

**INVENTORY OF MADRID CITY GREENHOUSE GAS
EMISSIONS 2023**

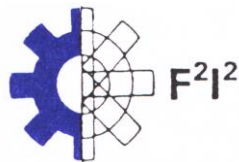


**Directorate General for Sustainability and
Environmental Control
Sub-directorate of Energy and Climate Change**

INVENTORY OF MADRID CITY GREENHOUSE GAS EMISSIONS 2023

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

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1 INTRODUCTION

1.1 Background

Tackling climate change, due to the complex nature of the phenomenon, requires designing a wide range of measures continuously over time, both to mitigate greenhouse gas (GHG) emissions and to minimize the negative impacts arising from the phenomenon itself, and to take advantage of the opportunities that the process offers in terms of efficiency and improved quality of life.

In order that climate change mitigation measures can be properly implemented and planned, so that they are as effective as possible, it is absolutely necessary to have the information required. In this respect, two strategic information tools are essential for planning actions and being able to track progress: an energy balance and an emissions inventory.

The Air Pollutant Emissions Inventory relies on the CORINAIR methodology, which is coordinated by the European Environment Agency (EEA), and meets the requirements established by the Intergovernmental Panel on Climate Change (IPCC) and the Task Force on Emission Inventories and Projections of the United Nations Economic Commission for Europe (TFEIP - UNECE).

The Energy Balance of the municipality of Madrid, from its first edition in 2006, is compiled according to a methodology developed by the working team of the *Fundación para el Fomento de la Innovación Industrial (F2I2)*, following the guidelines of the International Energy Agency and the Spanish Ministry for the Ecological Transition (MITECO), specifically adapted to the singularities of Madrid city (Pérez et al., 2019).

The City Council of Madrid is firmly committed to tackling climate change and, some years ago, acquired these two instruments, whose different editions made it possible to more precisely draw up the *Plan for the Sustainable Use of Energy and Climate Change Prevention 2008* that Council Meeting adopted in June 2008. This Plan has been applied to strengthen the actions that, for years, the City Council has been successfully implementing in this field, as shown by the results achieved so far in the framework of the targets of the Kyoto Protocol. With the *Plan for the Sustainable Use of Energy and Climate Change Prevention - Horizon 2020*, which sets more ambitious goals, Madrid was able to continue progressing in the fight against climate change and be in a position to meet future GHG reduction targets. In September 2017, the city adopted the so-called *Plan A: The Air Quality and Climate Change Plan for the City of Madrid* (hereinafter Plan A). It is a municipal tool aimed at reducing air pollution, helping to prevent climate change, and defining adaptation strategies. The Plan A fixed the GHG emissions reductions to be achieved in 2030. In September 2019, the City Council started developing a new air quality and sustainability strategy (*M360 Strategy*), which has not set new targets for reducing GHG emissions. In March of 2021, the city of Madrid presented its "*Roadmap towards Climate Neutrality for 2050*", which aligns municipal policies aimed at the fight against climate change with European and national policies. The main

goals of this Roadmap are to reduce the GHG emissions of the city of Madrid by 65% in 2030, compared to 1990, and to achieve climate neutrality in 2050.

1.2 **Boundary setting and gases**

The boundary of the inventory comprises the boundary of the Madrid municipality, where the Madrid City Council has the jurisdictional authority.

The GHG emissions sources are:

- Direct or “Scope 1” emissions: All direct emissions from sources within the boundary of the municipality
- Indirect or “Scope 2 + Scope 3” emissions: Energy-related emissions that occur outside the boundary of the municipality as a consequence of consumption of grid-supplied electricity (Scope 2 emissions), including associated transmission and distribution losses (Scope 3 emissions)

Regarding Scope 1, emission sources have been grouped according to the Selected Nomenclature for sources of Air Pollution (SNAP), shown in Table 1. Direct emissions of GHG from these activities include: carbon dioxide (CO₂), nitrous oxide (N₂O), methane (CH₄), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and Sulphur hexafluoride (SF₆). Emission figures are expressed in terms of CO₂ equivalent (CO₂-eq). For this purpose, the emissions of each GHG have been weighted by their corresponding global warming potential (GWP, Table 2), in accordance with the Fifth Assessment Report of Intergovernmental Panel on Climate Change (IPCC, 2013).

Table 1. SNAP Nomenclature. Activity Groups

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.

For Scope 2 and Scope 3 emissions, only carbon dioxide emissions were considered since reliable information is only available at national level for this pollutant. These emissions are calculated using electricity consumption data and electricity emission factors (EF) (Table 3).

Table 2. Individual GHG Global Warming Potential

SPECIES	CHEMICAL FORMULA	IPCC GWP, 2013
Carbon dioxide	CO ₂	1
Methane	CH ₄	28
Nitrous oxide	N ₂ O	265
HYDROFLUOROCARBONS		
HFC-23	CHF ₃	12 400
HFC-32	CH ₂ F ₂	677
HFC-125	C ₂ HF ₅	3 170
HFC-134a	C ₂ H ₂ F ₄ (CH ₂ FCF ₃)	1 300
HFC-152a	C ₂ H ₄ F ₂ (CH ₃ CHF ₂)	138
HFC-143a	C ₂ H ₃ F ₃ (CF ₃ CH ₃)	4 800
HFC-227ea	C ₃ HF ₇	3 350
HFC-236fa	C ₃ H ₂ F ₆	8 060
PERFLUOROCARBONS		
Perfluoromethane (PFC-14)	CF ₄	6 630
Perfluoroethane (PFC-116)	C ₂ F ₆	11 100
Perfluoropropane (PFC-218)	C ₃ F ₈	8 900
Perfluorobutane (PFC-410)	C ₄ F ₁₀	9 200
SF₆		
Sulphur hexafluoride	SF ₆	22 800
NF₃		
Nitrogen trifluoride ¹	NF ₃	16 100

Source: IPCC (2013), https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter08_FINAL.pdf

The electricity EF correspond to national values and were obtained from the emission of carbon dioxide attributable to electricity generation, according to the National Emissions Inventory 1990–2012 (MAPAMA, 2014) and the Spanish Power Transmission Grid (REE, 2025b), and the national electricity consumption (MITECO, 2025; REE, 2025a).

Table 3. Electricity emission factors*

Year	EF (tCO ₂ /MWh)	Year	EF (tCO ₂ /MWh)
1990	0.536	2007	0.469
1991	0.532	2008	0.401
1992	0.573	2009	0.362
1993	0.530	2010	0.292
1994	0.508	2011	0.350
1995	0.556	2012	0.374
1996	0.433	2013	0.301
1997	0.481	2014	0.305
1998	0.464	2015	0.348
1999	0.542	2016	0.284
2000	0.521	2017	0.326
2001	0.458	2018	0.283
2002	0.524	2019	0.222
2003	0.462	2020	0.171
2004	0.476	2021	0.164
2005	0.495	2022	0.206
2006	0.456	2023	0.152

(*) Emission factor calculation is based on consumption (final energy). National data. Determined from electric generation CO₂ emissions, found in the National Emission Inventory (years 1990–2012), in the national statistical series from Red Eléctrica de España (years 2013–2023) and the national electricity consumption reported by the Ministry for the Ecological Transition and Demographic Challenge (MITECO, 2025; REE, 2025a). This emission factor does not reflect that from any of particular generation/distribution/selling company.

¹ Currently, there is no evidence of nitrogen trifluoride emissions in the municipality and therefore they are not estimated.

2 GHG EMISSIONS

2.1 Direct (Scope 1) emissions

The trends of Scope 1 emissions in Madrid city are showed in Table 4 and Figure 1.

