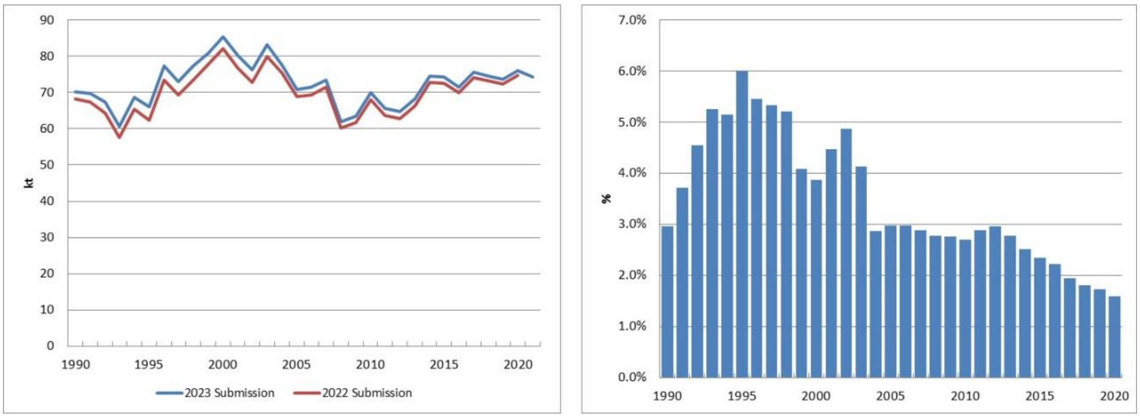


Figure 5.5.13 Evolution of the difference in 3D NOx emissions

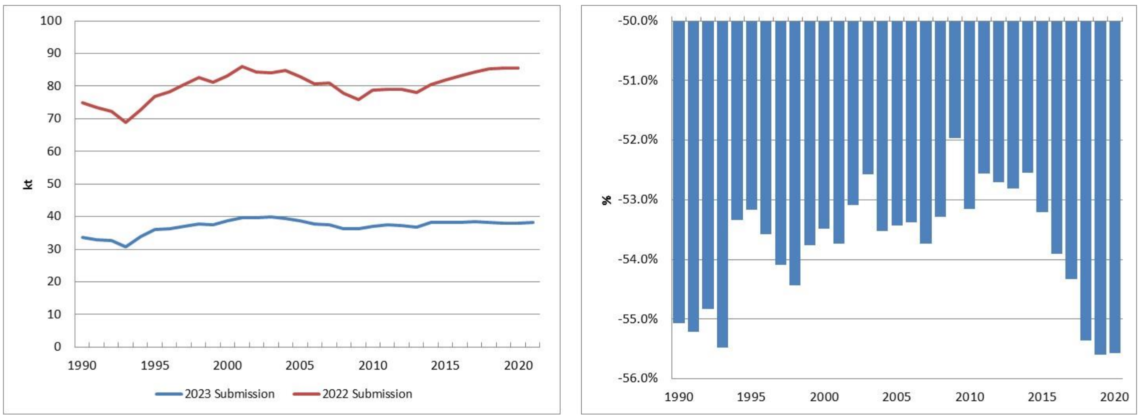


Figure 5.5.14 Evolution of the difference in 3D NMVOC emissions

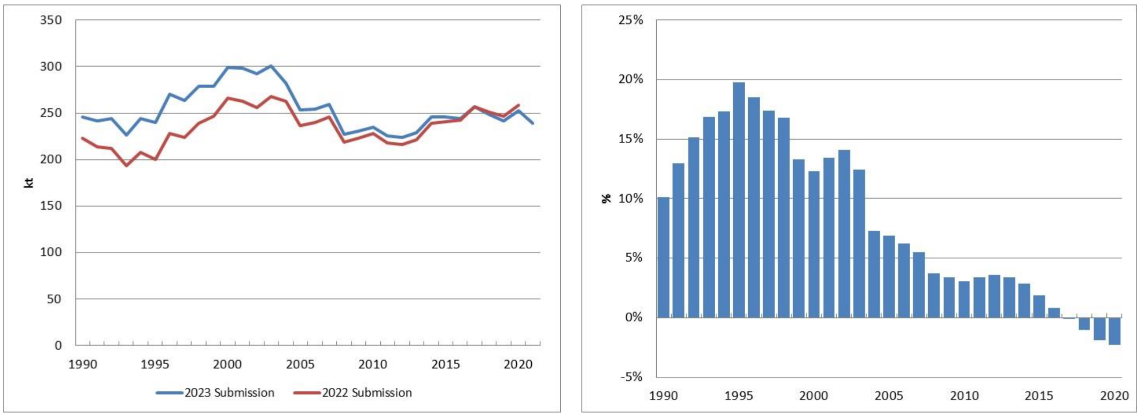


Figure 5.5.15 Evolution of the difference in 3D NH_3 emissions

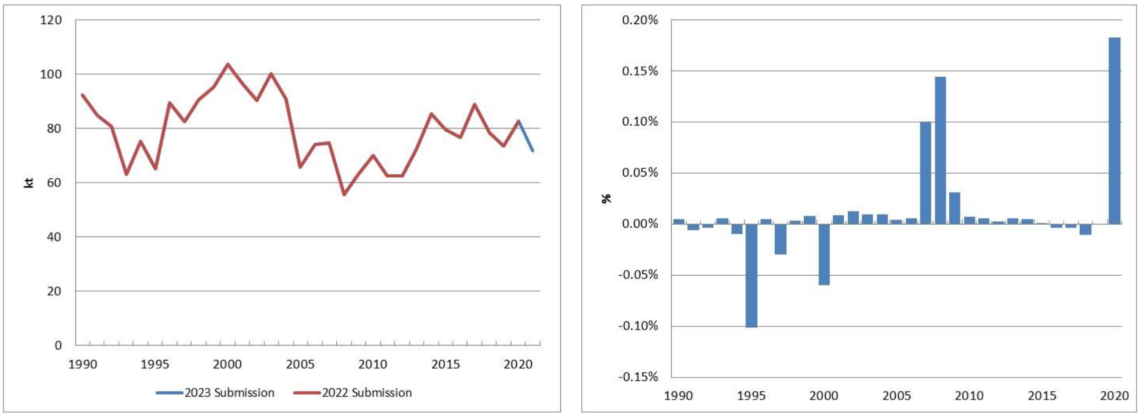


Figure 5.5.16 Evolution of the difference in 3Da1 (Inorganic n-fertilizers) NH_3 emissions

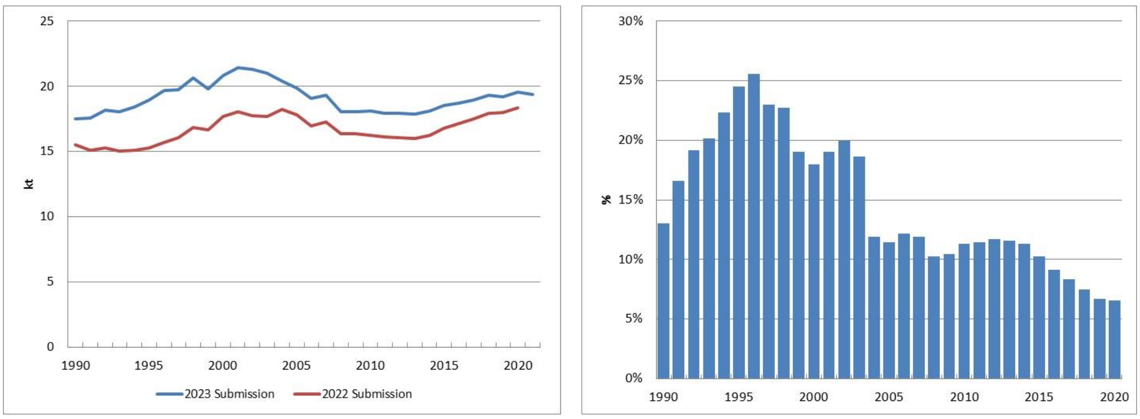


Figure 5.5.17 Evolution of the difference in 3Da2a (Animal manure applied to soils) NOx emissions

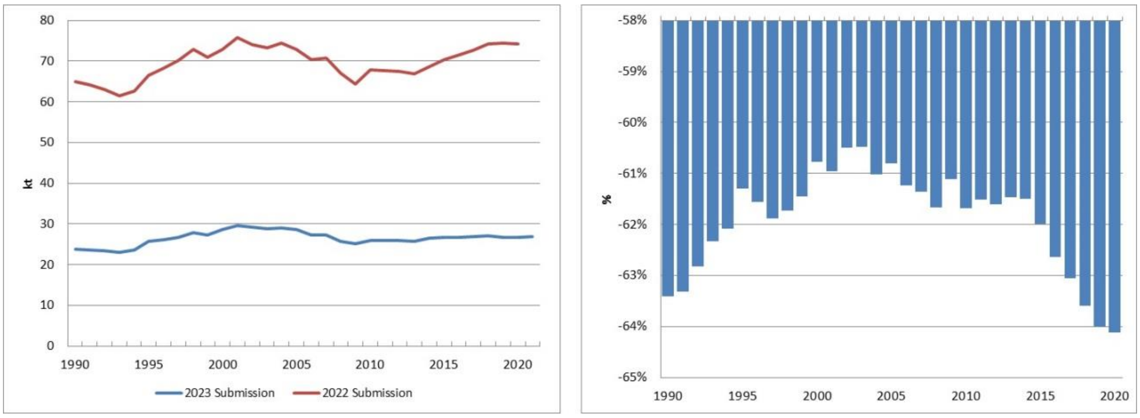


Figure 5.5.18 Evolution of the difference in 3Da2a (Animal manure applied to soils) NMVOC emissions

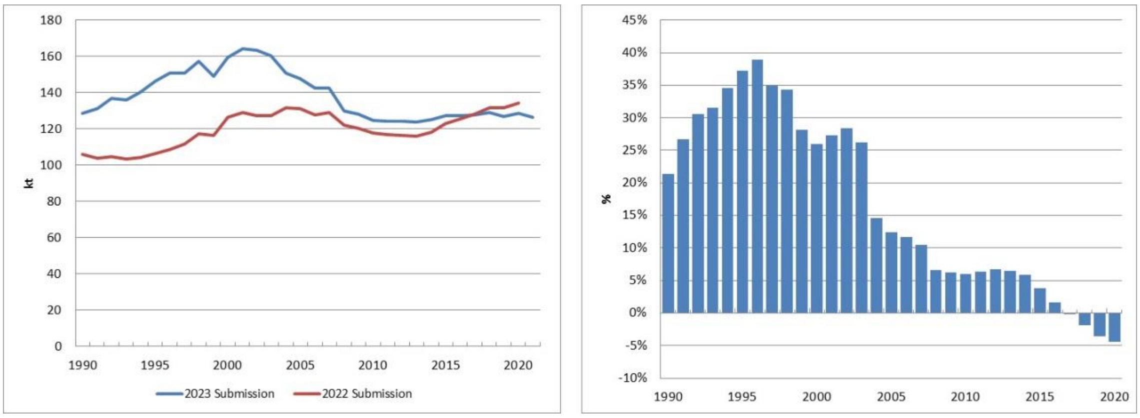


Figure 5.5.19 Evolution of the difference in 3Da2a (Animal manure applied to soils) NH_3 emissions

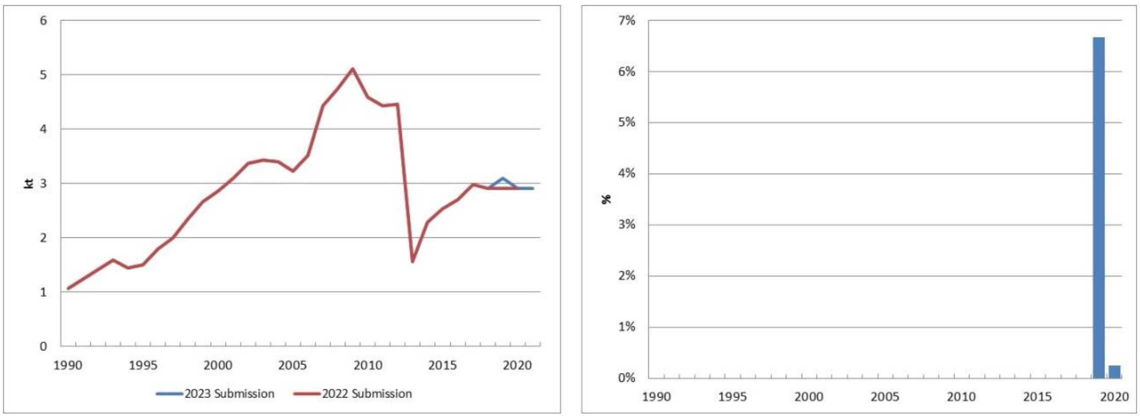


Figure 5.5.20 Evolution of the difference in 3Da2b (Sewage sludge applied to soils) NH_3 emissions

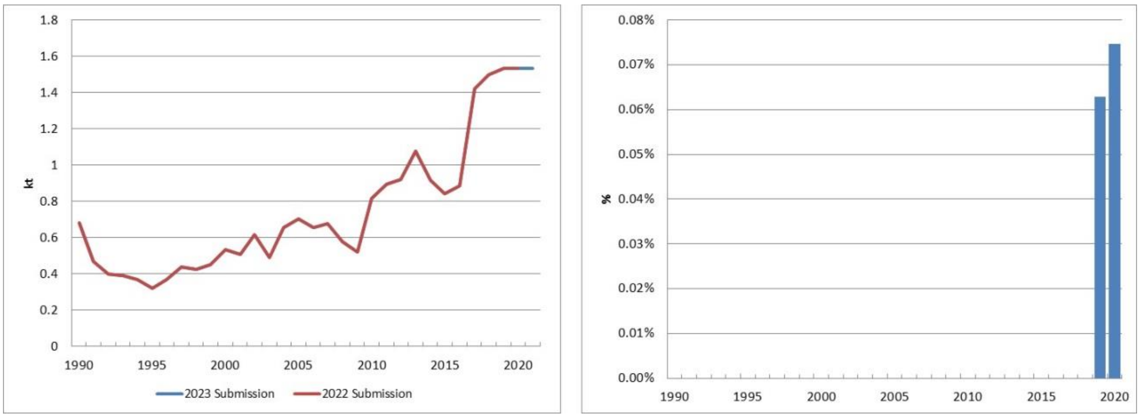


Figure 5.5.21 Evolution of the difference in 3Da2c (Other organic fertilizers applied to soils (including compost)) NH_3 emissions

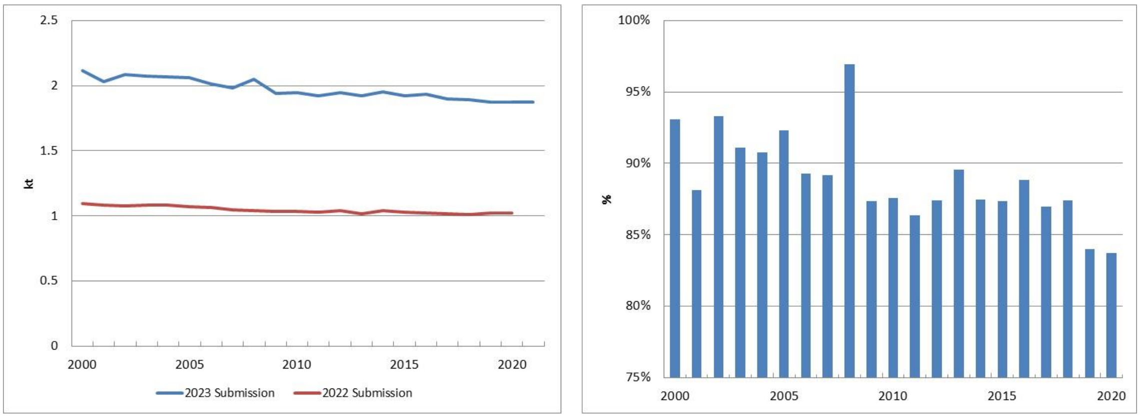


Figure 5.5.22 Evolution of the difference in 3Dc (Farm-level agricultural operations including storage, handling and transport of agricultural products) (unique PM category of 3D) $PM_{2.5}$ emissions

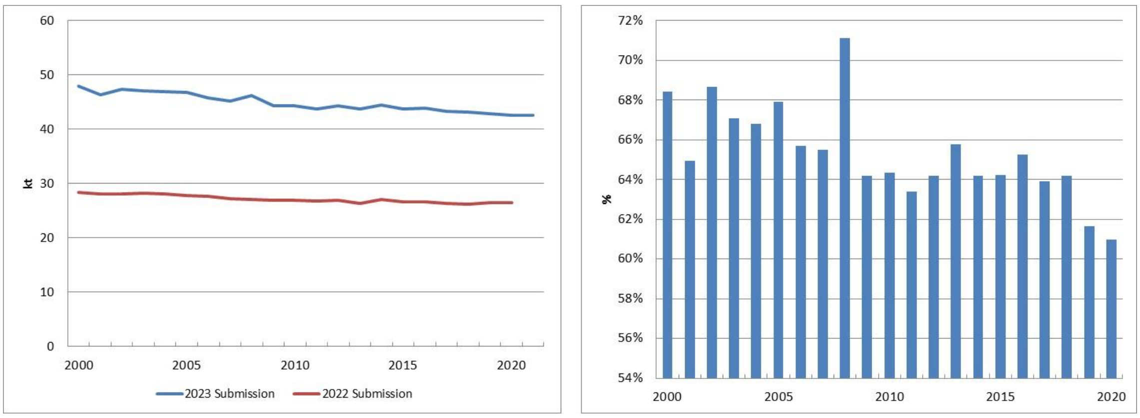


Figure 5.5.23 Evolution of the difference in 3Dc (Farm-level agricultural operations including storage, handling and transport of agricultural products) (unique PM category of 3D) PM_{10} emissions

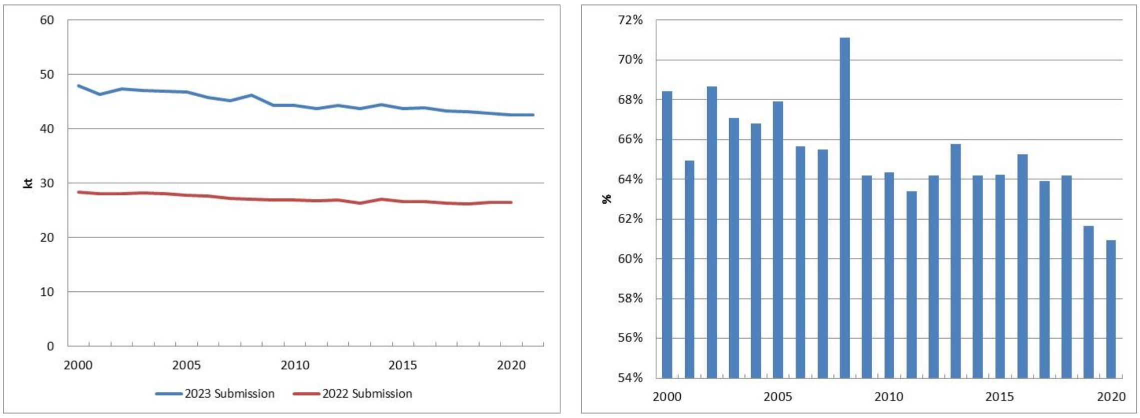


Figure 5.5.24 Evolution of the difference in 3Dc (Farm-level agricultural operations including storage, handling and transport of agricultural products) (unique PM category of 3D) TSP emissions

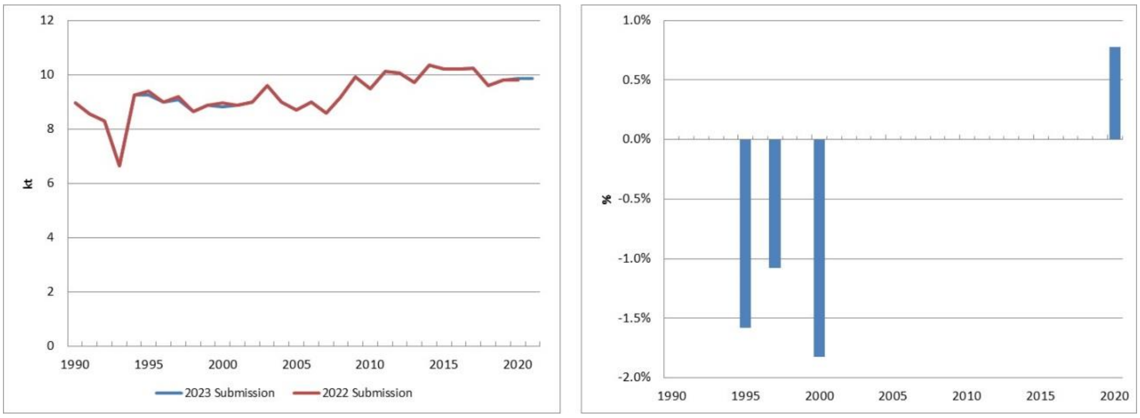


Figure 5.5.25 Evolution of the difference in 3De NMVOC emissions (cultivated crops)

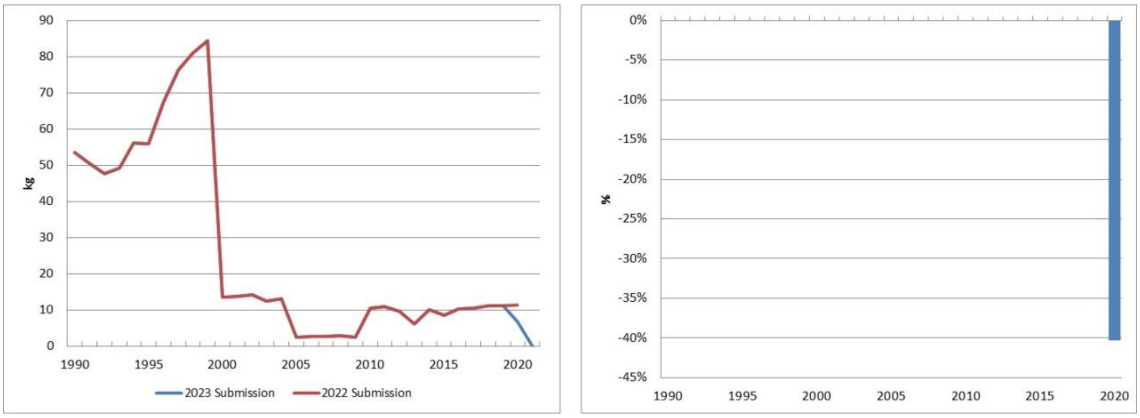


Figure 5.5.26 Evolution of the difference in 3Df (Use of pesticides) HCB emissions

3F Field burning of agricultural residues

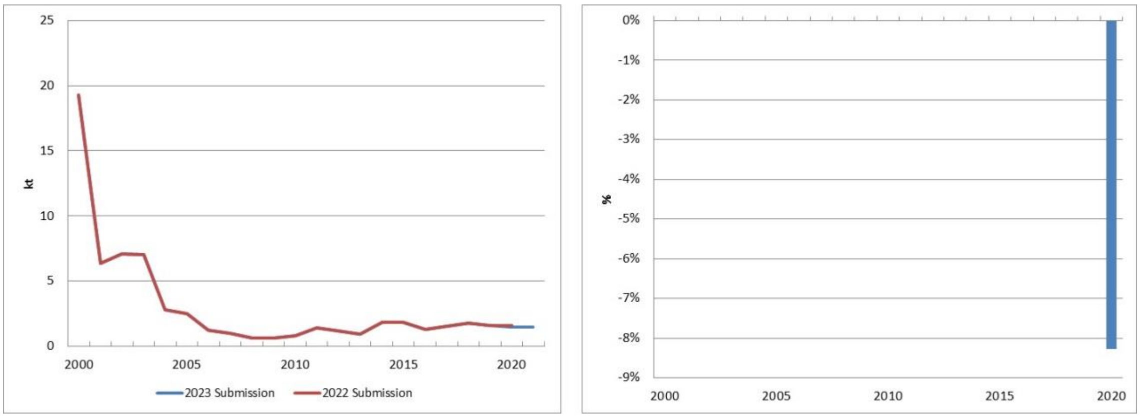


Figure 5.5.27 Evolution of the difference in 3F $PM_{2.5}$ emissions

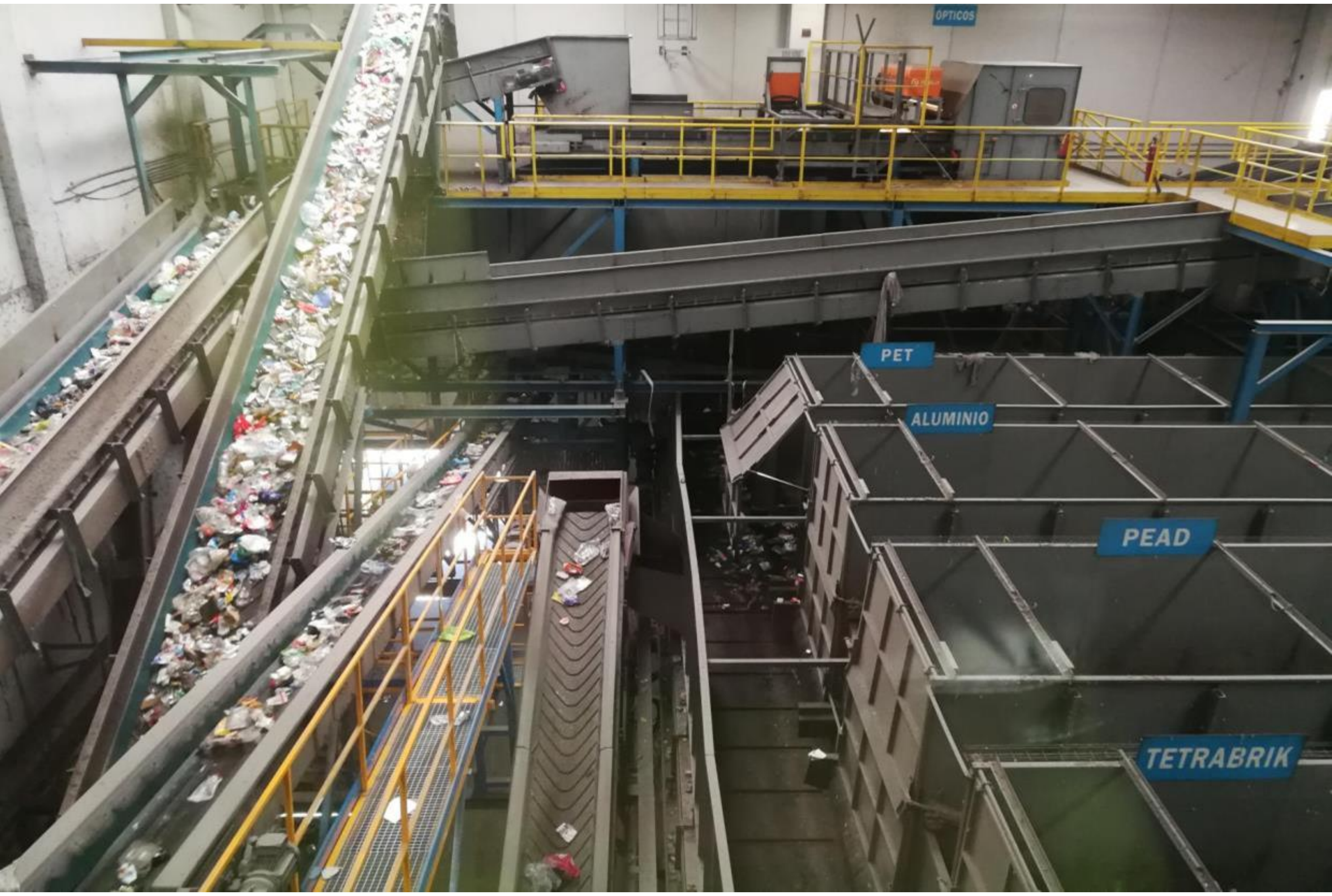
5.6. Sector improvements

Areas of improvement intended to be accomplished, include:

- Incorporate into inventory the information supplied by new reviews of zootechnical documents” are being completed.
- Continue with the research together with the team of experts in charge of preparing and reviewing the zootechnical documents on the methodology for estimating the zootechnical coefficients in relation to changes marked in these coefficients for different reasons in some years of the time series, such as changes in diet or legislation of use of antibiotics or due to other reasons.
- Incorporate into inventory the information supplied by technical sources about country-specific Manure Management Systems (MMSs), zootechnical coefficients and Best Available Techniques (BATs), if available, from ECOGAN, new legislation, surveys or others.

Continuation with the elaboration of methodological factsheets[35] in which the methodology for calculating emissions is expanded and examples are presented.

[35] Methodological factsheets.



6. WASTE (NFR 5)

CONTENTS

FIGURES

TABLES

6. WASTE (NFR 5)

Chapter updated in February, 2023.

Sector Waste at a glance

The emissions of air pollutants from the Waste sector compared to the global inventory emissions in Spain are represented in the following figure (Figure 6.1.1), where PCDD/PCDF and BC emissions stand out, accounting for 73% and 65% of the total, respectively. Similarly, other contaminants as $PM_{2.5}$ and CO have a great weight in the total emissions inventoried in Spain in 2021 aswell (between 41% and 45%, respectively). All these emissions are linked mainly to a particular activity, Burnt of agricultural residues, which is still practiced in Spain.

Parallelly, the emissions of air pollutants from the Waste sector are relatively major compared to 1990 (2000 for $PM_{2.5}$ and BC). Such significant increases happen for all contaminants except for NH_3, Hg, HCB and PCBs.

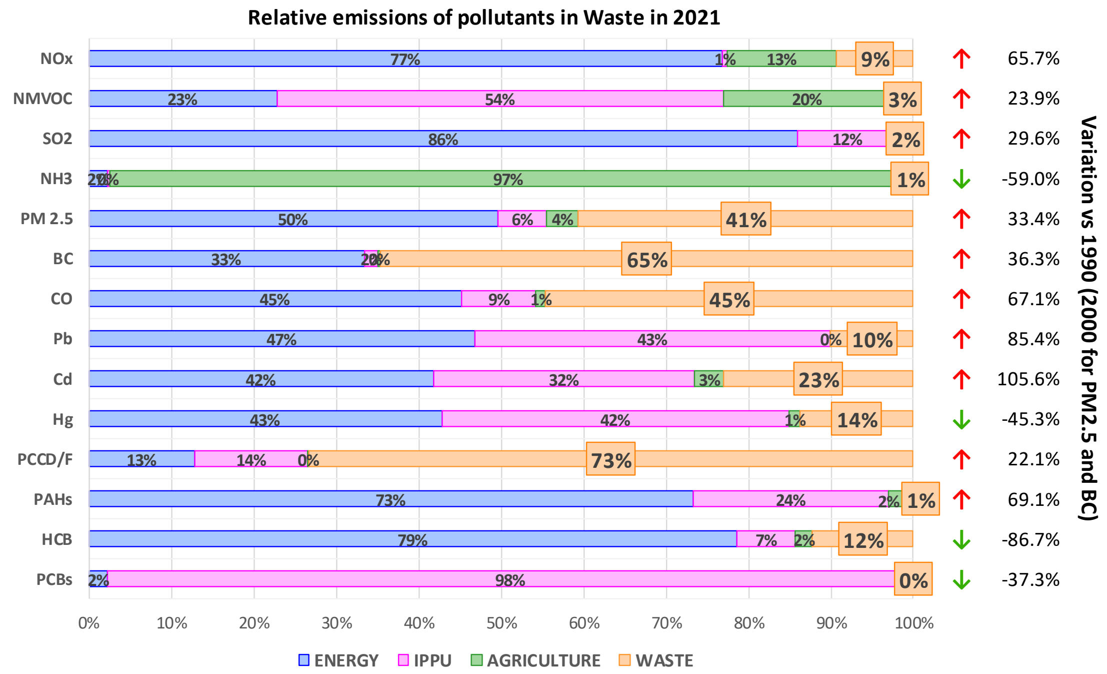


Figure 6.1.1 Relative emissions in Waste in 2021 and its relative variation (2021 vs. 1990)

Waste sector activities in Spain comprises the emissions of waste management in 133 landfills, 222 composting plants, 67 biomethanization facilities and more than 2,000 wastewater treatment plants across the country. Despite this large variety of activities covered, in terms of air emissions, the Open burning of agricultural residues (mostly pruning rests) (5C2) is the principal key category for the sector and dominates most of the annual emissions and emissions trends.

In this sense, emissions levels for most of the pollutants show an upwards trend driven by the relative higher activity of Open burning of agricultural residues in the last part of the time series. However, pollutants linked to burning of domestic residues, as HCB or PCBs, show a clear reduction of emission along the time series due to the limitation of this kind of activities.

6.1. Sector overview

The table below shows the detailed source categories for Waste, particularly, NFR categories and pollutants coverage, methodology approach (Method) as well as their selection as key categories (KC).

Table 6.1.1 Coverage of NFR category in 2021

NFR Code	NFR category	Pollutants				Method	KC
		Covered	Exceptions				
			IE	NA	NE		
5A	Biological treatment of waste - Solid waste disposal on land	NOx, NMVOC, PM, CO	–	Rest of pollutants	NH_3, Hg	T2	–
5B1	Biological treatment of waste - Composting	NH_3	–	Rest of pollutants	NOx, NMVOC, SO_2, PM, BC, CO	T2	–
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	NOx, NH_3, PM, CO	–	As, Cu, Ni, Se	Rest of pollutants	T1	–
5C1a	Municipal waste incineration	IE (since 2004, reported in 1A1a)					
5C1bi	Industrial waste incineration	IE (reported in 1A1a)					
5C1bii	Hazardous waste incineration	NO					–
5C1biii	Clinical waste incineration	IE (since 2006, reported in 1A1a)					
5C1biv	Sewage sludge incineration	All	–		NH_3	T2	✓
5C1bv	Cremation	All	–	NH_3	BC	T1	–
5C1bvi	Other waste incineration (please specify in the IIR)	NO					–
5C2	Open burning of waste	All	–	PCB	NH_3, Hg, Ni, PCDD/PCDF, HCB	T2	✓
5D1	Domestic wastewater handling	NOx, NMVOC, PM, CO	–	Rest of pollutants	NH_3, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, BC	T2	
5D2	Industrial wastewater handling	NOx, NMVOC, PM, CO	–	Rest of pollutants	NH_3, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, BC	T1	✓
5D3	Other wastewater handling	NH_3	–	Rest of pollutants	NMVOC, PM, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn	T2	
5E	Other waste	All	–	Rest of pollutants	NOx, CO	T2	✓

IE: included elsewhere; NA: not applicable; NE: not estimated; NO: not occurring.

6.2. Sector analysis

The following table relates the detailed source categories for Waste in the Inventory to the equivalent NFR source categories, including their main features in 2021. These main features do not consider the Canary Islands, as their territory is not under the EMEP grid.

For further information on methodology applied to non-key categories, links to the methodology factsheets published in MITECO-SEI website are included in the following table. For key categories, links to the available methodology factsheets have been included in the corresponding methodology section.

Table 6.2.1 Sector analysis

NFR Code	NFR category	Main features (2021)	Main sources of activity data
5A	Solid waste disposal on land (Methodology factsheets: Deposit of solid waste in managed landfills Deposit of solid waste in unmanaged landfills)	- 133 landfills with waste disposal covered, 93 of them with biogas capture. - 12,114 kt of waste deposited in landfills.	- SGEC (MITECO).
5B1	Biological treatment of waste-composting (Methodology factsheet: Compost production)	- 222 composting plants covered. - 3,115 kt of waste entering the composting process.	- SGEC (MITECO).
5B2	Biological treatment of waste-anaerobic digestion at biogas facilities (Methodology factsheet: Biological treatment of solid waste (biomethanization))	- 67 biomethanization facilities covered: 3 of them mainly treating slurry, and the rest of facilities treating the organic fraction of municipal solid waste (MSW) and/or sludge.	- IQ. - SGEC (MITECO).
5C1biv	Sewage sludge incineration (Methodology factsheet: Sewage sludge incineration)	- 58.7 kt of sludge incinerated (7 % of the total sludge produced).	- IQ. - National Sludge Registry (RNL (MITECO)).
5C1bv	Cremation (Methodology factsheet: Cremation)	- 203,620 corpses incinerated (45.2 % of deaths).	- 1990-2009: European Federation of Funeral Services. - 2010-2014: Estimation based on data provided by the main entrepreneurial association for the period 1990-2009 and data of deaths from INE. - 2015-2021: PANASEF.
5C2	Open burning of waste (Methodology factsheet: Controlled burning of agricultural residues)	- 8,117.7 kt of agricultural residues burned (dry matter).	-Statistical Yearbook 2020[1] (MAPA). - Nitrogen and Phosphorus Balance in Spanish Agriculture (BNPAE) Yearbook.

[1] Cultivated areas data and crop yields for BNPAE calculates are provided by MAPA's Statistics Yearbook with two-year lag. In these cases, the Inventory replicates the x-2 year values published in the Yearbook, into x-1 year, the last year inventoried. This edition has updated the values of 2020 according to the yearbook, and has replicated them into 2021.

NFR Code	NFR category	Main features (2021)	Main sources of activity data
5D1	Domestic wastewater handling (Methodologicy factsheet: Domestic wastewater handling)	- 79.9 kt of biogas produced and recovered in domestic wastewater plants from anaerobic treatment of sludge. - 7.07% of biogas burned in flares.	- "Uses of biogas produced in urban wastewater treatment plants in Spain" by CEDEX. - Indicators on wastewater from the Spanish Statistical Office. - Data from OECC and MITECO. - Data from CNV (Censo Nacional de Vertidos).
5D2	Industrial wastewater handling (Methodology factsheet: Industrial wastewater handling)	- 7.8 kt of CH_4 recovered from industrial wastewater treatment plants. - 42% of CH_4 burned in flares. - PM emissions are related to the burning in flares of a part of the biogas produced in wastewater treatment plants, and as the 2019 EMEP/EEA Guidebook does not provide default emission factors, emission factors from US EPA AP-42. 5th Ed. (1998), chapter 2.4., table 2.4-4, have been used, which provides the same emission factor for particle matter emissions. Final Review Report (ES-5D2-2019-0001 (Table 3)).	- Estimation based on data from OECC, MITECO and INE.
5D3	Other wastewater handling: Latrines (Methodology factsheet: Latrines)	- 3.5% of population lacks an urban wastewater collecting system.	- Indicators on Population connected to wastewater collection and treatment systems from Eurostat. - Population data by INE.
5E	Other waste: Sludge spreading, accidental fires (Methodology factsheets: Sludge spreading Accidental fires)	- 0.7 kt of sludge dried by spreading (0.1% of total sludge produced in domestic wastewater plants). - Accidental fires: • 2,741 detached houses fires. • 3,175 undetached houses fires. • 11,397 flat fires. • 13,436 industrial fires. • 11,810 cars fires.	- National Sludge Registry (RNL (MITECO)). - CEDEX. - Madrid Council Government Area of Security and Community Services. General Directorate of Emergencies. - MAPFRE Foundation and Professional Association of Firemen Technicians. - Distribution of population by degree of urbanisation, dwelling type and income group (Eurostat). - Fleet vehicle (DGT).

6.2.1. Key categories

According to the information provided in section 1.5 of this IIR and the Annex 1, the identified Key Categories within the Waste sector are summarised in the following table.

Table 6.2.2 Assignation of KC

NFR	NFR Category	NOx	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	PCDD PCDF	PAHs	HCB	PCBs
5C	Incineration	L-T	L-T	L	-	L-T	L-T	L-T	L-T	L-T	L-T	L-T	L-T	L-T	-	L-T	-
5D	Wastewater handling	-	-	-	T	-	-	-	-	-	-	-	-	-	-	-	-

NFR	NFR Category	NOx	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	PCDD PCDF	PAHs	HCB	PCBs
5E	Other waste	-	-	-	-	-	-	-	-	-	-	-	-	L	-	-	-

L: level; T: trend

6.2.2. Analysis by pollutant

Featured below are the charts of the time series by pollutants and NFR categories. Each pollutant is represented independently, broken down by main NFR categories within the sector.

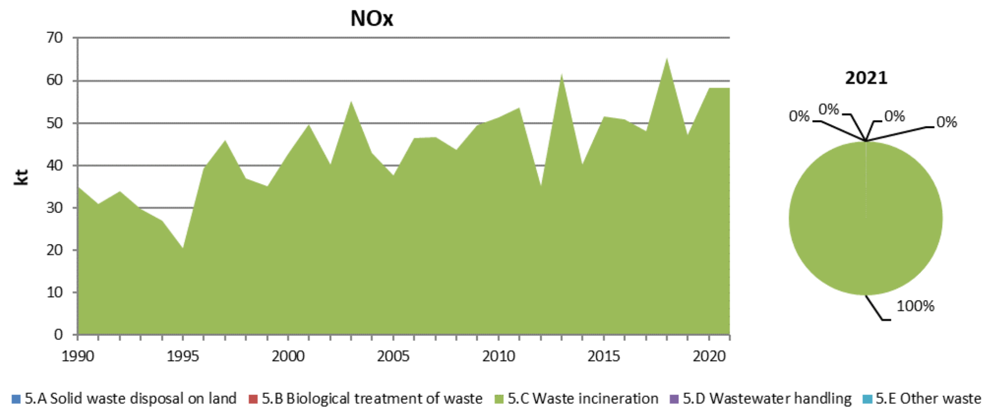
Additionally, a pie chart showing the weight distribution of the main categories for the year 2021 is included. Explanation boxes are included below the graphs, providing specific details on the pollutant emissions for the year 2021 as well as main drivers and its trends during the time series.

Emissions from the Canary Islands are not considered, as their territory is not under the EMEP grid.

For category 5B2 Biological treatment of waste, for the whole time series, $PM_{2.5}$ emissions are equal to PM_{10} emissions because of the PM emissions are related to the burning in flares of a part of the biogas produced in this process. As the 2016 EMEP/EEA Guidebook does not provide default emission factors, emission factors from US EPA AP-42. 5th Ed. (1998), chapter 2.4. (Table 2.4-4), have been used, which provides the same emission factor for particle matter emissions (NECD Inventory Review ES-5B2-2019-0001 (Table 3)).

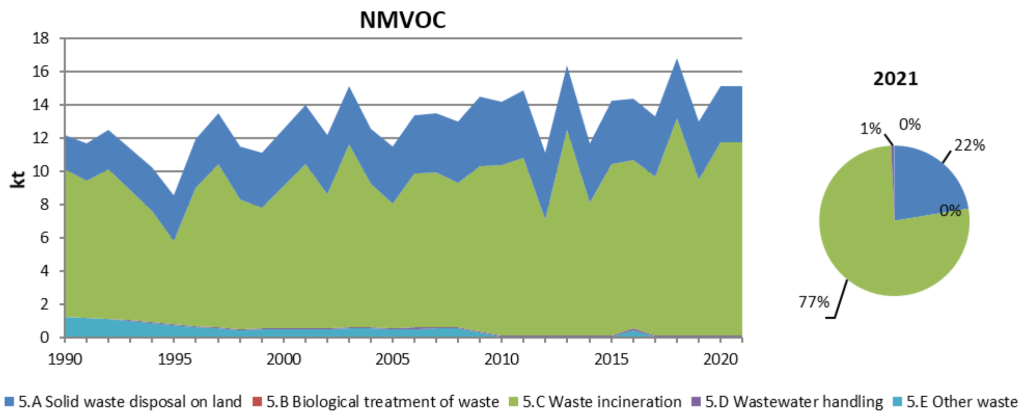
Detailed emission data of the Spanish Inventory are available from the MITECO-SEI website WebTable.

Main Pollutants



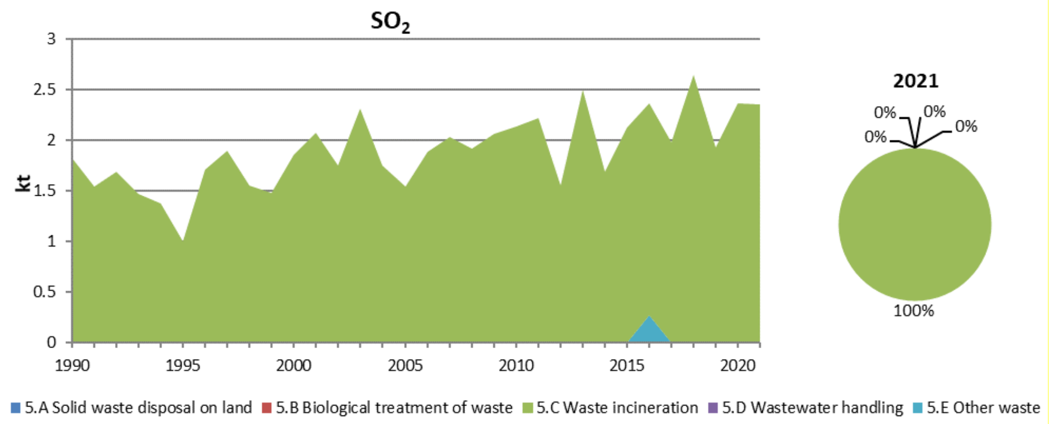
NOx	58.19 kt emitted in 2021 9.38% of the total NOx emissions of the Inventory in 2021	
	1990-2021	Main source of NOx emissions is linked to Open burning of agricultural residues (NFR 5C2). NOx emissions present variations in absolute terms, in line with annual production and its consequent burning of wastes.

Figure 6.2.1 Evolution of NOx emissions by category and distribution in year 2021



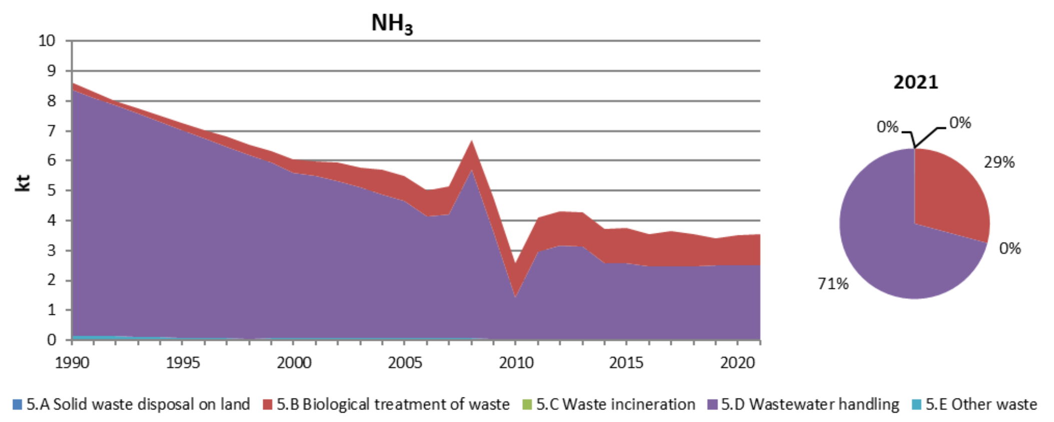
NMVOC	15.12 kt emitted in 2021 2.75% of the total NMVOC emissions of the Inventory in 2021	
	1990-2021	Main source of NMVOC emissions is linked to Open burning of agricultural residues (NFR 5C2) and Solid waste disposal on land (NFR 5A). NMVOC emissions present variations in absolute terms, in line with annual waste production and its consequent disposal or burning. Emissions related to Other waste (5E) are no longer relevant since 2010, except from a relative maximum in 2016 due to an accidental fire at a tire dump.

Figure 6.2.2 Evolution of NMVOC emissions by category and distribution in year 2021



SO_2	2.36 kt emitted in 2021 1.92% of the total SO_2 emissions of the Inventory in 2021	
	1990-2021	SO_2 emissions within the Waste sector are totally dominated by agriculture residues burning activities (5C2). The uptick in 2016 is due to accidental tire fire emissions reported under Other waste (5E) for that specific year.

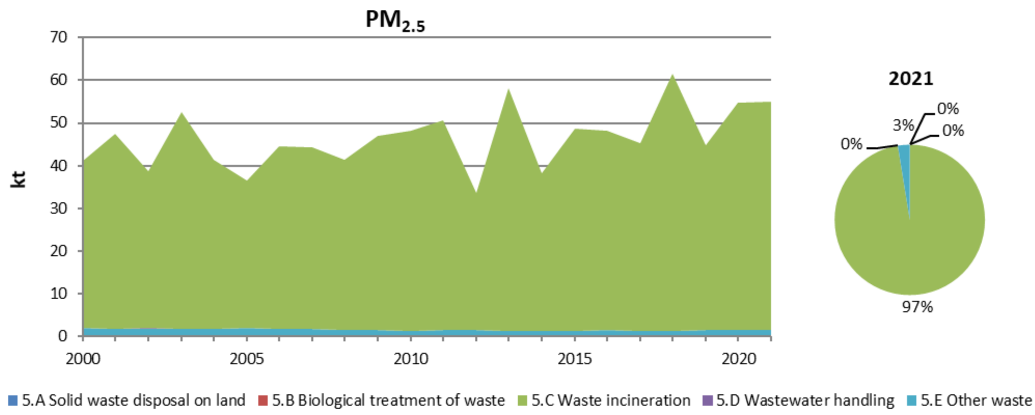
Figure 6.2.3 Evolution of SO_2 emissions by category and distribution in year 2021



NH_3	3.54 kt emitted in 2021 0.74% of the total NH_3 emissions of the Inventory in 2021	
	1990-2021	Ammonia emissions are directly related with other wastewater treatment systems (5D3-latrines) which show a declining trend due to the progressive incorporation of the population to the urban wastewater collecting systems till 2011, where a slight increase of wastewater not collected is represented. Emissions related to Biological treatment of waste (5B) increase gradually throughout the time series.

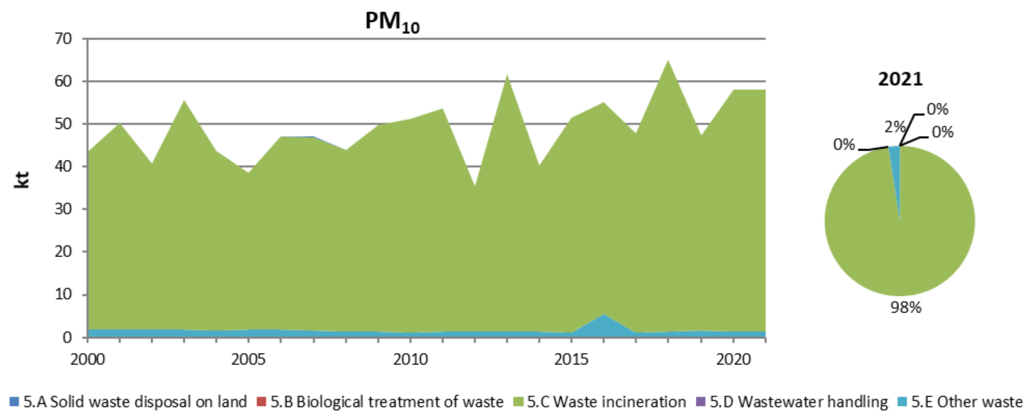
Figure 6.2.4 Evolution of NH_3 emissions by category and distribution in year 2021

Particulate Matter



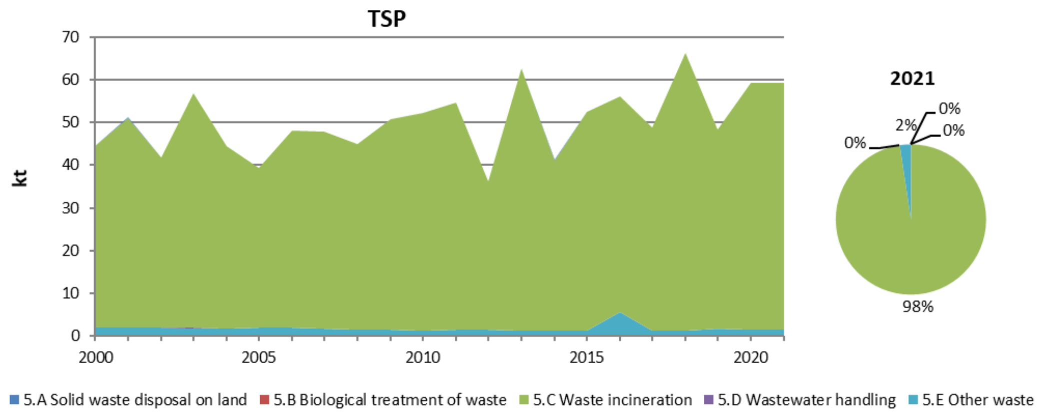
$PM_{2.5}$	54.90 kt emitted in 2021 40.67% of the total $PM_{2.5}$ emissions of the Inventory in 2021	
	2000-2021	$PM_{2.5}$ emissions within the Waste sector are totally dominated by agriculture residues burning activities (5C2). Other waste (5E) corresponds to the series of Accidental fires.

Figure 6.2.5 Evolution of $PM_{2.5}$ emissions by category and distribution in year 2021



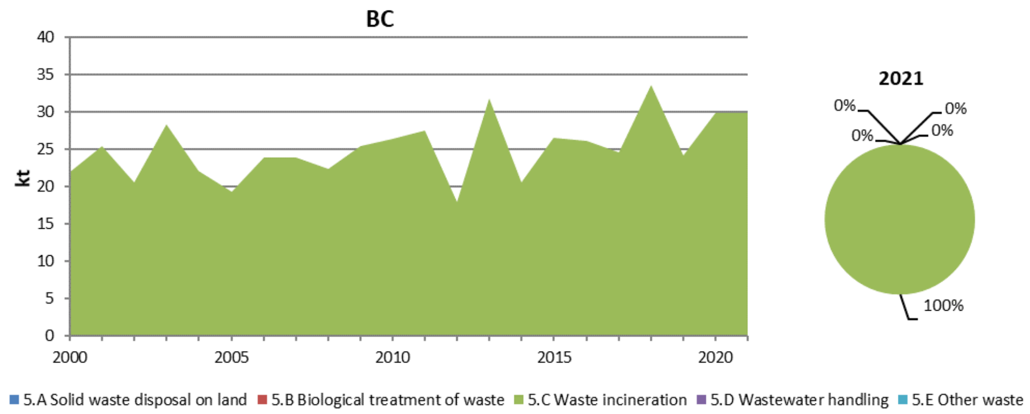
PM_{10}	58.16 kt emitted in 2021 27.01% of the total PM_{10} emissions of the Inventory in 2021	
	2000-2021	The trend during this period led by the incineration of agricultural residues (5C2). Other waste (5E) corresponds to the series of Accidental fires. The uptick in 2016 is due to accidental tire fire emissions reported under Other waste (5E) for that specific year.

Figure 6.2.6 Evolution of PM_{10} emissions by category and distribution in year 2021



TSP	59.30 kt emitted in 2021 19.96% of the total TSP emissions of the Inventory in 2021	
	2000-2021	The trend during this period led by the incineration of agricultural residues (5C2). Other waste (5E) corresponds to the series of Accidental fires. The uptick in 2016 is due to accidental tire fire emissions reported under Other waste (5E) for that specific year.

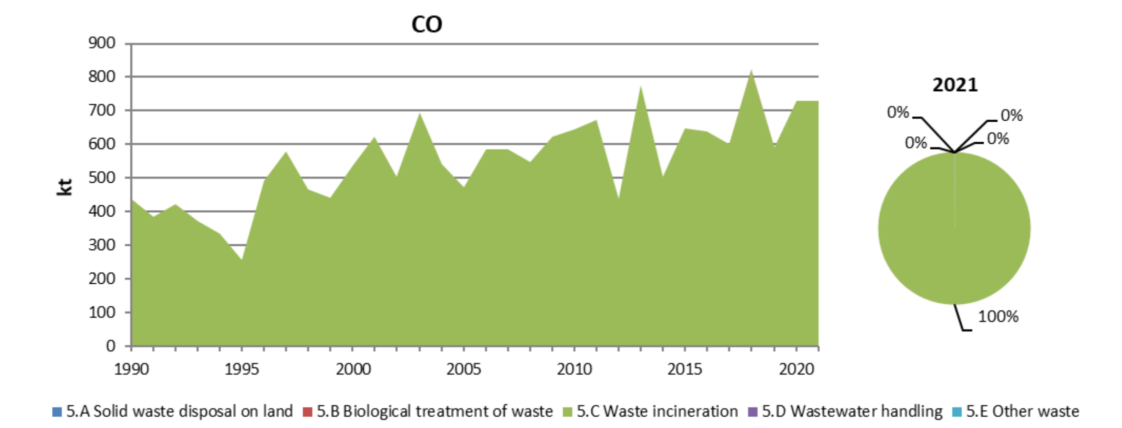
Figure 6.2.7 Evolution of TSP emissions by category and distribution in year 2021



BC	29.88 kt emitted in 2021 64.66% of the total BC emissions of the Inventory in 2021	
	2000-2021	Trend led by the incineration of agricultural residues (5C2).

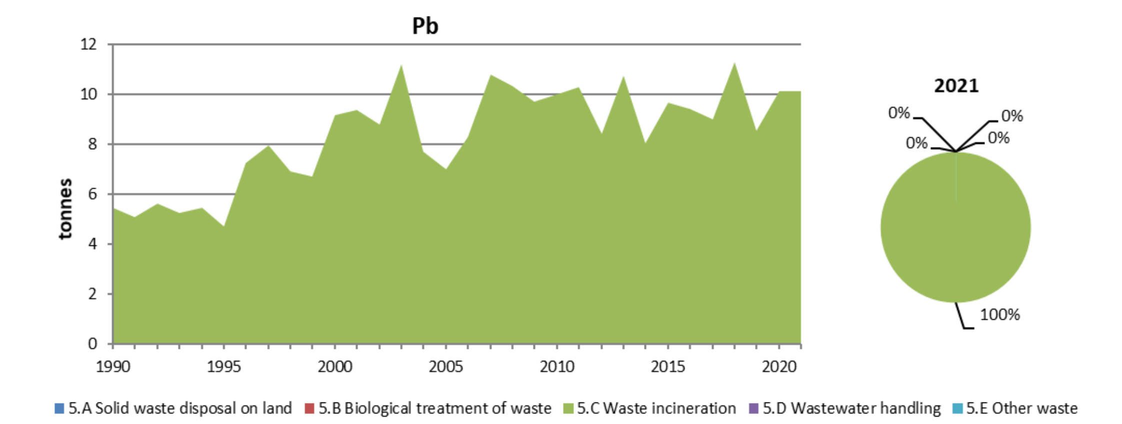
Figure 6.2.8 Evolution of BC emissions by category and distribution in year 2021

CO and Priority Heavy Metals



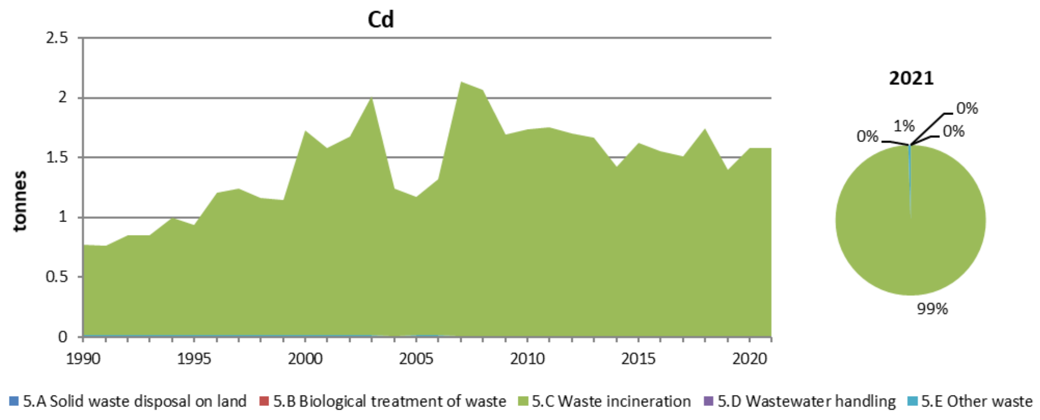
CO	730.79 kt emitted in 2021 44.65% of the total CO emissions of the Inventory in 2021	
	1990-2021	CO emissions within the Waste sector are totally dominated by agriculture residues burning activities (5C2). CO emissions present variations in absolute terms, in line with annual production and its consequent burning of wastes.

Figure 6.2.9 Evolution of CO emissions by category and distribution in year 2021



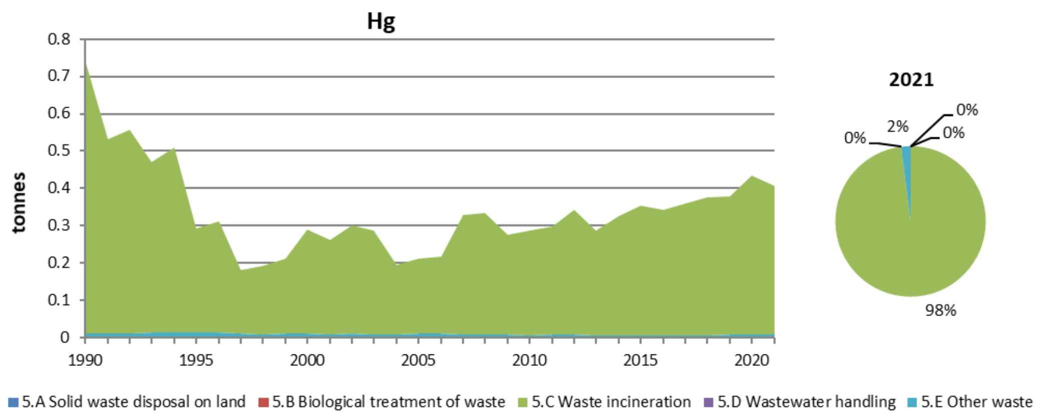
Pb	10.14 tonnes emitted in 2021 10.07% of the total Pb emissions of the Inventory in 2021	
	1990-2021	Pb emissions within the Waste sector are mainly by agriculture residues burning activities (5C2).

Figure 6.2.10 Evolution of Pb emissions by category and distribution in year 2021



Cd	1.58 tonnes emitted in 2021 23.04% of the total Cd emissions of the Inventory in 2021	
	1990-2021	Cd emissions within the Waste sector are totally dominated by agriculture residues burning activities (5C2). Other waste (5E) corresponds to the series of Accidental fires.

Figure 6.2.11 Evolution of Cd emissions by category and distribution in year 2021



Hg	0.41 tonnes emitted in 2021 13.77% of the total Hg emissions of the Inventory in 2021	
	1990-2005	Downward trend due to the decrease of Burning of unmanaged waste (5C1a), the introduction of municipal waste incineration plants with energy recovery (1A1a) and the progressive reduction of Clinical waste incineration (5C1biii).
	1990-2021	The trend slighty grows due to emissions from Sewage sludge incineration (5C1biv) and Crematoria under 5C (5C1bv). Other waste (5E) corresponds to the series of Accidental fires.

Figure 6.2.12 Evolution of Hg emissions by category and distribution in year 2021

POPs

Emissions of POPs are mainly generated in categories 5C (Incineration) and 5E (Other waste). Therefore, a unique figure with the pollutants is shown.

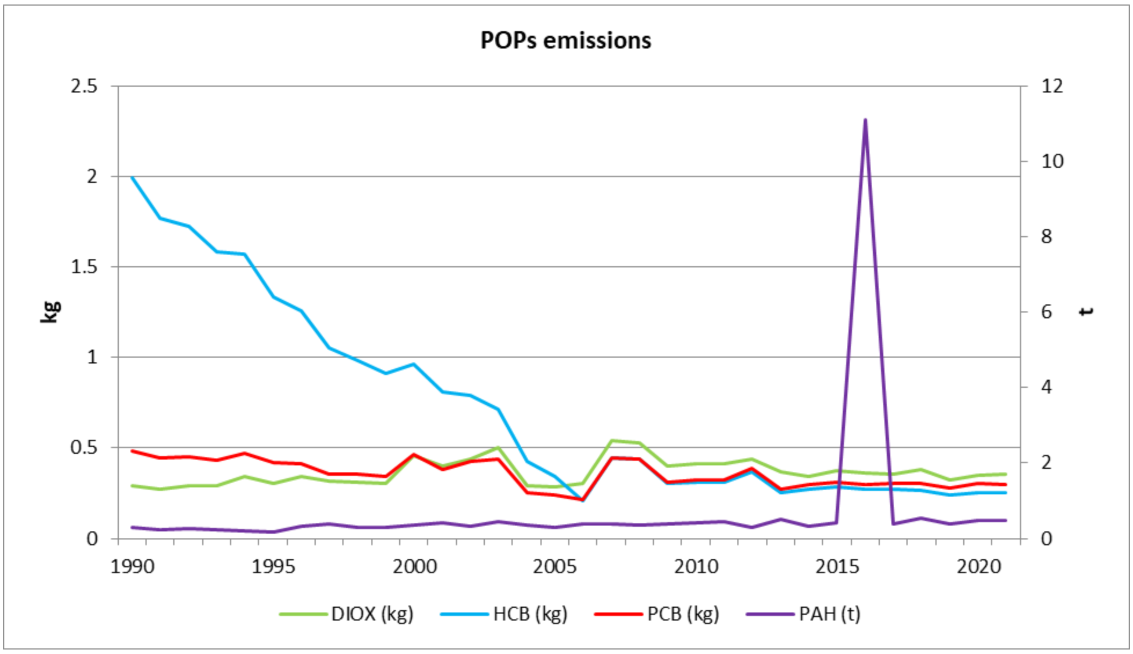


Figure 6.2.13 Evolution of POPs emissions in 5C and 5E

PCDD/ PCDF	0.35 kg I-TEQ emitted in 2021 73.39% of the total PCDD/PCDF emissions of the Inventory in 2021	
	1990-2005	The trend of the firsts years is explained by the progressive ending of the Clinical waste incineration (5C1biii) in 2005 combined with the ending of Burning of unmanaged waste (5C1a) in 2003 because of the introduction of Municipal waste incineration plants with energy recovery (1A1a).
	1990-2021	Steady trend with fluctuations connected with annual production and its consequent burning of wastes in agriculture residues burning activities (5C2). It is also linked, to a lesser extent, to the amount of Sewage sludge incineration (5C1biv) and Accidental fires (5E).

HCB	0.25 kg emitted in 2021 12.23% of the total HCB emissions of the Inventory in 2021	
	1990-2005	The trend of the firsts years is explained by the progressive ending of the Clinical waste incineration (5C1biii) in 2005 combined with the ending of Burning of unmanaged waste (5C1a) in 2003 because of the introduction of Municipal waste incineration plants with energy recovery (1A1a).
	1990-2021	Steady trend due to the amount of Sewage sludge incineration (5C1biv) and Cremations (5C1bv).

PCBs	0.29 kg emitted in 2021 0.06% of the total PCBs emissions of the Inventory in 2021	
	1990-2005	The trend of the firsts years is explained by the progressive ending of the Clinical waste incineration (5C1biii) in 2005 combined with the ending of Burning of unmanaged waste (5C1a) in 2003 because of the introduction of Municipal waste incineration plants with energy recovery (1A1a).
	1990-2021	Steady trend due to the amount of Sewage sludge incineration (5C1biv) and Cremations (5C1bv).

PAHs	0.46 tonnes emitted in 2021 1.27% of the total PAHs emissions of the Inventory in 2021	
	1990-2021	PAHs emissions within the Waste sector are totally dominated by Agriculture residues burning activities (5C2). In 2016 there is a slight uptick due to accidental tire fire emissions reported under Other waste (5E).

6.2.3. Condensable component of PM_{10} and $PM_{2.5}$

As detailed in Annex V, indication of whether the emission estimates and emission factors for PM_{10} and $PM_{2.5}$ in the Waste sector include or exclude the condensable component can be found in the table below:

Table 6.2.3 Information on condensable component of PM

NFR	Source/sector name	PM emissions: the condensable component is		EF reference and comments
		Included	Excluded	
5A	Biological treatment of waste – Solid waste disposal on land	No information in the EMEP/EEA GB 2019.		EMEP/EEA GB 2019.
5B1	Biological treatment of waste – Composting	NE		
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	No information in the EMEP/EEA GB 2019.		No information in the EMEP/EEA GB 2019.
5C1a	Municipal waste incineration	IE		Included in 1A1a.
5C1bi	Industrial waste incineration	IE		Included in 1A1a.
5C1bii	Hazardous waste incineration	NO		
5C1biii	Clinical waste incineration	IE		Included in 1A1a.
5C1biv	Sewage sludge incineration		X	US EPA AP-42 Section 2.4 Chapter 2.2.
5C1bv	Cremation	No information in the EMEP/EEA GB 2019.		EMEP/EEA GB 2019.
5C1bvi	Other waste incineration	NO		
5C2	Open burning of waste	No information in the EMEP/EEA GB 2019.		EMEP/EEA GB 2019.
5D1	Domestic wastewater handling	No information in the EMEP/EEA GB 2019.		EMEP/EEA GB 2019.
5D2	Industrial wastewater handling	No information in the EMEP/EEA GB 2019.		EMEP/EEA GB 2019.
5D3	Industrial wastewater handling	NE		
5E	Other waste	No information in the EMEP/EEA GB 2019.		EMEP/EEA GB 2019.

