



## **INVENTORY OF MADRID CITY AIR POLLUTANT EMISSIONS 2023**

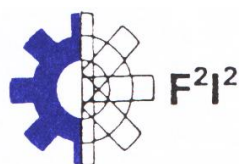


**Directorate General for Sustainability and  
Environmental Control  
Sub-directorate of Energy and Climate Change**

# **INVENTORY OF MADRID CITY AIR POLLUTANT EMISSIONS 2023**

*DG for Sustainability and Environmental Control  
Sub-directorate of Energy and Climate Change*

*December 2025*



Prepared by:

Fundación para el Fomento de la Innovación Industrial (F2I2)

Escuela Técnica Superior de Ingenieros Industriales

Technical University of Madrid (U.P.M)

## **1 INTRODUCTION**

The Department of Environment and Mobility of the City of Madrid, annually elaborates the Air Pollutant Emissions Inventory of Madrid city. This Inventory is a useful tool for decision making regarding environmental policy as well as being an essential element for a basic understanding of the activities affecting air quality, sustainable energy management and Climate Change mitigation.

For the elaboration of the Air Pollutant Emissions Inventory of Madrid city 2023 (hereinafter Inventory 2023), the working team of the *Fundación para el Fomento de la Innovación Industrial* (F2I2) has followed the methodology of the air pollutant emission inventory guidebooks published by the European Environment Agency (EMEP/EEA air pollutant emission inventory guidebook 2009, 2013, 2016, 2019 y 2023). Base information has been compiled from questionnaires sent to major local industries as well as from data provided by the National Statistics Institute, the Ministry for the Ecological Transition and the Demographic Challenge (MITECO) and the Energy Balance of the municipality of Madrid in 2023, among others.

The relevant emitting activities considered in the Inventory 2023 have been gathered according to the Selected Nomenclature for sources of Air Pollution (SNAP). This nomenclature considers 11 categories at the higher level of aggregation. These categories are referred to as activity groups (Table 1). As for the pollutants considered,

Table 2 shows those included in the Inventory, distinguishing between greenhouse gases (GHG), acidifying gases and ozone precursors and particulate matter.

**Table 1. SNAP Nomenclature. Activity groups**

<b>Code</b>	<b>Group name</b>
01	Combustion in energy and transformation industries (*)
02	Non-industrial combustion plants
03	Combustion in manufacturing industry
04	Production processes
05	Extraction and distribution of fossil fuels and geothermal energy
06	Solvent and other product use
07	Road transport
08	Non-road transport
09	Waste treatment and disposal
10	Agriculture
11	Other sources and sinks (nature)

*(\*) Without emissions in the municipality of Madrid.*

**Table 2. Pollutants**

Type	Chemical formula	Compound
Greenhouse gases (GHG)	CH <sub>4</sub>	Methane
	CO <sub>2</sub>	Carbon dioxide
	HFC	Hydrofluorocarbons
	N <sub>2</sub> O	Nitrous oxide
	PFC	Perfluorocarbons
	SF <sub>6</sub>	Sulphur hexafluoride
Acidifying gases and ozone precursors	CO	Carbon monoxide
	NMVOC	Non-methane volatile organic compounds
	NH <sub>3</sub>	Ammonia
	NO <sub>x</sub>	Nitrogen oxides (NO+NO <sub>2</sub> ), as NO <sub>2</sub>
	SO <sub>x</sub> (hereinafter SO <sub>2</sub> )	Sulphur oxides (SO <sub>2</sub> +SO <sub>3</sub> ), as SO <sub>2</sub>
Particulate matter	PM <sub>2.5</sub>	Particles with aerodynamic diameter less than 2.5 microns
	PM <sub>10</sub>	Particles with aerodynamic diameter less than 10 microns
	TPM	Total particulate matter
	BC	Black Carbon (see Appendix I)

## 2 EMISSIONS IN MADRID CITY

### 2.1 Total emissions

Table 3 shows the annual total emissions of Madrid city for each of the pollutant evaluated from 1999 to 2023.

**Table 3. Total emissions by pollutant<sup>1</sup>**

Pollutant	Ud.	1999	2000	2005	2010	2015	2020	2021	2022	2023
CH <sub>4</sub>	t	47 628	47 809	20 817	19 875	15 940	15 474	14 781	14 710	14 900
CO	t	112 897	95 963	42 242	19 229	11 488	7 622	7 268	7 077	6 741
CO <sub>2</sub> (*)	kt	8 045	8 071	8 476	7 130	6 050	5 148	5 571	4 978	4 803
COVNM	t	51 407	48 096	31 643	22 312	18 411	15 527	15 826	15 666	15 650
HFC-125	kg	18 396	27 027	75 399	121 677	66 328	23 379	24 091	32 010	31 104
HFC-134a	kg	57 662	72 170	147 042	189 049	127 113	86 121	87 616	99 265	73 352
HFC-143a	kg	14 384	19 798	50 162	64 385	25 014	4 640	4 242	3 886	1 376
HFC-152a	kg	0.00	0.00	0.00	0.00	164	75	49	35	21
HFC-227ea	kg	92	106	372	837	1 408	877	769	683	613
HFC-23	kg	223	300	595	625	477	297	266	239	215
HFC-236fa	kg	1.08	0.90	0.53	0.31	0.17	0.13	0.11	0.10	0.10
HFC-32	kg	4 730	7 909	25 691	34 102	27 667	20 371	22 707	35 255	54 450
N <sub>2</sub> O	t	868	891	849	822	569	546	557	538	530
NH <sub>3</sub>	t	1 183	1 363	1 704	1 665	655	700	743	679	707
NO <sub>x</sub>	t	30 201	29 923	28 374	19 773	15 177	10 648	10 678	11 052	10 518
PFC-116	kg	0.04	0.07	0.24	0.32	3.32	2.22	2.03	2.23	0.40
PFC-218	kg	0.23	0.31	1.88	4.39	46.60	39.71	169.78	96.73	0.14
PFC-410	kg	1.95	1.72	1.02	0.59	0.34	0.21	0.18	0.16	0.15
PM <sub>10</sub>	t	2 364	2 283	1 920	1 345	1 049	745	747	615	598
PM <sub>2.5</sub>	t	2 094	2 011	1 634	1 097	829	591	564	480	466
SF <sub>6</sub>	kg	278	285	435	592	607	667	674	681	680
SO <sub>2</sub>	t	4 586	3 848	2 142	1 192	860	584	684	568	609
PST	t	2 672	2 595	2 238	1 615	1 290	925	948	773	763

1) CO<sub>2</sub> removals by nature sinks are not included (SNAP activity Group 11). CH<sub>4</sub> and N<sub>2</sub>O emissions from said Group are included.

With the exception of fluorine compounds (HFCs, PFCs and SF<sub>6</sub>), emissions decreased in this period of time. Particularly relevant are the reductions of CH<sub>4</sub>, CO, NMVOC, SO<sub>2</sub> and PM<sub>2.5</sub>, reaching 69, 94, 70, 87 and 78%, respectively.

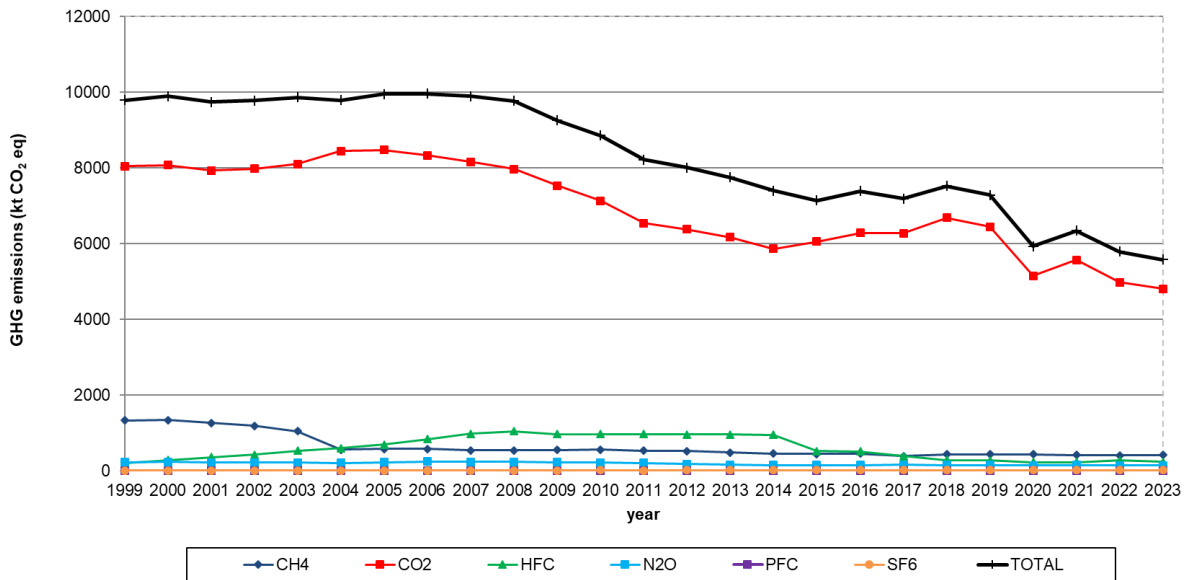
Table 4 and Figure 1 show the total GHG emissions in Madrid city expressed in terms of CO<sub>2</sub> equivalent (CO<sub>2</sub>-eq). For this purpose, emissions of each GHG have been weighted by their corresponding global warming potential (GWP), in accordance with the recommended values of the Fifth Assessment Report

of Intergovernmental Panel on Climate Change (IPCC, 2013), available at: [http://www.ipcc.ch/publications\\_and\\_data/publications\\_and\\_data\\_reports.shtml#UVq7jDdOnZc](http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml#UVq7jDdOnZc)

**Table 4. Total GHG emissions (kt CO<sub>2</sub>-eq)<sup>1</sup>**

Pollutant	1999	2000	2005	2010	2015	2020	2021	2022	2023
CH <sub>4</sub>	1 334	1 339	583	556	446	433	414	412	417
CO <sub>2</sub>	8 045	8 071	8 476	7 130	6 050	5 148	5 571	4 978	4 803
HFC	209	284	697	974	525	229	232	278	242
N <sub>2</sub> O	230	236	225	218	151	145	148	143	140
PFC	0.0	0.0	0.0	0.0	0.5	0.4	1.5	0.9	0.0
SF <sub>6</sub>	7	7	10	14	14	16	16	16	16
<b>TOTAL</b>	<b>9 823</b>	<b>9 936</b>	<b>9 991</b>	<b>8 893</b>	<b>7 187</b>	<b>5 971</b>	<b>6 381</b>	<b>5 828</b>	<b>5 619</b>

<sup>1</sup>) CO<sub>2</sub> removals by nature sinks are not included (SNAP activity Group 11). CH<sub>4</sub> and N<sub>2</sub>O emissions from said Group are included.