Table 4. Scope 1 emissions in the municipality of Madrid (kt CO₂ eq)*

Year	CH ₄	CO ₂	HFC	N ₂ O	PFC	SF ₆	TOTAL
1990	1 057.7	7 200.5	0.0	119.2	0.0	4.3	8 381.7
1999	1 333.6	8 044.8	208.6	230.0	0.0	6.5	9 823.5
2000	1 338.6	8 071.0	284.0	236.0	0.0	6.7	9 936.4
2001	1 264.0	7 927.5	362.4	222.0	0.0	7.1	9 783.0
2002	1 186.5	7 975.7	432.2	219.4	0.0	7.5	9 821.4
2003	1 042.5	8 103.5	527.9	221.8	0.0	8.1	9 903.9
2004	557.6	8 444.9	601.4	213.4	0.0	9.1	9 826.5
2005	582.9	8 476.0	697.0	225.0	0.0	10.2	9 991.1
2006	575.8	8 333.4	837.6	243.5	0.0	11.0	10 001.4
2007	544.9	8 159.9	975.3	238.4	0.0	11.9	9 930.5
2008	544.1	7 965.6	1 048.7	237.4	0.1	12.7	9 808.5
2009	548.4	7 529.5	974.2	227.4	0.0	13.2	9 292.8
2010	556.5	7 130.2	974.2	217.7	0.0	13.9	8 892.6
2011	531.7	6 541.8	967.5	205.6	0.0	13.6	8 260.3
2012	519.6	6 375.3	962.0	177.3	0.0	13.9	8 048.2
2013	488.9	6 166.4	959.7	160.4	0.0	13.8	7 789.1
2014	460.1	5 860.4	950.4	156.1	0.1	13.8	7 440.8
2015	446.3	6 050.2	525.0	150.8	0.5	14.3	7 187.0
2016	457.9	6 286.2	517.4	155.8	0.4	14.6	7 432.3
2017	392.1	6 275.6	393.3	159.6	0.5	14.6	7 235.7
2018	433.5	6 681.1	282.8	150.5	0.5	15.1	7 563.4
2019	437.0	6 449.3	276.2	148.4	0.4	15.3	7 326.6
2020	433.3	5 148.0	228.8	144.7	0.4	15.7	5 970.8
2021	413.9	5 570.7	231.9	147.6	1.5	15.8	6 381.4
2022	411.9	4 978.3	278.3	142.6	0.9	16.0	5 827.9
2023	417.2	4 803.3	242.1	140.5	0.0	16.0	5 619.1

(*) CO₂ removals by nature sinks are not included (SNAP activity Group II). CH₄ and N₂O emissions from said Group are included.

Scope 1 emissions were 33% lower in 2023 than in 1990. Since 2008, a significant reduction is observed, with the road transport sector as the largest driver (Table 5). The most important GHG contributor is CO₂, with an average contribution around 83% in 1999 – 2023.

Table 5 presents Scope 1 emissions grouped according to the activity sectors, considered in the Energy Balance of the city (AM, 2025b).

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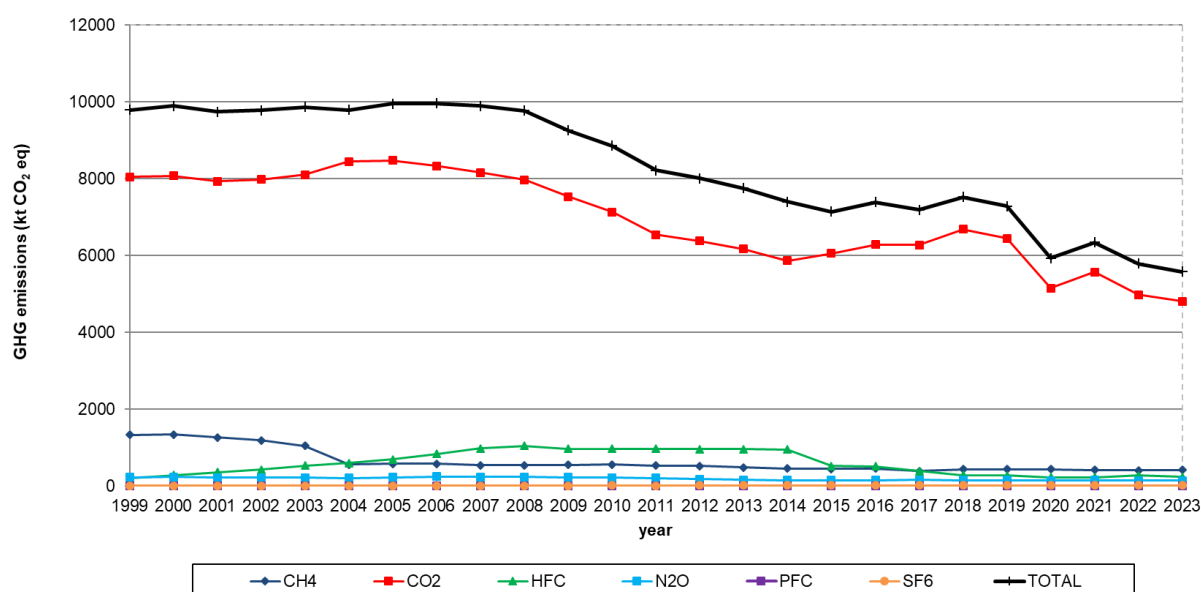


Figure 1. Scope 1 emissions trend by compound

Table 5. Scope 1 emissions by sector (kt CO₂ eq)

Year	Residential/ Commercial/ Institutional	Industry*	Road transport	Non-road transport	Waste treatment and disposal**	Others***	TOTAL
1999	2 595.5	623.0	4 009.7	675.2	1 537.4	382.8	9 823.5
2000	2 550.5	578.9	4 049.7	742.0	1 555.1	460.1	9 936.4
2001	2 479.4	515.7	4 001.1	760.8	1 489.1	537.0	9 783.0
2002	2 358.2	471.5	4 141.4	717.2	1 532.9	600.2	9 821.4
2003	2 559.0	517.1	4 023.3	668.6	1 444.7	691.2	9 903.9
2004	2 676.2	485.3	4 208.6	705.0	995.4	756.0	9 826.5
2005	2 695.3	482.1	4 195.6	728.1	1 032.1	857.8	9 991.1
2006	2 557.8	491.0	4 050.3	881.1	1 011.8	1 009.4	10 001.4
2007	2 614.5	514.2	3 779.2	912.9	964.0	1 145.6	9 930.5
2008	2 611.5	506.4	3 636.4	851.9	992.6	1 209.7	9 808.5
2009	2 508.2	393.1	3 449.0	780.9	1 036.9	1 124.7	9 292.8
2010	2 372.7	381.5	3 267.8	726.2	1 026.4	1 118.0	8 892.6
2011	2 235.9	367.2	2 875.9	724.1	955.2	1 101.9	8 260.3
2012	2 326.5	334.4	2 720.6	671.7	910.5	1 084.4	8 048.2
2013	2 341.4	364.2	2 613.7	594.9	801.4	1 073.5	7 789.1
2014	2 106.8	363.7	2 640.5	602.4	666.6	1 060.9	7 440.8
2015	2 045.6	374.1	2 836.4	657.7	642.6	630.6	7 187.0
2016	2 202.5	410.4	2 805.7	724.1	663.2	626.4	7 432.3
2017	2 073.0	407.6	2 872.5	751.3	628.2	503.2	7 235.7
2018	2 360.4	437.3	2 783.7	807.5	777.3	397.1	7 563.4
2019	2 220.2	377.5	2 718.9	850.7	771.1	388.2	7 326.6
2020	2 086.8	380.6	2 021.9	405.0	742.2	334.3	5 970.8
2021	2 038.3	410.1	2 284.6	496.5	811.6	340.3	6 381.4
2022	1 790.2	416.7	1 867.5	703.3	665.7	384.5	5 827.9
2023	1 626.1	420.1	1 800.9	756.0	671.4	344.7	5 619.1

(*) Emissions from SNAP 3 and 4 activity Groups

(**) Emissions from waste disposal and wastewater treatment plants

(***) Emissions from SNAP 5, 6, 10 and 11 activity Groups (excluding CO₂ removals by sinks)

Regarding emissions by activity sectors, Figure 2 shows that ‘Residential/Commercial/Institutional, RCI’ and ‘Road transport’ are particularly relevant, accounting for approximately a 61 to 70% of Scope 1 emissions.