6.3. Major changes

The main changes performed in the Waste sector were due to the recalculation of EF for category 5Cbiv (Sewage sludge incineration) and the correction of VA for category 5D3 (Other wastewater handling) for 1990-2020, and 5C2 for 2020.

Further details of recalculations can be found in section 6.5 (Recalculations).

6.4. Key categories analysis

Within this sector, the following categories have been identified as key (table 6.2.2 for reference):

A. Incineration - 5C.

B. Wastewater handling - 5D.

C. Other waste - 5E.

Activity data sources, methodologies and a general assessment for each category are provided.

Information on which NFR categories of Waste sector include the condensable component of PM_{10} and $PM_{2.5}$ can be found in Annex 5.

A. Incineration (5C)

This source category includes emissions estimates for the following activities:

- Municipal waste incineration (5C1a) without energy recovery[2].
- Clinical waste incineration (5C1biii).
- Sewage sludge incineration (5C1biv).
- Cremation (5C1bv).
- Burning of unmanaged waste and agricultural waste within the activity Open burning of waste (5C2).

Emissions from industrial and hazardous waste incineration do not account for this category since they have always taken place with energy recovery. Therefore, their corresponding emissions are allocated under the energy category 1A1a.

Category 5C is considered as a key category for its contribution to the Level and the Trend of emissions of the following pollutants: NOx, NMVOC, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, PCDD/PCDF and PCBs. In addition, it also contributes to the Level of emissions of SO_2 (Table 6.2.2).

A.1. Activity variables

Table 6.4.1 Summary of activity variables, data, and information sources for category 5C

Activities included	Activity data	Source of information
Municipal waste incineration (**5C1a**)	- Amount and composition of waste incinerated. - Energy produced. - Emissions and abatement techniques implemented. - Other parameters concerning the incineration process (LHV, incineration units, stacks, etc.).	- 1990-2003: publication “Medio Ambiente en España” (Environment in Spain) and IQ. Since 2004 no incineration of MSW takes place without energy recovery, so no activity variable is reported under 5C1a. Emissions from energy recovery are reported within the Energy category (1A1a).
Clinical waste incineration (**5C1biii**)	- Number of hospital beds. - Clinical waste generation parameter per bed and day.	- 1990-1994: INE. “Statistics Yearbook of Spain” (INE). - 1995-1998: statistic interpolation. - “Study on generation and management of clinical wastes in Spain, 1995” (Institute for the Sustainability of Resources MITECO). - 1999-2005: statistics from the Health Information Institute. Since 2006 no incineration without energy recovery takes place. Emissions are reported under the Energy category (1A1a).

[2] According to the information available, all incineration facilities have undertaken incineration with energy recovery since 2004.

Activities included	Activity data	Source of information
Sewage sludge incineration (**5C1biv**)	- Amount and percentage of sludge incinerated at a regional level (area sources). - Volume of water treated at industrial wastewater handling plants in refinery and paper pulp manufacturing plants (LPS).	AREA SOURCES: - 1989: publication “Medio Ambiente en España, 1991” (The Environment in Spain, 1991) MOPT. - 1993: “Study on treatment and final disposal of urban wastewater sewage sludge” (MOPTMA). - 1990-1992 and 1994-1996: estimated by interpolation. - 1997-2021: National Sewage Register SGEC (MITECO) (Data from 2020 replicated in 2021). LARGE POINT SOURCES (LPS): - 1990-1993: Refinery plants: statistical extrapolation based on the volume of water treated at industrial wastewater treatment plants. - 1994-2013: Refinery plants: IQ. - 1997-2021: Paper pulp manufacturing plants: IQ.
Cremation (**5C1bv**)	- Number of deaths per year. - Number of corpses incinerated in crematoriums per year.	- 1990-2009: data provided by the main entrepreneurial association. - 2010-2021: estimation based on the death statistics available from the INE and a cremation percentage provided by "The National Funeral Services Association" (PANASEF).
Open burning of waste: burning of unmanaged waste (**5C2**)	- Rate of burned unmanaged waste.	- 1990-2000: SGR (MITECO).
Open burning of waste: burning of agricultural waste **(5C2)**	- Crop surface and crop yield. - Burnt fraction by crop. - Annual N-amount of burnt crop residue. - Nitrogen fraction by crop. - Dry matter fraction.	- 1990-2021: Statistical Yearbook (MAPA). - 1990-2021: Nitrogen and Phosphorous Balance in Spanish Agriculture Book (BNyPAE). - 1990-2021: Nitrogen fraction by crop (several authors); Ref. Man. & Good Pract. Guide IPCC; Martínez, X.; Roselló, J. and Domínguez, A. (2006); Harvest index. (2006); Krider J.N. *et al.*; Villalobos, F.J. *et al.* (2002); Wheeler, R.M. (2003); Energy Andalucia Agency (1999); Senovilla, L. and Antolín, G. (2005); La Cal, J.A. (2007). - 1990-2021: “Dry matter fraction”. Francesc Giró, *Compostarc*, 2007. - Forest fire prevention legislation[3]

[3] See chapter 5.4 of the IIR.

A.2. Methodology

Table 6.4.2 Summary of methodologies applied in category 5C

Pollutants	Tier	Methodology applied	Observations
Municipal waste incineration (5C1a) (Methodology factsheet: Municipal waste incineration)			
LARGE POINT SOURCES (LPS): NOx, NMVOC, SO_2, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, PAHs, HCB, PCB	T1/T2	IQ from incineration plants treated as a point source of pollution. EMEP/EEA Guidebook (2019). Chapter 5C1a.	EE: - Measured emissions, emissions estimates and abatement techniques applied provided by incineration plants. EF: - Emission factors by tonne of waste. - Table 3-2, Abatement techniques applied (table 3-3): 1990-1996 for these years it was assumed only “Particle Abatement” as control techniques. - Table 3-1: 1996-2003 for this period, it is considered as a minimum the control techniques of “Particle Abatement + acid gas abatement”.
AREA SOURCES: NOx, NMVOC, SO_2, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, PAHs, HCB, PCB	T1	EMEP/EEA Guidebook (2019) Chapter 5C1a.	EF - Emission factors by tonne of waste. - Table 3-2, Abatement techniques applied (table 3-3): 1990-1995 for these years it was assumed only “Particle Abatement” as control techniques. - Table 3-1: 1996-2003 for this period it is considered as a minimum the control techniques of “Particle Abatement + acid gas abatement”.
Clinical waste incineration (5C1biii) (Methodology factsheet: Clinical waste incineration)			
NOx, NMVOC, SO_2, TSP, BC, CO, Cd, Hg, As, Cr, Cu, Ni, PCDD/PCDF, PAHs, HCB, PCB, PCP	T2	EMEP/EEA Guidebook (2019) Chapter 5C1biii.	EF - Emission factors by tonne of waste. - Table 3-2, Abatement techniques applied (table 3-3).
Sewage sludge incineration (5C1biv) (Methodology factsheet: Sewage sludge incineration)			
NOx, NMVOC, SO_2, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Zn, Ni, Se, PCDD/PCDF, PAHs, HCB, PCB	T2	EMEP/EEA Guidebook (2019) Chapter 5C1bi, 5C1bii, 5C1biv.	EF: - Emission factors by tonne of waste. - Table 3-2. - Abatement efficiencies Table 3-4 (NMVOC, SO_2 and PM).
Cremation (5C1bv) (Methodology factsheet: Cremation)			
NOx, NMVOC, SO_2, $PM_{2.5}$, PM_{10}, TSP, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, PAHs, HCB, PCB	T1	EMEP/EEA Guidebook (2019) Chapter 5C1bv.	EF - Emission factors by cremation. - Table 3-1. - CO emissions are included in 1A4 category to avoid double counting, as they are not related to the incinerated bodies but to the auxiliary combustion of fuels associated (NECD Inventory Review ES-5C1bv-2021-0001).

Pollutants	Tier	Methodology applied	Observations
Open burning of waste: burning of agricultural waste (5C2) (Methodology factsheet: Open burning of waste: burning of agricultural waste)			
NOx, NMVOC, SO_2, PM2.5, PM10, TSP, BC, CO, Pb, Cd, As, Cr, Cu, Se, Zn, PCDD/PCDF, PAHs	T2	EMEP/EEA Guidebook (2019) Chapter 5C2.	EF - Emission factors by tonne of waste (except PAH (by dry matter)). - Table 3-3 (orchard crops) (except Cr (Table 3-1 (T1))).
Open burning of waste: burning of unmanaged waste (municipal solid waste (1990-2000)) (5C2) (Methodology factsheet: Open burning of waste: burning of unmanaged waste (1990-2000))			
NOx, NMVOC, SO_2, $PM_{2.5}$, PM_{10}, TSP, CO	T1	US EPA AP-42. 5ª Ed. (1998) Capítulo 2.5. Tabla 2.5-1 and UK Inventory (only for NMVOC)	- EF (Default). - 1990-2000 (from 2000 onwards, this activity was prohibited).

A.3. Assessment

As shown in the figure below, the trend of 5C is significantly led by category Open burning of waste (5C2). The irregular behaviour of the activity data is due to variations in the production of crops that generate waste that is eliminated through open burning.

Since 2004 no incineration of MSW (5C1a) takes place without energy recovery, so its activity variable is not reported under Waste sector, but under Energy Sector (1A1a). The same occurs to category Clinical waste incineration (5Cbiii) since 2006.

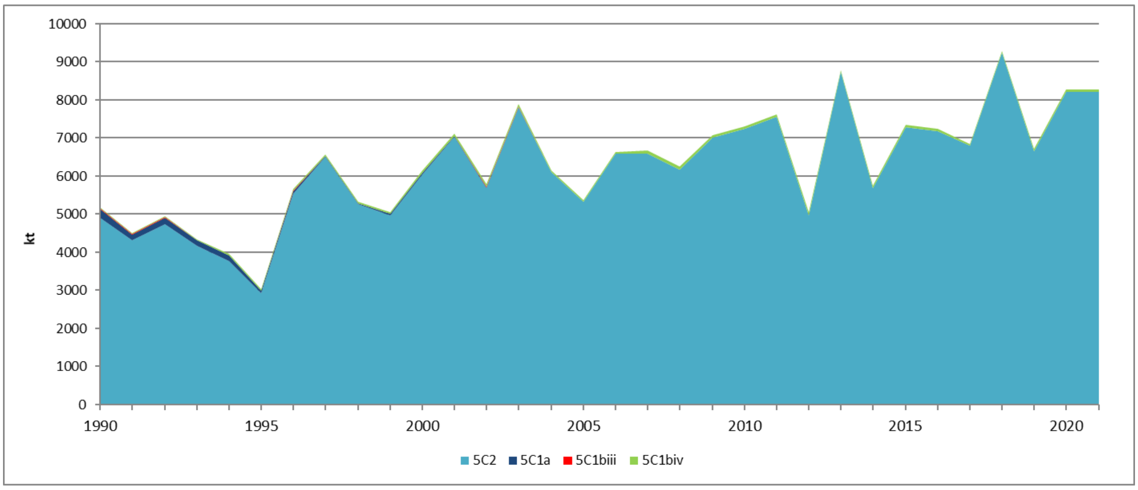


Figure 6.4.1 Evolution of activity variables in category Waste incineration (5C) without Cremations (5C1bv)

Considering 5C activity data in detail (see figure below), only Cremation (5C1bv) shows an upward trend, especially during 2020 where it had a noticeable increased due to the scourge of COVID-19 in Spain. However, in 2021 there is a decrease in the number of bodies cremated mainly due to the diminution of deaths as the pandemic stabilizes, although the numbers of deaths and cremations are still superior to the pre-pandemic values in line with the observed trend. Activity data in the other categories decrease or even disappear due to the reallocation within the Energy sector.

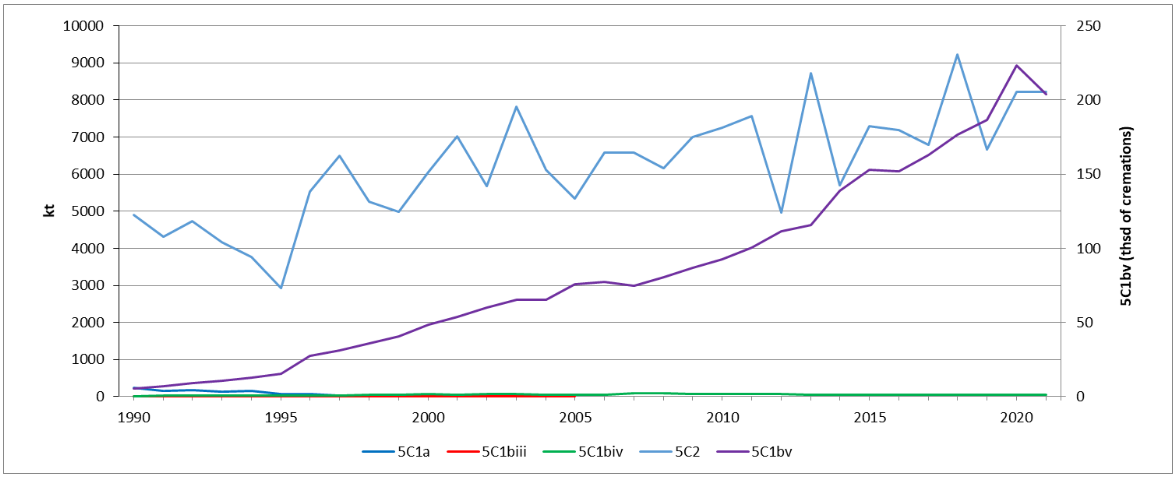


Figure 6.4.2 Evolution of activity variables in category Waste incineration (5C)

In the following table, amount of matter burned by type in category 5C2 for the time series are provided[4].

Table 6.4.3 Ammount of matter burned by type in category 5C2

Year	Activity data for "Open burning of waste: burning of unmanaged waste (municipal solid waste (1990-2000)) (5C2)" (Quantity burned in kt)	Activity data for "Open burning of waste: burning of agricultural waste (5C2)" (Amount of dry matter burned in kt)	Activity data for "Open burning of waste: burning of agricultural waste (5C2)" (Waste burned in kt)
1990	279.97	4,800,343.73	6,857,627.05
1991	308.42	4,218,061.92	6,025,796.71
1992	322.26	4,643,090.79	6,632,980.21
1993	262.10	4,081,400.83	5,830,566.78
1994	190.40	3,677,034.27	5,252,900.85
1995	121.42	2,830,594.37	4,043,702.20
1996	68.09	5,454,132.04	7,791,609.41
1997	88.08	6,406,457.12	9,152,072.44
1998	59.19	5,156,550.66	7,366,493.57
1999	36.29	4,891,912.55	6,988,439.51
2000	10.77	5,955,315.19	8,507,584.61
2001	-	6,923,455.96	9,890,641.47
2002	-	5,592,543.05	7,989,339.23
2003	-	7,713,930.73	11,019,890.02
2004	-	6,012,244.52	8,588,912.15
2005	-	5,242,115.37	7,488,728.75
2006	-	6,496,314.63	9,280,440.19

[4] Recommendation made by the ERT in the 2021 NECD Final Review Report

Year	Activity data for "Open burning of waste: burning of unmanaged waste (municipal solid waste (1990-2000)) (5C2)" (Quantity burned in kt)	Activity data for "Open burning of waste: burning of agricultural waste (5C2)" (Amount of dry matter burned in kt)	Activity data for "Open burning of waste: burning of agricultural waste (5C2)" (Waste burned in kt)
2007	-	6,492,019.24	9,274,303.93
2008	-	6,071,583.966	8,673,682.71
2009	-	6,918,252.215	9,883,207.57
2010	-	7,153,375.380	10,219,097.47
2011	-	7,476,545.658	10,680,768.83
2012	-	4,876,345.810	6,966,201.33
2013	-	8,638,223.031	12,340,306.27
2014	-	5,599,347.039	7,999,059.20
2015	-	7,195,628.071	10,279,458.39
2016	-	7,084,442.323	10,120,621.77
2017	-	6,690,650.990	9,558,063.28
2018	-	9,138,656.385	13,055,210.35
2019	-	6,563,809.001	9,376,860.62
2020	-	8,117,711.05	11,596,718.47
2021	-	8,117,711.05	11,596,718.47

B. Wastewater handling (5D)

This category includes emissions from both domestic (5D1) and industrial wastewater handling (5D2) as well as Other wastewater handling (latrines) (5D3).

Emissions from combustion in wastewater treatment plants with energy recovery are reported under the Energy sector (1A1a), whereas flaring of biogas is considered within NFR category 5D in this chapter.

In this sense, emissions reported under this category 5D are mainly due to the combustion of biogas. Considering wastewater treatment activities themselves, category 5D only accounts for two of the pollutants covered in this report: NMVOC and NH_3.

Category 5D is considered as key category in 2021 for its contribution to the Trend of emissions of NH_3 (Table 6.2.2).

B.1. Activity variables

Table 6.4.4 Summary of activity variables, data, and information sources for category 5D

Activities included	Activity data	Source of information
Domestic wastewater handling (**5D1**)	- Amount of biogas produced in sludge anaerobic digesters from wastewater treatment plants. - Share of biogas/CH_4 burned into different devices (flares, engines or boilers).	- "Uses of biogas produced in urban wastewater treatment plants in Spain". CEDEX. - Spanish Climate Change Office data (OECC)
Industrial wastewater handling (**5D2**)	- Volume of wastewater treated in refinery and paper pulp manufacturing plants. - Share of biogas/CH_4 burned into different devices (flares, engines or boilers). - Industrial production, wastewater discharge rate, volume of discharge, organic load of water discharged. - Industrial production index.	- 1990-2021: IQ from refinery and paper pulp manufacturing plants. - Final project: "Comparative analysis of biogas energy utilization technologies in wastewater treatment plants", 2016, OECC. - "Studies on regulation of wastewater discharges". MITECO. - IPCC 2019 GL. Table 6.9, Ch. 6, Vol. 5. - INE.
Latrines (**5D3**)	- Percentage of urban wastewater not collected. - Population data.	- EUROSTAT. - INE.

B.2. Methodology

Table 6.4.5 Summary of methodologies applied in category 5D

Pollutants	Tier	Methodology applied	Observations
Domestic wastewater handling (5D1) ***Industrial wastewater handling (5D2)*** (Methodology factsheets: Domestic wastewater handling, Industrial wastewater handling)			

Pollutants	Tier	Methodology applied	Observations
NOx, CO, $PM_{2.5}$, PM_{10}, TSP	T1	US EPA AP-42. 5th Edition (1998), Chapter 2.4. Table 2.4-4.	EF The factors for these pollutants, broken down by type of combustion facility, are expressed in the original source quoted in kg pollutant/millions of m^3 of standard dry methane burnt. To express the factor in g pollutant/methane burnt, the m^3 S (standard cubic metre) conversion factors were applied to m^3 N (normal cubic meter) of (273.15+15)/(273.15) and the density under normal circumstances of methane (715 g /m^3 N) to convert volume into mass. Final Review Report (ES-5D1-2019-0001/ES-5D2-2019-0001 (Table 3)). PM emissions are related to the burning in flares of a part of the biogas produced in wastewater treatment plants, and as the 2019 EMEP/EEA Guidebook does not provide default emission factors, emission factors from US EPA AP-42. 5th Ed. (1998), chapter 2.4, table 2.4-4, have been used, which provides the same emission factor for particle matter emissions.
NMVOC	T1	EMEP/EEA Guidebook (2019). Chapter 5D.	EF - Emission factors by m^3 wastewater handled. - Table 3-1.
Latrines (5D3) (Methodology factsheet: Latrines)			
NH_3	T2	EMEP/EEA Guidebook (2019). Chapter 5D.	EF - Emission factors by person/year. - Table 3-2. Final Review Report (ES-5D3-2019-0001 (Table 3)). - Domestic wastewater handling by latrines systems in Spain is a minority management system in Spain. The inventory team considers it more transparent to allocate these emissions within 5D3 sub-activity “Other wastewater handling”, in order to facilitate its monitoring and control and avoid confusing implied emission factors.

B.3. Assessment

NMVOC emissions from domestic wastewater treatment plants show an upward trend as a consequence of the increase in the amount of m^3 of wastewater treated in Spain along the time series. Significant rise in 2004 is linked to the deadline in the application of Council Directive 91/271/EEC, concerning mandatory urban wastewater treatments in European member states (see figure below).

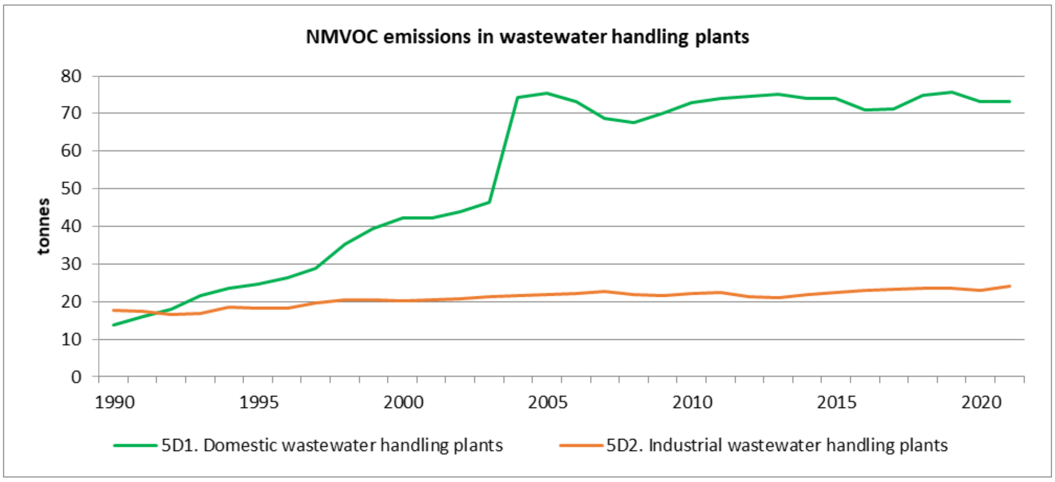


Figure 6.4.3 Evolution of NMVOC emissions in category 5D

Regarding NH_3 emissions from latrines (see figure below), the trend shows a downward evolution according to the development of the urban wastewater handling. The relative up and down peaks of emissions in 2009-2011 are related to the percentage of wastewater not collected obtained from the focal point (EUROSTAT). Latrines have become a minor activity in Spain, as long as new wastewater treatment plants have been implemented in the country along the Inventory period. These estimates account for 69.6% of ammonia emissions in the Waste sector in 2021 whereas in 2020 it was the 71.8%.

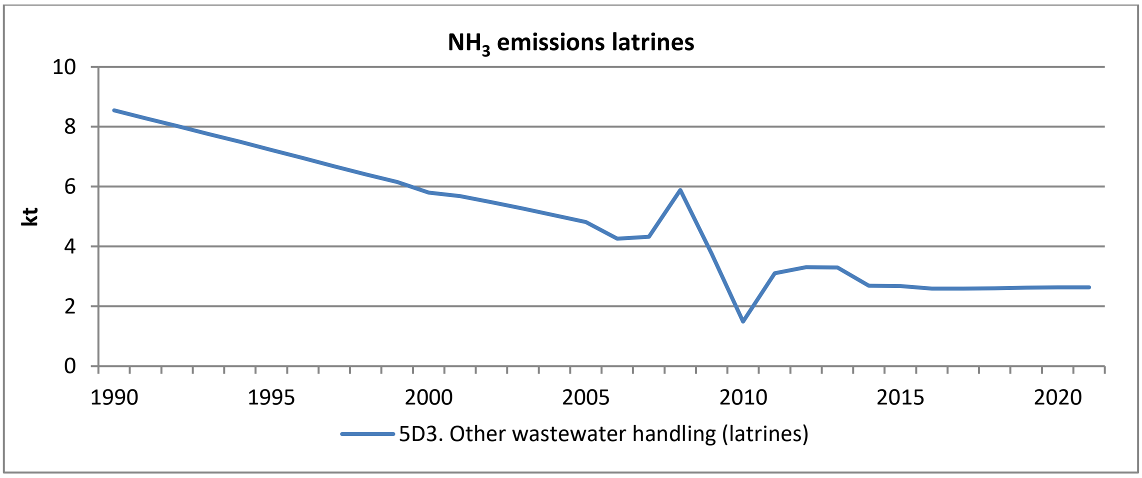


Figure 6.4.4 Evolution of NH_3 emissions in 5D3

Concerning biogas flaring in wastewater treatment plants, the figure below shows an increasing trend of the activity data until 2010, when it decreases markedly and then remains constant. Flaring is decreasing in favour of combustion of biogas in energy recovery devices. In 1990, 25% of biogas was burned in flares whereas in 2021, the share dropped to 12%.

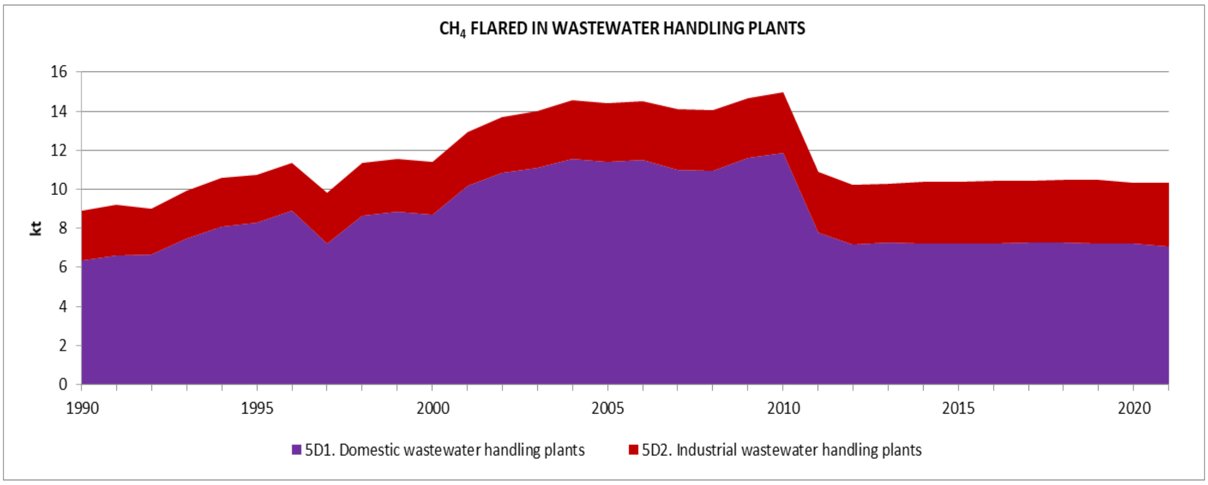


Figure 6.4.5 Evolution of activity variables in category 5D

C. Other waste (5E)

Category 5E is considered as key category in 2021 for its contribution to the Level of emissions of PCDD/PCDF (Table 6.2.1).

This category includes emissions from the following activities:

- Sludge spreading.
- Accidental car fire.
- Accidental detached house.
- Accidental undetached house.
- Accidental flat fire.
- Accidental industrial fire.

On May 13th, 2016, a fire accidentally started in a tire deposit located between the municipal term of Seseña (Castilla-La Mancha) and Valdemoro (Community of Madrid). This singular event lasted for more than a week and supposed the emissions of several pollutants, mainly Particulate Matter, PCDD/PCDF and PAHs.

In consequence, in 2016, the Spanish Inventory estimated the information about the accidental tire fire for the whole time series, following the recommendation (ES-5E-2017-0001) made by the ERT in the 2017 NECD Inventory Review. This information is included in the 1990-2016 edition as an additional activity in category 5E and, in the 1990-2017 edition, TSP emissions were estimated; however, this additional activity was removed from the IIR, and the emissions incorporated in category 5E, in the subsequents editions to date. As a recommendation in the 2021 NECD Inventory Review (ES-5E-2021-0001) it was re-included in the past edition and will remain in the subsequents editions.

C.1. Activity variables

Table 6.4.6 Summary of activity variables, data, and information sources for category 5E

Activities included	Activity data	Source of information
Sludge spreading.	- Total amount of sludge generated in EDARs.	- National Sludge Registry (RNL (MITECO)). - Estimation of the production and treatment of sewage sludge from wastewater treatment plants, prepared by the Centre for Studies and Experimentation of Public Works (CEDEX).
Accidental fires: - Accidental car fire. - Accidental detached house. - Accidental undetached house. - Accidental flat fire. - Accidental industrial fire.	- Number of fires of the different categories.	- Government Area of Security and Community Services. General Directorate of Emergencies. City of Madrid. - MAPFRE foundation and Professional Association of Bombers Technicians. - Distribution of population by degree of urbanisation, dwelling type and income group (Eurostat). - Fleet vehicle (DGT).
Accidental fires: - Accidental fire at a tire landfill	- Total amount (tonnes) of tires burned.	- Department of Agriculture, Environment and Rural Development. Castilla-La Mancha. - Department of Agriculture, Environment and Rural Development. Community of Madrid.

C.2. Methodology

Table 6.4.7 Summary of methodologies applied in category 5E

Pollutants	Tier	Methodology applied	Observations
Sludge spreading (5E) (Methodology factsheet: Sludge spreading)			
NH_3	T2	EMEP/EEA Guidebook (2019) Chapter 5E.	EF - Emission factors by g/kg NH_3 in the sludge. - Table 3-1.
NMVOC	T2	EMEP/EEA Guidebook (2019) Chapter 5E.	EF - NMVOC. Report on Complementary Information in the Frame of the Assistance Provided for CORINAIR 90 Inventory. Pg. 14.
Accidental fires (cars, detached and undetached houses, industrial, flats) (5E) (Methodology factsheets: Accidental fires)			
$PM_{2.5}$, PM_{10}, TSP, Pb, Cd, Hg, As, Cr, Cu, PCDD/PCDF	T2	EMEP/EEA Guidebook (2019). Chapter 5E.	EF - Emission factors by kg/fire; g/fire and mg/fire. - Table 3-2; 3-3; 3-4; 3-5; 3-6.
Accidental fires (Accidental fire at a tire landfill) (5E) (Methodology factsheets: Accidental fires)			
NMVOC, $PM_{2.5}$, PM_{10}, TSP, BC, PAH, SO_2, Pb, As, Cr, Cu, Se, Ni, Zn	T2	EMEP/EEA Guidebook (2019) Chapter 5E.	EF - NMVOCs, PM_{10}, TSP, PAHs. EPA. U.S. Air emission from scrap tire combustion. (October 1997). - As, Cr, Cu, Pb, Ni, Se, Zn. AP-42, Vol. I, Chapter 2.5: Open burning (October 1992). Table 2. 5-2. - $PM_{2.5}$, SO_2. "Uncontrolled combustion of shredded tires in a landfill, Part I: Characterization of gaseous and particulate emissions". University of Iowa. - BC. 3.5% of $PM_{2.5}$ (Olmez *et al*. (1988)).

C.3. Assessment

Considering 5E activity data in detail, Sludge spreading activity shows a downward trend until 2010, because this activity is a minor treatment in Spain nowadays. On the contrary, Accidental fires show an irregular behaviour, especially Industrial fire with an important decrease since 1996. Car fires present an increase between 2000 and 2003.

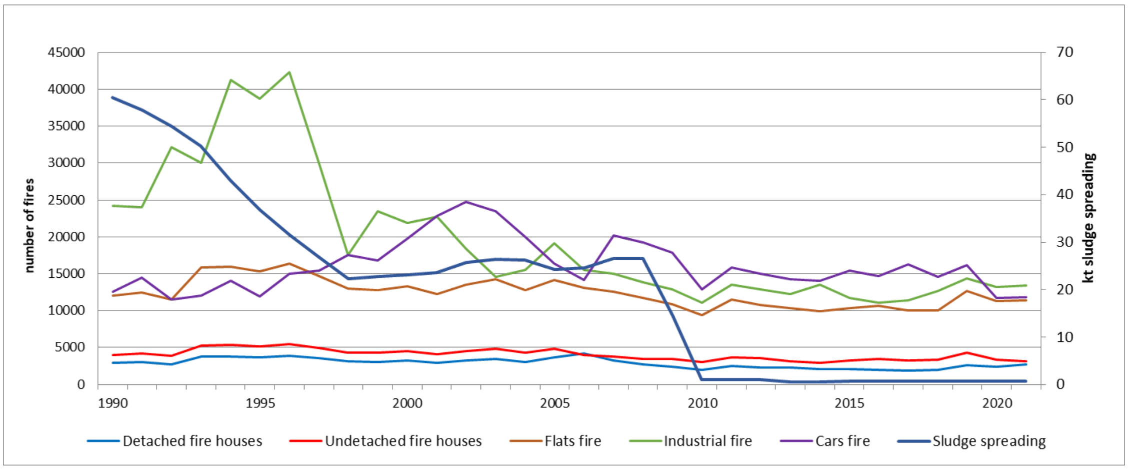


Figure 6.4.6 Evolution of activity variables in category 5E

Regarding the emissions of pollutants under 5E, PAHs emissions in 2016 are linked to the above-mentioned accidental tire fire and, therefore, can be considered as a singularity in the time series emissions.

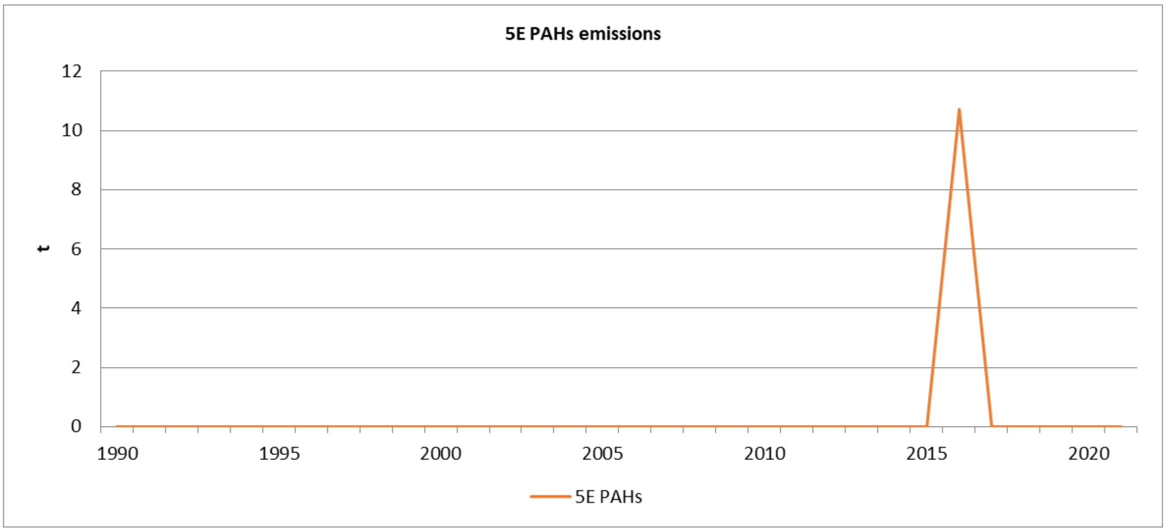


Figure 6.4.7 Evolution of PAHs

On the other hand, PCDD/PCDF emissions show a downward trend, except for some years in which they increase slightly, as displayed in the figure below. These emissions are mainly related to the accidental fires, and more specifically to the accidental industrial fires.

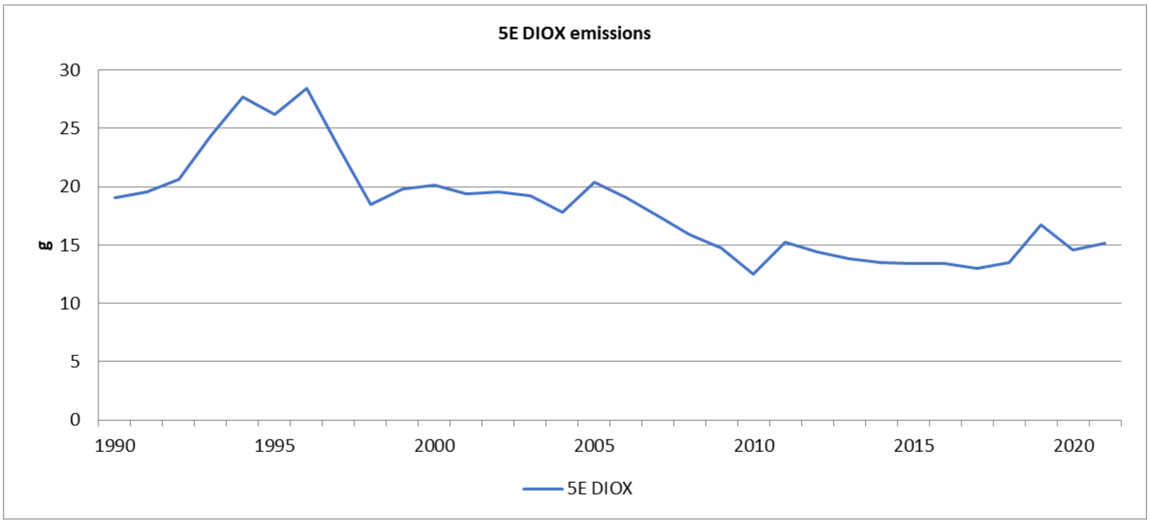


Figure 6.4.8 Evolution of PCDD/PCDF

The following figure shows the trend for Particulate Matter emissions. The uptick in 2016 is due to the accidental tire fire in Seseña.

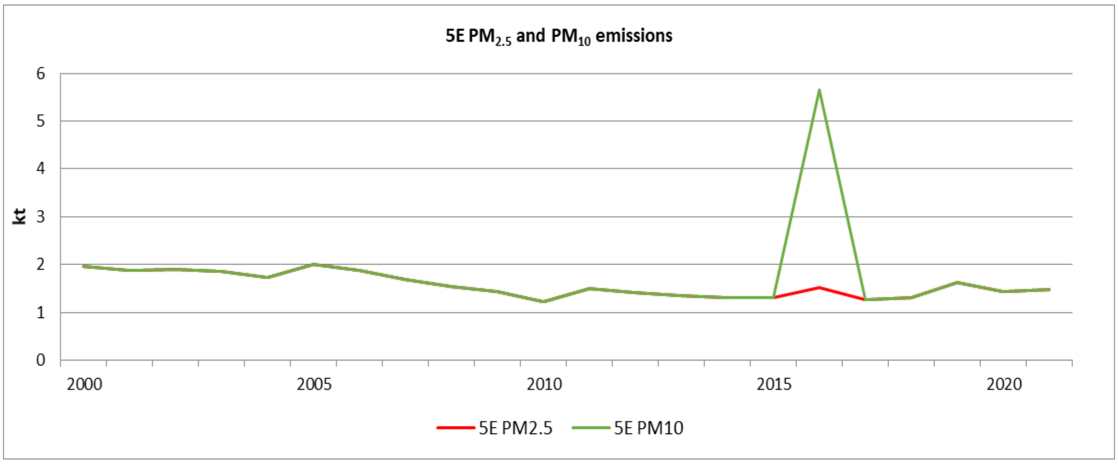


Figure 6.4.9 Evolution of PM emissions in 5E

6.5. Recalculations

The following table shows a brief view of the recalculations in the Waste sector:

Table 6.5.1 Recalculation by pollutants – Waste

Pollutants affected	Recalculation
5A- Biological treatment of waste - Solid waste disposal on land	
NOx, NMVOC, $PM_{2.5}$, PM_{10}, TSP, CO	The amount of waste disposed corresponding to the year 2020 has been updated, being then replicated for 2021, in line with the information provided (with a one-year lag) by the focal point. Additionally, a new landfill with information for 2020 and 2021 has been included in the Inventory database. Finally, due to the corrections of some errors in the data entry, there are also recalculations since 2019. These updates have caused the recalculation of the emission of methane and other contaminants emissions of the ulterior biogas burn.
5B-Biological treatment of waste	
Composting NH_3	The amount of waste treated corresponding to the year 2020 has been updated, being replicated for 2021, in line with the information provided (with a one-year lag) by the focal point. Additionally, a new composting plant with information for 2020 and 2021 has been included in the Inventory database.
Anaerobic digestion at biogas facilities NOx, NH_3, $PM_{2.5}$, PM_{10}, TSP, CO	The amount of waste treated corresponding to the year 2020 has been updated, being replicated for 2021, in line with the information provided (with a one-year lag) by the focal point. In addition, due to the update of LPG Low Calorific Value (LCV) according to new information available, there are also recalculations for 2007 and 2008. Finally, incorporation of activity data corresponding to new biomethanization plants for years 2015 to 2020. These updates have caused the recalculation of the emission of methane and other contaminants emissions of the ulterior biogas burn.
5C1biv-Sewage sludge incineration	
NOx, CO, PCB, HCB, PCDD/PCDF, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn	Recalculation of the whole time series due to the correction of the wrong use of abatement efficiency percenteges for these contaminants as brought up in the last NECD Inventory Review (ES-5C11biv-2022-0002). In addition, recalculation of the activity data for period 2019-2020, being replicated for 2021, due to an update of the information provided by the focal point (Registro Nacional de Lodos (RNL)).
NMVOC, SO_2, $PM_{2.5}$, PM_{10}, TSP, BC, PAHs	Recalculation of the activity data for period 2019-2020, being replicated for 2021, due to an update of the information provided by the focal point (Registro Nacional de Lodos (RNL)).

Pollutants affected	Recalculation
5C1bv-Cremation	
NOx, NMVOC, SO_2, $PM_{2.5}$, PM_{10}, TSP, PCB, HCB, PCDD/PCDF, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PAHs	Recalculation in 2020 due to new information obtained from the focal point in the number of deaths and the percentage of cremations.
5C2-Open burning of waste	
Burning of agricultural waste NOx, NMVOC, SO_2, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, As, Cr, Cu, Se, Zn, PAHs, PCDD/PCDF	Cultivated areas data and crop yields for BNPAE calculates are provided by MAPA's Statistics Yearbook with two-year lag. In these cases, the Inventory replicates the x-2 year values published in the Yearbook, into x-1 year, the last year inventoried. This edition has updated the values of 2020 according to the yearbook, and has replicated them into 2021.
5D-Wastewater handling	
Domestic wastewater handling NOx, NMVOC, $PM_{2.5}$, PM_{10}, TSP, CO	Correction of biogas burned in motors for period of time 2015-2017. This update has caused the recalculation of the emission of methane in the wastewater treatment and other contaminants emissions of the ulterior biogas burn. Recalculation of the volume of treated wastewater for 2020 due to new information from the focal point (INE).
Latrines NH_3	The activity data corresponding to the period 1990-2007, 2010 and 2012 has been updated due to new information of the Urban wastewater collecting system in EUROSTAT and the correction of the interpolated data as recommended in the last NECD Inventory Review (ES-5D3-2022-0002).
5E-Other waste	
Sludge spreading NH_3, NMVOC	Recalculation of the activity data for period 2019-2020, being replicated for 2021, due to an update of the information provided by the focal point (Registro Nacional de Lodos (RNL)).
Accidental fires (Car, detached and undetached houses, industrial and flats) $PM_{2.5}$, PM_{10}, TSP, PCDD/PCDF	Recalculation due to the update in the amount of cars fires in Spain for the whole time series.

Next figures show the evolution as a result of the recalculations implemented in the current Inventory edition explained before. The line chart shows emissions (kt) in absolute terms, while the bar chart displays the relative difference between emission values before and after recalculations.

