

**INVENTORY OF MADRID CITY
GREENHOUSE GAS EMISSIONS 2019**

**Directorate General for Sustainability and
Environmental Control**



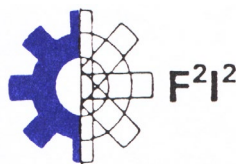
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MADRID

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DG for Sustainability and Environmental Control

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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.

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

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

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). 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, 2020a), and the national electricity consumption (MITECO, 2021; REE, 2020b).

Table 3. Electricity emission factors

Year	EF (tCO ₂ /MWh)	Year	EF (tCO ₂ /MWh)
1990	0.536	2005	0.495
1991	0.532	2006	0.456
1992	0.573	2007	0.469
1993	0.530	2008	0.401
1994	0.508	2009	0.362
1995	0.556	2010	0.292
1996	0.433	2011	0.350
1997	0.481	2012	0.374
1998	0.464	2013	0.301
1999	0.542	2014	0.305
2000	0.521	2015	0.348
2001	0.458	2016	0.284
2002	0.524	2017	0.326
2003	0.462	2018	0.283
2004	0.476	2019	0.221

2 GHG EMISSIONS

2.1 Direct (Scope 1) emissions

The trends of Scope 1 emissions in Madrid city is 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	1 334.6	7 920.7	209.1	228.4	0.0	6.5	9 699.4
2000	1 339.3	7 948.1	284.8	234.5	0.0	6.7	9 813.5
2001	1 264.5	7 806.0	363.7	217.0	0.0	7.1	9 658.3
2002	1 186.9	7 849.0	433.8	215.2	0.0	7.5	9 692.4
2003	1 043.3	7 981.0	529.8	217.7	0.0	8.1	9 779.9
2004	558.0	8 318.3	603.8	210.3	0.0	9.1	9 699.4
2005	583.0	8 350.9	699.9	220.7	0.0	10.2	9 864.7
2006	575.8	8 229.0	841.8	239.3	0.0	11.0	9 896.9
2007	544.6	8 059.9	980.7	233.6	0.0	11.9	9 830.8
2008	543.8	7 866.4	1 054.8	232.3	0.1	12.7	9 710.0
2009	547.6	7 431.0	981.2	221.6	0.0	13.2	9 194.7
2010	555.1	7 003.7	981.3	217.4	0.0	13.9	8 771.5
2011	530.0	6 437.7	974.6	205.5	0.0	13.6	8 161.4
2012	517.7	6 290.7	970.2	178.4	0.0	13.9	7 970.9
2013	486.8	6 096.2	969.7	161.4	0.0	13.8	7 727.9
2014	458.0	5 764.4	960.5	157.5	0.1	13.8	7 354.1
2015	444.2	5 948.1	531.3	151.8	0.5	14.3	7 090.1
2016	455.8	6 189.6	522.1	156.0	0.4	14.6	7 338.5
2017	390.3	6 151.2	398.4	160.9	0.5	14.6	7 115.9
2018	431.6	6 542.4	289.2	152.1	0.5	15.1	7 430.8
2019	401.1	6 361.2	279.7	150.0	0.8	15.3	7 208.1

(*) CO₂ removals by sinks are not included (SNAP activity Group 11)

Scope 1 emissions were 14% lower in 2019 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 – 2019.

Table 5 presents Scope 1 emissions grouped according to the activity sectors, considered in the Energy Balance of the city (AM, 2021b).