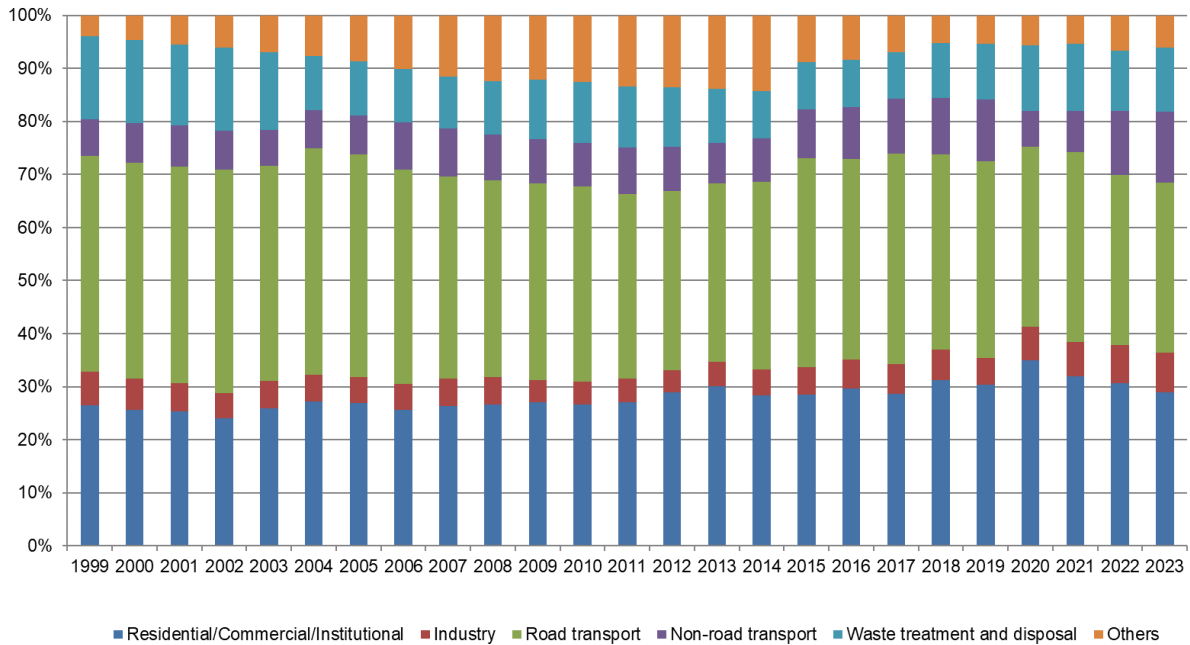


Figure 2. Scope 1 emissions breakdown by sector

In 2023, the main source of Scope 1 GHG emissions in the city of Madrid is ‘Road Transport’ (32%), followed by ‘RCI’ (29%).

2.2 Indirect (Scope 2 + Scope 3) emissions

Table 6 and Figure 3 include indirect electricity-related GHG emissions. Indirect (Scope 2 + Scope 3) emissions decreased by 63% in 2023 in comparison to 1990, whereas electricity consumption increased by 30% in that period.

Table 6. Scope 2 + Scope 3 emissions in the municipality of Madrid

Year	Electricity consumption, GWh	EF, ktCO ₂ /GWh	Scope 2 + Scope 3 emissions, kt CO ₂
1990	8 712	0.536	4 670.8
1991	9 424	0.532	5 009.5
1992	9 393	0.573	5 384.9
1993	9 418	0.530	4 989.7
1994	9 490	0.508	4 818.5
1995	9 519	0.556	5 295.3
1996	9 737	0.433	4 214.1
1997	9 756	0.481	4 690.6
1998	10 370	0.464	4 816.0
1999	10 914	0.542	5 918.1
2000	11 462	0.521	5 968.9
2001	13 465	0.458	6 173.7
2002	12 276	0.524	6 427.5
2003	12 815	0.462	5 925.5
2004	13 278	0.476	6 321.4
2005	13 661	0.495	6 760.8
2006	13 948	0.456	6 360.2
2007	14 201	0.469	6 662.7
2008	14 590	0.401	5 845.5
2009	14 413	0.362	5 211.9
2010	14 228	0.292	4 148.6
2011	13 842	0.350	4 847.0
2012	13 716	0.374	5 131.5
2013	13 004	0.301	3 916.5
2014	12 575	0.305	3 832.1
2015	12 630	0.348	4 391.0
2016	12 573	0.284	3 570.7
2017	12 366	0.326	4 027.2
2018	13 091	0.283	3 708.2
2019	12 836	0.222	2 846.2
2020	11 360	0.171	1 943.6
2021	11 395	0.164	1 867.6
2022	11 639	0.206	2 397.9
2023	11 309	0.152	1 714.4

Sources: Electricity consumption: CM, 2025 (1990–2002); AM, 2025a (2003–2005); AM, 2025b (2006–2023)

Emission factors estimated from MAPAMA, 2014, MITECO, 2025, REE, 2025a

Emission factor calculation is based on consumption (final energy). National data. Determined from electric generation CO₂ emissions, found in the National Emission Inventory (years 1990–2012), in the national statistical series from Red Eléctrica de España (years 2013–2023) and the national electricity consumption reported by the Ministry for the Ecological Transition and Demographic Challenge (MITECO, 2025; REE, 2025a). This emission factor does not reflect that from any of particular generation/distribution/selling company.

This trend is explained by a decrease of 71% in the electricity EF, as a result of the increasing penetration of renewable energy and the decreasing importance of coal-fuelled power plants in the national electricity mix.

In 2023, electric consumption decreased by approximately 3% in comparison to that of 2022 while indirect emissions decreased by 29%. This is due to the decrease in the electricity EF (26%), as a consequence of a lower contribution of high-emitting energy sources (coal) to the electricity mix in 2023 (REE, 2025b).

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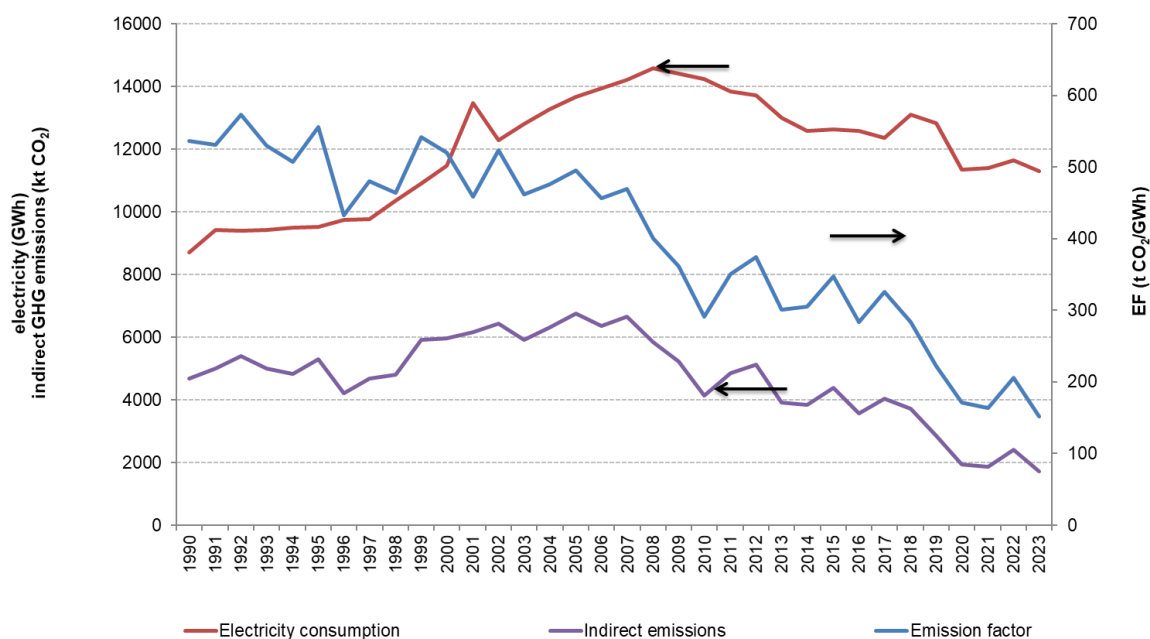