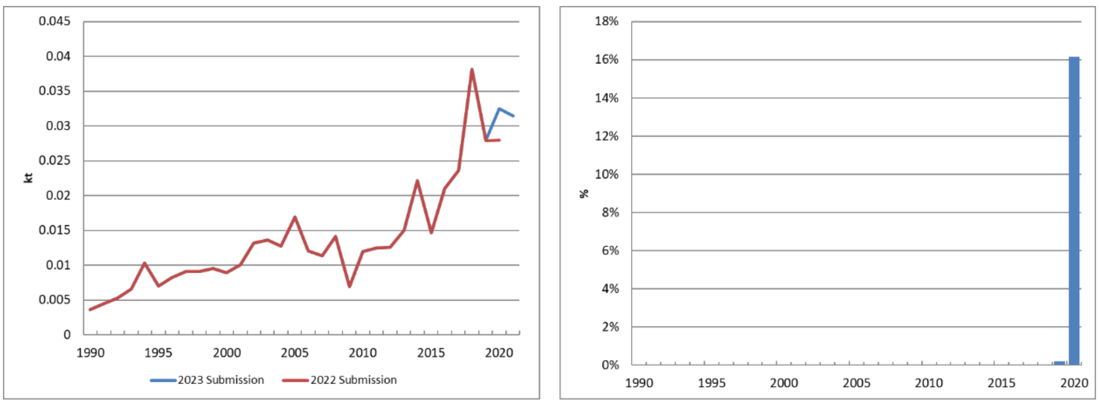


Figure 6.5.1 Evolution of the difference in 5A NOx emissions

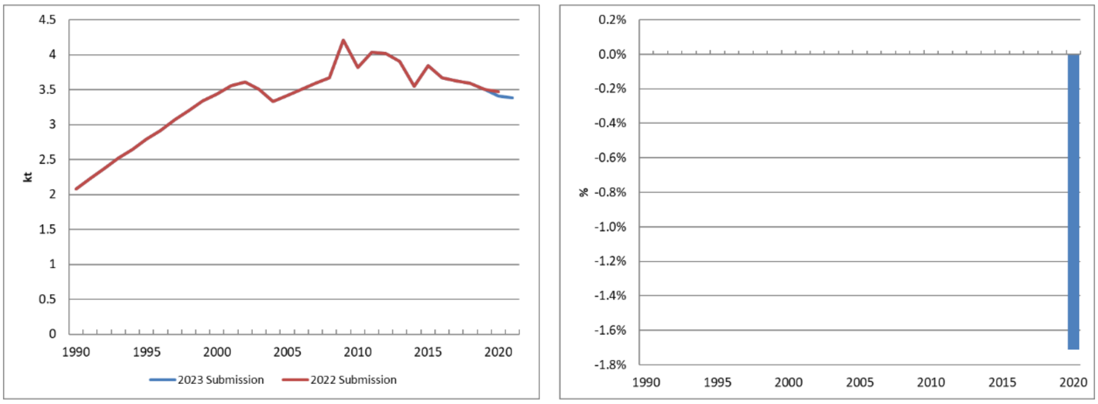


Figure 6.5.2 Evolution of the difference in 5A NMVOC emissions

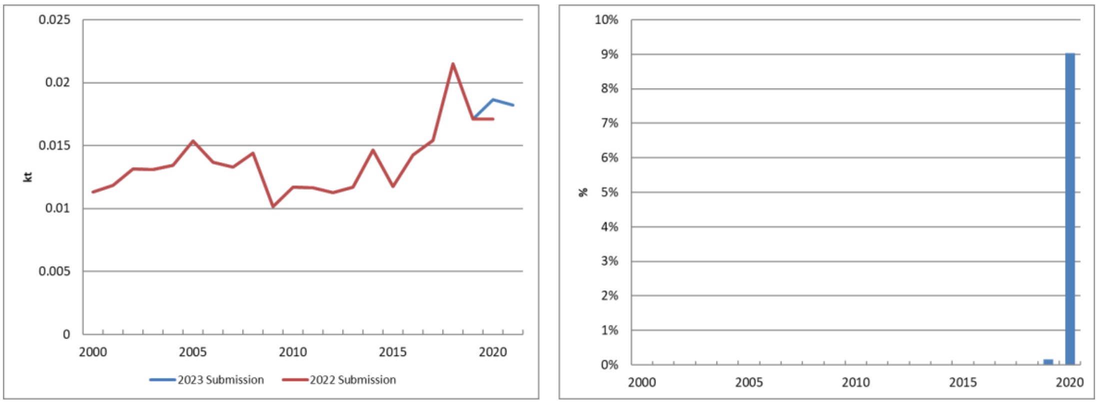


Figure 6.5.3 Evolution of the difference in 5A TSP emissions

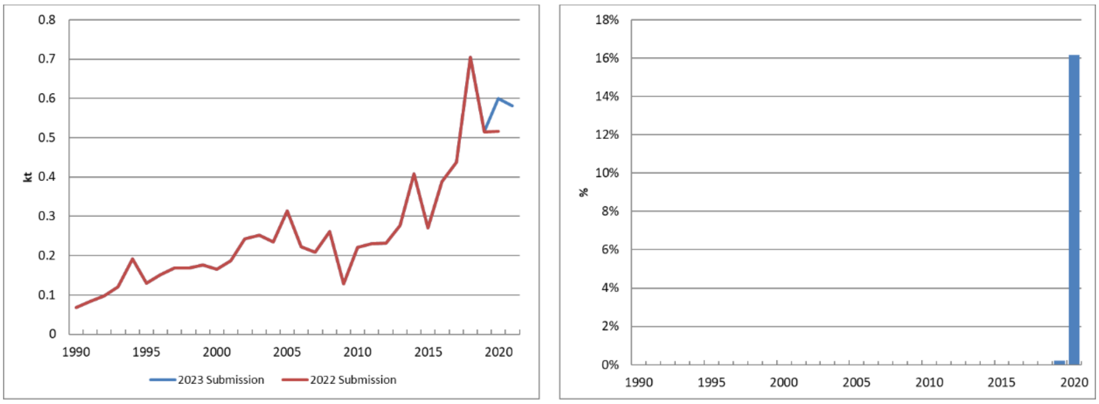


Figure 6.5.4 Evolution of the difference in 5A CO emissions

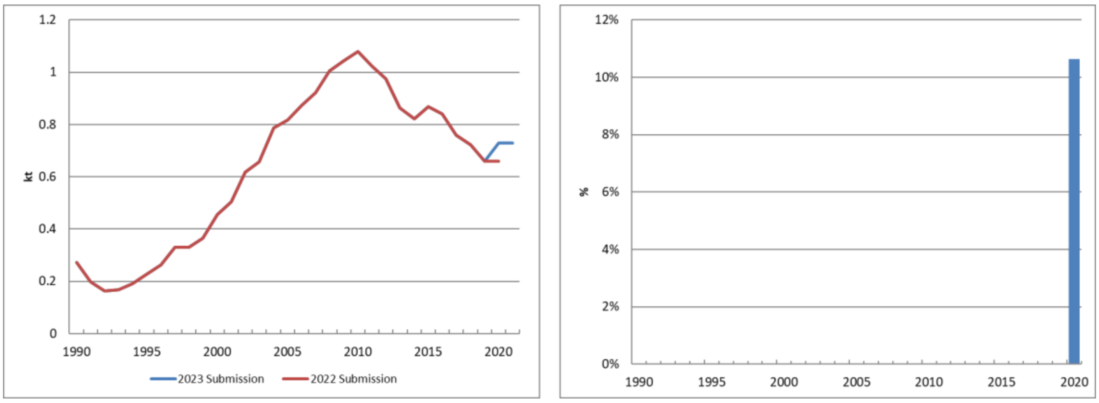


Figure 6.5.5 Evolution of the difference in 5B1 NH_3 emissions

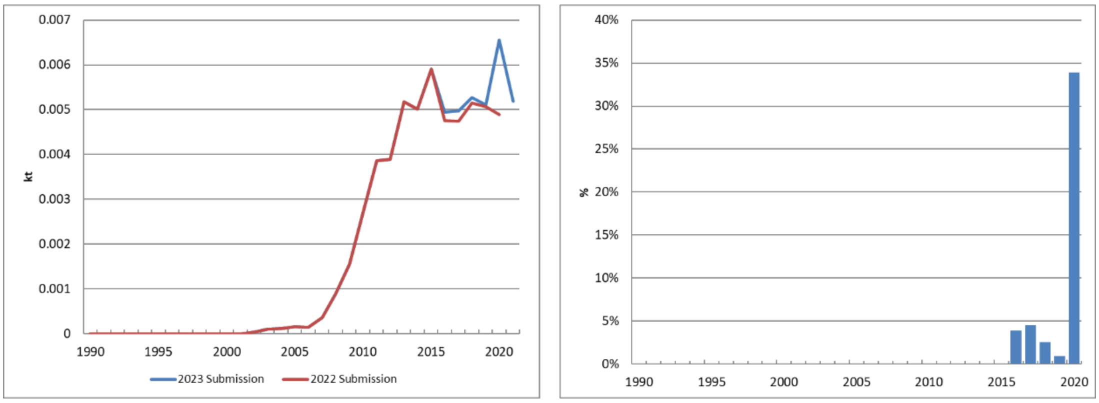


Figure 6.5.6 Evolution of the difference in 5B2 NOx emissions

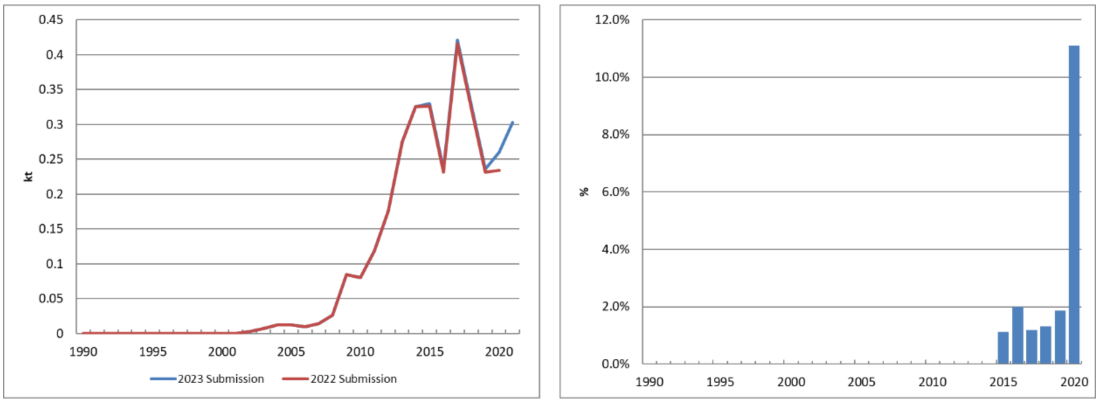


Figure 6.5.7 Evolution of the difference in 5B2 NH_3 emissions

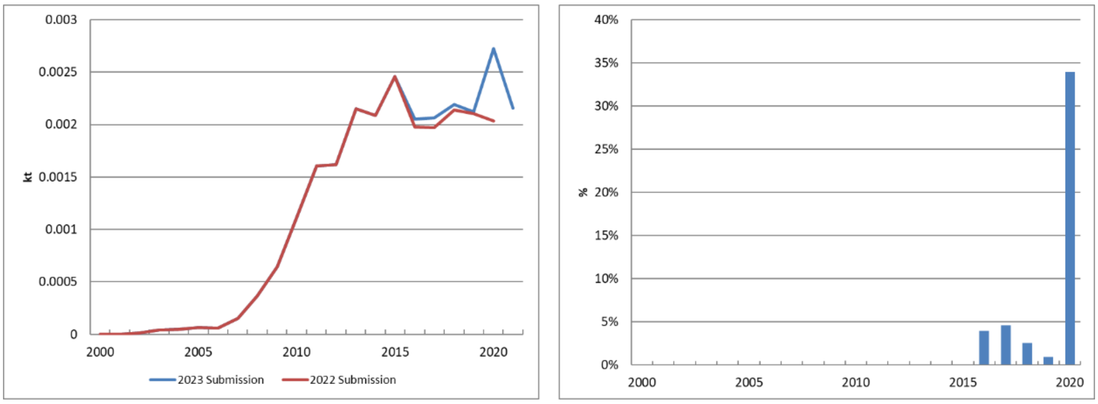


Figure 6.5.8 Evolution of the difference in 5B2 TSP emissions

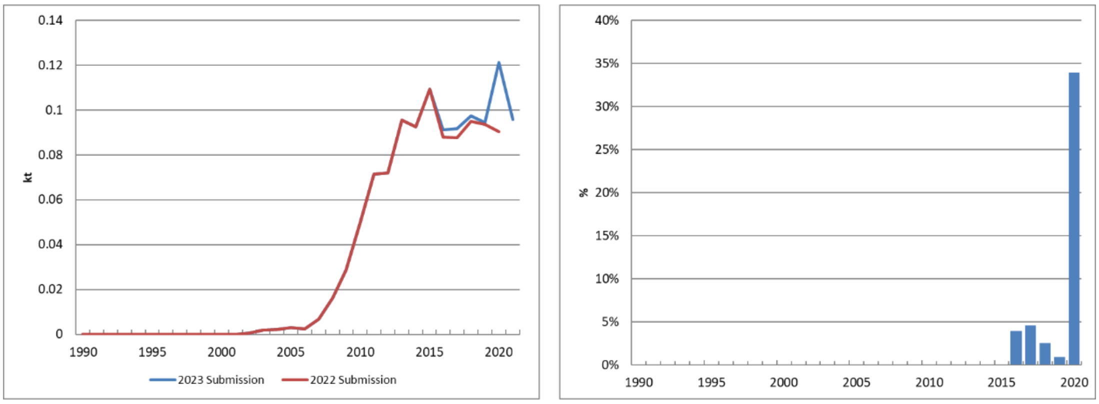


Figure 6.5.9 Evolution of the difference in 5B2 CO emissions

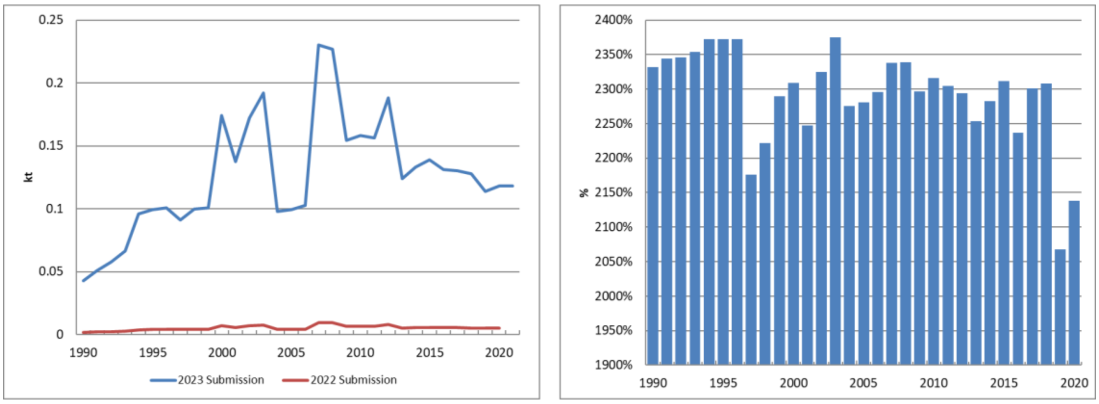


Figure 6.5.10 Evolution of the difference in 5C1biv NOx emissions

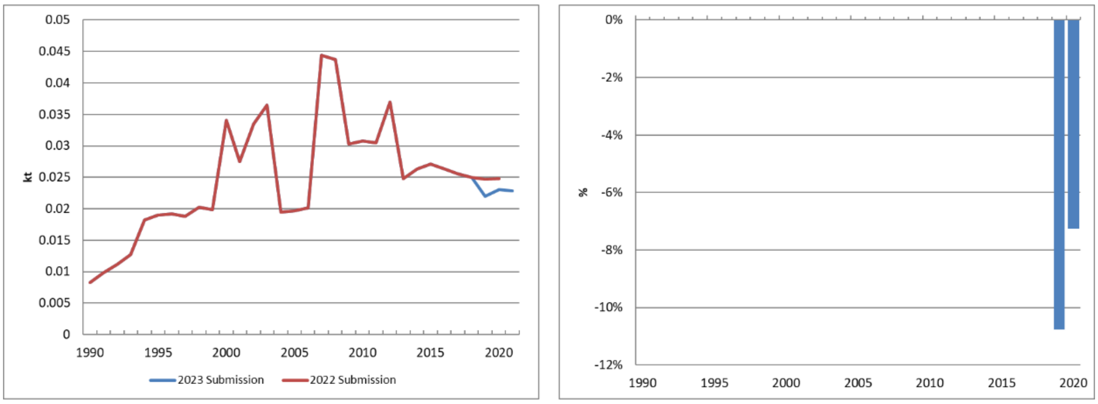


Figure 6.5.11 Evolution of the difference in 5C1biv NMVOC emissions

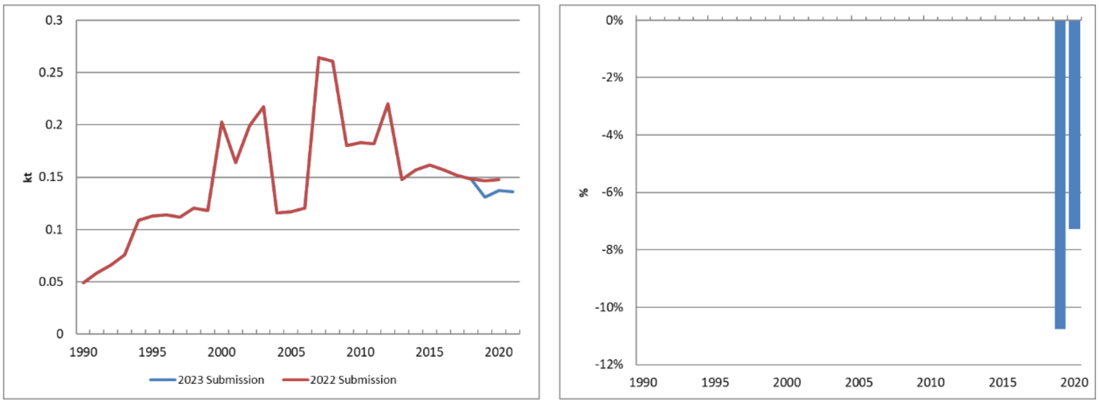


Figure 6.5.12 Evolution of the difference in 5C1biv SO_2 emissions

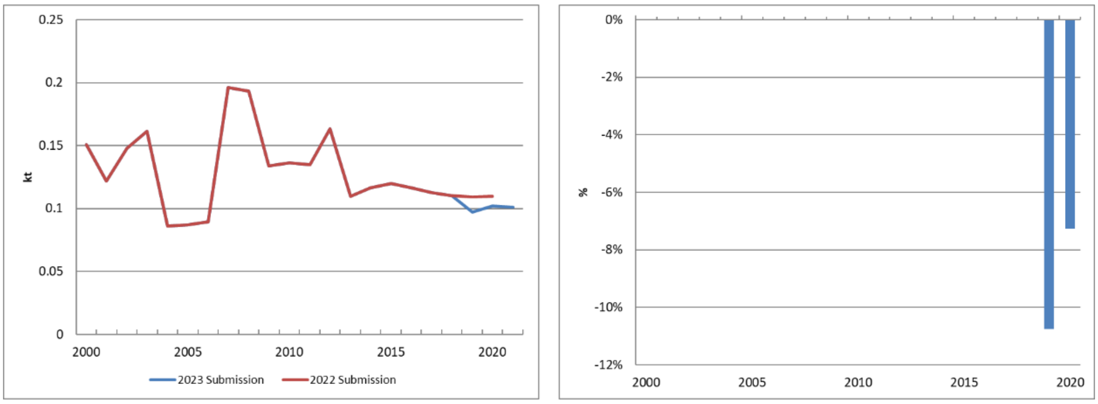


Figure 6.5.13 Evolution of the difference in 5C1biv TSP emissions

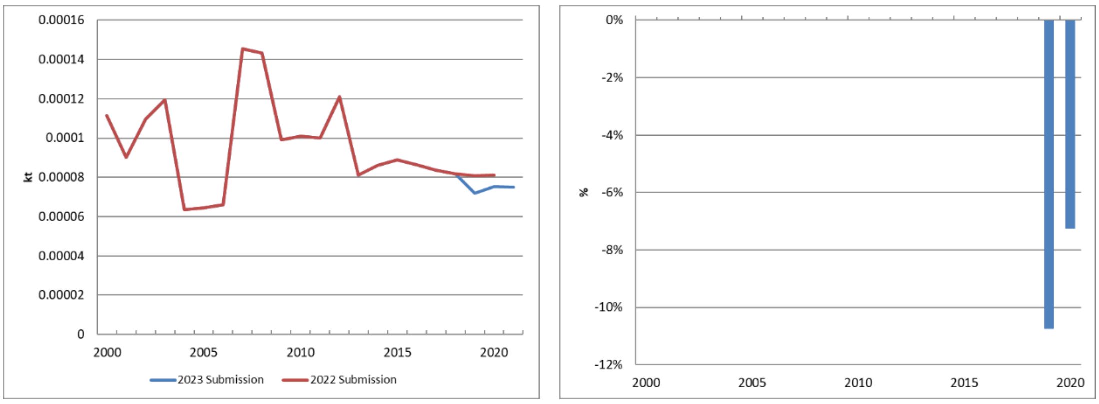


Figure 6.5.14 Evolution of the difference in 5C1biv BC emissions

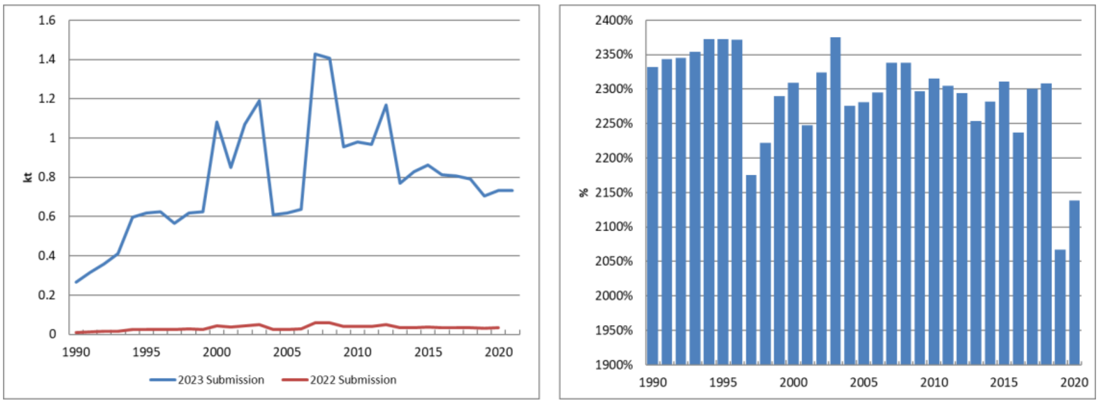


Figure 6.5.15 Evolution of the difference in 5C1biv CO emissions

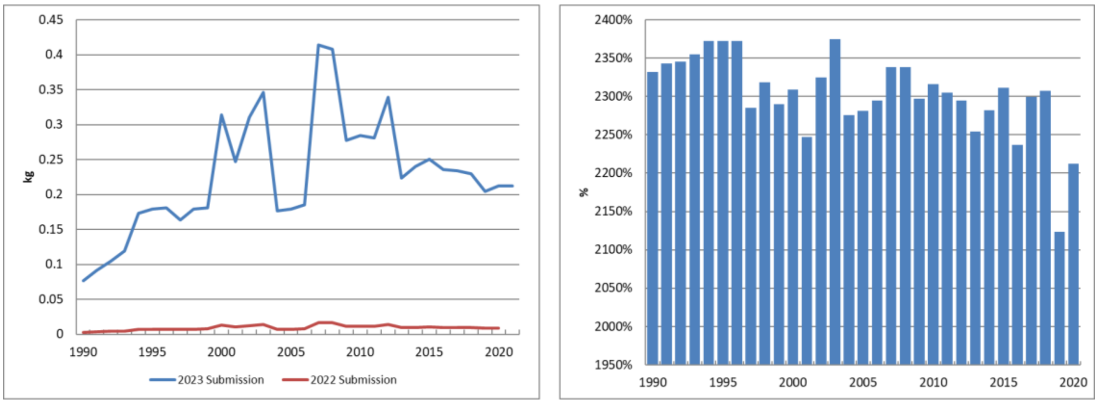


Figure 6.5.16 Evolution of the difference in 5C1biv PCB emissions

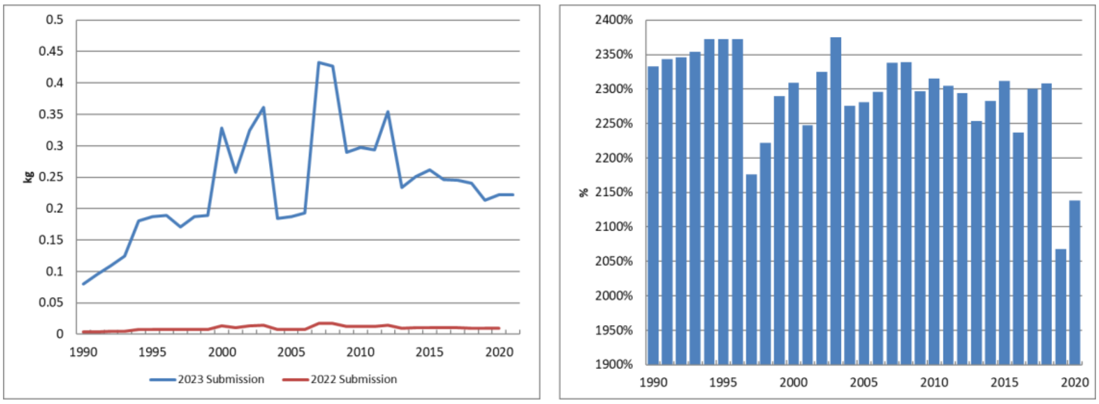


Figure 6.5.17 Evolution of the difference in 5C1biv HCB emissions

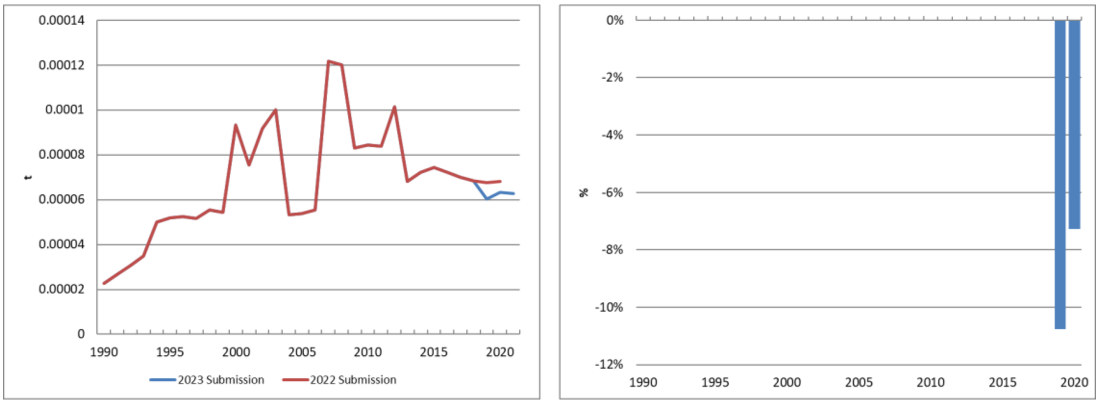


Figure 6.5.18 Evolution of the difference in 5C1biv PAH emissions

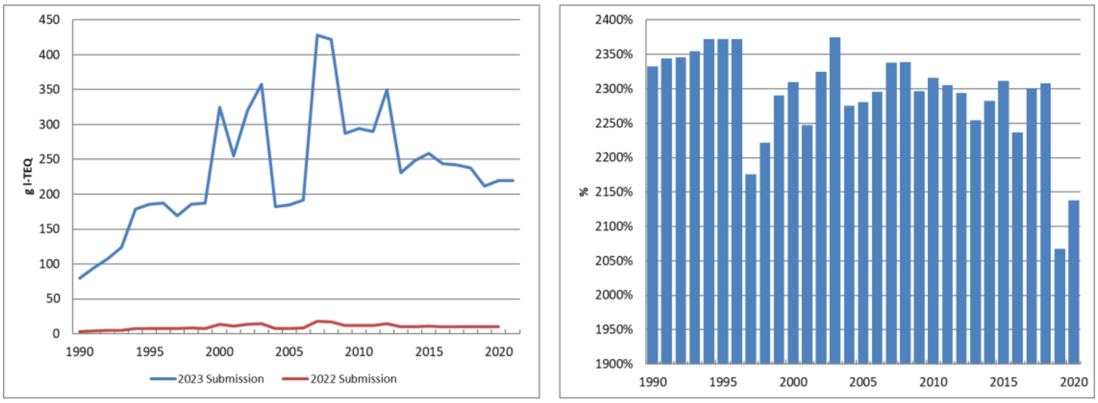


Figure 6.5.19 Evolution of the difference in 5C1biv PCDD/PCDF emissions

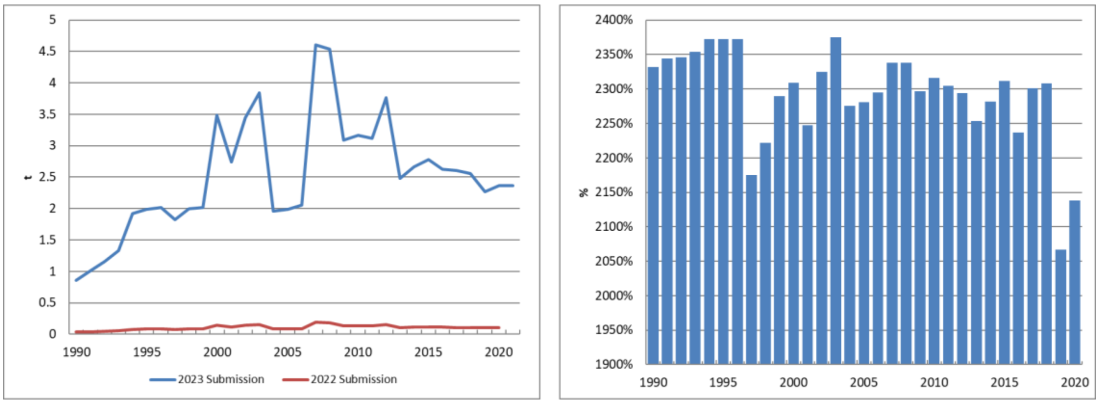


Figure 6.5.20 Evolution of the difference in 5C1biv Pb emissions

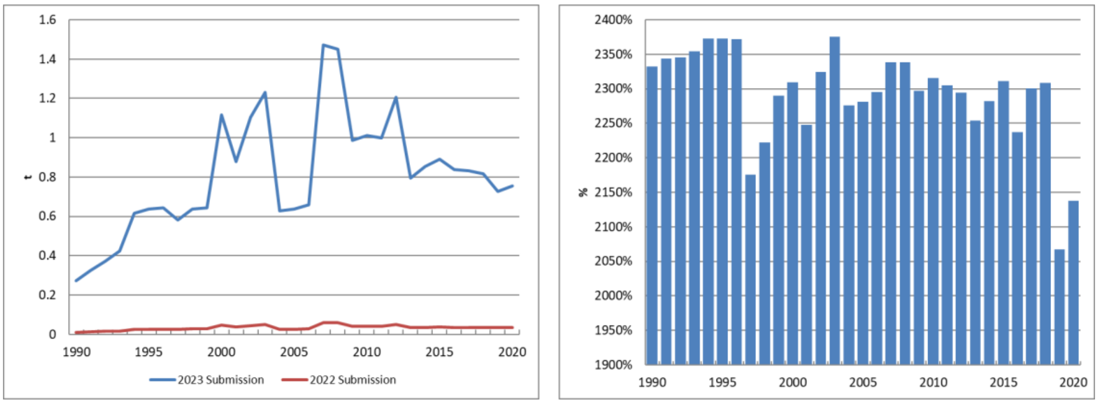


Figure 6.5.21 Evolution of the difference in 5C1biv Cd emissions

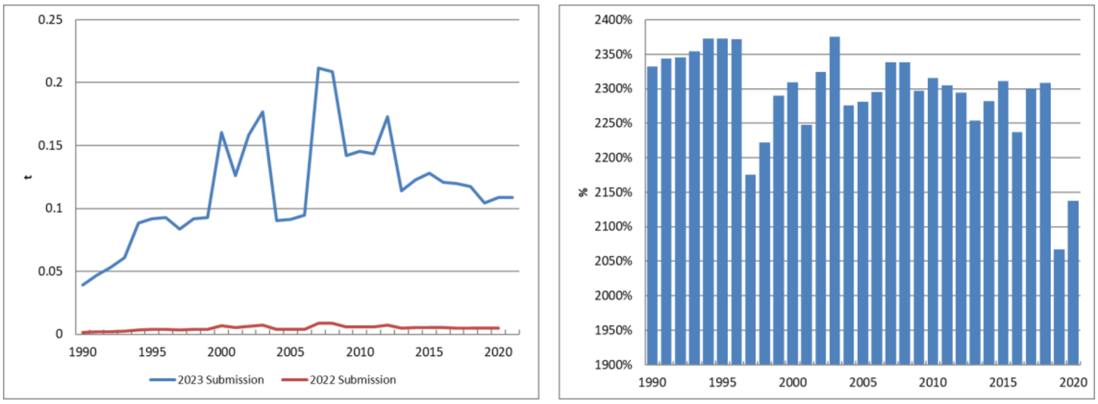


Figure 6.5.22 Evolution of the difference in 5C1biv Hg emissions

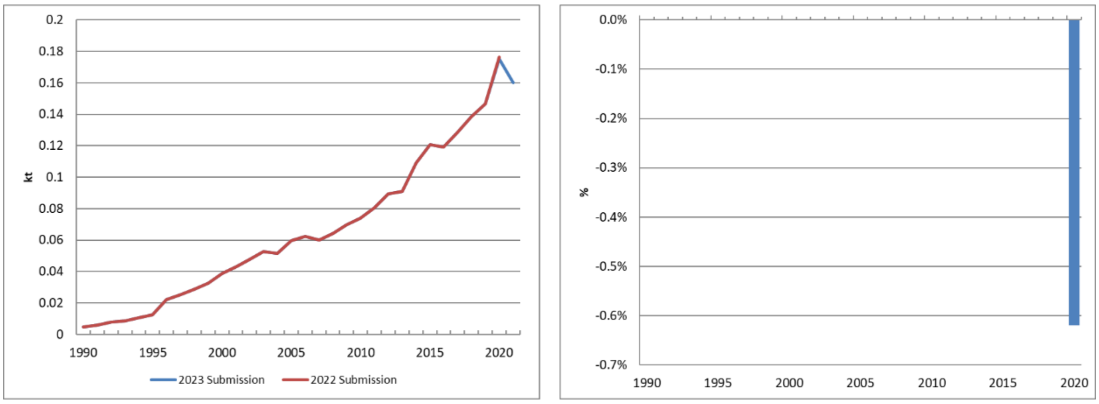


Figure 6.5.23 Evolution of the difference in 5C1bv NOx emissions

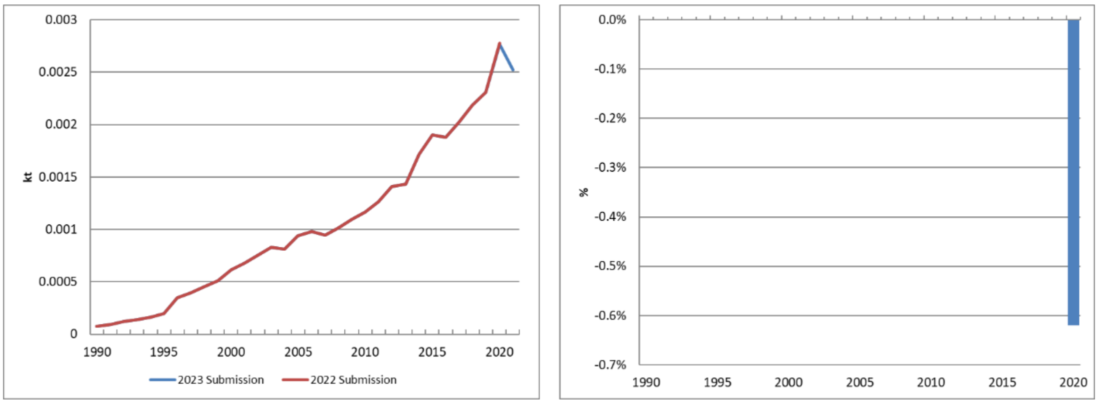


Figure 6.5.24 Evolution of the difference in 5C1bv NMVOC emissions

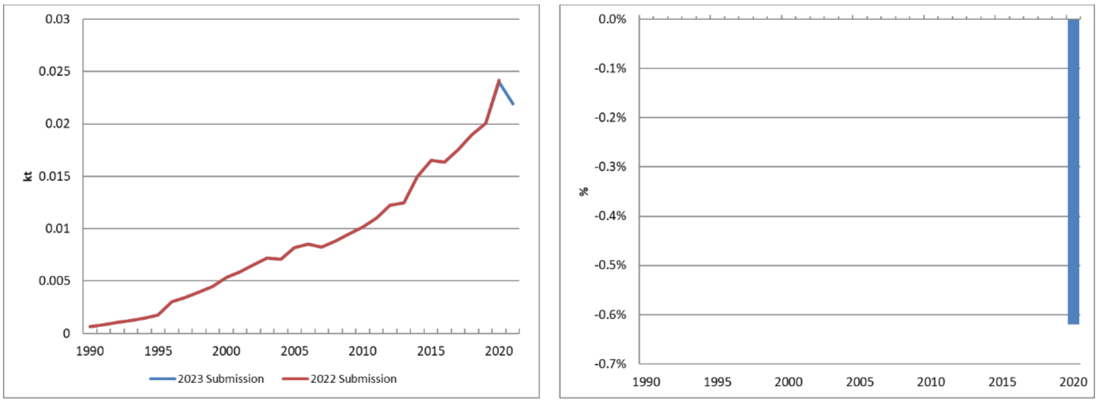


Figure 6.5.25 Evolution of the difference in 5C1bv SO_2 emissions

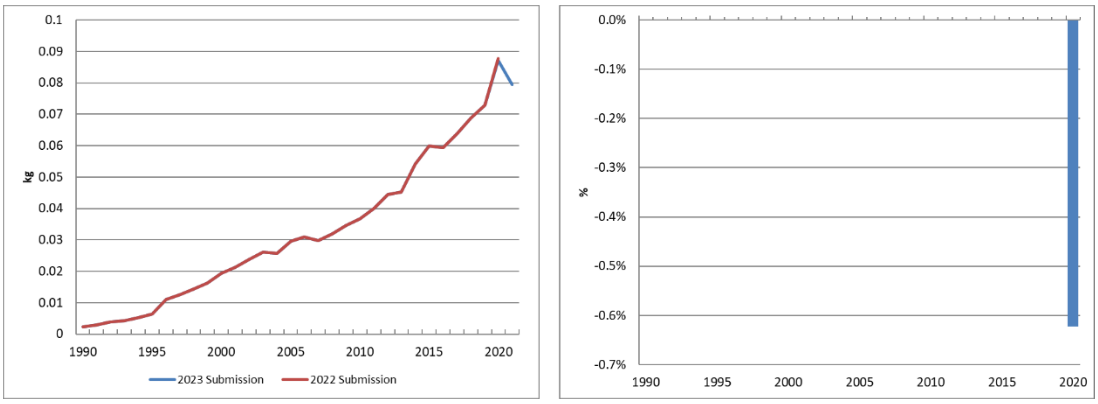


Figure 6.5.26 Evolution of the difference in 5C1bv PCB emissions

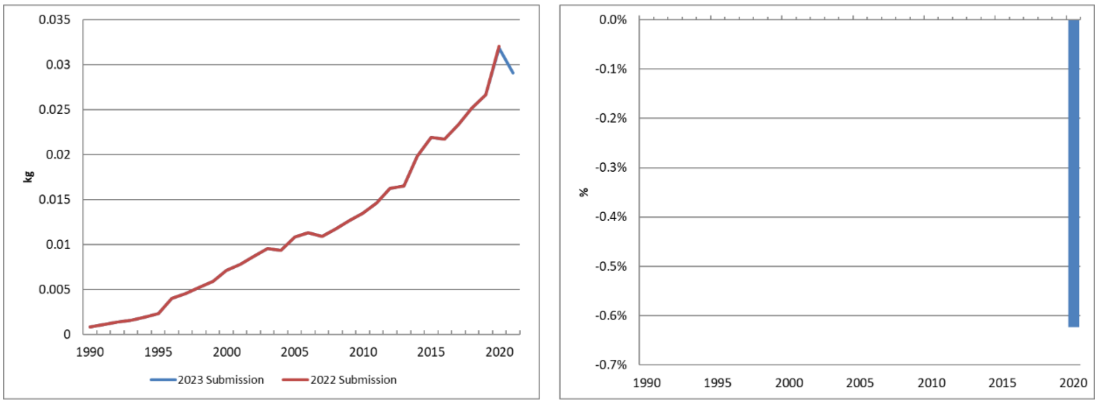


Figure 6.5.27 Evolution of the difference in 5C1bv HCB emissions

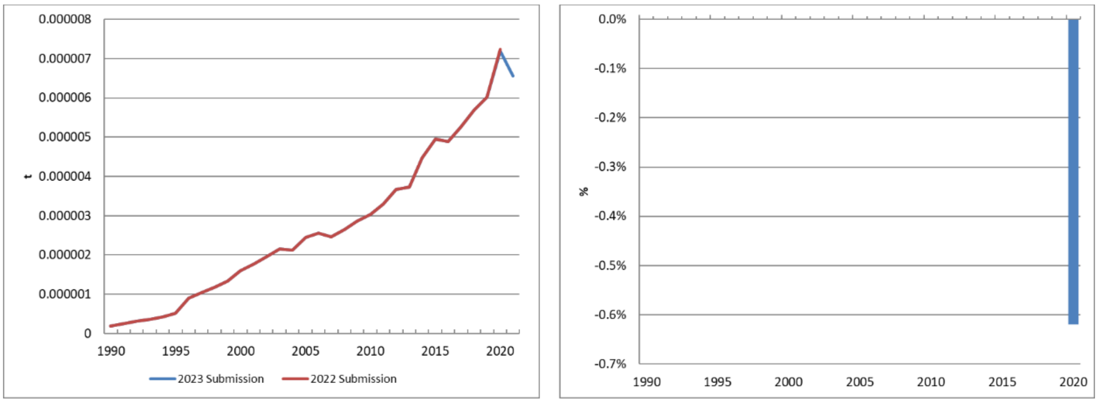


Figure 6.5.28 Evolution of the difference in 5C1bv PAH emissions

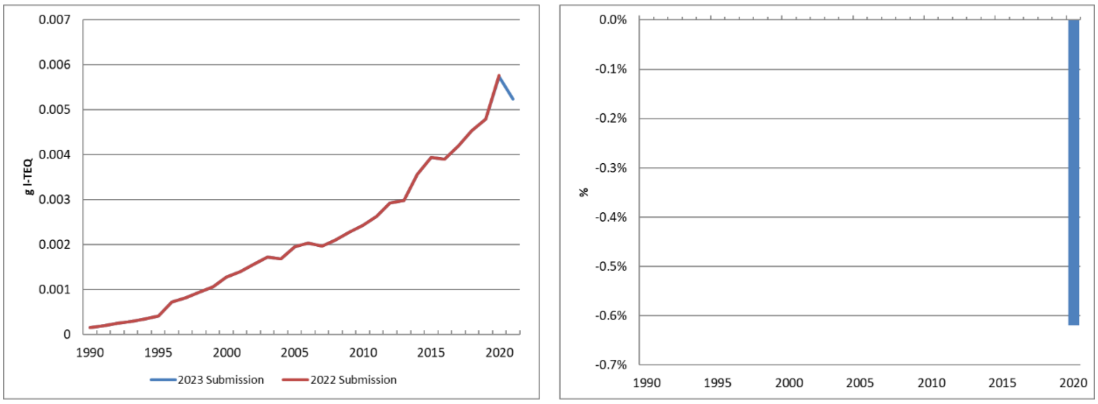


Figure 6.5.29 Evolution of the difference in 5C1bv PCDD/PCDF emissions

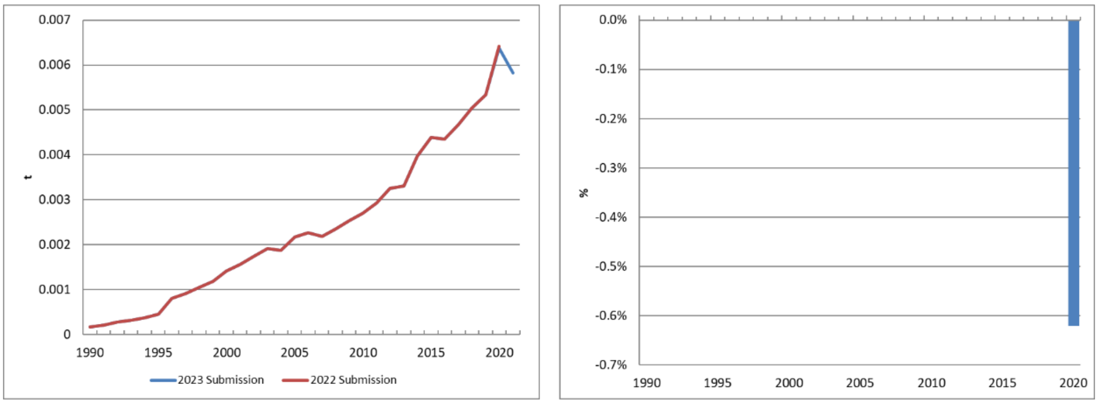


Figure 6.5.30 Evolution of the difference in 5C1bv Pb emissions

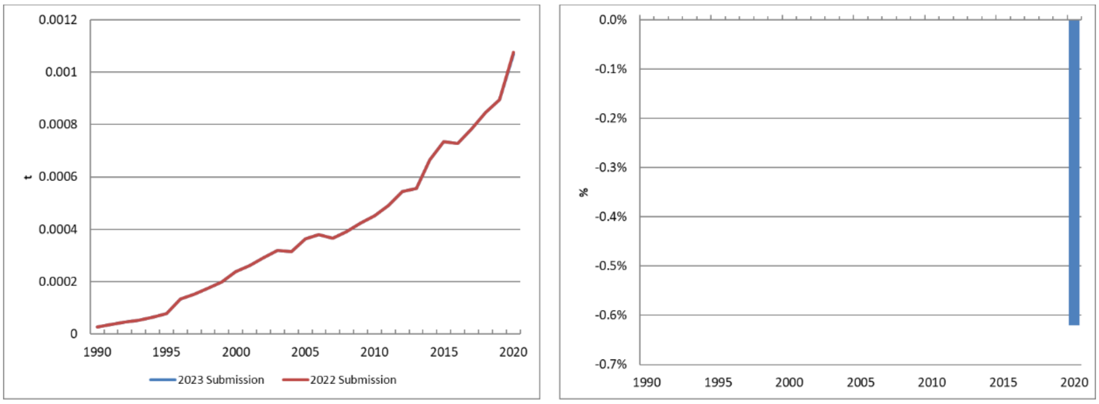


Figure 6.5.31 Evolution of the difference in 5C1bv Cd emissions

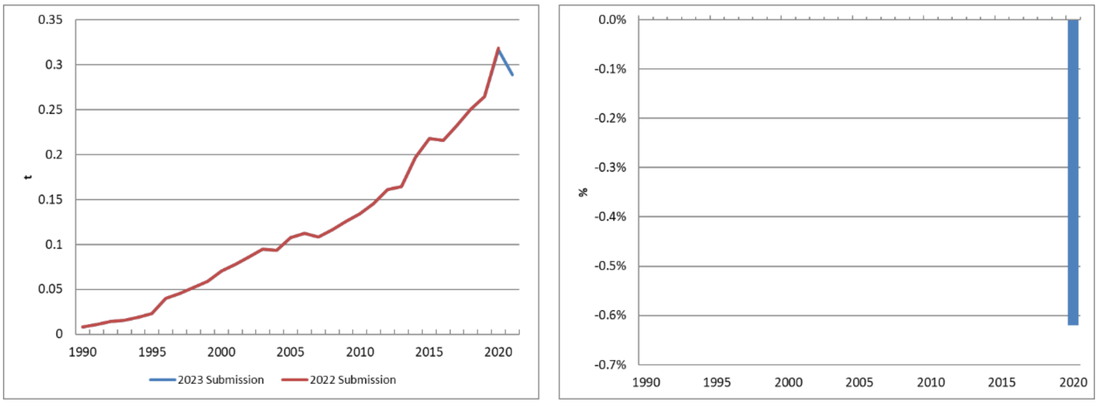


Figure 6.5.32 Evolution of the difference in 5C1bv Hg emissions

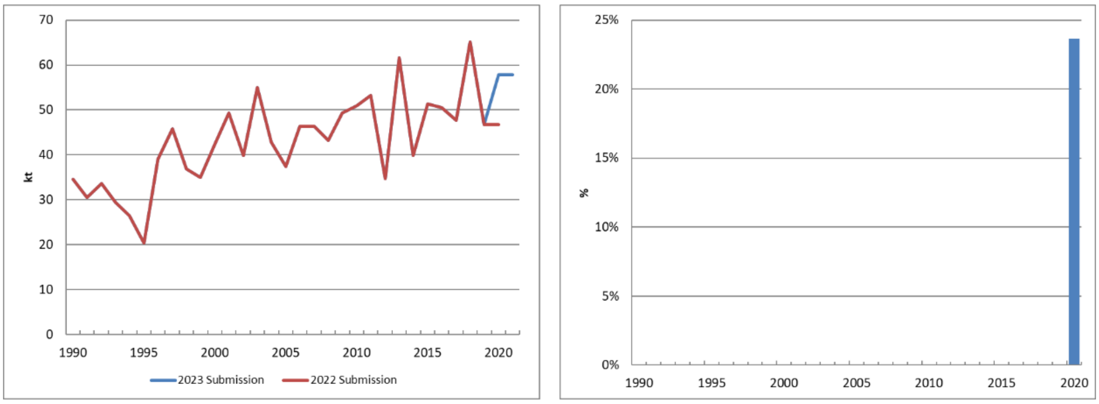


Figure 6.5.33 Evolution of the difference in 5C2 NOx emissions

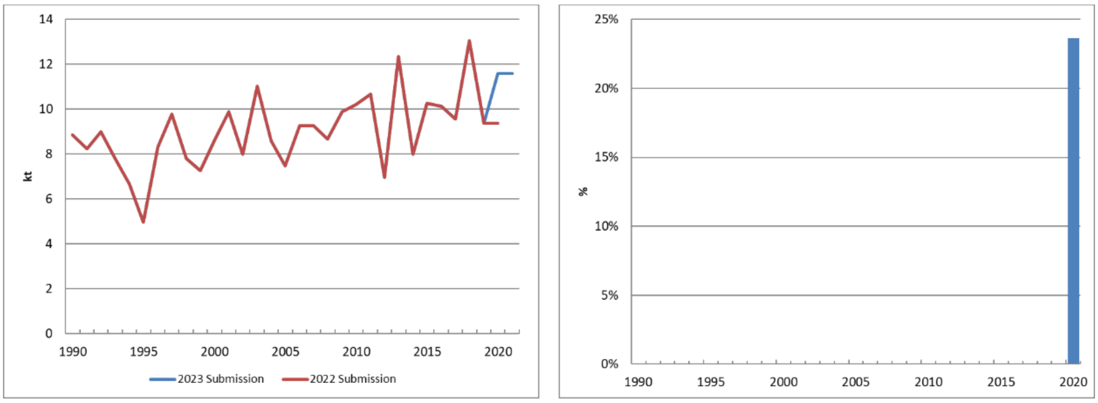


Figure 6.5.34 Evolution of the difference in 5C2 NMVOC emissions

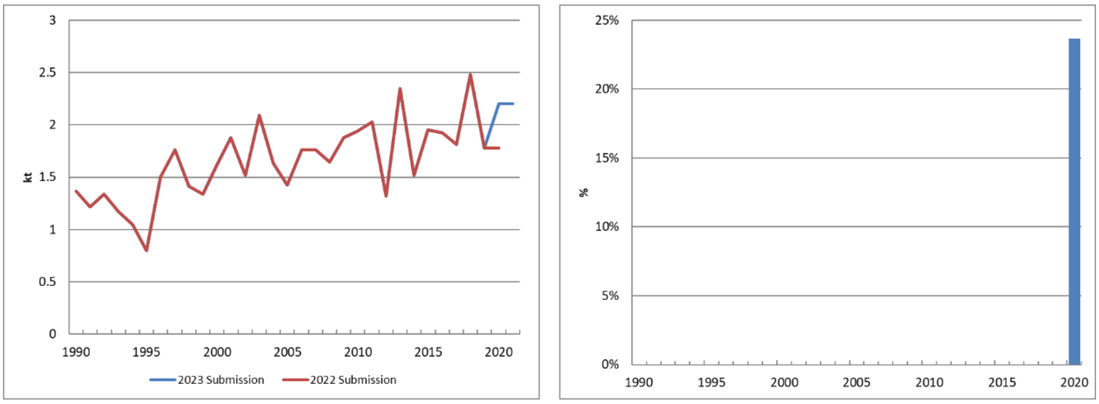


Figure 6.5.35 Evolution of the difference in 5C2 SO_2 emissions

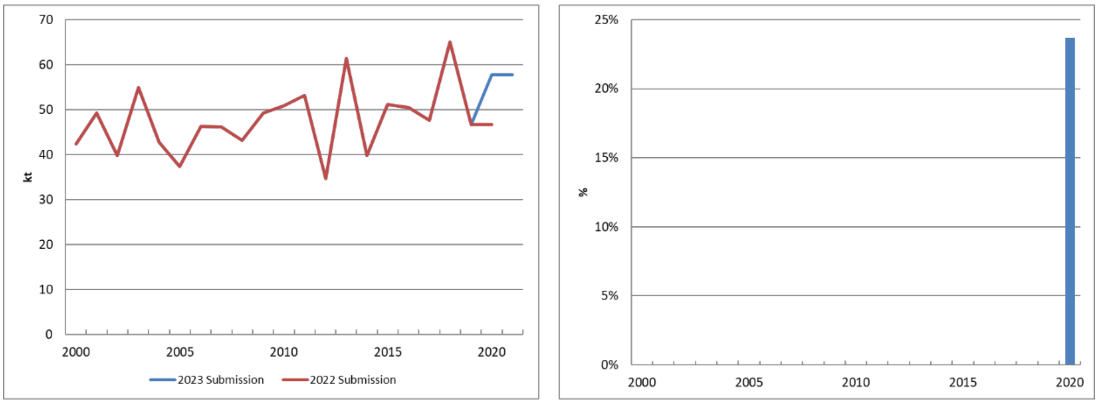


Figure 6.5.36 Evolution of the difference in 5C2 TSP emissions

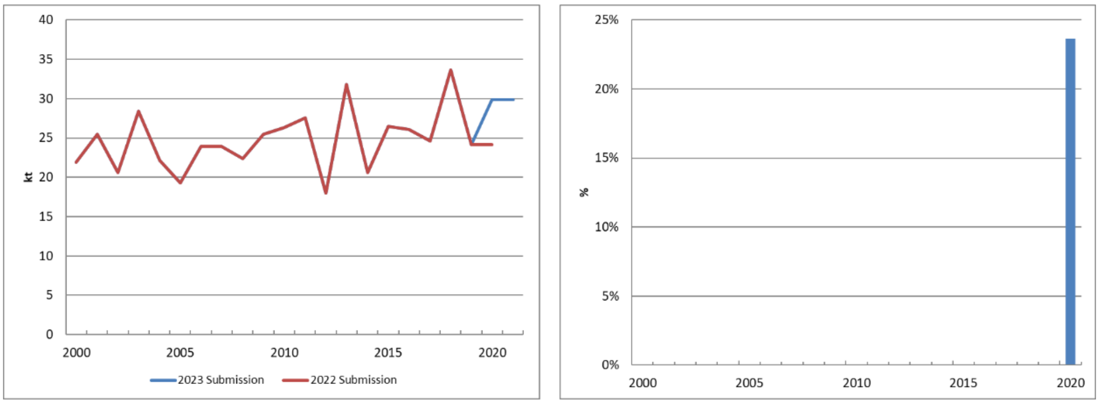


Figure 6.5.37 Evolution of the difference in 5C2 BC emissions

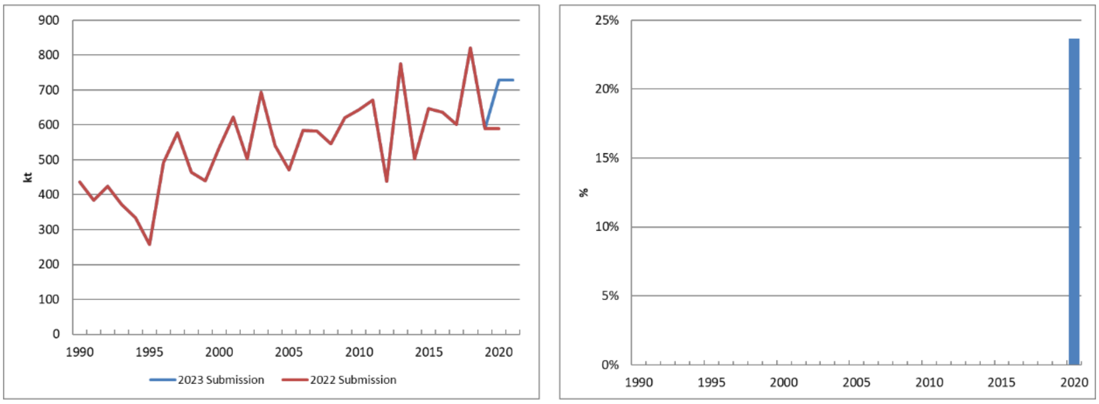


Figure 6.5.38 Evolution of the difference in 5C2 CO emissions

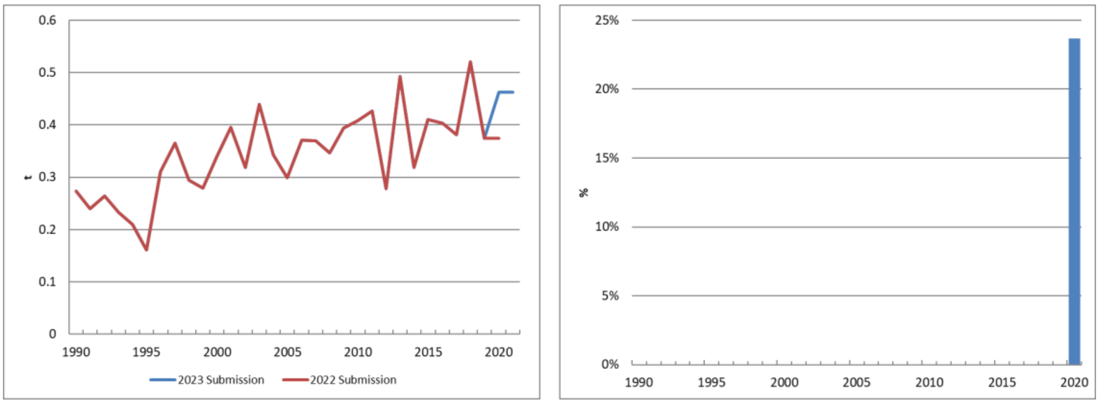


Figure 6.5.39 Evolution of the difference in 5C2 PAH emissions

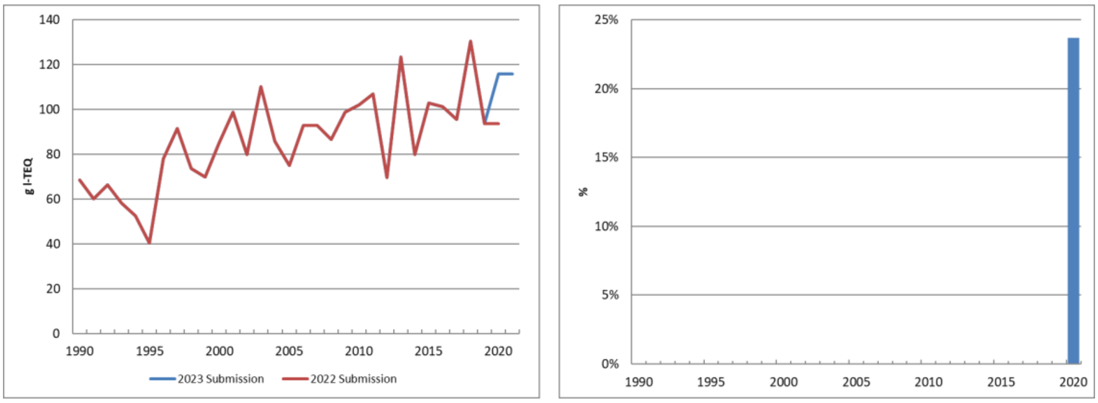


Figure 6.5.40 Evolution of the difference in 5C2 PCDD/PCDF emissions

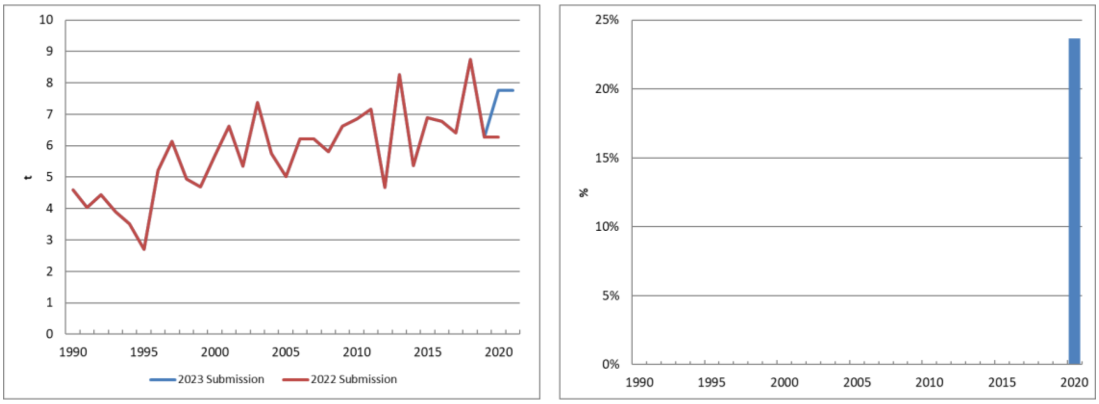


Figure 6.5.41 Evolution of the difference in 5C2 Pb emissions

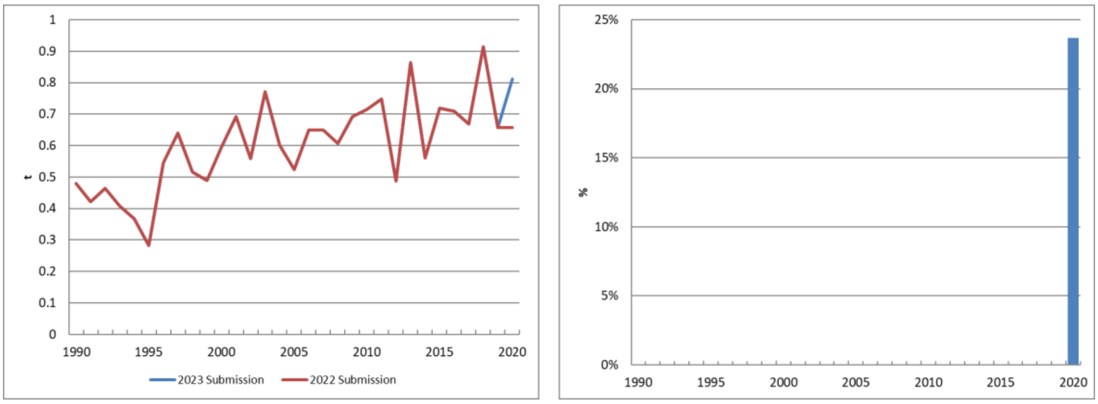


Figure 6.5.42 Evolution of the difference in 5C2 Cd emissions

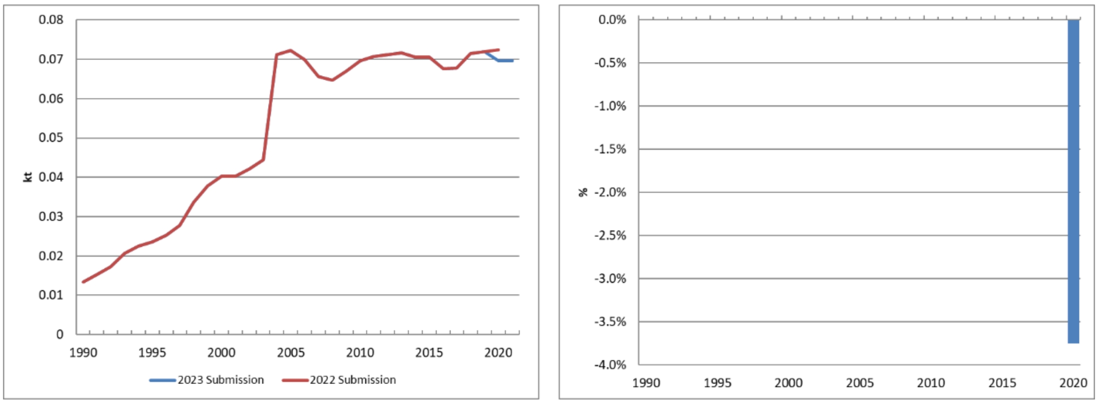


Figure 6.5.43 Evolution of the difference in 5D1 NMVOC emissions

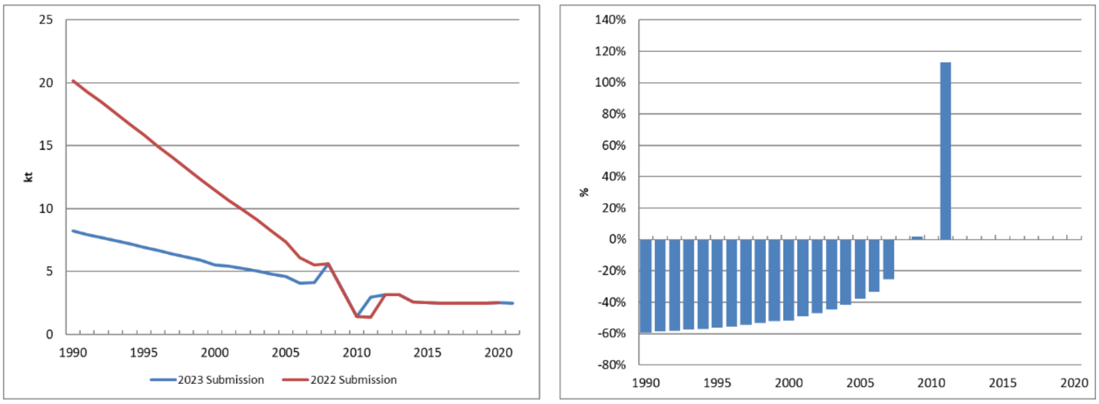


Figure 6.5.44 Evolution of the difference in 5D3 NH_3 emissions

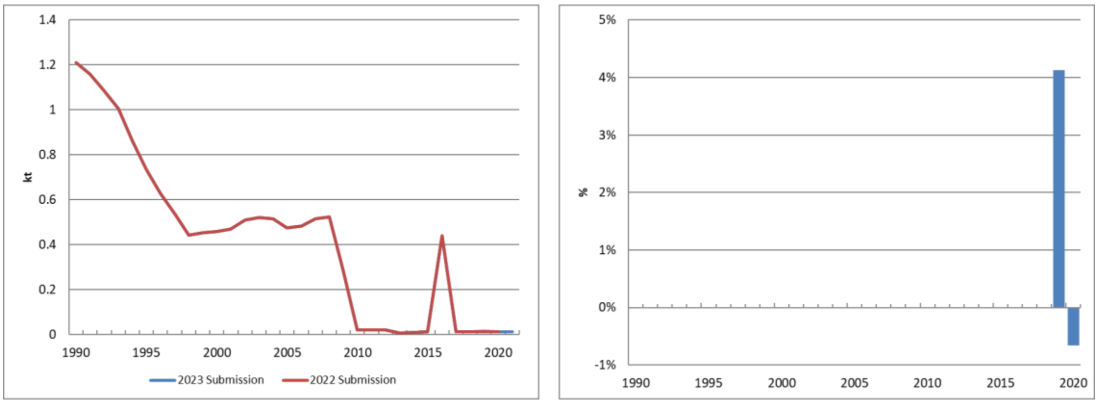


Figure 6.5.45 Evolution of the difference in 5E NMVOC emissions

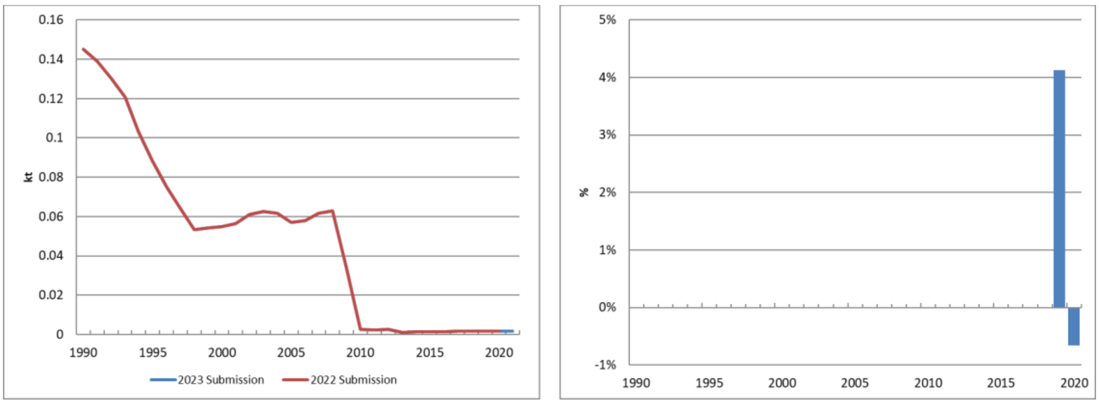


Figure 6.5.46 Evolution of the difference in 5E NH_3 emissions

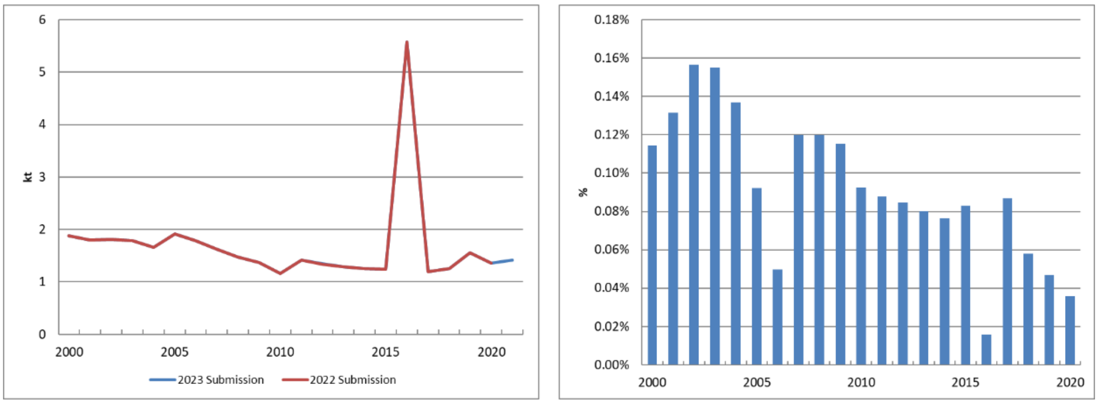


Figure 6.5.47 Evolution of the difference in 5E TSP emissions

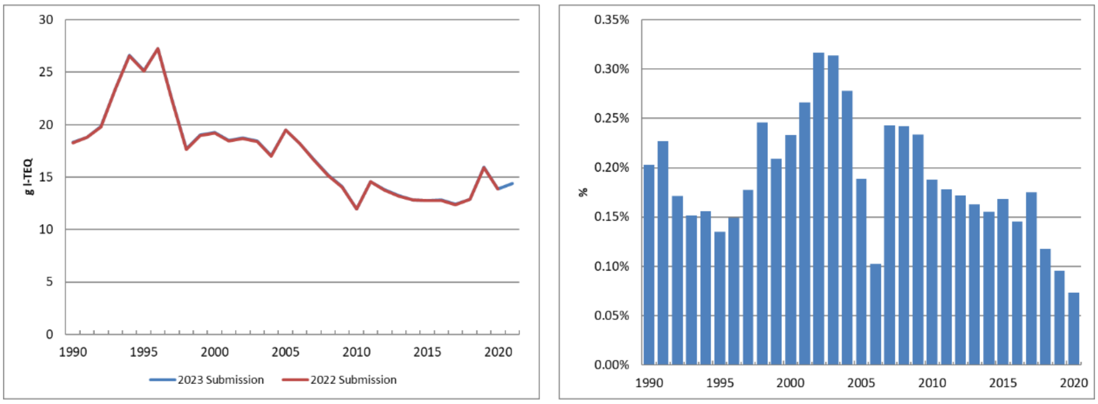
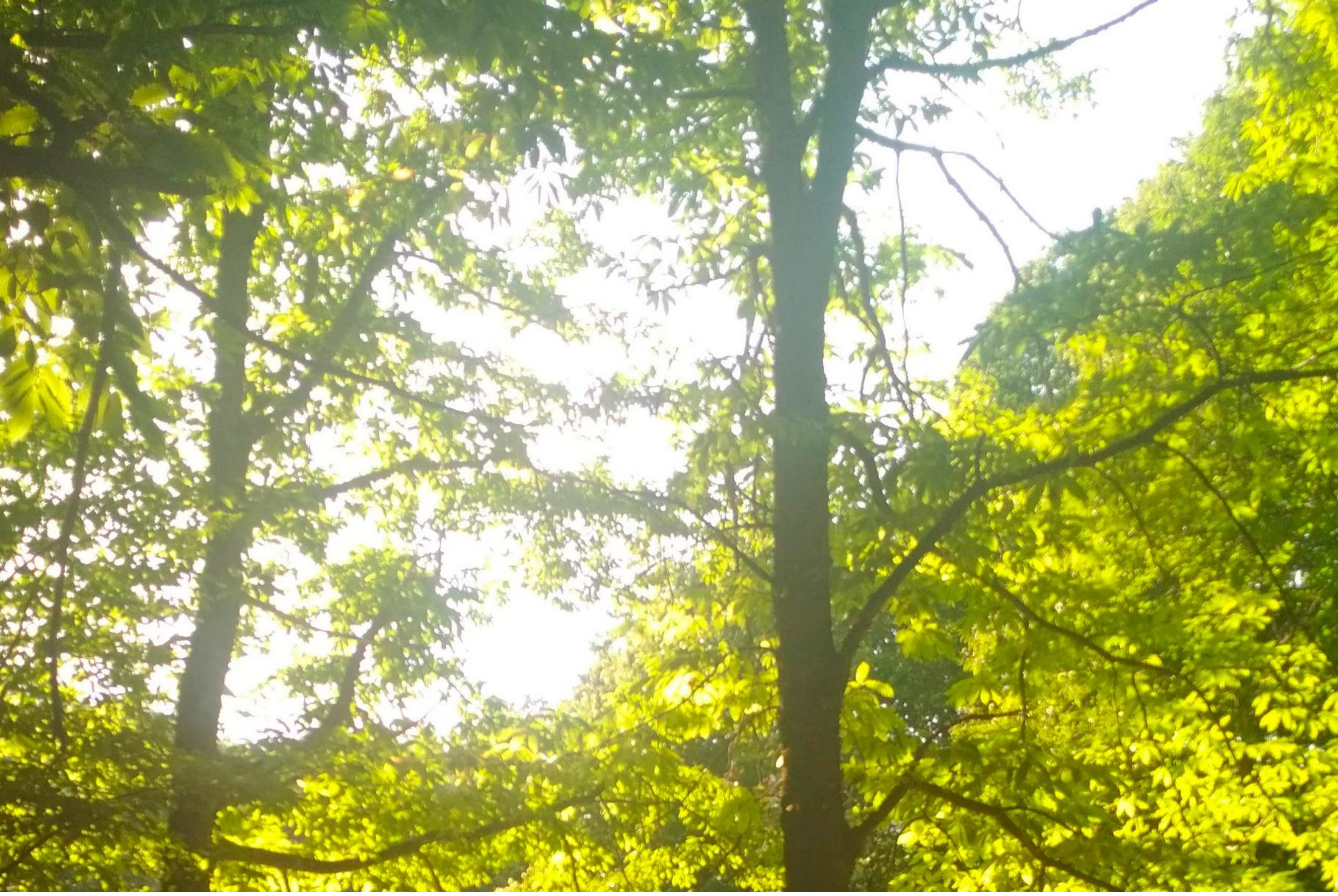


Figure 6.5.48 Evolution of the difference in 5E PCDD/PCDF emissions

6.6. Sector improvements

The collaboration with the main focal points: Sub-directorate General of Circular Economy at the Ministry for the Ecological Transition and Demographic Challenge (SGEC-MITECO), Spanish Climate Change Office (OECC), National Census for Sewage Disposal (CNV) and National Sludge Registry (RNL) will continue.

On the other hand, is planned to continue with the work initiated on the inclusion of the incineration of animal carcasses.



7. NATURAL EMISSIONS (NFR 11)

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7. NATURAL EMISSIONS (NFR 11)

Chapter updated in March, 2023.

Natural emissions are reported on a *pro memoria* basis in the EMEP template for emission data and are not included in the national totals emissions. Information is provided in the Inventory Report for reference.

7.1. Sector overview

Main issues regarding gas emissions reported for this sector are shown in the following table, in particular, NFR categories and pollutants coverage, methodology approach (Method) and selection as key categories (KC).

Table 7.1.1 Coverage of NFR category for reported year 2021

NFR Code	NFR category	Pollutants				Method	KC
		Covered	Exceptions				
			IE	NA	NE		
11A	Volcanoes	–	–	All	–	–	–
11B	Forest fires	NOx, SO_2, NH_3, NMVOC, CO, $PM_{2.5}$, PM_{10}, TSP and BC	–	PCBs	Rest of pollutants	T2	–
11C	Other natural emissions	–	–	All	–	–	–

IE: included elsewhere; NA: not applicable; and NE: not estimated.

7.2. Sector analysis

Main features of the Natural Sector in Spain in 2021 are listed in the following table for reference.

Table 7.2.1 Sector analysis

NFR Code	NFR category	Main features	Main sources of activity data
11A	Volcanoes	–	–
11B	Forest fires(**)	Number of forest fires per year(*): 11,341 (2011-2020 average)[1] Area (hectares) of forest affected per year: 96,592.57 (2011-2020 average)	MITECO
11C	Other natural emissions	–	–

(*) 2021 official data on forest fires are not yet available, emission data has been calculated as an average of the last decade available data (2011-2020[2]).

(**) Data include the Canary Islands.

[1] Source: Information for the period 2011-2020 included in the publication "Los Incendios Forestales en España. 1 enero - 31 diciembre 2021. Avance Informativo" ("Forest fires in Spain: 1st January - 31th December 2021. Preliminary report").

[2] 2016, 2017, 2018, 2019 and 2020 official data are provisional.

7.2.1. Key categories

This sector has not been included in the key categories analysis because is reported on a *pro memoria* basis.

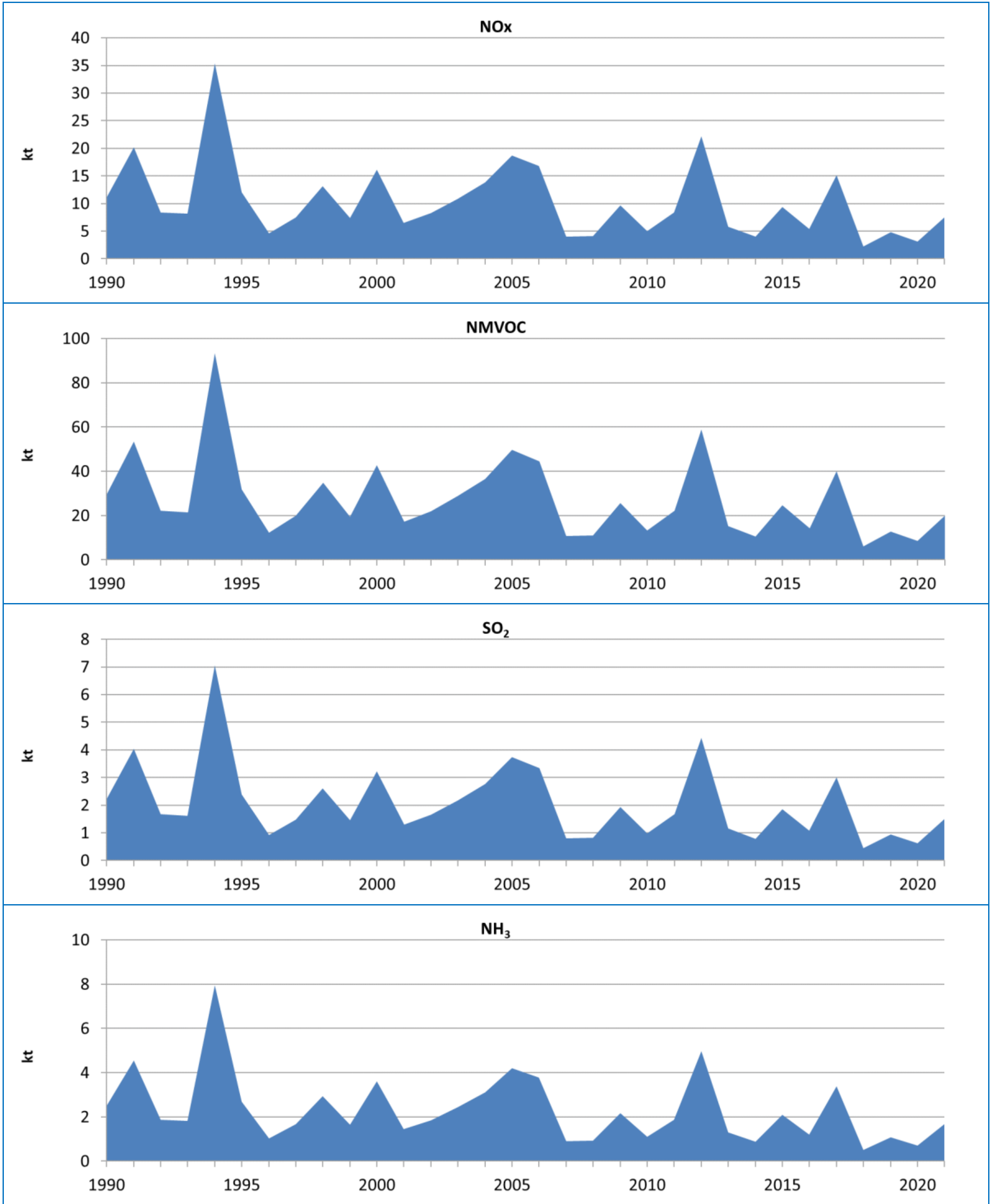
7.2.2. Analysis by pollutant

Charts of the time series by pollutants and NFR categories are shown next. Each pollutant is represented independently.

Explanation boxes are included beside the graphs, providing specific details on the pollutant emissions in year 2021 and main drivers and trends during the time series. Emissions from the Canary Islands are not considered, as their territory is not under the EMEP grid.

Detailed emission data of the Spanish Inventory are available from the MITECO-SEI website WebTable.

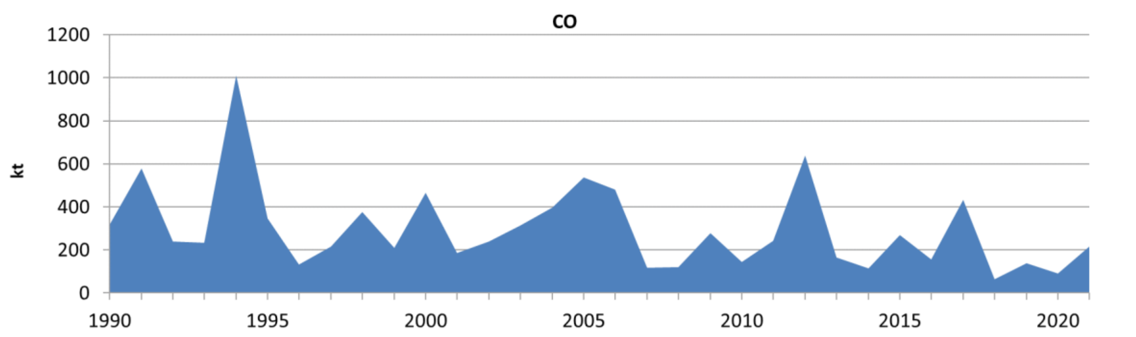
Main Pollutants



NOx	7.49 kt emitted in 2021	
NMVOC	19.88 kt emitted in 2021	
SO_2	1.49 kt emitted in 2021	
NH_3	1.68 kt emitted in 2021	
	1990-2021	Continuous series of peaks and troughs due to the randomness of forest fires, highlighting the peaks corresponding to the years 1991, 1994, 2000, 2004-2006, 2012, 2015 and 2017. This trend depends, to a large extent, on such effects as annual rainfall, summer temperatures, terrain, biomass content in the area affected, etc.

Figure 7.2.1 Evolution of main pollutants emissions

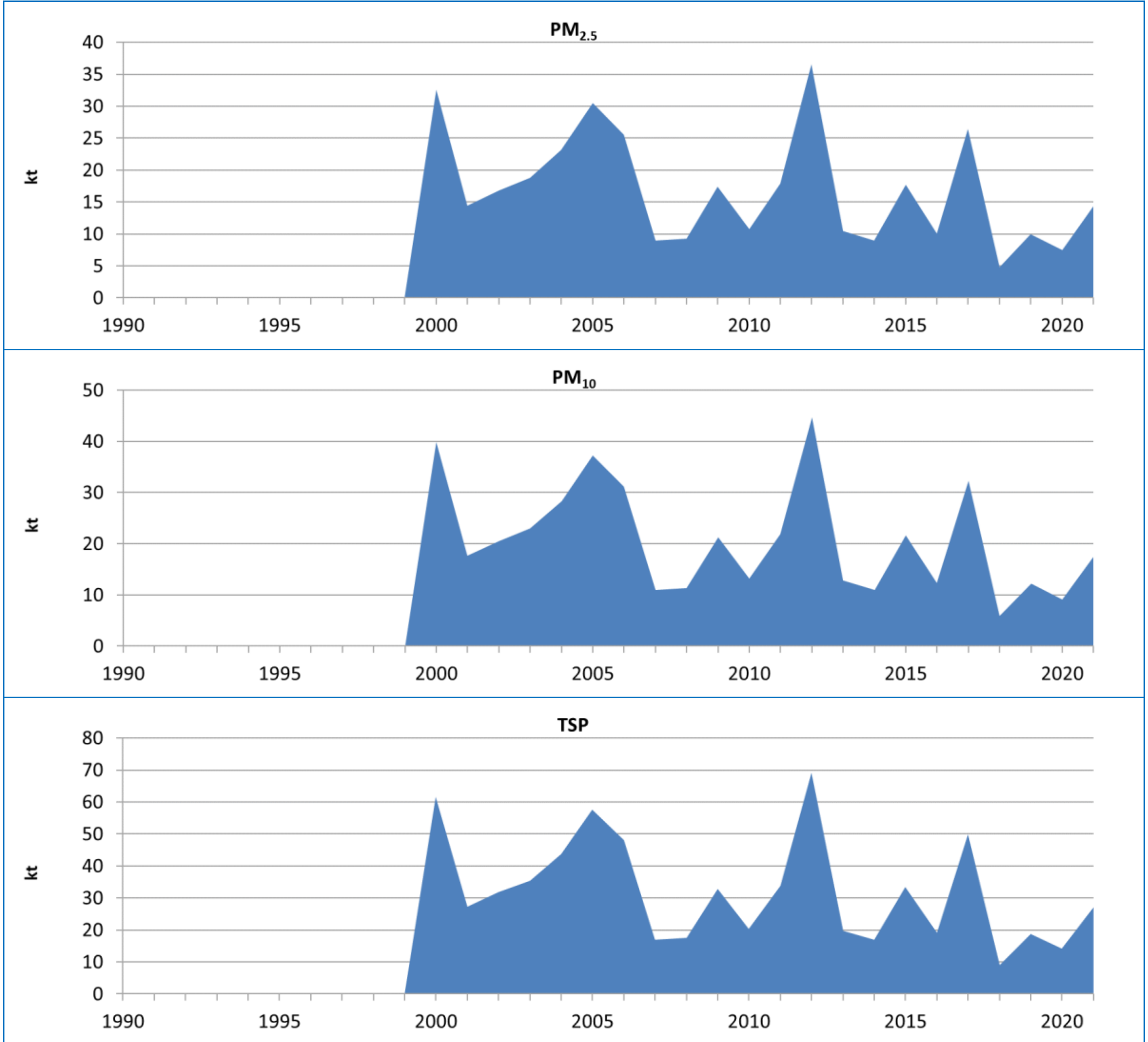
CO and Priority Heavy Metals

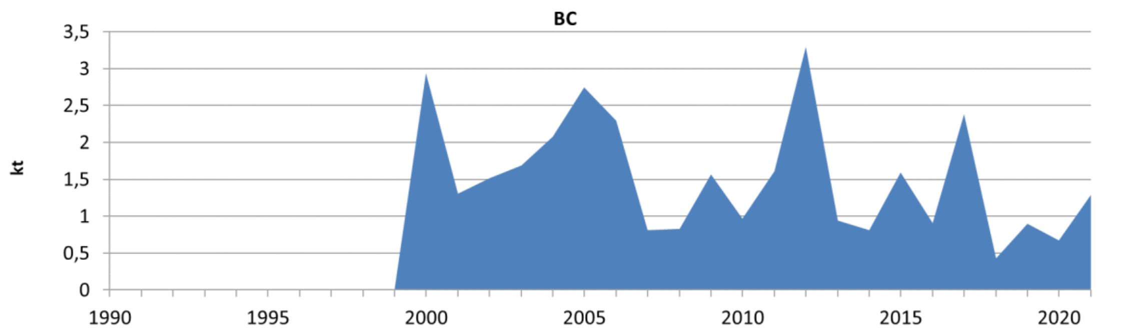


CO	215.43 kt emitted in 2021	
	1990-2021	See main pollutants analysis of the trend in the series above.

Figure 7.2.2 Evolution of CO emissions

Particulate Matter





PM2.5	14.29 kt emitted in 2021	
PM10	17.47 kt emitted in 2021	
TSP	27.00 kt emitted in 2021	
BC	1.29 kt emitted in 2021	
	2000-2021	See main pollutants analysis of the trend in the series above.

Figure 7.2.3 Evolution of PMs emissions

7.3. Major changes

No major changes have been implemented in this sector in the current edition of the Inventory. The data for the activity variables for the years 2016, 2017, 2018, 2019 and 2020 have been corrected, but the source considers that they are still provisional.

7.4. Activity analysis

7.4.1. Forest Fires (11B)

This category considers the immediate emissions caused by forest fires. It does not include delayed emissions attributable in origin to the fires, such as those caused by the biodegradation of unburnt biomass biologically affected by the fires (fire waste).

Forest fires are associated with emissions of NOx, NMVOC, SO_2, NH_3, CO, $PM_{2.5}$, PM_{10}, TSP, and BC. This section examines the emissions from burning biomass in forest fires.

Activity variables

The following table shows the activity variables considered within this category and their corresponding sources of information.

Table 7.4.1 Contents of category 11B Forest fires

Activities included	Activity data	Source of information
Forest fires	- Surface area affected (hectare). - Biomass factor per hectare for broad-leaved or coniferous species (cubic metre per hectare). - Carbon density (grams per cubic centimetre) for broad-leaved or coniferous species. - Ratios between the components of the total biomass in the species affected. - Annual amount of burnt shrubland and grass-steppe biomass.	- Directorate-General of Biodiversity, Forests and Desertification. - Methodology and factors extracted from Rodríguez Murillo (1994). - IPCC 2006 Guidebook (Table 2.4 - Chapter 2.4 - Vol 4).

Since 2021 official data on surface area affected by forest fires are not yet available, the activity data for year 2021 has been calculated as an average of the last decade available data (2011-2020[3]).

Methodology

The methodology employed to estimate the emissions of NOx, NMVOC, SO_2, NH_3, CO, $PM_{2.5}$, PM_{10}, TSP and BC from the burning of biomass in forest land caused by forest fires by anthropic causes is based by obtaining:

- the surface area affected by anthropic causes;
- the prior biomass existing in the tree-covered areas affected by forests fires; and
- the burnt biomass in shrublands and grass/steppe and other temperate forest.

Calculation of the prior biomass existing in the tree-covered areas affected by forest fires

In tree-covered areas it is possible to distinguish the following biomass components liable to be affected by fire, its distribution and ratios of fraction burnt:

Table 7.4.2 Biomass components, distribution and fraction burnt

Components	Total biomass (T) T = M + B + U + PL
	Above-ground biomass: - Merchantable fraction (M) - Rest of the above-ground biomass (B)
	Underground biomass (U)
	Residual biomass in the soil (PL)
Distribution[4]	T = 2.7 M
	U = 0.25 (M + B)
	PL = 0.1 (M + B + U)
Fraction burnt	20% of the carbon forming part of the above-ground biomass[5]
	60% of the carbon forming part of the biomass in soil litter[6]

The parameters applied in the calculation methodology are listed in the following table:

Table 7.4.3 Parameters of the emissions model for forest fires

Parameters	Species	
	Coniferous	Broad-leaved
Volumes of biomass by surface area	43 m^3/ha	73 m^3/ha
Density of dry wood	0.504 g/cm^3	0.703 g/cm^3
Density of C in dry wood	0.227 g/cm^3	0.316 g/cm^3

Source: Rodríguez Murillo (1994).