**Figure 1. GHG emissions trend by compound**

Total GHG emissions in 2023 declined by 43% compared to 1999, mainly due to the reduction of CO<sub>2</sub> emissions in the “Road transport” (group 07) sector and CH<sub>4</sub> emissions from “Waste treatment and disposal” (group 09). In 2021, GHG emissions are 7% higher than in 2020, due to the return of normal activity after the COVID-19 pandemic. In 2023, GEI emissions decreased 4% from 2022.

The contribution of each GHG to total CO<sub>2</sub>-eq figures is shown in Figure 2. CO<sub>2</sub> is the single most important specie with an average contribution of 83% in the period 1999 – 2023. Unlike the rather constant contribution of CO<sub>2</sub>, Figure 2 shows a decreasing contribution of CH<sub>4</sub> and the increasing relevance of HFCs until the year 2015.

INVENTORY OF MADRID CITY AIR POLLUTANT EMISSIONS 2023 - Period 1999-2023

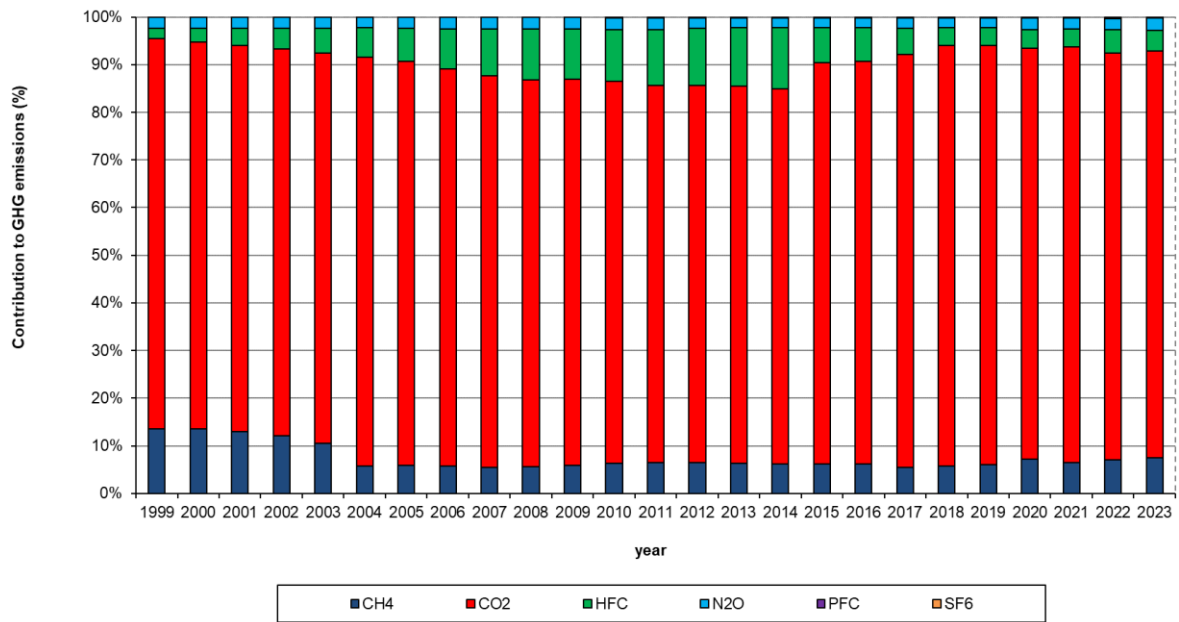


Figure 2. GHG emissions breakdown by compound (%)

## 2.2 Emissions disaggregated by pollutant and SNAP group

### 2.2.1 Greenhouse gases

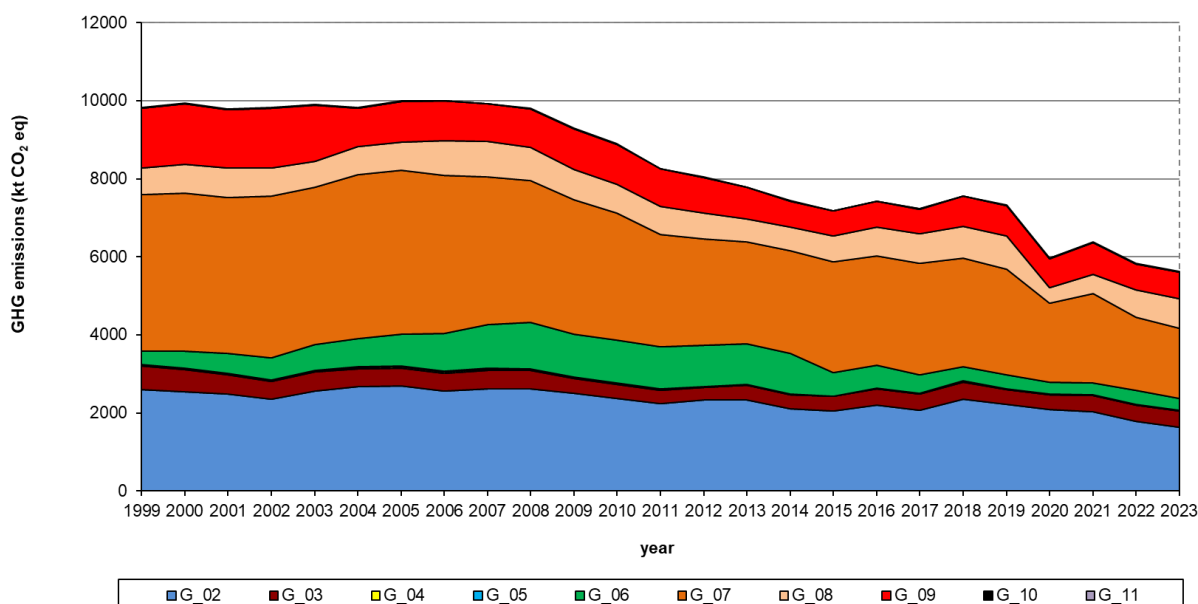
Table 5 and Figure 3 show the GHG emissions by activity group expressed in terms of CO<sub>2</sub> equivalent. It is noticeable that the total GHG emissions have not undergone major changes in the period inventoried until 2008, when emissions began to decrease. This is mainly due to the reduction of emissions from the “Road transport” sector as a result of the decrease of the total distance travelled within the city, the promotion of mopeds and motorcycles, the turnover of the fleet and the improvement of the municipal public transport system, among others.

**Table 5. GHG emissions by SNAP group (kt CO<sub>2</sub>-eq)<sup>1,2</sup>**

Year	G_02	G_03	G_04	G_05	G_06	G_07	G_08	G_09	G_10	G_11	TOTAL
1999	2 595	604	19	21	347	4 010	675	1 537	6.1	9.1	9 823
2000	2 551	556	23	21	424	4 050	742	1 555	6.3	9.1	9 936
2005	2 695	455	27	18	827	4 196	728	1 032	3.3	9.9	9 991
2010	2 373	363	19	18	1 087	3 268	726	1 026	3.1	10.2	8 893
2015	2 046	373	1.0	17	601	2 836	658	643	3.0	9.8	7 187
2020	2 087	380	0.5	19	302	2 022	405	742	3.3	10.4	5 971
2021	2 038	409	0.6	20	307	2 285	497	812	3.2	10.3	6 381
2022	1 790	416	1.0	18	353	1 868	703	666	3.3	10.2	5 828
2023	1 626	420	1.0	16	315	1 801	756	671	3.1	10.4	5 619

1) G\_02: Non-industrial combustion; G\_03: Combustion in manufacturing industry; G\_04: Production processes; G\_05: Extraction and distribution of fossil fuels; G\_06: Solvent and other product use; G\_07: Road transport; G\_08: Non-road transport; G\_09: Waste treatment and disposal; G\_10: Agriculture; G\_11: Other sources and sinks (nature).

2) CO<sub>2</sub> removals by nature sinks are not included (SNAP activity Group 11). CH<sub>4</sub> and N<sub>2</sub>O emissions from said Group are included.



**Figure 3. GHG emissions trend by SNAP group (kt CO<sub>2</sub>-eq)**

Figure 4 shows the relative contribution to total GHG emissions of each group. The SNAP groups 02 and 07 combined account for about 66% of GHG emissions in the period inventoried. Other SNAP groups, such as 03, 06, 08 y 09, have a lower contribution to total emissions (ranging from 5% to 12%).