Figure 3. Evolution of indirect emissions (Scope 2+3), electricity consumption and electricity EF

Table 7 shows indirect (Scope 2+3) emissions results by activity sectors:

Table 7. Scope 2 + Scope 3 emissions by sector

Year	Residential/ Commercial/ Institutional	Industry	Road transport	Non-road transport	Waste treatment and disposal	Wastewater treatment	TOTAL
2006	5 187.6	733.8	0.0	406.6	0	32.2	6 360.2
2007	5 421.2	725.7	0.0	479.3	0	36.5	6 662.7
2008	4 802.8	572.0	0.1	442.0	0	28.6	5 845.5
2009	4 502.5	414.3	0.1	268.2	0	26.8	5 211.9
2010	3 439.0	347.8	0.1	343.7	0	18.1	4 148.6
2011	4 017.1	379.7	0.1	430.0	0	20.1	4 847.0
2012	4 373.5	300.6	0.1	436.9	0	20.4	5 131.5
2013	3 363.9	218.6	0.1	320.1	0	13.9	3 916.5
2014	3 295.2	213.7	0.1	311.5	0	11.6	3 832.1
2015	3 773.9	244.5	0.1	360.1	0	12.4	4 391.0
2016	3 064.0	196.0	0.1	300.2	0	10.3	3 570.7
2017	3 444.4	214.5	0.8	354.5	0	13.0	4 027.2
2018	3 254.1	197.5	1.4	242.8	0	12.4	3 708.2
2019	2 450.8	153.9	2.2	229.8	0	9.5	2 846.2
2020	1 728.3	92.5	1.5	113.6	0	7.7	1 943.6
2021	1 610.1	91.6	1.9	157.8	0	6.3	1 867.6
2022	2 035.9	113.7	12.0	229.0	0	7.1	2 397.9
2023	1 473.4	76.1	9.5	148.8	0	6.6	1 714.4

A breakdown of each activity sector is shown in Figure 4. The "RCI" sector accounts for 81-89% of indirect emissions in the evaluated period. The share of "Industry" decreases from 12% in 2006 to 4% in 2023 (as a result of a lower electricity consumption of this sector) while "Non-road transport" has a contribution between 5 and 10% in the period 2006-2023.

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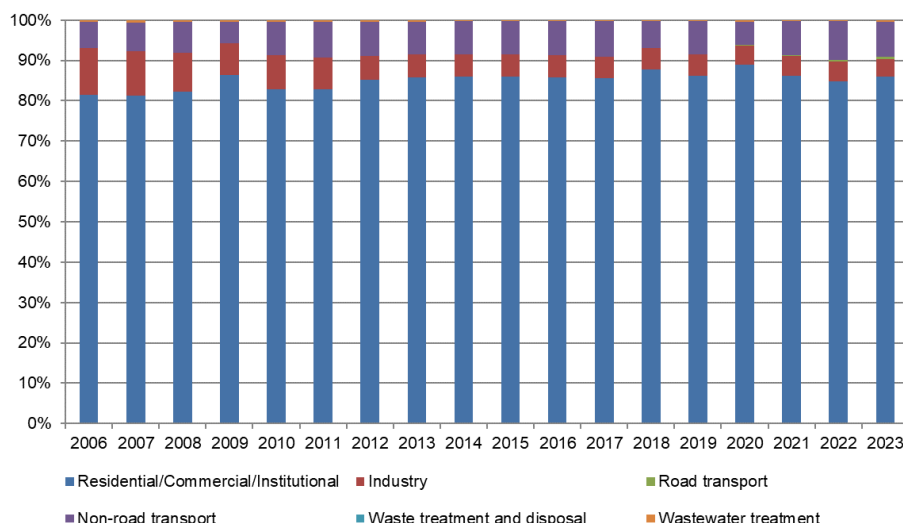


Figure 4. Scope 2+3 emissions breakdown by sector

2.3 Total Emissions

Table 8 and Figure 5 show the Scope 1, Scope 2+3 and Total GHG emissions trends in Madrid city. The dashed orange line in Figure 5 shows the emissions target set by the Roadmap towards Climate Neutrality for 2050 of the City of Madrid, which aims to reduce the emissions of the city of Madrid by 65% in 2030, compared to 1990, achieving climate neutrality in 2050. It can be observed that total GHG emissions in 2023 are 61% above the 2030 goal.

Table 8. Scope 1, Scope 2+3 and Total GHG emissions (kt CO₂ eq)

Year	Emissions			Contribution (%)		
	Scope 1	Scope 2+3	TOTAL	Scope 1	Scope 2+3	TOTAL
1990	8 381.7	4 670.8	13 052.5	64.2	35.8	100
1999	9 823.5	5 918.1	15 741.5	62.4	37.6	100
2000	9 936.4	5 968.9	15 905.2	62.5	37.5	100
2001	9 783.0	6 173.7	15 956.7	61.3	38.7	100
2002	9 821.4	6 427.5	16 248.9	60.4	39.6	100
2003	9 903.9	5 925.5	15 829.5	62.6	37.4	100
2004	9 826.5	6 321.4	16 147.9	60.9	39.1	100
2005	9 991.1	6 760.8	16 751.9	59.6	40.4	100
2006	10 001.4	6 360.2	16 361.6	61.1	38.9	100
2007	9 930.5	6 662.7	16 593.2	59.8	40.2	100
2008	9 808.5	5 845.5	15 654.0	62.7	37.3	100
2009	9 292.8	5 211.9	14 504.7	64.1	35.9	100
2010	8 892.6	4 148.6	13 041.2	68.2	31.8	100
2011	8 260.3	4 847.0	13 107.2	63.0	37.0	100
2012	8 048.2	5 131.5	13 179.7	61.1	38.9	100
2013	7 789.1	3 916.5	11 705.7	66.5	33.5	100
2014	7 440.8	3 832.1	11 272.9	66.0	34.0	100
2015	7 187.0	4 391.0	11 578.0	62.1	37.9	100
2016	7 432.3	3 570.7	11 002.9	67.5	32.5	100
2017	7 235.7	4 027.2	11 262.9	64.2	35.8	100
2018	7 563.4	3 708.2	11 271.7	67.1	32.9	100
2019	7 326.6	2 846.2	10 172.8	72.0	28.0	100
2020	5 970.8	1 943.6	7 914.4	75.4	24.6	100
2021	6 381.4	1 867.6	8 249.1	77.4	22.6	100
2022	5 827.9	2 397.9	8 225.8	70.8	29.2	100
2023	5 619.1	1 714.4	7 333.4	76.6	23.4	100