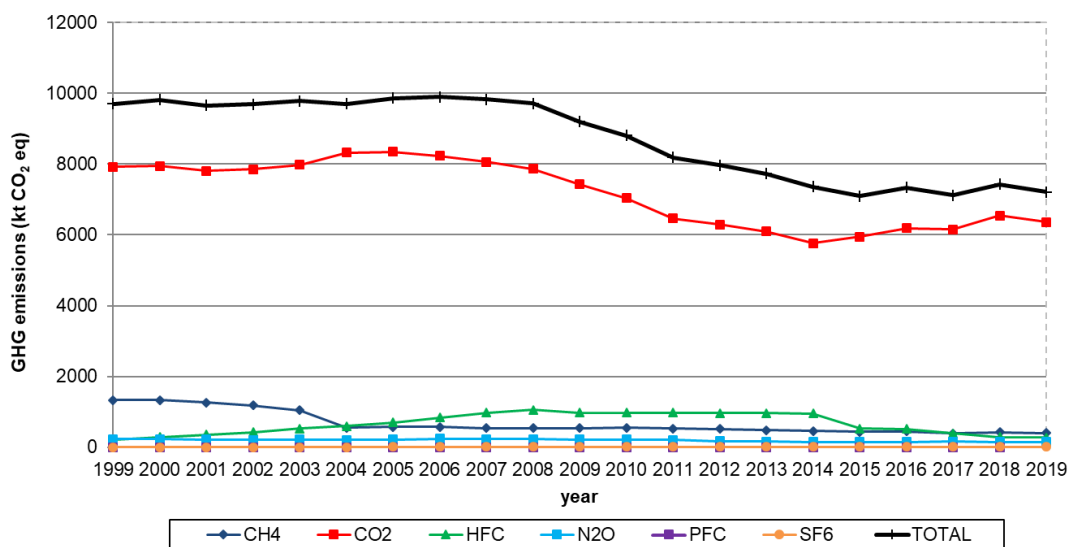


Figure 1. Scope 1 emissions trend by compound

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	3 885.1	675.2	1 537.4	383.2	9 699.4
2000	2 550.5	578.9	3 926.2	742.0	1 555.1	460.8	9 813.5
2001	2 479.4	515.7	3 875.3	760.8	1 489.1	538.1	9 658.3
2002	2 358.2	471.5	4 011.0	717.2	1 532.9	601.6	9 692.4
2003	2 559.0	517.1	3 897.1	668.6	1 444.7	693.4	9 779.9
2004	2 676.2	485.3	4 079.1	705.0	995.4	758.4	9 699.4
2005	2 695.3	482.1	4 066.4	728.1	1 032.1	860.7	9 864.7
2006	2 557.7	491.0	3 924.6	898.2	1 011.9	1 013.5	9 896.9
2007	2 614.2	514.2	3 659.9	927.5	964.0	1 151.0	9 830.8
2008	2 611.1	506.4	3 519.8	864.3	992.6	1 215.8	9 710.0
2009	2 507.5	393.1	3 333.9	791.7	1 036.9	1 131.6	9 194.7
2010	2 371.1	349.0	3 166.1	732.8	1 026.4	1 126.0	8 771.4
2011	2 233.9	344.1	2 786.6	731.0	955.3	1 110.1	8 161.1
2012	2 324.4	326.3	2 635.1	680.6	910.6	1 094.0	7 970.9
2013	2 339.0	368.5	2 531.6	602.1	801.5	1 085.2	7 727.9
2014	2 104.2	364.6	2 537.2	608.8	666.6	1 072.7	7 354.1
2015	2 043.0	377.0	2 724.8	663.8	642.6	638.9	7 090.1
2016	2 199.9	413.3	2 694.3	734.7	663.2	633.2	7 338.5
2017	2 070.4	407.1	2 736.7	763.0	628.2	510.5	7 115.9
2018	2 318.5	455.9	2 652.7	820.8	777.3	405.7	7 431.0
2019	2 183.3	442.8	2 590.8	864.0	735.2	392.0	7 208.1

(*) 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 67% of Scope 1 emissions.

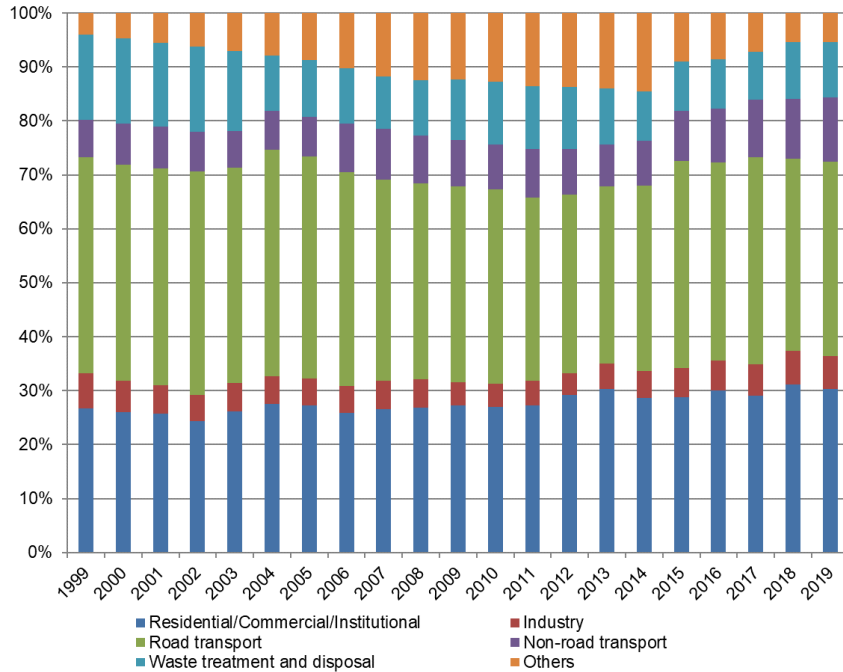


Figure 2. Scope 1 emissions breakdown by sector

In 2019, the main source of Scope 1 GHG emissions in the city of Madrid is ‘Road Transport’ (36%), followed by ‘RCI’ (30%). Figure 3 shows CO₂ emissions from ‘Road Transport’ spatially disaggregated in a regular grid for 2019 (cell size 1x1 km). The spatial pattern is strongly related to the distribution of road traffic.