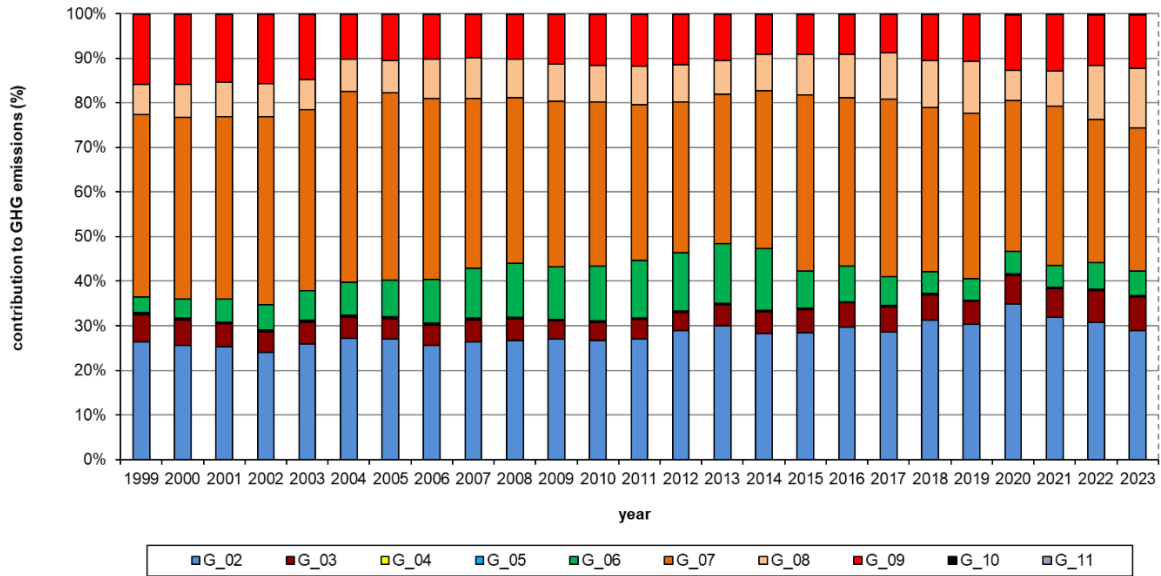


Figure 4. GHG emissions breakdown by SNAP group (%)

Figure 5 shows the relative change of GHG emissions for each SNAP group between 1999 and 2023, taking 1999 emissions as a reference. It can be seen that the emissions from SNAP groups 02, 03, 04, 05, 06, 07, 08, 09 and 10 decreased while those from SNAP group 11 increased. The significant rise of emissions from group 06 up to 2014 is mainly due to the increasing use of HFC in refrigeration, air conditioning and firefighting equipment. However, the emissions of these compounds have followed a decreasing trend since 2008, and especially since 2014.

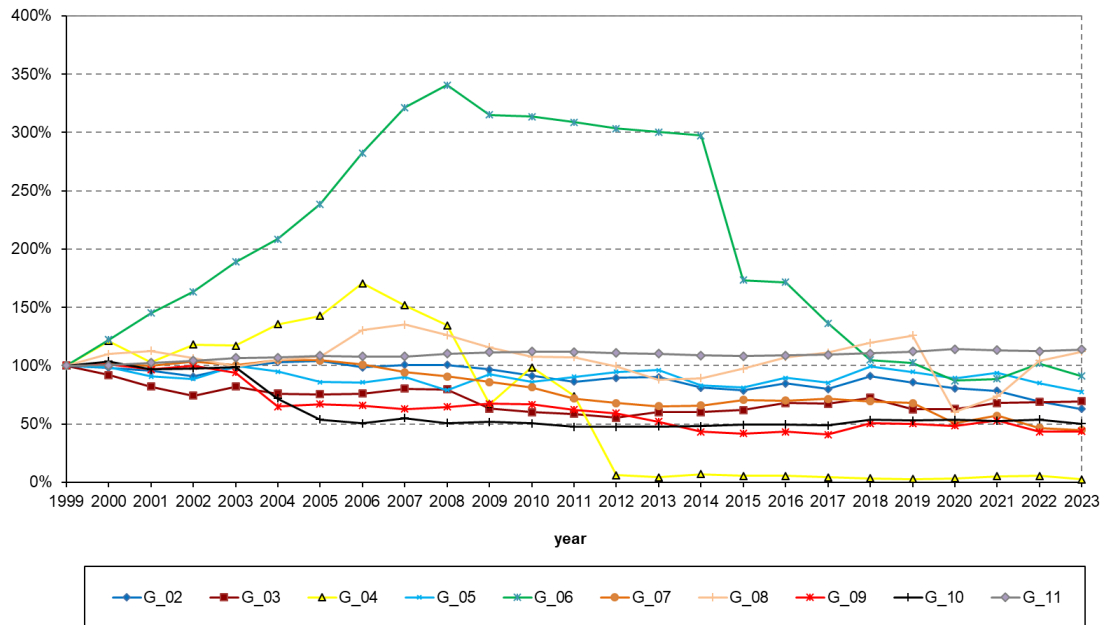


Figure 5. GHG emissions trend by SNAP group compared to 1999 (1999 = 100)

### 2.2.2 Acidifying gases

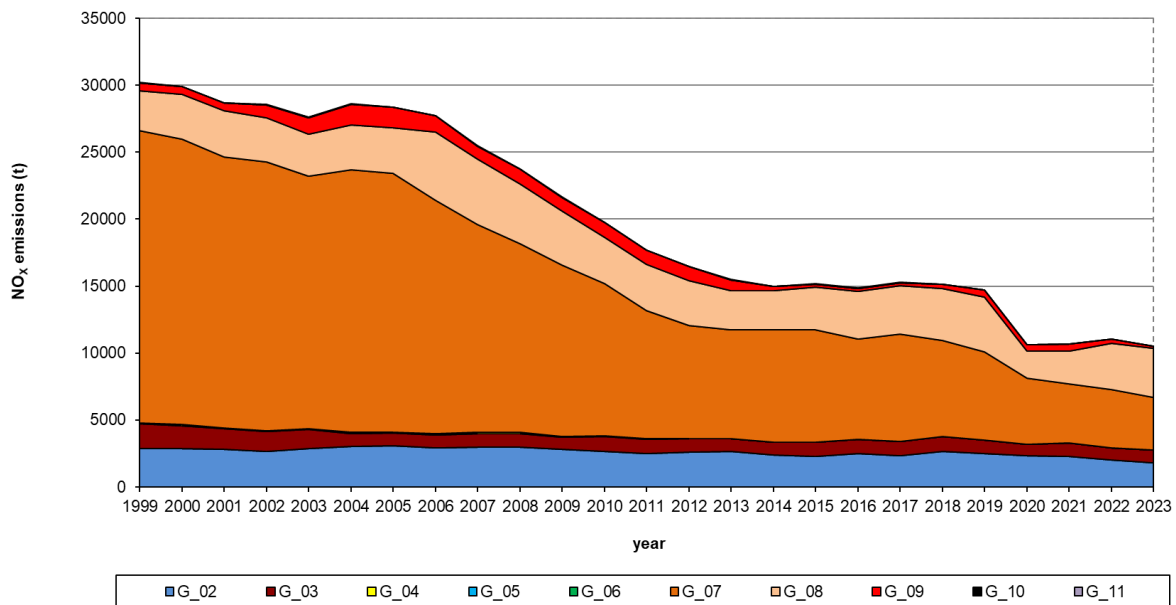
This section includes information on NO<sub>x</sub>, SO<sub>2</sub> and NH<sub>3</sub> emissions.

As it can be seen in Table 6 and Figure 6, NO<sub>x</sub> emissions decreased by 65% from 1999 to 2023 in Madrid city. This is mainly due to the reduction of emissions from group 07. The emissions of groups 02, 03, 10 and 11 show small variation in the period and those of group 08 increased by 41% from 1999 to 2019, but decreased in the years 2020 and 2021. The global reduction reached in 2021 was 18%; however, in 2023, SNAP 08 emissions increased by a 23%. The NO<sub>x</sub> emissions of group 09 grew by up to 77% between 1999 and 2012. However, later 2013, it can be observed a sharp decrease of emissions due to the cessation of sewage sludge drying. There are no emissions from activity group 04 since 2012 as a result of the interruption of steel production in the municipality.

**Table 6. NO<sub>x</sub> emissions by SNAP group (t)<sup>1</sup>**

Year	G_02	G_03	G_04	G_05	G_06	G_07	G_08	G_09	G_10	G_11	TOTAL
1999	2 855	1 854	71	0.00	0.00	21 830	2 979	592	4.2	16.2	30 201
2000	2 845	1 738	82	0.00	0.00	21 315	3 317	606	2.9	16.4	29 923
2005	3 059	959	89	0.00	0.00	19 293	3 411	1 544	1.4	16.5	28 374
2010	2 669	1 097	75	0.00	0.00	11 336	3 487	1 093	1.3	16.0	19 773
2015	2 305	1 023	0.00	0.00	0.00	8 422	3 163	245	1.1	17.3	15 177
2020	2 339	851	0.00	0.00	0.00	4 919	2 045	475	1.2	17.3	10 648
2021	2 295	1 015	0.00	0.00	0.00	4 390	2 457	503	1.1	16.4	10 678
2022	2 000	917	0.00	0.00	0.00	4 380	3 430	306	1.2	17.7	11 052
2023	1 824	921	0.00	0.00	0.00	3 962	3 654	138	1.2	17.4	10 518

1) G\_02: Non-industrial combustion; G\_03: Combustion in manufacturing industry; G\_04: Production processes; G\_05: Extraction and distribution of fossil fuels; G\_06: Solvent and other product use; G\_07: Road transport; G\_08: Non-road transport; G\_09: Waste treatment and disposal; G\_10: Agriculture; G\_11: Other sources and sinks (nature).



**Figure 6. NO<sub>x</sub> emissions trend by SNAP group (t)**

As for the contribution of each group to total NO<sub>x</sub> emissions, Figure 7 shows that “Road transport” is the most relevant emitting group, accounting for approximately 58% of Madrid’s NO<sub>x</sub> emissions as an average in the period inventoried. It should be highlighted that the share of NO<sub>x</sub> has steadily decreased in the period (varying from 72 to 48% in the period inventoried). This trend can be partially explained by the policies and abatement efforts implemented in the last years by the Madrid City Council in the local traffic. Groups 02 and 08 follow in importance, with emission shares of 17 and 35% in 2022, respectively. Emissions from groups 03 and 09 make up a minor portion of the total, contributing with

approximately 9 and 1% to total NO<sub>x</sub> emissions, respectively. The remaining groups combined represent only 0.18% of the emissions.