3 2016, 2017, 2018, 2019 and 2020 official data are provisional.

4 Equations used in the scenarios mentioned in the article by Rodríguez Murillo (1994).

5 In line with Seiler and Crutzen (1980).

6 Inventory working group assumption.

Calculation of the burnt biomass in shrublands and grass/steppe.

For shrublands and grass/steppe, the amount of biomass burnt is estimated by multiplying the area burnt by default values for the amount of fuel actually burnt provided by the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (the product $M_B \times C_f$, Table 2.4, Chapter 2, Volume 4). Those default values are listed in the following table:

Table 7.4.4 Fuel biomass consumption values for fires (tonnes dry matter ha^{-1})

Vegetation type	Subcategory	Value
Shrublands	Shrubland (general)	26.7
All savanna grasslands (mid/late dry season burns)		10.0
All "other" temperate forests		50.4

Emission factors

New Tier 2 emission factors for source category 11.B forest fires (temperate forest (table 3-5 EMEP 2019 GB), Mediterranean forest (table 3-6), shrubland (table 3-7) and grass/steppe (table 3-8)) have been used.

The emission factors for the NOx, NMVOC, SO_2, NH_3, CO, $PM_{2.5}$, PM_{10}, TSP and BC are calculated with values extracted of the source of reference indicated in the last column of the following table. In this table, type of activity variable and its units are displayed.

Table 7.4.5 Sources of reference for the emission factors, type of activity variable and units

Pollutants	Type of VA Units	Tier	Source of reference
NOx	kg/ha area burned	T2	EFs in tables 3-5, 3-6, 3-7 and 3-8 of chapter 11.B of the EMEP/EEA emission inventory guidebook 2019.
NMVOC			
SO_2			
NH_3			
CO			
$PM_{2.5}$	g/kg wood burned	T2	EFs in tables 3-5, 3-6, 3-7 and 3-8 of chapter 11.B of the EMEP/EEA emission inventory guidebook 2019.
PM_{10}			
TSP			
BC			

Evolution assessment

Within the 1990-2021 period, in Spain there were significant forest fires in years 1991, 1994, 2000, 2005, 2012 and 2017 as shown in the next table and figure.

Table 7.4.6 Activity variable: Surface area affected (amounts in ha) and burnt biomass (amount in tonnes)

		1990	2005	2010	2015	2019	2020	2021
Surface area affected by anthropic causes (ha)	Coniferous species	25,344	38,405	5,456	13,822	4,644	1,849	11,059
	Broad-leaved species	10,564	19,855	3,455	9,969	5,821	3,141	7,842
	Shrublands	47,716	87,486	37,293	54,348	31,349	24,922	44,082
	Grass/steppe	11,187	11,008	4,924	9,898	6,777	6,145	8,484
	Total	**94,811**	**156,754**	**51,128**	**88,037**	**48,591**	**36,057**	**71,467**
Burnt biomass by anthropic causes (tonnes)	Coniferous species	279,584	423,670	60,191	152,474	51,231	20,396	121,994
	Broad-leaved species	275,413	517,642	90,082	259,897	151,755	81,890	204,447
	Shrublands	1,274,018	2,335,872	995,711	1,451,093	837,010	665,413	1,176,989
	Grass/steppe	111,866	110,081	49,236	98,980	67,771	61,448	84,843
	Total	**1,940,881**	**3,387,265**	**1,195,220**	**1,962,444**	**1,107,767**	**829,147**	**1,588,273**

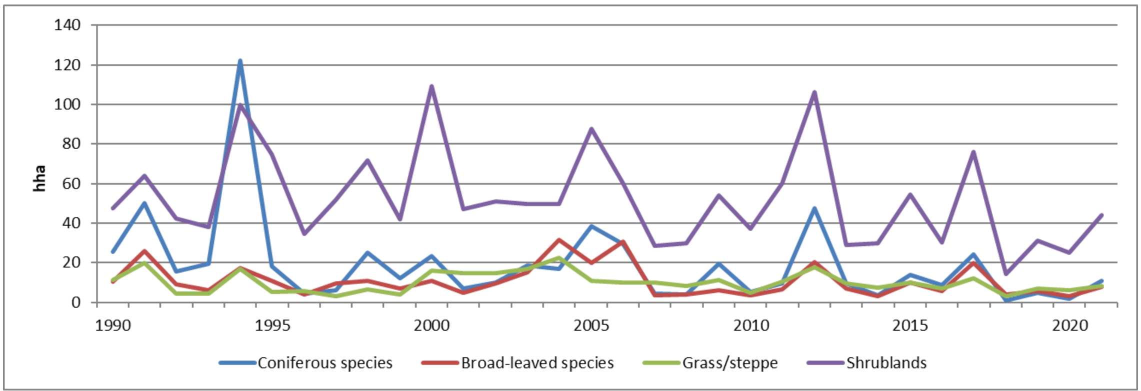


Figure 7.4.1 Evolution of surface area affected by anthropic causes.

8. RECALCULATIONS AND PLANNED IMPROVEMENTS

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8. RECALCULATIONS AND PLANNED IMPROVEMENTS

Chapter updated in March, 2023.

This chapter summarises the impact on the emissions totals of the recalculations performed in this Inventory edition, using a by-pollutant analysis. Furthermore, the largest changes (in absolute value) for each pollutant are highlighted including the main reasons for the changes observed. Sector-specific recalculations are described within each of the relevant chapters. These chapters should be referred to for details of recalculations and method changes.

8.1. Overview

Throughout the Spanish Inventory, emission estimates are updated annually across the fulltime series in response to new research and revisions to data sources, as well as error corrections and methodology changes or as a result of the implementation of reviews' recommendations. Main features regarding revised estimates are presented below:

In this edition of the Inventory, 66 categories[1] (52% of the total accounting for the National Total) have been recalculated along with the reported period 1990-2021. Among them, for six categories recalculations consisted of new estimations for one or several pollutants[2] for which no estimations had been provided in the last edition. For details on completeness and use of notation keys, please refer to section 1.8.

Table 8.1.1 Summary of categories/pollutants estimated for first time in this Inventory edition

NFR Pollutant	NFR Pollutant
1A4ai	NH_3
1A4ci	NH_3
2C7c	SO_2, TSP
2K	PCB
3B4g	NO_2, NMVOC, NH_3, $PM_{2,5}$, PM_{10}, TSP
5C1biii	NO_2, NMVOC, NH_3, $PM_{2,5}$, PM_{10}, TSP

As a summary, the relative impact of recalculations in the National Totals of Emissions for pivot years is shown in the following tables.

[1] Only categories and pollutants with more than a ±0.00001% variation have been accounted for as a real recalculation. Minor variations could be found under this threshold due to rounding effects in the calculation process or minor error corrections performed.

[2] New estimations have been performed in this inventory edition for individual PAH following the recommendation ES-0A-2019-0001 made by the TERT in the 2019 NECD.

Table 8.1.2 Relative impact of recalculations in the National Totals of Emissions

Year	NOx	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
1990	-1.1%	-2.3%	-0.1%	6.5%	NA	NA	NA	NA	-0.7%
1995	-1.3%	-0.5%	0.0%	15.5%	NA	NA	NA	NA	-0.9%
2000	-1.1%	0.6%	0.0%	10.9%	5.2%	13.2%	18.2%	-2.7%	-1.1%
2005	-1.5%	-1.2%	0.1%	6.6%	6.0%	14.6%	21.4%	-2.8%	-1.6%
2010	-1.5%	2.7%	0.2%	5.8%	5.6%	12.7%	13.2%	-3.3%	-2.4%
2011	-1.4%	2.8%	0.2%	6.4%	6.2%	15.8%	21.4%	-3.1%	-2.3%
2012	-2.1%	2.7%	0.2%	6.2%	7.4%	18.1%	23.9%	-4.0%	-2.7%
2013	-2.1%	1.9%	0.3%	6.1%	6.1%	14.7%	17.2%	-2.9%	-2.2%
2014	-3.8%	2.2%	0.3%	5.6%	6.9%	16.1%	18.3%	-4.1%	-2.7%
2015	-4.2%	1.9%	0.2%	4.6%	6.3%	17.3%	23.6%	-3.5%	-2.7%
2016	-5.6%	0.7%	0.3%	4.0%	4.1%	12.6%	12.8%	-3.1%	-2.3%
2017	-6.9%	0.0%	0.2%	3.3%	4.1%	13.4%	14.8%	-3.3%	-2.4%
2018	-7.1%	-0.7%	0.2%	2.8%	2.7%	11.5%	13.2%	-2.9%	-2.3%
2019	-8.4%	-3.5%	0.2%	2.2%	2.3%	13.4%	17.7%	-4.0%	-3.5%
2020	-5.3%	4.4%	9.1%	2.2%	10.8%	18.5%	18.8%	10.4%	6.5%
1990-2020	-2.1%	0.0%	0.0%	8.3%	5.6%	14.2%	18.5%	-2.6%	-1.3%

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/ PCDF	PAHs	HCB	PCBs
1990	0.0%	0.7%	-0.1%	1.1%	0.2%	2.6%	-1.0%	2.3%	0.1%	16.2%	-2.9%	-84.9%	7737.2%
1995	0.2%	2.5%	0.3%	2.2%	1.0%	3.3%	-0.6%	2.1%	0.6%	36.3%	-3.3%	-71.2%	5127.5%
2000	1.2%	6.2%	0.9%	3.1%	2.0%	3.2%	-0.9%	0.8%	1.0%	109.4%	-4.2%	-91.9%	5580.8%
2005	1.2%	4.2%	-0.2%	1.5%	0.5%	1.9%	-1.5%	0.5%	0.4%	67.1%	-4.8%	-96.6%	3554.7%
2010	2.2%	11.5%	0.8%	4.7%	1.9%	2.3%	-2.8%	-0.3%	0.7%	97.3%	-9.1%	2.3%	1832.1%
2011	2.9%	10.5%	0.9%	4.2%	1.9%	2.4%	-2.9%	-0.3%	0.7%	94.9%	-8.9%	2.2%	1903.4%
2012	3.8%	15.1%	1.8%	5.2%	2.6%	2.9%	-2.6%	-0.1%	1.0%	132.1%	-9.2%	2.9%	1932.0%
2013	2.2%	9.2%	0.7%	3.9%	1.5%	2.0%	-3.5%	-0.5%	0.4%	74.3%	-9.2%	2.7%	2049.3%
2014	2.5%	11.3%	2.1%	4.7%	2.2%	2.2%	0.0%	0.6%	0.6%	91.8%	-9.4%	2.0%	1981.4%
2015	2.7%	11.6%	2.6%	4.9%	2.3%	2.1%	1.5%	0.9%	0.6%	86.5%	-9.5%	2.4%	1848.3%
2016	2.7%	11.9%	2.4%	5.4%	2.3%	2.2%	1.4%	1.2%	0.6%	88.6%	-7.3%	1.9%	1997.6%
2017	2.8%	11.6%	2.4%	5.5%	2.2%	2.3%	1.2%	1.6%	0.6%	91.3%	-8.6%	1.8%	1760.3%
2018	2.6%	10.7%	2.5%	5.7%	2.1%	2.0%	1.2%	1.5%	0.4%	78.3%	-9.6%	1.6%	1652.5%
2019	2.2%	10.2%	3.1%	7.2%	2.0%	1.7%	0.1%	1.6%	0.4%	79.3%	-11.4%	1.4%	1625.6%
2020	6.4%	13.9%	8.7%	12.8%	3.4%	2.2%	-1.4%	2.7%	13.0%	100.9%	-11.8%	-32.5%	1761.6%
1990-2020	0.5%	5.2%	0.7%	3.1%	1.4%	2.5%	-1.1%	1.0%	1.0%	71.3%	-5.4%	-77.2%	3943.5%

Regarding major changes performed, when aggregated variations per category for the reported period 1990-2020 are listed and rated from the highest to the lowest absolute value, 7 categories account for the 95% of the accumulated contribution as a percentage of the recalculation over the total variation observed in absolute value (henceforth, contribution level or CL). As shown in the following table, recalculations in categories 2K, 5C1biv and 2B10a are dominant in this Inventory Edition.

Table 8.1.3 Main categories whose aggregated contribution level (CL) adds up the 95% of the total (reported period 1990-2020)

NFR	DESCRIPTION	Edition 2023	Edition 2022	Difference	Absolute value of the difference	CL	Aggregated CL
2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)	4,1839.88	0	4,1839.88	4,1839.88	71.13%	71.1%
5C1biv	Sewage sludge incineration	7,414.69	316.90	7,097.79	7,097.79	12.07%	83.2%
2B10a	Chemical industry: Other (please specify in the IIR)	674,84	3,654.42	-2,979.58	2,979.58	5.07%	88.3%
2D3a	Domestic solvent use including fungicides	2,985.16	1,712.29	1,272.87	1,272.87	2.16%	90.4%
3B4h	Manure management - Other animals (please specify in IIR)	836.12	0	836.12	836.12	1.43%	91.9%
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	1,842.40	1,109.57	732.83	732.83	1.25%	93.1%
2A5b	Construction and demolition	1,023.17	301.51	721.65	721.65	1.23%	94.3%

Reasons for recalculations of these categories are shown in the following table.

Table 8.1.4 Explanations of recalculations for the most contributing categories to the total recalculation (reported period 1990-2020)

NFR	DESCRIPTION	Edition 2023
2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)	TERT recommended to include any missing emission from 2K. After applying a T2 methodology to this AD, new estimates of this pollutant have been added to the Inventory.
5C1biv	Sewage sludge incineration	Recalculation of the whole time series due to the correction of the wrong use of abatement efficiency percenteges for these contaminants as brought up in the last NECD Inventory Review (ES-5C11biv-2022-0002). In addition, recalculation of the activity data for period 2019-2020, being replicated for 2021, due to an update of the information provided by the focal point (Registro Nacional de Lodos (RNL)).
2B10a	Chemical industry: Other.	Production of persistent organic compounds have been removed because neither were they well allocated within this category nor this substances appeared in the Stockholm Convention on Persistent Organic Pollutant's list.
2D3a	Domestic solvent use including fungicides	In this edition 2D3a activity revised estimate has been included in 2023 NFR and IIR submission. This has resulted in a broad recalculation and an increase in estimates for this activity due to the incorporation of NMVOC emissions produced by ethanol consumption.
3B4h	Manure management - Other animals (please specify in IIR)	Incorporation as a new category (rabbits).

NFR	DESCRIPTION	Edition 2023
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	Recalculations due to methodological changes carried out to pass this category to level 2. Furthermore, data of areas of agricultural soils are provided by MAPA`s Statistics Yearbook to BNPAE technical team with two year lag compared with inventory report. In these cases, the Inventory replicates the x-2 year values published in the Yearbook, into x-1 year, the last year inventoried. This edition has updated the values of 2020 according to the yearbook and has replicated them into 2021.
2A5b	Construction and demolition	The area of constructed roads has been included under category 2A5b.

In terms of impact on each pollutant, category 5C1biv registers the biggest values of CL in more cases, with 98% of PCDD/PCDF recalculation. The other categories only have an impact on one or a few pollutants but contribute the most to their recalculation, among which the most noteworthy are categories 2B10a and 2K with 100% of HCB and PCBs recalculation, respectively.

Table 8.1.5 CL by category and pollutant for the top 7 most contributing categories to the overall recalculation (reported period 1990-2020)

NFR	NOx	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/ PCDF	PAHs	HCB	PCBs
2A5b	0%	0%	0%	0%	6%	19%	49%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2B10a	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
2D3a	0%	37%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2K	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%
3B4h	4%	1%	0%	40%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
3Dc	0%	0%	0%	0%	9%	51%	30%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
5C1biv	0%	0%	0%	0%	0%	0%	0%	0%	2%	83%	86%	60%	75%	68%	62%	12%	3%	66%	98%	0%	0%	0%

In the next section, an analysis by pollutant is performed. Information is structured in a table containing values of recalculation for the reported year 2020 and the reported period 1990-2020. Furthermore, the top four most recalculated categories are presented, including an explanation for each revised estimate as well as the value and its contribution level. For each pollutant, figures showing the evolution of the differences between editions are included, being the average percentage of recalculation in the period 1990-2020 represented with an orange dotted line.

8.2. Analysis by pollutant

8.2.1. NOx

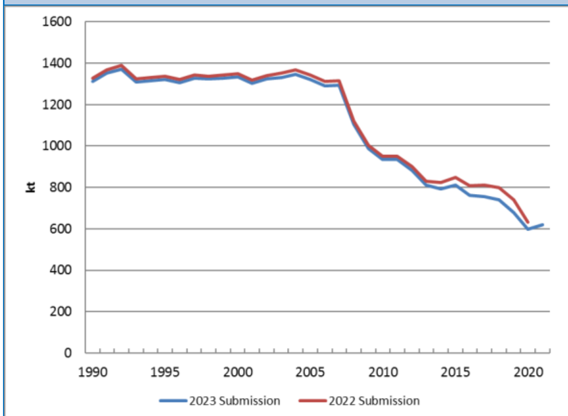
Table 8.2.1 Summary of recalculations for NOx

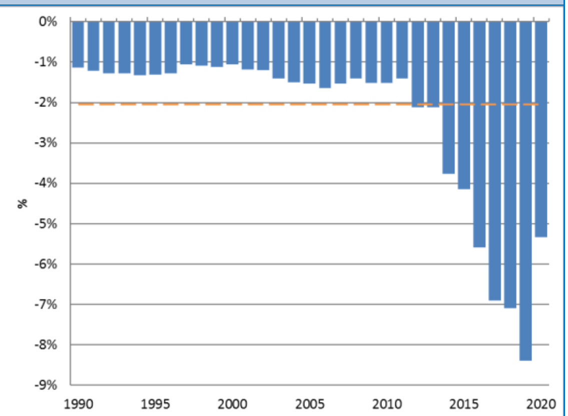
TOTAL NUMBER OF REVISED CATEGORIES
40 out of 62 estimated (65%) for reported year 2020

IMPACT OF REVISED ESTIMATES	
Reported year 2020	Reported period 1990-2020 (average)
-33.7 kt (-5.3%)	-23.4 kt/year (-2.1%)

TOP MOST RECALCULATED CATEGORIES FOR REPORTED YEAR 2020					
Order	NFR	Category name	Difference		Explanation
			kt	CL	
1	1A3dii	National navigation (shipping)	-25.9	38%	EF have been updated according to the Dec 2021 version of EMEP/EEA Guidebook (2019).
2	1A4ciii	Agriculture/Forestry/Fishing: National fishing	-17.0	25%	EF have been updated according to the Dec 2021 version of EMEP/EEA Guidebook (2019).
3	1A3bi	Road transport: Passenger cars	-5.0	7%	EF and PM equations updated to MEP/EEA GB (2019) version Oct 2021. Update of LPG LCV. Update of CNG consumption and correction of CNG characteristics in 2020. Small adjusts in activity data (fleet data).
4	1A1c	Manufacture of solid fuels and other energy industries	-0.1	0%	EF correction and update on fuel consumption (see section 3.6.)

Evolution of the difference





TOP MOST RECALCULATED CATEGORIES FOR REPORTED PERIOD 1990-2020					
Order	NFR	Category name	Difference		Explanation
			kt/year	CL	
1	1A3dii	National navigation (shipping)	-14.5	38%	See 1 in table above.
2	1A4ciii	Agriculture/Forestry/Fishing: National fishing	-10.1	27%	See 2 in table above.
3	3Da2a	Animal manure applied to soils	2.4	6%	Data update by integration of new data (see section 5.5.)
4	1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)	-1.6	4%	Reallocation of two misplaced rubrics to category 1A2f.

8.2.2. NMVOC

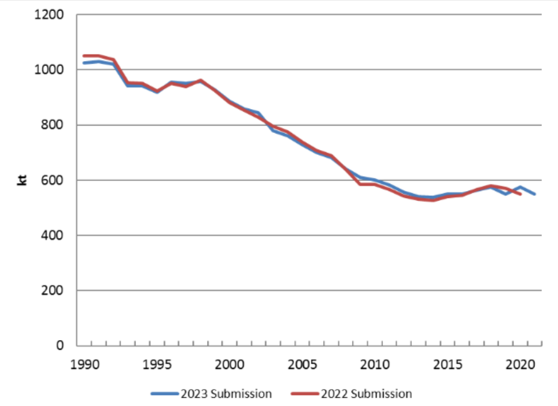
Table 8.2.2 Summary of recalculations for NMVOC

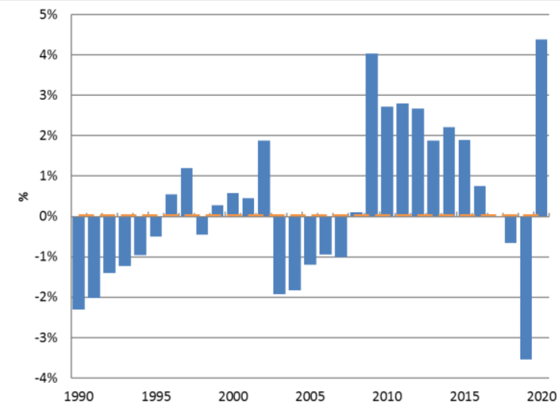
TOTAL NUMBER OF REVISED CATEGORIES
54 out of 71 estimated (75%) for reported year 2020

IMPACT OF REVISED ESTIMATES	
Reported year 2020	**Reported period 1990-2020 (average)**
24.2 kt (4.4%)	0.3 kt/year (0.0%)

TOP MOST RECALCULATED CATEGORIES FOR REPORTED YEAR 2020					
Order	NFR	Category name	Difference		Explanation
			kt	CL	
1	2D3a	Domestic solvent use including fungicides	93.0	59%	Recalculation due to revised estimate.
2	3Da2a	Animal manure applied to soils	-47.6	30%	Recalculation due to methodology change for NMVOC emissions calculations based on NH_3 emissions ratio instead of NH_3 emission factors ratio.
3	2D3e	Degreasing	-13.8	9%	Recalculation due to methodological change.
4	2D3g	Chemical products	-9.1	6%	Recalculations due to new methodology into polyester processing emissions estimates.

Evolution of the difference





TOP MOST RECALCULATED CATEGORIES FOR REPORTED PERIOD 1990-2020					
Order	NFR	Category name	Difference		Explanation
			kt/year	CL	
1	2D3a	Domestic solvent use including fungicides	44.1	38%	See 1 in table above.
2	3Da2a	Animal manure applied to soils	-43.1	37%	See 2 in table above.
3	1A4bi	Residential: Stationary	9.9	8%	Disaggregation of biomass consumption. Update of fuel-activity allocation for the whole series. Update of natural gas consumption since 2015.
4	3B4giv	Manure management - Other poultry	-3.1	3%	Recalculation due to Incorporation of a new category for Turkeys which was previously included into “Other poultry” in addition recalculations cited for NMVOC.

8.2.3. SO_2

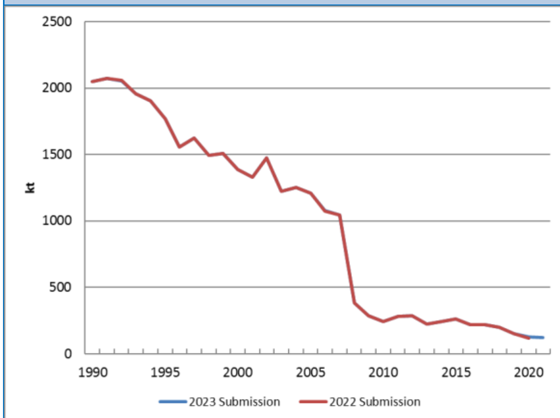
Table 8.2.3 Summary of recalculations for SO_2

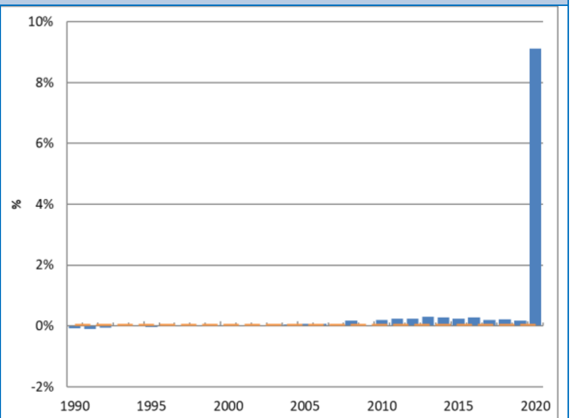
TOTAL NUMBER OF REVISED CATEGORIES
27 out of 44 estimated (61%) for reported year 2020

IMPACT OF REVISED ESTIMATES	
Reported year 2020	Reported period 1990-2020 (average)
10.7kt (9.1%)	0.4 kt/year (0.0%)

TOP MOST RECALCULATED CATEGORIES FOR REPORTED YEAR 2020					
Order	NFR	Category name	Difference		Explanation
			kt	CL	
1	2C7c	Other metal production (please specify in the IIR)	0.6	29%	New estimation according to EMEP/EEA GB 2019.
2	1A3dii	National navigation (shipping)	-5.0	251%	Correction of SO_2 emission factor was made in 2020.
3	1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)	0.3	16%	Reallocation of two misplaced rubrics to category 1A2f.
4	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	0.0	0%	Fuel balance recalculation for consistency with energy statistics.

Evolution of the difference





TOP MOST RECALCULATED CATEGORIES FOR REPORTED PERIOD 1990-2020					
Order	NFR	Category name	Difference		Explanation
			kt/year	CL	
1	2C7c	Other metal production (please specify in the IIR)	0.7	33%	See 1 in table above.
2	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	0.5	23%	Fuel balance recalculation for consistency with energy statistics.
3	1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)	-0.3	13%	See 3 in table above.
4	1A3dii	National navigation (shipping)	-0.2	9%	See 2 in table above.

8.2.4. NH_3

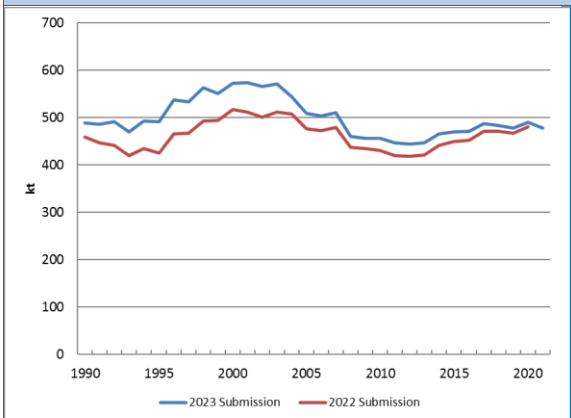
Table 8.2.4 Summary of recalculations for NH_3

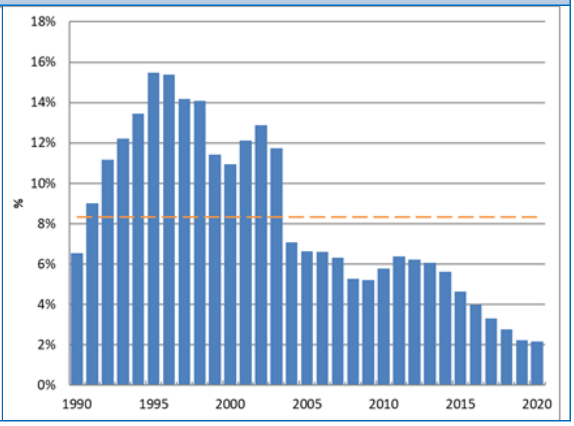
TOTAL NUMBER OF REVISED CATEGORIES
37 out of 51 estimated (73%) for reported year 2020

IMPACT OF REVISED ESTIMATES	
Reported year 2020	Reported period 1990-2020 (average)
10.4 kt (2.2%)	38.5 kt/year (8.3%)

TOP MOST RECALCULATED CATEGORIES FOR REPORTED YEAR 2020					
Order	NFR	Category name	Difference		Explanation
			kt	CL	
1	3B4h	Manure management - Other animals (please specify in IIR)	15.1	35%	Incorporation as a new category (rabbits).
2	3B4giv	Manure management - Other poultry	-7.3	17%	Recalculation due to Incorporation of a new category for Turkeys which was previously included into “Other poultry”.
3	3B4giii	Manure mangement - Turkeys	6.1	14%	Incorporation as a new and independent category from the category “Other poultry”.
4	3Da2a	Animal manure applied to soils	-6.0	14%	Recalculation due the incorporation of data from new surveys on manure management systems and variations by incorporating BAT data obtained from ECOGAN cited for 3B categories that produce alterations in nitrogen balance calculations and nitrogen applied to soils from manure. Incorporation of new data for ammonia BATs from ECOGAN in relation to application of manure to soils.

Evolution of the difference





TOP MOST RECALCULATED CATEGORIES FOR REPORTED PERIOD 1990-2020					
Order	NFR	Category name	Difference		Explanation
			kt/year	CL	
1	3B4h	Manure management - Other animals (please specify in IIR)	25.1	40%	See 1 in table above.
2	3Da2a	Animal manure applied to soils	19.1	30%	See 4 in table above.
3	3B4giv	Manure management - Other poultry	-4.9	8%	See 2 in table above.
4	5D3	Other wastewater handling	-3.9	6%	The activity data corresponding to the period 1990-2007, 2010 and 2012 has been updated due to new information of the Urban wastewater collecting system in EUROSTAT and the correction of the interpolated data as recommended in the last NECD Inventory Review (ES-5D3-2022-0002).

8.2.5. $PM_{2.5}$

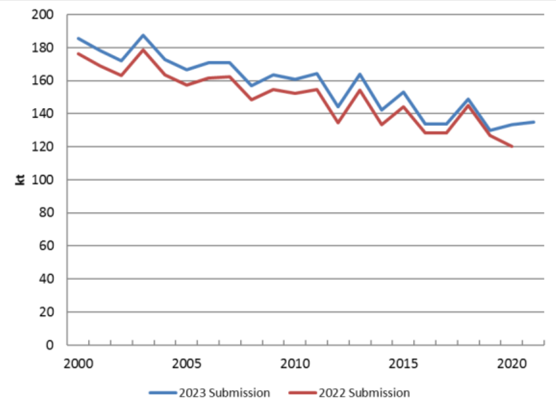
Table 8.2.5 Summary of recalculations for $PM_{2.5}$

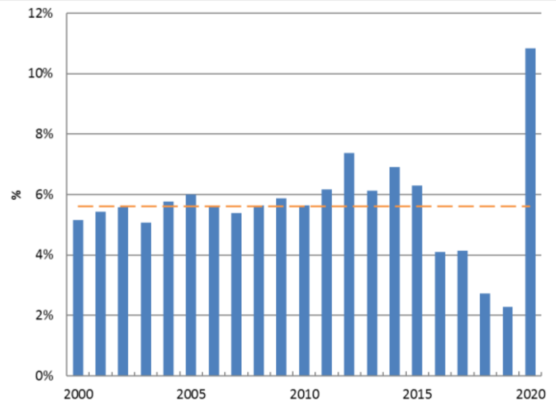
TOTAL NUMBER OF REVISED CATEGORIES
43 out of 73 estimated (59%) for reported year 2020

IMPACT OF REVISED ESTIMATES	
Reported year 2020	**Reported period 1990-2020 (average)**
13.0 kt (10.8%)	5.7 kt/year (5.6%)

TOP MOST RECALCULATED CATEGORIES FOR REPORTED YEAR 2020					
Order	**NFR**	**Category name**	**Difference**		**Explanation**
			kt	**CL**	
1	1A4bi	Residential: Stationary	1.3	20%	Disaggregation of biomass consumption. Update of fuel-activity allocation for the whole series. Update of natural gas consumption since 2015.
2	3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	0.9	13%	Methodological changes due to tier upgrade and updating data by data provider (see section 5.5.).
3	2A5b	Construction and demolition	0.4	6%	Recalculations due to update to EEA/EMEP GB 2019 as well as data enhancement with AD from road construction.
4	1A3dii	National navigation (shipping)	-0.4	7%	EF have been updated according to the Dec 2021 version of EMEP/EEA Guidebook (2019).

Evolution of the difference





TOP MOST RECALCULATED CATEGORIES FOR REPORTED PERIOD 1990-2020					
Order	**NFR**	**Category name**	**Difference**		**Explanation**
			kt/year	**CL**	
1	1A4bi	Residential: Stationary	4.8	67%	See 1 in table above.
2	3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	0.6	9%	See 2 in table above.
3	2A5b	Construction and demolition	0.4	6%	See 3 in table above.
4	5C2	Open burning of waste	0.3	5%	Cultivated areas data and crop yields for BNPAE calculates are provided by MAPA's Statistics Yearbook with two-year lag. In these cases, the Inventory replicates the x-2 year values published in the Yearbook, into x-1 year, the last year inventoried. This edition has updated the values of 2020 according to the yearbook, and has replicated them into 2021.

8.2.6. PM_{10}

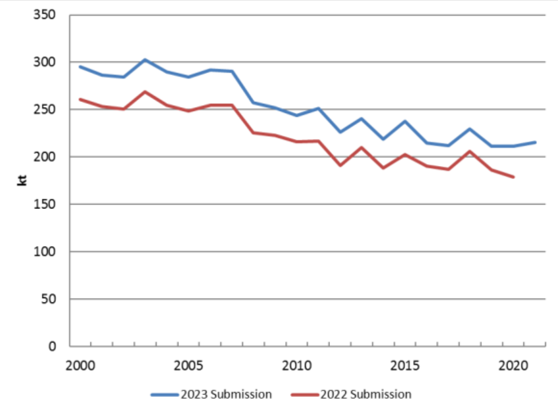
Table 8.2.6 Summary of recalculations for PM_{10}

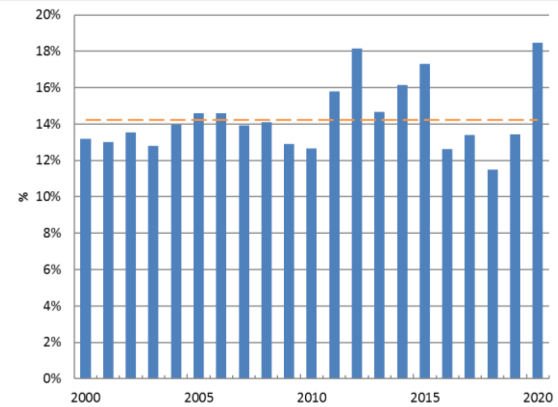
TOTAL NUMBER OF REVISED CATEGORIES
44 out of 73 estimated (60%) for reported year 2020

IMPACT OF REVISED ESTIMATES	
Reported year 2020	Reported period 1990-2020 (average)
33.0 kt 18.5%)	21.4 kt/year (14.2%)

TOP MOST RECALCULATED CATEGORIES FOR REPORTED YEAR 2020					
Order	NFR	Category name	Difference		Explanation
			kt	CL	
1	3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	16.2	58%	Recalculations due to methodological changes carried out to pass this category to level 2. Furthermore, data of areas of agricultural soils are provided by MAPA's Statistics Yearbook to BNPAE technical team with two-year lag compared with inventory report. In these cases, the Inventory replicates the x-2 year values published in the Yearbook, into x-1 year, the last year inventoried. This edition has updated the values of 2020 according the yearbook and has replicated them into 2021.
2	2A5b	Construction and demolition	4.0	14%	Recalculations due to update to EEA/EMEP GB 2019 as well as data enhancement with AD from road construction.
3	1A4bi	Residential: Stationary	1.5	5%	Disaggregation of biomass consumption. Update of fuel-activity allocation for the whole series. Update of natural gas consumption since 2015.
4	3B4giii	Manure mangement - Turkeys	1.1	4%	Incorporation as a new and independent category from the category "Other poultry.

Evolution of the difference





TOP MOST RECALCULATED CATEGORIES FOR REPORTED PERIOD 1990-2020					
Order	NFR	Category name	Difference		Explanation
			kt/year	CL	
1	3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	12.0	51%	See 1 in table above.
2	1A4bi	Residential: Stationary	5.1	21%	See 3 in table above.
3	2A5b	Construction and demolition	4.4	19%	See 2 in table above.
4	3B4giii	Manure mangement - Turkeys	0.5	2%	See 4 in table above.

8.2.7. TSP

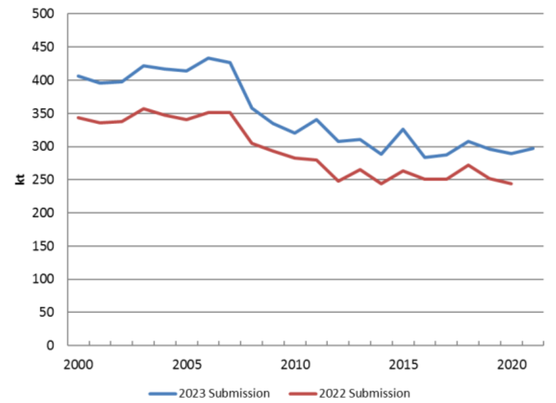
Table 8.2.7 Summary of recalculations for TSP

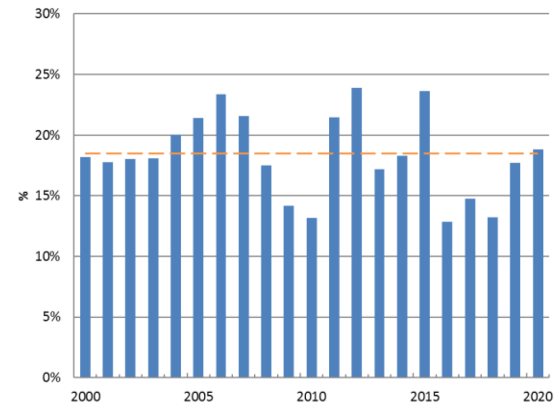
TOTAL NUMBER OF REVISED CATEGORIES
45 out of 75 estimated (60%) for reported year 2020

IMPACT OF REVISED ESTIMATES	
Reported year 2020	**Reported period 1990-2020(average)**
45.8 kt (18.8%)	37.0 kt/year (18.5%)

TOP MOST RECALCULATED CATEGORIES FOR REPORTED YEAR 2020					
Order	**NFR**	**Category name**	**Difference**		**Explanation**
			kt	**CL**	
1	2A5b	Construction and demolition	15.8	39%	Recalculations due to update to EEA/EMEP GB 2019 as well as data enhancement with AD from road construction.
2	3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	16.2	40%	Recalculations due to methodological changes carried out to pass this category to level 2. Furthermore, data of areas of agricultural soils are provided by MAPA's Statistics Yearbook to BNPAE technical team with two-year lag compared with inventory report. In these cases, the Inventory replicates the x-2 year values published in the Yearbook, into x-1 year, the last year inventoried. This edition has updated the values of 2020 according to the yearbook and has replicated them into 2021.
3	1A4bi	Residential: Stationary	1.8	5%	Disaggregation of biomass consumption. Update of fuel-activity allocation for the whole series. Update of natural gas consumption since 2015.
4	3B4giii	Manure mangement - Turkeys	1.1	3%	Incorporation as a new and independent category from the category "Other poultry.

Evolution of the difference





TOP MOST RECALCULATED CATEGORIES FOR REPORTED PERIOD 1990-2020					
Order	**NFR**	**Category name**	**Difference**		**Explanation**
			kt/year	**CL**	
1	2A5b	Construction and demolition	19.1	48%	See 1 in table above.
2	3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	12.0	30%	See 2 in table above.
3	1A4bi	Residential: Stationary	5.6	14%	See 3 in table above.
4	3B4giii	Manure mangement - Turkeys	0.5	1%	See 4 in table above.

8.2.8. BC

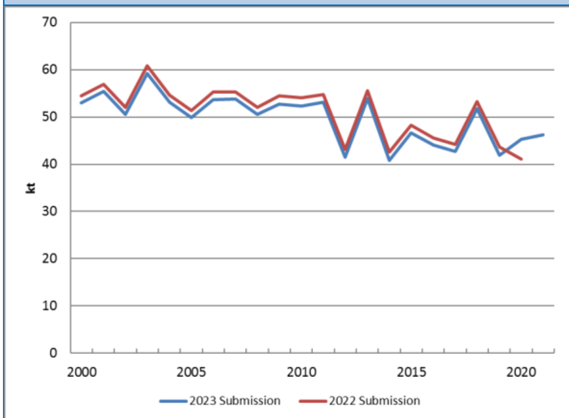
Table 8.2.8 Summary of recalculations for BC

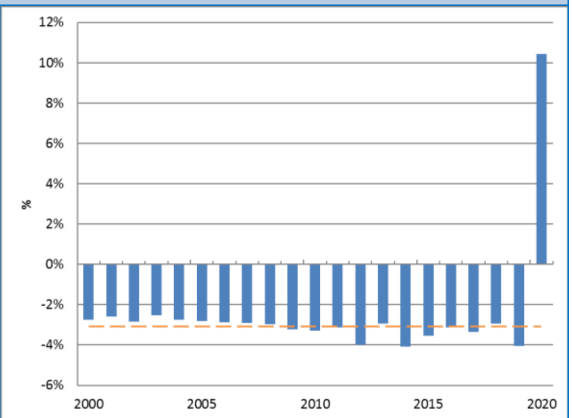
TOTAL NUMBER OF REVISED CATEGORIES
31 out of 48 estimated (65%) for reported year 2020

IMPACT OF REVISED ESTIMATES	
Reported year 2020	Reported period 1990-2020 (average)
4.3 kt (10.4%)	-0.9 kt/year (-2.6%)

TOP MOST RECALCULATED CATEGORIES FOR REPORTED YEAR 2020					
Order	NFR	Category name	Difference		Explanation
			kt	CL	
1	1A4bi	Residential: Stationary	-1.2	72%	Disaggregation of biomass consumption. Update of fuel-activity allocation for the whole series. Update of natural gas consumption since 2015.
2	1A3dii	National navigation (shipping)	-0.2	12%	EF have been updated according to the Dec 2021 version of EMEP/EEA Guidebook (2019).
3	1A3bi	Road transport: Passenger cars	-0.1	4%	Update of LPG LCV. Update of CNG consumption and correction of CNG characteristics in 2020. Small adjusts in activity data (fleet data).
4	1A4ciii	Agriculture/Forestry/Fishing: National fishing	-0.1	7%	EF have been updated according to the Dec 2021 version of EMEP/EEA Guidebook (2019).

Evolution of the difference





TOP MOST RECALCULATED CATEGORIES FOR REPORTED PERIOD 1990-2020					
Order	NFR	Category name	Difference		Explanation
			kt/year	CL	
1	1A4bi	Residential: Stationary	-0.7	56%	See 1 in table above.
2	5C2	Open burning of waste	0.2	14%	Cultivated areas data and crop yields for BNPAE calculates are provided by MAPA's Statistics Yearbook with two-year lag. In these cases, the Inventory replicates the x-2 year values published in the Yearbook, into x-1 year, the last year inventoried. This edition has updated the values of 2020 according to the yearbook, and has replicated them into 2021.
3	1A3dii	National navigation (shipping)	-0.2	12%	See 2 in table above.
4	1A4ciii	Agriculture/Forestry/Fishing: National fishing	-0.1	9%	See 4 in table above.

8.2.9. CO

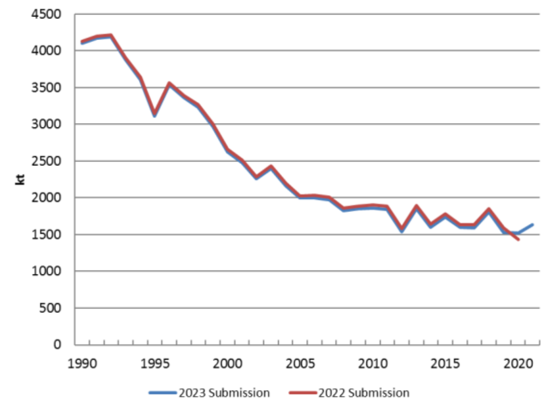
Table 8.2.9 Summary of recalculations for CO

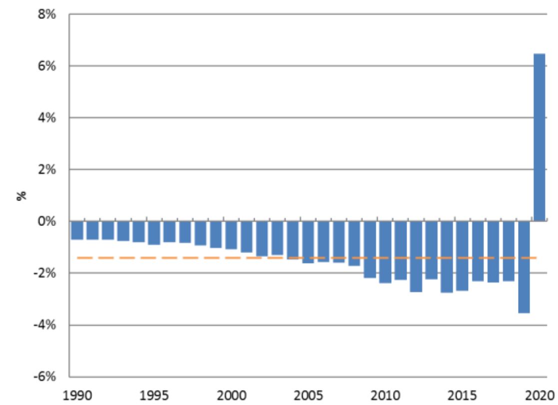
TOTAL NUMBER OF REVISED CATEGORIES
26 out of 45 estimated (58%) for reported year 2020

IMPACT OF REVISED ESTIMATES	
Reported year 2020	Reported period 1990-2020 (average)
92.6 kt (6.5%)	-31.2 kt/year (-1.3%)

TOP MOST RECALCULATED CATEGORIES FOR REPORTED YEAR 2020					
Order	NFR	Category name	Difference		Explanation
			kt	CL	
1	1A4bi	Residential: Stationary	-43.3	95%	Disaggregation of biomass consumption. Update of fuel-activity allocation for the whole series. Update of natural gas consumption since 2015.
2	1A3biv	Road transport: Mopeds & motorcycles	0.4	1%	EF and PM equations have been updated according to the Oct 2021 version of EMEP/EEA Guidebook (2019).
3	1A3bi	Road transport: Passenger cars	-1.4	3%	EF and PM equations have been updated according to the Oct 2021 version of EMEP/EEA Guidebook (2019).
4	1A3dii	National navigation (shipping)	-2.0	4%	EF have been updated according to the Dec 2021 version of EMEP/EEA Guidebook (2019).

Evolution of the difference





TOP MOST RECALCULATED CATEGORIES FOR REPORTED PERIOD 1990-2020					
Order	NFR	Category name	Difference		Explanation
			kt/year	CL	
1	1A4bi	Residential: Stationary	-32.2	70%	See 1 in table above.
2	5C2	Open burning of waste	4.5	10%	Cultivated areas data and crop yields for BNPAE calculates are provided by MAPA's Statistics Yearbook with two-year lag. In these cases, the Inventory replicates the x-2 year values published in the Yearbook, into x-1 year, the last year inventoried. This edition has updated the values of 2020 according to the yearbook, and has replicated them into 2021.
3	1A3dii	National navigation (shipping)	-2.8	6%	See 4 in table above.
4	1A4ciii	Agriculture/Forestry/Fishing: National fishing	-1.6	3%	EF have been updated according to the Dec 2021 version of EMEP/EEA Guidebook (2019).

8.2.10. Pb

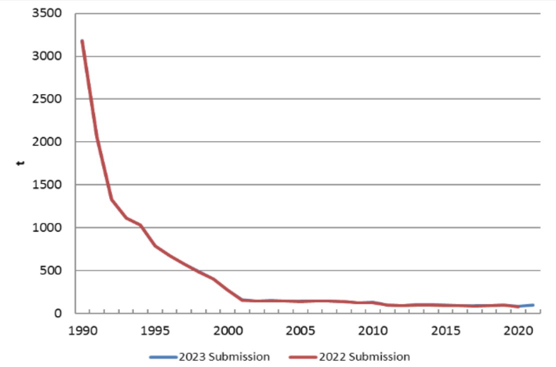
Table 8.2.10 Summary of recalculations for Pb

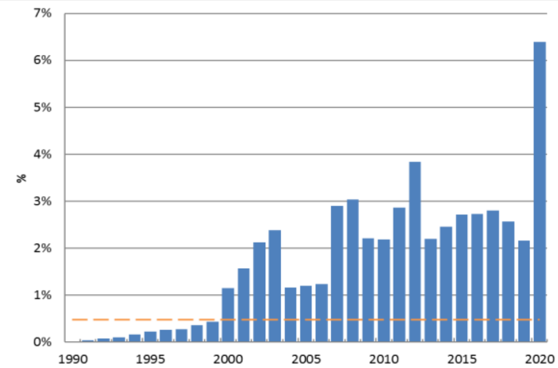
TOTAL NUMBER OF REVISED CATEGORIES
27 out of 39 estimated (69%) for reported year 2020

IMPACT OF REVISED ESTIMATES	
Reported year 2020	Reported period 1990-2020 (average)
5.2 t (6.4%)	2.4 t/year (0.5%)

TOP MOST RECALCULATED CATEGORIES FOR REPORTED YEAR 2020					
Order	NFR	Category name	Difference		Explanation
			t	CL	
1	5C1biv	Sewage sludge incineration	2.3	85%	Correction of abatement efficiency and updating data provided by the focal point (see section 6.5).
2	1A3bi	Road transport: Passenger cars	0.0	1%	Update of LPG LCV. Update of CNG consumption and correction of CNG characteristics in 2020. Small adjusts in activity data (fleet data).
3	1A3biv	Road transport: Mopeds & motorcycles	0.0	1%	Update of LPG LCV. Update of CNG consumption and correction of CNG characteristics in 2020. Small adjusts in activity data (fleet data).
4	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	1.6	59%	Fuel balance recalculation for consistency with energy statistics.

Evolution of the difference





TOP MOST RECALCULATED CATEGORIES FOR REPORTED PERIOD 1990-2020					
Order	NFR	Category name	Difference		Explanation
			t/year	CL	
1	5C1biv	Sewage sludge incineration	2.4	81%	See 1 in table above.
2	1A3biv	Road transport: Mopeds & motorcycles	-0.2	5%	See 3 in table above.
3	1A3bi	Road transport: Passenger cars	0.2	5%	See 2 in table above.
4	1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	-0.1	3%	Fuel balance recalculation for consistency with energy statistics.

8.2.11. Cd

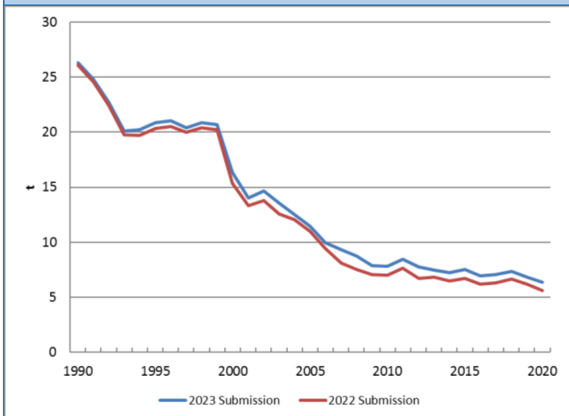
Table 8.2.11 Summary of recalculations for Cd

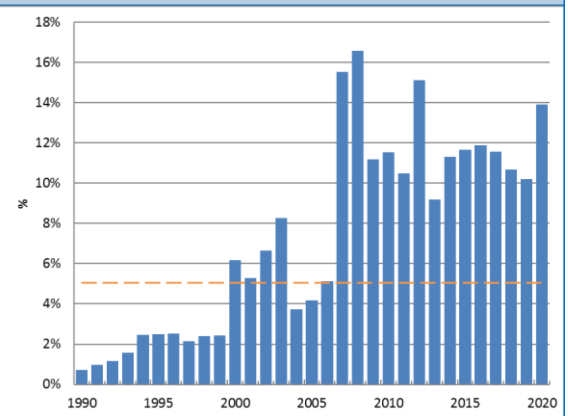
TOTAL NUMBER OF REVISED CATEGORIES
28 out of 41 estimated (68%) for reported year 2020

IMPACT OF REVISED ESTIMATES	
Reported year 2020	Reported period 1990-2020 (average)
0.8 t (13.9%)	0.7 t/year (5.2%)

TOP MOST RECALCULATED CATEGORIES FOR REPORTED YEAR 2020					
Order	NFR	Category name	Difference		Explanation
			t	CL	
1	5C1biv	Sewage sludge incineration	0.7	83%	Correction of abatement efficiency and updating data provided by the focal point (see section 6.5).
2	1A1b	Petroleum refining	0.0	5%	Data corrections and update for period 1998-2020.
3	1A4bi	Residential: Stationary	0.0	2%	Disaggregation of biomass consumption. Update of fuel-activity allocation for the whole series. Update of natural gas consumption since 2015.
4	1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	0.0	1%	Fuel balance recalculation for consistency with energy statistics.

Evolution of the difference





TOP MOST RECALCULATED CATEGORIES FOR REPORTED PERIOD 1990-2020					
Order	NFR	Category name	Difference		Explanation
			t/year	CL	
1	5C1biv	Sewage sludge incineration	0.8	86%	See 1 in table above.
2	1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	-0.1	6%	Fuel balance recalculation for consistency with energy statistics.
3	1A1b	Petroleum refining	0.0	4%	See 2 in table above.
4	1A4bi	Residential: Stationary	0.0	3%	See 3 in table above.

8.2.12. Hg

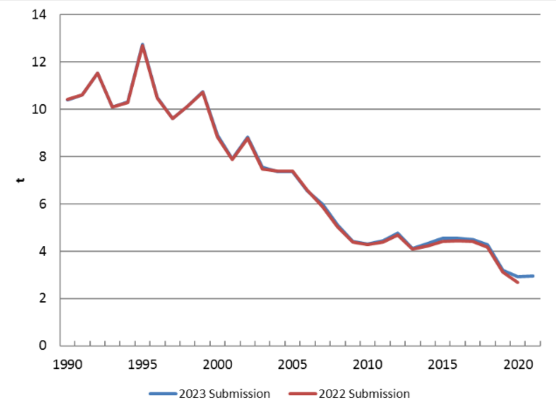
Table 8.2.12 Summary of recalculations for Hg

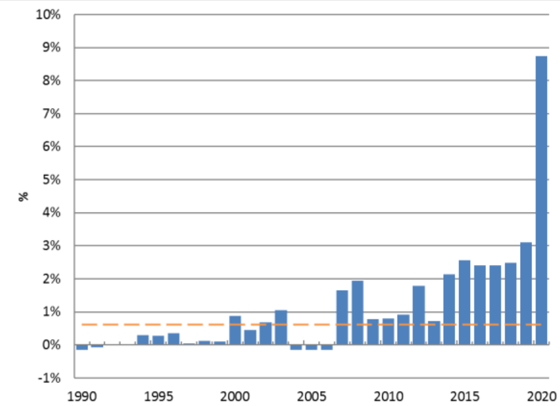
TOTAL NUMBER OF REVISED CATEGORIES
23 out of 34 estimated (68%) for reported year 2020

IMPACT OF REVISED ESTIMATES	
Reported year 2020	Reported period 1990-2020 (average)
0.2 t (8.7%)	0.1 t/year (0.7%)

TOP MOST RECALCULATED CATEGORIES FOR REPORTED YEAR 2020					
Order	NFR	Category name	Difference		Explanation
			t	CL	
1	5C1biv	Sewage sludge incineration	0.1	77%	Correction of abatement efficiency and updating data provided by the focal point (see section 6.5).
2	1A1b	Petroleum refining	0.0	5%	Data corrections and update for period 1998-2020.
3	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	0.1	106%	Fuel balance recalculation for consistency with energy statistics.
4	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	0.0	2%	EF update to EMEP/EEA Guidebook (2019).

Evolution of the difference





TOP MOST RECALCULATED CATEGORIES FOR REPORTED PERIOD 1990-2020					
Order	NFR	Category name	Difference		Explanation
			t/year	CL	
1	5C1biv	Sewage sludge incineration	0.1	60%	See 1 in table above.
2	1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	-0.1	31%	Fuel balance recalculation for consistency with energy statistics.
3	1A1b	Petroleum refining	0.0	3%	See 2 in table above.
4	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	0.0	3%	See 3 in table above.

8.2.13. As

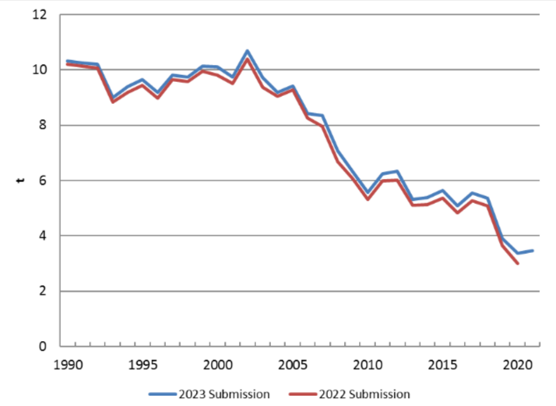
Table 8.2.13 Summary of recalculations for As

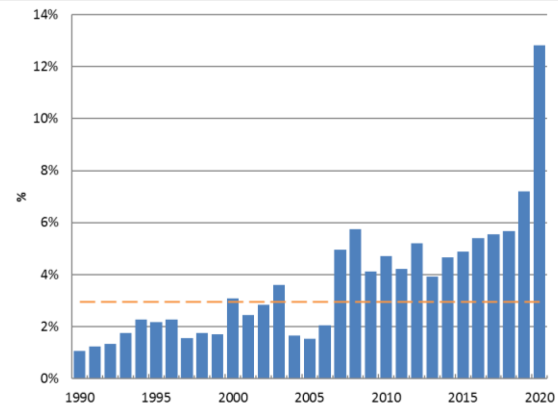
TOTAL NUMBER OF REVISED CATEGORIES
27 out of 37 estimated (73%) for reported year 2020

IMPACT OF REVISED ESTIMATES	
Reported year 2020	**Reported period 1990-2020 (average)**
0.4 t (12.8%)	0.2 t/year (3.1%)

TOP MOST RECALCULATED CATEGORIES FOR REPORTED YEAR 2020					
Order	**NFR**	**Category name**	**Difference**		**Explanation**
			t	**CL**	
1	5C1biv	Sewage sludge incineration	0.2	67%	Correction of abatement efficiency and updating data provided by the focal point (see section 6.5).
2	1A3dii	National navigation (shipping)	0.0	5%	EF have been updated according to the Dic 2021 version of EMEP/EEA Guidebook (2019).
3	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	0.0	3%	EF update to EMEP/EEA Guidebook (2019).
4	1A1b	Petroleum refining	0.0	2%	Data corrections and update for period 1998-2020.

Evolution of the difference





TOP MOST RECALCULATED CATEGORIES FOR REPORTED PERIOD 1990-2020					
Order	**NFR**	**Category name**	**Difference**		**Explanation**
			t/year	**CL**	
1	5C1biv	Sewage sludge incineration	0.2	74%	See 1 in table above.
2	1A3dii	National navigation (shipping)	0.0	10%	See 2 in table above.
3	1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	0.0	9%	Fuel balance recalculation for consistency with energy statistics.
4	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	0.0	2%	See 3 in table above.

8.2.14. Cr

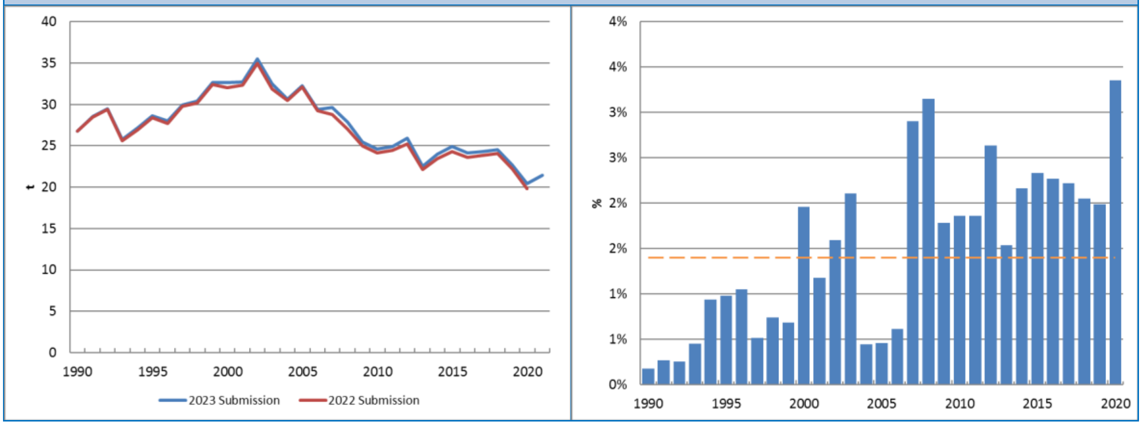
Table 8.2.14 Summary of recalculations for Cr

TOTAL NUMBER OF REVISED CATEGORIES
27 out of 39 estimated (69%) for reported year 2020

IMPACT OF REVISED ESTIMATES	
Reported year 2020	Reported period 1990-2020 (average)
0.7 t (3.4%)	0.4 t/year (1.4%)

TOP MOST RECALCULATED CATEGORIES FOR REPORTED YEAR 2020					
Order	NFR	Category name	Difference		Explanation
			t	CL	
1	5C1biv	Sewage sludge incineration	0.6	70%	Recalculation of the whole time series due to the correction of the wrong use of abatement efficiency percenteges for these contaminants as brought up in the last NECD Inventory Review (ES-5C11biv-2022-0002). In addition, recalculation of the activity data for period 2019-2020, being replicated for 2021, due to an update of the information provided by the focal point (Registro Nacional de Lodos (RNL)).
2	1A1b	Petroleum refining	-0.1	14%	Data corrections and update for period 1998-2020.
3	1A4bi	Residential: Stationary	0.0	3%	Disaggregation of biomass consumption. Update of fuel-activity allocation for the whole series. Update of natural gas consumption since 2015.
4	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	0.0	1%	Fuel balance recalculation for consistency with energy statistics.

Evolution of the difference



TOP MOST RECALCULATED CATEGORIES FOR REPORTED PERIOD 1990-2020					
Order	NFR	Category name	Difference		Explanation
			t/year	CL	
1	5C1biv	Sewage sludge incineration	0.7	68%	See 1 in table above.
2	1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	-0.1	15%	Fuel balance recalculation for consistency with energy statistics.
3	1A1b	Petroleum refining	-0.1	10%	See 2 in table above.
4	1A4bi	Residential: Stationary	0.0	4%	See 3 in table above.

8.2.15. Cu

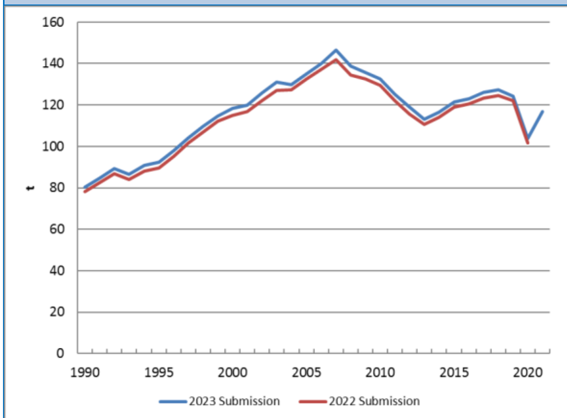
Table 8.2.15 Summary of recalculations for Cu

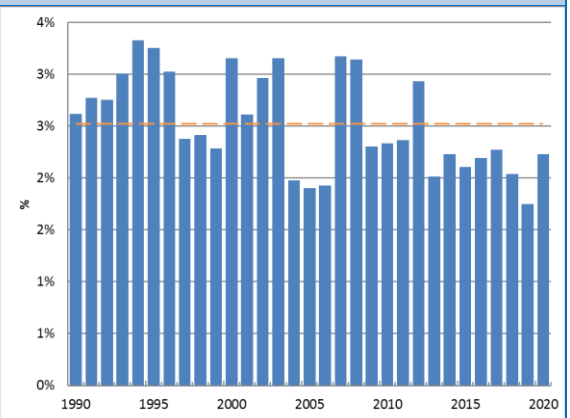
TOTAL NUMBER OF REVISED CATEGORIES
27 out of 39 estimated (69%) for reported year 2020

IMPACT OF REVISED ESTIMATES	
Reported year 2020	**Reported period 1990-2020(average)**
2.3 t (2.2%)	2.8 t/year (2.5%)

TOP MOST RECALCULATED CATEGORIES FOR REPORTED YEAR 2020					
Order	**NFR**	**Category name**	**Difference**		**Explanation**
			t	**CL**	
1	5C1biv	Sewage sludge incineration	1.8	57%	Correction of abatement efficiency and updating data provided by the focal point (see section 6.5).
2	1A3dii	National navigation (shipping)	0.3	11%	EF have been updated according to the Dec 2021 version of EMEP/EEA Guidebook (2019).
3	1A4ciii	Agriculture/Forestry/Fishing: National fishing	0.2	5%	EF have been updated according to the Dec 2021 version of EMEP/EEA Guidebook (2019).
4	1A3bvi	Road transport: Automobile tyre and brake wear	-0.3	9%	Update of LPG LCV. Update of CNG consumption and correction of CNG characteristics in 2020. Small adjusts in activity data (fleet data).

Evolution of the difference





TOP MOST RECALCULATED CATEGORIES FOR REPORTED PERIOD 1990-2020					
Order	**NFR**	**Category name**	**Difference**		**Explanation**
			t/year	**CL**	
1	5C1biv	Sewage sludge incineration	1.9	61%	See 1 in table above.
2	1A3dii	National navigation (shipping)	0.6	20%	See 2 in table above.
3	1A4ciii	Agriculture/Forestry/Fishing: National fishing	0.4	11%	See 3 in table above.
4	1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	-0.1	2%	Fuel balance recalculation for consistency with energy statistics.

8.2.16. Ni

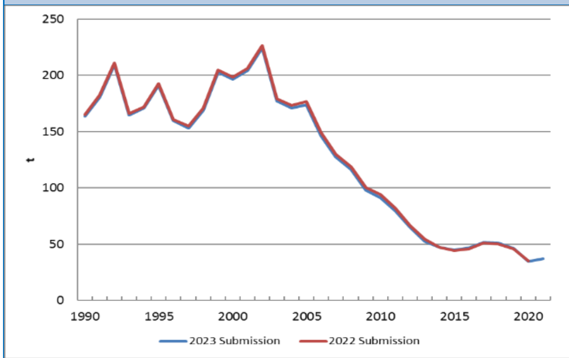
Table 8.2.16 Summary of recalculations for Ni

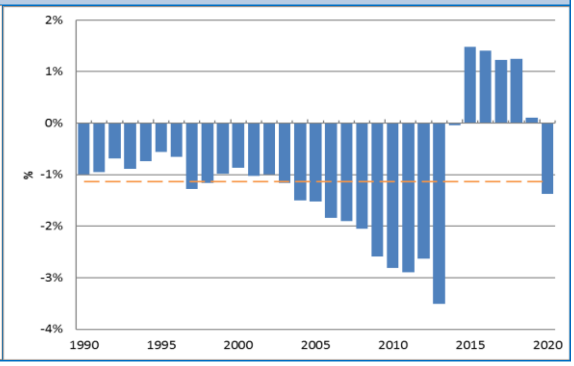
TOTAL NUMBER OF REVISED CATEGORIES
26 out of 37 estimated (70%) for reported year 2020

IMPACT OF REVISED ESTIMATES	
Reported year 2020	Reported period 1990-2020 (average)
-0.4 t (-1.4%)	-1.5 t/year (-1.1%)

TOP MOST RECALCULATED CATEGORIES FOR REPORTED YEAR 2020					
Order	NFR	Category name	Difference		Explanation
			t	CL	
1	1A3dii	National navigation (shipping)	-1.2	91%	EF have been updated according to the Dec 2021 version of EMEP/EEA Guidebook (2019).
2	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	0.4	35%	EF update to EMEP/EEA Guidebook 2019.
3	5C1biv	Sewage sludge incineration	0.4	28%	Recalculation of the whole time series due to the correction of the wrong use of abatement efficiency percenteges for these contaminants as brought up in the last NECD Inventory Review (ES-5C11biv-2022-0002). In addition, recalculation of the activity data for period 2019-2020, being replicated for 2021, due to an update of the information provided by the focal point (Registro Nacional de Lodos (RNL)).
4	1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)	0.1	9%	Reallocation ot two misplace rubrics to category 1A2f.

Evolution of the difference





TOP MOST RECALCULATED CATEGORIES FOR REPORTED PERIOD 1990-2020					
Order	NFR	Category name	Difference		Explanation
			t/year	CL	
1	1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	-2.0	67%	Fuel balance recalculation for consistency with energy statistics.
2	5C1biv	Sewage sludge incineration	0.4	13%	See 3 in table above.
3	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	0.4	12%	See 2 in table above.
4	1A1b	Petroleum refining	-0.1	4%	Data corrections and update for period 1998-2020.