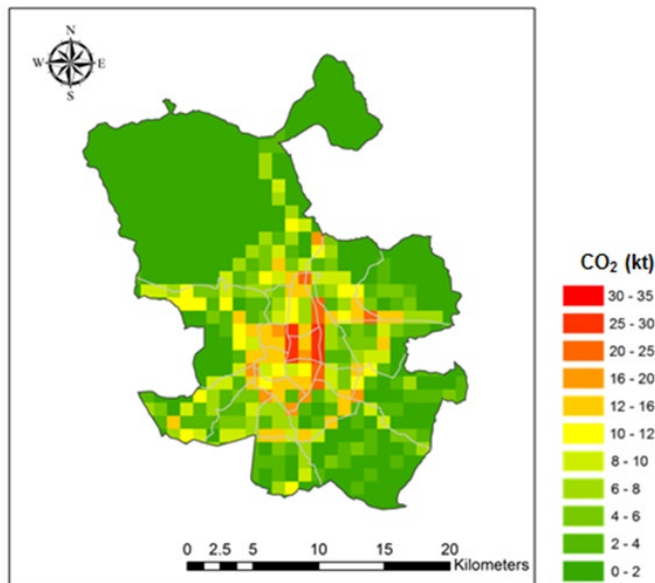


Figure 3. Spatial distribution of road transport CO₂ emissions (cell size 1x1 km)

2.2 Indirect (Scope 2 + Scope 3) emissions

Table 6 and Figure 4 include indirect electricity-related GHG emissions. Indirect (Scope 2 + Scope 3) emissions decreased by 39% in 2019 in comparison to 1990, whereas electricity consumption increased by 47% 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	12 843	0.462	5 925.5
2004	13 271	0.476	6 321.4
2005	13 614	0.495	6 760.8
2006	13 871	0.456	6 360.2
2007	14 115	0.469	6 662.7
2008	14 590	0.401	5 845.5
2009	14 413	0.362	5 211.9
2010	14 217	0.292	4 148.6
2011	13 862	0.350	4 847.0
2012	13 716	0.374	5 131.5
2013	13 005	0.301	3 916.5
2014	12 576	0.305	3 832.1
2015	12 630	0.348	4 391.0
2016	12 573	0.284	3 570.7
2017	12 846	0.326	4 027.2
2018	13 091	0.283	3 708.2
2019	12 836	0.221	2 839.6

Sources: Electricity consumption: CM, 2021 (1990-2002); AM, 2021a (2003-2005); AM, 2021b (2006-2019)
Emission factors estimated from MAPAMA, 2014, MITECO, 2021, REE, 2020a and REE, 2020b

This trend is explained by a decrease of 59% 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 2019, electric consumption decreased by 2% in comparison to that of 2018 and indirect emissions decreased by 23%. This is due to the decrease in the electricity EF (22%), as a consequence of a lower contribution of high-emitting energy sources (coal) to the electricity mix in 2019 (REE, 2020a).