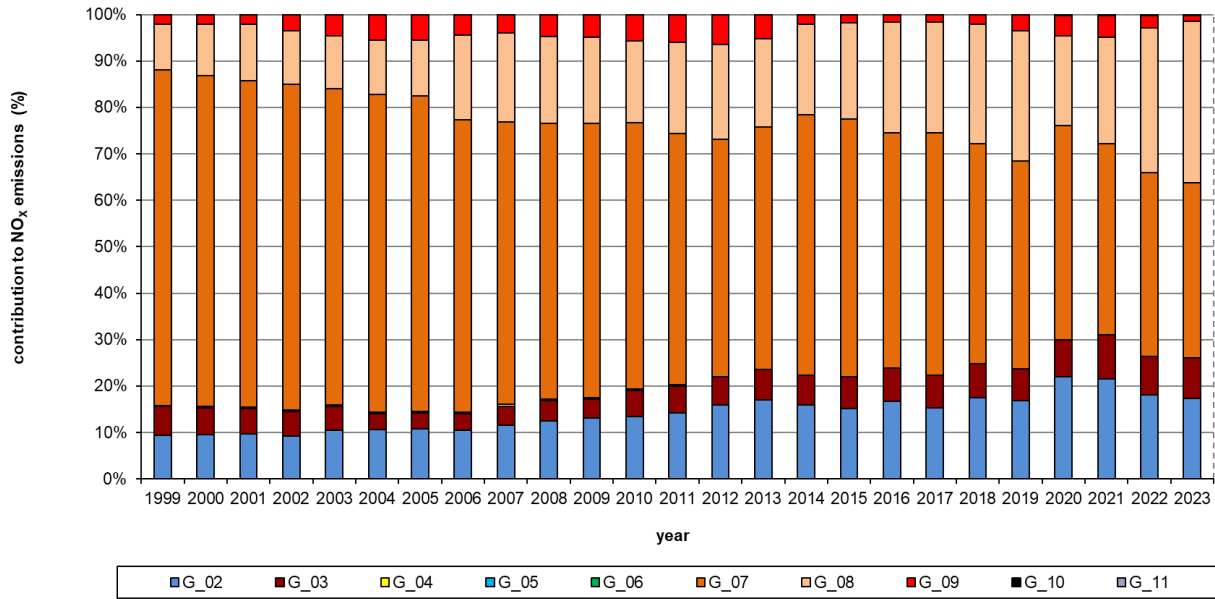


Figure 7. NO<sub>x</sub> emissions breakdown by SNAP group (%)

Figure 8 shows the relative change of NO<sub>x</sub> emissions for each SNAP group between 1999 and 2023. Except for group 11 and group 08, the emissions in 2023 are lower than in 1999 mainly due to a reduction in fuel consumption.

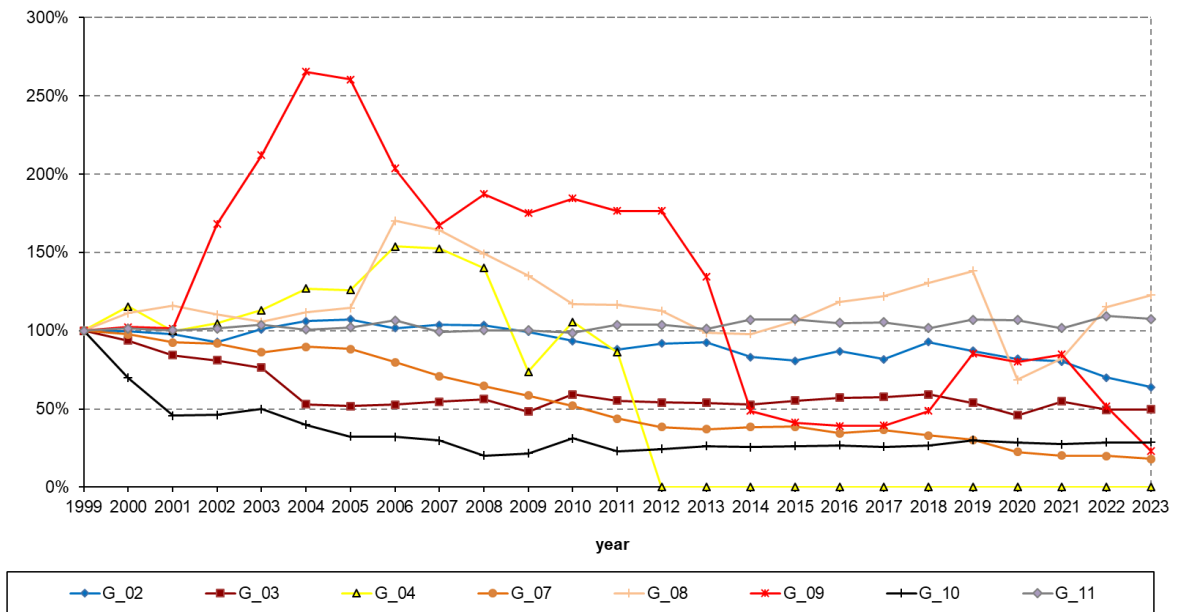


Figure 8. Evolution of NO<sub>x</sub> emissions by SNAP group compared to 1999 (1999 = 100)

The emissions of group 11 slightly change between 1999 and 2023. However, emissions from group 08 are highly influenced by the activity of the airports. Consequently, the increase of activity of this mode of transport since 2014 explains the increase of NO<sub>x</sub> emissions compared to those of 1999

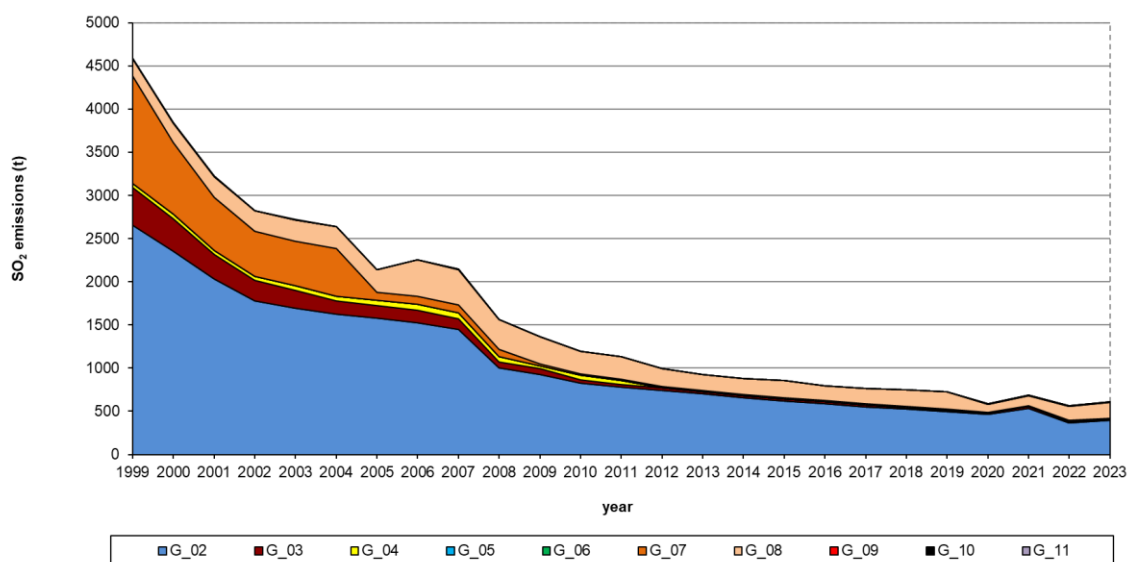
(around 34%). However, in 2020 and 2021, during and after the COVID pandemic and due to the drastic drop in air traffic, the NO<sub>x</sub> emissions decreased approximately in a 25 and 15% from 1999, respectively.

Table 7 and Figure 9 show the evolution of SO<sub>2</sub> emissions from 1999 to 2023. A significant reduction in emissions over this period (87%) is observed, especially from groups 02 and 07, as a result of a lower sulphur content in liquid fuels and the decreasing use of fuels with high-sulphur content (coal and fuel oil).

**Table 7. SO<sub>2</sub> emissions by SNAP group (t)<sup>1</sup>**

Year	G_02	G_03	G_04	G_05	G_06	G_07	G_08	G_09	G_10	G_11	TOTAL
1999	2 653	441	46	0.00	0.00	1 242	200	3.6	0.34	0.03	4 586
2000	2 353	380	53	0.00	0.00	827	224	12.0	0.11	0.08	3 848
2005	1 577	149	58	0.00	0.00	97	260	1.1	0.00	0.03	2 142
2010	826	41	49	0.00	0.00	19	257	0.7	0.00	0.00	1 192
2015	622	19	0.00	0.00	0.00	16	202	1.3	0.00	0.02	860
2020	463	15	0.00	0.00	0.00	11	87	7.6	0.00	0.05	584
2021	531	24	0.00	0.00	0.00	13	116	1.3	0.00	0.02	684
2022	365	17	0.00	0.00	0.00	10	168	7.3	0.00	0.03	568
2023	399	12	0.00	0.00	0.00	10	183	4.8	0.00	0.01	609

1) G\_02: Non-industrial combustion; G\_03: Combustion in manufacturing industry; G\_04: Production processes; G\_05: Extraction and distribution of fossil fuels; G\_06: Solvent and other product use; G\_07: Road transport; G\_08: Non-road transport; G\_09: Waste treatment and disposal; G\_10: Agriculture; G\_11: Other sources and sinks (nature).



**Figure 9. SO<sub>2</sub> emissions trend by SNAP group (t)**

As for the contribution of each group to total SO<sub>2</sub> emissions, Figure 10 clearly reflects that group 02 is the main emitting sector, accounting for 66% of emissions in 2023. Over the earlier years of the inventoried period, group 07 had a relevant contribution to SO<sub>2</sub> emissions. However, the sharp decrease of sulphur content of automotive fuels explains the lower importance of this group from 2005 onwards. The decreasing emissions from the aforementioned groups along with the increased consumption of kerosene and gas-oil accounted for the higher contribution of group 08 since 2006.