8.2.17. Se

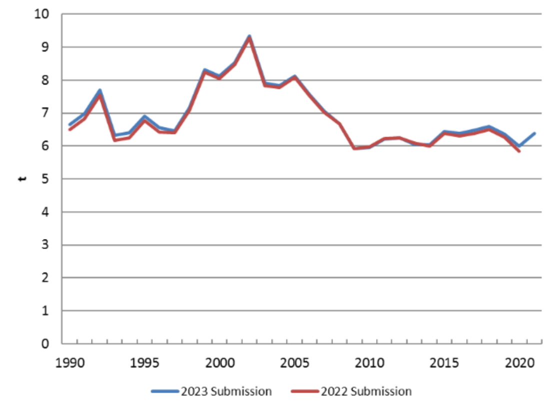
Table 8.2.17 Summary of recalculations for Se

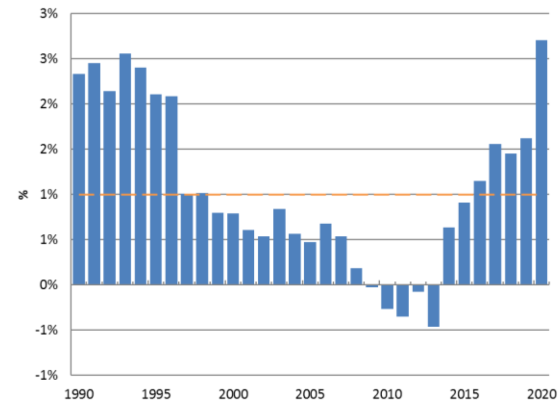
TOTAL NUMBER OF REVISED CATEGORIES
26 out of 35 estimated (74%) for reported year 2020

IMPACT OF REVISED ESTIMATES	
Reported year 2020	Reported period 1990-2020 (average)
0.2 t (2.7%)	0.1t/year (1.0%)

TOP MOST RECALCULATED CATEGORIES FOR REPORTED YEAR 2020					
Order	NFR	Category name	Difference		Explanation
			t	CL	
1	1A3dii	National navigation (shipping)	0.1	32%	EF have been updated according to the Dec 2021 version of EMEP/EEA Guidebook (2019).
2	1A4ciii	Agriculture/Forestry/Fishing: National fishing	0.0	15%	EF have been updated according to the Dec 2021 version of EMEP/EEA Guidebook (2019).
3	1A1b	Petroleum refining	0.0	18%	Data corrections and update for period 1998-2020.
4	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	0.0	4%	EF update to EMEP/EEA Guidebook 2019.

Evolution of the difference





TOP MOST RECALCULATED CATEGORIES FOR REPORTED PERIOD 1990-2020					
Order	NFR	Category name	Difference		Explanation
			t/year	CL	
1	1A3dii	National navigation (shipping)	0.1	38%	See 1 in table above.
2	1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	-0.1	24%	Fuel balance recalculation for consistency with energy statistics.
3	1A4ciii	Agriculture/Forestry/Fishing: National fishing	0.0	20%	See 2 in table above.
4	1A1b	Petroleum refining	0.0	10%	See 3 in table above.

8.2.18. Zn

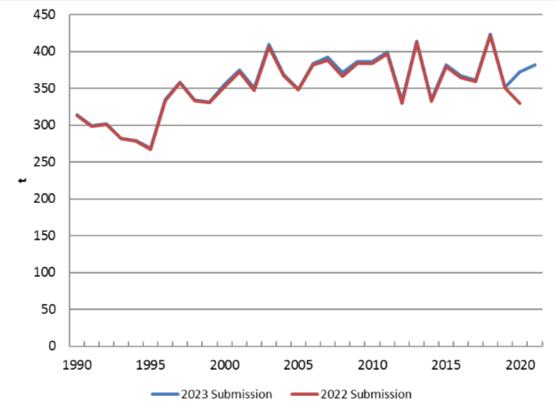
Table 8.2.18 Summary of recalculations for Zn

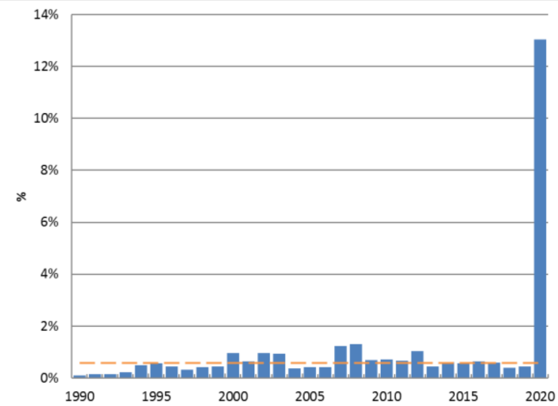
TOTAL NUMBER OF REVISED CATEGORIES
28 out of 40 estimated (70%) for reported year 2020

IMPACT OF REVISED ESTIMATES	
Reported year 2020	**Reported period 1990-2020 (average)**
42.9 t (13.0%)	3.4 t/year (1.0%)

TOP MOST RECALCULATED CATEGORIES FOR REPORTED YEAR 2020					
Order	**NFR**	**Category name**	**Difference**		**Explanation**
			T	**CL**	
1	5C1biv	Sewage sludge incineration	3.0	56%	Correction of abatement efficiency and updating data provided by the focal point (see section 6.5).
2	1A4bi	Residential: Stationary	-0.7	13%	Disaggregation of biomass consumption. Update of fuel-activity allocation for the whole series. Update of natural gas consumption since 2015.
3	1A1b	Petroleum refining	-0.3	6%	Data corrections and update for period 1998-2020.
4	1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	-0.3	6%	Fuel balance recalculation for consistency with energy statistics.

Evolution of the difference





TOP MOST RECALCULATED CATEGORIES FOR REPORTED PERIOD 1990-2020					
Order	**NFR**	**Category name**	**Difference**		**Explanation**
			t/year	**CL**	
1	5C1biv	Sewage sludge incineration	3.2	51%	See 1 in table above.
2	5C2	Open burning of waste	1.3	21%	Cultivated areas data and crop yields for BNPAE calculates are provided by MAPA's Statistics Yearbook with two-year lag. In these cases, the Inventory replicates the x-2 year values published in the Yearbook, into x-1 year, the last year inventoried. This edition has updated the values of 2020 according to the yearbook, and has replicated them into 2021.
3	1A4bi	Residential: Stationary	-0.9	14%	See 2 in table above.
4	1A1b	Petroleum refining	-0.3	4%	See 3 in table above.

8.2.19. PCDD/PCDF

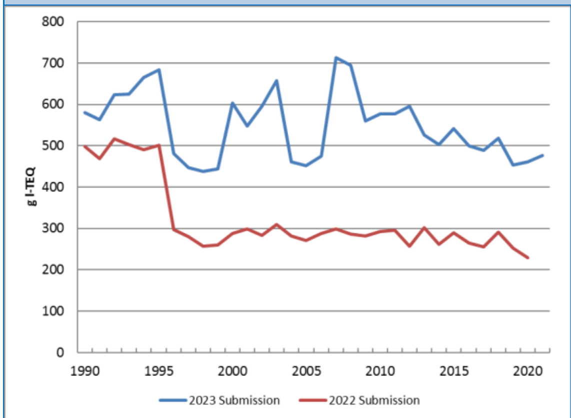
Table 8.2.19 Summary of recalculations for PCDD/PCDF

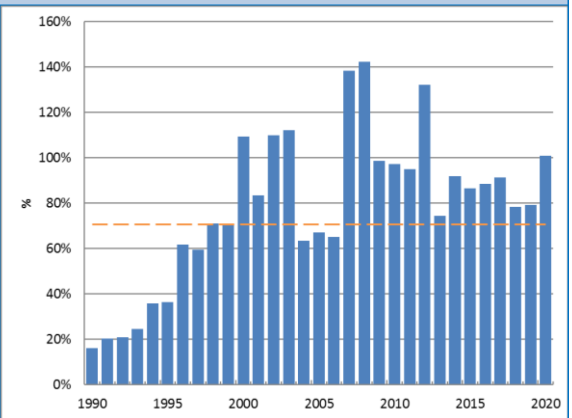
TOTAL NUMBER OF REVISED CATEGORIES
25 out of 34 estimated (74%) for reported year 2020

IMPACT OF REVISED ESTIMATES	
Reported year 2020	Reported period 1990-2020 (average)
231.7 g I-TEQ 100.9%)	229.0 g I-TEQ/year (71.3%)

TOP MOST RECALCULATED CATEGORIES FOR REPORTED YEAR 2020					
Order	NFR	Category name	Difference		Explanation
			g I-TEQ	CL	
1	5C1biv	Sewage sludge incineration	209.9	92%	Correction of abatement efficiency and updating data provided by the focal point (see section 6.5).
2	1A4bi	Residential: Stationary	-2.0	1%	Disaggregation of biomass consumption. Update of fuel-activity allocation for the whole series. Update of natural gas consumption since 2015.
3	1A3bi	Road transport: Passenger cars	0.0	0%	Update of LPG LCV. Update of CNG consumption and correction of CNG characteristics in 2020. Small adjusts in activity data (fleet data).
4	1A3bii	Road transport: Light duty vehicles	0.0	0%	Update of LPG LCV. Update of CNG consumption and correction of CNG characteristics in 2020. Small adjusts in activity data (fleet data).

Evolution of the difference





TOP MOST RECALCULATED CATEGORIES FOR REPORTED PERIOD 1990-2020					
Order	NFR	Category name	Difference		Explanation
			g I-TEQ /year	CL	
1	5C1biv	Sewage sludge incineration	225.0	98%	See 1 in table above.
2	1A4bi	Residential: Stationary	3.2	1%	See 2 in table above.
3	5C2	Open burning of waste	0.7	0%	Cultivated areas data and crop yields for BNPAE calculates are provided by MAPA's Statistics Yearbook with two-year lag. In these cases, the Inventory replicates the x-2 year values published in the Yearbook, into x-1 year, the last year inventoried. This edition has updated the values of 2020 according the yearbook, and has replicated them into 2021.
4	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	0.1	0%	Fuel balance recalculation for consistency with energy statistics.

8.2.20. PAH

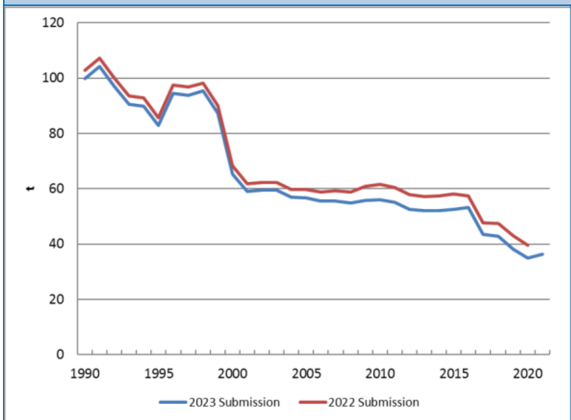
Table 8.2.20 Summary of recalculations for PAH

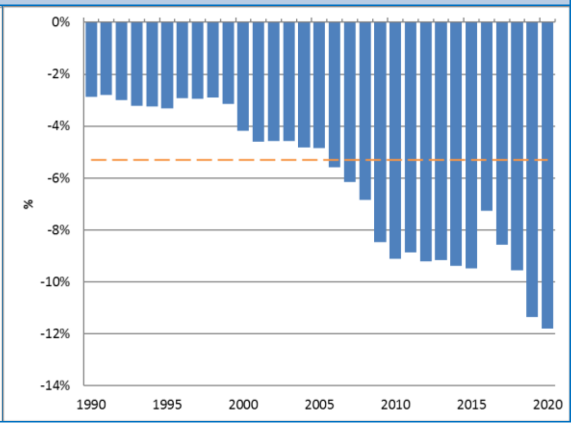
TOTAL NUMBER OF REVISED CATEGORIES
26 out of 37 estimated (70%) for reported year 2020

IMPACT OF REVISED ESTIMATES	
Reported year 2020	Reported period 1990-2020 (average)
-4.7 t (-11.8%)	-3.8 t/year (-5.4%)

TOP MOST RECALCULATED CATEGORIES FOR REPORTED YEAR 2020					
Order	NFR	Category name	Difference		Explanation
			T	CL	
1	1A4bi	Residential: Stationary	-5.3	117%	Disaggregation of biomass consumption. Update of fuel-activity allocation for the whole series. Update of natural gas consumption since 2015.
2	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	0.7	16%	Fuel balance recalculation for consistency with energy statistics.
3	1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	0.0	0%	Fuel balance recalculation for consistency with energy statistics.
4	1A4ai	Commercial/institutional: Stationary	0.0	0%	Update of fuel-activity allocation for the whole series. Update of natural gas consumption since 2015. Emission factors update and minor corrections.

Evolution of the difference





TOP MOST RECALCULATED CATEGORIES FOR REPORTED PERIOD 1990-2020					
Order	NFR	Category name	Difference		Explanation
			t/year	CL	
1	1A4bi	Residential: Stationary	-3.8	99%	See 1 in table above.
2	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	0.0	1%	See 2 in table above.
3	1A4ai	Commercial/institutional: Stationary	0.0	0%	See 4 in table above.
4	1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)	0.0	0%	Reallocation ot two misplace rubrics to category 1A2f.

8.2.21. HCB

Table 8.2.21 Summary of recalculations for HCB

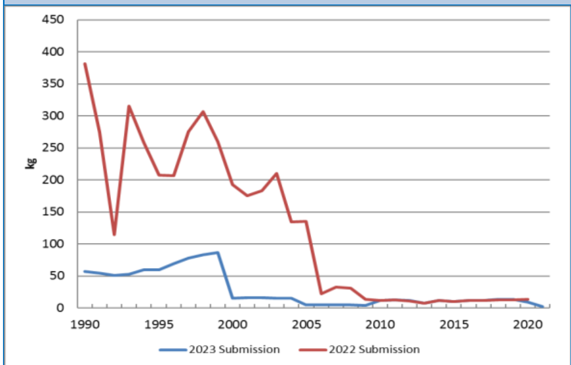
TOTAL NUMBER OF REVISED CATEGORIES
17 out of 20 estimated (85%) for reported year 2020

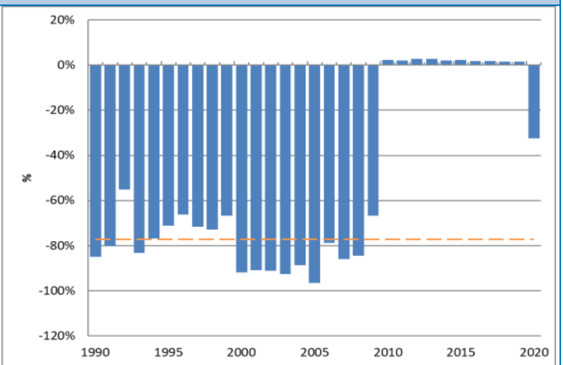
IMPACT OF REVISED ESTIMATES	
Reported year 2020	Reported period 1990-2020 (average)
-4.3 kg (-32.5%)	-96.0 kg/year (-77.2%)

TOP MOST RECALCULATED CATEGORIES FOR REPORTED YEAR 2020

Order	NFR	Category name	Difference		Explanation
			kg	CL	
1	5C1biv	Sewage sludge incineration	0.2	86%	Correction of abatement efficiency and updating data provided by the focal point (see section 6.5).
2	1A4bi	Residential: Stationary	0.0	3%	Disaggregation of biomass consumption. Update of fuel-activity allocation for the whole series. Update of natural gas consumption since 2015.
3	1A3dii	National navigation (shipping)	0.0	3%	EF have been updated according to the Dec 2021 version of EMEP/EEA Guidebook (2019).
4	1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	0.0	1%	Fuel balance recalculation for consistency with energy statistics.

Evolution of the difference





TOP MOST RECALCULATED CATEGORIES FOR REPORTED PERIOD 1990-2020

Order	NFR	Category name	Difference		Explanation
			kg/year	CL	
1	2B10a	Chemical industry: Other (please specify in the IIR)	-96.1	100%	Production of persistent organic compounds: emission removal for NMVOC and HCB, as neither were well allocated within this category nor substances considered appeared in the Stockholm Convention on Persisten Organic Pollutant's list and thus not proper POPs.
2	5C1biv	Sewage sludge incineration	0.2	0%	See 1 in table above.
3	3Df	Use of pesticides	-0.1	0%	Recalculation due to correction of variations in Activity Variable data for the year 2020.
4	1A4bi	Residential: Stationary	0.0	0%	See 2 in table above.

8.2.22. PCB

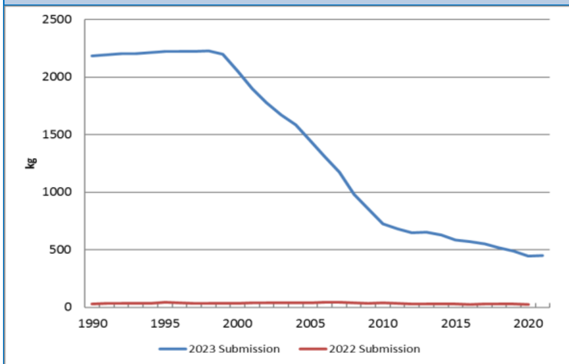
Table 8.2.22 Summary of recalculations for PCB

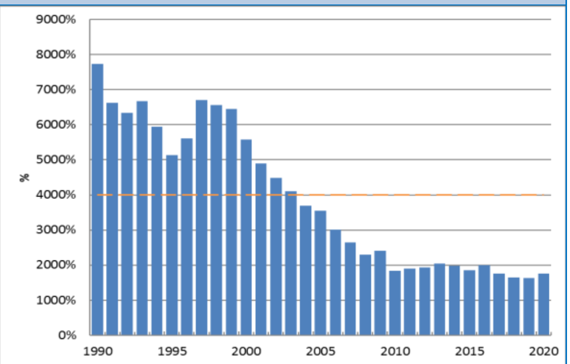
TOTAL NUMBER OF REVISED CATEGORIES
20 out of 26 estimated (77%) for reported year 2020

IMPACT OF REVISED ESTIMATES	
Reported year 2020	**Reported period 1990-2020 (average)**
419.5 kg (+1761.6%)	1363.4 kg/year (+3943.5%)

TOP MOST RECALCULATED CATEGORIES FOR REPORTED YEAR 2019					
Order	**NFR**	**Category name**	**Difference**		**Explanation**
			kg	**CL**	
1	2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)	416.6	85%	New estimates included after review recommendation.
2	5C1biv	Sewage sludge incineration	0.2	0%	Correction of abatement efficiency and updating data provided by the focal point (see section 6.5).
3	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	2.7	1%	Fuel balance recalculation for consistency with energy statistics.
4	1A3bi	Road transport: Passenger cars	0.0	0%	Update of LPG LCV. Update of CNG consumption and correction of CNG characteristics in 2020. Small adjusts in activity data (fleet data).

Evolution of the difference





TOP MOST RECALCULATED CATEGORIES FOR REPORTED PERIOD 1990-2020					
Order	**NFR**	**Category name**	**Difference**		**Explanation**
			kg/year	**CL**	
1	2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)	1363.1	100%	See 1 in table above.
2	5C1biv	Sewage sludge incineration	0.2	0%	See 2 in table above.
3	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	0.1	0%	See 3 in table above.
4	1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	0.0	0%	Fuel balance recalculation for consistency with energy statistics.

8.3. Summary of categories/pollutants recalculated in the reported period 1990-2020

A summary of the categories and pollutants that have been recalculated in the reported period 1990-2020 are presented below. R stands for “Recalculated”, N means “New estimation” and D is for “Deletion”. In order to reduce the length of this document, only categories with revised estimates are presented below.

TABLE 8.3.1 SUMMARY OF CATEGORIES AND POLLUTANTS WITH REVISED ESTIMATES IN THE REPORTED PERIOD 1990-2020

NFR Code	NOx	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/ PCDF	B(a)P	B(b)F	B(k)F	IP	Total 1-4 PAH	HCB	PCBs
1A1a	R	R	R	R	R	R	R	R	R	R	R	-	-	R	R	-	-	R	R	R	R	R	R	R	R	-
1A1b	R	R	R	-	R	R	R	R	R	R	R	R	R	R	R	R	R	R	-	R	R	R	R	R	-	-
1A1c	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	-
1A2a	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
1A2b	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	-
1A2c	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
1A2d	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
1A2e	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
1A2f	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
1A2gviii	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
1A3bi	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	-	R
1A3bii	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	-	R
1A3biii	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	-	R
1A3biv	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	-	R
1A3bv	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A3bvi	-	-	-	-	R	R	R	R	-	R	R	-	R	R	R	R	R	R	-	R	R	R	-	R	-	-
1A3bvii	-	-	-	-	R	R	R	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A3dii	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

NFR Code	NOx	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/ PCDF	B(a)P	B(b)F	B(k)F	IP	Total 1-4 PAH	HCB	PCBs
1A4ai	R	R	R	N	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
1A4bi	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
1A4ci	R	R	R	N	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	-	-
1A4cii	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1A4ciii	R	R	-	-	R	R	R	R	R	-	-	-	-	-	R	-	R	-	-	-	-	-	-	-	-	-
1A5b	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
1B2aiv	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1B2av	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1B2b	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2A5a	-	-	-	-	R	R	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2A5b	-	-	-	-	R	R	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2A5c	-	-	-	-	R	R	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2B10a	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	D	-
2C5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R
2C7c	-	-	N	-	-	-	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2D3a	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2D3b	-	R	-	-	R	R	R	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2D3e	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2D3g	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2D3i	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2K	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N
3B1a	R	R	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B1b	R	R	-	R	R	R	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B2	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B3	R	R	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

NFR Code	NOx	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/ PCDF	B(a)P	B(b)F	B(k)F	IP	Total 1-4 PAH	HCB	PCBs
3B4d	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B4e	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B4f	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B4gi	R	R	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B4gii	R	R	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B4giii	N	N	-	N	N	N	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B4giv	R	R	-	R	R	R	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B4h	N	N	-	N	N	N	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3Da1	R	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3Da2a	R	R	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3Da2b	R	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3Da2c	R	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3Da3	R	R	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3Dc	-	-	-	-	R	R	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3De	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3F	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5A	R	-	-	-	R	R	R	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5B2	R	-	-	R	R	R	R	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5C1biv	R	R	R	-	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
5C1bv	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5C2	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5D3	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5E	-	R	-	R	R	R	R	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-

8.4. Planned improvements

8.4.1. General/Cross-cutting

The following actions can be highlighted for the entire Inventory as planned improvements:

- Complete the implementation of the EMEP/EEA GB 2019.
- Harmonization of the Inventory with other registers (EU ETS, E-PRTR, etc.).

The review of the methodology for the elaboration of the fuel balance will continue, in collaboration with the relevant departments of the Secretary of State for Energy at MITECO. The collaboration with the IDAE-MITECO continues in the sense of providing specific information for the balance.

Minor improvements are progressively addressed in order to achieve full implementation of EMEP/EEA GB 2019.

1A1a Public electricity and heat production

NH_3 data (measured or estimated) provided by large power plants are being collected and will be reviewed.

1A1c Manufacture of solid fuels and other energy industries

It will be carried out the segregation of RMS (Regulating and Metering Stations) belonging to the natural gas pipeline distribution network (low pressure pipelines), out from the Inventory fuel balance.

The process of collaboration with the General Subdirectorate of Energy Planning and Monitoring of MITECO will continue, in order to improve the information provided by this source and its correct adaptation to the Inventory.

1A2 Manufacturing industries and construction (combustion)

Review and standardise the emission factors.

1A3a Air traffic at airports

Continue alignment with the methodology established by EUROCONTROL, applying all the new adjustments and improvements proposed.

1A3b Road transport

Work will continue in road transport methodology with the aim to be aligned with the improvements proposed in further editions of EMEP/EEA Guidebook, paying special attention to the emission estimation of alternative modes of propulsion and new Euro Standards.

Carry on with the process of continuous improvement of activity variable data (vehicle fleet, mileage and driving patterns distribution) when more accurate information would be available.

1A3c Railways

Continue with the collaboration with the focal point on railways, National Network of Spanish Railways (RENFE), with the aim of improving background information on fuel consumption broken down by type of machinery.

1A4ai Commercial/Institutional: Stationary

Continue the search of reliable data for carrying out separate estimates for pellet stoves and boilers burning wood pellets for source category Stationary combustion in Commercial/Institutional sector.

Continue alignment with activity data source of information in order to update the whole fuel consumption series for stationary combustion sectors.

1A4bi Residential: Stationary

Following the recommendation made in the Spanish Stage 3 Review Report (2014)[3], planned improvements for this sector are focused on making separate estimates for Household and gardening mobile machinery subcategory (1A4bii) currently included in the stationary.

8.4.2. Industrial processes and other product use (NFR 2)

The main improvements planned for this sector are:

2B10a Other chemical industry

Within this category, an update in the activity data for ammonium sulphate by the National Statistics Institution (INE) for 2020, results in a minor recalculation. Production of persistent organic compounds have been removed because neither were they well allocated within this category nor these substances appeared in the Stockholm Convention on Persistent Organic Pollutant's list, and thus not proper POPs.

2K Consumption of POPs and heavy metals

TERT recommended to include any missing emission from 2K. After consulting the SGEC, they sent an inventory of electric equipment which are produced, polluted or could containing PCB. After applying a T2 methodology to this AD, new estimates of this pollutant have been added to the Inventory.

2A5b Construction and demolition

Following the recommendation ES-2A5b-2022-001 made by the TERT in the 2022 NECD review (pursuant to Directive (EU) 2016/2284) the area of constructed roads has been included under category 2A5b.

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[3] Final Review Report available in: https://www.ceip.at/fileadmin/inhalte/ceip/00_pdf_other/2014_s3/spain_stage3_rr_2014.pdf

8.4.3. Agriculture (NFR 3)

Areas of improvement intended to be accomplished, include:

Incorporate into inventory the information supplied by new reviews of zootechnical documents are being completed.

Continue with the research, together with the team of experts in charge of preparing and reviewing the zootechnical documents, on the methodology for estimating the zootechnical coefficients in relation to changes marked in these coefficients for different reasons in some years of the time series, such as changes in diet or legislation of use of antibiotics or due to other reasons.

Incorporate into inventory the information supplied by technical sources about country-specific Manure Management Systems (MMSs), zootechnical coefficients and Best Available Techniques (BATs), if available, from ECOGAN, new legislation, surveys or others.

Continuation with the elaboration of methodological factsheets[4] in which the methodology for calculating emissions is expanded and examples are presented.

8.4.4. Waste (NFR 5)

The collaboration with the focal point (Sub-directorate General of Circular Economy at the MITECO) regarding the National Sludge Registry and (General Directorate of Water) regarding the National Census for Sewage Disposal will continue.

On the other hand, it is planned to continue with the work initiated on the inclusion of the incineration of animal carcasses.

[4] Methodological factsheets.

9. PROJECTIONS

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9. PROJECTIONS

Chapter updated in March, 2021.

Report of national emission projections is due by 15th March 2021.

This chapter is coherent with data contained in the official report format. It constitutes a summarized translation of the National Emission Projections Report 2021 edition (in Spanish) to be also uploaded to the Spanish Emissions Inventories and Projections System website. For more detailed information or verification of data, please refer always to the original source, available at: https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/sistema-espanol-de-inventario-sei-/Proyecciones.aspx.

9.1. Introduction

Air Pollutant Emissions Projections in Spain are estimated by the Spanish Emissions Inventories and Projections System. Projections are calculated jointly and coherently for the main air pollutants (NOx, NMVOC, SO_2, NH_3, and $PM_{2.5}$) and greenhouse gases (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6 and CO_2-eq).

The projections are calculated at national level (whole national territory, including the Canary Islands). However, for coherence with the National Air Pollutant Inventories under Directive (EU) 2016/2284 and under CLRTAP[1], projected emissions from the Canary Islands are not included in the official reporting tables or its associated Report, nor in this Chapter.

This edition of the Projections (2021) is built upon inventory data from 1990 to 2019 (that is, using the latest reported Inventory, year 2021).

These Air Pollutant Emissions Projections respond to the obligations set by Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants, and the reporting obligations within the 1999 Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone to the LRTAP Convention.

These emission projections are coherent with the Spanish National Air Pollution Control Programme (NAPCP) required by Directive (EU) 2016/2284, with the Spanish National Integrated Energy and Climate Plan (NIECP) required by Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action, and with the Spanish Decarbonization Long Term Strategy (LTS). More information about the general methods (models), data sources and assumptions used for estimating projected emissions and activity data can be found at:

https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/atmosfera-y-calidad-del-aire/primerpnccca_2019_tcm30-502010.pdf

https://www.miteco.gob.es/es/prensa/pniec.aspx

https://www.miteco.gob.es/es/prensa/ultimas-noticias/el-gobierno-aprueba-la-estrategia-de-descarbonizaci%C3%B3n-a-largo-plazo-que-marca-la-senda-para-alcanzar-la-neutralidad-clim%C3%A1tica-a-2050/tcm:30-516141

[1] The Spanish National Emission Inventory under Directive (EU) 2016/2284 and under CLRTAP cover the whole national mainland territory in the Iberian Peninsula, the archipelago of Balearic Islands and the cities of Ceuta and Melilla. The Canary Islands are neither covered under Directive (EU) 2016/2284, according to its Article 2.2, nor by CLRTAP grid (http://www.ceip.at/ms/ceip_home1/ceip_home/new_emep-grid/).

9.2. Institutional arrangements

9.2.1. Legal framework

The National System for the elaboration of Emissions Inventories and Projections is set and ruled by the following legal framework:

- Law 34/2007, of November 15, on air quality and protection of the atmosphere foresees in its article 27.4 the Spanish Emissions Inventory System (SEI).
- Royal Decree 818/2018 on measures for the reduction of national emissions of certain atmospheric pollutants sets in article 10 the rules of functioning of the Spanish Atmospheric Emissions and Projections Inventory System.
- Royal Decree 500/2020, which develops the basic organic structure of the Ministry for the Ecological Transition and Demographic Challenge, designates, in its article 7.1.f), the General Directorate for Environmental Quality and Assessment as competent authority of the Spanish Emissions and Projections Inventory System.

Within the General Directorate for Environmental Quality and Assessment of the Ministry for Ecological Transition and Demographic Challenge, the Emissions Inventory Unit manages the functioning of the SEI. Additionally, the General Directorate for Environmental Quality and Assessment as National Authority of the SEI awarded in 2017 the society TRAGSATEC a contract for the technical assistance in the management, maintenance and updating of the SEI.

9.2.2. Cross-cutting issues

Air Pollutant Emissions Projections have been based on the reference scenario used in the elaboration of the aforementioned Spanish National Integrated Energy and Climate Plan (NIECP) and the National Air Pollution Control Programme (NAPCP), in order to maintain coherence with other international reporting obligations.

In this framework, relevant and concerned departments within the national administration were involved in a deep, intense and coordinated collaborative process. Experts from all concerned sectors, internal and external, were consulted to build the projected scenarios and define policy options. The TIMES-Sinergia programme was used for simulating the wohe of the energy related scenarios, including fuel consumed by industry and transport.

The 2021 edition of the National Emission Projections for Air Pollutants were formally approved by the Government Delegate Commission for Economic Affairs in its meeting of 26th February 2021, in compliance with article 10.6 of Royal Decree 818/2018.

9.3. General description of methodologies and models for estimating projected emissions

Air Pollutant Emissions Projections have been elaborated in a four step process:

- Step 0: setting the general framework for modelling.
- Step 1: modelling sectors, policies and measures.
- Step 2: estimation of emissions.

– Step 3: assessment of objectives, policies and measures.

Steps 1 to 3 were iteratively run all along the preparation of the NIECP and the NAPCP.

9.3.1. Step 0: setting the general framework for modelling

In order to design future scenarios, in a first step, general macroeconomic assumptions such as GDP, GDP *per capita*, population projections, number of households, elasticity or relationship of energy service demands with main macroeconomic variables have been taken, according to data used to prepare the Spanish NIECP. Additionally, other relevant variables for projections modelling have been established such as carbon prices under the European Emission Trading System pursuant to Directive 2003/87/EC, as well as the price of the main energy commodities (coal, gas and oil import prices). These are those recommended by the European Commission for the development of the National Energy and Climate Plans (NECPs).

9.3.2. Step 1: modelling sectors, policies and measures

Once the general macroeconomic framework has been set up, activity data for all activity sectors (energy, industry, agriculture, transport, waste and use of products) are modelled for a time horizon until 2040. This has been initially done for a business as usual scenario (with existing measures, WeM). At a later stage, policies and measures have been iteratively included in the with additional measures (WaM) scenario.

Energy, Industry and Transport Sectors

The modelling of the energy system, together with the main industry sectors related to energy consumption and all the transport, has been carried out with the TIMES-Sinergia model. Additionally, higher order models (ROM and REE models) have been used to determine the effects of a high penetration of renewable energies in the electrical system, in order to make the results compatible with an adequate security of supply.

The TIMES tool (The Integrated MARKAL-EFOM System) was developed by the International Energy Agency, within the framework of the ETSAP program (Energy Technology Systems Analysis Program) for the development of energy and environmental analysis. From the General Directorate of Energy Policy and Mines (DGPEM), under the Secretariat of Energy of the Spanish Ministry for the Ecological Transition and Demographic Challenge, the necessary work has been done to use TIMES as a prospective and energy analysis tool in the preparation of the Spanish NIECP. The new adapted model has received the name of TIMES-Sinergia (Sistema Integrado para el Estudio de la Energía).

TIMES is a bottom-up mathematical model combining two complementary approaches, one technical and the other economic. It is based on the linear optimization of the energy system, looking for a solution under the principle of minimum cost. It has a detailed characterization of energy technologies and demands for energy services. For the different scenarios proposed in the model, TIMES covers the demand for energy services through the combination of operational and investment decisions, minimizing the cost of the energy system throughout the analysed horizon.

Agriculture sector

Two fundamental sets of data input have been taken into account in the projections: cattle and consumption of inorganic fertilizers in agricultural soils.

The evolution forecasts of the livestock numbers by animal type (dairy and non-dairy cattle, sheep, pigs -white and Iberian-, poultry, goats and horses) for the projected period have been provided by the Ministry of Agriculture, Fisheries and Food, based on historical data and market forecasts of livestock production.

For each animal type, in addition to the census data, parameters related to enteric fermentation and manure management have been taken into account in a consistent manner with the National Emissions Inventory. These data are based on the zootechnical documents with specific data for Spain for each animal type, and current data and forecasts on manure management systems. Calculations are carried out in a coordinated manner, consistent with the estimation of emissions derived from the application of manure to the field as organic fertilizer (NFR 3Da2a) or those derived from grazing activities (NFR 3Da3).

For the estimation of the projected emissions derived from crop management (NFR 3C and 3D), both the total cultivation areas (including rice) and the total amount and type of inorganic fertilizers applied to the field as fertilizers have been taken into account. Within these practices, the current level of implementation of good practices and their foreseeable future evolution have also been taken into account. The cultivable area used is consistent with the data inventoried in the last edition of the National Emissions Inventory, as well as the data on the use and application of inorganic fertilizers, consistent with the National Balances for Nitrogen and Phosphorus in the Spanish Agriculture (BNPAE).

Waste sector

For the projection of the emissions derived from waste management and treatment, the historically inventoried data has been used as starting data (since 1950 for landfill discharges and since 1990 for the rest of activities). These data are consistent with the national official series (MITECO Circular Economy General Subdirectorate and the National Statistics Office (INE)) and those published in EUROSTAT.

The forecasts of evolution of the total generation of waste (NFR 5A, 5B and 5C), as well as the distribution of management and treatment systems at the national level for the BAU scenario have been provided by the competent unit (MITECO Circular Economy General Subdirectorate). For the scenario with additional measures, complementary policies and measures have been considered.

Regarding emissions from wastewater treatment (NFR 5D), the projection has been linked to the national population forecast considering that the activity has reached maturity in terms of its development (maximum percentages of population and volume of water treated, protein consumption, equilibrium in treatment systems and maximum efficiency in the uptake of biogas generated and its use).

Product Use sector

Besides the manufacturing industry which is projected within the energy system, this sector includes, basically, the activities linked to the use of solvents and lubricants (NFR 2D).

The projection of the variables of activities linked to the use of solvents and lubricants has been linked by elasticity to the GDP and population forecasts, determined in the general macroeconomic context of the National Plan.

9.3.3. Step 2: estimation of emissions

Emissions from the energy sectors, both derived from combustion (NFR 1A, including the whole Transport sector, NFR 1A3) and fugitive emissions (NFR 1B), as well as emissions derived from industrial processes (NFR 2A, 2B and 2C) have been built upon the activity variables projected as a result of the scenarios generated by the TIMES-Sinergia model.

In a complementary manner, emissions from the rest of the non-energy sectors (agriculture, waste and use of products) have been projected, case by case, according to national forecasts of the main activity variables representative of each sector.

From activity variables, emissions for each pollutant have been estimated, applying calculation methodologies consistent with those implemented in the National Emissions Inventory (EMEP/EEA Air Pollutant Emission Inventory Guidebook 2019, and IPCC 2006 Guidelines). The most recent 2021 edition of the National Emissions Inventory, corresponding to the 1990-2019 series, has been used as a reference for the calculation of projected emissions, in terms of characteristics and average parameters, emission trends and emission factors (direct and implicit). The projected time period has been 2020-2040, with five-year milestones.

Estimates of projected emissions have been made jointly and consistently for greenhouse gases (CO_2, CH_4, N_2O and fluorinated gases), as well as for air pollutant emissions (NH_3, NMVOC, $PM_{2.5}$, SO_2, NOx).

Quality control (QC) checks for consistency of the projected and inventoried emission data and for completeness are frequently carried out within the emissions projections elaboration process.

9.3.4. Step 3: assessment of objectives, policies and measures

The macroeconomic assumptions and the policies and measures considered in the different projected scenarios have been outlined and defined in a progressive manner according to different approaches and assumptions. The resulting calculations of the emissions, both for greenhouse gases and air pollutants, were evaluated against the objectives set for Spain for the year 2030. In this way, the sectoral forecast models and the calculation system of the projections have been executed in an iterative manner until a set of additional policies and measures has been defined and considered adequate for compliance with the mitigation objectives and feasible for incorporation into the Spain's NAPCP and NIECP.

9.4. Policies and measures

The existing and additional Policies and Measures (PAMs) that have been taken into account in the construction of the projection scenarios are those contemplated in the NIECP and the NAPCP. In total it is a set of 17 packages or groups of measures (each one composed of one or several measures with synergic effects in affected sectors). Below is a summary of the considered measures.

Table 9.4.1 Policies and measures (PAMs) considered in the projected scenarios

	Description	Sector	Scenario	Source
1	Package of measures for electricity mix proposed in the Integrated National Energy and Climate Plan.	1A1a	WeM/ WaM	NECP
2	Package of measures in the industry energy sector (measures on energy efficiency in the manufacturing industry sector (NECP), application of BREF documents (among others: non-ferrous metals industry, paper, steel, aluminum), Industrial Emissions Directive, Medium Combustion Plant (MCP) Directive.	1A2	WeM/ WaM	NECP/ NAPCP
3	EU Emission Trading System (ETS).	Several	WeM	NECP
4	Mitigation measures in the refining sector (energy efficiency, BAT application in BREF documents and reviews of the Integrated Environmental Authorizations accordingly).	1A1b	WeM/ WaM	NECP/ NAPCP
5	Package of measures for the aviation sector proposed by the NECP.	1A3a	WeM/ WaM	NECP
6	Package of measures for the road transport sector proposed by the NECP and application of regulations relating to EURO technologies for vehicles and proposal for a regulation establishing emission standards for new passenger cars and new light commercial vehicles.	1A3b	WeM/ WaM	NECP/ NAPCP
7	Package of measures for the rail transport sector raised by the NECP and application of the Off-road Directive 2004/26.	1A3c	WeM/ WaM	NECP/ NAPCP
8	Package of measures for the domestic navigation sector proposed by the NECP, application of off-road Directive 2004/26 and marine fuel regulations (RD 1027/2006 and Directive 2016/802).	1A3d	WeM/ WaM	NECP/ NAPCP
9	Package of measures related to the residential sector (energy efficiency and energy mix changes foreseen in the NECP, technological improvements, boiler Ecodesign directive and relative regulations, to the ecological design requirements applicable to boilers and local heating devices).	1A4b	WeM/ WaM	NECP/ NAPCP
10	Package of measures related to the commercial and institutional sector (energy efficiency and energy mix changes foreseen in the NECP, technological improvements, relative regulations to the requirements of ecological design applicable to boilers and local heating devices and Medium Combustion Plant (MCP) Directive).	1A4a	WeM/ WaM	NECP/ NAPCP
11	Regulation EU / 517/2014 on fluorinated gases.	2F-2G	WeM	NECP
12	Package of improvements in practices of fertilization of crops and improvements in manure soil application (dairy cattle and swine) - BATs-BREF.	3D	WaM	NECP/ NAPCP
13	Package of improvements in manure management systems (dairy cattle, swine and poultry), application of BATs of BREF documents.	3B	WaM	NECP/ NAPCP
14	Package of measures in the consumption of fuels in off-road machinery (NECP measures, application of off-road Directive 2004/26 and marine fuel regulations (RD 1027/2006 and Directive 2016/802)).	1A4c	WeM/ WaM	NECP/ NAPCP
15	NMVOC reduction measures associated with the use of products (BREF for painting).	2D3d	WaM	NAPCP
16	Package of measures for the waste management sector (compliance with the objectives of Directives 2018/850 and 2018/851 on waste, promotion of separate collection, biomethanization and composting).	5	WeM/ WaM	NECP
17	Reduction of field burning of pruning remains.	5C2	WeM/ WaM	NECP/ NAPCP

NECP: Spanish Integrated National Energy and Climate Plan, whose measures up to 2030 are fully integrated into the Spanish Decarbonization Long Term Strategy.

NAPCP: Spanish National Air Pollution Control Programme

9.5. Projections results

Two scenarios have been considered in the emissions projections, one in which the impact of the existing policies and regulation is foreseen (scenario with existing measures, WeM) and a second scenario including the foreseeable impact on the emissions of the measures and policies adopted in the Integrated National Energy and Climate Plan and in the National Air Pollution Control Program (scenario with additional measures, WaM).

Scenario-with existing measures (WeM)

In this scenario, a similar reduction trend is expected for sulphur oxides (SO_2) and particulate matter ($PM_{2.5}$) (-27% and -23% respectively in 2030 and -31% and -27% in 2040 compared to 2019 levels). While the rest of pollutants (NOx, NMVOC and NH_3) register slighter decreases, all of them are decoupled from the foreseen economy and population growth. The general downward trends of emissions is due to the foreseeable evolution of the national electricity mix (with increasing penetration of renewable energies), the modernization of the road transport fleet with the complete introduction of EURO technologies, and the continuation of the effect of energy efficiency and emissions reduction measures, in practically all economic sectors.

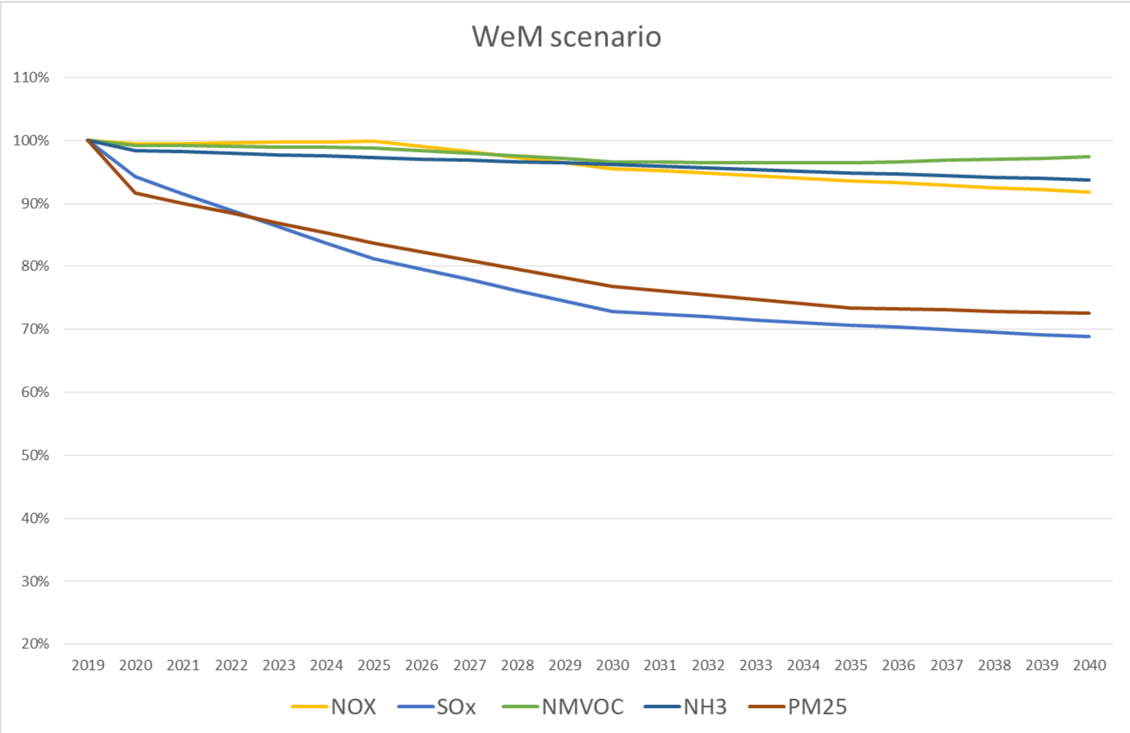

Figure 9.5.1 Emission projections evolution for WeM scenario 2019-2040 (2019=100%)

In this WeM scenario, emissions of sulphur oxides (SO_2) would present the highest levels of reduction, due to the double effect of the existing measures to reduce sulphur content of petroleum-derived fuels and the shift in the use of coal for energy purposes towards other non-SO_2-emitting fuels. Ammonia emissions (NH_3) show a slightly downward trend linked to the variations expected in livestock and the entry into force of mitigation measures in the agricultural sector.

Scenario-with additional measures (WaM)

The projections of emissions in the WaM scenario contemplated in the framework of the Integrated National Energy and Climate Plan (NIECP) and the National Program for the Control of Atmospheric Pollution (NAPCP) show a steeper downward trend in all of the pollutants due to the effect of the additional policies and measures adopted in the NIECP and the NAPCP.

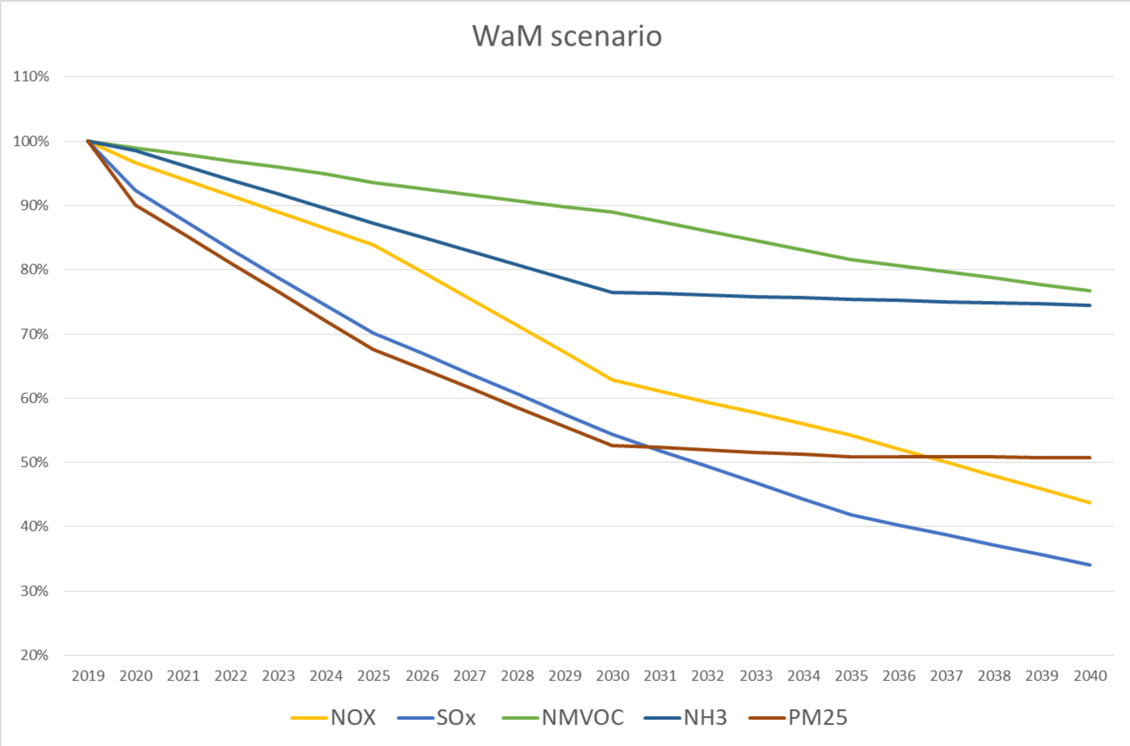

Figure 9.5.2 Emission projections evolution for WeM scenario 2019-2040 (2019=100%)

The emissions of sulphur oxides would be those that would present higher levels of reduction (-46% in 2030 and -66% in 2040 with respect to 2019) due to the combined effect of the end of the use of coal for energy purposes, the additional reduction in the consumption of petroleum-derived liquid fuels, and the measures to reduce the sulphur content in these fuels. The emissions of nitrogen oxides (NOx) would follow a similar decreasing trend during the projected period.

The ammonia emissions (NH_3) in the scenario with additional measures would reach reductions in 2030, due to the application of additional measures to reduce these emissions both in the management of manures and in soil fertility practices foreseen in the National Program for the Control of Atmospheric Pollution. For ammonia emissions, as well as for the fine particulate matter ($PM_{2.5}$) ones, additional measures woul be necessary after 2030 to continue the reduction trend.

Finally, as in the WeM scenario, the emissions of non-methane volatile organic compounds (NMVOC) would be the ones showing a smaller reduction trend, possibly because these are mainly linked to product consumption patterns (with a foreseeable growing trend) and for which there is little room for additional mitigation policies and measures, without compromising the internal market rules in case of national solvent restrictions in products for domestic use.

9.5.1. Projections by pollutant

In the following sections, data results and summarized analysis of the projections for each pollutant are provided.

9.5.1.1. NOx

In the WeM scenario, projected emissions remain practically steady with a slight downward trend (annual reduction rates of -0.4% from 2020 onwards). However, in the WaM scenario the projection of NOx emissions for time horizons 2030 and 2040 shows descending trends but with slightly different slopes. In the period between 2020 and 2030, the effect of the additional measures proposed in the WaM scenario produces an annual emission reduction rate of -3.5%, while in the period between 2030 and 2040 the reduction in emissions is -3.0% per year, on average. The main decreases in emissions in the WaM scenario occur in the transport sector, followed by industry and electricity generation, as can be seen in the following graph.

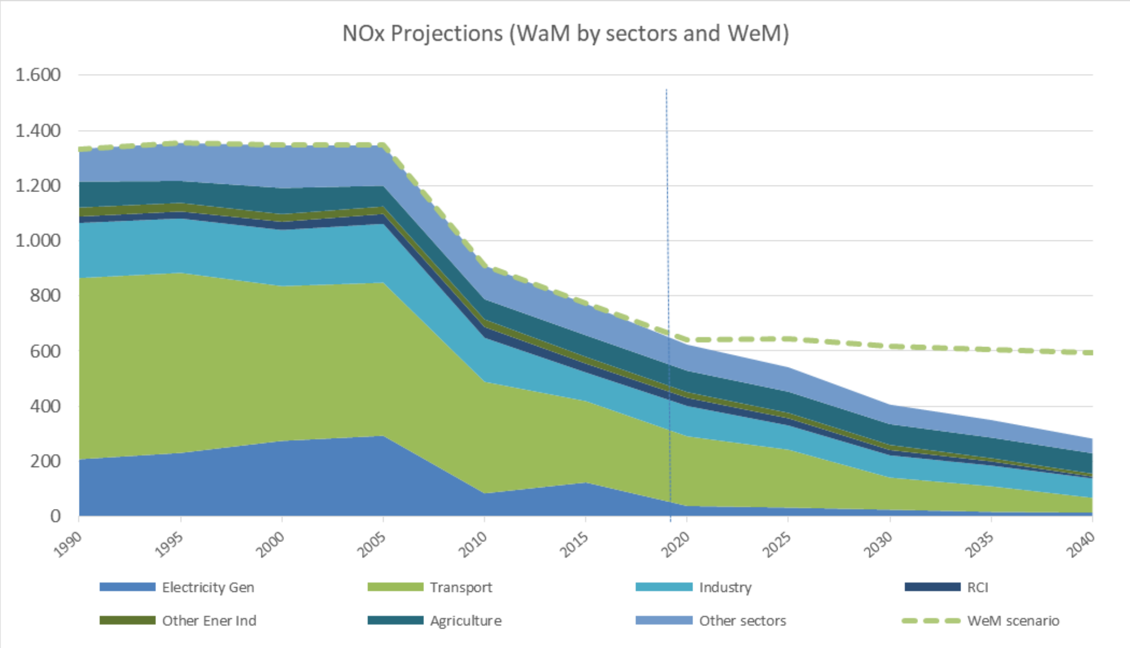

Figure 9.5.3 NOx emission and projections by sector (WaM by sector and WeM)

Policies and measures in the WaM scenario

The main measures that have been taken into account in the projection include:

i. the renewal of the vehicle fleet and the progressive incorporation of new models with EURO 6 technology, with lower NOx emission ratios (package of measures nº 6 of the list of PAMs, which would contribute with up to a 76% of the total reductions projected for the year 2030 in the WaM scenario);

ii. the changes in the electric mix by, among other measures, the end of the use of coal and reduction in petroleum products in thermal power plants (package of measures nº 1 with a contribution of 7% to the total reductions of the WaM scenario in 2030); and

iii. the gradual introduction of energy efficiency measures and abatement of NOx emissions in large and medium-sized combustion plants and industrial installations (package of measures 2, with a contribution of 5% to the total reductions of the WaM scenario in 2030).

Table 9.5.1 NOx projected emissions as reported according to Annex IV tabular format

			Projected emissions (kt)					
			NOx					
			WeM scenario			WaM scenario		
NFR codes	Activity sectors	2019	2020	2030	2040	2020	2030	2040
1A1	**Energy industries**	55.58	55.50	54.36	46.01	53.86	38.93	22.08
1A2	**Manufacturing Industries and Construction**	110.81	107.95	86.58	83.08	106.39	76.85	66.12
1A3b	**Road Transport**	**211.22**	**218.84**	**242.09**	**226.85**	**207.06**	**82.70**	**29.11**
1A3bi	R.T., Passenger cars	126.54	133.86	153.25	140.58	124.00	16.09	4.02
1A3bii	R.T., Light duty vehicles	22.29	22.71	24.83	25.13	21.90	16.65	2.59
1A3biii	R.T., Heavy duty vehicles	60.45	60.17	61.04	58.37	59.09	47.67	21.28
1A3biv	R.T., Mopeds & Motorcycles	1.93	2.10	2.97	2.78	2.07	2.28	1.23
1A3bv	R.T., Gasoline evaporation	NA	NA	NA	NA	NA	NA	NA
1A3bvi	R.T., Automobile tyre and brake wear	NA	NA	NA	NA	NA	NA	NA
1A3bvii	R.T., Automobile road abrasion	NA	NA	NA	NA	NA	NA	NA
1A3a,c,d,e	**Off-road transport**	53.82	46.82	34.27	37.67	45.50	33.57	24.47
1A4	**Stationary combustion: Residential, Commercial/Institutional, other**	108.60	110.82	98.73	98.57	108.92	81.65	51.23
1A5	**Other**	2.38	2.42	2.69	2.90	2.42	2.69	2.90
1B	**Fugitive emissions**	4.98	5.06	5.03	4.85	5.01	4.79	2.98
2A,B,C,H,I,J,K,L	**Industrial Processes**	3.57	3.67	3.88	4.16	3.67	3.88	4.13
2D, 2G	**Solvent and other product use**	0.12	0.13	0.15	0.16	0.13	0.15	0.08
3B	**Animal husbandry and manure management**	**5.52**	**5.47**	**5.29**	**5.11**	**5.47**	**5.29**	**5.11**
3B1a	Cattle Dairy	0.79	0.78	0.75	0.70	0.78	0.75	0.70
3B1b	Cattle Non-Dairy	1.36	1.35	1.29	1.23	1.35	1.29	1.23
3B2	Sheep	0.43	0.43	0.37	0.35	0.43	0.37	0.35
3B3	Swine	0.31	0.31	0.32	0.31	0.31	0.32	0.31
3B4a	Buffalo	NO	NO	NO	NO	NO	NO	NO
3B4d	Goats	0.26	0.23	0.24	0.23	0.23	0.24	0.23
3B4e	Horses	0.21	0.22	0.25	0.25	0.22	0.25	0.25
3B4f	Mules and asses	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3B4g	Poultry	2.15	2.14	2.07	2.03	2.14	2.07	2.03
3B4h	Other	NA	NA	NA	NA	NA	NA	NA
3D	**Plant production and agricultural soils**	71.90	71.44	70.15	69.33	71.40	69.25	68.25
3F,I	**Field burning and other agriculture**	0.76	0.76	0.76	0.76	0.76	0.76	0.76
5	**Waste**	16.59	13.21	13.19	13.19	13.21	5.63	5.63
6A	**Other**	NA	NA	NA	NA	NA	NA	NA
NATIONAL TOTAL	**National total (excluding Canary Islands)**	**645.86**	**642.09**	**617.16**	**592.64**	**623.78**	**406.13**	**282.84**

Reduction commitments compliance

Regarding the compliance with the reduction commitments set in the Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants, as shown in the following graph, in the WeM projected scenario the reduction commitments will not be fulfilled in some of the projected time series.

But, according to the scenario with additional measures (WaM), the projected NOx emissions for compliance in Spain would accomplish the required reduction commitments set for both the period 2020-2029 (-41%), and for 2030 onwards (-62% with respect to 2005 emissions). Emissions from activities falling under NFR categories 3B (manure management) and 3D (agricultural soils) are not accounted for the purpose of complying¸ according to the article 4.3.d) of Directive EU/2284/2016 (The step in the 2020 emissions is due to the non inclusion of 3B and 3D activities).

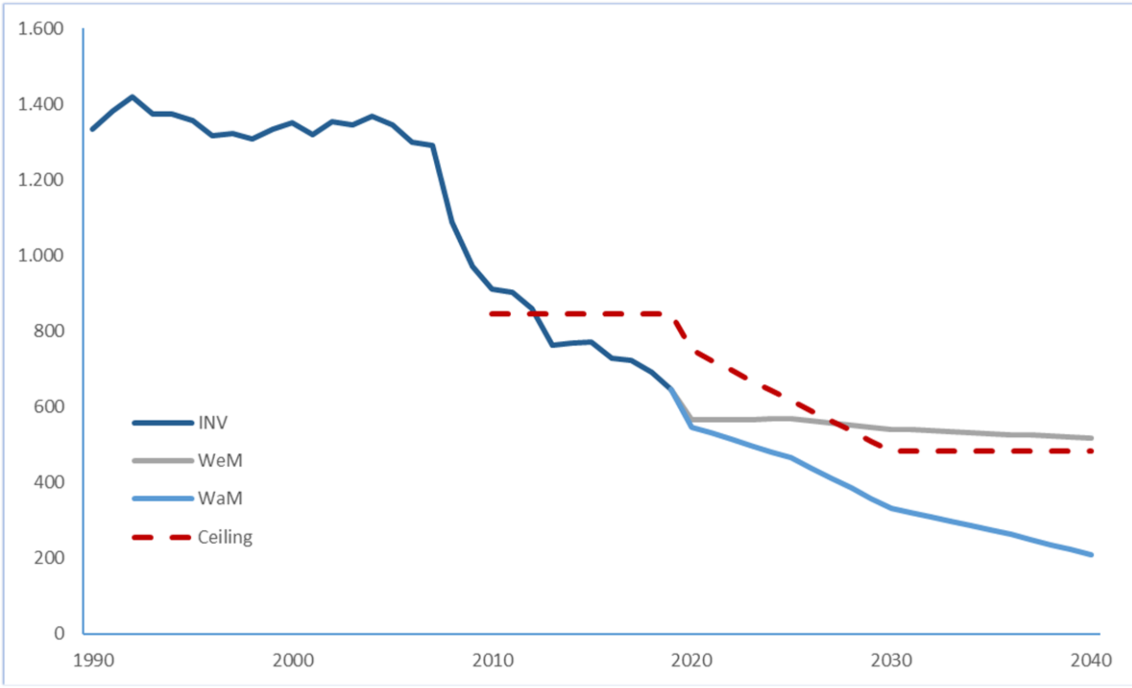

Figure 9.5.4 Expected compliance for NOx projections

9.5.1.2. SO_2

The projection of SO_2 emissions in the WeM scenario is already significantly reduced reaching -91% in 2030 with respect to 2005 emissions. This is mainly due to the already registered decrease of coal use in the energy sectors (electricity generation, industrial and residential and commercial combustion), that will continue in the coming years.

In the scenario with additional measures (WaM) the foreseeable effect of the mitigation measures contemplated in the National Integrated Energy and Climate Plan goes a little further in the expected reduction, reaching reductions of -93% in 2030 compared to the 2005 level. The higher reductions are registered in the same sectors as in the WeM scenario: electricity generation, industry and other energy industries.

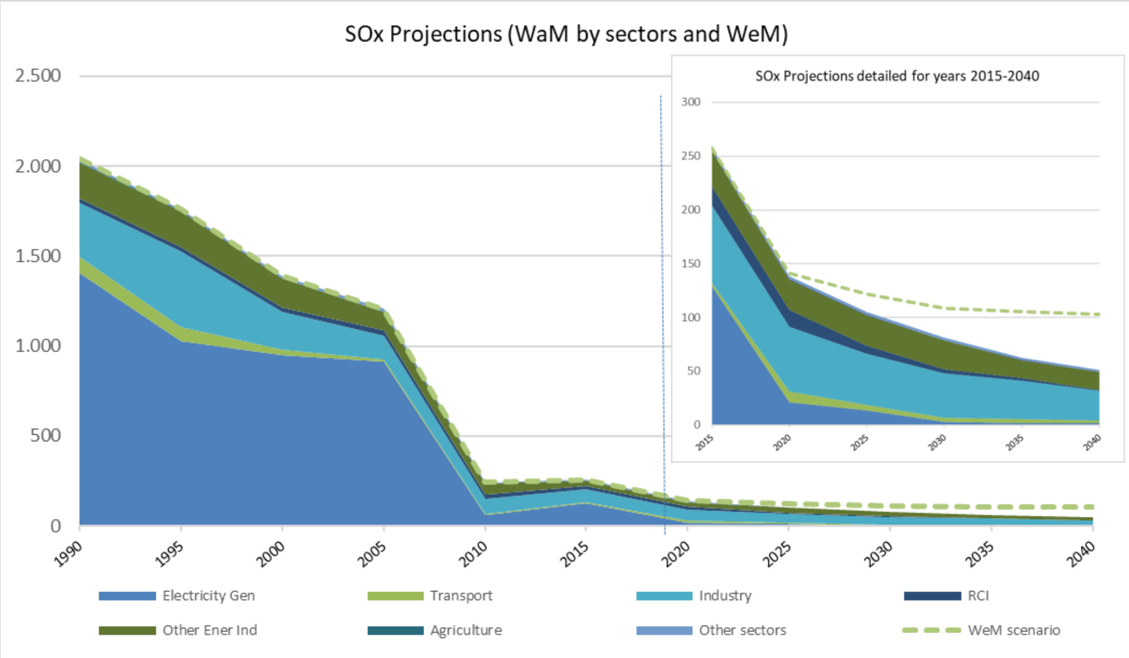

Figure 9.5.5 SO_2 emission and projections by sector (WaM by sector and WeM), and detail for years 2015-2040

Policies and measures in the WaM scenario

The main measures that have been taken into account in the projection include:

i. changes in the electric mix due to the foreseeable substitution of coal and petroleum products consumption in thermal power plants (package of measures number 1 of the list of PAMs, which would contribute as a whole in 55% of the total SO_2 reductions projected for the year 2030 on the WaM stage);

ii. gradual introduction of measures to reduce SO_2 emissions in large and medium-sized combustion plants and industrial facilities, as foreseen in Directive 2010/75/EU, on industrial emissions, Directive 2017/1042 on Medium-sized Combustion Facilities and the specific BREF documents (package of measures 2 with a contribution of 30% to the total reductions of the WaM scenario in 2030); and

iii. improvements in energy efficiency in the commercial and institutional sector and the change in the energy mix associated with this sector with a foreseeable reduction in the consumption of coal and petroleum products (package of measures No. 10 with a contribution of 5% to the total reductions in WaM scenario in 2030).

Table 9.5.2 SO_2 projected emissions as reported according to Annex IV tabular format

			Projected emissions (kt)					
			SOx					
			WeM scenario			WaM scenario		
NFR codes	*Activity sectors*	*2019*	*2020*	*2030*	*2040*	*2020*	*2030*	*2040*
1A1	**Energy industries**	26.98	26.72	21.89	20.30	25.48	6.64	3.65
1A2	**Manufacturing Industries and Construction**	51.97	49.48	37.66	35.72	48.47	29.33	14.51
1A3b	**Road Transport**	**0.32**	**0.33**	**0.33**	**0.30**	**0.31**	**0.18**	**0.08**
1A3bi	R.T., Passenger cars	0.19	0.20	0.19	0.17	0.19	0.08	0.03
1A3bii	R.T., Light duty vehicles	0.02	0.02	0.02	0.02	0.02	0.01	0.00
1A3biii	R.T., Heavy duty vehicles	0.10	0.10	0.11	0.10	0.10	0.08	0.04
1A3biv	R.T., Mopeds & Motorcycles	0.00	0.01	0.01	0.01	0.01	0.01	0.00
1A3bv	R.T., Gasoline evaporation	NA	NA	NA	NA	NA	NA	NA
1A3bvi	R.T., Automobile tyre and brake wear	NA	NA	NA	NA	NA	NA	NA
1A3bvii	R.T., Automobile road abrasion	NA	NA	NA	NA	NA	NA	NA
1A3a,c,d,e	**Off-road transport**	12.28	9.96	4.07	4.50	9.82	3.66	2.71
1A4	**Stationary combustion: Residential, Commercial/Institutional, other**	19.47	18.11	7.77	4.96	17.88	5.71	2.06
1A5	**Other**	0.11	0.11	0.12	0.13	0.11	0.12	0.13
1B	**Fugitive emissions**	23.71	24.07	23.92	23.05	23.83	22.80	14.19
2A,B,C,H,I,J,K,L	**Industrial Processes**	13.91	11.48	12.40	13.18	11.48	12.40	13.15
2D, 2G	**Solvent and other product use**	0.01	0.01	0.01	0.02	0.01	0.01	0.01
3B	**Animal husbandry and manure management**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
3B1a	Cattle Dairy	NA	NA	NA	NA	NA	NA	NA
3B1b	Cattle Non-Dairy	NA	NA	NA	NA	NA	NA	NA
3B2	Sheep	NA	NA	NA	NA	NA	NA	NA
3B3	Swine	NA	NA	NA	NA	NA	NA	NA
3B4a	Buffalo	NO	NO	NO	NO	NO	NO	NO
3B4d	Goats	NA	NA	NA	NA	NA	NA	NA
3B4e	Horses	NA	NA	NA	NA	NA	NA	NA
3B4f	Mules and asses	NA	NA	NA	NA	NA	NA	NA
3B4g	Poultry	NA	NA	NA	NA	NA	NA	NA
3B4h	Other	NA	NA	NA	NA	NA	NA	NA
3D	**Plant production and agricultural soils**	NA	NA	NA	NA	NA	NA	NA
3F,I	**Field burning and other agriculture**	0.17	0.16	0.16	0.16	0.16	0.16	0.16
5	**Waste**	0.53	0.46	0.46	0.49	0.46	0.30	0.33
6A	**Other**	NA	NA	NA	NA	NA	NA	NA
NATIONAL TOTAL	**National total (excluding Canary Islands)**	**149.46**	**140.90**	**108.80**	**102.82**	**138.02**	**81.32**	**50.97**

Reduction commitments compliance

Regarding the compliance of the ceiling set in the Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants, as shown in the following graph, the projection of the emissions foresees the compliance with the emission limits in the two scenarios, for both time periods (2020-2019: reduction of -67% compared to 2005 emissions, and 2030 and onwards: reduction of -88% compared to the emissions of the year 2005).