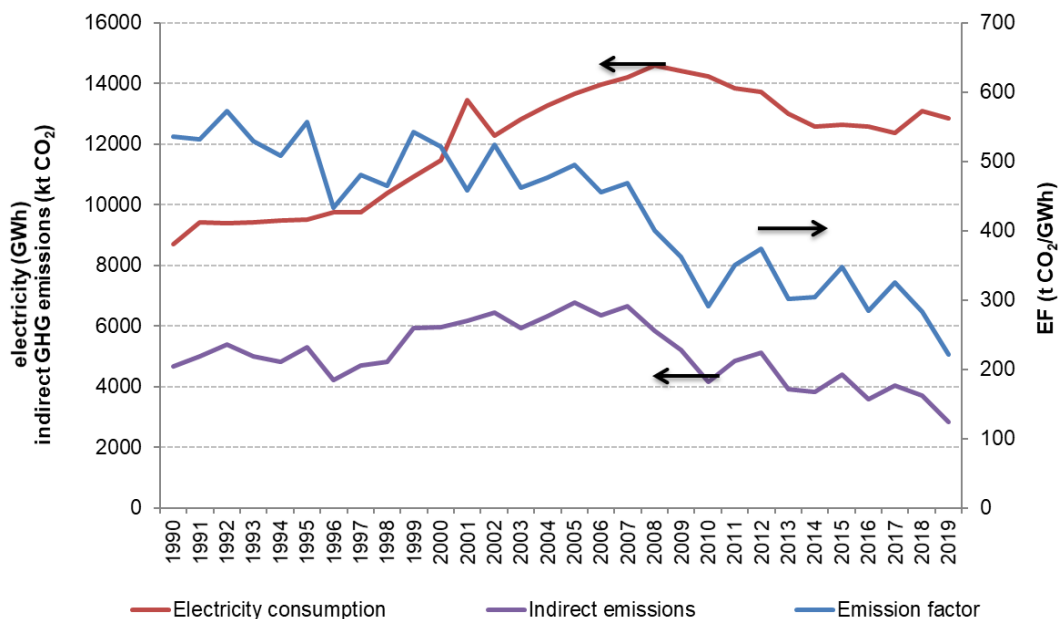


Figure 4. Evolution of indirect emissions (Scope 2+3), electricity consumption and electricity EF

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	3 254.9	197.5	0.7	242.8	0	12.4	3 708.2
2019	2 446.7	153.5	0.6	229.2	0	9.5	2 839.6

A breakdown of each activity sector is shown in Figure 5. The "RCI" sector accounts for 81-88% of indirect emissions in the evaluated period. The share of "Industry" decreases from 12% in 2006 to 5% in 2019 (as a result of a lower electricity consumption of this sector) while "Non-road transport" has a contribution between 5 and 9% in the period 2006-2019.

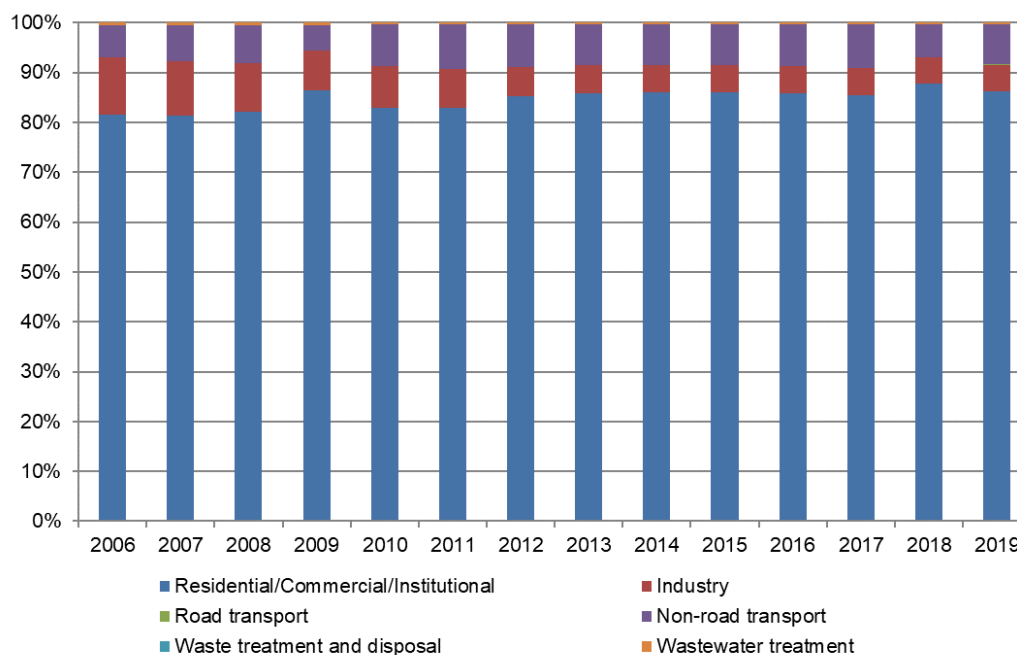


Figure 5. Scope 2+3 emissions breakdown by sector

2.3 Total Emissions

Table 8 and Figure 6 show the Scope 1, Scope 2+3 and Total GHG emissions trends in Madrid city. The dashed orange line in Figure 6 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 2019 are 120% 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	9 699.4	5 918.1	15 617.5	62.1	37.9	100
2000	9 813.5	5 968.9	15 782.3	62.2	37.8	100
2001	9 658.3	6 173.7	15 832.0	61.0	39.0	100
2002	9 692.4	6 427.5	16 119.9	60.1	39.9	100
2003	9 779.9	5 925.5	15 705.5	62.3	37.7	100
2004	9 699.4	6 321.4	16 020.9	60.5	39.5	100
2005	9 864.7	6 760.8	16 625.6	59.3	40.7	100
2006	9 896.9	6 360.2	16 257.2	60.9	39.1	100
2007	9 830.8	6 662.7	16 493.5	59.6	40.4	100
2008	9 710.0	5 845.5	15 555.5	62.4	37.6	100
2009	9 194.7	5 211.9	14 406.6	63.8	36.2	100
2010	8 771.5	4 148.6	12 920.1	67.9	32.1	100
2011	8 161.4	4 847.0	13 008.4	62.7	37.3	100
2012	7 970.9	5 131.5	13 102.5	60.8	39.2	100
2013	7 727.9	3 916.5	11 644.5	66.4	33.6	100
2014	7 354.1	3 832.1	11 186.2	65.7	34.3	100
2015	7 090.1	4 391.0	11 481.0	61.8	38.2	100
2016	7 338.5	3 570.7	10 909.1	67.3	32.7	100
2017	7 115.9	4 027.2	11 143.1	63.9	36.1	100
2018	7 430.8	3 708.2	11 139.0	66.7	33.3	100
2019	7 208.1	2 839.6	10 047.6	71.7	28.3	100