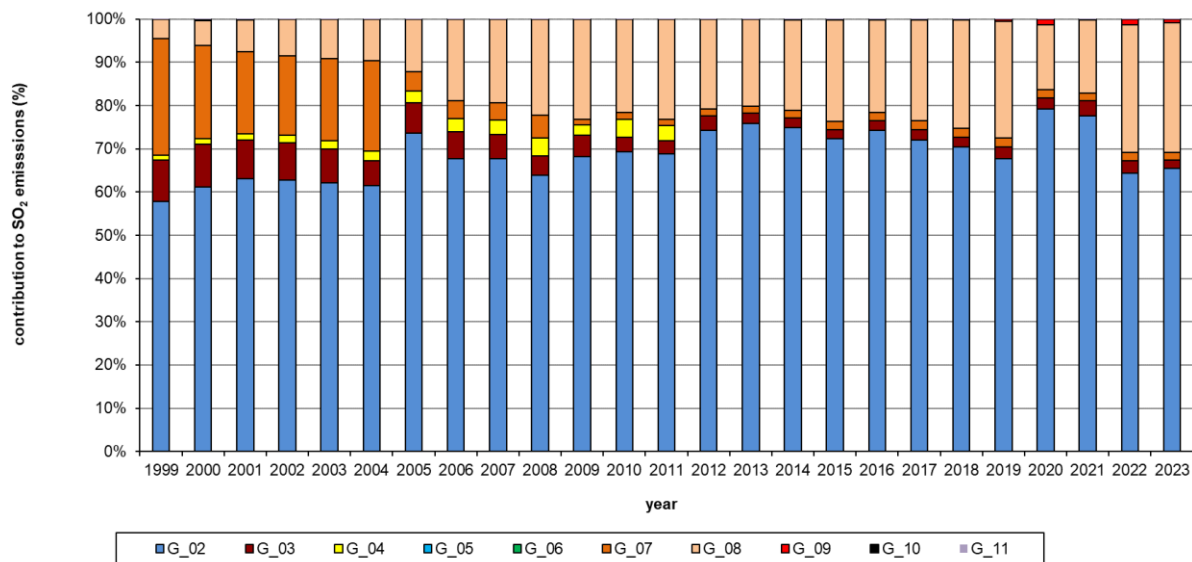


Figure 10. SO<sub>2</sub> emissions breakdown by SNAP group (%)

Table 8 and Figure 11 present the NH<sub>3</sub> emissions trend in Madrid city.

Table 8. NH<sub>3</sub> emissions by SNAP group (t)<sup>1</sup>

Year	G_02	G_03	G_04	G_05	G_06	G_07	G_08	G_09	G_10	G_11	TOTAL
1999	0.6	0.00	0.00	0.00	5.8	417	0.1	568	47	144	1 183
2000	0.5	0.00	0.00	0.00	6.0	426	0.1	742	44	144	1 363
2005	0.3	0.00	0.00	0.00	6.2	330	0.1	1 181	29	158	1 704
2010	1.5	0.00	0.00	0.00	3.6	207	0.2	1 259	29	164	1 665
2015	2.3	0.00	0.00	0.00	5.6	174	0.2	288	27	157	655
2020	2.7	0.00	0.00	0.00	10.4	123	0.3	365	32	167	700
2021	2.9	0.00	0.00	0.00	10.8	165	0.3	367	32	165	743
2022	3.0	0.00	0.00	0.00	8.4	143	0.3	328	32	164	679
2023	3.5	0.00	0.00	0.00	8.6	131	0.2	364	32	167	707

1) G\_02: Non-industrial combustion; G\_03: Combustion in manufacturing industry; G\_04: Production processes; G\_05: Extraction and distribution of fossil fuels; G\_06: Solvent and other product use; G\_07: Road transport; G\_08: Non-road transport; G\_09: Waste treatment and disposal; G\_10: Agriculture; G\_11: Other sources and sinks (nature).

In 2023, total emissions of ammonia are 40% lower than in 1999. From 1999 to 2011, the NH<sub>3</sub> emissions rose by 39%, mainly due to the increase of NH<sub>3</sub> emissions related to domestic waste composting. However, in 2012, part of the municipal waste formerly composted is treated by biomethanization, resulting in a sharp decrease of emissions. In 2016 returns composting activity in one of the plants. Despite the aforementioned, Figure 12 shows that group 09 is still the most important for this pollutant, accounting for 52% of emissions in 2023. Groups 07 and 11 contribute with 19 and 24% of emissions in 2023, respectively.

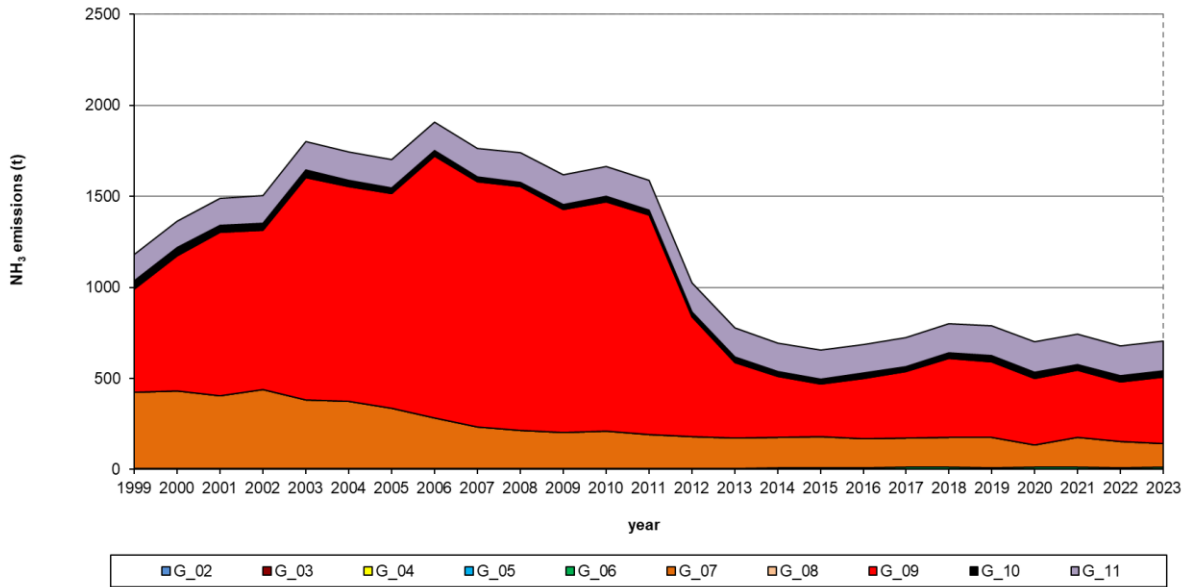


Figure 11. NH<sub>3</sub> emissions trend by SNAP group (t)

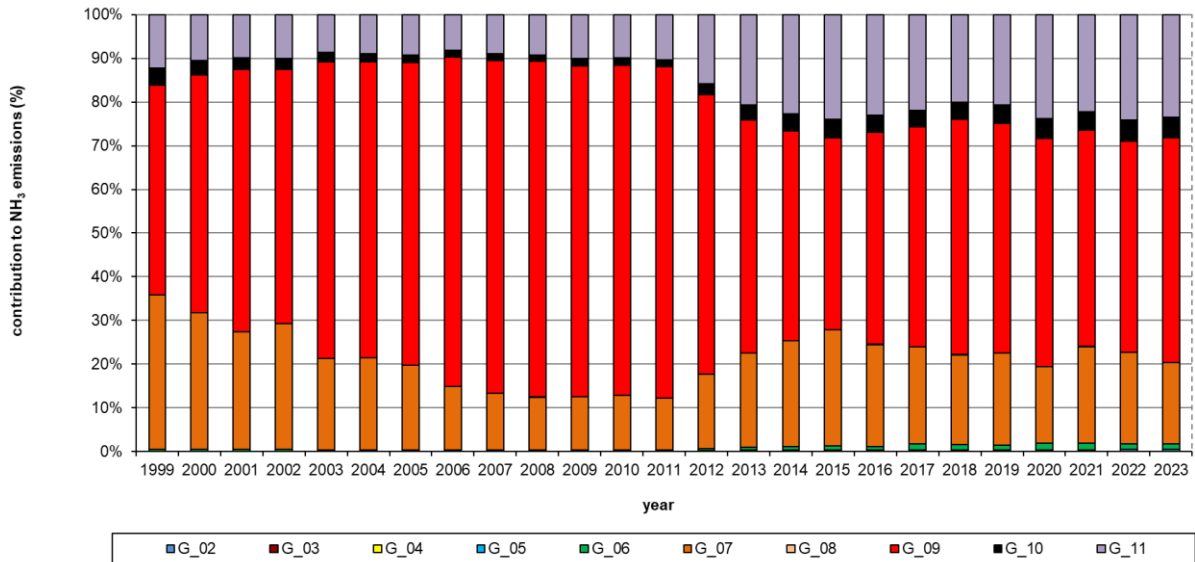


Figure 12. NH<sub>3</sub> emissions breakdown by SNAP group (%)

### 2.2.3 Ozone precursors

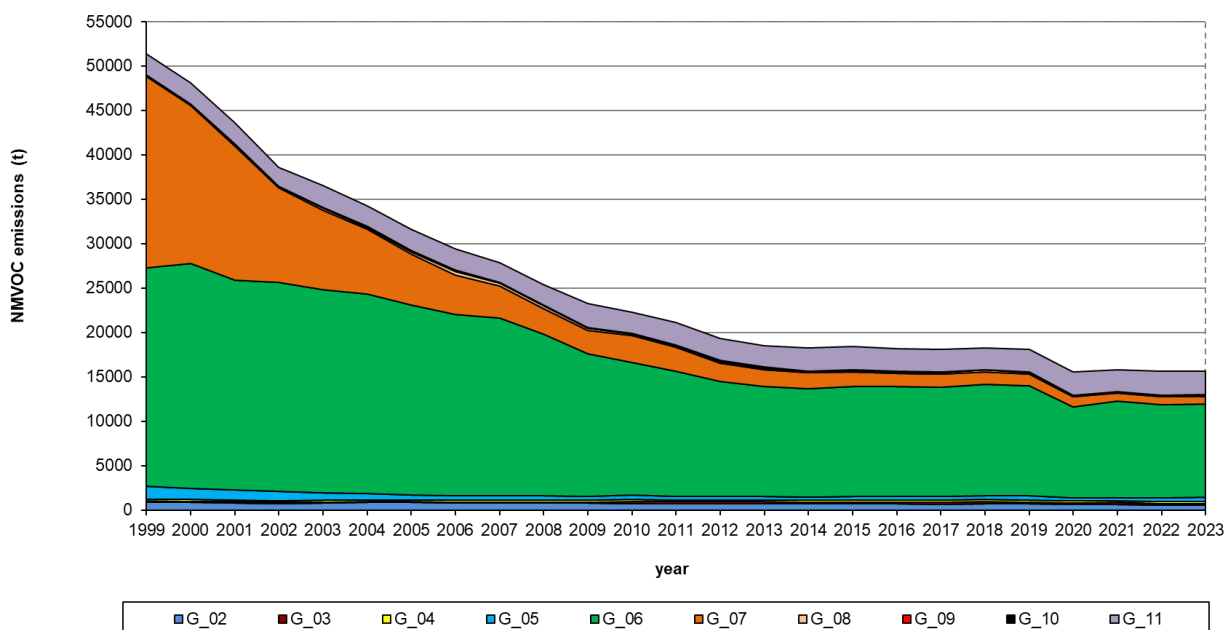
This section includes the emissions of NMVOC and CO. Although NO<sub>x</sub> are important precursors of tropospheric ozone, their emissions were presented in the previous section (acidifying gases).