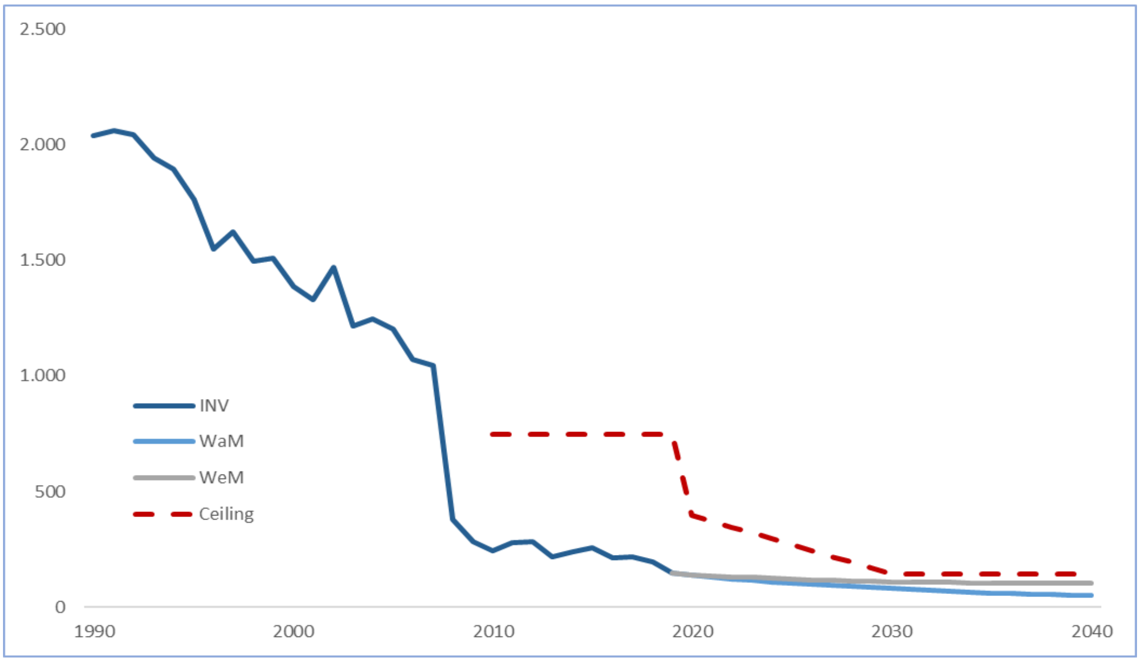

Figure 9.5.6 Expected compliance for SO_2 projections

9.5.1.3. NMVOC

The projection of NMVOC emissions under the WeM scenario is slightly decreasing from 2020 to 2030, showing a slighter upward trend until 2040. However, in the WaM scenario the decreasing trend is clear, mostly led by the use of products sector and the road transport (due to the penetration of alternative energy vehicles in the fleet). The use of biomass in electricity generation in 2030 leads to some increase in NMVOC emission from this sector.The replacement of wood by pellets in the residential sector counterbalences the increase in NMVOC emissions due to the promotion of the use of biomass instead of natural gas. This effect is to be further analysed in the next years.

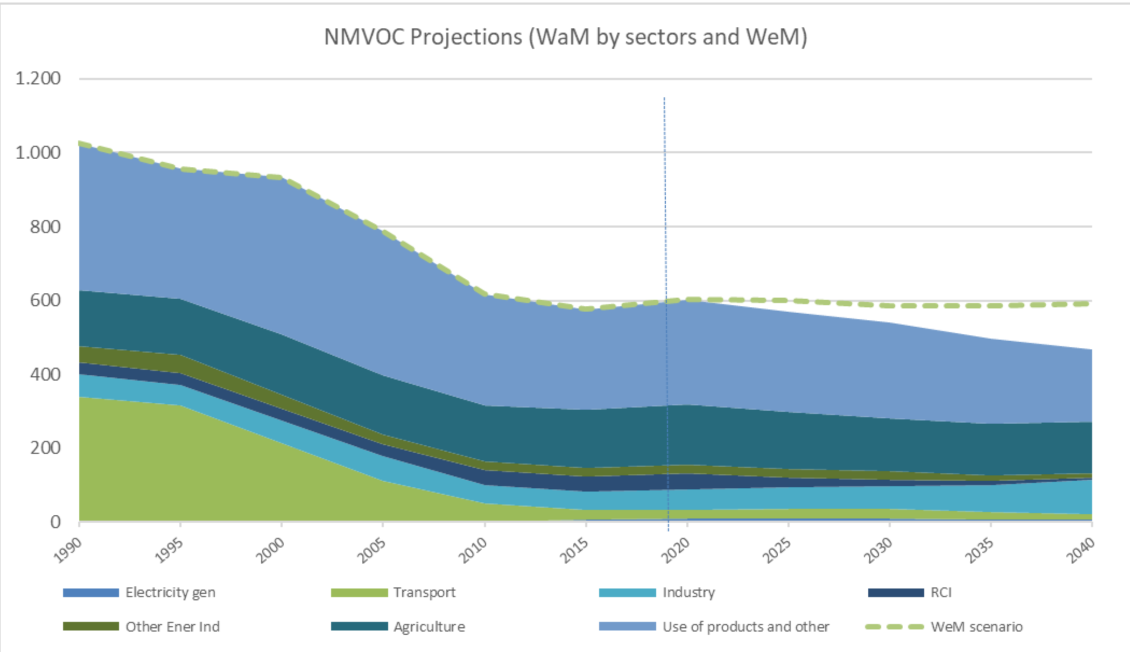

Figure 9.5.7 NMVOC emission and projections by sector (WaM by sector and WeM)

Policies and measures in the WaM scenario

The slight decreases in 2030 in the WaM scenario, compared to the WeM are due to measures in agriculture (package of measures number 18 of the list of PAMs, which would contribute with a 36% of the total reductions for the year 2030 on the WaM stage), measures related to the use of products (package of measures number 15, with a 33% of the projected reductions: Directive 2010/75/EU on industrial emissions; Directive 1999/12/CE on the limitation of VOC emissions due to the use of organic solvents in certain activities and facilities; and Directive 2004/42/EC, concerning the limitation of VOC emissions due to the use of organic solvents in certain paints and varnishes) and to the reduction of open burning of agricultural waste (pruning remains) (package of measures number 18 of PAMs, accounting for 17% of the projected reductions). The package of measures number 1 of the list of PAMs, the changes in the electricity mix, lead to an increase in 2030 in NMVOC emissions with respect to the WeM scenario.

Table 9.5.3 NMVOC projected emissions as reported according to Annex IV tabular format

			Projected emissions (kt)					
			NMVOC					
			WeM scenario			WaM scenario		
NFR codes	*Activity sectors*	*2019*	*2020*	*2030*	*2040*	*2020*	*2030*	*2040*
1A1	**Energy industries**	10.30	10.45	8.86	4.60	10.58	12.93	8.23
1A2	**Manufacturing Industries and Construction**	20.79	20.98	22.14	33.08	20.82	21.39	55.77
1A3b	**Road Transport**	**20.17**	**21.16**	**23.06**	**21.16**	**21.12**	**23.24**	**11.99**
1A3bi	R.T., Passenger cars	5.28	5.13	3.12	2.67	5.24	5.45	2.51
1A3bii	R.T., Light duty vehicles	0.42	0.43	0.46	0.46	0.41	0.31	0.05
1A3biii	R.T., Heavy duty vehicles	1.25	1.26	1.23	1.13	1.24	1.06	0.49
1A3biv	R.T., Mopeds & Motorcycles	11.40	12.40	17.57	16.45	12.26	13.52	7.26
1A3bv	R.T., Gasoline evaporation	1.82	1.96	0.69	0.44	1.96	2.91	1.68
1A3bvi	R.T., Automobile tyre and brake wear	NA	NA	NA	NA	NA	NA	NA
1A3bvii	R.T., Automobile road abrasion	NA	NA	NA	NA	NA	NA	NA
1A3a,c,d,e	**Off-road transport**	2.93	3.00	2.76	3.03	2.93	2.74	1.93
1A4	**Stationary combustion: Residential, Commercial/Institutional, other**	51.17	49.39	32.86	24.42	48.10	24.80	8.93
1A5	**Other**	0.08	0.08	0.09	0.09	0.08	0.09	0.09
1B	**Fugitive emissions**	23.20	23.54	23.45	22.48	23.28	22.19	13.68
2A,B,C,H,I,J,K,L	**Industrial Processes**	35.94	36.65	37.91	38.39	36.65	37.91	38.37
2D, 2G	**Solvent and other product use**	257.62	256.96	259.70	274.71	256.96	244.49	182.17
3B	**Animal husbandry and manure management**	**78.51**	**77.99**	**75.85**	**72.98**	**77.99**	**75.85**	**72.98**
3B1a	Cattle Dairy	22.34	22.22	21.35	19.77	22.22	21.35	19.77
3B1b	Cattle Non-Dairy	17.17	17.03	16.28	15.47	17.03	16.28	15.47
3B2	Sheep	1.23	1.20	1.04	0.98	1.20	1.04	0.98
3B3	Swine	14.14	14.31	14.50	14.45	14.31	14.50	14.45
3B4a	Buffalo	NO	NO	NO	NO	NO	NO	NO
3B4d	Goats	0.62	0.56	0.58	0.55	0.56	0.58	0.55
3B4e	Horses	1.08	1.10	1.28	1.29	1.10	1.28	1.29
3B4f	Mules and asses	0.06	0.05	0.05	0.05	0.05	0.05	0.05
3B4g	Poultry	21.87	21.53	20.76	20.42	21.53	20.76	20.42
3B4h	Other	NA	NA	NA	NA	NA	NA	NA
3D	**Plant production and agricultural soils**	86.26	85.75	83.62	80.83	85.75	67.15	65.30
3F,I	**Field burning and other agriculture**	0.17	0.16	0.16	0.16	0.16	0.16	0.16
5	**Waste**	21.17	17.58	16.94	16.55	17.55	8.26	7.27
6A	**Other**	NA	NA	NA	NA	NA	NA	NA
NATIONAL TOTAL	**National total (excluding Canary Islands)**	**608.30**	**603.69**	**587.39**	**592.47**	**601.96**	**541.19**	**466.87**

Reduction commitments compliance

Regarding the compliance of the reduction commintments set in the Gothenburg Protocol and in the Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants, as shown in the following graph, the projection foresees compliance with the reduction commitment of -22% in 2020 (with respect to 2005 levels), in the two scenarios (WeM and WaM), but the linear trajectory does not lead to compliance in 2030. According to projected data, in the year 2030 the WaM scenario would reach a level of reduction of emissions compared to 2005 of -37%, while the reduction commitment set by the Directive is -39% compared to 2005 emissions. It will therefore be necessary to carry out a more detailed analysis of the potential measures to be applied and their effect on future editions of the projections.

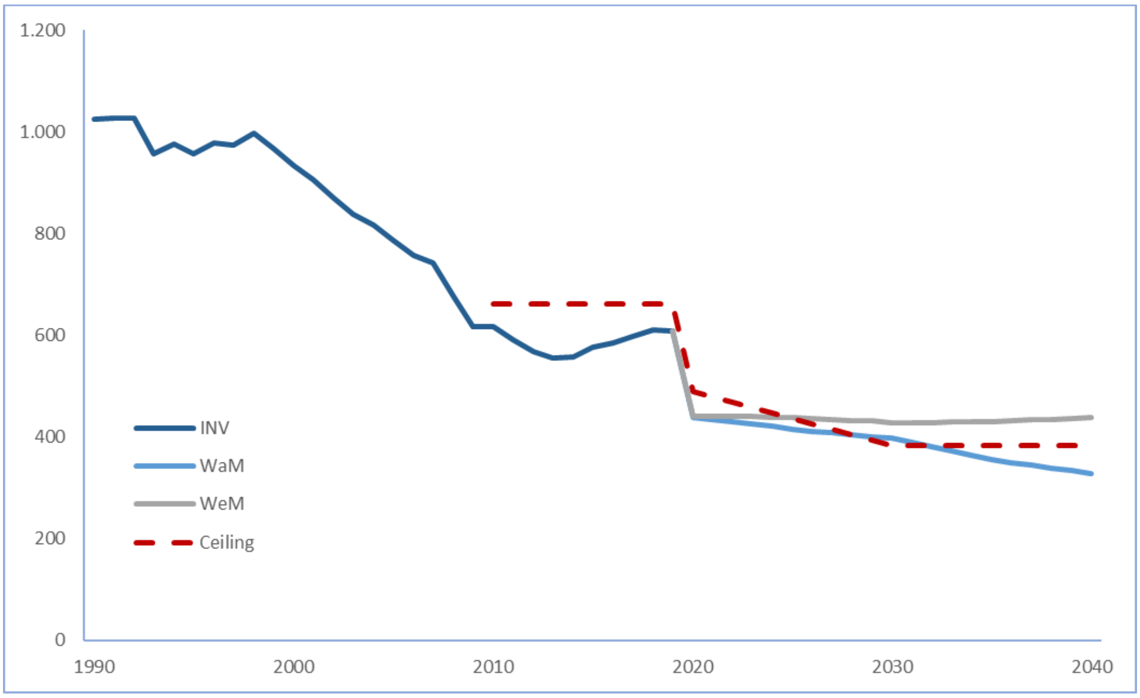

Figure 9.5.8 Expected compliance for NMVOC projections

Emissions from activities falling under NFR categories 3B (manure management) and 3D (agricultural soils) are not accounted for the purpose of complying¸ according to the article 4.3.d) of Directive EU/2284/2016 (The step in the 2020 emissions is due to the non inclusion of 3B and 3D activities).

9.5.1.4. NH_3

The projection of ammonia emissions in the WeM scenario remains practically constant due to the compensation that occurs in the emissions of the growing livestock numbers and the limited effect of existing policies and measures. In the scenario with additional measures (WaM), the initiatives contemplated in the PNCCA have a direct impact on emissions, reducing them by -25% (-123 kt) in 2030 compared to 2015. These are measures aimed at improving the management of manure for cattle, pigs and poultry, both within the farm by application of the BAT of the BREF documents, as well as by the limitation of slurry spreading to the field and the application of techniques that reduce the emissions of this pollutant. Other policies and measures are aimed at a sustainable and efficient fertilization of crops would have the double effect to reduce the total amount of nitrogen compounds and implement application and soil management practices that would reduce the emissions of ammonia in the agricultural soil sector (cultivated crops).

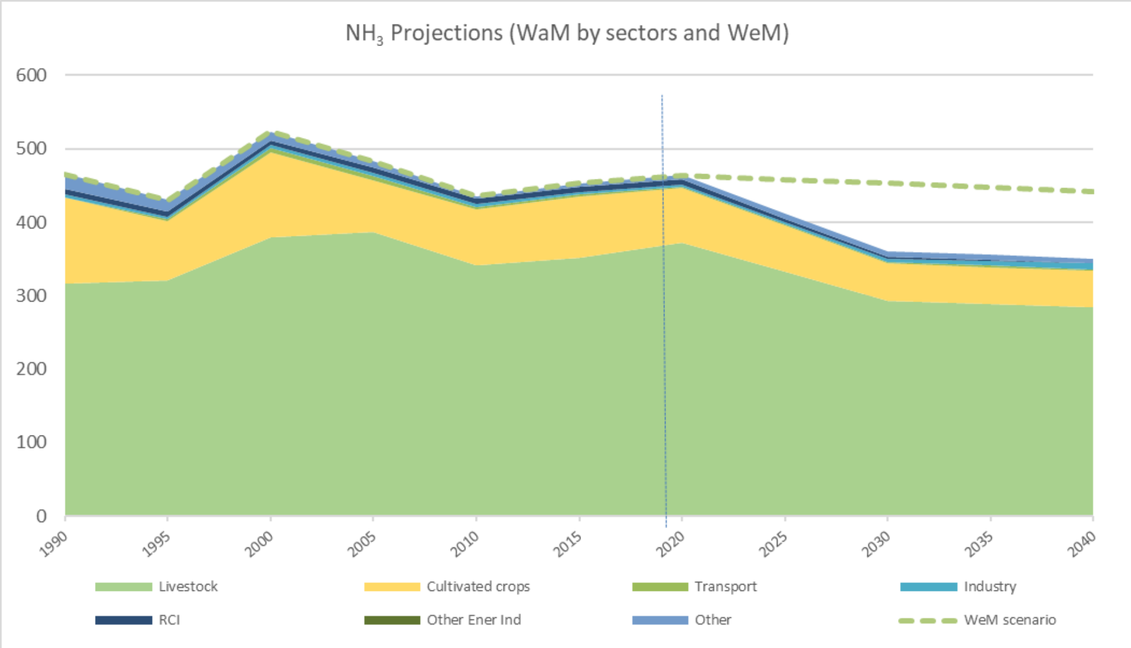

Figure 9.5.9 NH_3 emission and projections by sector (WaM by sector and WeM)

Policies and measures in the WaM scenario

The main measures that have been taken into account in the projections include:

i. package of improvements in manure management systems (cattle, swine and poultry), BAT application of BAT documents (package of measures No. 13 of the list of PAMs, which would contribute as a whole by 64% to the absolute variation of total emissions of ammonia projected for the year 2030 on the WaM stage); and

ii. package of improvements in crop fertilization practices and improvements in the application of manure to the field (swine and cattle) -BATs-BREF (package of measures nº 12 with a contribution of 33% to the total absolute variation of the WaM scenario in 2030).

Table 9.5.4 NH_3 projected emissions as reported according to Annex IV tabular format

			Projected emissions (kt)					
			NH_3					
			WeM scenario			WaM scenario		
NFR codes	*Activity sectors*	*2019*	*2020*	*2030*	*2040*	*2020*	*2030*	*2040*
1A1	**Energy industries**	1.48	1.45	1.54	0.64	1.51	2.92	2.07
1A2	**Manufacturing Industries and Construction**	1.58	1.63	1.99	3.41	1.62	1.92	6.33
1A3b	**Road Transport**	**2.17**	**2.07**	**1.04**	**0.87**	**2.17**	**2.78**	**1.29**
1A3bi	R.T., Passenger cars	1.89	1.77	0.71	0.57	1.88	2.53	1.18
1A3bii	R.T., Light duty vehicles	0.03	0.03	0.02	0.02	0.02	0.02	0.00
1A3biii	R.T., Heavy duty vehicles	0.23	0.24	0.26	0.23	0.23	0.20	0.10
1A3biv	R.T., Mopeds & Motorcycles	0.03	0.03	0.05	0.04	0.03	0.04	0.02
1A3bv	R.T., Gasoline evaporation	NA	NA	NA	NA	NA	NA	NA
1A3bvi	R.T., Automobile tyre and brake wear	NA	NA	NA	NA	NA	NA	NA
1A3bvii	R.T., Automobile road abrasion	NA	NA	NA	NA	NA	NA	NA
1A3a,c,d,e	**Off-road transport**	0.01	0.01	0.00	0.01	0.00	0.00	0.00
1A4	**Stationary combustion: Residential, Commercial/Institutional, other**	7.39	7.07	4.28	2.71	6.87	3.25	0.89
1A5	**Other**	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1B	**Fugitive emissions**	0.03	0.04	0.04	0.04	0.04	0.04	0.00
2A,B,C,H,I,J,K,L	**Industrial Processes**	1.39	1.42	1.58	1.69	1.42	1.58	1.68
2D, 2G	**Solvent and other product use**	0.28	0.29	0.34	0.38	0.29	0.34	0.19
3B	**Animal husbandry and manure management**	**204.95**	**201.61**	**197.71**	**192.32**	**201.61**	**161.33**	**155.82**
3B1a	Cattle Dairy	28.78	28.63	27.51	25.47	28.63	17.82	15.92
3B1b	Cattle Non-Dairy	38.50	38.28	36.61	34.78	38.28	24.73	23.21
3B2	Sheep	9.83	8.81	7.59	7.21	8.81	7.59	7.21
3B3	Swine	73.16	72.39	72.90	72.63	72.39	64.98	64.02
3B4a	Buffalo	NO	NO	NO	NO	NO	NO	NO
3B4d	Goats	5.40	5.24	5.50	5.23	5.24	5.50	5.23
3B4e	Horses	5.24	5.17	6.03	6.07	5.17	6.03	6.07
3B4f	Mules and asses	0.08	0.08	0.08	0.08	0.08	0.08	0.08
3B4g	Poultry	43.97	43.01	41.49	40.86	43.01	34.60	34.08
3B4h	Other	NA	NA	NA	NA	NA	NA	NA
3D	**Plant production and agricultural soils**	248.11	244.37	240.58	235.15	244.35	181.56	177.92
3F,I	**Field burning and other agriculture**	0.80	0.79	0.79	0.79	0.79	0.79	0.79
5	**Waste**	3.06	3.07	3.33	3.51	3.44	4.04	3.92
6A	**Other**	NA	NA	NA	NA	NA	NA	NA
NATIONAL TOTAL	**National total (excluding Canary Islands)**	**471.25**	**463.81**	**453.23**	**441.52**	**464.12**	**360.56**	**350.91**

Reduction commitments compliance

Regarding the compliance of the ceiling set in the Gothenburg Protocol and the Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants, as shown in the following graph, the absolute ceiling set for the period 2010-2019 is clearly underestimated according to the current methodology for calculating emissions. This fixed ceiling was established 20 years ago (in 1999 in the framework of the negotiations of the Gothenburg Protocol) according to obsolete methodologies. It is considered that compliance could not be technically fulfilled until the underestimated ceilings be substituted by the reduction commitments that come into effect after 2020. In this new scenario, nevertheless, the projection of the emissions in the WeM scenario (only taking into account the existing measures) foresees a breach of the reduction commitment. In the WaM scenario, as a result of the effect of the measures included in the PNCCA, the emission ceilings set by the Directive (EU) 2016/2284 are expected to be met in the whole projected time series.

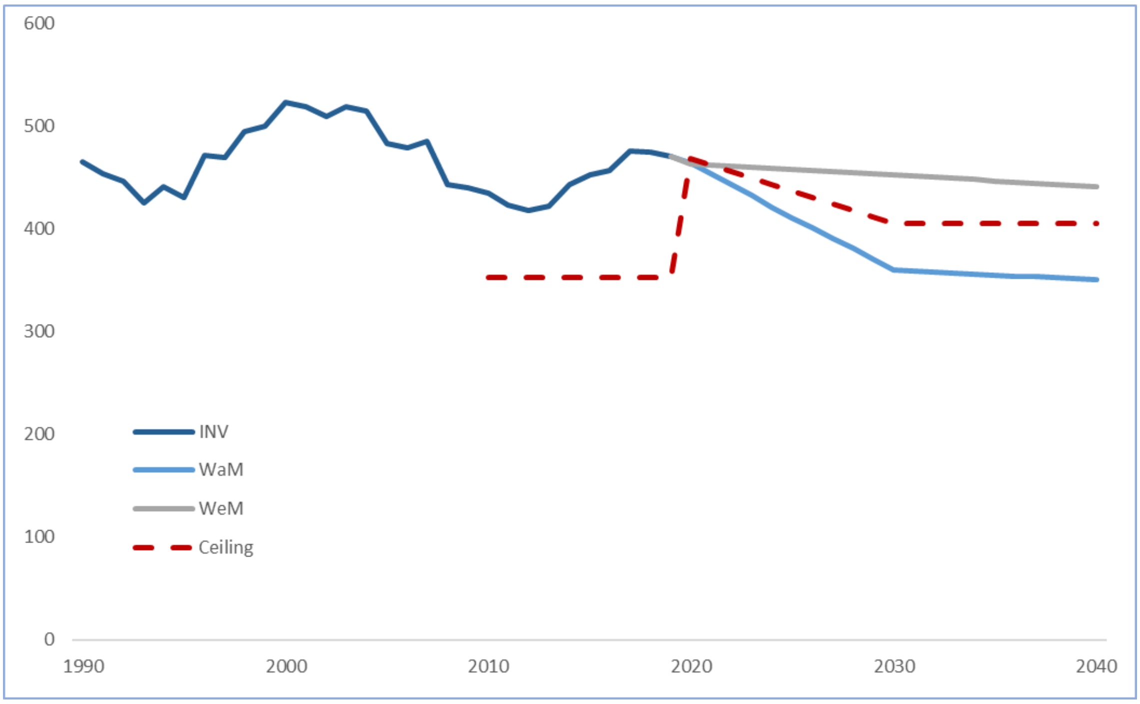

Figure 9.5.10 Expected compliance for NH_3 projections

9.5.1.5. $PM_{2.5}$

The projection of fine particulate matter emissions ($PM_{2.5}$) for the studied time series in the WeM scenario presents a constant downward trend, linked to the replacement of traditional biomass fuels by pellets and the predictable technological advances in domestic combustion and heating systems. In this scenario, the projected global levels of emissions of particulate matter are reduced in 2030 by -30% compared to 2005.

In the scenario with additional measures (WaM), the reduction of emissions is higher due to the reduction of the practices of burning of remains of pruning of fruit trees, grapevine and olive trees, and the forecast in the PNIEC of strengthening the use of pellets as fuel in the residential sector. According to these assumptions, emission levels are reduced by -52% in 2030 compared to 2005.

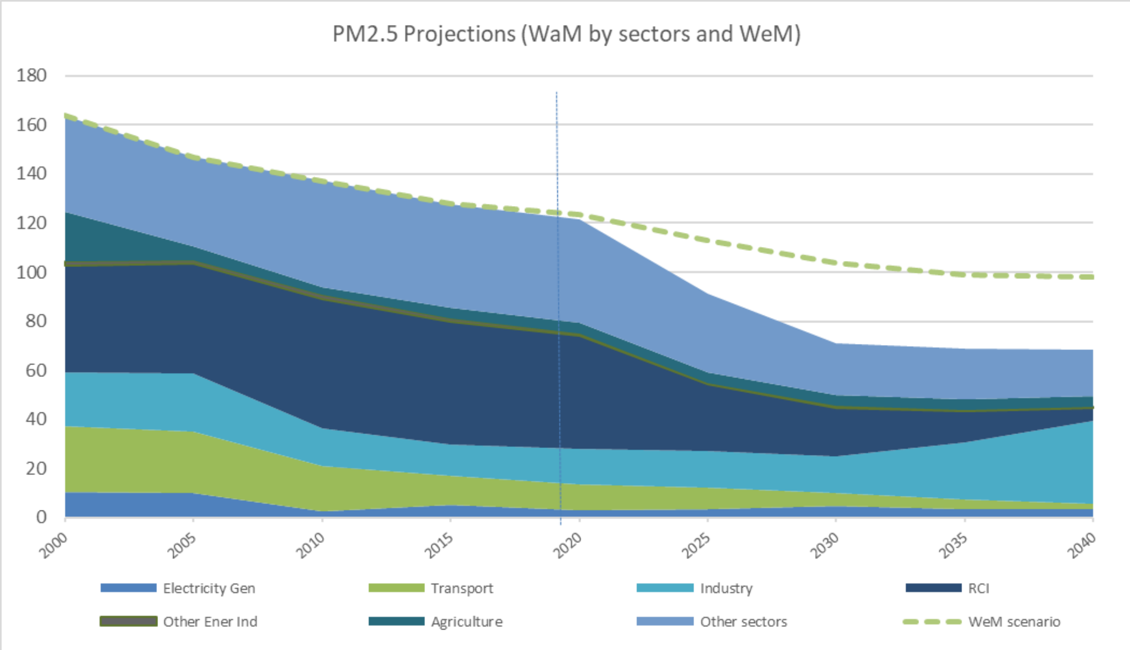

Figure 9.5.11 $PM_{2.5}$ emission and projections by sector (WaM by sector and WeM)

Policies and measures in the WaM scenario

The main measures that have been taken into account in the projection include:

i. measure of limitation of burning practices of the remains of pruning of fruit trees, olive trees and vines (package of measures nº 18 of the list of PAMs, which would contribute by 63% to the total absolute variation of projected particulate emissions for the year 2030 on the WaM stage);

ii. package of measures related to the residential sector (energy efficiency and energy mix changes foreseen in the PNIEC, technological improvements, Ecodesign Directive and relative regulations, to the ecological design requirements applicable to boilers and local heating devices) (package of measures No. 9 with a contribution of 24% to the total absolute variation of the WaM scenario in 2030).

Table 9.5.5 $PM_{2.5}$ projected emissions as reported according to Annex IV tabular format

			Projected emissions (kt)					
			$PM_{2.5}$					
			WeM scenario			WaM scenario		
NFR codes	*Activity sectors*	*2019*	*2020*	*2030*	*2040*	*2020*	*2030*	*2040*
1A1	**Energy industries**	3.32	3.29	3.35	1.94	3.36	4.87	3.40
1A2	**Manufacturing Industries and Construction**	8.63	8.79	9.79	15.72	8.72	9.20	27.50
1A3b	**Road Transport**	**8.88**	**8.88**	**8.80**	**7.66**	**8.59**	**4.12**	**1.51**
1A3bi	R.T., Passenger cars	2.47	2.61	2.98	2.74	2.42	0.32	0.08
1A3bii	R.T., Light duty vehicles	0.38	0.39	0.43	0.43	0.38	0.29	0.04
1A3biii	R.T., Heavy duty vehicles	0.71	0.71	0.70	0.63	0.70	0.54	0.26
1A3biv	R.T., Mopeds & Motorcycles	0.14	0.15	0.21	0.20	0.15	0.16	0.09
1A3bv	R.T., Gasoline evaporation	NA	NA	NA	NA	NA	NA	NA
1A3bvi	R.T., Automobile tyre and brake wear	3.28	3.19	2.85	2.32	3.15	1.79	0.66
1A3bvii	R.T., Automobile road abrasion	1.89	1.83	1.63	1.33	1.80	1.02	0.38
1A3a,c,d,e	**Off-road transport**	2.37	2.11	1.25	1.38	2.08	1.18	0.82
1A4	**Stationary combustion: Residential, Commercial/Institutional, other**	52.61	50.45	30.04	20.20	49.05	21.90	6.55
1A5	**Other**	0.04	0.04	0.04	0.04	0.04	0.04	0.04
1B	**Fugitive emissions**	0.25	0.25	0.27	0.27	0.25	0.27	0.08
2A,B,C,H,I,J,K,L	**Industrial Processes**	5.85	6.02	5.97	6.30	5.68	5.97	6.26
2D, 2G	**Solvent and other product use**	2.10	2.15	2.50	2.78	2.15	2.50	1.39
3B	**Animal husbandry and manure management**	**1.74**	**1.72**	**1.67**	**1.61**	**1.72**	**1.67**	**1.61**
3B1a	Cattle Dairy	0.33	0.33	0.32	0.29	0.33	0.32	0.29
3B1b	Cattle Non-Dairy	0.37	0.37	0.35	0.33	0.37	0.35	0.33
3B2	Sheep	0.09	0.08	0.07	0.07	0.08	0.07	0.07
3B3	Swine	0.19	0.19	0.19	0.19	0.19	0.19	0.19
3B4a	Buffalo	NO	NO	NO	NO	NO	NO	NO
3B4d	Goats	0.03	0.03	0.03	0.03	0.03	0.03	0.03
3B4e	Horses	0.03	0.03	0.04	0.04	0.03	0.04	0.04
3B4f	Mules and asses	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3B4g	Poultry	0.69	0.69	0.67	0.66	0.69	0.67	0.66
3B4h	Other	NA	NA	NA	NA	NA	NA	NA
3D	**Plant production and agricultural soils**	1.01	1.02	1.02	1.02	1.02	1.02	1.02
3F,I	**Field burning and other agriculture**	1.79	1.78	1.78	1.78	1.78	1.78	1.78
5	**Waste**	46.25	37.07	37.08	37.12	37.07	16.50	16.54
6A	**Other**	NA	NA	NA	NA	NA	NA	NA
NATIONAL TOTAL	**National total (excluding Canary Islands)**	**134.83**	**123.57**	**103.56**	**97.82**	**121.51**	**71.01**	**68.51**

Reduction commitments compliance

Regarding the compliance of the reduction commitments set in the Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants, as shown in the following graph, the projection of the emissions foresees a breach of reduction commitments in the WeM scenario for practically the entire projected period. However, in the projection of the scenario WaM, with additional measures, the reduction commitment would be met in all projected horizons.

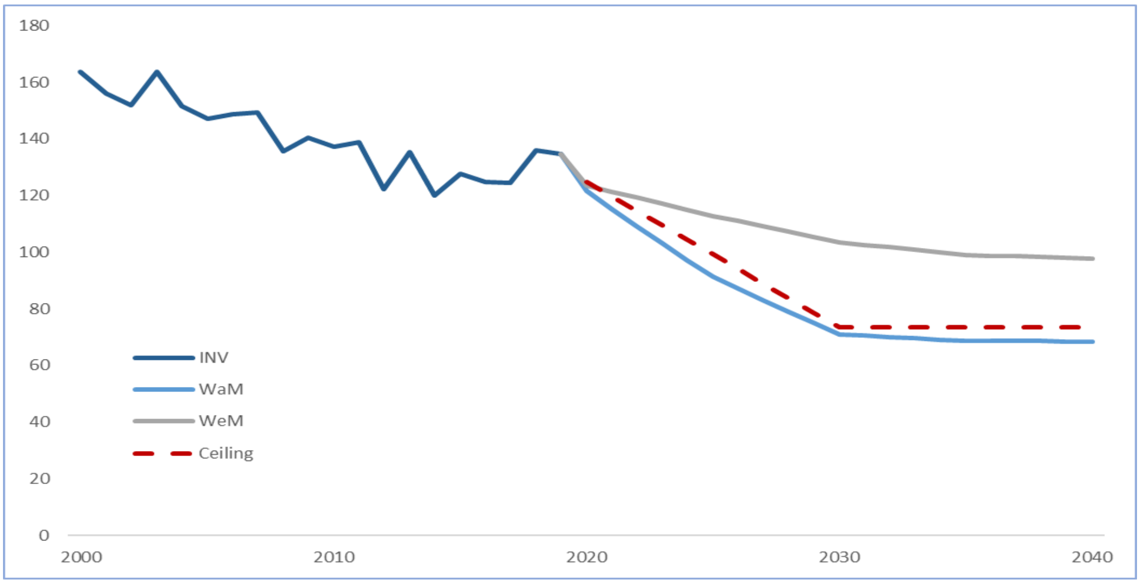

Figure 9.5.12 Expected compliance for $PM_{2.5}$ projections

9.6. Projections editions comparison

For informative purposes a comparison of the global results of the latest projected emission data (edition 2021) compared to the previous reported projections (edition 2019) is provided.

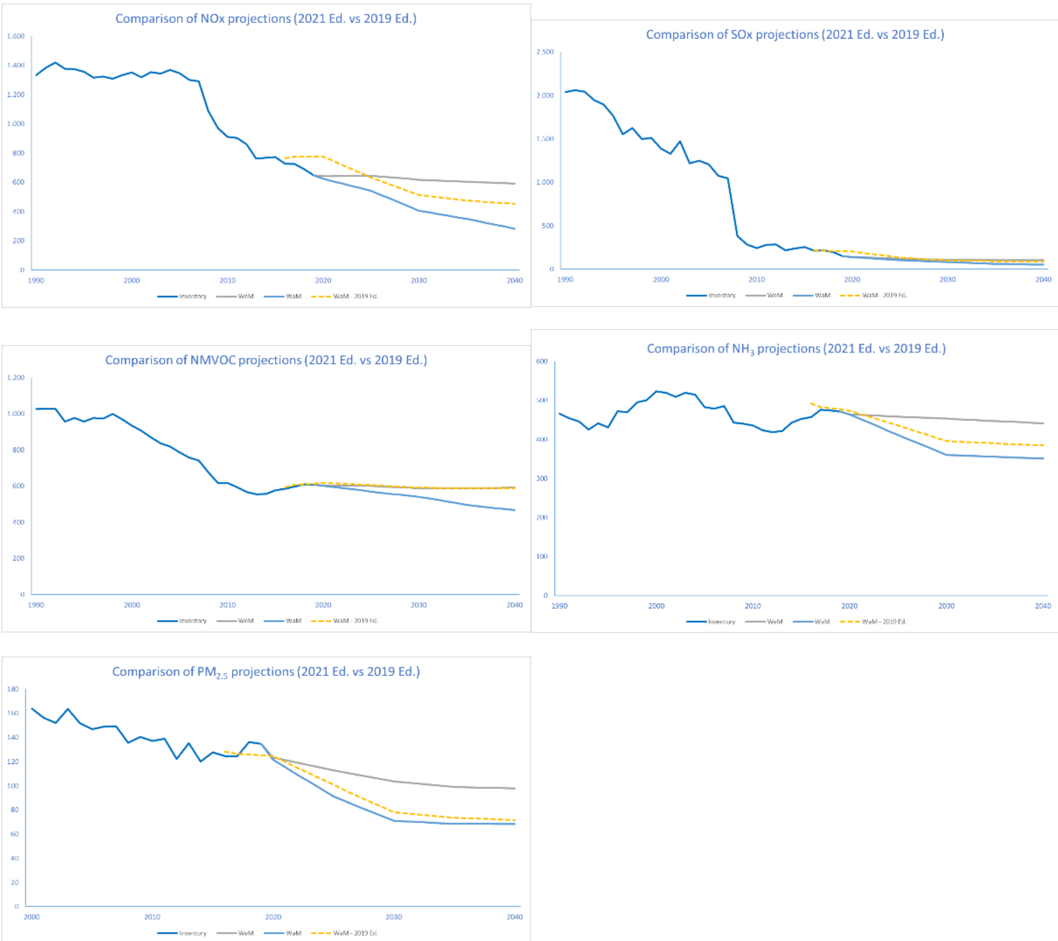

Figure 9.6.1 Projected emission data (Ed. 2021 vs. Ed. 2019)

9.7. Sensitivity analysis

In the framework of the elaboration of the Integrated National Energy and Climate Plan, sensitivity analyses of the different scenarios contemplated have been carried out, in particular with respect to the effect of different fuel price scenarios. For more information, please refer to the Integrated National Energy and Climate Plan.

The assumptions in the non-energy sectors are complex and bring together a large variety of independent variables (livestock population, industrial production, use of products, generation of waste, etc.), that make complex to choose any variable representative of the total emissions. In general, projected emissions are more related to the reference scenario used in the PNIEC and to the effect and intensity of the mitigation measures proposed in that National Energy and Climate Plan and in the National Air Pollution Control Programme, rather than to other macro parameters such as GDP or population evolution.

For more information, please consult the final report of emissions projections, available at:

https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/sistema-espanol-deinventario-sei-/Proyecciones.aspx

10. REPORTING OF GRIDDED EMISSIONS AND LPS

CONTENTS

FIGURES

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10. REPORTING OF GRIDDED EMISSIONS AND LPS

10.1. Introduction

Chapter updated in March, 2023.

Aggregated sectoral gridded and LPS emissions is reported complying with Directive 2016/2284[1].

Following the recommendation ES-GRID-GEN-2020-0001 made by the TERT in the 2021 NECD review (pursuant to Directive (EU) 2016/2284), the Spanish Inventory has revised this chapter, adjusting to the criteria of the Recommended Structure for Informative Inventory Report (Annex 2).

10.2. Grid and LPS dataset

The pollutants reported as gridded emissions by the Spanish inventory are the following: NO_X, NMVOC, SO_2, NH_3, $PM_{2.5}$, PM_{10}, BC, CO, Pb, Cd, Hg, PCDD/PCDF, PAH, HCB, PCB.

In the case of the LPS report, they are the same pollutants with the exception of BC, which is not considered. Must be added that LPS data are also included in the gridded data submission and every LPS accounted for the Inventory it is been incorporated in both submissions.

For all pollutants mentioned above except for particles, the Inventory reports the complete series from 1990 to the current year. Particles are only reported from the year 2000 onwards, as established by CLRTAP criteria.

Both, the gridded emissions data and the LPS reports are fully consistent with the emissions data from the inventory.

10.3. Changes in gridded emissions

Following the recommendation ES-GRID-G-2021-0001 made by the TERT in the 2021 NECD review (pursuant to Directive (EU) 2016/2284), the Spanish Inventory has proceeded to correct the error that provided sector G_Shipping emissions in cells that were not over maritime domain.

Also following the recommendation ES-LPS-D-2021-0001 made by the TERT in the same review, the Inventory has reported emissions of offshore facilities near but outside the EMEP grid initially assigned to Spain.

Finally, regarding the observations made during the review, the indicated LPS coordinates have been revised and corrected, following the recommendation ES-LPS-GEN-2021-0001 made by the TERT.

In addition to these changes produced because of the revision, the Inventory is currently carrying out the 1970-2018 series of the LULUCF cartography, which will be used in future

[1] Directive (EU) 2016/2284 of the European Parliament and of the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC (http://data.europa.eu/eli/dir/2016/2284/oj).

editions for the mandatory report that must be carried out in 2025. The 2018 land use map is still in error correcting process.

10.4. Grid methodology

10.4.1. Summary

The criterion of the Spanish Inventory to consider facilities as LPS are the thresholds set up by the CLRTAP Guidelines. However, the Inventory registers other point sources that do not fall into this criterion, and whose emissions are geographically assigned in the same way, in order to improve the allocation of emissions for the grid report. This completes the Area source distribution based on the land use map that is explained in epigraphs 10.4.2 and 10.4.3, and the Road transport emissions map explained in epigraph 10.4.4.

Below is a summary table with the tier methodological approach for gridding into each of the GNFR sectors and percentage corresponding to area source and LPS estimates.

Table 10.4.1 GNFR Spatial mapping Tier and 2021 source percentage emission

GNFR Sector	Tier	Emission source	NOx	NMVOC	SO_2	NH_3
A_Public power	T2/T3	Area	24%	60%	11%	99%
		LPS	76%	40%	89%	1%
B_Industry	T2/T3	Area	40%	82%	28%	59%
		LPS	60%	18%	72%	41%
C_OtherStatComb	T1/T2/T3	Area	99%	99%	100%	100%
		LPS	1%	1%	0%	0%
D_Fugitives	T2/T3	Area	0%	94%	0%	8%
		LPS	100%	6%	100%	92%
E_Solvents	T1/T2	Area	100%	97%	100%	100%
		LPS	0%	3%	0%	0%
F_RoadTransport	T3	Area	100%	100%	100%	100%
		LPS	0%	0%	0%	0%
G_Shipping	T2	Area	100%	100%	100%	100%
		LPS	0%	0%	0%	0%
H_Aviation	T3	Area	0%	0%	0%	-
		LPS	100%	100%	100%	-
I_OffRoad	T1	Area	100%	100%	100%	100%
		LPS	0%	0%	0%	0%
J_Waste	T1/T2/T3	Area	100%	100%	100%	100%
		LPS	0%	0%	0%	0%
K_AgriLivestock	T2	Area	100%	100%	100%	100%
		LPS	0%	0%	0%	0%
L_AgriOther	T2	Area	100%	100%	100%	100%
		LPS	0%	0%	0%	0%
TOTAL SOURCE PERCENTAGE		**Area**	**84,1%**	**95,6%**	**36,6%**	**99,7%**
		LPS	**15,9%**	**4,4%**	**63,4%**	**0,3%**

Every area source estimates in GNFR sectors except Road transport, are distributed according to land use maps elaborated by Spanish Inventory. Land use map elaboration is explained in next epigraph 10.4.2. Road transport estimates distribution are explained in epigraph 10.4.4

10.4.2. Land use map

As advanced in the 2021 edition of the IIR, geo-location of emissions has been upgraded through a specific project that is being conducted by the Spanish inventory, with the aim to compile and analyse the available land-use cartography for Spain for 1970–2018 in order to implement IPCC advanced criteria for the whole time series (more information about the cartographic project is available in https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/sistema-espanol-de-inventario-sei-/intro-proyecto-cartografia_tcm30-553028.pdf). The sources of geographical data used in this analysis have been:

- Historical cartographies of land occupation (coverage and / or use) of Spain:
  - Maps of Crop and Land Use. Ministry of Agriculture, Fisheries and Food. 1980-1990 and 2000-2010 editions.
  - CORINE Land Cover maps. National Geographic Institute. 1990, 2000, 2006, and 2012 editions.
  - National Forest Map scale 1:50,000 (MFE50), 1996-2007; Change layer in the MFE snapshot, 2009, 2012 and 2015. Ministry for the Ecological Transition and the Demographic Challenge.
  - Agricultural Plot Geographic Information System (SIGPAC). Ministry of Agriculture, Fisheries and Food. 2009, 2012, and 2015.
- Urban Cadastre of Spain. General Directorate of Cadastre, Ministry of Finance and Provincial Council of Álava. 1970-2015.
- Cartography of water masses from the General Directorate of Water (MITECO) and Reference Geographical Information on Hydrography "IGR Hidrografía" from the National Geographic Institute (IGN).
- Road infrastructure of the National Topographic Base (BTN) of the IGN.
- Railway infrastructure of the IGN National Topographic Base (BTN).
- Highways shapefiles with AMD traffic density.
- Rocky areas obtained from the analysis carried out by remote sensing from SENTINEL and LANDSAT images.
- Information on peat bogs from the Geological and Mining Institute of Spain (IGME).

The harmonization and standardization of these cartographic data sources, developed for different purposes, has been one of the major challenges in the project development. Similarly, new data provided by the cartography project are being cross-checked with data currently used in the national inventory.

The result of this project will be a land-use cartography (LULUCF maps), with 25x25 m pixel size, for the years 1970, 1990, 2000, 2006, 2009, 2012, 2015 and 2018.

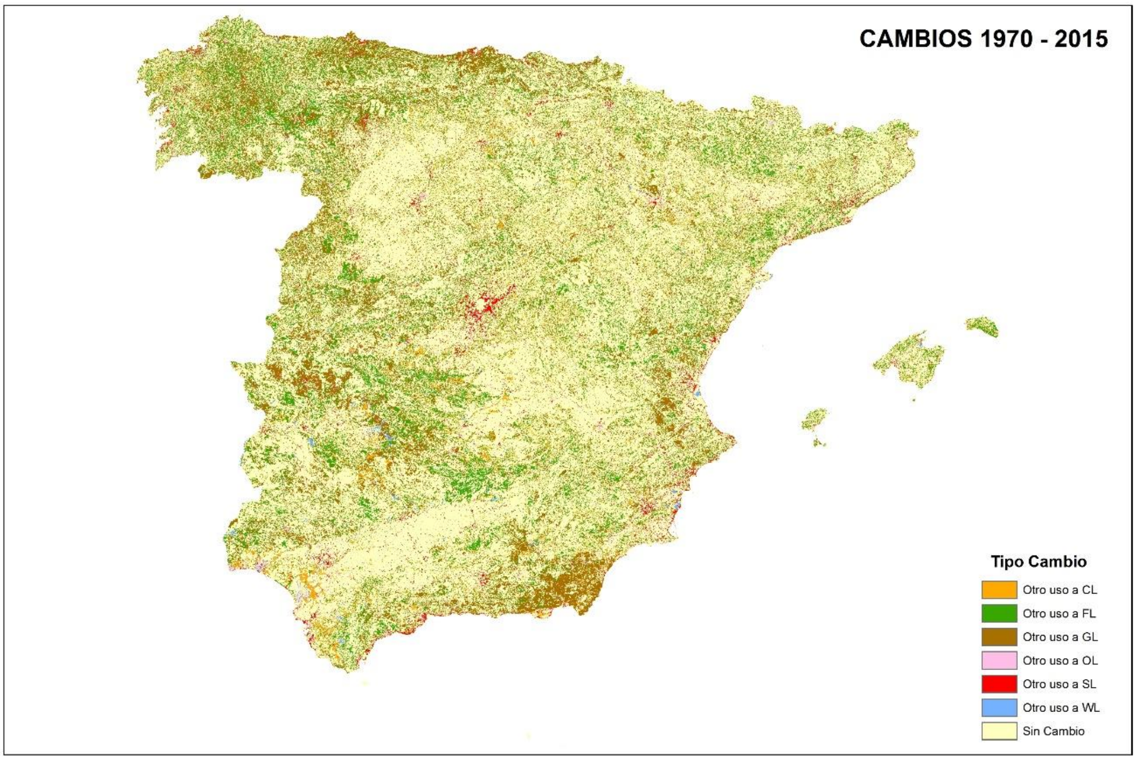


Figure 10.4.1 Example of land use map changes between 1970 and 2015

These maps consider 73 different land uses coded according to three digits number where the first digit responds to general use based on the following scheme:

Table 10.4.2 Land Use group classification

First digit group	Land use category
1	Forest Land
2	Grassland
4	Other land
5	Wetlands
7	Cropland
8	Settlements

The second and third digit goes deeper into breakdown land uses. As an example, the group 8 disintegration is shown in the following table:

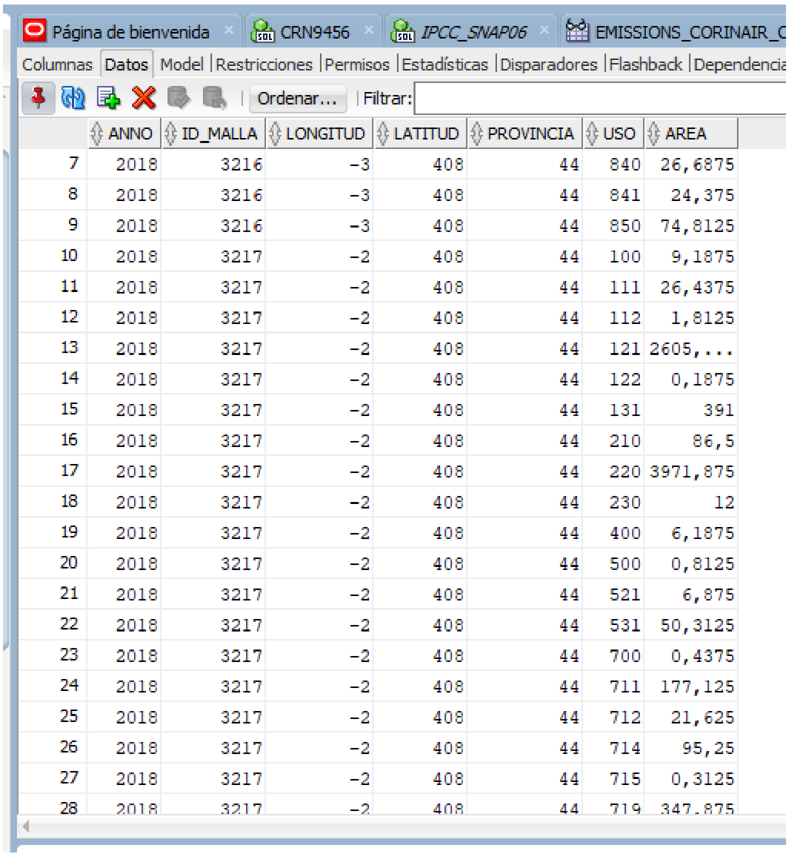
Table 10.4.3 Group 8 classification

Group	Subcategory		Code
8 Settlement	All developed land, including transportation infrastructure and human settlements of any size, unless included in other categories.		800
	Urban units	Residential area	810
	Industrial or commercial units	Industrial or commercial area	820
		Industrial area	821
		Commercial area	822
		Wind turbine park	823
		Solar panel park	824

Group	Subcategory		Code
	Port areas and airports	Port areas and airports	830
		Port areas	831
		Airport	832
		Other	839
	Road and rail transport networks	Road and rail transport networks	840
		Roads	841
		Railroad tracks	842
		Other	849
	Mineral extraction sites	Mineral extraction sites	850
	Dump sites	Dump sites	860
	Construction sites	Construction sites	870
	Vegetated areas	Land with vegetative cover, which is not considered within the Forest Land, Cropland or Grassland categories.	880
		Wooded area	881
		Bushy area	882
		Herbaceous area	883

10.4.3. Land use map and area source emission interaction

Once the LULUCF cartography has been obtained, it has been intersected with the EMEP grid, as well as with the layer of provinces of Spain (NUT3 level). The result is a georeferenced table with the surface area of each of land use activities considered in the Inventory (Figure 10.4.2).



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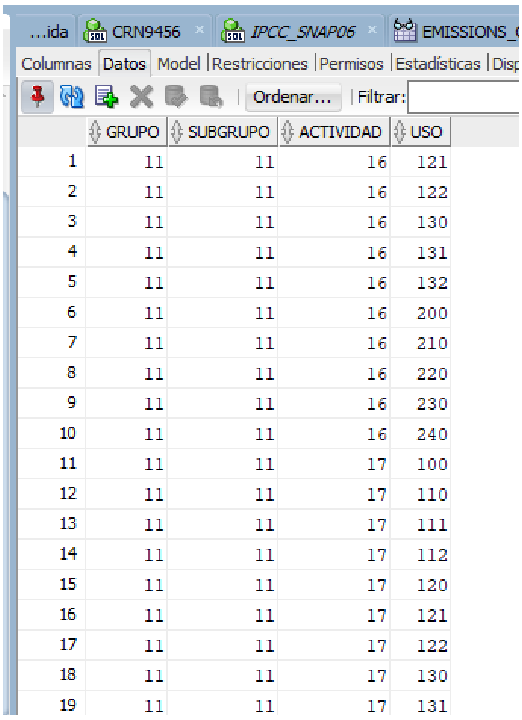
Columnas | Datos | Model | Restricciones | Permisos | Estadísticas | Disparadores | Flashback | Dependencia

Ordenar... | Filtrar:

	ANNO	ID_MALLA	LONGITUD	LATITUD	PROVINCIA	USO	AREA
7	2018	3216	-3	408	44	840	26,6875
8	2018	3216	-3	408	44	841	24,375
9	2018	3216	-3	408	44	850	74,8125
10	2018	3217	-2	408	44	100	9,1875
11	2018	3217	-2	408	44	111	26,4375
12	2018	3217	-2	408	44	112	1,8125
13	2018	3217	-2	408	44	121	2605,...
14	2018	3217	-2	408	44	122	0,1875
15	2018	3217	-2	408	44	131	391
16	2018	3217	-2	408	44	210	86,5
17	2018	3217	-2	408	44	220	3971,875
18	2018	3217	-2	408	44	230	12
19	2018	3217	-2	408	44	400	6,1875
20	2018	3217	-2	408	44	500	0,8125
21	2018	3217	-2	408	44	521	6,875
22	2018	3217	-2	408	44	531	50,3125
23	2018	3217	-2	408	44	700	0,4375
24	2018	3217	-2	408	44	711	177,125
25	2018	3217	-2	408	44	712	21,625
26	2018	3217	-2	408	44	714	95,25
27	2018	3217	-2	408	44	715	0,3125
28	2018	3217	-2	408	44	719	347,875

Figure 10.4.2 View of land use distribution table for each year, province and EMEP cell

At the same time, a correlation between SNAP issuing activities and the three digit land use codes has been established.



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Columnas | Datos | Model | Restricciones | Permisos | Estadísticas | Disp

Ordenar... | Filtrar:

	GRUPO	SUBGRUPO	ACTIVIDAD	USO
1	11	11	16	121
2	11	11	16	122
3	11	11	16	130
4	11	11	16	131
5	11	11	16	132
6	11	11	16	200
7	11	11	16	210
8	11	11	16	220
9	11	11	16	230
10	11	11	16	240
11	11	11	17	100
12	11	11	17	110
13	11	11	17	111
14	11	11	17	112
15	11	11	17	120
16	11	11	17	121
17	11	11	17	122
18	11	11	17	130
19	11	11	17	131

Figure 10.4.3 View of table to correlate SNAP and land use

With this operation, it has been possible to obtain the percentage distribution of emissions for each activity and EMEP cell. Below is an image of the resulting table in Oracle software.

	ANNO	LONGITUD	LATITUD	ID_MALLA	PROVINCIA	GRUPO	SUBGRUPO	ACTIVIDAD	F
1	2015	-2	415	3802	50	6	5	2	0,0081985959662132565288346364513840703024 76
2	2015	-2	416	3895	50	6	5	2	0,0000096910117803939202468494520701939365 2775
3	2015	-1	411	3458	50	6	5	2	0,0004380337324738051951575952335727659310 54
4	2015	-1	412	3542	50	6	5	2	0,0118869950498311825747855379092998825449
5	2015	-1	413	3629	50	6	5	2	0,0014885394094685061499160758379817886506 62
6	2015	-1	414	3716	50	6	5	2	0,0010330618557899918983141515906826736338 58
7	2015	0	410	3378	50	6	5	2	0,0000368258447654968969380279178667369588 0545
8	2015	0	411	3459	50	6	5	2	0,0018664888689038690395432044687193521752 45
9	2015	0	412	3543	50	6	5	2	0,0021610956270278442150474278116532478456 88
10	2015	0	413	3630	50	6	5	2	0,0043415732776164762705885545274468835644 32
11	2015	1	410	3379	50	6	5	2	0,0001376123672815936675052622193967538986 94
12	2015	1	411	3460	50	6	5	2	0,0040585957336289737993805505269972206178 21
13	2015	1	412	3544	50	6	5	2	0,0011241573665256947486345364401424966372 19
14	2015	1	413	3631	50	6	5	2	0,0006202247539452108957983649324924119377 76
15	2015	2	410	3380	50	6	5	2	0,0000348876424094181128886580274526981714 999
16	2015	2	411	3461	50	6	5	2	0,0001182303437208058270115633152563660256 39
17	2015	2	412	3545	50	6	5	2	0,0030526687108240848777575774021110900062 41
18	2015	2	413	3632	50	6	5	2	0,0009594101662589981044380957549491997162 47
19	2015	2	414	3719	50	6	5	2	0,0000426404518337332490861375891088533207 221
20	2015	3	411	3462	50	6	5	2	0,0000251966306290241926418085753825042349 7215
21	2015	3	412	3546	50	6	5	2	0,0010601966887750948750053300564792166561 36
22	2015	3	413	3633	50	6	5	2	0,0020564326997995898763814537292951533311 88
23	2015	3	414	3720	50	6	5	2	0,0001085393319404119067647138631861720891 11
24	2015	-22	412	3521	50	6	5	3	0,0016395331977589328534941389476501883046 63
25	2015	-22	413	3608	50	6	5	3	0,0003197275623747578807267481848025310526 1
26	2015	-21	411	3438	50	6	5	3	0,0005056156800345008346376482922458630599 41
27	2015	-21	412	3522	50	6	5	3	0,0004758735812089419620119042750549299387 68

Figure 10.4.4 View of emissions percentage distribution into EMEP grid

In this table, F field represents the emission's percentage distribution applied to each EMEP cell, of the emissions of each SNAP by province for each of the years of LULUCF maps. Explained in another way, filtering by a year, a province and a SNAP, the sum of field F will be one.

The generation of the gridded emission report for each year within the 1990-2021 series is therefore based on this F distribution using the correspondent LULUCF map and the aggregation of SNAP into NFR codes. It follows that the report for 2021 emissions is based on the 2018 LULUCF map.

10.4.4. Road transport emissions map

Road transport emissions are the main contributor to the area source estimates in many pollutants so, the Inventory has made a specific mapping for this activity.

To elaborate this map, the interurban traffic intensities available and provided by the DGT. Also, urban areas with the representation of their population density have been taken into account.

This cartography is the result of the fusion of three maps generated for each of the three driving patterns included in the inventory. For the generation of each map, the geographical distribution of its corresponding road level or the distribution of urban centers have been taken into account and their respective emissions have been assigned. Subsequently, the emissions per unit of length or area have been estimated for each entity. In the specific case of the emission layer in the interurban driving pattern, the traffic densities have been taken into account for this distribution of emissions per unit length. This operation has been carried out for several years of the series, using cartography as close as possible to the estimation year. Latest traffic and population data taken into analysis are from 2019.

Finally, resulting shapes and the EMEP grid has been intersected, thus, it is possible to estimate road transport emissions per cell. The analysis results are incorporated to gridded emissions report, thus completing emissions accuracy achieved with the LULUCF maps methodology for the rest of activities.

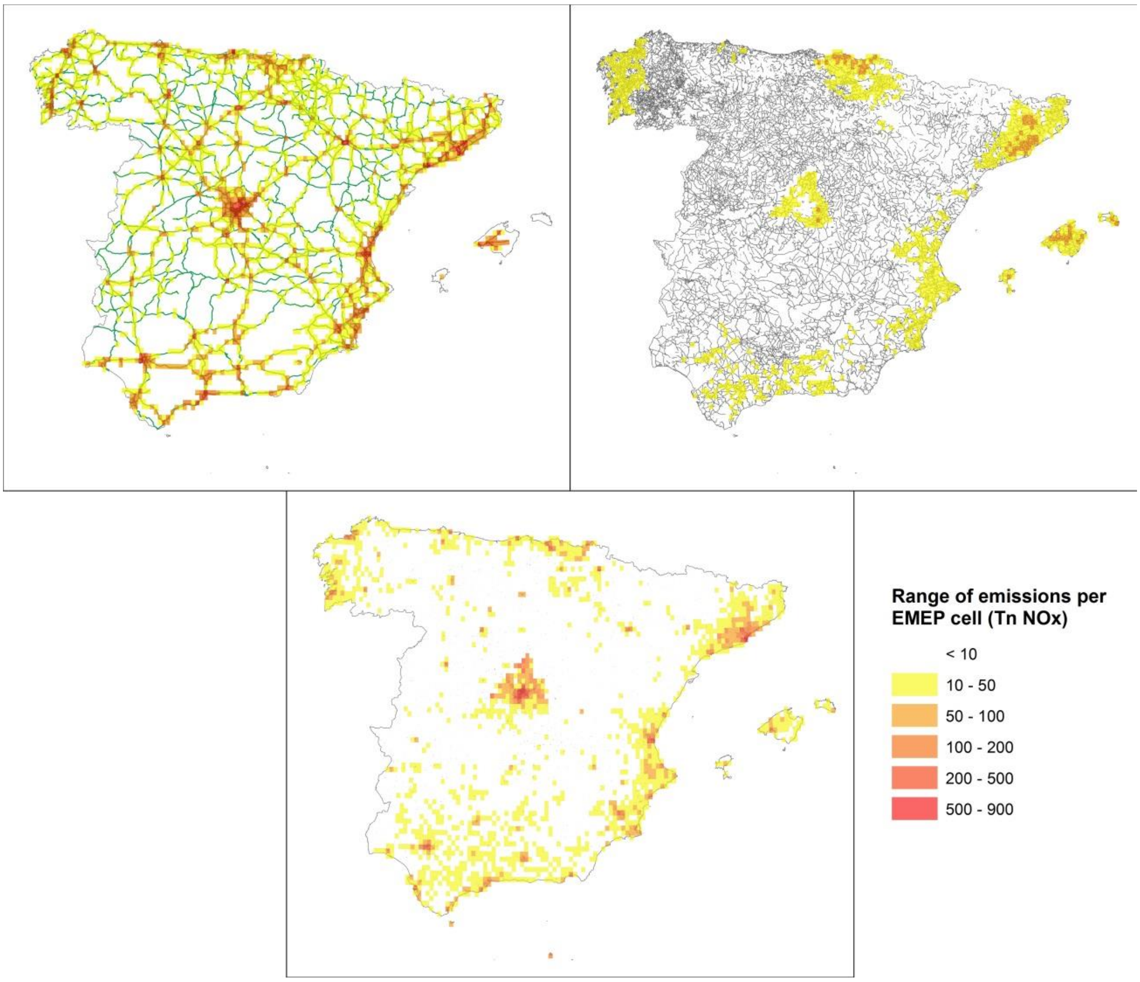

Figure 10.4.5 Maps of gridded emissions in interurban, rural and urban pattern driving in 2019 (Interpolation)

10.5. Planned improvements

In this edition, the updated LULUCF cartography has been incorporated. In the next editions, errors in this cartography will continue to be monitored and identified in order to have it ready for the 2025 official grid and LPS report.

On the other hand, following the recommendation ES-LPS-K-2020-0001 made by the TERT in the 2021 NECD review (pursuant to Directive (EU) 2016/2284), the Spanish Inventory has begun working into geolocation of intensive livestock facilities to be included in LPS report within K Agriculture Livestock sector.

The Ministry of Agriculture is currently implementing a digital platform for the management of livestock farms called ECOGAN: Registro General de MTDs y Cálculo de emisiones (mapa.gob.es). The Spanish Inventory is incorporating its methodologies for estimating emissions from the agricultural sector into this platform, in such a way that each of the registered entities has its emission volume associated with it.

Currently, only the porcine species has been incorporated in the ECOGAN platform, and 50% of their emissions was obtained through specific facilities registered into ECOGAN. The rest of the livestock species will be added as the corresponding management regulations would be implemented. The incorporation of this data in next Inventory editions will be assessed.

10.6. LPS reporting

The Inventory reports the LPS that exceed the 2023 Guideline reporting threshold established by CLRTAP. Below is a table with the relationship of LPS reported throughout the series (1 means reported; 0 means not reported because do not overcome threshold; Blank means without activity).