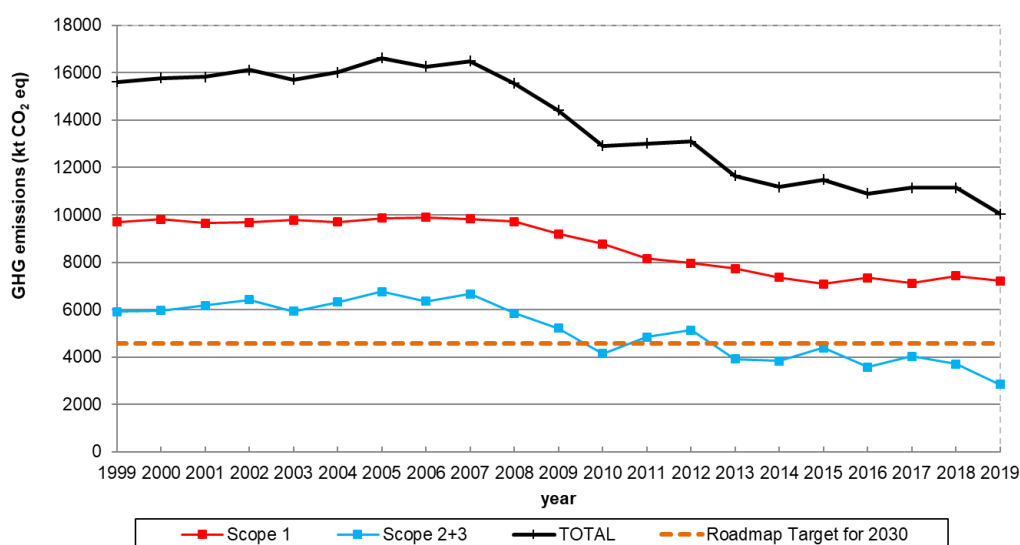


Figure 6. GHG emissions trends in Madrid city

As shown in Figure 6, Scope 1 emissions are higher than Scope 2+3. Between 1999 and 2019, the contribution of Scope 1 to total emissions ranged between 59 to 72%. Over this period of time, total emissions have decreased by 36%, Scope 1 emissions by 26% and Scope 2+3 emissions by 52%.

Table 9 shows GHG emissions results by activity sector in 2019.

Table 9. Scope 1, Scope 2+3 and Total GHG emissions by sector (2019)

Emissions	Residential/ Commercial/ Institutional	Industry*	Road transport	Non-road transport	Waste treatment and disposal**	Others***	TOTAL
kt CO ₂ eq							
Scope 1	2 183.3	442.8	2 590.8	864.0	735.2	392.0	7 207.7
Scope 2+3	2 446.7	153.5	0.6	229.2	9.5	0.0	2 839.6
TOTAL	4 630.0	596.3	2 591.3	1 093.3	744.7	392.0	10 047.6
Breakdown by sector (%)							
Scope 1	30.3	6.1	35.9	12.0	10.2	5.4	100
Scope 2+3	86.2	5.4	0.02	8.1	0.34	0.0	100
TOTAL	46.1	5.9	25.8	10.9	7.4	3.9	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 46,1%, followed by 'Road transport' (25,8%). This is partially explained by the high electricity consumption in 'RCI' (with the highest share of Scope 2+3 emissions, 86,2%).

2.4 GHG emissions by Scope and sector

Table 10 and Figure 7 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).