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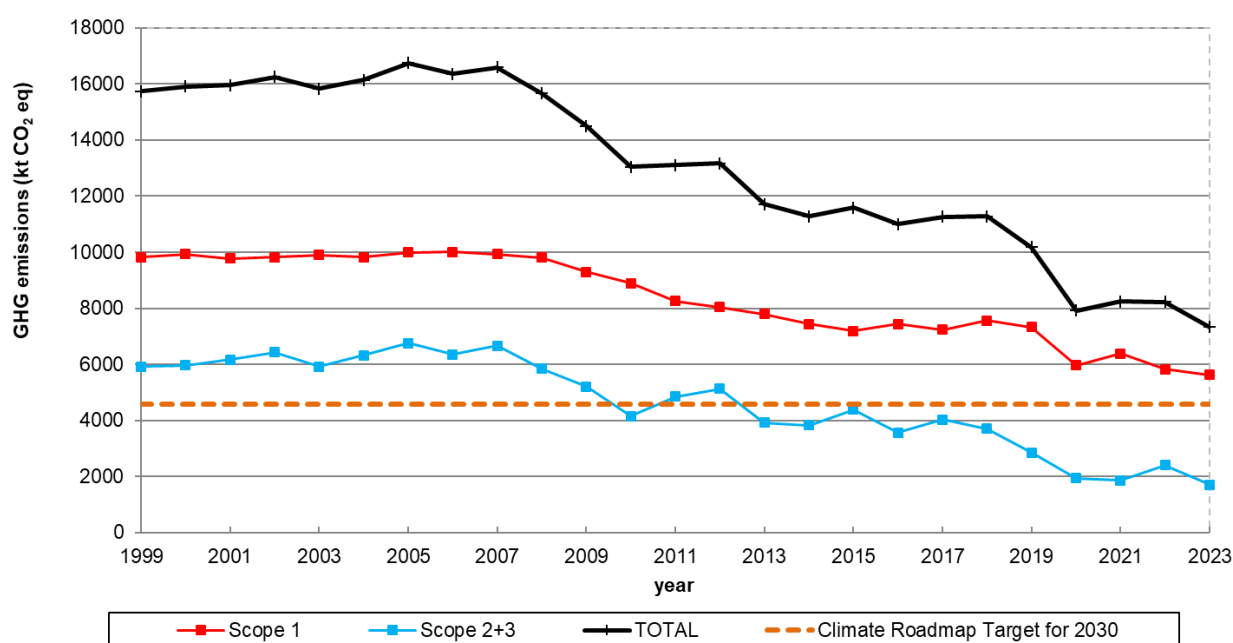


Figure 5. GHG emissions trends in Madrid city

As shown in Figure 5, Scope 1 emissions are higher than Scope 2+3. Between 1999 and 2023, the contribution of Scope 1 to total emissions ranged between 60 to 77%. Over this period of time, total emissions have decreased by 53%, Scope 1 emissions by 43% and Scope 2+3 emissions by 71%.

Table 9 shows GHG emissions results by activity sector in 2023.

Table 9. Scope 1, Scope 2+3 and Total GHG emissions by sector (2023)

Emissions	Residential/ Commercial/ Institutional	Industry*	Road transport	Non-road transport	Waste treatment and disposal**	Others***	TOTAL
kt CO ₂ eq							
Scope 1	1 626.1	420.1	1 800.9	756.0	671.4	344.7	5 619.1
Scope 2+3	1 473.4	76.1	9.5	148.8	6.6	0.0	1 714.4
TOTAL	3 099.5	496.1	1 810.4	904.8	678.0	344.7	7 333.4
Breakdown by sector (%)							
Scope 1	28.9	7.5	32.0	13.5	11.9	6.1	100
Scope 2+3	85.9	4.4	0.6	8.7	0.4	0.0	100
TOTAL	42.3	6.8	24.7	12.3	9.2	4.7	100

(*) Emissions from SNAP 3 and 4 activity Groups

(**) Emissions from waste disposal and wastewater treatment plants

(***) Emissions from SNAP 5, 6, 10 and 11 activity Groups (excluding CO₂ removals by sinks)

Considering GHG Total emissions, 'RCI' is the most important source, accounting for 42%, followed by 'Road transport' (25%). This is partially explained by the high electricity consumption in 'RCI' (with the highest share of Scope 2+3 emissions, 86%). Due to the particular relevance of this sector, a disaggregation of the emissions associated to the RCI sector is provided in Table 10.

Table 10. Disaggregation of GHG emissions for the RCI sector (kt CO₂ eq)

Year	Direct			Indirect		
	Residential	Commercial/ Institutional	TOTAL	Residential	Commercial/ Institutional	TOTAL
2006	1 729.4	828.3	2 557.8	2 154.2	3 031.2	5 187.6
2007	1 817.1	797.4	2 614.5	2 241.3	3 177.6	5 421.2
2008	1 839.0	772.4	2 611.5	1 998.6	2 802.0	4 802.8
2009	1 765.7	742.5	2 508.2	1 826.6	2 673.7	4 502.5
2010	1 670.6	702.1	2 372.7	1 437.7	1 999.6	3 439.0
2011	1 574.4	661.5	2 235.9	1 648.0	2 367.0	4 017.1
2012	1 636.8	689.7	2 326.5	1 750.8	2 620.7	4 373.5
2013	1 647.3	694.1	2 341.4	1 344.5	2 017.8	3 363.9
2014	1 482.4	624.4	2 106.8	1 316.0	1 977.6	3 295.2
2015	1 439.2	606.4	2 045.6	1 518.5	2 253.7	3 773.9
2016	1 545.8	656.7	2 202.5	1 249.8	1 812.5	3 064.0
2017	1 454.5	618.5	2 073.0	1 385.3	2 057.0	3 444.4
2018	1 647.0	713.4	2 360.4	1 251.5	2 002.6	3 254.1
2019	1 548.4	671.8	2 220.2	946.8	1 504.0	2 450.8
2020	1 455.9	630.9	2 086.8	735.5	992.8	1 728.3
2021	1 428.6	609.7	2 038.3	674.3	935.8	1 610.1
2022	1 246.3	543.9	1 790.2	837.9	1 206.8	2 044.7
2023	1 139.2	486.9	1 626.1	611.6	861.9	1 473.4

2.4 GHG emissions by Scope and sector

Table 11 and Figure 6 show GHG emissions by sector distinguishing between "Scope 1" (direct emissions), "Scope 2" (energy-related emissions that occur outside the boundary of the municipality as a consequence of consumption of grid-supplied electricity), and "Scope 3" (emissions concerning transmission and distribution losses).

In "Road Transport", "Waste treatment and disposal" and "Others", total GHG emissions are almost entirely direct emissions (Scope 1). Scope 1 emissions in "Non-road transport" account for 2 and 3 times indirect emissions (Scope 2 + Scope 3). 'RCI' is the only sector where Scope 2 emissions are higher than Scope 1 emissions although in the last year both emissions are practically the same.