Table 9 and Figure 13 show the NMVOC emissions trend. From 1999 to 2023, total emissions decreased by 70%. Especially relevant is the reduction of emissions from group 07, close to 96%. This mainly has to do with the increasing implementation of measures to reduce NMVOC emissions at vehicles themselves (on-board canisters in gasoline vehicles).

**Table 9. NMVOC emissions by SNAP group (t)<sup>1</sup>**

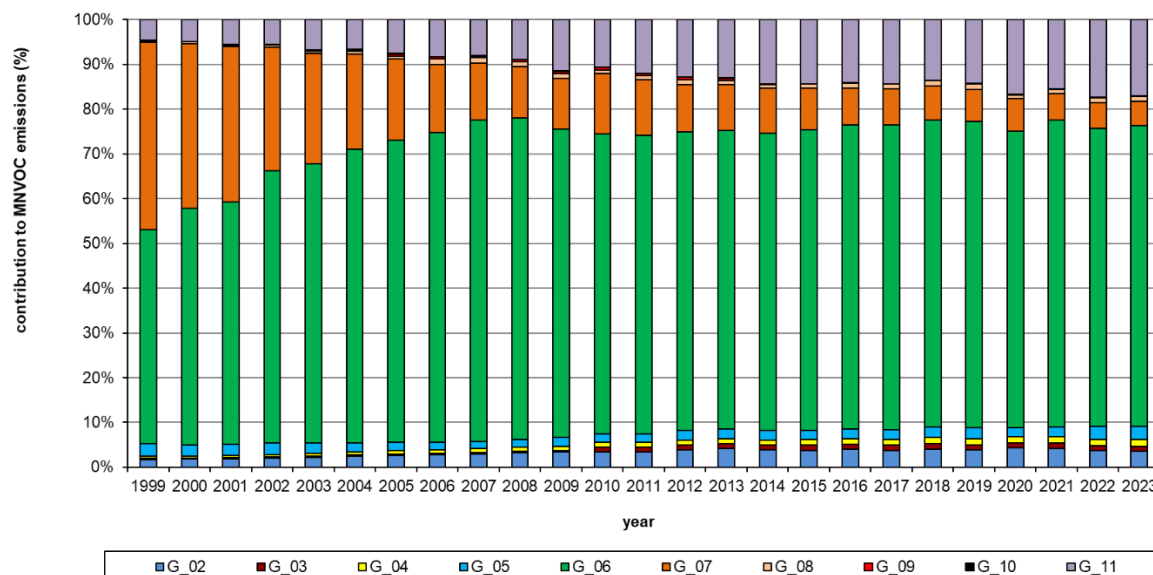
Year	G_02	G_03	G_04	G_05	G_06	G_07	G_08	G_09	G_10	G_11	TOTAL
1999	885	140	225	1 429	24 606	21 530	166	7	30	2 390	<b>51 407</b>
2000	861	133	226	1 196	25 387	17 726	179	13	25	2 350	<b>48 096</b>
2005	856	79	240	575	21 362	5 773	188	151	17	2 402	<b>31 643</b>
2010	764	224	249	431	14 950	3 004	187	120	14	2 368	<b>22 312</b>
2015	685	218	228	375	12 383	1 709	161	6	14	2 632	<b>18 411</b>
2020	679	168	213	318	10 270	1 141	125	10	16	2 587	<b>15 527</b>
2021	657	203	225	334	10 867	913	146	12	15	2 453	<b>15 826</b>
2022	572	175	233	443	10 431	912	178	8	16	2 700	<b>15 666</b>
2023	560	174	233	474	10 504	858	172	5	16	2 653	<b>15 650</b>

1) G\_02: Non-industrial combustion; G\_03: Combustion in manufacturing industry; G\_04: Production processes; G\_05: Extraction and distribution of fossil fuels; G\_06: Solvent and other product use; G\_07: Road transport; G\_08: Non-road transport; G\_09: Waste treatment and disposal; G\_10: Agriculture; G\_11: Other sources and sinks (nature).



**Figure 13. NMVOC emissions trend by SNAP group (t)**

A breakdown of NMVOC emissions by group is shown in Figure 14. The most important contributor is group 06. In 2023, the share of this group was as high as 67%, even though emissions in this sector have been reduced by 57% from 1999. Groups 07 and 11 accounted for 6 and 17% of emissions, respectively. The rest of groups present a less significant contribution.



**Figure 14. NMVOC emissions breakdown by SNAP group (%)**

Regarding CO, Table 10 and Figure 15 show a sharp decrease of emissions from 1999 to 2023 (94%). According to Figure 16, most of the emissions were generated by group 07 in the early years of the period. However, the relevant reduction of emissions from “Road transport” over the last years increased the share of other activity groups in the last years, such as 02 and 08. Such a relevant reduction is mainly due to the progressive turnover of the fleet (engine technologies Euro V-VI produce much lower CO emissions per kilometre than older technologies) and the replacement of gasoline vehicles with diesel vehicles.

**Table 10. CO emissions by SNAP group (t)<sup>1</sup>**

Year	G_02	G_03	G_04	G_05	G_06	G_07	G_08	G_09	G_10	G_11	TOTAL
1999	4 236	337	3 549	0.00	0.00	102 015	2 658	52	45.6	4.2	112 897
2000	3 975	351	4 095	0.00	0.00	84 682	2 749	85	14.1	12.3	95 963
2005	3 020	250	4 470	0.00	0.00	30 976	2 534	986	0.5	4.8	42 242
2010	2 338	1 087	3 745	0.00	0.00	8 799	2 361	897	0.4	0.6	19 229
2015	1 933	1 058	0.15	0.00	0.00	6 197	2 021	275	0.3	3.4	11 488
2020	1 752	788	0.10	0.00	0.00	3 580	1 227	266	0.4	7.8	7 622
2021	1 652	963	0.14	0.00	0.00	2 778	1 592	280	0.3	2.7	7 268
2022	1 342	811	0.13	0.00	0.00	2 692	2 008	219	0.2	3.7	7 077
2023	1 298	810	0.11	0.00	0.00	2 332	2 133	166	0.2	1.2	6 741

1) G\_02: Non-industrial combustion; G\_03: Combustion in manufacturing industry; G\_04: Production processes; G\_05: Extraction and distribution of fossil fuels; G\_06: Solvent and other product use; G\_07: Road transport; G\_08: Non-road transport; G\_09: Waste treatment and disposal; G\_10: Agriculture; G\_11: Other sources and sinks (nature).

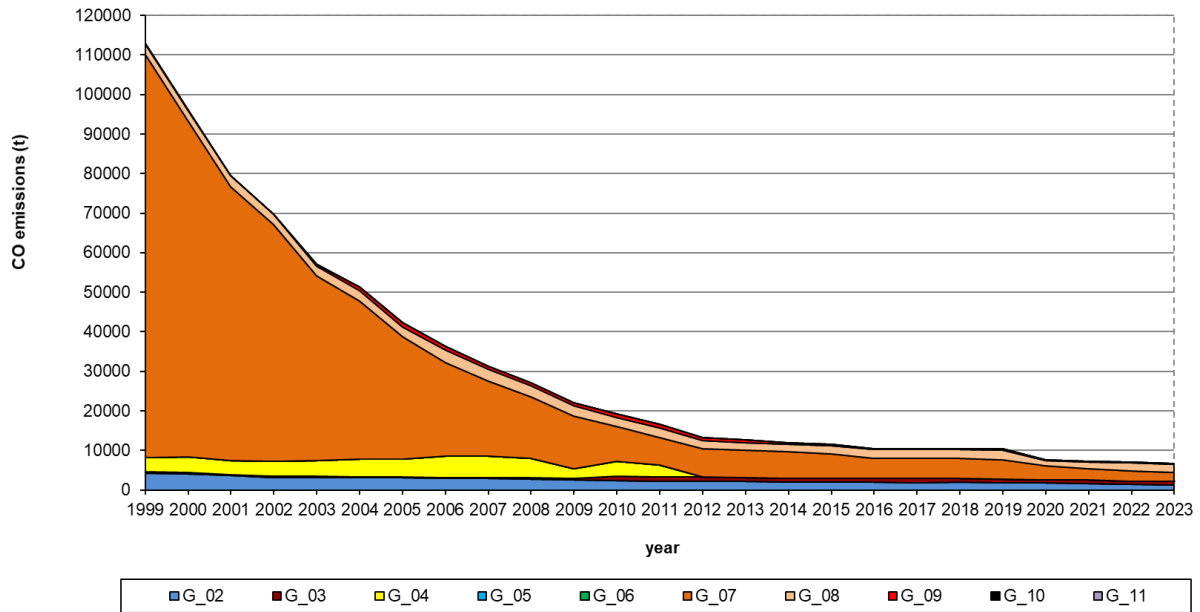


Figure 15. CO emissions trend by SNAP group (t)