Table 10. 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	2 557.7	491.0	3 924.6	898.2	1 011.9	1 013.5	9 896.9
2007	2 614.2	514.2	3 659.9	927.5	964.0	1 151.0	9 830.8
2008	2 611.1	506.4	3 519.8	864.3	992.6	1 215.8	9 710.0
2009	2 507.5	393.1	3 333.9	791.7	1 036.9	1 131.6	9 194.7
2010	2 371.1	349.0	3 166.1	732.8	1 026.4	1 126.0	8 771.4
2011	2 233.9	344.1	2 786.6	731.0	955.3	1 110.1	8 161.1
2012	2 324.4	326.3	2 635.1	680.6	910.6	1 094.0	7 970.9
2013	2 339.0	368.5	2 531.6	602.1	801.5	1 085.2	7 727.9
2014	2 104.2	364.6	2 537.2	608.8	666.6	1 072.7	7 354.1
2015	2 043.0	377.0	2 724.8	663.8	642.6	638.9	7 090.1
2016	2 199.9	413.3	2 694.3	734.7	663.2	633.2	7 338.5
2017	2 070.4	407.1	2 736.7	763.0	628.2	510.5	7 115.9
2018	2 318.5	455.9	2 652.7	820.8	777.3	405.7	7 431.0
2019	2 183.3	442.8	2 590.8	864.0	735.2	392.0	7 208.1
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	2 973.5	180.4	0.6	221.8	11.3	0.0	3 387.6
2019	2 205.1	138.4	0.5	206.6	8.6	0.0	2 559.1
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	281.4	17.1	0.1	21.0	1.1	0.0	320.6
2019	241.6	15.2	0.1	22.6	0.9	0.0	280.4
TOTAL emissions							
2006	7 745.3	1 224.8	3 924.6	1 304.9	1 044.0	1 013.5	16 257.2
2007	8 035.4	1 239.9	3 659.9	1 406.7	1 000.6	1 151.0	16 493.5
2008	7 413.9	1 078.3	3 519.9	1 306.4	1 021.2	1 215.8	15 555.5
2009	7 010.0	807.4	3 334.0	1 060.0	1 063.7	1 131.6	14 406.6
2010	5 810.0	696.8	3 166.2	1 076.5	1 044.5	1 126.0	12 920.0
2011	6 251.0	723.9	2 786.6	1 161.0	975.4	1 110.1	13 008.0
2012	6 697.9	626.9	2 635.2	1 117.5	930.9	1 094.0	13 102.5
2013	5 702.9	587.1	2 531.7	922.2	815.4	1 085.2	11 644.5
2014	5 399.4	578.3	2 537.3	920.3	678.2	1 072.7	11 186.2
2015	5 817.0	621.5	2 724.9	1 023.8	654.9	638.9	11 481.0
2016	5 263.9	609.3	2 694.3	1 034.9	673.5	633.2	10 909.1
2017	5 514.8	621.7	2 737.4	1 117.6	641.2	510.5	11 143.1
2018	5 573.4	653.4	2 653.4	1 063.6	789.7	405.7	11 139.2
2019	4 630.0	596.3	2 591.3	1 093.3	744.7	392.0	10 047.6

(*) 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)

It can be seen that 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.