Table 10.6.1 LPS Reporting series

LPS	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
0002	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0003	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0004	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0005	1																															
0006	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0007	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0008	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0009	1	1	1		1	1	1																									
0010	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0011	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0012				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0014	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0015	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0016	0	0																														
0017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1										
0018	1	1	1	1	1	1	1	1	1	1	1	1	1																			
0019	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0020	0																															
0021	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0													
0022	1	1	1	1																												
0023	1																															
0025	0																															
0026																							0	0	0	0	0	0	0	1	0	0
0028	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1															
0029	1	1	1	1	1	1	1	1	1	1	1	1	0																			
0030	0	0	0	0	0	0	0	0	0	0																						
0031	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0032	1	1	1	1	1	1	1	1																								
0033	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
0034	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
0035	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

LPS	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
0037	1	1	1	1	1	1	1	1	1	1	1	1	1	1																		
0038	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0039	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0040	1	0																														
0041	1																															
0042	1																															
0043	1	1	1																													
0044	1	1	0																													
0045	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0050	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0051	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0052	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1							
0053	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1													
0054	1	1	1	0																												
0055	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0056	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0057	1	1	1	1																												
0058	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0059	0	0	0			1	0	1	1	1	1	1	1	1	1	1	1	1	1	1												
0060	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0061	0																															
0062	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0063													0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0064														1																		
0065	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1	1	1	1	
0070	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0071	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0072	1	1	1	1	1																											
0073																1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
0075	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0076	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0077	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	
0078	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	
0080	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0081	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0082	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0083	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0084	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0085	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0086	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0087	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0089	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0100	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	
0101	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
0102	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1									
0103	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
0104	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
0105	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1
0106	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	
0107	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	
0108	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
0109	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
0110	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1			
0111	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
0112	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0										
0113	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0114	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
0115	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1									

LPS	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
0118	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0														
0119	1	1	1	1	1	1	1	1	1	1	1	1	1																			
0120	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1														
0121	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0									
0122	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0												
0123	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1
0124	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	0	0												
0125	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0126	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
0127	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0								
0128	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0											
0129	1	1	1	1	0	1	1	1	1	1	1	1	1	1																		
0130	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0											
0131	1	1	1	1	0																											
0132		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0															
0133			0	0	0	0																										
0134				0	1	1	0	1	1	1	1	1	1	1	1	1	0															
0135					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0136							0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1						
0137	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0138	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0139	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0140	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0141	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0																
0150												1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1
0151													0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
0152													0	1	1	1	1	0	1	0	1	1	0	0	0	0	1	1	1	1	1	1
0153													0	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1	1	1
0154													0	1	1	1	1	1	1	1	1	0	0	0	0	1	0	1	0	0	0	0
0155													1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0156													1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0157														0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	0
0158														1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
0159															1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0160						0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0161							1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1
0162							0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
0163	1	1	1	1	1	1	0	0	0	0	0	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0				
0164						1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1
0165			1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1
0166	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0167	1	1	1	1	1	1	0	0	0	0	0	1	0	0	1																	
0168												0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0169																1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0170																	0	1	0	1	1	1	1	0	1	1	1	1	0	1	1	1
0171												0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0172																	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
0173																							1	1	1	1	1	1	1	1	1	1
0174																															0	0
0180	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0181	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0182	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
0183	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0184	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0185	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0201											1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1
0202											1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	0	0	1
0203											1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

LPS	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
0204											1	1	1	1	1	1	1	0	0	0	0											
0205												0	0	0	0	0																
0210	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1							
0211	1	1	1	1	1	1	1	1	1	1	1	1	1																			
0212	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
0213	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
0214	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0215	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
0216	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0												
0217	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
0218	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
0230	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0231	1	1	1	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0232	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0233	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0234	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0235	1	1	1	1	0	0	1	1	1	1	1	1	1	1																		
0236	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0
0237				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
0238	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0
0239		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0240	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0242	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0							
0243												0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0244	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1
0245	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	0	0	0	0	0	0	0									
0246	1	1	1	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
0247	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	1	0	0	0	0	0	1
0248	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0															
0249														1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0250	1	1	1	1	1	1	1	1	1	1	1	1	1																			
0251	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0252																1	1	1	0	0	0	0	0									
0253																0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0
0254																1	1	1	0	0	0	0										
0255																1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0260															0	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1
0261															1	1	1	1	1	1	1	1	1	0				0	0			0
0262															1	1	1	1	1	1	1	0	0	0	0	0	0	0				
0263																1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	1
0264																1	1	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1
0266																1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
0267																1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0268																1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	1	0
0269																1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
0270																	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
0272																	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1
0273																	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1	1
0274																	0	1	1	1	1	1	0	0	0	0	0	0	0	1	0	1
0275																	1	1	1	1	1	1	0	0	0	0	1	0	0	0	0	1
0276																	0	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1
0277																	0	1	1	1	1	1	0	0	0	0		0	0	0	1	0
0278																		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0279																		1	1	1	0	1	1	1	0	0	0	0	0	1	0	
0280																			1	1	1	1	1	0	0	1	1	1	1	1	1	1
0281																			0	0	0	1	0	0	0	0	0	0	0	1	1	1
0282																			1	1	1	1	1	0	0	0	0	1	0	1	1	0
0283																			1	1	1	0	0	0	0	0	0	1	1	1	0	1

LPS	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
0284																			1	1	1	1	0	0	0	0	0	0	1	1	1	1
0285																			1	0	0	0	0	0	0	0	0	0	0	0	0	0
0286																					0	1	1	1	1	1	1	1	1	1	0	0
0287																					0	1	1	1	1	1	1	1	1	1	0	0
0288																						1	0	0	0	0	1	1	1	1	1	1
0289																						1	1	0	1	1	1	1	1	1	1	1
0290																											0	0	0	0	0	1
0291																														0	0	
0292																												0		1	0	0
0300																	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0301																	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0302																	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0303																	1	1	1	1	1	1	1	1	1	0						
0304																	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
0305																	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0310																	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0311																	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0312																	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0315																	0	0	0	0	0	0	0				0	0	0	0	0	0
0316																	0	0	0													
0317																	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0318																	0	0	0													
0319																	0	0	0	0	0											
0320																	0	0														
0325																	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0326																	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0327																	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0328																	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0329																	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0330																	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0331																	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0332																	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0333																	1	1	1	1												
0334																	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0335																	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0336																	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0338																	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0340																	0															
0341																	0	0	0													
0342																	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0343																	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0344																	0	0	0	0	0	0	0									
0345																	1	1	1	1												
0346																	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
0347																	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1
0348																	1	1	1	0	0	0	0	0								
0349																	0	0	0	0	0	0	0									
0400									0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1								
0401													1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1
0402																											1	1	1	1	1	1
0403																											1	1	1	1	1	1
0404																											1	1	1	1	1	1
0405																											1	1	1	1	1	1
0406																											1	1	1	1	1	1
0407															0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0408																0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0409													0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0450																											1	1	1	1	1	1

LPS	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
0451																											1	1	1	1	1	1
0452																											1	1	1	1	1	1
0453																											1	1	1	1	1	1
0454																											1	1	1	1	1	1
0455																											1	1	1	1	1	1
0456																											1	1	1	1	1	1
0457																											1	1	1	1	1	1
0458																											0	0	1	1	1	1
0459																											1	1	1	1	1	1
0460																											1	1	1	0	0	0
0461																											1	1	1	1	1	1
0462																											1	1	1	1	1	1
0463																											1	1	1	1	1	1
0464																											1	1	1	1	1	1
0466																											1	1	1	0	0	0
0467																											1	1	1	1	1	1
0468																											1	1	1	1	1	1
0469																											1	1	1	1	1	1
0470																											1	1	1	1	1	1
0471																											1	1	1	1	1	1
0472																											1	1	1	1	1	1
0473																											1	1	1	1	1	1
0474																											1	1	1	1	1	1
0475																											0	1	1	1	0	1
0476																											1	1	1	1	1	1
0478																											1	1	1	1	1	1
0479																											1	1	1	1	1	1
0480																											1	1	1	1	1	1
0482																											1	1	1	0	1	1
0483																											0	0	0	1	0	0
0484																											1	1	1	1	1	1
0490										0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0491								0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0492														0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0493																		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0494																		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0495																0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0496																0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0497																		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0498																		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0499																0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0500																0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0501																0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0502																0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0503								0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0504																		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0505																		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0506																		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0508											0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0509																											0	0	0	0	0	0
0510	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	1	0	1	0	0	0	0	0	0	0
0511	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0512	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0
0513																										0	0	0	0	0	0	0
0514	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0515						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0516																					0	0	0	0	0	0	0	0	0	0	0	0
0517															0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

LPS	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
0518																		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0519																	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0520																1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0521																1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
0522																0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0523																1	1	1	1													
0524																				1	1	1	1	1	1	1	1	1	1	1	1	1
0525																1	1	1	1	1	1											
0526																1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0527																	0	0	0													
0528																0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0529																0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0530																0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0531																1	1	1	1	1	1	1										
0532																1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0533																1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0534																1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0535																		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0536																1	1	1	1	1	1	1	1	1	1	1	1					
0537																1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0538																1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0539																1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0540																0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
0541																0	0	0	0	0	0	0	0	0								
0542																1	1	1	1	1	0	1	1	1	0	0	0	0				
0543																0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0544																1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0545																1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0546																0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0547																1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0548																1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0549																1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0550																1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0551																1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
0552																0	0	0	0	0	0	0	0									
0553																													0	0	0	0
0554												0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1
0555																1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0556								0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0557	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0558																							0	1	1	1	0	0	0	0	0	
0559							1	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0560	1	1	0	0	0	0	0	0																								
0561	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
0562																										0	0	0	0	0	0	0
0563	1	1	1	0	0	0																										
0564															0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0565										0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
0566										0	0	0	0	0	0	0	0	0	0	0												
0567	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				0	0	0	0	0	0	0		0	0			
0568								0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0
0569	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	0
0570	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0571	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0572	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	0
0573	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
0574	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0575	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

LPS	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
0576	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0577	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0578																							0	1	1	1	1	1	1	1	1	1
0579	0	0	1	0	0	1	1	1	1	1	1	1	1																			
0580	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0582	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0584	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0585	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0586	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0587	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0588	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0589	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0590	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0592	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0593	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0594	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0595	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0596	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0597	0	0	0	0	1	1	0	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0599	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0600	0	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0601	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0602	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0603	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0604	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0605	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0606	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0607	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0608	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0609	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0610	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0611	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0612	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0613	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0614	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0615	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0616	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0617																													0		0	0
0618	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0													
0619	0	0	0	0	0	0	0	0	0	0	0	0	0	0									0					0	0			
0620	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0													
0621	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0													
8001	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8002	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8003	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8004	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8006	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8007	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8009	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8013	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8014	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8015	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8016	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8018	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
8019	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8020	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
8021	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
8022	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1

LPS	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
8023	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8024	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8025	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
8026	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
8027	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
8028	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8029	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8030	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
8031	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8032	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8034	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0
8036	1	1	1	1	0	0	0	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8037																									0	0	0	0	0	0	0	0
8038	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8039														0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8040	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8041	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	0	1
8042	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	0	0
8043																					0	0	0	0	0	0	0	0	0	0	0	1
8044	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	1	0	1
8045	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8046			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8047	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8048	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
8049																								0	0	0	0	0	0	0	0	0
8050			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8051	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8052	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8053																0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8054	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8055	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8056			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8057	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8058	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8059	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8060																	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8061			0	0			0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
8062	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
8063	0	0	0	0			0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8064	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8065	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0				0	0
8066															0	0	0	0	0	0	0	0	0	0	0		0	0	0		0	
8067	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
8068	0	0	0	0			0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0
8069	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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8072																			0	0	0	0	0							0	0	0
8078																												0				
8080	0	0	0	0			0	0	0	0	0	0	0	0	0	0	0	0	0	0		0		0								
8081	0	0	0	0			0	0	0	0	0	0	0	0	0	0			0		0	0	0			0		0	0	0		
8087	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8088	0	0	0	0			0	0	0	0	0	0	0	0	0	0	0	0												0		
8090																	0															
8094																				0			0						0			
8101	0	0	0	0			0	0	0	0	0	0	0	0	0	0			0	0	0		0	0		0		0	0	0	0	0
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LPS	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
8107																	0	0	0		0	0	0		0		0	0	0			
8108	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																
8110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0			0	0					
8111																		0	0	0	0		0								0	
8113																		0			0							0	0	0		0
8114	0	0	0	0			0	0	0	0	0	0	0	0	0	0		0		0	0						0					0
8115																	0															
8117																	0	0														
8119	0	0	0	0			0	0	0	0	0	0	0	0	0	0		0	0													
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8122																			0									0				0
8125	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																
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8132																								0								
8133																				0				0	0	0						
8134																															0	
8135																				0	0				0	0						0
8138																			0	0												0
8139																							0		0	0	0	0	0	0		0
8145	0	0	0	0			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
8146																	0								0	0	0	0		0		0
8148	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0									
8150																														1	0	0

11. ADJUSTMENTS

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11. ADJUSTMENTS

Chapter updated in March, 2023.

11.1. Adjustment applications by Spain

Spain has not requested new adjustment applications in 2023 reporting edition.

ANNEXES

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ANNEX 1. KEY CATEGORY ANALYSIS

Chapter updated in March 2023.

For clarification purposes, key categories are shown in bold.

A1.1. Analysis by level (2021)

Main Pollutants

NOx

NFR Code	NFR Category	Emissions (kt)	Level valuation	Accumulated total
1A3b	**Road transport**	**229.64**	**0.37**	**0.3701**
1A2	**Manufacturing Industries and Construction**	**103.53**	**0.17**	**0.5370**
3D	**Crop production and agricultural soils**	**74.36**	**0.12**	**0.6568**
5C	**Incineration**	**58.15**	**0.09**	**0.7505**
1A4c	**Agriculture/Forestry/Fishing**	**57.30**	**0.09**	**0.8429**
1A1a	**Public electricity and heat production**	**30.75**	**0.05**	**0.8924**
1A4a + 1A4b	**Commercial/institutional/residential**	**28.31**	**0.05**	**0.9381**
1A1b	**Petroleum refining**	**7.36**	**0.01**	**0.9499**
3B	**Manure management**	**7.11**	**0.01**	**0.9614**
1A3a	Aviation LTO (civil)	4.52	0.01	0.9687
1A3c + 1A3e + 1A5	Other transport	4.50	0.01	0.9759
1A3d	Navigation	4.15	0.01	0.9826
1B	Fugitive Emissions from Fuels	4.03	0.01	0.9891
1A1c	Manufacture of solid fuels and other energy industries	2.38	0.00	0.9929
2G + 2H + 2I + 2J + 2K + 2L	Other products use and industrial processes	1.79	0.00	0.9958
2C	Metal production	1.50	0.00	0.9982
3F	Field burning of agricultural wastes	0.62	0.00	0.9992
2B	Chemical industry	0.42	0.00	0.9999
5A	Biological treatment of waste: Solid waste disposal on land	0.03	0.00	1.0000

NMVOC

NFR Code	NFR Category	Emissions (kt)	Level valuation	Accumulated total
2D	**Solvents use**	**262.49**	**0.48**	**0.4777**
3B	**Manure management**	**73.23**	**0.13**	**0.6110**
1A4a + 1A4b	**Commercial/institutional/residential**	**41.16**	**0.07**	**0.6859**
3D	**Crop production and agricultural soils**	**38.25**	**0.07**	**0.7555**
2G + 2H + 2I + 2J + 2K + 2L	**Other products use and industrial processes**	**23.84**	**0.04**	**0.7989**
1A3b	**Road transport**	**22.28**	**0.04**	**0.8395**
1B	**Fugitive Emissions from Fuels**	**21.81**	**0.04**	**0.8792**

NFR Code	NFR Category	Emissions (kt)	Level valuation	Accumulated total
1A2	**Manufacturing Industries and Construction**	**21.69**	**0.04**	**0.9186**
5C	**Incineration**	**11.62**	**0.02**	**0.9398**
1A1a	**Public electricity and heat production**	**10.25**	**0.02**	**0.9585**
2B	Chemical industry	10.21	0.02	0.9770
1A4c	Agriculture/Forestry/Fishing	5.89	0.01	0.9878
5A	Biological treatment of waste: Solid waste disposal on land	3.39	0.01	0.9939
1A3d	Navigation	0.95	0.00	0.9956
2C	Metal production	0.76	0.00	0.9970
1A3a	Aviation LTO (civil)	0.39	0.00	0.9977
1A1b	Petroleum refining	0.37	0.00	0.9984
1A1c	Manufacture of solid fuels and other energy industries	0.28	0.00	0.9989
1A3c + 1A3e + 1A5	Other transport	0.27	0.00	0.9994
3F	Field burning of agricultural wastes	0.14	0.00	0.9997
5D	Wastewater handling	0.09	0.00	0.9998
2A	Mineral products	0.08	0.00	1.0000

SO_2

NFR Code	NFR Category	Emissions (kt)	Level valuation	Accumulated total
1A2	**Manufacturing Industries and Construction**	**54.03**	**0.44**	**0.4396**
1B	**Fugitive Emissions from Fuels**	**21.36**	**0.17**	**0.6134**
1A4a + 1A4b	**Commercial/institutional/residential**	**16.71**	**0.14**	**0.7494**
2C	**Metal production**	**7.66**	**0.06**	**0.8117**
1A1a	**Public electricity and heat production**	**5.54**	**0.05**	**0.8568**
2B	**Chemical industry**	**3.64**	**0.03**	**0.8864**
2G + 2H + 2I + 2J + 2K + 2L	**Other products use and industrial processes**	**3.39**	**0.03**	**0.9140**
1A3d	**Navigation**	**2.86**	**0.02**	**0.9372**
5C	**Incineration**	**2.36**	**0.02**	**0.9564**
1A1b	Petroleum refining	2.30	0.02	0.9751
1A4c	Agriculture/Forestry/Fishing	1.63	0.01	0.9884
1A1c	Manufacture of solid fuels and other energy industries	0.63	0.01	0.9935
1A3b	Road transport	0.30	0.00	0.9959
1A3a	Aviation LTO (civil)	0.27	0.00	0.9981
3F	Field burning of agricultural wastes	0.14	0.00	0.9992
1A3c + 1A3e + 1A5	Other transport	0.09	0.00	1.0000

NH_3

NFR Code	NFR Category	Emissions (kt)	Level valuation	Accumulated total
3D	**Crop production and agricultural soils**	**239.52**	**0.50**	**0.5003**
3B	**Manure management**	**223.15**	**0.47**	**0.9664**
1A4a + 1A4b	Commercial/institutional/residential	4.25	0.01	0.9752
5D	Wastewater handling	2.51	0.01	0.9805
1A3b	Road transport	2.43	0.01	0.9856
1A1a	Public electricity and heat production	1.87	0.00	0.9895
1A2	Manufacturing Industries and Construction	1.69	0.00	0.9930
2B	Chemical industry	1.03	0.00	0.9951
5B	Biological treatment of waste	1.03	0.00	0.9973
3F	Field burning of agricultural wastes	0.65	0.00	0.9987
2G + 2H + 2I + 2J + 2K + 2L	Other products use and industrial processes	0.38	0.00	0.9995
1A4c	Agriculture/Forestry/Fishing	0.12	0.00	0.9997
2A	Mineral products	0.12	0.00	1.0000

Particulate Matter

$PM_{2.5}$

NFR Code	NFR Category	Emissions (kt)	Level valuation	Accumulated total
5C	**Incineration**	**53.47**	**0.40**	**0.3961**
1A4a + 1A4b	**Commercial/institutional/residential**	**36.16**	**0.27**	**0.6639**
1A3b	**Road transport**	**12.93**	**0.10**	**0.7597**
1A2	**Manufacturing Industries and Construction**	**9.15**	**0.07**	**0.8275**
1A1a	**Public electricity and heat production**	**3.24**	**0.02**	**0.8515**
2A	**Mineral products**	**2.47**	**0.02**	**0.8698**
2G + 2H + 2I + 2J + 2K + 2L	**Other products use and industrial processes**	**2.46**	**0.02**	**0.8880**
1A4c	**Agriculture/Forestry/Fishing**	**2.43**	**0.02**	**0.9061**
3D	**Crop production and agricultural soils**	**1.87**	**0.01**	**0.9199**
3B	**Manure management**	**1.86**	**0.01**	**0.9337**
2B	**Chemical industry**	**1.63**	**0.01**	**0.9457**
3F	**Field burning of agricultural wastes**	**1.47**	**0.01**	**0.9566**
5E	Other waste	1.41	0.01	0.9670
1A1c	Manufacture of solid fuels and other energy industries	1.36	0.01	0.9771
2C	Metal production	1.36	0.01	0.9872
1A3d	Navigation	1.19	0.01	0.9961
1B	Fugitive Emissions from Fuels	0.18	0.00	0.9974
1A1b	Petroleum refining	0.16	0.00	0.9986

NFR Code	NFR Category	Emissions (kt)	Level valuation	Accumulated total
1A3c + 1A3e + 1A5	Other transport	0.09	0.00	0.9992
2D	Solvents use	0.05	0.00	0.9996
1A3a	Aviation LTO (civil)	0.04	0.00	0.9999
5A	Biological treatment of waste: Solid waste disposal on land	0.01	0.00	1.0000

PM_{10}

NFR Code	NFR Category	Emissions (kt)	Level valuation	Accumulated total
5C	**Incineration**	**56.72**	**0.26**	**0.2635**
3D	**Crop production and agricultural soils**	**42.65**	**0.20**	**0.4616**
1A4a + 1A4b	**Commercial/institutional/residential**	**37.49**	**0.17**	**0.6357**
2A	**Mineral products**	**17.60**	**0.08**	**0.7175**
1A3b	**Road transport**	**17.16**	**0.08**	**0.7972**
3B	**Manure management**	**12.19**	**0.06**	**0.8538**
1A2	**Manufacturing Industries and Construction**	**10.18**	**0.05**	**0.9010**
1A1a	**Public electricity and heat production**	**4.06**	**0.02**	**0.9199**
2G + 2H + 2I + 2J + 2K + 2L	**Other products use and industrial processes**	**2.83**	**0.01**	**0.9330**
1A4c	**Agriculture/Forestry/Fishing**	**2.48**	**0.01**	**0.9445**
2B	**Chemical industry**	**2.21**	**0.01**	**0.9548**
1A1c	Manufacture of solid fuels and other energy industries	2.16	0.01	0.9648
2C	Metal production	1.93	0.01	0.9738
3F	Field burning of agricultural wastes	1.55	0.01	0.9810
5E	Other waste	1.41	0.01	0.9875
1A3d	Navigation	1.40	0.01	0.9940
2D	Solvents use	0.57	0.00	0.9967
1B	Fugitive Emissions from Fuels	0.39	0.00	0.9985
1A1b	Petroleum refining	0.16	0.00	0.9993
1A3c + 1A3e + 1A5	Other transport	0.10	0.00	0.9997
1A3a	Aviation LTO (civil)	0.04	0.00	0.9999
5A	Biological treatment of waste: Solid waste disposal on land	0.02	0.00	1.0000

TSP

NFR Code	NFR Category	Emissions (kt)	Level valuation	Accumulated total
5C	**Incineration**	**57.86**	**0.19**	**0.1948**
3B	**Manure management**	**50.97**	**0.17**	**0.3664**

NFR Code	NFR Category	Emissions (kt)	Level valuation	Accumulated total
2A	**Mineral products**	**43.64**	**0.15**	**0.5133**
3D	**Crop production and agricultural soils**	**42.65**	**0.14**	**0.6568**
1A4a + 1A4b	**Commercial/institutional/residential**	**39.72**	**0.13**	**0.7906**
1A3b	**Road transport**	**22.87**	**0.08**	**0.8676**
1A2	**Manufacturing Industries and Construction**	**12.34**	**0.04**	**0.9091**
1A1a	**Public electricity and heat production**	**5.62**	**0.02**	**0.9280**
2C	**Metal production**	**3.72**	**0.01**	**0.9405**
2G + 2H + 2I + 2J + 2K + 2L	**Other products use and industrial processes**	**3.46**	**0.01**	**0.9522**
2B	Chemical industry	2.83	0.01	0.9617
1A4c	Agriculture/Forestry/Fishing	2.49	0.01	0.9701
1A1c	Manufacture of solid fuels and other energy industries	2.22	0.01	0.9776
3F	Field burning of agricultural wastes	1.57	0.01	0.9829
5E	Other waste	1.41	0.00	0.9876
1A3d	Navigation	1.40	0.00	0.9924
2D	Solvents use	1.20	0.00	0.9964
1B	Fugitive Emissions from Fuels	0.74	0.00	0.9989
1A1b	Petroleum refining	0.17	0.00	0.9994
1A3c + 1A3e + 1A5	Other transport	0.11	0.00	0.9998
1A3a	Aviation LTO (civil)	0.04	0.00	0.9999
5A	Biological treatment of waste: Solid waste disposal on land	0.02	0.00	1.0000

BC

NFR Code	NFR Category	Emissions (kt)	Level valuation	Accumulated total
5C	**Incineration**	**29.88**	**0.65**	**0.6466**
1A3b	**Road transport**	**6.68**	**0.14**	**0.7911**
1A4a + 1A4b	**Commercial/institutional/residential**	**4.32**	**0.09**	**0.8844**
1A2	**Manufacturing Industries and Construction**	**2.17**	**0.05**	**0.9313**
1A4c	**Agriculture/Forestry/Fishing**	**1.38**	**0.03**	**0.9612**
2G + 2H + 2I + 2J + 2K + 2L	Other products use and industrial processes	0.70	0.02	0.9763
1A1c	Manufacture of solid fuels and other energy industries	0.65	0.01	0.9905
3F	Field burning of agricultural wastes	0.14	0.00	0.9934
1A1a	Public electricity and heat production	0.10	0.00	0.9956
2C	Metal production	0.05	0.00	0.9967
1A3c + 1A3e + 1A5	Other transport	0.05	0.00	0.9977
1A3d	Navigation	0.03	0.00	0.9984

NFR Code	NFR Category	Emissions (kt)	Level valuation	Accumulated total
2B	Chemical industry	0.03	0.00	0.9990
1A1b	Petroleum refining	0.02	0.00	0.9995
1A3a	Aviation LTO (civil)	0.02	0.00	0.9999
2A	Mineral products	0.00	0.00	0.9999
2D	Solvents use	0.00	0.00	1.0000

CO and Priority Heavy Metals

CO

NFR Code	NFR Category	Emissions (kt)	Level valuation	Accumulated total
5C	**Incineration**	**729.93**	**0.45**	**0.4460**
1A4a + 1A4b	**Commercial/institutional/residential**	**278.50**	**0.17**	**0.6161**
1A3b	**Road transport**	**212.87**	**0.13**	**0.7462**
1A2	**Manufacturing Industries and Construction**	**178.34**	**0.11**	**0.8552**
2C	**Metal production**	**115.96**	**0.07**	**0.9260**
1A1a	**Public electricity and heat production**	**29.20**	**0.02**	**0.9439**
1A4c	**Agriculture/Forestry/Fishing**	**28.52**	**0.02**	**0.9613**
2B	Chemical industry	20.17	0.01	0.9736
3F	Field burning of agricultural wastes	18.11	0.01	0.9847
2G + 2H + 2I + 2J + 2K + 2L	Other products use and industrial processes	12.38	0.01	0.9922
1A3a	Aviation LTO (civil)	3.16	0.00	0.9942
1A3d	Navigation	2.02	0.00	0.9954
1A1c	Manufacture of solid fuels and other energy industries	1.95	0.00	0.9966
1B	Fugitive Emissions from Fuels	1.91	0.00	0.9978
1A1b	Petroleum refining	1.74	0.00	0.9988
1A3c + 1A3e + 1A5	Other transport	1.08	0.00	0.9995
5A	Biological treatment of waste: Solid waste disposal on land	0.58	0.00	0.9998
5D	Wastewater handling	0.18	0.00	0.9999
5B	Biological treatment of waste	0.10	0.00	1.0000

Pb

NFR Code	NFR Category	Emissions (t)	Level valuation	Accumulated total
2C	**Metal production**	**34.08**	**0.34**	**0.3384**
1A3b	**Road transport**	**32.00**	**0.32**	**0.6562**
1A2	**Manufacturing Industries and Construction**	**10.38**	**0.10**	**0.7593**

NFR Code	NFR Category	Emissions (t)	Level valuation	Accumulated total
5C	**Incineration**	**10.14**	**0.10**	**0.8599**
2A	**Mineral products**	**9.29**	**0.09**	**0.9522**
1A4a + 1A4b	Commercial/institutional/residential	3.52	0.03	0.9872
1A1a	Public electricity and heat production	0.43	0.00	0.9915
1A3a	Aviation LTO (civil)	0.33	0.00	0.9947
1A1b	Petroleum refining	0.17	0.00	0.9964
1A3c + 1A3e + 1A5	Other transport	0.13	0.00	0.9977
1A4c	Agriculture/Forestry/Fishing	0.11	0.00	0.9988
1A3d	Navigation	0.08	0.00	0.9996
3F	Field burning of agricultural wastes	0.03	0.00	0.9999
1A1c	Manufacture of solid fuels and other energy industries	0.01	0.00	0.9999
5E	Other waste	0.00	0.00	1.0000

Cd

NFR Code	NFR Category	Emissions (t)	Level valuation	Accumulated total
5C	**Incineration**	**1.57**	**0.23**	**0.2292**
2C	**Metal production**	**1.47**	**0.21**	**0.4439**
1A4a + 1A4b	**Commercial/institutional/residential**	**1.06**	**0.16**	**0.5992**
1A2	**Manufacturing Industries and Construction**	**0.85**	**0.12**	**0.7236**
2A	**Mineral products**	**0.40**	**0.06**	**0.7819**
1A1a	**Public electricity and heat production**	**0.37**	**0.05**	**0.8353**
2G + 2H + 2I + 2J + 2K + 2L	**Other products use and industrial processes**	**0.30**	**0.04**	**0.8792**
1A3b	**Road transport**	**0.28**	**0.04**	**0.9199**
3F	**Field burning of agricultural wastes**	**0.24**	**0.03**	**0.9548**
1A1b	Petroleum refining	0.23	0.03	0.9880
1A4c	Agriculture/Forestry/Fishing	0.07	0.01	0.9976
5E	Other waste	0.01	0.00	0.9987
1A3d	Navigation	0.01	0.00	0.9998
1A3c + 1A3e + 1A5	Other transport	0.00	0.00	0.9999
1B	Fugitive Emissions from Fuels	0.00	0.00	1.0000

Hg

NFR Code	NFR Category	Emissions (t)	Level valuation	Accumulated total
2C	**Metal production**	**1.14**	**0.39**	**0.3853**
1A2	**Manufacturing Industries and Construction**	**0.63**	**0.21**	**0.5978**

NFR Code	NFR Category	Emissions (t)	Level valuation	Accumulated total
5C	**Incineration**	**0.40**	**0.13**	**0.7327**
1A1a	**Public electricity and heat production**	**0.29**	**0.10**	**0.8294**
1A3b	**Road transport**	**0.15**	**0.05**	**0.8793**
1A4a + 1A4b	**Commercial/institutional/residential**	**0.13**	**0.04**	**0.9225**
2D	**Solvents use**	**0.10**	**0.04**	**0.9580**
1A1b	Petroleum refining	0.04	0.02	0.9732
3F	Field burning of agricultural wastes	0.04	0.01	0.9861
1A4c	Agriculture/Forestry/Fishing	0.01	0.00	0.9907
1A3d	Navigation	0.01	0.00	0.9951
5E	Other waste	0.01	0.00	0.9979
2A	Mineral products	0.00	0.00	0.9987
1A1c	Manufacture of solid fuels and other energy industries	0.00	0.00	0.9993
1A3c + 1A3e + 1A5	Other transport	0.00	0.00	0.9996
1A3a	Aviation LTO (civil)	0.00	0.00	0.9999
1B	Fugitive Emissions from Fuels	0.00	0.00	1.0000

POPs

PCDD/PCDF

NFR Code	NFR Category	Emissions (g)	Level valuation	Accumulated total
5C	**Incineration**	**335.67**	**0.70**	**0.7037**
2C	**Metal production**	**65.41**	**0.14**	**0.8408**
1A4a + 1A4b	**Commercial/institutional/residential**	**38.45**	**0.08**	**0.9214**
5E	**Other waste**	**14.41**	**0.03**	**0.9516**
1A3b	Road transport	10.70	0.02	0.9740
1A2	Manufacturing Industries and Construction	9.01	0.02	0.9929
1A1a	Public electricity and heat production	1.89	0.00	0.9969
1A1c	Manufacture of solid fuels and other energy industries	0.85	0.00	0.9987
1A4c	Agriculture/Forestry/Fishing	0.34	0.00	0.9994
1A3d	Navigation	0.14	0.00	0.9997
3F	Field burning of agricultural wastes	0.14	0.00	1.0000

PAHs

NFR Code	NFR Category	Emissions (t)	Level valuation	Accumulated total
1A4a + 1A4b	**Commercial/institutional/residential**	**20.16**	**0.55**	**0.5546**
2C	**Metal production**	**8.63**	**0.24**	**0.7919**

NFR Code	NFR Category	Emissions (t)	Level valuation	Accumulated total
1A2	**Manufacturing Industries and Construction**	**2.26**	**0.06**	**0.8541**
1A3b	**Road transport**	**2.22**	**0.06**	**0.9153**
1A1a	**Public electricity and heat production**	**0.98**	**0.03**	**0.9423**
3F	**Field burning of agricultural wastes**	**0.62**	**0.02**	**0.9594**
1B	Fugitive Emissions from Fuels	0.50	0.01	0.9733
5C	Incineration	0.46	0.01	0.9861
1A4c	Agriculture/Forestry/Fishing	0.44	0.01	0.9981
1A3d	Navigation	0.02	0.00	0.9987
1A1c	Manufacture of solid fuels and other energy industries	0.02	0.00	0.9992
2G + 2H + 2I + 2J + 2K + 2L	Other products use and industrial processes	0.01	0.00	0.9995
1A3c + 1A3e + 1A5	Other transport	0.01	0.00	0.9999
1A3a	Aviation LTO (civil)	0.00	0.00	1.0000

HCB

NFR Code	NFR Category	Emissions (kg)	Level valuation	Accumulated total
1A1a	**Public electricity and heat production**	**0.60**	**0.29**	**0.2919**
1A2	**Manufacturing Industries and Construction**	**0.51**	**0.25**	**0.5385**
1A4a + 1A4b	**Commercial/institutional/residential**	**0.41**	**0.20**	**0.7395**
5C	**Incineration**	**0.25**	**0.12**	**0.8618**
2C	**Metal production**	**0.14**	**0.07**	**0.9320**
1A3d	**Navigation**	**0.05**	**0.03**	**0.9584**
3D	Crop production and agricultural soils	0.04	0.02	0.9801
1A4c	Agriculture/Forestry/Fishing	0.04	0.02	0.9994
1A3c + 1A3e + 1A5	Other transport	0.00	0.00	1.0000

PCBs

NFR Code	NFR Category	Emissions (kg)	Level valuation	Accumulated total
2G + 2H + 2I + 2J + 2K + 2L	**Other products use and industrial processes**	**415.74**	**0.92**	**0.9219**
2C	**Metal production**	**24.57**	**0.05**	**0.9764**
1A2	Manufacturing Industries and Construction	7.02	0.02	0.9920
1A3b	Road transport	2.21	0.00	0.9969
1A4a + 1A4b	Commercial/institutional/residential	0.90	0.00	0.9989
5C	Incineration	0.29	0.00	0.9995
1A3d	Navigation	0.14	0.00	0.9998
1A1a	Public electricity and heat production	0.06	0.00	1.0000

A1.2. Analysis by trend (2021)

Main Pollutants

NOx

NFR Code	NFR Category	Emissions (kt) 1990	Emissions (kt) 2021	Rating trend	Contribution to the trend	Accumulated total
1A1a	**Public electricity and heat production**	**208.04**	**30.75**	**0.05**	**0.25**	**0.2508**
5C	**Incineration**	**35.12**	**58.15**	**0.03**	**0.15**	**0.4047**
3D	**Crop production and agricultural soils**	**70.23**	**74.36**	**0.03**	**0.15**	**0.5571**
1A3d	**Navigation**	**75.40**	**4.15**	**0.02**	**0.12**	**0.6740**
1A3b	**Road transport**	**527.40**	**229.64**	**0.02**	**0.07**	**0.7477**
1A4a + 1A4b	**Commercial/institutional/residential**	**21.96**	**28.31**	**0.01**	**0.07**	**0.8141**
1A2	**Manufacturing Industries and Construction**	**188.76**	**103.53**	**0.01**	**0.05**	**0.8668**
1A4c	**Agriculture/Forestry/Fishing**	**100.75**	**57.30**	**0.01**	**0.04**	**0.9025**
3F	**Field burning of agricultural wastes**	**21.67**	**0.62**	**0.01**	**0.04**	**0.9382**
3B	**Manure management**	**6.05**	**7.11**	**0.00**	**0.02**	**0.9539**
2B	Chemical industry	7.92	0.42	0.00	0.01	0.9662
1A3a	Aviation LTO (civil)	2.81	4.52	0.00	0.01	0.9781
1A1b	Petroleum refining	19.66	7.36	0.00	0.01	0.9853
2G + 2H + 2I + 2J + 2K + 2L	Other products use and industrial processes	1.38	1.79	0.00	0.00	0.9895
1B	Fugitive Emissions from Fuels	6.35	4.03	0.00	0.00	0.9933
2C	Metal production	1.35	1.50	0.00	0.00	0.9964
1A1c	Manufacture of solid fuels and other energy industries	6.75	2.38	0.00	0.00	0.9994
1A3c + 1A3e + 1A5	Other transport	9.77	4.50	0.00	0.00	0.9999
5A	Biological treatment of waste: Solid waste disposal on land	0.00	0.03	0.00	0.00	1.0000

NMVOC

NFR Code	NFR Category	Emissions (kt) 1990	Emissions (kt) 2021	Rating trend	Contribution to the trend	Accumulated total
1A3b	**Road transport**	**324.80**	**22.28**	**0.15**	**0.43**	**0.4284**
2D	**Solvents use**	**388.44**	**262.49**	**0.05**	**0.15**	**0.5820**
3B	**Manure management**	**60.58**	**73.23**	**0.04**	**0.12**	**0.6971**
3F	**Field burning of agricultural wastes**	**40.07**	**0.14**	**0.02**	**0.06**	**0.7573**
3D	**Crop production and agricultural soils**	**33.64**	**38.25**	**0.02**	**0.06**	**0.8144**
1A4a + 1A4b	**Commercial/institutional/residential**	**43.90**	**41.16**	**0.02**	**0.05**	**0.8642**
2G + 2H + 2I + 2J + 2K + 2L	**Other products use and industrial processes**	**21.95**	**23.84**	**0.01**	**0.03**	**0.8983**
1A1a	**Public electricity and heat production**	**0.76**	**10.25**	**0.01**	**0.03**	**0.9261**
2B	**Chemical industry**	**6.07**	**10.21**	**0.01**	**0.02**	**0.9458**
5C	**Incineration**	**8.87**	**11.62**	**0.01**	**0.02**	**0.9652**

NFR Code	NFR Category	Emissions (kt) 1990	Emissions (kt) 2021	Rating trend	Contribution to the trend	Accumulated total
1A2	Manufacturing Industries and Construction	30.29	21.69	0.01	0.02	0.9806
5A	Biological treatment of waste: Solid waste disposal on land	2.08	3.39	0.00	0.01	0.9870
1A4c	Agriculture/Forestry/Fishing	13.79	5.89	0.00	0.00	0.9912
1B	Fugitive Emissions from Fuels	43.23	21.81	0.00	0.00	0.9950
5E	Other waste	1.21	0.01	0.00	0.00	0.9968
1A3d	Navigation	2.51	0.95	0.00	0.00	0.9980
1A3a	Aviation LTO (civil)	0.26	0.39	0.00	0.00	0.9987
1A1b	Petroleum refining	0.36	0.37	0.00	0.00	0.9992
1A3c + 1A3e + 1A5	Other transport	0.74	0.27	0.00	0.00	0.9995
5D	Wastewater handling	0.03	0.09	0.00	0.00	0.9998
2A	Mineral products	0.02	0.08	0.00	0.00	0.9999
1A1c	Manufacture of solid fuels and other energy industries	0.55	0.28	0.00	0.00	1.0000

SO_2

NFR Code	NFR Category	Emissions (kt) 1990	Emissions (kt) 2021	Rating trend	Contribution to the trend	Accumulated total
1A1a	**Public electricity and heat production**	**1407.36**	**5.54**	**0.04**	**0.45**	**0.4491**
1A2	**Manufacturing Industries and Construction**	**279.43**	**54.03**	**0.02**	**0.21**	**0.6613**
1B	**Fugitive Emissions from Fuels**	**63.12**	**21.36**	**0.01**	**0.10**	**0.7614**
1A4a + 1A4b	**Commercial/institutional/residential**	**25.00**	**16.71**	**0.01**	**0.09**	**0.8480**
2C	**Metal production**	**6.05**	**7.66**	**0.00**	**0.04**	**0.8896**
1A1b	**Petroleum refining**	**125.55**	**2.30**	**0.00**	**0.03**	**0.9194**
1A3b	**Road transport**	**65.51**	**0.30**	**0.00**	**0.02**	**0.9401**
2G + 2H + 2I + 2J + 2K + 2L	**Other products use and industrial processes**	**2.35**	**3.39**	**0.00**	**0.02**	**0.9585**
2B	Chemical industry	9.95	3.64	0.00	0.02	0.9759
5C	Incineration	1.82	2.36	0.00	0.01	0.9887
1A3d	Navigation	34.05	2.86	0.00	0.00	0.9934
1A4c	Agriculture/Forestry/Fishing	14.00	1.63	0.00	0.00	0.9979
1A3a	Aviation LTO (civil)	0.19	0.27	0.00	0.00	0.9993
3F	Field burning of agricultural wastes	3.15	0.14	0.00	0.00	0.9996
1A3c + 1A3e + 1A5	Other transport	1.05	0.09	0.00	0.00	0.9998
1A1c	Manufacture of solid fuels and other energy industries	11.02	0.63	0.00	0.00	1.0000

NH_3

NFR Code	NFR Category	Emissions (kt) 1990	Emissions (kt) 2021	Rating trend	Contribution to the trend	Accumulated total
3B	**Manure management**	**201.26**	**223.15**	**0.05**	**0.43**	**0.4303**
3F	**Field burning of agricultural wastes**	**22.16**	**0.65**	**0.04**	**0.35**	**0.7788**
5D	**Wastewater handling**	**8.22**	**2.51**	**0.01**	**0.09**	**0.8705**
1A3b	**Road transport**	**0.34**	**2.43**	**0.00**	**0.03**	**0.9053**

NFR Code	NFR Category	Emissions (kt) 1990	Emissions (kt) 2021	Rating trend	Contribution to the trend	Accumulated total
2B	**Chemical industry**	**2.92**	**1.03**	**0.00**	**0.03**	**0.9355**
1A4a + 1A4b	**Commercial/institutional/residential**	**5.46**	**4.25**	**0.00**	**0.02**	**0.9537**
3D	Crop production and agricultural soils	245.55	239.52	0.00	0.02	0.9705
5B	Biological treatment of waste	0.27	1.03	0.00	0.01	0.9832
1A2	Manufacturing Industries and Construction	2.11	1.69	0.00	0.01	0.9894
2G + 2H + 2I + 2J + 2K + 2L	Other products use and industrial processes	0.15	0.38	0.00	0.00	0.9933
5E	Other waste	0.15	0.00	0.00	0.00	0.9957
1A4c	Agriculture/Forestry/Fishing	0.01	0.12	0.00	0.00	0.9975
1A1c	Manufacture of solid fuels and other energy industries	0.08	0.00	0.00	0.00	0.9988
2A	Mineral products	0.06	0.12	0.00	0.00	0.9998
1B	Fugitive Emissions from Fuels	0.02	0.01	0.00	0.00	0.9999
1A3d	Navigation	0.01	0.00	0.00	0.00	1.0000

Particulate Matter

$PM_{2.5}$

NFR Code	NFR Category	Emissions (kt) 2000	Emissions (kt) 2021	Rating trend	Contribution to the trend	Accumulated total
5C	**Incineration**	**39.27**	**53.47**	**0.13**	**0.43**	**0.4265**
3F	**Field burning of agricultural wastes**	**19.29**	**1.47**	**0.07**	**0.22**	**0.6422**
1A3b	**Road transport**	**25.75**	**12.93**	**0.03**	**0.10**	**0.7421**
1A1a	**Public electricity and heat production**	**10.05**	**3.24**	**0.02**	**0.07**	**0.8121**
1A4c	**Agriculture/Forestry/Fishing**	**6.88**	**2.43**	**0.01**	**0.04**	**0.8563**
2G + 2H + 2I + 2J + 2K + 2L	**Other products use and industrial processes**	**1.12**	**2.46**	**0.01**	**0.03**	**0.8844**
1A2	**Manufacturing Industries and Construction**	**14.74**	**9.15**	**0.01**	**0.03**	**0.9116**
1A4a + 1A4b	**Commercial/institutional/residential**	**51.74**	**36.16**	**0.01**	**0.03**	**0.9375**
1A1c	**Manufacture of solid fuels and other energy industries**	**0.16**	**1.36**	**0.01**	**0.02**	**0.9589**
1A1b	Petroleum refining	1.15	0.16	0.00	0.01	0.9705
3B	Manure management	1.96	1.86	0.00	0.01	0.9779
1A3d	Navigation	1.08	1.19	0.00	0.01	0.9848
3D	Crop production and agricultural soils	2.11	1.87	0.00	0.01	0.9905
2B	Chemical industry	1.99	1.63	0.00	0.00	0.9936
1B	Fugitive Emissions from Fuels	0.48	0.18	0.00	0.00	0.9965
2A	Mineral products	3.54	2.47	0.00	0.00	0.9982
5E	Other waste	1.88	1.41	0.00	0.00	0.9990
1A3c + 1A3e + 1A5	Other transport	0.17	0.09	0.00	0.00	0.9996
5A	Biological treatment of waste: Solid waste disposal on land	0.00	0.01	0.00	0.00	0.9997
2D	Solvents use	0.08	0.05	0.00	0.00	0.9998
1A3a	Aviation LTO (civil)	0.05	0.04	0.00	0.00	0.9999
2C	Metal production	1.88	1.36	0.00	0.00	1.0000

PM_{10}

NFR Code	NFR Category	Emissions (kt) 2000	Emissions (kt) 2021	Rating trend	Contribution to the trend	Accumulated total
5C	**Incineration**	**41.66**	**56.72**	**0.09**	**0.31**	**0.3076**
3F	**Field burning of agricultural wastes**	**20.23**	**1.55**	**0.04**	**0.15**	**0.4616**
1A1a	**Public electricity and heat production**	**22.50**	**4.06**	**0.04**	**0.14**	**0.6056**
3D	**Crop production and agricultural soils**	**47.92**	**42.65**	**0.03**	**0.09**	**0.6957**
3B	**Manure management**	**10.96**	**12.19**	**0.01**	**0.05**	**0.7448**
1A3b	**Road transport**	**29.29**	**17.16**	**0.01**	**0.05**	**0.7937**
2A	**Mineral products**	**29.29**	**17.60**	**0.01**	**0.04**	**0.8374**
1A2	**Manufacturing Industries and Construction**	**18.00**	**10.18**	**0.01**	**0.03**	**0.8717**
1A4c	**Agriculture/Forestry/Fishing**	**7.01**	**2.48**	**0.01**	**0.03**	**0.9024**
1A1c	**Manufacture of solid fuels and other energy industries**	**0.24**	**2.16**	**0.01**	**0.02**	**0.9255**
2G + 2H + 2I + 2J + 2K + 2L	**Other products use and industrial processes**	**1.41**	**2.83**	**0.01**	**0.02**	**0.9465**
1A4a + 1A4b	**Commercial/institutional/residential**	**53.78**	**37.49**	**0.01**	**0.02**	**0.9664**
1A1b	Petroleum refining	1.60	0.16	0.00	0.01	0.9782
1B	Fugitive Emissions from Fuels	1.44	0.39	0.00	0.01	0.9858
1A3d	Navigation	1.27	1.40	0.00	0.01	0.9913
2C	Metal production	3.02	1.93	0.00	0.00	0.9945
2B	Chemical industry	2.68	2.21	0.00	0.00	0.9975
2D	Solvents use	0.95	0.57	0.00	0.00	0.9989
5E	Other waste	1.88	1.41	0.00	0.00	0.9994
1A3c + 1A3e + 1A5	Other transport	0.18	0.10	0.00	0.00	0.9998
5A	Biological treatment of waste: Solid waste disposal on land	0.01	0.02	0.00	0.00	0.9999
1A3a	Aviation LTO (civil)	0.05	0.04	0.00	0.00	1.0000

TSP

NFR Code	NFR Category	Emissions (kt) 2000	Emissions (kt) 2021	Rating trend	Contribution to the trend	Accumulated total
5C	**Incineration**	**42.56**	**57.86**	**0.07**	**0.22**	**0.2229**
3B	**Manure management**	**39.65**	**50.97**	**0.05**	**0.18**	**0.4061**
1A1a	**Public electricity and heat production**	**35.53**	**5.62**	**0.05**	**0.17**	**0.5758**
3F	**Field burning of agricultural wastes**	**20.55**	**1.57**	**0.03**	**0.11**	**0.6879**
2A	**Mineral products**	**77.96**	**43.64**	**0.03**	**0.11**	**0.7991**
3D	**Crop production and agricultural soils**	**47.92**	**42.65**	**0.02**	**0.06**	**0.8627**
1A2	**Manufacturing Industries and Construction**	**21.30**	**12.34**	**0.01**	**0.03**	**0.8896**
1A4c	**Agriculture/Forestry/Fishing**	**7.04**	**2.49**	**0.01**	**0.02**	**0.9117**
1A4a + 1A4b	**Commercial/institutional/residential**	**57.15**	**39.72**	**0.01**	**0.02**	**0.9289**
1A3b	**Road transport**	**34.03**	**22.87**	**0.00**	**0.02**	**0.9456**
1A1c	**Manufacture of solid fuels and other energy industries**	**0.34**	**2.22**	**0.00**	**0.02**	**0.9620**
1A1b	Petroleum refining	2.06	0.17	0.00	0.01	0.9731

NFR Code	NFR Category	Emissions (kt) 2000	Emissions (kt) 2021	Rating trend	Contribution to the trend	Accumulated total
1B	Fugitive Emissions from Fuels	2.71	0.74	0.00	0.01	0.9835
2G + 2H + 2I + 2J + 2K + 2L	Other products use and industrial processes	3.64	3.46	0.00	0.01	0.9902
1A3d	Navigation	1.27	1.40	0.00	0.00	0.9941
2B	Chemical industry	3.40	2.83	0.00	0.00	0.9970
2D	Solvents use	1.89	1.20	0.00	0.00	0.9985
2C	Metal production	5.22	3.72	0.00	0.00	0.9993
5E	Other waste	1.88	1.41	0.00	0.00	0.9996
1A3c + 1A3e + 1A5	Other transport	0.19	0.11	0.00	0.00	0.9999
5A	Biological treatment of waste: Solid waste disposal on land	0.01	0.02	0.00	0.00	1.0000

BC

NFR Code	NFR Category	Emissions (kt) 2000	Emissions (kt) 2021	Rating trend	Contribution to the trend	Accumulated total
5C	**Incineration**	**21.92**	**29.88**	**0.20**	**0.46**	**0.4550**
1A3b	**Road transport**	**14.19**	**6.68**	**0.11**	**0.24**	**0.6955**
3F	**Field burning of agricultural wastes**	**2.24**	**0.14**	**0.03**	**0.08**	**0.7723**
1A2	**Manufacturing Industries and Construction**	**4.49**	**2.17**	**0.03**	**0.07**	**0.8461**
1A4c	**Agriculture/Forestry/Fishing**	**3.54**	**1.38**	**0.03**	**0.07**	**0.9182**
1A4a + 1A4b	**Commercial/institutional/residential**	**5.71**	**4.32**	**0.01**	**0.03**	**0.9462**
1A1c	**Manufacture of solid fuels and other energy industries**	**0.07**	**0.65**	**0.01**	**0.03**	**0.9713**
2G + 2H + 2I + 2J + 2K + 2L	Other products use and industrial processes	0.27	0.70	0.01	0.02	0.9911
1A1a	Public electricity and heat production	0.24	0.10	0.00	0.00	0.9956
1A1b	Petroleum refining	0.08	0.02	0.00	0.00	0.9974
1A3c + 1A3e + 1A5	Other transport	0.10	0.05	0.00	0.00	0.9990
2C	Metal production	0.07	0.05	0.00	0.00	0.9994
1A3a	Aviation LTO (civil)	0.03	0.02	0.00	0.00	0.9997
2B	Chemical industry	0.04	0.03	0.00	0.00	0.9998
1A3d	Navigation	0.04	0.03	0.00	0.00	0.9999
2D	Solvents use	0.00	0.00	0.00	0.00	1.0000

CO and Priority Heavy Metals

CO

NFR Code	NFR Category	Emissions (kt) 1990	Emissions (kt) 2021	Rating trend	Contribution to the trend	Accumulated total
1A3b	**Road transport**	**2088.05**	**212.87**	**0.15**	**0.36**	**0.3575**
5C	**Incineration**	**437.24**	**729.93**	**0.14**	**0.32**	**0.6779**
3F	**Field burning of agricultural wastes**	**664.72**	**18.11**	**0.06**	**0.14**	**0.8204**
1A4a + 1A4b	**Commercial/institutional/residential**	**399.52**	**278.50**	**0.03**	**0.07**	**0.8891**
1A2	**Manufacturing Industries and Construction**	**268.43**	**178.34**	**0.02**	**0.04**	**0.9302**

NFR Code	NFR Category	Emissions (kt) 1990	Emissions (kt) 2021	Rating trend	Contribution to the trend	Accumulated total
2C	**Metal production**	**151.65**	**115.96**	**0.01**	**0.03**	**0.9622**
1A1a	Public electricity and heat production	6.61	29.20	0.01	0.02	0.9775
1A4c	Agriculture/Forestry/Fishing	36.31	28.52	0.00	0.01	0.9856
2B	Chemical industry	22.61	20.17	0.00	0.01	0.9920
2G + 2H + 2I + 2J + 2K + 2L	Other products use and industrial processes	8.01	12.38	0.00	0.01	0.9973
1A3a	Aviation LTO (civil)	2.93	3.16	0.00	0.00	0.9985
1A1b	Petroleum refining	2.26	1.74	0.00	0.00	0.9990
1B	Fugitive Emissions from Fuels	2.69	1.91	0.00	0.00	0.9995
5A	Biological treatment of waste: Solid waste disposal on land	0.07	0.58	0.00	0.00	0.9998
5D	Wastewater handling	0.15	0.18	0.00	0.00	0.9998
1A3c + 1A3e + 1A5	Other transport	2.45	1.08	0.00	0.00	0.9999
1A1c	Manufacture of solid fuels and other energy industries	4.63	1.95	0.00	0.00	1.0000

Pb

NFR Code	NFR Category	Emissions (t) 1990	Emissions (t) 2021	Rating trend	Contribution to the trend	Accumulated total
1A3b	**Road transport**	**3081.67**	**32.00**	**0.02**	**0.50**	**0.4999**
2C	**Metal production**	**47.84**	**34.08**	**0.01**	**0.25**	**0.7480**
5C	**Incineration**	**5.46**	**10.14**	**0.00**	**0.08**	**0.8240**
1A2	**Manufacturing Industries and Construction**	**26.72**	**10.38**	**0.00**	**0.07**	**0.8966**
2A	**Mineral products**	**5.66**	**9.29**	**0.00**	**0.07**	**0.9660**
1A4a + 1A4b	Commercial/institutional/residential	5.81	3.52	0.00	0.03	0.9915
1A1a	Public electricity and heat production	2.86	0.43	0.00	0.00	0.9941
1A3a	Aviation LTO (civil)	0.72	0.33	0.00	0.00	0.9964
1A1b	Petroleum refining	0.45	0.17	0.00	0.00	0.9976
1A3c + 1A3e + 1A5	Other transport	0.68	0.13	0.00	0.00	0.9984
1A4c	Agriculture/Forestry/Fishing	0.14	0.11	0.00	0.00	0.9992
1A3d	Navigation	0.18	0.08	0.00	0.00	0.9998
1A1c	Manufacture of solid fuels and other energy industries	0.63	0.01	0.00	0.00	0.9999
3F	Field burning of agricultural wastes	0.60	0.03	0.00	0.00	1.0000

Cd

NFR Code	NFR Category	Emissions (t) 1990	Emissions (t) 2021	Rating trend	Contribution to the trend	Accumulated total
1A2	**Manufacturing Industries and Construction**	**15.73**	**0.85**	**0.12**	**0.37**	**0.3701**
5C	**Incineration**	**0.76**	**1.57**	**0.05**	**0.16**	**0.5266**
3F	**Field burning of agricultural wastes**	**5.28**	**0.24**	**0.04**	**0.13**	**0.6561**
2C	**Metal production**	**1.29**	**1.47**	**0.04**	**0.13**	**0.7854**
1A4a + 1A4b	**Commercial/institutional/residential**	**1.17**	**1.06**	**0.03**	**0.09**	**0.8720**

NFR Code	NFR Category	Emissions (t) 1990	Emissions (t) 2021	Rating trend	Contribution to the trend	Accumulated total
2A	**Mineral products**	**0.26**	**0.40**	**0.01**	**0.04**	**0.9098**
2G + 2H + 2I + 2J + 2K + 2L	**Other products use and industrial processes**	**0.10**	**0.30**	**0.01**	**0.03**	**0.9410**
1A3b	**Road transport**	**0.15**	**0.28**	**0.01**	**0.03**	**0.9684**
1A1b	Petroleum refining	0.25	0.23	0.01	0.02	0.9869
1A4c	Agriculture/Forestry/Fishing	0.02	0.07	0.00	0.01	0.9937
1A1a	Public electricity and heat production	1.24	0.37	0.00	0.00	0.9986
5E	Other waste	0.01	0.01	0.00	0.00	0.9992
1A3d	Navigation	0.02	0.01	0.00	0.00	0.9996
1A1c	Manufacture of solid fuels and other energy industries	0.01	0.00	0.00	0.00	0.9999
1A3c + 1A3e + 1A5	Other transport	0.00	0.00	0.00	0.00	1.0000

Hg

NFR Code	NFR Category	Emissions (t) 1990	Emissions (t) 2021	Rating trend	Contribution to the trend	Accumulated total
2C	**Metal production**	**1.06**	**1.14**	**0.08**	**0.28**	**0.2837**
1A1a	**Public electricity and heat production**	**3.38**	**0.29**	**0.06**	**0.23**	**0.5124**
2B	**Chemical industry**	**1.88**	**0.00**	**0.05**	**0.18**	**0.6937**
3F	**Field burning of agricultural wastes**	**1.02**	**0.04**	**0.02**	**0.09**	**0.7794**
5C	**Incineration**	**0.73**	**0.40**	**0.02**	**0.06**	**0.8440**
1A2	**Manufacturing Industries and Construction**	**1.66**	**0.63**	**0.02**	**0.05**	**0.8973**
1A3b	**Road transport**	**0.11**	**0.15**	**0.01**	**0.04**	**0.9368**
1A4a + 1A4b	**Commercial/institutional/residential**	**0.17**	**0.13**	**0.01**	**0.03**	**0.9637**
2D	Solvents use	0.21	0.10	0.00	0.02	0.9791
1A1b	Petroleum refining	0.05	0.04	0.00	0.01	0.9895
1A1c	Manufacture of solid fuels and other energy industries	0.05	0.00	0.00	0.00	0.9938
1A4c	Agriculture/Forestry/Fishing	0.02	0.01	0.00	0.00	0.9961
5E	Other waste	0.01	0.01	0.00	0.00	0.9979
1A3d	Navigation	0.04	0.01	0.00	0.00	0.9988
2A	Mineral products	0.00	0.00	0.00	0.00	0.9995
1A3c + 1A3e + 1A5	Other transport	0.00	0.00	0.00	0.00	0.9997
1A3a	Aviation LTO (civil)	0.00	0.00	0.00	0.00	0.9999
1B	Fugitive Emissions from Fuels	0.00	0.00	0.00	0.00	1.0000

POPs

PCDD/PCDF

NFR Code	NFR Category	Emissions (g) 1990	Emissions (g) 2021	Rating trend	Contribution to the trend	Accumulated total
5C	**Incineration**	**268.44**	**335.67**	**0.20**	**0.46**	**0.4616**
1A1a	**Public electricity and heat production**	**133.83**	**1.89**	**0.19**	**0.44**	**0.8973**
1A4a + 1A4b	**Commercial/institutional/residential**	**60.58**	**38.45**	**0.02**	**0.05**	**0.9432**
1A3b	**Road transport**	**5.16**	**10.70**	**0.01**	**0.03**	**0.9691**
3F	Field burning of agricultural wastes	4.62	0.14	0.01	0.01	0.9839
2C	Metal production	77.21	65.41	0.00	0.01	0.9914
5E	Other waste	18.34	14.41	0.00	0.00	0.9941
1A1c	Manufacture of solid fuels and other energy industries	0.42	0.85	0.00	0.00	0.9962
1A2	Manufacturing Industries and Construction	10.34	9.01	0.00	0.00	0.9982
1A4c	Agriculture/Forestry/Fishing	0.15	0.34	0.00	0.00	0.9991
1A1b	Petroleum refining	0.18	0.00	0.00	0.00	0.9996
1A3d	Navigation	0.27	0.14	0.00	0.00	1.0000

PAHs

NFR Code	NFR Category	Emissions (t) 1990	Emissions (t) 2021	Rating trend	Contribution to the trend	Accumulated total
3F	**Field burning of agricultural wastes**	**42.14**	**0.62**	**0.15**	**0.50**	**0.4968**
1A4a + 1A4b	**Commercial/institutional/residential**	**38.06**	**20.16**	**0.06**	**0.21**	**0.7100**
2C	**Metal production**	**13.58**	**8.63**	**0.04**	**0.12**	**0.8345**
1A3b	**Road transport**	**0.88**	**2.22**	**0.02**	**0.06**	**0.8988**
1A2	**Manufacturing Industries and Construction**	**2.95**	**2.26**	**0.01**	**0.04**	**0.9389**
1A1a	**Public electricity and heat production**	**0.05**	**0.98**	**0.01**	**0.03**	**0.9715**
5C	Incineration	0.27	0.46	0.00	0.01	0.9838
1A4c	Agriculture/Forestry/Fishing	0.22	0.44	0.00	0.01	0.9959
1A1c	Manufacture of solid fuels and other energy industries	0.24	0.02	0.00	0.00	0.9983
1B	Fugitive Emissions from Fuels	1.46	0.50	0.00	0.00	0.9991
2G + 2H + 2I + 2J + 2K + 2L	Other products use and industrial processes	0.00	0.01	0.00	0.00	0.9995
1A3d	Navigation	0.04	0.02	0.00	0.00	0.9997
1A3c + 1A3e + 1A5	Other transport	0.02	0.01	0.00	0.00	0.9999
1A3a	Aviation LTO (civil)	0.00	0.00	0.00	0.00	1.0000

HCB

NFR Code	NFR Category	Emissions (kg) 1990	Emissions (kg) 2021	Rating trend	Contribution to the trend	Accumulated total
3D	**Crop production and agricultural soils**	**53.56**	**0.04**	**0.03**	**0.50**	**0.5000**
1A1a	**Public electricity and heat production**	**0.74**	**0.60**	**0.01**	**0.15**	**0.6533**
1A2	**Manufacturing Industries and Construction**	**0.55**	**0.51**	**0.01**	**0.13**	**0.7835**
1A4a + 1A4b	**Commercial/institutional/residential**	**0.44**	**0.41**	**0.01**	**0.11**	**0.8897**
5C	**Incineration**	**1.89**	**0.25**	**0.00**	**0.05**	**0.9388**
2C	**Metal production**	**0.11**	**0.14**	**0.00**	**0.04**	**0.9763**
1A3d	Navigation	0.12	0.05	0.00	0.01	0.9896
1A4c	Agriculture/Forestry/Fishing	0.06	0.04	0.00	0.01	0.9997
1A3c + 1A3e + 1A5	Other transport	0.00	0.00	0.00	0.00	1.0000

PCBs

NFR Code	NFR Category	Emissions (kg) 1990	Emissions (kg) 2021	Rating trend	Contribution to the trend	Accumulated total
2G + 2H + 2I + 2J + 2K + 2L	**Other products use and industrial processes**	**2157.34**	**415.74**	**0.01**	**0.50**	**0.4997**
2C	**Metal production**	**19.00**	**24.57**	**0.01**	**0.35**	**0.8501**
1A2	**Manufacturing Industries and Construction**	**3.77**	**7.02**	**0.00**	**0.11**	**0.9560**
1A3b	Road transport	1.38	2.21	0.00	0.03	0.9887
1A4a + 1A4b	Commercial/institutional/residential	2.75	0.90	0.00	0.01	0.9943
5C	Incineration	0.47	0.29	0.00	0.00	0.9976
1A3d	Navigation	0.22	0.14	0.00	0.00	0.9993
1A1a	Public electricity and heat production	0.19	0.06	0.00	0.00	0.9997
1A4c	Agriculture/Forestry/Fishing	0.19	0.02	0.00	0.00	1.0000

ANNEX 2. COMPLIANCE WITH INVENTORY REVIEWS

Chapter updated in March 2023.

A2.1. Compliance with 2022 comprehensive technical review pursuant to the directive (EU) 2016/2284

11 out of 19 recommendations are considered resolved; 8 addressing.