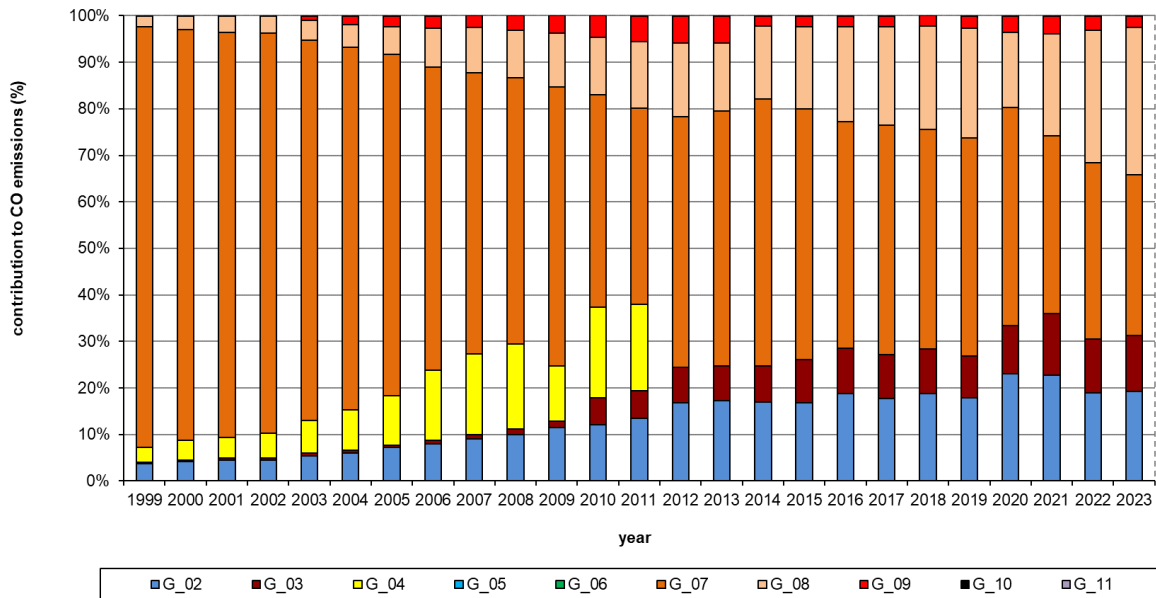


Figure 16. CO emissions breakdown by SNAP group (%)

### 2.2.4 Particulate matter

Table 11 to Table 13 and Figure 17 to Figure 19 show the PM<sub>2.5</sub>, PM<sub>10</sub> and TPM emissions.

Total emissions of particulate matter have decreased from 1999 to 2023 by 78, 75 and 71% for PM<sub>2.5</sub>, PM<sub>10</sub> and TPM, respectively. It can be seen that groups 07 and 02 presented the largest contribution to total emissions.

**INVENTORY OF MADRID CITY AIR POLLUTANT EMISSIONS 2023 - Period 1999-2023**

**Table 11. PM<sub>2.5</sub> emissions by SNAP group (t)<sup>1</sup>**

Year	G_02	G_03	G_04	G_05	G_06	G_07	G_08	G_09	G_10	G_11	TOTAL
1999	602	60	8.1	0.00	0.00	1 345	49	26	4.5	0.4	<b>2 094</b>
2000	539	54	9.3	0.00	0.00	1 321	52	33	1.9	1.1	<b>2 011</b>
2005	371	23	10.2	0.00	0.00	1 148	49	33	0.7	0.4	<b>1 634</b>
2010	302	12	8.7	0.00	0.00	706	48	20	0.7	0.1	<b>1 097</b>
2015	255	5	0.5	0.00	0.00	501	42	25	0.7	0.3	<b>829</b>
2020	222	5	0.4	0.00	0.00	292	46	24	0.7	0.7	<b>591</b>
2021	200	8	0.5	0.00	0.00	279	50	25	0.7	0.2	<b>564</b>
2022	163	6	0.5	0.00	0.00	237	53	20	0.7	0.3	<b>480</b>
2023	178	4	0.4	0.00	0.00	221	45	16	0.7	0.1	<b>466</b>

1) G\_02: Non-industrial combustion; G\_03: Combustion in manufacturing industry; G\_04: Production processes; G\_05: Extraction and distribution of fossil fuels; G\_06: Solvent and other product use; G\_07: Road transport; G\_08: Non-road transport; G\_09: Waste treatment and disposal; G\_10: Agriculture; G\_11: Other sources and sinks (nature).

**Table 12. PM<sub>10</sub> emissions by SNAP group (t)<sup>1</sup>**

Year	G_02	G_03	G_04	G_05	G_06	G_07	G_08	G_09	G_10	G_11	TOTAL
1999	627	63	15	0.00	0.00	1 575	49	26	8.3	0.4	<b>2 364</b>
2000	562	58	16	0.00	0.00	1 555	52	33	5.5	1.3	<b>2 283</b>
2005	385	23	16	0.00	0.00	1 409	49	33	4.2	0.5	<b>1 920</b>
2010	310	12	15	0.00	0.00	935	48	21	4.1	0.1	<b>1 345</b>
2015	262	5	4	0.00	0.00	707	42	25	4.1	0.4	<b>1 049</b>
2020	226	5	4	0.00	0.00	435	46	25	4.1	0.8	<b>745</b>
2021	210	8	4	0.00	0.00	446	50	25	4.1	0.3	<b>747</b>
2022	170	6	3	0.00	0.00	358	53	20	4.1	0.4	<b>615</b>
2023	186	4	4	0.00	0.00	340	45	15	4.1	0.1	<b>598</b>

1) G\_02: Non-industrial combustion; G\_03: Combustion in manufacturing industry; G\_04: Production processes; G\_05: Extraction and distribution of fossil fuels; G\_06: Solvent and other product use; G\_07: Road transport; G\_08: Non-road transport; G\_09: Waste treatment and disposal; G\_10: Agriculture; G\_11: Other sources and sinks (nature).

**Table 13. TPM emissions by SNAP group (t)<sup>1</sup>**

Year	G_02	G_03	G_04	G_05	G_06	G_07	G_08	G_09	G_10	G_11	TOTAL
1999	647	71	50	0.00	0.00	1 815	50	26	13	0.7	<b>2 672</b>
2000	580	64	52	0.00	0.00	1 801	53	33	10	2.0	<b>2 595</b>
2005	397	23	44	0.00	0.00	1 684	50	33	7	0.8	<b>2 238</b>
2010	318	12	44	0.00	0.00	1 164	49	21	7	0.1	<b>1 615</b>
2015	268	5	20	0.00	0.00	922	43	25	7	0.6	<b>1 290</b>
2020	231	5	22	0.00	0.00	588	47	25	7	1.3	<b>925</b>
2021	214	8	20	0.00	0.00	624	50	25	7	0.4	<b>948</b>
2022	173	6	14	0.00	0.00	499	53	20	7	0.6	<b>773</b>
2023	189	4	23	0.00	0.00	478	46	16	7	0.2	<b>763</b>

1) G\_02: Non-industrial combustion; G\_03: Combustion in manufacturing industry; G\_04: Production processes; G\_05: Extraction and distribution of fossil fuels; G\_06: Solvent and other product use; G\_07: Road transport; G\_08: Non-road transport; G\_09: Waste treatment and disposal; G\_10: Agriculture; G\_11: Other sources and sinks (nature).

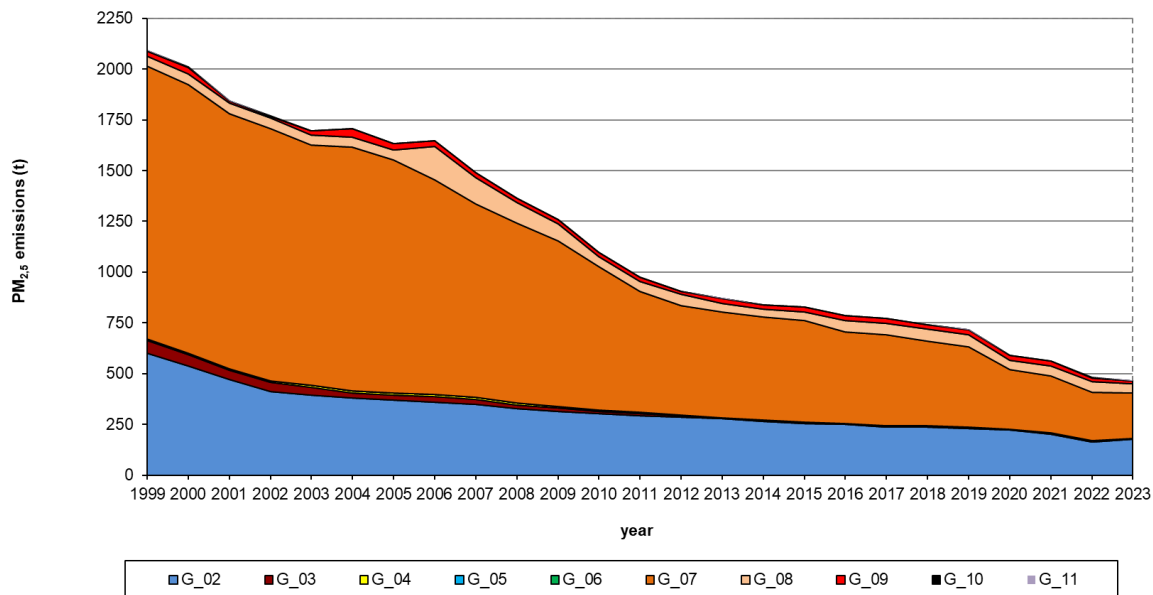


Figure 17. PM<sub>2.5</sub> emissions trend by SNAP group (t)