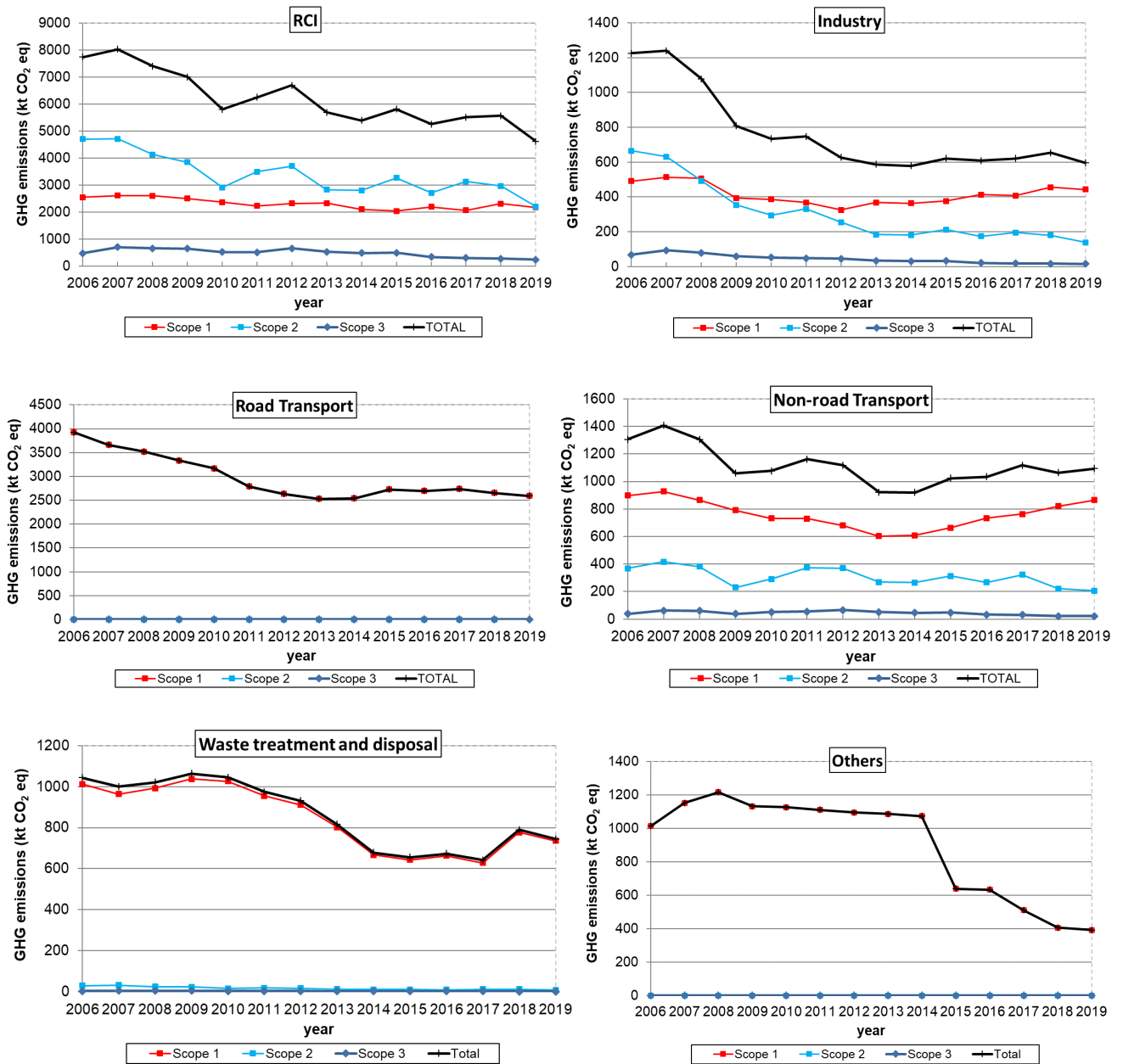


Figure 7. GHG emissions by Scope and sector

3 INDICATORS

Table 11 and Figure 8 show the evolution of the population, the Gross Domestic Product (GDP) and the GHG emissions in Madrid city from 2000 to 2019. 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 11. Emission and economic indicators (period 2000-2019), 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 per capita (t CO ₂ eq/inhab)	Emissions per unit of GDP (t CO ₂ eq / million € ₂₀₁₀)
2000	2 882 860	95 262	9 813.5	5 968.9	15 782.3	5.5	166
2001	2 957 058	101 067	9 658.3	6 173.7	15 832.0	5.4	157
2002	3 016 788	104 194	9 692.4	6 427.5	16 119.9	5.3	155
2003	3 092 759	107 467	9 779.9	5 925.5	15 705.5	5.1	146
2004	3 099 834	111 036	9 699.4	6 321.4	16 020.9	5.2	144
2005	3 155 359	116 922	9 864.7	6 760.8	16 625.6	5.3	142
2006	3 128 600	122 043	9 896.9	6 360.2	16 257.2	5.2	133
2007	3 132 463	126 669	9 830.8	6 662.7	16 493.5	5.3	130
2008	3 213 271	129 351	9 710.0	5 845.5	15 555.5	4.8	120
2009	3 255 944	125 970	9 194.7	5 211.9	14 406.6	4.4	114
2010	3 273 049	125 339	8 771.4	4 148.6	12 920.0	3.9	103
2011	3 265 038	126 276	8 161.1	4 847.0	13 008.0	4.0	103
2012	3 233 527	123 495	7 970.9	5 131.5	13 102.5	4.1	106
2013	3 207 247	121 276	7 727.9	3 916.5	11 644.5	3.6	96
2014	3 165 235	123 019	7 354.1	3 832.1	11 186.2	3.5	91
2015	3 141 991	127 266	7 090.1	4 391.0	11 481.0	3.7	90
2016	3 165 541	132 071	7 338.5	3 570.7	10 909.1	3.4	83
2017	3 182 981	137 004	7 115.9	4 027.2	11 143.1	3.5	81
2018	3 223 334	141 144	7 431.0	3 708.2	11 139.2	3.5	79
2019	3 266 126	144 480	7 208.1	2 839.6	10 047.6	3.1	70

The emission per capita rate decreased by 44% in the period 2000-2019, as a result of population growth (13%) and a decrease of total GHG emissions (36%). Likewise, the "emission intensity per unit of GDP" fell 58% in that period of time.