Table 11. GHG emissions by Scope and sector (kt CO₂)

Year	Residential/ Commercial/ Institutional	Industry*	Road transport	Non-road transport	Waste treatment and disposal**	Others***	TOTAL
Scope 1 emissions (direct)							
2006	2 557.8	491.0	4 050.3	881.1	1 011.8	1 009.4	10 001.4
2007	2 614.5	514.2	3 779.2	912.9	964.0	1 145.6	9 930.5
2008	2 611.5	506.4	3 636.4	851.9	992.6	1 209.7	9 808.5
2009	2 508.2	393.1	3 449.0	780.9	1 036.9	1 124.7	9 292.8
2010	2 372.7	381.5	3 267.8	726.2	1 026.4	1 118.0	8 892.6
2011	2 235.9	367.2	2 875.9	724.1	955.2	1 101.9	8 260.3
2012	2 326.5	334.4	2 720.6	671.7	910.5	1 084.4	8 048.2
2013	2 341.4	364.2	2 613.7	594.9	801.4	1 073.5	7 789.1
2014	2 106.8	363.7	2 640.5	602.4	666.6	1 060.9	7 440.8
2015	2 045.6	374.1	2 836.4	657.7	642.6	630.6	7 187.0
2016	2 202.5	410.4	2 805.7	724.1	663.2	626.4	7 432.3
2017	2 073.0	407.6	2 872.5	751.3	628.2	503.2	7 235.7
2018	2 360.4	437.3	2 783.7	807.5	777.3	397.1	7 563.4

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Year	Residential/ Commercial/ Institutional	Industry*	Road transport	Non-road transport	Waste treatment and disposal**	Others***	TOTAL
2019	2 220.2	377.5	2 718.9	850.7	771.1	388.2	7 326.6
2020	2 086.8	380.6	2 021.9	405.0	742.2	334.3	5 970.8
2021	2 038.3	410.1	2 284.6	496.5	811.6	340.3	6 381.4
2022	1 790.2	416.7	1 867.5	703.3	665.7	384.5	5 827.9
2023	1 626.1	420.1	1 800.9	756.0	671.4	344.7	5 619.1
Scope 2 emissions (indirect, electricity generation)							
2006	4 704.2	665.4	0.0	368.7	29.2	0.0	5 767.5
2007	4 717.7	631.5	0.0	417.1	31.8	0.0	5 798.0
2008	4 139.8	493.0	0.1	381.0	24.7	0.0	5 038.6
2009	3 853.9	354.6	0.1	229.6	23.0	0.0	4 461.2
2010	2 917.2	295.1	0.1	291.5	15.3	0.0	3 519.2
2011	3 501.0	331.0	0.1	374.7	17.5	0.0	4 224.3
2012	3 710.7	255.1	0.1	370.7	17.3	0.0	4 353.8
2013	2 831.6	184.0	0.1	269.4	11.7	0.0	3 296.9
2014	2 804.9	181.9	0.1	265.1	9.9	0.0	3 262.0
2015	3 273.7	212.1	0.1	312.3	10.7	0.0	3 808.9
2016	2 720.5	174.1	0.1	266.5	9.2	0.0	3 170.3
2017	3 139.1	195.5	0.7	323.1	11.8	0.0	3 670.2
2018	2 972.8	180.4	1.3	221.8	11.3	0.0	3 387.6
2019	2 203.3	138.4	2.0	206.6	8.6	0.0	2 558.8
2020	1 509.8	80.8	1.3	99.2	6.7	0.0	1 697.9
2021	1 410.9	80.3	1.6	138.3	5.5	0.0	1 636.5
2022	1 652.6	92.3	9.8	185.9	5.8	0.0	1 946.4
2023	1 244.4	64.2	8.0	125.7	5.6	0.0	1 447.9
Scope 3 emissions (indirect, transmission and distribution losses)							
2006	483.5	68.4	0.0	37.9	3.0	0.0	592.7
2007	703.5	94.2	0.0	62.2	4.7	0.0	864.6
2008	663.0	79.0	0.0	61.0	4.0	0.0	807.0
2009	648.5	59.7	0.0	38.6	3.9	0.0	750.7
2010	521.7	52.8	0.0	52.1	2.7	0.0	629.4
2011	516.1	48.8	0.0	55.2	2.6	0.0	622.7
2012	662.9	45.6	0.0	66.2	3.1	0.0	777.7
2013	532.2	34.6	0.0	50.6	2.2	0.0	619.7
2014	490.3	31.8	0.0	46.3	1.7	0.0	570.1
2015	500.3	32.4	0.0	47.7	1.6	0.0	582.1
2016	343.6	22.0	0.0	33.7	1.2	0.0	400.4
2017	305.3	19.0	0.1	31.4	1.2	0.0	356.9
2018	281.3	17.1	0.1	21.0	1.1	0.0	320.6
2019	247.5	15.5	0.2	23.2	1.0	0.0	287.4
2020	218.5	11.7	0.2	14.4	1.0	0.0	245.7
2021	199.2	11.3	0.2	19.5	0.8	0.0	231.1
2022	383.4	21.4	2.3	43.1	1.3	0.0	451.5
2023	229.0	11.8	1.5	23.1	1.0	0.0	266.5
TOTAL emissions							
2006	7 745.4	1 224.8	4 050.3	1 287.7	1 044.0	1 009.4	16 361.6
2007	8 035.8	1 239.9	3 779.2	1 392.2	1 000.6	1 145.6	16 593.2
2008	7 414.3	1 078.3	3 636.5	1 294.0	1 021.2	1 209.7	15 654.0
2009	7 010.7	807.4	3 449.1	1 049.1	1 063.7	1 124.7	14 504.7
2010	5 811.6	729.3	3 267.9	1 069.9	1 044.5	1 118.0	13 041.2
2011	6 253.0	747.0	2 876.0	1 154.1	975.4	1 101.9	13 107.2
2012	6 700.1	635.1	2 720.7	1 108.6	930.9	1 084.4	13 179.7
2013	5 705.3	582.7	2 613.8	915.0	815.4	1 073.5	11 705.7
2014	5 402.0	577.4	2 640.6	913.9	678.2	1 060.9	11 272.9
2015	5 819.5	618.6	2 836.5	1 017.8	654.9	630.6	11 578.0
2016	5 266.5	606.5	2 805.8	1 024.3	673.5	626.4	11 002.9
2017	5 517.3	622.1	2 873.2	1 105.8	641.2	503.2	11 262.9
2018	5 614.5	634.8	2 785.2	1 050.3	789.7	397.1	11 271.7
2019	4 671.0	531.4	2 721.1	1 080.4	780.7	388.2	10 172.8
2020	3 815.0	473.1	2 023.5	518.6	749.9	334.3	7 914.4

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Year	Residential/ Commercial/ Institutional	Industry*	Road transport	Non-road transport	Waste treatment and disposal**	Others***	TOTAL
2021	3 648.4	501.7	2 286.4	654.3	817.9	340.3	8 249.1
2022	3 826.1	530.5	1 879.6	932.3	672.9	384.5	8 225.8
2023	3 099.5	496.1	1 810.4	904.8	678.0	344.7	7 333.4

(* Emissions from SNAP 3 and 4 activity Groups (** Emissions from waste disposal and wastewater treatment plants (***) Emissions from SNAP 5, 6, 10 and 11 activity Groups (excluding CO₂ removals by sinks)