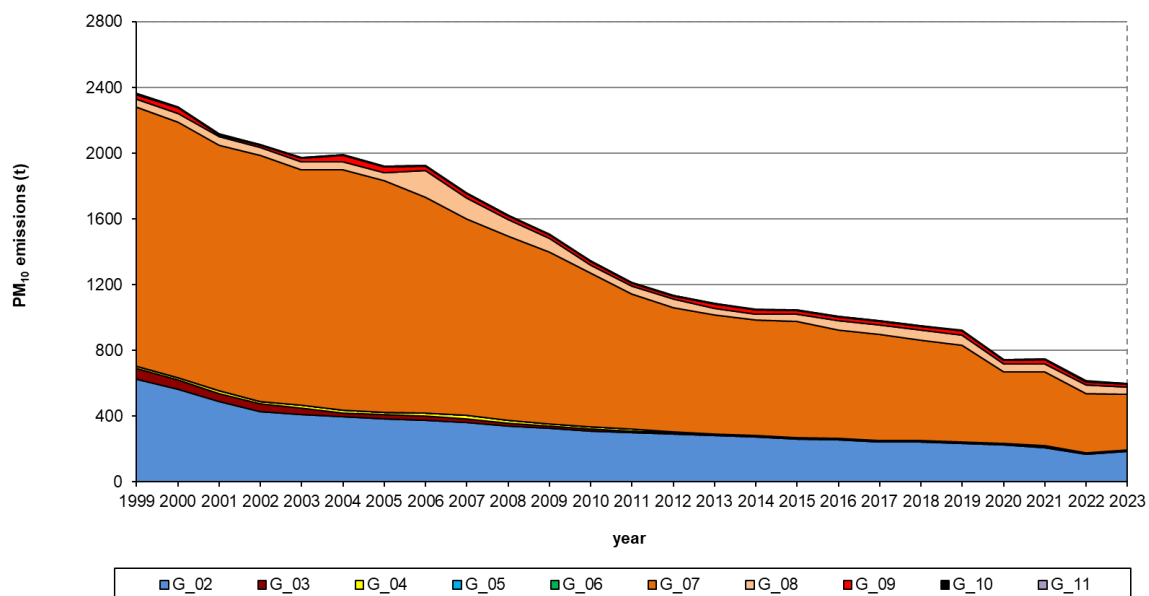


Figure 18. PM<sub>10</sub> emissions trend by SNAP group (t)

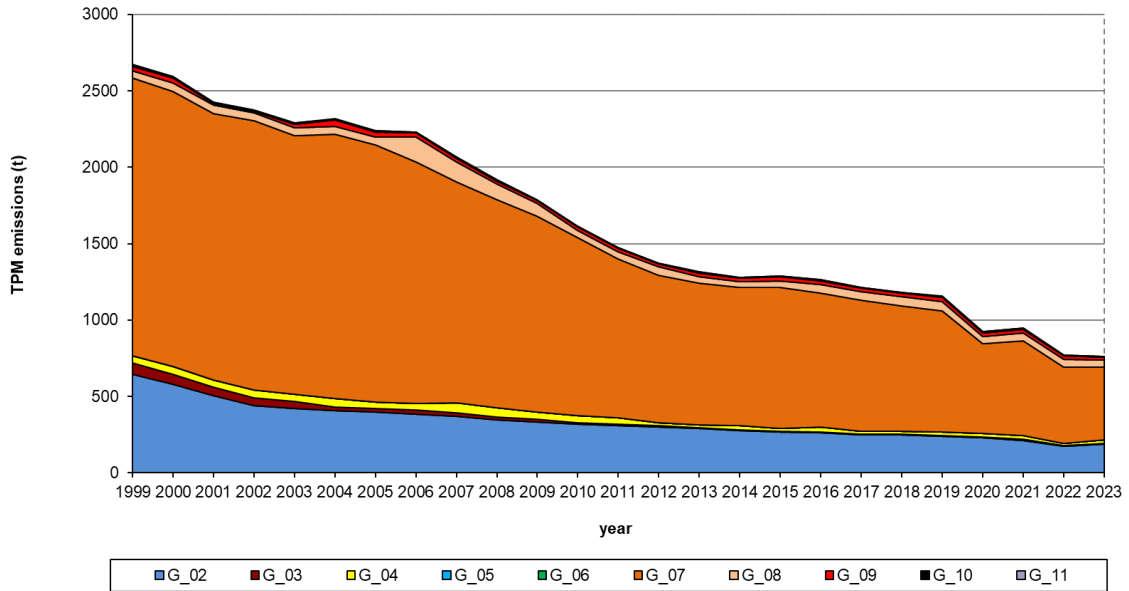


Figure 19. TPM emissions trend by SNAP group (t)

Because of its higher impact on human health, the following analysis will be focused on PM<sub>2.5</sub> emissions. Figure 20 shows the relative contribution of each activity group to PM<sub>2.5</sub> emissions in Madrid. “Road transport” is the most emitting sector, accounting for 48% of total emissions in 2023. It can be seen that the PM<sub>2.5</sub> emissions of group 02 represent 38% of total emissions in 2023, even though its emissions decreased since 1999. As for the rest of groups, only SNAP 08 presented a contribution of 10% in 2023, the others being virtually irrelevant.

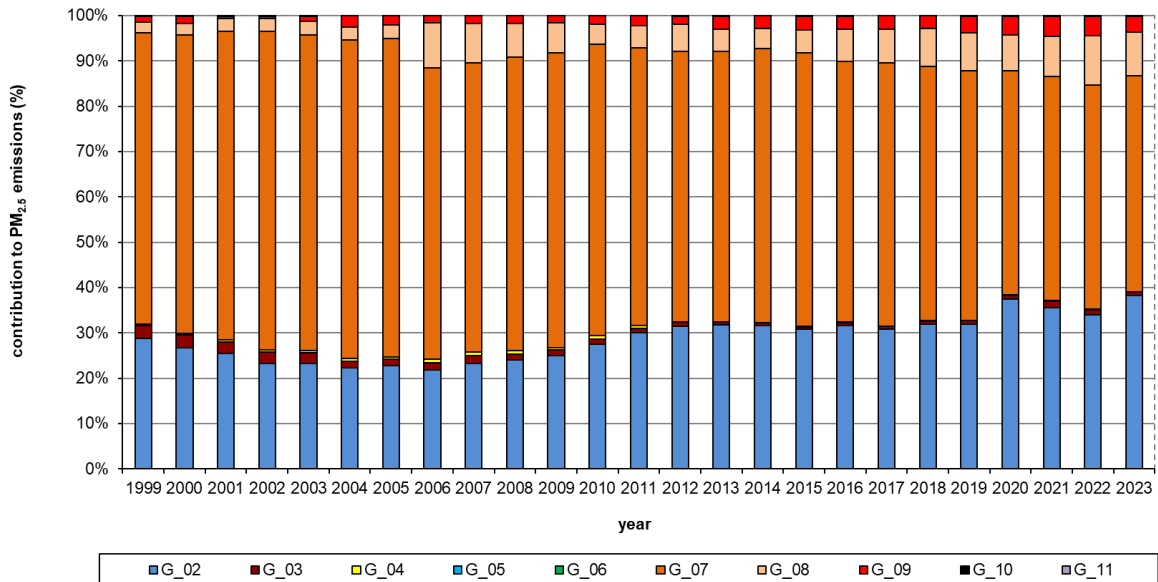


Figure 20. PM<sub>2.5</sub> emissions breakdown by SNAP group (%)

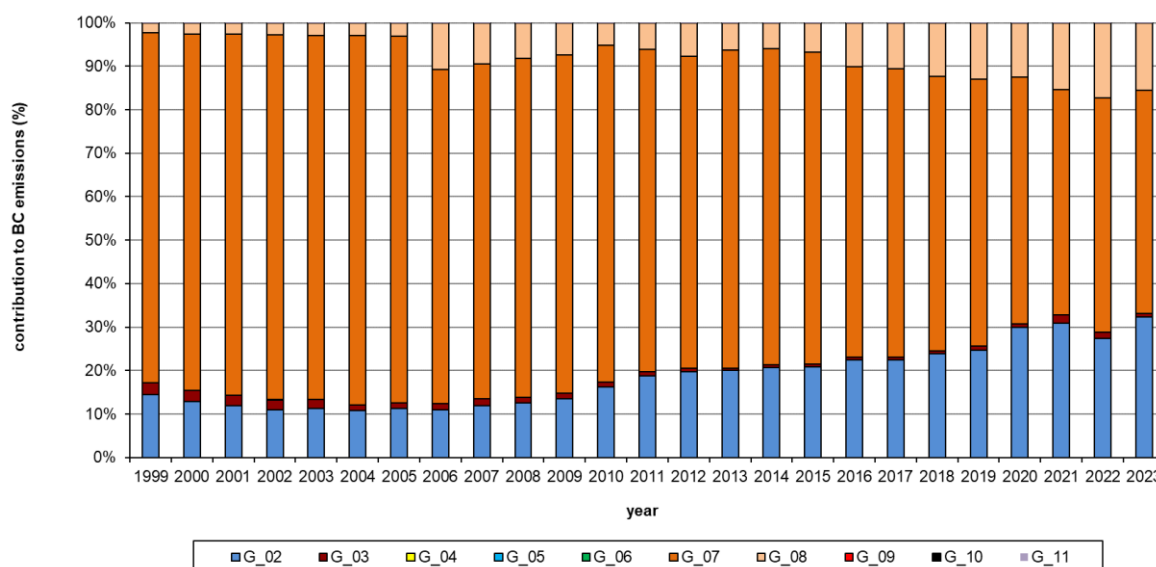
## APPENDIX I. Emissions of Black Carbon (BC)

Table A1 shows the BC emissions by SNAP group. BC has been estimated as a fraction of the PM<sub>2.5</sub> emissions for each of the emitting activities, according to the reference guidelines currently available for the preparation of emission inventories (EMEP / EEA).

**Table A1. BC emissions by SNAP group (t)<sup>1</sup>**

Year	G_02	G_03	G_04	G_05	G_06	G_07	G_08	G_09	G_10	G_11	TOTAL
1999	175	33	0.04	0.00	0.00	968	26	1.04	0.341	0.032	1 204
2000	149	30	0.04	0.00	0.00	945	28	1.40	0.106	0.095	1 153
2005	106	12	0.04	0.00	0.00	793	28	0.49	0.004	0.037	939
2010	93	6	0.04	0.00	0.00	442	29	0.08	0.003	0.005	571
2015	78	2	0.00	0.00	0.00	266	25	0.02	0.002	0.027	371
2020	68	2	0.01	0.00	0.00	129	28	0.08	0.003	0.060	228
2021	61	4	0.00	0.00	0.00	103	31	0.02	0.002	0.021	198
2022	51	2	0.00	0.00	0.00	99	32	0.03	0.001	0.029	184
2023	56	1	0.01	0.00	0.00	89	27	0.15	0.001	0.009	174

1) G\_02: Non-industrial combustion; G\_03: Combustion in manufacturing industry; G\_04: Production processes; G\_05: Extraction and distribution of fossil fuels; G\_06: Solvent and other product use; G\_07: Road transport; G\_08: Non-road transport; G\_09: Waste treatment and disposal; G\_10: Agriculture; G\_11: Other sources and sinks (nature).



**Figure A1. BC emissions breakdown by SNAP group (%)**