[Table 4:] All findings for NO_X, NMVOC, SO_2, NH_3, $PM_{2.5}$ and PM_{10}, including those made during the 2022 NECD inventory review and those not implemented from previous reviews

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation made in previous review report	Status	Section in IIR
ES-2D3a-2022-0001	Yes	2D3a Domestic Solvent Use Including Fungicides, NMVOC, 1990-2020	For category 2D3a Domestic Solvent Use Including Fungicides and NVMOC for 1990-2020, the TERT noted a lack of transparency of the activity data used (NFR tables SPAIN_2022-NECD_Annex_I.xlsx). In response to a question raised during the review, Spain explained that population data (without Canary Islands) and country-specific data for Spain from ESIG has been used for the years 2013, 2015-2020; for 1990-2009 interpolation was used. Spain provided revised estimates for years 2005, 2015, and 2018-2020 and stated that it will continue its efforts to improve the estimations in this category. The TERT agreed with the revised estimate provided by Spain. **The TERT recommends that Spain include the revised estimate in its 2023 NFR and IIR submission.**	Resolved	Chap. 4
ES-1A4ai-2022-0001	No	1A4ai Commercial/Institutional: Stationary, NH_3, 1990-2020	For 1A4ai Commercial/Institutional: Stationary and NH_3 and all years, the TERT noted that there is a lack of transparency regarding the use of 'NE' whilst activity data of biomass is reported. In response to a question raised during the review, Spain explained that no emissions were reported mistakenly and that this will be corrected. The TERT noted that the issue is below the threshold of significance for a technical correction. **The TERT recommends that Spain include the emissions of NH_3 from the use of biomass in the 2023 submission.**	Resolved	Chap. 3
ES-1A4ci-2022-0001	No	1A4ci Agriculture/Forestry/Fis	For 1A4ci Agriculture/Forestry/Fishing: Stationary and NH_3 for all years, the TERT noted that there is a lack of transparency regarding the use of 'NE' whilst activity data of biomass is reported. In response to a question raised during the review, Spain explained that no emissions were reported mistakenly and that	Resolved	Chap. 3

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation made in previous review report	Status	Section in IIR
		hing: Stationary, NH_3, 1990-2020	this will be corrected. The TERT noted that the issue is below the threshold of significance for a technical correction. **The TERT recommends that Spain include the emissions of NH_3 from the use of biomass in the next submission.**		
ES-2-2022-0001	No	2 Industry, NA, 1990-2020	The TERT notes with reference to NFR tables and related documentation in the IIR that it is not clear if the following sources exist or not in Spain: 2C7c, 2J and 2K, as the notation key 'NO' (not occurring) has not been used. There is also a lack of transparency on the reason why NO_X, NMVOC, SO_2, CO, $PM_{2.5}$ and NH_3 emissions are reported as 'NE' in the following categories: 2A2, 2A3, 2B1, 2B2, 2B5, 2B6, 2C2, 2C3, 2C5, 2C6, 2C7a. In response to a question raised during the review, Spain explained the reasoning for the use of these notation keys. With respect to the 2K category, Spain explained that the General Subdirectorate for Circular Economy has provided data on PCBs from electrical equipment, that is to be analysed to assess if a robust and complete data series can be derived from it. **The TERT recommends Spain to include any missing emissions from 2K in the next submission and further to explain in the IIR when notation keys 'NE' and 'IE' are used.**	Resolved	Chap. 4
ES-2A5b-2022-0001	No	2A5b Construction and Demolition, $PM_{2.5}$, PM_{10}, TSP, 1990-2020	For 2A5b Construction and Demolition and particulate matter for all years, the TERT noted that the documentation in the IIR only shows activity data and emission factors for the different housing types but not for road construction. In response to a question raised during the review, Spain explained that currently, under category 2A5b, the inventory only accounts for emissions from construction of buildings. Emissions from road construction are not included. Spain indicated that an effort will be made to find complete and time-consistent data that could allow them to estimate the emissions related to it. The TERT noted that the issue is below the threshold of significance for a technical correction. **The TERT recommends that Spain collect the activity data for estimating particle emissions from road construction, e.g. by contacting relevant authorities such as the ministry of transport, infrastructure agencies or statistical agencies and report the missing emissions in the next submission.**	Resolved	Chap. 4
ES-2B1-2022-0001	No	2B1 Ammonia Production, NH_3, 1990-2020	The TERT noted that the notation key 'NA' (not applicable) is used for category 2B1 Ammonia Production for the years 1990-2020 and pollutant NH_3 whilst a Tier 1 method is available in the 2019 EMEP/EEA Guidebook, and, that there may be an under-estimate of emissions. This under-estimate does not have an impact on total emissions that is above the threshold of significance. To the question on the issue Spain responded that emissions from category 2B1 Ammonia Production are estimated by using a Tier 3 method. Facilities provide specific plant information for the ammonia process and, according to them, the processes that only use natural gas, as both feedstock and fuel, do not emit CO, NH_3 nor NMVOC. **The TERT recommends Spain to provide more explanation in the next IIR submission on why specifically**	Addressing	

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation made in previous review report	Status	Section in IIR
			emissions of these pollutants do not occur considering the EMEP/EEA Guidebook lists them specifically as occuring from ammonia production using steam reforming with natural gas as a feedstock.		
ES-2C7d-2022-0001	No	2C7d Storage, Handling and Transport of Metal Products, $PM_{2.5}$, PM_{10}, TSP, 1990-2020	For 2C7d Storage, Handling and Transport of Metal Products and particulate matter for all years, the TERT noted that there is a lack of transparency regarding the use of notation key. The TERT noted that $PM_{2.5}$, PM_{10} and TSP emissions are reported as 'NE' while there are default EFs in the EMEP/EEA Guidebook and that metal industry processes occur in Spain. In response to a question raised during the review, Spain clarified that these emissions from the iron and steel sector and from ferroalloys production are already reported under activities 2C1 Iron and Steel Production and 2C2 Ferroalloys Production. Therefore, in the next submission the notation key 'NE' will be replaced by 'IE', and this will be explained in the IIR. This does not relate to an over- or under-estimate of emissions. **The TERT recommends that Spain change the notation keys to follow the definitions and to provide the related explanations in the IIR in the next submission.**	Resolved	Chap. 4
ES-2D3e-2022-0001	Yes	2D3e Degreasing, NMVOC, 1990-2020	For category 2D3e Degreasing and NMVOC for 1990-2020, the TERT noted that Spain uses an NMVOC emission factor per employee, which is not in line with the EMEP/EEA Guidebook 2019 (provision of AD to facilitate the review, ES-2D3e-2022-0001-AD.xlsx). In response to a question raised during the review, Spain explained that it is not possible to provide an emission estimate based on a Tier 1 or Tier 2 method according to the EMEP/EEA GB 2019. This finding could be related to an over/under-estimate of emissions with an impact on total emissions that is above the threshold of significance. Spain has not provided a revised estimate which has been accepted by the TERT. It is currently not possible for the TERT to provide a numerical emission estimate with an adequate level of certainty as the TERT has no activity data available. **Therefore, this issue is flagged as a recommendation only, however the TERT strongly recommends that Spain develop a Tier 1 or Tier 2 method for NMVOC emissions from 2D3e Degreasing for inclusion in next years' inventory submission.**	Resolved	Chap. 4
ES-2H1-2022-0001	No	2H1 Pulp and Paper Industry, PM_{10}, 2005	For 2H1 Pulp and Paper Industry and particulate matter for 2005, the TERT noted that recalculations have been applied for PM_{10}, but no recalculation has been made to $PM_{2.5}$. In response to a question raised during the review Spain explained that within the activity paper pulp production, measured emissions for TSP are available, while PM_{10} and $PM_{2.5}$ are estimated by applying default emissions ratios from the EMEP/EEA Guidebook. By mistake, for one of the facilities, PM_{10} ratio was wrongly applied, so the resultant recalculation only affects this pollutant. The TERT noted that the issue is below the threshold of significance for a technical correction. **The TERT recommends that Spain correct any incorrect values in the next submission.**	Resolved	Chap. 4

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation made in previous review report	Status	Section in IIR
ES-2H1-2022-0002	Yes	2H1 Pulp and Paper Industry, SO_2, 1990-2020	The TERT noted with reference to NFR 2H1 Pulp and Paper Industry, SO_2 and IIR table A6.111 that there may be an over-estimation of emissions. This over-estimate may have an impact on total emissions that is above the threshold of significance. The TERT noted that this over-estimate may be because SO_2 emissions from pulp production are estimated using the EF in EMEP/EEA Guidebook Chapter 2H1 Table 3.2 (reference to EC 2001), which may over-estimate emissions at modern kraft pulp plants in Spain. In response to a question raised during the review, Spain explained that process emissions of SO_2 from kraft pulp plants in Spain are estimated by using the Tier 2 EF from the 2019 EMEP/EEA Guidebook (Chapter 2H1, Table 3.2) where the abatement technologies considered are scrubber and electrostatic precipitator and that at the moment, they do not have a better approach for this category. **As 2H1 currently is a key category for SO_2 for Spain, the TERT recommends Spain to try to increase the accuracy of the method used e.g. by using data reported by the plants according to their environmental permits, by comparing the inventory calculations to data reported to the E-PRTR and preferably by contacting the plant operators to verify the correctness of the EMEP/EEA Guidebook Tier 2 EFs for the actual emission levels at the individual pulp production plants in Spain.**	Resolved	Chap. 4
ES-2H2-2022-0002	Yes	2H2 Food and Beverages Industry, NMVOC, 1990-2020	The TERT noted with reference to the key category NFR 2H2 Food and Beverages Industry and IIR table 4.2.1 that there is a lack of transparency regarding NMVOC sources included in the inventory as the IIR does not provide AD for the following sources for which there are methods in the EMEP/EEA Guidebook: sugar production, animal rendering, fish meals, margarine & solid fats, animal feed, beer, spirits. In response to a question raised during the review, Spain provided the missing activity data and stated the intention to include these in the next IIR submission. **The TERT recommends Spain to document the inventory on a level which allows review of the reported values and thus to include these data into the next IIR submission.**	Resolved	Chap. 4
ES-2H2-2022-0001	No	2H2 Food and Beverages Industry, PM_{10}, 1990-2020	For 2H2 Food and Beverages Industry and PM_{10} for all years, the TERT noted that emissions of PM_{10} from handing of agricultural products are missing from the inventory while there are default EFs in the EMEP/EEA Guidebook. In response to a question raised during the review Spain explained that in the EMEP/EEA Guidebook, the section for technology specific emissions factors is split into two separate parts, the first one with emission factors taken from an earlier version of the EMEP/EEA Guidebook (Background emission factors, whose original reference is not always clear, as the EMEP/EEA Guidebook itself says), and the second with the default emission factors derived from the former ones. According to the EMEP/EEA Guidebook, it is recommended to use the product-based default emission factors from that second part. Spain has estimated emissions from the food and beverages industry activities that are most relevant in the country, and that have a Tier 2 default emission factor in the second part of the aforementioned section of the EMEP/EEA Guidebook. As PM_{10} appears in all these tables as 'NE', Spain has reported this contaminant under this notation key. The TERT noted that the issue is below the threshold of significance	Resolved	Chap. 4

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation made in previous review report	Status	Section in IIR
			for a technical correction. **The TERT recommends that Spain use the emission factor provided in the EMEP/EEA Guidebook (Chapter 2H2 Table 3-10) to estimate the missing PM_{10} emissions from handling of agricultural products or develop a country specific emission factor in the next submission.**		
ES-3-2022-0001	Yes	3 Agriculture, $PM_{2.5}$, PM_{10}, 1990-2020	For category 3Dc Farm-Level Agricultural Operations Including Storage, Handling and Transport of Agricultural Products and PM_{10} for all years, the TERT noted that a Tier 1 method is used for a key category. In response to a question raised during the review Spain explained that work is ongoing on implementing the Tier 2 method for category 3Dc (PM_{10} and $PM_{2.5}$) for the next submission. The TERT noted that the issue is below the threshold of significance for a technical correction. **The TERT recommends Spain to provide a Tier 2 calculation for $PM_{2.5}$ and PM_{10} emission in the next submission.**	Addressing	
ES-3B4d-2022-0001	No	3B4d Manure Management - Goats, NO_X, NH_3, NMVOC, $PM_{2.5}$, PM_{10}, TSP, 1990-2020	For category 3B4d Manure Management - Goats and 3B4f Manure Management - Mules and asses and all main pollutants for all years, the TERT noted that there is a lack of transparency regarding the implied emission factor (IEF). Reported data shows significant change of IEF from year to year, which could indicate a time series error. Since this change of IEF has occurred for all pollutants, it could have something to do with housing/grassing period or allocation of subcategories. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Spain confirmed that the variations for IEF are due to the ratio between grazing and housing, which vary from year to year. **The TERT recommends that Spain include information in the next IIR for this variation between grazing and housing days for 3B4D and 3B4f, because this explains the trend for the IEF.**	Addressing	
ES-3Da2a-2022-0001	Yes	3Da2a Animal Manure Applied to Soils, NMVOC, 1990-2020	For category 3Da2a Animal Manure Applied to Soils and NMVOC for all years, the TERT noted that there is a lack of transparency regarding the calculation. The amount of NMVOC emission from 3Da2a is approximately at the same level as the sum emission for 3B manure management, which is different from all other member states. Typically, the largest part of the NMVOC emission is related to housing. IIR (Table 5.4.7 – 5.4.10) includes data for some of the variables used for NMVOC estimation, but no information is given on estimates for NH_3 emission (housing, storage, application). This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Spain explained that they follow a calculation recommended by the TERT during the NECD inventory review 2018 and provided the spreadsheet. Analysing the spreadsheet provided, the TERT concluded that this calculation is not correct. The variable for E NH_3 (housing, storage, application) is unfortunately based on NH_3 emission factor, should be based on the NH_3 emission (national estimate). This explains why the share of NMVOC for 3Da2a is significantly higher in the Spanish inventory. The TERT regrets any confusion caused during this and previous reviews.	Addressing	

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation made in previous review report	Status	Section in IIR
			The TERT recommends that Spain correct the calculation of NMVOC emission from 3B, 3Da2 and 3Da3 in the next submission.		
ES-5C1biv-2022-0002	No	5C1biv Sewage Sludge Incineration, NO_X, 1990-2020	For 5C1biv Sewage Sludge Incineration and NO_X for all years, the TERT noted that emissions could be under-estimated. Indeed, Spain notes in the IIR p369 that emission factors used come from the 2019 EMEP/EEA Guidebook (Table 3-2 and Abatement efficiencies Table 3-4). However, the NO_X emission factor provided in the 2019 EMEP/EEA Guidebook is 2.5 kg/Mg (table 3-2) and no abatement efficiency is provided for this pollutant in table 3-4. The NO_X emission factor used by Spain is 0.1 kg/kt (calculated in the NFR table). In response to a question raised during the review, Spain explained that NO_X emissions have been wrongly calculated using the abatement efficiency percentages in Table 3-4 and that it will be corrected in the next submission. The TERT noted that the issue is below the threshold of significance for a technical correction. **The TERT recommends that Spain correct the NO_X emission factor used and provide information about the abatement efficiency applied, including its reference in its 2023 submission.**	Addressing	
ES-5C1biv-2022-0001	No	5C1biv Sewage Sludge Incineration, SO_2, NO_X, NMVOC, 1990-2020	For 5C1biv Sewage Sludge Incineration and NMVOC, SO_2 and NO_X for all years, the TERT noted that the activity data reported in the IIR (51 kt of sludge incinerated) is different compared with activity data reported in the NFR table (52.8 kt). In response to a question raised during the review Spain explained that this difference is due to the fact that in IIR table 6.2.1 (p335) only the kilotonnes of incinerated sludge from area sources are indicated, the kilotonnes of incinerated sludge from Large Point Sources (LPS) were not added by mistake. In the NFR table, the AD includes both data sources. **The TERT recommends that Spain correct the data provided in the IIR in the next submission.**	Addressing	
ES-5C2-2022-0001	Yes	5C2 Open Burning of Waste, SO_2, NO_X, NMVOC, $PM_{2.5}$, PM_{10}, 1990-2020	For 5C2 Open Burning of Waste and all pollutants for all years, the TERT noted that there is a lack of transparency because Spain notes in the IIR p370 that the emission factors used come from 2019 EMEP/EEA Guidebook (table 3-3) but the IEFs calculated based on the AD and emissions provided in the NFR tables are higher. For example, for year 2020, the NO_X IEF is 7.1 kg/Mg waste whereas the EF provided in the 2019 EMEP/EEA Guidebook is 4.99. In response to a question raised during the review, Spain explained that units of EFs used from the 2019 EMEP/EEA Guidebook (Table 3-3) are indicated by dry matter for some pollutants and by waste for others. Activity variable data of Spanish NFR tables for 5C2 category are only indicated by units of dry matter, not by waste. A summary of calculation values and operations for all years was provided during the review. Furthermore, the TERT noted that Spain only mentioned emissions from orchards whereas the 2019 EMEP/EEA Guidebook also identifies crop residues and forest residues in the 5C2 category. In response to a question raised during the review, Spain confirmed that 5C2 activity reported only included open controlled burning of orchard crops and provided no information on off field crop residue burning. Concerning forest residue, Spain informed that legislation	Addressing	

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation made in previous review report	Status	Section in IIR
			comes mainly from the regional entities and the date of entrance into force is not always the same. **The TERT recommends that Spain provide all this information in the next submission of the IIR to improve the transparency.**		
ES-5D3-2022-0002	No	5D3 Other Wastewater Handling, NH_3, 2011-2014	For 5D3 Other Wastewater Handling and NH_3 for 2011-2014, the TERT noted a potential inconsistency in the emission trend. Indeed, NH_3 emissions increase by 127% between 2011 and 2012, then decrease by 19% between 2013 and 2014. This trend is unlikely concerning this sector where the population using latrines is the variable factor. In response to a question raised during the review, Spain explained that the activity variable (population using latrines) is obtained based on Spain's EUROSTAT data on the percentage of population connected to wastewater treatment plants and Spain assumes the percentage of unconnected population as population using latrines. Spain added that the EUROSTAT series is an incomplete series, so the data have been interpolated to obtain a time series for the period 1990-2012, while for 2013 and subsequent years the data has been replicated from the even years available and that some recalculations have not been calculated properly and this has caused errors in the emissions. The TERT noted that the issue is below the threshold of significance for a technical correction and related to a non-mandatory year. **The TERT recommends that Spain correct the time series inconsistency identified and improve the transparency in the IIR by providing the data of the percentage of unconnected population as population using latrines used in the calculation of the total for uncollected wastewater treatment.**	Addressing	

ANNEX 3. UNCERTAINTY ANALYSIS

Chapter updated in March 2023.

A3.1. Uncertainty Analysis NOx

Sector		Emissions in 1990	Emissions in 2021	Level assess ment	Cumulative total	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to variance in 2021	Type A sensitivity	Type B sensitivity	Uncertainty in trend in total emissions due to EF	Uncertainty in trend in total emissions due to AD	Uncertainty introduced into the trend in total national emissions
NFR	Name sector	kt	kt	(%)	(%)	(%)	(%)	(%)				(%)	(%)	(%)
1A3bi	Road transport: Passenger cars	288.5	139.2	22.4	22.4	10.0	10.0	14.1	10.0	0.002	0.106	0.02	1.50	2.25
1A3biii	Road transport: Heavy duty vehicles and buses	201.7	65.6	10.6	32.9	10.0	10.0	14.1	2.2	0.023	0.050	0.23	0.71	0.55
5C2	Open burning of waste	34.6	57.9	9.3	42.3	40.0	100.0	107.7	100.5	0.032	0.044	3.16	2.50	16.22
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	110.7	50.7	8.1	50.4	5.3	76.0	76.2	38.5	0.001	0.039	0.11	0.29	0.09
3Da1	Inorganic N-fertilizers (includes also urea application)	42.8	40.7	6.6	57.0	5.0	160.0	160.1	110.0	0.016	0.031	2.49	0.22	6.27
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	51.3	35.5	5.7	62.7	15.0	39.6	42.3	5.8	0.008	0.027	0.34	0.57	0.44
1A1a	Public electricity and heat production	208.0	30.8	4.9	67.6	1.5	20.0	20.1	1.0	0.052	0.023	1.03	0.05	1.07
1A3bii	Road transport: Light duty vehicles	34.7	22.5	3.6	71.2	10.0	10.0	14.1	0.3	0.005	0.017	0.05	0.24	0.06
1A4ci	Agriculture/Forestry/Fishing: Stationary	13.4	20.3	3.3	74.5	15.0	40.0	42.7	2.0	0.011	0.016	0.43	0.33	0.29
3Da2a	Animal manure applied to soils	17.5	19.4	3.1	77.6	70.8	160.0	175.0	29.7	0.008	0.015	1.35	1.48	4.00
1A4bi	Residential: Stationary	17.4	17.9	2.9	80.5	20.0	40.4	45.0	1.7	0.007	0.014	0.30	0.39	0.24
3Da3	Urine and dung deposited by grazing animals	9.3	12.6	2.0	82.5	70.8	160.0	175.0	12.6	0.006	0.010	1.00	0.96	1.93
1A4ai	Commercial/institutional: Stationary	4.6	10.3	1.7	84.2	5.0	35.6	35.9	0.4	0.006	0.008	0.22	0.06	0.05
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	6.7	10.1	1.6	85.8	4.4	23.0	23.4	0.1	0.005	0.008	0.12	0.05	0.02
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	10.8	8.7	1.4	87.2	3.5	1.0	3.6	0.0	0.003	0.007	0.00	0.03	0.00
1A2gvii	Mobile Combustion in manufacturing industries and construction	38.5	7.5	1.2	88.4	10.0	40.0	41.2	0.2	0.008	0.006	0.33	0.08	0.11
1A1b	Petroleum refining	19.7	7.4	1.2	89.6	10.0	11.0	14.9	0.0	0.001	0.006	0.02	0.08	0.01
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	9.4	7.3	1.2	90.8	4.6	14.0	14.7	0.0	0.002	0.006	0.03	0.04	0.00
1A2d	Stationary combustion in manufacturing industries and construction: Pulp. Paper and Print	5.4	7.1	1.1	91.9	4.9	10.0	11.1	0.0	0.003	0.005	0.03	0.04	0.00
1A2e	Stationary combustion in manufacturing industries and construction: Food processing. beverages and tobacco	3.7	7.0	1.1	93.0	4.5	39.0	39.3	0.2	0.004	0.005	0.16	0.03	0.03
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	3.4	5.2	0.8	93.9	4.3	48.0	48.2	0.2	0.003	0.004	0.13	0.02	0.02
1A3dii	National navigation (shipping)	75.4	4.2	0.7	94.5	50.0	40.0	64.0	0.2	0.024	0.003	0.96	0.22	0.98
1B2c	Venting and flaring (oil. gas. combined oil and gas)	3.8	3.0	0.5	95.0	10.0	16.6	19.4	0.0	0.001	0.002	0.02	0.03	0.00
1A3ai(i)	International aviation LTO (civil)	1.6	2.9	0.5	95.5	25.0	10.0	26.9	0.0	0.002	0.002	0.02	0.08	0.01
1A3c	Railways	6.9	2.4	0.4	95.9	2.0	77.5	77.5	0.1	0.001	0.002	0.05	0.01	0.00
1A1c	Manufacture of solid fuels and other energy industries	6.7	2.4	0.4	96.3	16.0	110.0	111.2	0.2	0.001	0.002	0.07	0.04	0.01
1A3biv	Road transport: Mopeds & motorcycles	2.5	2.4	0.4	96.6	10.0	10.0	14.1	0.0	0.001	0.002	0.01	0.03	0.00
3B1b	Manure management - Non-dairy cattle	0.9	2.2	0.4	97.0	70.8	100.0	122.5	0.2	0.001	0.002	0.14	0.17	0.05
*	Other categories	81.2	18.7	3.0	100.0	100.0	100.0	141.4	18.1	0.015	0.014	1.51	2.01	6.34
kt		**1311.4**	**620.5**						**334.2**					**41.0**
Uncertainty									**18.3**					**6.4**

A3.2. Uncertainty Analysis NMVOC

Sector		Emissions in 1990	Emissions in 2021	Level assess ment	Cumulative total	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to variance in 2021	Type A sensitivity	Type B sensitivity	Uncertainty in trend in total emissions due to EF	Uncertainty in trend in total emissions due to AD	Uncertainty introduced into the trend in total national emissions
NFR	Name sector	kt	kt	(%)	(%)	(%)	(%)	(%)				(%)	(%)	(%)
2D3a	Domestic solvent use including fungicides	91.1	113.7	20.7	20.7	2.0	67.0	67.0	192.5	0.063	0.111	4.24	0.31	18.07
2D3d	Coating applications	190.3	60.5	11.0	31.7	24.0	58.0	62.8	47.7	0.040	0.059	2.34	2.00	9.49
2D3g	Chemical products	38.8	53.2	9.7	41.4	17.0	78.0	79.8	59.8	0.032	0.052	2.47	1.25	7.65
1A4bi	Residential: Stationary	43.7	29.2	5.3	46.7	20.0	293.1	293.7	243.4	0.006	0.028	1.65	0.80	3.39
3Da2a	Animal manure applied to soils	23.8	26.9	4.9	51.6	50.1	300.0	304.2	221.2	0.014	0.026	4.13	1.86	20.48
3B1a	Manure management - Dairy cattle	23.2	21.1	3.8	55.4	50.1	300.0	304.2	135.9	0.008	0.021	2.52	1.45	8.48
2H2	Food and beverages industry	19.3	20.2	3.7	59.1	7.0	490.0	490.0	323.7	0.010	0.020	4.70	0.19	22.09
3B1b	Manure management - Non-dairy cattle	13.2	18.9	3.4	62.5	50.1	300.0	304.2	109.9	0.012	0.018	3.47	1.31	13.77
2D3i	Other solvent use	19.1	17.5	3.2	65.7	10.0	60.0	60.8	3.8	0.007	0.017	0.43	0.24	0.24
1B2ai	Fugitive emissions oil: Exploration. production. transport	13.1	15.3	2.8	68.5	10.0	200.0	200.2	30.9	0.008	0.015	1.61	0.21	2.62
3B3	Manure management - Swine	9.6	13.9	2.5	71.0	50.1	300.0	304.2	59.2	0.009	0.014	2.57	0.96	7.51
2D3h	Printing	11.9	12.7	2.3	73.4	40.0	125.0	131.2	9.2	0.006	0.012	0.77	0.70	1.08
3B4gii	Manure management - Broilers	8.6	12.1	2.2	75.6	50.1	300.0	304.2	45.1	0.007	0.012	2.21	0.84	5.59
5C2	Open burning of waste	8.8	11.6	2.1	77.7	40.0	200.0	204.0	18.5	0.007	0.011	1.34	0.64	2.20
1A1a	Public electricity and heat production	0.8	10.3	1.9	79.5	3.0	121.0	121.0	5.1	0.010	0.010	1.16	0.04	1.35
2B10a	Chemical industry: Other	6.1	10.2	1.9	81.4	10.0	75.0	75.7	2.0	0.007	0.010	0.51	0.14	0.28
1A4aii	Commercial/institutional: Mobile	0.0	10.2	1.9	83.3	15.0	100.0	101.1	3.5	0.010	0.010	1.00	0.21	1.03
3De	Cultivated crops	9.0	9.9	1.8	85.0	3.0	300.0	300.0	29.0	0.005	0.010	1.48	0.04	2.19
1A3bi	Road transport: Passenger cars	193.8	8.9	1.6	86.7	10.0	12.0	15.6	0.1	0.092	0.009	1.11	0.12	1.24
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	16.1	7.8	1.4	88.1	4.6	50.0	50.2	0.5	0.001	0.008	0.04	0.05	0.00
1A3biv	Road transport: Mopeds & motorcycles	28.7	7.1	1.3	89.4	10.0	12.0	15.6	0.0	0.008	0.007	0.10	0.10	0.02
1A2e	Stationary combustion in manufacturing industries and construction: Food processing. beverages and tobacco	0.2	6.6	1.2	90.6	4.5	48.0	48.2	0.3	0.006	0.006	0.30	0.04	0.09
1B2av	Distribution of oil products	26.6	4.8	0.9	91.5	40.0	2.0	40.0	0.1	0.009	0.005	0.02	0.27	0.07
2D3e	Degreasing	33.3	4.1	0.7	92.2	10.0	200.0	200.2	2.2	0.013	0.004	2.68	0.06	7.17
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	11.8	3.9	0.7	92.9	15.0	35.9	38.9	0.1	0.002	0.004	0.09	0.08	0.01
2H1	Pulp and paper industry	2.6	3.4	0.6	93.5	5.0	100.0	100.1	0.4	0.002	0.003	0.20	0.02	0.04
5A	Biological treatment of waste - Solid waste disposal on land	2.1	3.4	0.6	94.1	30.0	92.3	97.1	0.4	0.002	0.003	0.20	0.14	0.06
1A3bv	Road transport: Gasoline evaporation	78.8	3.2	0.6	94.7	20.0	20.0	28.3	0.0	0.038	0.003	0.76	0.09	0.59
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	0.3	2.3	0.4	95.1	4.4	40.0	40.2	0.0	0.002	0.002	0.08	0.01	0.01
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	3.1	2.1	0.4	95.5	5.3	76.0	76.2	0.1	0.000	0.002	0.03	0.01	0.00
3B4gi	Manure management - Laying hens	1.7	2.0	0.4	95.9	50.1	300.0	304.2	1.2	0.001	0.002	0.31	0.14	0.11
1A4ai	Commercial/institutional: Stationary	0.2	1.8	0.3	96.2	5.0	36.8	37.1	0.0	0.002	0.002	0.06	0.01	0.00
1A3biii	Road transport: Heavy duty vehicles and buses	13.8	1.7	0.3	96.5	10.0	12.0	15.6	0.0	0.006	0.002	0.07	0.02	0.00
1A2d	Stationary combustion in manufacturing industries and construction: Pulp. Paper and Print	2.0	1.6	0.3	96.8	5.0	100.0	100.1	0.1	0.001	0.002	0.05	0.01	0.00
3Da3	Urine and dung deposited by grazing animals	0.9	1.5	0.3	97.1	50.0	50.0	70.7	0.0	0.001	0.001	0.05	0.10	0.01
*	Other categories	79.3	16.0	2.9	100.0	100.0	100.0	141.4	17.0	0.026	0.016	2.58	2.21	11.53
Kt		**1025.6**	**549.4**						**1563.0**					**148.5**
Uncertainty									**39.5**					**12.2**

A3.3. Uncertainty Analysis SO_2

Sector		Emissions in 1990	Emissions in 2021	Level assess ment	Cumulative total	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to variance in 2021	Type A sensitivity	Type B sensitivity	Uncertainty in trend in total emissions due to EF	Uncertainty in trend in total emissions due to AD	Uncertainty introduced into the trend in total national emissions
NFR	**Name sector**	**kt**	**kt**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**				**(%)**	**(%)**	**(%)**
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	88.1	21.0	17.1	17.1	5.3	1.0	5.4	0.8	0.008	0.010	0.01	0.08	0.01
1B2aiv	Fugitive emissions oil: Refining / storage	39.1	18.9	15.4	32.4	10.0	2.0	10.2	2.5	0.008	0.009	0.02	0.13	0.02
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	28.5	13.9	11.3	43.8	35.8	4.0	36.0	16.7	0.006	0.007	0.02	0.34	0.12
1A4ai	Commercial/institutional: Stationary	6.0	9.0	7.3	51.1	5.0	40.3	40.6	8.8	0.004	0.004	0.17	0.03	0.03
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	18.5	7.8	6.3	57.4	4.3	2.0	4.7	0.1	0.003	0.004	0.01	0.02	0.00
1A4bi	Residential: Stationary	19.0	7.6	6.2	63.6	20.0	40.2	44.9	7.8	0.003	0.004	0.13	0.11	0.03
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	47.4	6.1	4.9	68.5	4.4	363.0	363.0	319.3	0.002	0.003	0.57	0.02	0.32
1A1a	Public electricity and heat production	1407.4	5.5	4.5	73.0	1.5	20.0	20.1	0.8	0.038	0.003	0.76	0.01	0.58
2H1	Pulp and paper industry	2.3	3.4	2.8	75.8	5.0	100.0	100.1	7.6	0.002	0.002	0.16	0.01	0.03
2B10a	Chemical industry: Other	9.7	3.4	2.7	78.5	2.0	20.0	20.1	0.3	0.001	0.002	0.03	0.00	0.00
1A3dii	National navigation (shipping)	34.1	2.9	2.3	80.8	50.0	30.0	58.3	1.8	0.000	0.001	0.01	0.10	0.01
1A2e	Stationary combustion in manufacturing industries and construction: Food processing. beverages and tobacco	36.2	2.8	2.3	83.1	4.5	2.0	4.9	0.0	0.000	0.001	0.00	0.01	0.00
1B2c	Venting and flaring (oil. gas. combined oil and gas)	24.0	2.5	2.0	85.1	10.0	18.9	21.4	0.2	0.000	0.001	0.01	0.02	0.00
2C3	Aluminium production	2.7	2.4	2.0	87.0	2.0	20.0	20.1	0.2	0.001	0.001	0.02	0.00	0.00
1A1b	Petroleum refining	125.5	2.3	1.9	88.9	10.0	2.0	10.2	0.0	0.003	0.001	0.01	0.02	0.00
5C2	Open burning of waste	1.4	2.2	1.8	90.7	40.0	200.0	204.0	13.4	0.001	0.001	0.21	0.06	0.05
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	28.2	1.9	1.6	92.3	4.6	2.0	5.0	0.0	0.000	0.001	0.00	0.01	0.00
2C1	Iron and steel production	1.3	1.4	1.1	93.4	40.0	190.0	194.2	4.8	0.001	0.001	0.12	0.04	0.02
2C7a	Copper production	1.0	1.3	1.1	94.5	5.0	2.0	5.4	0.0	0.001	0.001	0.00	0.00	0.00
1A4ci	Agriculture/Forestry/Fishing: Stationary	1.2	1.0	0.8	95.3	15.0	40.0	42.7	0.1	0.000	0.001	0.02	0.01	0.00
2C5	Lead production	0.3	1.0	0.8	96.1	5.0	20.0	20.6	0.0	0.000	0.000	0.01	0.00	0.00
2C6	Zinc production	0.4	0.8	0.6	96.8	5.0	567.0	567.0	12.6	0.000	0.000	0.21	0.00	0.04
2C7c	Other metal production	0.3	0.8	0.6	97.4	5.0	792.0	792.0	24.2	0.000	0.000	0.29	0.00	0.08
*	Other categories	126.9	3.2	2.6	100.0	100.0	100.0	141.4	13.7	0.002	0.002	0.21	0.22	0.10
Kt		**2049.6**	**122.9**						**435.7**					**1.4**
Uncertainty									**20.9**					**1.2**

A3.4. Uncertainty Analysis NH_3

Sector		Emissions in 1990	Emissions in 2021	Level assess ment	Cumulative total	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to variance in 2021	Type A sensitivity	Type B sensitivity	Uncertainty in trend in total emissions due to EF	Uncertainty in trend in total emissions due to AD	Uncertainty introduced into the trend in total national emissions
NFR	Name sector	kt	kt	(%)	(%)	(%)	(%)	(%)				(%)	(%)	(%)
3Da2a	Animal manure applied to soils	128.7	126.4	26.4	26.4	70.8	50.0	86.7	523.8	0.001	0.259	0.04	25.90	670.74
3B3	Manure management - Swine	60.0	80.3	16.8	43.2	70.8	136.0	153.3	660.7	0.044	0.164	5.97	16.44	305.96
3Da1	Inorganic N-fertilizers (includes also urea application)	92.3	71.9	15.0	58.2	5.0	50.0	50.2	56.9	0.038	0.147	1.90	1.04	4.68
3Da3	Urine and dung deposited by grazing animals	22.8	36.8	7.7	65.9	70.8	136.0	153.3	138.8	0.030	0.075	4.01	7.54	72.90
3B1b	Manure management - Non-dairy cattle	27.4	35.8	7.5	73.3	70.8	136.0	153.3	131.2	0.018	0.073	2.48	7.33	59.84
3B1a	Manure management - Dairy cattle	38.1	31.0	6.5	79.8	70.8	136.0	153.3	98.3	0.013	0.063	1.76	6.34	43.31
3B4gii	Manure management - Broilers	20.8	21.1	4.4	84.2	70.8	136.0	153.3	45.8	0.002	0.043	0.22	4.33	18.81
3B4h	Manure management - Other animals	19.5	15.1	3.2	87.4	70.8	136.0	153.3	23.3	0.008	0.031	1.12	3.09	10.79
3B2	Manure management - Sheep	9.3	8.1	1.7	89.1	70.8	136.0	153.3	6.7	0.002	0.017	0.28	1.66	2.83
3B4gi	Manure management - Laying hens	8.5	7.9	1.7	90.7	70.8	136.0	153.3	6.5	0.001	0.016	0.11	1.63	2.66
3B4giv	Manure management - Other poultry	10.8	7.6	1.6	92.3	70.8	136.0	153.3	5.9	0.006	0.015	0.85	1.55	3.12
3B4giii	Manure management - Turkeys	2.4	6.0	1.2	93.5	70.8	136.0	153.3	3.6	0.007	0.012	0.99	1.22	2.48
3B4e	Manure management - Horses	1.9	5.3	1.1	94.7	35.0	50.0	61.0	0.5	0.007	0.011	0.36	0.54	0.42
3B4d	Manure management - Goats	2.1	5.0	1.0	95.7	70.8	136.0	153.3	2.5	0.006	0.010	0.81	1.02	1.70
1A4bi	Residential: Stationary	5.5	4.1	0.9	96.5	3.0	100.0	100.0	0.7	0.003	0.008	0.26	0.04	0.07
3Da2b	Sewage sludge applied to soils	1.1	2.9	0.6	97.2	70.8	136.0	153.3	0.9	0.004	0.006	0.52	0.60	0.63
*	Other categories	37.7	13.6	2.8	100.0	100.0	100.0	141.4	16.2	0.048	0.028	4.76	3.95	38.18
Kt		**488.7**	**478.8**						**1722.2**					**1239.1**
Uncertainty									**41.5**					**35.2**

A3.5. Uncertainty Analysis $PM_{2.5}$

Sector		Emissions in 2000	Emissions in 2021	Level assess ment	Cumulative total	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to variance in 2021	Type A sensitivity	Type B sensitivity	Uncertainty in trend in total emissions due to EF	Uncertainty in trend in total emissions due to AD	Uncertainty introduced into the trend in total national emissions
NFR	Name sector	kt	kt	(%)	(%)	(%)	(%)	(%)				(%)	(%)	(%)
5C2	Open burning of waste	39.3	53.5	39.6	39.6	63.0	200.0	209.7	6893.2	0.134	0.288	26.77	25.69	1376.80
1A4bi	Residential: Stationary	49.6	34.0	25.2	64.8	20.0	99.7	101.7	655.3	0.011	0.183	1.14	5.18	28.18
1A3bi	Road transport: Passenger cars	9.3	5.4	4.0	68.8	10.0	9.0	13.5	0.3	0.007	0.029	0.06	0.41	0.18
1A3bvi	Road transport: Automobile tyre and brake wear	2.7	3.3	2.4	71.2	10.0	32.0	33.5	0.7	0.007	0.018	0.23	0.25	0.11
1A1a	Public electricity and heat production	10.1	3.2	2.4	73.6	1.5	30.0	30.0	0.5	0.022	0.017	0.66	0.04	0.44
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	3.3	3.1	2.3	75.9	4.6	77.5	77.6	3.3	0.004	0.017	0.30	0.11	0.10
1A2e	Stationary combustion in manufacturing industries and construction: Food processing. beverages and tobacco	1.8	2.7	2.0	77.9	4.5	85.5	85.7	2.9	0.007	0.015	0.63	0.09	0.40
1A4ai	Commercial/institutional: Stationary	2.2	2.0	1.5	79.4	5.0	33.7	34.0	0.3	0.002	0.011	0.08	0.08	0.01
1A3bvii	Road transport: Automobile road abrasion	1.6	1.9	1.4	80.9	10.0	25.0	26.9	0.1	0.004	0.010	0.10	0.15	0.03
3Dc	Farm-level agricultural operations including storage. handling and transport of agricultural products	2.1	1.9	1.4	82.2	3.0	400.0	400.0	30.8	0.002	0.010	0.72	0.04	0.52
2B10a	Chemical industry: Other	2.0	1.6	1.2	83.4	10.0	132.0	132.4	2.5	0.001	0.009	0.12	0.12	0.03
2G	Other product use	0.7	1.6	1.2	84.6	2.0	13.0	13.2	0.0	0.006	0.009	0.07	0.02	0.01
3F	Field burning of agricultural residues	19.3	1.5	1.1	85.7	63.0	24.1	67.5	0.5	0.068	0.008	1.63	0.70	3.17
5E	Other waste	1.9	1.4	1.0	86.7	25.2	50.5	56.4	0.3	0.000	0.008	0.01	0.27	0.07
1A1c	Manufacture of solid fuels and other energy industries	0.2	1.4	1.0	87.8	16.0	30.0	34.0	0.1	0.007	0.007	0.20	0.17	0.07
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	5.7	1.3	1.0	88.7	15.0	39.3	42.1	0.2	0.015	0.007	0.60	0.15	0.38
1A3dii	National navigation (shipping)	1.1	1.2	0.9	89.6	50.0	50.0	70.7	0.4	0.002	0.006	0.11	0.45	0.22
1A3bii	Road transport: Light duty vehicles	4.9	1.1	0.8	90.4	10.0	9.0	13.5	0.0	0.013	0.006	0.12	0.09	0.02
1A3biii	Road transport: Heavy duty vehicles and buses	6.7	1.0	0.8	91.2	10.0	9.0	13.5	0.0	0.021	0.006	0.19	0.08	0.04
2C1	Iron and steel production	1.0	1.0	0.8	92.0	3.1	472.0	472.0	13.0	0.002	0.006	0.72	0.02	0.51
1A2d	Stationary combustion in manufacturing industries and construction: Pulp. Paper and Print	2.4	1.0	0.8	92.7	4.9	77.0	77.2	0.3	0.004	0.005	0.30	0.04	0.09
2A5a	Quarrying and mining of minerals other than coal	1.3	0.9	0.7	93.4	5.0	100.0	100.1	0.5	0.000	0.005	0.02	0.04	0.00
1A4ci	Agriculture/Forestry/Fishing: Stationary	0.6	0.9	0.7	94.1	15.0	39.8	42.6	0.1	0.002	0.005	0.10	0.10	0.02
2H1	Pulp and paper industry	0.4	0.9	0.7	94.7	5.0	194.0	194.1	1.6	0.003	0.005	0.63	0.03	0.40
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	0.2	0.8	0.6	95.4	3.5	71.0	71.1	0.2	0.004	0.005	0.26	0.02	0.07
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	2.4	0.8	0.6	96.0	5.3	39.3	39.7	0.1	0.005	0.004	0.20	0.03	0.04
2A3	Glass production	0.7	0.8	0.6	96.5	5.0	120.2	120.3	0.5	0.002	0.004	0.19	0.03	0.04
2A5b	Construction and demolition	1.5	0.7	0.5	97.0	5.0	563.0	563.0	7.6	0.002	0.004	1.24	0.03	1.54
*	Other categories	10.6	4.0	3.0	100.0	100.0	100.0	141.4	17.8	0.020	0.022	1.98	3.07	13.35
Kt		**185.4**	**135.0**						**7633.1**					**1.426.9**
Uncertainty									**87.4**					**37.8**

A3.6. Uncertainty Analysis BC

Sector		Emissions in 2000	Emissions in 2021	Level assess ment	Cumulative total	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to variance in 2021	Type A sensitivity	Type B sensitivity	Uncertainty in trend in total emissions due to EF	Uncertainty in trend in total emissions due to AD	Uncertainty introduced into the trend in total national emissions
NFR	Name sector	kt	kt	(%)	(%)	(%)	(%)	(%)				(%)	(%)	(%)
5C2	Open burning of waste	21.9	29.9	64.7	64.7	63.0	276.0	283.1	33502.6	0.202	0.564	55.83	50.23	5640.30
1A3bi	Road transport: Passenger cars	6.8	4.6	10.0	74.7	10.0	40.0	41.2	17.1	0.025	0.087	0.98	1.24	2.49
1A4bi	Residential: Stationary	5.5	4.1	8.9	83.6	20.0	87.4	89.7	63.3	0.014	0.077	1.21	2.19	6.24
1A3bii	Road transport: Light duty vehicles	3.2	0.9	2.0	85.5	10.0	40.0	41.2	0.7	0.035	0.017	1.39	0.24	2.00
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	0.8	0.9	1.9	87.4	4.6	32.0	32.3	0.4	0.003	0.016	0.10	0.11	0.02
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	3.1	0.8	1.8	89.1	15.0	40.0	42.7	0.6	0.036	0.015	1.43	0.33	2.15
1A2e	Stationary combustion in manufacturing industries and construction: Food processing. beverages and tobacco	0.4	0.7	1.6	90.7	4.5	39.0	39.3	0.4	0.007	0.014	0.27	0.09	0.08
1A3biii	Road transport: Heavy duty vehicles and buses	3.8	0.7	1.5	92.2	10.0	40.0	41.2	0.4	0.049	0.013	1.96	0.18	3.88
2G	Other product use	0.3	0.7	1.5	93.6	2.0	65.4	65.4	0.9	0.009	0.013	0.56	0.04	0.32
1A1c	Manufacture of solid fuels and other energy industries	0.1	0.7	1.4	95.0	16.0	97.9	99.2	2.0	0.011	0.012	1.10	0.28	1.29
1A4ci	Agriculture/Forestry/Fishing: Stationary	0.4	0.5	1.2	96.2	15.0	40.0	42.7	0.3	0.004	0.010	0.15	0.22	0.07
1A3bvi	Road transport: Automobile tyre and brake wear	0.3	0.4	0.8	97.0	10.0	50.0	51.0	0.2	0.002	0.007	0.10	0.10	0.02
*	Other categories	6.5	1.4	3.0	100.0	100.0	100.0	141.4	18.0	0.081	0.026	8.06	3.70	78.56
Kt		**53.0**	**46.2**						**33.606.6**					**5.737.4**
Uncertainty									**183.3**					**75.7**

ANNEX 4. NATIONAL EMISSIONS DATA

Chapter updated in March 2023.

A4.1. National emissions data

The EMEP grid domain employed in the current IIR edition includes the Balearic Islands and Ceuta and Melilla autonomous cities, and excludes the Canary Islands. As a consequence, geographical coverage of CLRTAP's and NEC Directive's Reports fully match.

The current IIR edition describes the information related to the emission estimates covered by the EMEP grid domain.

In this Annex, national emissions data, including the Canary Islands, are provided for information purposes only.

In addition, emissions of NOx and NMVOC pollutants from 1987 and 1988 are included in compliance with the Protocol concerning the Control of Emissions of Nitrogen Oxides and the Protocol on Volatile Organic Compounds.

Year	NOx (kt)	NMVOC (kt)	SO_2 (kt)	NH_3 (kt)	$PM_{2.5}$ (kt)	PM_{10} (kt	TSP (kt)	BC (kt)	CO (kt)
1987	1,191								
1988	1,229	928							
1989	1,341	957							
1990	1,373	1,055	2,127	496	0	0	0	0	4,195
1995	1,410	944	1,822	495	0	0	0	0	3,192
2000	1,434	924	1,420	578	190	302	416	54	2,766
2005	1,413	756	1,230	514	171	291	424	51	2,099
2010	1,004	619	262	460	165	249	326	53	1,912
2011	1,003	598	297	451	168	256	348	54	1,891
2012	945	574	300	448	148	231	315	42	1,588
2013	871	556	235	451	168	245	317	55	1,897
2014	847	552	253	470	146	223	295	42	1,637
2015	869	565	271	474	157	243	333	47	1,775
2016	817	564	230	475	137	219	289	45	1,635
2017	812	581	236	491	137	217	294	44	1,632
2018	795	592	214	487	152	234	314	53	1,841
2019	733	566	167	481	134	217	303	43	1,570
2020	645	592	135	494	137	216	296	46	1,556
2021	668	565	131	482	138	220	303	47	1,673

Year	Pb (t)	Cd (t)	Hg (t)	As (t)	Cr (t)	Cu (t)	Ni (t)	Se (t)	Zn (t)	PCDD/F (g I TEQ)	PAHs (t)	HCB (kg)	PCB (kg)
1990	3,285	27	11	11	29	84	201	8	320	586	101	58	2,241
1995	812	22	14	10	31	96	234	8	276	696	84	60	2,286
2000	306	18	10	11	36	128	250	10	365	616	66	16	2,116
2005	156	13	9	10	36	147	229	10	360	457	57	5	1,491
2010	139	9	6	6	28	140	141	7	395	581	57	12	749
2011	106	10	6	7	28	132	125	8	407	582	56	13	707

Year	Pb (t)	Cd (t)	Hg (t)	As (t)	Cr (t)	Cu (t)	Ni (t)	Se (t)	Zn (t)	PCDD/F (g I TEQ)	PAHs (t)	HCB (kg)	PCB (kg)
2012	98	9	6	7	29	126	110	8	342	599	53	12	667
2013	108	9	5	6	26	120	95	7	422	530	53	8	672
2014	108	8	5	6	27	124	85	7	343	507	53	12	651
2015	100	9	6	6	28	128	84	8	389	545	53	10	606
2016	96	8	6	6	27	130	90	8	375	503	54	12	591
2017	93	8	6	6	28	134	99	8	370	493	44	12	568
2018	98	9	5	6	28	135	96	8	431	523	43	13	535
2019	107	8	4	5	26	132	88	8	360	457	39	13	504
2020	91	7	4	4	23	110	65	7	380	465	35	9	458
2021	105	8	4	4	23	124	65	7	390	481	37	2	466

ANNEX 5. INFORMATION ON CONDENSABLE COMPONENT OF PM

Chapter updated in March 2023.

A5.1. Information on the condensable component of PM

Within the CLRTAP, the Executive Body at its thirty-eight session formally requested that Parties describe their practices for reporting the condensable component of PM in their IIRs, (ECE/EB.AIR/142 para 18.f). The purpose is to provide transparent information that can easily be used by the modellers. To this end, information regarding the inclusion or not of the condensable component of PM in the reported emissions is provided in this annex. An extract of this annex has been included in the relevant sector chapters in order to inform on the matter on a sector basis.

NFR	Source/sector name	PM emissions: the condensable component is		EF reference and comments
		included	excluded	
1A1a	Public electricity and heat production		X	LPS: continuous stack measurements of TSP (mainly opacimeters, calibrated by gravimetry and isokinetic sampling); $PM_{2,5}$ and PM_{10} fractions based in CEPMEIP (2000), from TSP data. Area sources: default EF from CEPMEIP Database (2000).
1A1b	Petroleum refining		X	Varying degrees of complexity; in majority emission factors represent filterable PM emissions.
1A1c	Manufacture of solid fuels and other energy industries		X	LPS (coke plants): country-specific TSP and PM_{10} EF; $PM_{2,5}$ fraction based in CEPMEIP. Area sources: mainly default EF from CEPMEIP Database (2000), but also from EEA/EMEP Guidebook (2019) where most of the EF used represents only filterable PM emissions.
1A2a	Stationary combustion in manufacturing industries and construction: Iron and Steel	Mostly excluded but unclear		Varying degrees of complexity: in majority emissions factors represent filterable PM emissions, but it may not be clear whether only the filterable part or the total part is represented (EMEP/EEA Guidebook (2019); TSP (mainly opacimeters, calibrated by gravimetry and isokinetic sampling); $PM_{2,5}$ and PM_{10} fractions based in CEPMEIP (2000), from TSP data Periodic measurements (between one time a week and once a year).

NFR	Source/sector name	PM emissions: the condensable component is		EF reference and comments
		included	excluded	
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	Mostly excluded but unclear		Varying degrees of complexity: in majority emissions factors represent filterable PM emissions, but it may not be clear whether only the filterable part or the total part is represented (EMEP/EEA Guidebook (2019); TSP (mainly opacimeters, calibrated by gravimetry and isokinetic sampling); $PM_{2,5}$ and PM_{10} fractions based in CEPMEIP (2000), from TSP data Periodic measurements (between one time a month and once a year).
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	Mostly excluded but unclear		Varying degrees of complexity: in majority emissions factors represent filterable PM emissions, but it may not be clear whether only the filterable part or the total part is represented (EMEP/EEA Guidebook (2019).
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	Mostly excluded but unclear		Varying degrees of complexity: in majority emissions factors represent filterable PM emissions, but it may not be clear whether only the filterable part or the total part is represented (EMEP/EEA Guidebook (2019), Periodic measurements (between one time a month and more than once a year).
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	Mostly excluded but unclear		Varying degrees of complexity: in majority emissions factors represent filterable PM emissions, but it may not be clear whether only the filterable part or the total part is represented (EMEP/EEA Guidebook (2019).
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	Mostly excluded but unclear		Varying degrees of complexity; in majority emission factors represent filterable PM emissions (EMEP/EEA Guidebook (2019), OFICEMEN).
1A2gvii	Mobile combustion in manufacturing industries and construction (please specify in the IIR)	X		EF from EEA/EMEP Guidebook (2019).
1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)		X	$PM_{2,5}$ and PM_{10} fractions based in CEPMEIP (2000), from TSP data Periodic measurements (between one time a week and once a year).

NFR	Source/sector name	PM emissions: the condensable component is		NFR
		included	excluded	
1A3ai(i)	International aviation LTO (civil)	X		EF from FEIS model (EUROCONTROL).
1A3aii(i)	Domestic aviation LTO (civil)	X		
1A3bi	Road transport: Passenger cars	X		EF from EEA/EMEP Guidebook (2019): The measurement procedure regulated for vehicle exhaust PM mass characterisation requires that samples are taken at a temperature lower than 52ºC, At this temperature, PM contains a large fraction of condensable species, Hence, PM mass emission factors in this sector are considered to include both filterable and condensable material.
1A3bii	Road transport: Light duty vehicles	X		
1A3biii	Road transport: Heavy duty vehicles and buses	X		
1A3biv	Road transport: Mopeds & motorcycles	X		
1A3bv	Road transport: Gasoline evaporation	NA		
1A3bvi	Road transport: Automobile tyre and brake wear	X		EF from EEA/EMEP Guidebook (2019).
1A3bvii	Road transport: Automobile road abrasion	X		EF from EEA/EMEP Guidebook (2019).
1A3c	Railways	X		Default T1 EF from EEA/EMEP Guidebook (2019).
1A3di(ii)	International inland waterways	NO		
1A3dii	National navigation (shipping)	X		EF from EEA/EMEP Guidebook (2019).
1A3ei	Pipeline transport		X	Default EF from CEPMEIP Database (2000).
1A3eii	Other (please specify in the IIR)	NO		
1A4ai	Commercial/Institutional: Stationary	Depending on category and fuel.		EF from EEA/EMEP Guidebook (2019), Chapter 1A4, Small combustion Boilers – Solid and Liquid fuels: It is unclear whether PM emissions include or not the condensable component Boilers – Gaseous fuels: Condensable component excluded Boilers – Biomass: Condensable component included Turbines – All fuels: It is unclear whether PM emissions include or not the condensable component Stationary engines – Liquid fuels: Condensable component excluded Stationary engines – Gaseous fuels: It is unclear whether PM emissions include or not the condensable component.
1A4aii	Commercial/Institutional: Mobile	X		Default EF from EEA/EMEP Guidebook (2019), Chapter 1A4, Non-road mobile machinery, table 3-1.

NFR	Source/sector name	PM emissions: the condensable component is		NFR
		included	excluded	
1A4bi	Residential: Stationary	Depending on category and fuel.		EF from EEA/EMEP Guidebook (2019), Chapter 1A4, Small combustion Boilers – Solid fuels: Condensable component excluded Boilers – Gas oil: Condensable component excluded, Boilers – Rest of Liquid fuels: It is unclear whether PM emissions include or not the condensable component Boilers – Gaseous fuels: It is unclear whether PM emissions include or not the condensable component Boilers – Biomass: Condensable component included.
1A4bii	Residential: Household and gardening (mobile)	IE		
1A4ci	Agriculture/Forestry/Fishing: Stationary	Depending on category and fuel.		EF from EEA/EMEP Guidebook (2019), Chapter 1A4, Small combustion Boilers – Solid and Liquid fuels: It is unclear whether PM emissions include or not the condensable component Boilers – Gaseous fuels: Condensable component excluded Boilers – Biomass: Condensable component included Stationary engines – Gas oil: Condensable component excluded Stationary engines – Rest of Liquid fuels: It is unclear whether PM emissions include or not the condensable component.
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	X		EF from EEA/EMEP Guidebook (2019).
1A4ciii	Agriculture/Forestry/Fishing: National fishing	X		EF from EEA/EMEP Guidebook (2019).
1A5a	Other stationary (including military)	IE		
1A5b	Other, Mobile (including military, land based and recreational boats)	X		Aggregated methodology from 1A3a, 1A3b, 1A3dii (see categories above).
1B1a	Fugitive emission from solid fuels: Coal mining and handling	No information available.		EF from EEA/EMEP Guidebook (2019).
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	No information available.		EF from EEA/EMEP Guidebook (2019).
1B1c	Other fugitive emissions from solid fuels	NO		
1B2ai	Fugitive emissions oil: Exploration, production, transport	NA		
1B2aiv	Fugitive emissions oil: Refining and storage	No information available.		EMEP/EEA Guidebook (2019), Continuous measurements.
1B2av	Distribution of oil products	NA		

NFR	Source/sector name		PM emissions: the condensable component is		NFR
			included	excluded	
1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)		NA		
1B2c	Venting and flaring (oil, gas, combined oil and gas)		No information available.		Continuous measurements.
1B2d	Other fugitive emissions from energy production		NO		
2A1	Cement production		IE		
2A2	Lime production		No information available.		EMEP/EEA GB 2019.
2A3	Glass production		No information available.		EMEP/EEA GB 2019.
2A5a	Quarrying and mining of minerals other than coal		No information available.		EMEP/EEA GB 2016.
2A5b	Construction and demolition		No information available.		EMEP/EEA GB 2013.
2A5c	Storage, handling and transport of mineral products		No information available.		EMEP/EEA GB 2019.
2A6	Other mineral products (please specify in the IIR)		NA		
2B1	Ammonia production		NE		
2B2	Nitric acid production		NE		
2B3	Adipic acid production		NO		
2B5	Carbide production		No information available.		EMEP/EEA GB 2019.
2B6	Titanium dioxide production		No information available.		EMEP/EEA GB 2019.
2B7	Soda ash production		No information available.		EMEP/EEA GB 2019.
2B10a	Chemical industry: Other (please specify in the IIR)		No information available.		EMEP/EEA GB 2019.
2B10b	Storage, handling and transport of chemical products (please specify in the IIR)		IE		
2C1	Iron and steel production		No information available.		Stack measurements of TSP and PM_{10}; $PM_{2,5}$ fractions based in CEPMEIP (2000) or EMEP/EEA GB 2019, from TSP data.
				X	EMEP/EEA GB 2019.
2C2	Ferroalloys production			X	EMEP/EEA GB 2019.
2C3	Aluminium production	Primary prod	No information available.		Stack measurements of TSP; $PM_{2,5}$ and PM_{10} fractions based in CEPMEIP (2000), from TSP data.
		Secondary prod		X	EMEP/EEA GB 2019.
2C4	Magnesium production		NO		
2C5	Lead production			X	EMEP/EEA GB 2019.
2C6	Zinc production			X	EMEP/EEA GB 2019.
2C7a	Copper production			X	EMEP/EEA GB 2019.
2C7b	Nickel production		NO		
2C7c	Other metal production (please specify in the IIR)		NA		
2C7d	Storage, handling and transport of metal products (please specify in the IIR)		NE		

NFR	Source/sector name	PM emissions: the condensable component is		NFR
		included	excluded	
2D3a	Domestic solvent use including fungicides	NE		
2D3b	Road paving with asphalt	X		EMEP/EEA GB 2019.
2D3c	Asphalt roofing	No information available.		EMEP/EEA GB 2019.
2D3d	Coating applications	NA		
2D3e	Degreasing	NE		
2D3f	Dry cleaning	NE		
2D3g	Chemical products	NE		
2D3h	Printing NE			
2D3i	Other solvent use (please specify in the IIR)	NE		
2G	Other product use (please specify in the IIR)	No information available.		EMEP/EEA GB 2019.
2H1	Pulp and paper industry	No information in the EMEP/EEA GB 2019.		EMEP/EEA GB 2019.
2H2	Food and beverages industry	NE		
2H3	Other industrial processes (please specify in the IIR)	NO		
2I	Wood processing	NE		
2J	Production of POPs	NA		
2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)	NA		
2L	Other production, consumption, storage, transportation or handling of bulk products (please specify in the IIR).	NA		
3B1a	Manure management – Dairy cattle	No information available.		EF from EEA/EMEP Guidebook (2019).
3B1b	Manure management - Non-dairy cattle	No information available.		EF from EEA/EMEP Guidebook (2019).
3B2	Manure management – Sheep	No information available.		EF from EEA/EMEP Guidebook (2019).
3B3	Manure management – Swine	No information available.		EF from EEA/EMEP Guidebook (2019).
3B4a	Manure management - Buffalo	NO		
3B4d	Manure management – Goats	No information available.		EF from EEA/EMEP Guidebook (2019).
3B4e	Manure management – Horses	No information available.		EF from EEA/EMEP Guidebook (2019).
3B4f	Manure management - Mules and asses	No information available.		EF from EEA/EMEP Guidebook (2019).
3B4gi	Manure management – Laying hens	No information available.		EF from EEA/EMEP Guidebook (2019).
3B4gii	Manure management – Broilers	No information available.		EF from EEA/EMEP Guidebook (2019).
3B4giii	Manure management - Turkeys	IE		
3B4giv	Manure management – Other poultry	No information available.		EF from EEA/EMEP Guidebook (2019).
3B4h	Manure management – Other animals (please specify in the IIR)	NO		

NFR	Source/sector name	PM emissions: the condensable component is		NFR
		included	excluded	
3Da1	Inorganic N-fertilizers (includes also urea application)	NA		
3Da2a	Animal manure applied to soils	NA		
3Da2b	Sewage sludge applied to soils	NA		
3Da2c	Other organic fertilisers applied to soils (including compost)	NA		
3Da3	Urine and dung deposited by grazing animals	NA		
3Da4	Crop residues applied to soils	NA		
3Db	Indirect emissions from managed soils	NA		
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	No information available.		EF from EEA/EMEP Guidebook (2019).
3Dd	Off-farm storage, handling and transport of bulk agricultural products	NA		
3De	Cultivated crops	NA		
3Df	Use of pesticides	NA		
3F	Field burning of agricultural residues	No information available.		EF from EEA/EMEP Guidebook (2019).
3I	Agriculture other (please specify in the IIR)	NO		
5A	Biological treatment of waste - Solid waste disposal on land	No information in the EMEP/EEA GB 2019.		EMEP/EEA GB 2019.
5B1	Biological treatment of waste - Composting	NE		
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	No information in the EMEP/EEA GB 2019.		No information in the EMEP/EEA GB 2019.
5C1a	Municipal waste incineration	IE		Included in 1A1a.
5C1bi	Industrial waste incineration	IE		Included in 1A1a.
5C1bii	Hazardous waste incineration	NO		
5C1biii	Clinical waste incineration	IE		Included in 1A1a.
5C1biv	Sewage sludge incineration		X	US EPA AP-42 Section 2.4 Chapter 2.2.
5C1bv	Cremation	No information in the EMEP/EEA GB 2019.		
5C1bvi	Other waste incineration (please specify in the IIR)	NO		
5C2	Open burning of waste	No information in the EMEP/EEA GB 2019.		EMEP/EEA GB 2019.
5D1	Domestic wastewater handling	No information in the EMEP/EEA GB 2019.		EMEP/EEA GB 2019.
5D2	Industrial wastewater handling	No information in the EMEP/EEA GB 2019.		EMEP/EEA GB 2019.
5D3	Other wastewater handling	NE		
5E	Other waste (please specify in the IIR)	No information in the EMEP/EEA GB 2019.		EMEP/EEA GB 2019.
6A	Other (included in national total for entire territory) (please specify in the IIR)	No information in the EMEP/EEA GB 2019.		EMEP/EEA GB 2019.

ANNEX 6. EXPERT JUDGEMENT

Chapter updated in March 2023.

A6.1. Energy

EXPERT JUDGEMENT	
Expert judgment reference number	**INV-ESP-JE/ENER/2015-001**
Date	December 10, 2015
Name of the experts	María Pilar Martínez de la Calle José Luis García-Siñeriz Martínez
Organizations to which the experts belong	Asociación para la Investigación y Desarrollo Industrial de los Recursos Naturales (AITEMIN).
Evaluation	Emissions of particles and volatile organic compounds from coal mining in Spain.
Basis	Application of the new 2006 IPCC Guidelines in the National Inventory.
Results	New series of emission estimates for the period 1990-2014.
Identification of external validators	
Result of external validation	
Approval by the National Inventory Manager	

Web link to document:

INV-ESP-JE/ENER/2015-001

GLOSSARY

GLOSSARY

Chapter updated in March, 2023.

ADHAC	Spanish Association of District Heating and Cooling
AEMET	State Agency of Meteorology
AENA	Spanish Airports and Air Navigation
AFOEX	National Association of Companies for the Fostering and Extraction of Oleaginous Substances
AFOLU	Agriculture, Forestry and Other Land Use
AICA	Food Information and Control Agency
AITIM	Technical Research Association of the Wood and Cork Industries
AMBILAMP	Association for the Recycling of lighting equipment
ANAIP	Spanish Association of Plastics Industry
ANAPE	Spanish Association for Expanded Polystyrene Producers
ANCADE	Spanish National Association of Manufacturers of Lime and Derivatives
ANE	National Electrochemical Association
ANEO	National Association of Olive Oil Companies
ANEPROMA	National Association of Wood Protection Companies
ANFFE	National Association of Fertilizer Manufacturers
ANFFECC	National Association of Manufacturers of Frits, Enamels and Ceramic Colours
ANIACAM	National Association of Cars, Trucks, Buses and Motorbikes Importers
AOP	Association of Petroleum Operators
APPA	Biocarburantes Association of Generators of Renewable Energy (biofuels section)
AQ-AOS	Annual Questionnaire - Annual Oil Questionnaire (Annual Oil Statistics)
AQs	Annual Questionnaires
ASCER	Spanish Association of Manufacturers of Ceramic Floor Tiles, Wall Tiles, and Paving
ASEFAPI	Spanish Association of Manufacturers of Paint and Printing Dyes
ASEFMA	Spanish Association of Bituminous Mixture Factories
ASERAL	Spanish Association of Aluminium Refiners
ASOFRIO	Central purchasing and services of refrigeration
ASPAPEL	Association of Spanish Pulp and Paper Manufacturers
B(a)P	Benzo(a)pyrene
B(b)F	Benzo(b)fluoranthene
B(k)F	Benzo(k)fluoranthene
BAT	Best available Techniques
BBVA	Foundation Bilbao Vizcaya Argentaria Bank
BC	Black Carbon
BNPAE	Nitrogen and Phosphorous Balance in Agriculture

BREF	Best Available Techniques Reference Document
CAP	Common Agricultural Policy
CEDEX	Spanish Centre for Public Works Studies and Experimentation
CEIP	Centre on Emission Inventories and Projections
CEPE	European Council of the Paint, Printing Ink and Artists' Colours Industry
CEPMEIP	Co-ordinated European Programme on Particulate Matter Emission Inventories, Projections and Guidance
CIEDB	Core Inventory Emissions Database
CIEMAT	Research Centre for Energy, Environment and Technology
CITEPA	Interprofessional Technical Centre for Studies on Air Pollution-France
CLH	Logistics Company of Hydrocarbons
CLRTAP or LRTAP	Convention on Long-Range Transboundary Air Pollution
CNE	National Energy Commission
CNV	National Census for Sewage Disposal
CODA	Central Office for Delay Analysis (EUROCONTROL)
COFACO	National Consortium of Rubber Manufacturers
CONCAWE	Division of the European Petroleum Refiners Association
COPERT	Computer Programme to calculate Emissions from Road Transport
CORES	Corporation for Strategic Oil Reserves
CORINAIR	Core Inventory of Air emissions
CRF	Common Reporting Format
DG ENV	Directorate-General for environment
DGAC	Directorate General for Civil Aviation (Ministry of Transport, Mobility and Urban Agenda – MITMA)
DGCEA	Directorate-General for Environmental Quality and Assessment (Ministry for the Ecological Transition and the Demographic Challenge - MITECO)
DGPEM	Directorate-General for Energy Policy and Mines (Ministry for the Ecological Transition and the Demographic Challenge - MITECO)
DGT	Directorate General of Traffic (Ministry of Interior)
DIOX	Dioxins and furans
DRDB	Data Request Database
EAPA	European Asphalt Pavement Association
ECA	Emission Control Areas
ECOGAN	General Registry of BATs and Calculation of Livestock Emissions
EDARs	Waste Water Treatment Plants
EEA	European Environment Agency
EF	Emission factor
EMEP	European Monitoring Evaluation Programme of CLRTAP
ENAGÁS	Technical Manager of the Spanish gas system
ENDESA	National Electricity Company

E-PRTR	European Pollutant Release and Transfer Register
EPTMC	Continuing Survey of Road Goods Transport
ERT	Expert Review Team
ESIG	European Solvents Industry Group
ESyRCE	Official Survey on Crop Areas and Yields
ETSAP	Energy Technology Systems Analysis Program
EU	European Union
EU-ETS	European Union Emissions Trading System
EUROCONTROL	European Organisation for the Safety of Air Navigation
EUROSTAT	European Union Statistical Office
EXOLUM	(Formerly CLH) Logistics Company of Hydrocarbons
FAME	Fatty Acid Methyl Ester
FAOSTAT	Statistics Division of the Food and Agriculture Organization of the United Nations
FCC	Fluid catalytic cracking
FEAF	Spanish Federation of Foundry Associations
FEIQUE	Spanish Federation of Chemical Industries
FEIS	Fuel Burn and Emissions Inventory System
FEMP	Spanish Federation of Municipalities and Provinces
GDP	Gross Domestic Product
GE	Gross Energy
GFCF	Gross fixed capital formation
GHG	Greenhouse gases
GNFR	Gridded NFR
HCB	Hexachlorobenzene
HELCOM	Helsinki Commission
HFCs	Hydrofluorocarbons
HISPALYT	Spanish Association of Manufacturers of Clay Bricks and Tiles
HM	Heavy Metals
ICAO	International Civil Aviation Organization
IDAE	Institute for Energy Saving and Diversification
IE	Included Elsewhere
IEA	International Energy Agency
IEB	Inventory Energy Balance
IEF	Implicit Emission Factor
IF	Indeno(1,2,3-cd)pyrene
IGME	Geological and Mining Institute of Spain
IIASA	International Institute for Applied Systems Analysis
IIR	Informative Inventory Report
ITV	Technical Inspection of Vehicles

IMO	International Maritime Organization
INE	National Statistics Institute
INM	National Weather Institute
IPCC	Intergovernmental Panel for Climate Change
IPPU	Industrial Processes and Products Use
IPTS	Institute for Prospective Technological Studies
IPUR	Industry Association of Rigid Polyurethane
IQ	Individualized Questionnaire
IQMDB	Inventory quality management database
I-TEQ	International Toxic Equivalent
KC	Key Categories
KP	Kyoto Protocol
LCP	Directive Large Combustion Plants Directive
LHV	Lower Heating Value
LPG	Liquefied Petroleum Gases
LPS	Large Point Sources
LTO	cycles Landing and Take-off cycles
LULUCF	Land Use, Land-Use Change and Forestry
MAGRAMA	Ministry of Agriculture, Food and Environment (currently, Ministry for the Ecological Transition and the Demographic challenge - MITECO and the Ministry of Agriculture, Fisheries and Food- MAPA)
MAPA	Ministry of Agriculture, Fisheries and Food
MAPAMA	Ministry of Agriculture and Fisheries, Food and Environment (currently split into the Ministry for the Ecological Transition and the Demographic challenge -MITECO and the Ministry of Agriculture, Fisheries and Food -MAPA)
MAPFRE	Mutuality of the Group of Owners of Rural Estates of Spain
MARPOL	Marine Pollution - International Convention for the prevention of pollution from ships
MCP	Directive Medium Combustion Plant Directive
MDE	Ministry of Defence
MFOM	Ministry of Public Works (currently, Ministry of Transport, Mobility and Urban Agenda-MITMA)
MINCOTUR	Ministry of Industry, Trade and Tourism
MINER	Ministry of Industry and Energy (currently split into the Ministry for the Ecological Transition and the Demographic challenge –MITECO and Ministry of Industry, Trade and Tourism –MINCOTUR)
MINETAD	Ministry of Energy, Tourism and the Digital Agenda (currently, Directorate-General for Energy Policy and Mines, Ministry for the Ecological Transition and the Demographic challenge -MITECO)
MINETUR	Ministry of Industry, Energy and Tourism (currently, Directorate-General for Energy Policy and Mines, Ministry for the Ecological Transition and the Demographic challenge -MITECO)

MITECO	Ministry for the Ecological Transition and the Demographic Challenge
MITMA	Ministry of Transport, Mobility and Urban Agenda
MITYC	Ministry of Industry, Tourism and Trade (currently, Ministry of industry, trade and tourism - MINCOTUR)
MMR	Monitoring Mechanism Regulation
MMS	Manure Management System
MOPT	Ministry of Public Works and Transportation (currently, Ministry of Transport, Mobility and Urban Agenda - MITMA)
MOPTMA	Ministry of Public Works and Transportation and the Environment (currently, split into the Ministry of Transport, Mobility and Urban Agenda - MITMA and the Ministry for the Ecological Transition and the Demographic challenge -MITECO)
MSCBS	Ministry of Health, Consumer Affairs and Social welfare
MSW	Municipal Solid Waste
NA	Not Applicable
NAPCP	National Air Pollution Control Programme
NE	Not estimated
NECD	National Emissions Ceilings Directive
NFR	Nomenclature for Reporting
NIECP	National Integrated Energy and Climate Plan
NIR	National Inventory Report
NK	Notation Keys
NMVOC	Non-methanic Volatile Organic Compounds
NO	Not occurring
NPK	Nitrogen phosphorus and potassium
OECC	Spanish Office for Climate Change
OECD	Organisation for Economic Co-operation and Development
OFICEMEN	Spanish Association of Cement Manufacturers
OFICO	Office for Electricity Compensations
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
OSPARCOM	OSPAR Commission
PAH	Polycyclic aromatic hydrocarbons
PAMs	Policies and Measures
PANASEF	National Funeral Services Association
PARCOM-ATMOS	Emission factors manual PARCOM-ATMOS
PCBs	Polychlorinated biphenyls
PCDD	Dioxins
PCDD/F	Dioxins and Furans
PCDF	Furans
PDCA cycle	Plan–Do–Check–Act cycle

PER	Renewable Energy Plan
PFC	Perfluorocarbons
PM	Particulate Matter
PNCCA	National Air Pollution Control Programme
POPs	Persistent Organic Pollutants
PRTR	Pollutant Release and Transfer Register
QA/QC	Quality Assurance/Quality Control
RCE	Spain's Road Network
REE	Red Eléctrica de España (operator of the Spanish electricity transport system)
RENFE	Red Nacional de los Ferrocarriles Españoles (Spanish National Railways Network)
REGA	General Registry of Livestock Farming
RIIA	Registry of individual animal identification
RMS	Regulating and Metering Stations
RNL	National Sludge Registry
SEDIGAS	Spanish Gas Association
SEI	Spanish National Inventory System
SGALSI	Subdirectorate-General for Clean Air and Industrial Sustainability (Ministry for the Ecological Transition and the Demographic challenge -MITECO)
SGEC	Subdirectorate-General of Circular Economy (Ministry for the Ecological Transition and the Demographic challenge – MITECO)
SGIBP	Subdirectorate General of Basic and Process Industries
SGPEM	Subdirectorate-General of Energy Politic and Mines
SNAP	Selected Nomenclature for sources of Air Pollution
SOLVAY	Worldwide Chemical Company
TAN	Total Ammonia Nitrogen
TERT	Technical Expert Review Team
TFEIP	Task Force on Emission Inventories and Projections under the
	Convention on Long-range Transboundary Air Pollution
TSP	Total Suspended Particulate
UNECE	United Nations Economic Commission for Europe
UNESID	Union of Iron and Steel Companies
UNFCCC	United Nations Framework Convention on Climate Change
UNICOBRE	National Union for Copper Industries
UNIPLOM	Union of the lead industry
US EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds
WaM	With Additional Measures
WeM	With Existing Measures

WG I	Working Group I – “Annual inventories” under the EU Climate Change Committee (European Commission)

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