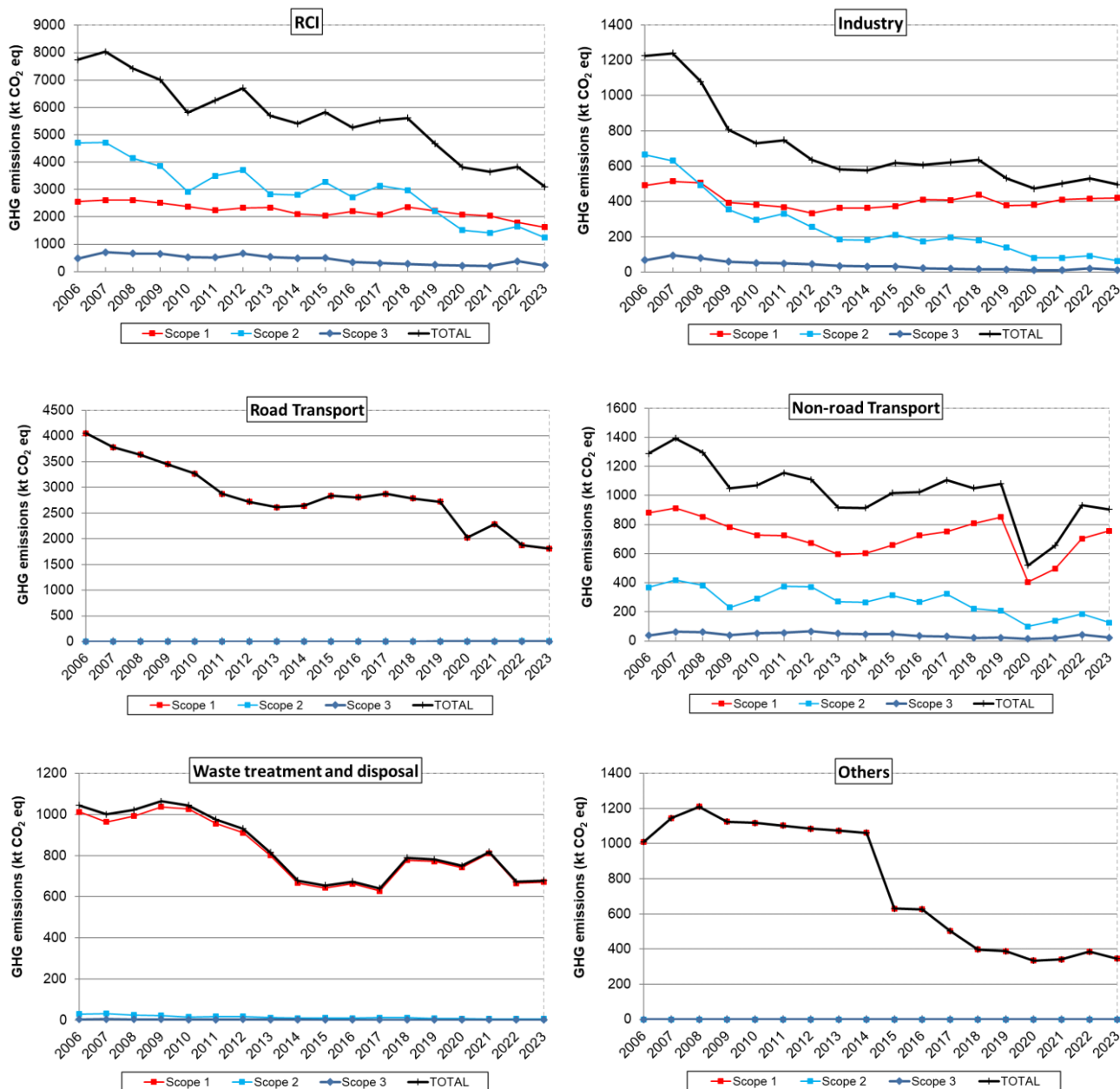


Figure 6. GHG emissions by scope and sector

3 INDICATORS

Table 12 and Figure 7 show the evolution of the population, the Gross Domestic Product (GDP) and the GHG emissions in Madrid city from 2000 to 2023. Additionally, the trend of two emission indicators is presented: the emission *per capita* (tonnes of CO₂ equivalent per inhabitant and year) and the emission per unit of GDP (tonnes of CO₂ equivalent per million euro of GDP).

Table 12. Emission and economic indicators (period 2000–2023), Madrid

Year	Population	GDP, million € ₂₀₁₀	Scope 1 emissions (kt CO ₂ eq)	Scope 2+3 emissions (kt CO ₂ eq)	Total GHG emissions (kt CO ₂ eq)	Emissions <i>per capita</i> (t CO ₂ eq/inhab)	Emissions per unit of GDP (t CO ₂ eq / million € ₂₀₁₀)
2000	2 882 860	95 262	9 936.4	5 968.9	15 905.2	5.5	167
2001	2 957 058	101 067	9 783.0	6 173.7	15 956.7	5.4	158
2002	3 016 788	104 194	9 821.4	6 427.5	16 248.9	5.4	156
2003	3 092 759	107 467	9 903.9	5 925.5	15 829.5	5.1	147
2004	3 099 834	111 036	9 826.5	6 321.4	16 147.9	5.2	145
2005	3 155 359	116 922	9 991.1	6 760.8	16 751.9	5.3	143
2006	3 128 600	122 043	10 001.4	6 360.2	16 361.6	5.2	134
2007	3 132 463	126 669	9 930.5	6 662.7	16 593.2	5.3	131
2008	3 213 271	129 351	9 808.5	5 845.5	15 654.0	4.9	121
2009	3 255 944	125 970	9 292.8	5 211.9	14 504.7	4.5	115
2010	3 273 049	125 339	8 892.6	4 148.6	13 041.2	4.0	104
2011	3 265 038	126 276	8 260.3	4 847.0	13 107.2	4.0	104
2012	3 233 527	123 495	8 048.2	5 131.5	13 179.7	4.1	107
2013	3 207 247	121 276	7 789.1	3 916.5	11 705.7	3.6	97
2014	3 165 235	123 019	7 440.8	3 832.1	11 272.9	3.6	92
2015	3 141 991	127 266	7 187.0	4 391.0	11 578.0	3.7	91
2016	3 165 541	132 071	7 432.3	3 570.7	11 002.9	3.5	83
2017	3 182 981	137 004	7 235.7	4 027.2	11 262.9	3.5	82
2018	3 223 334	141 144	7 563.4	3 708.2	11 271.7	3.5	80
2019	3 266 126	144 480	7 326.6	2 846.2	10 172.8	3.1	70
2020	3 334 730	130 130	5 970.8	1 943.6	7 914.4	2.4	61
2021	3 305 408	138 208	6 381.4	1 867.6	8 249.1	2.5	60
2022	3 280 782	147 613	5 827.9	2 397.9	8 225.8	2.5	56
2023	3 332 035	152 168	5 619.1	1 714.4	7 333.4	2.2	48

GDP in 2010 constant euro units

The emission per capita rate decreased by 60% in the period 2000–2023, as a result of population growth (16%) and a decrease of total GHG emissions (54%). Likewise, the "emission intensity per unit of GDP" fell 71% in that period of time.

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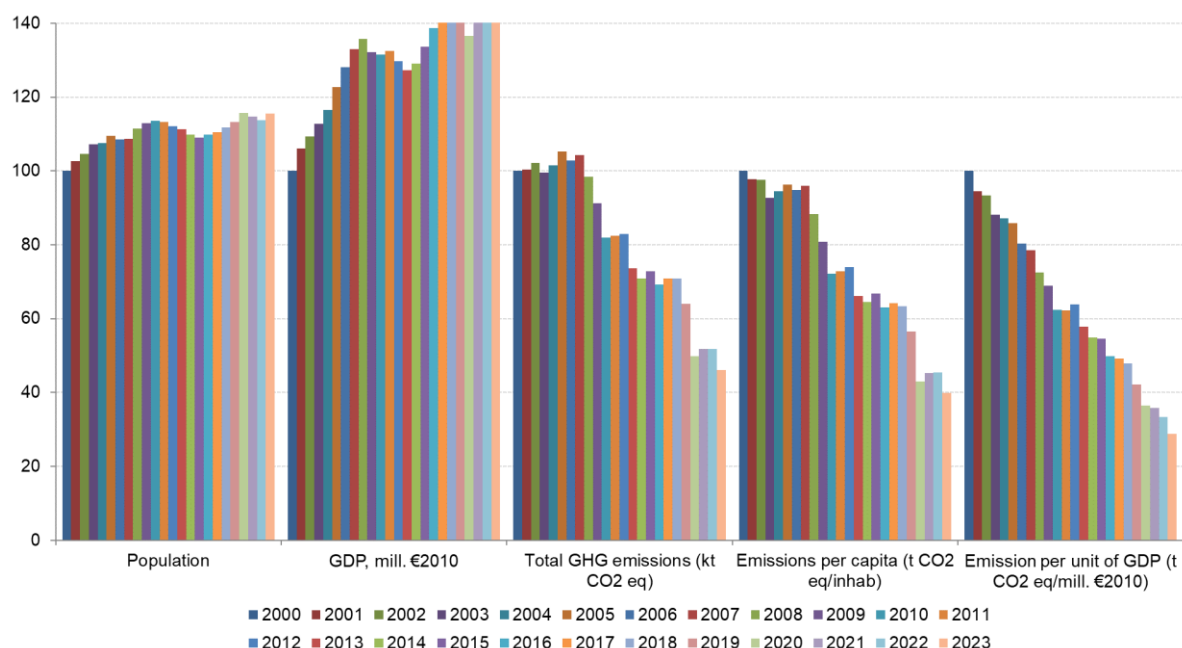


Figure 7. Trends of municipal GHG emissions and main indicators (year 2000=100)

Table 13 and Figure 8 compare the trend of population, GDP and total GHG emissions between 2000 and 2023 for Madrid and Spain. Directly comparable information about the emission indicators evaluated is also presented.

Table 13. Emission and economic indicators (period 2000–2023), Madrid and Spain

Year	MADRID					SPAIN				
	Population	GDP, million € ₂₀₁₀	Total GHG emissions (kt CO ₂ eq)	Emissions per capita (t CO ₂ eq/inhab)	Emissions per unit of GDP (t CO ₂ eq/mill. € ₂₀₁₀)	Population	GDP, million € ₂₀₁₀	Total GHG emissions (kt CO ₂ eq)	Emissions per capita (t CO ₂ eq/inhab)	Emissions per unit of GDP (t CO ₂ eq/mill. € ₂₀₁₀)
2000	2 882 860	95 262	15 905.2	5.5	167	40 499 791	781 631	381 945	9.4	489
2001	2 957 058	101 067	15 956.7	5.4	158	41 116 842	814 409	380 596	9.3	467
2002	3 016 788	104 194	16 248.9	5.4	156	41 837 894	840 246	398 902	9.5	475
2003	3 092 759	107 467	15 829.5	5.1	147	42 717 064	873 397	405 988	9.5	465
2004	3 099 834	111 036	16 147.9	5.2	145	43 197 684	909 818	421 384	9.8	463
2005	3 155 359	116 922	16 751.9	5.3	143	44 108 530	948 994	436 341	9.9	460
2006	3 128 600	122 043	16 361.6	5.2	134	44 708 964	989 390	430 650	9.6	435
2007	3 132 463	126 669	16 593.2	5.3	131	45 200 737	1 028 515	441 184	9.8	429
2008	3 213 271	129 351	15 654.0	4.9	121	46 157 822	1 040 121	407 859	8.8	392
2009	3 255 944	125 970	14 504.7	4.5	115	46 745 807	1 003 808	368 790	7.9	367
2010	3 273 049	125 339	13 041.2	4.0	104	47 021 031	1 005 939	353 628	7.5	352
2011	3 265 038	126 276	13 107.2	4.0	104	47 190 493	996 606	353 225	7.5	354
2012	3 233 527	123 495	13 179.7	4.1	107	47 265 321	976 370	345 968	7.3	354
2013	3 207 247	121 276	11 705.7	3.6	97	47 129 783	968 633	319 589	6.8	330
2014	3 165 235	123 019	11 272.9	3.6	92	46 771 341	993 605	320 363	6.8	322
2015	3 141 991	127 266	11 578.0	3.7	91	46 624 382	1 014 331	331 965	7.1	327
2016	3 165 541	132 071	11 002.9	3.5	83	46 557 008	1 053 530	320 390	6.9	304
2017	3 182 981	137 004	11 262.9	3.5	82	46 572 132	1 100 377	333 284	7.2	303
2018	3 223 334	141 144	11 271.7	3.5	80	46 722 980	1 116 060	327 577	7.0	294
2019	3 266 126	144 480	10 172.8	3.1	70	47 026 208	1 148 785	308 894	6.6	269
2020	3 334 730	130 130	7 914.4	2.4	61	47 398 695	1 017 567	269 803	5.7	265
2021	3 305 408	138 208	8 249.1	2.5	60	47 432 893	1 086 786	287 569	6.1	265
2022	3 280 782	147 613	8 225.8	2.5	56	47 475 420	1 146 336	292 297	6.2	255
2023	3 332 035	152 168	7 333.4	2.2	48	48 619 695	1 175 639	269 968	5.6	230

GDP in 2010 constant euro units

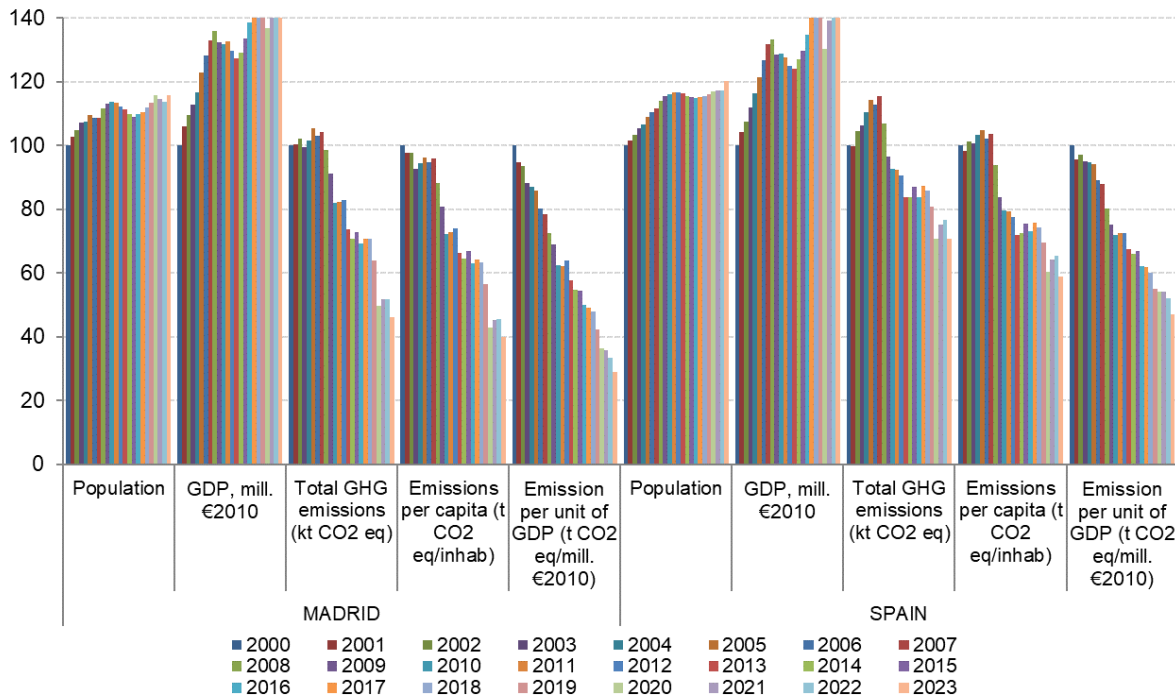


Figure 8. Trends of economic and emission indicators for Madrid and Spain (Year 2000=100)

In 2023, the city of Madrid accounted for 7% of national population but was only responsible for 3% of total GHG emissions in Spain. Thus, the local per capita emission rate is 60% lower than that of the national average (2.2 vs. 5.6 t CO₂eq/inhabitant). Similarly, Madrid accounted for 13% of national GDP in this same year, which means that local ‘emission intensity per unit of GDP’ was 79% lower than the corresponding national figure (48 vs. 230 t CO₂ eq/M€₂₀₁₀).

These remarkable differences can be largely explained by the productive structure of the municipality, whose economy is based on the tertiary sector (services) while the industrial activity (which is more energy demanding) is less significant.

From 2000 to 2023, the decrease in the emission per capita was larger in Madrid than in Spain (60% vs. 41%), due to a relevant reduction in local emissions (54% vs 29% in Spain). The emission per unit of GDP has decreased by 71% in Madrid vs the 53% in Spain. This evolution reflects a higher decrease in local GHG emissions and a higher local GDP growth.

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