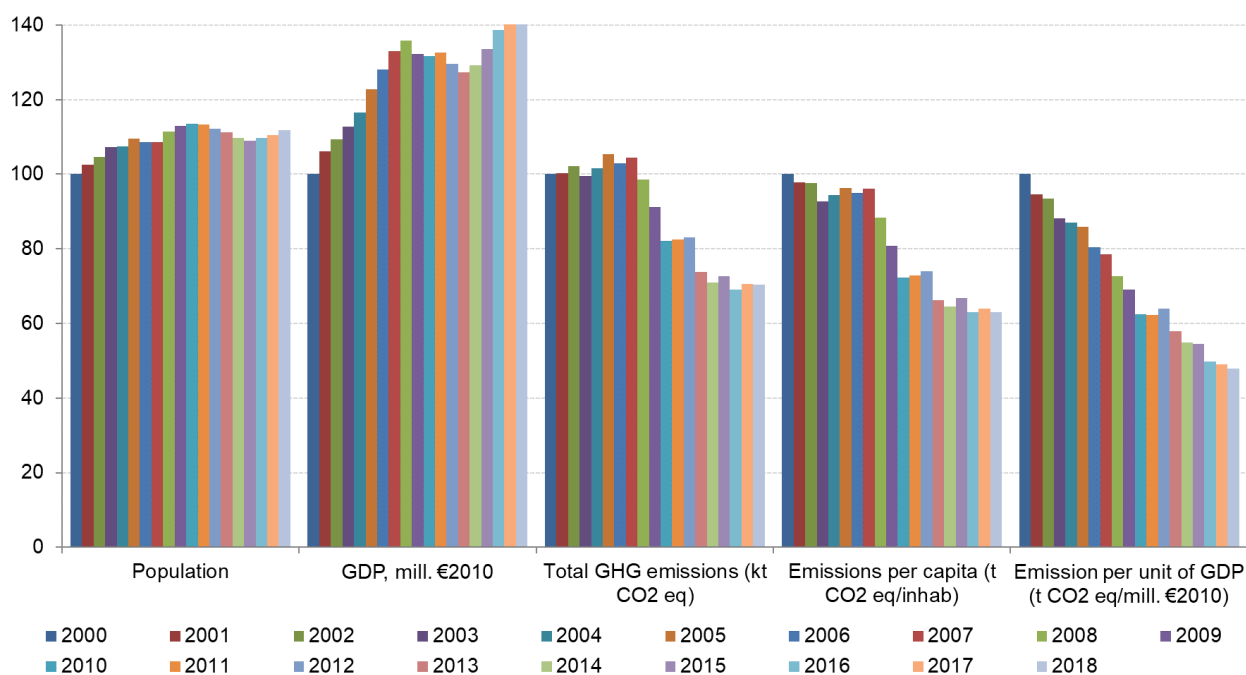


Figure 8. Trends of municipal GHG emissions and main indicators (year 2000=100)

Table 12 and Figure 9 compare the trend of population, GDP and total GHG emissions between 2000 and 2019 for Madrid and Spain. Directly comparable information about the emission indicators evaluated is also presented.

Table 12. Emission and economic indicators (period 2000-2019), 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	15 782	5.5	166	40 499 791	781 631	388 212	9.6	497
2001	2 957 058	101 067	15 832	5.4	157	41 116 842	814 409	385 643	9.4	474
2002	3 016 788	104 194	16 120	5.3	155	41 837 894	840 246	403 701	9.6	480
2003	3 092 759	107 467	15 705	5.1	146	42 717 064	873 397	411 525	9.6	471
2004	3 099 834	111 036	16 021	5.2	144	43 197 684	909 818	427 387	9.9	470
2005	3 155 359	116 922	16 626	5.3	142	44 108 530	948 994	442 075	10.0	466
2006	3 128 600	122 043	16 257	5.2	133	44 708 964	990 951	435 256	9.7	439
2007	3 132 463	126 669	16 493	5.3	130	45 200 737	1 030 136	446 328	9.9	433
2008	3 213 271	129 351	15 556	4.8	120	46 157 822	1 041 491	412 136	8.9	396
2009	3 255 944	125 970	14 407	4.4	114	46 745 807	1 003 945	372 319	8.0	371
2010	3 273 049	125 339	12 920	3.9	103	47 021 031	1 006 119	357 876	7.6	356
2011	3 265 038	126 276	13 008	4.0	103	47 190 493	996 743	357 588	7.6	359
2012	3 233 527	123 495	13 102	4.1	106	47 265 321	976 593	350 318	7.4	359
2013	3 207 247	121 276	11 644	3.6	96	47 129 783	968 957	323 526	6.9	334
2014	3 165 235	123 019	11 186	3.5	91	46 771 341	993 830	325 609	7.0	328
2015	3 141 991	127 266	11 481	3.7	90	46 624 382	1 017 525	336 995	7.2	331
2016	3 165 541	132 071	10 909	3.4	83	46 557 008	1 055 841	325 466	7.0	308
2017	3 182 981	137 004	11 143	3.5	81	46 572 132	1 104 201	338 738	7.3	307
2018	3 223 334	141 144	11 139	3.5	79	46 722 980	1 120 147	333 250	7.1	298
2019	3 266 126	144 480	10 048	3.1	70	47 026 208	1 143 267	314 529	6.7	275

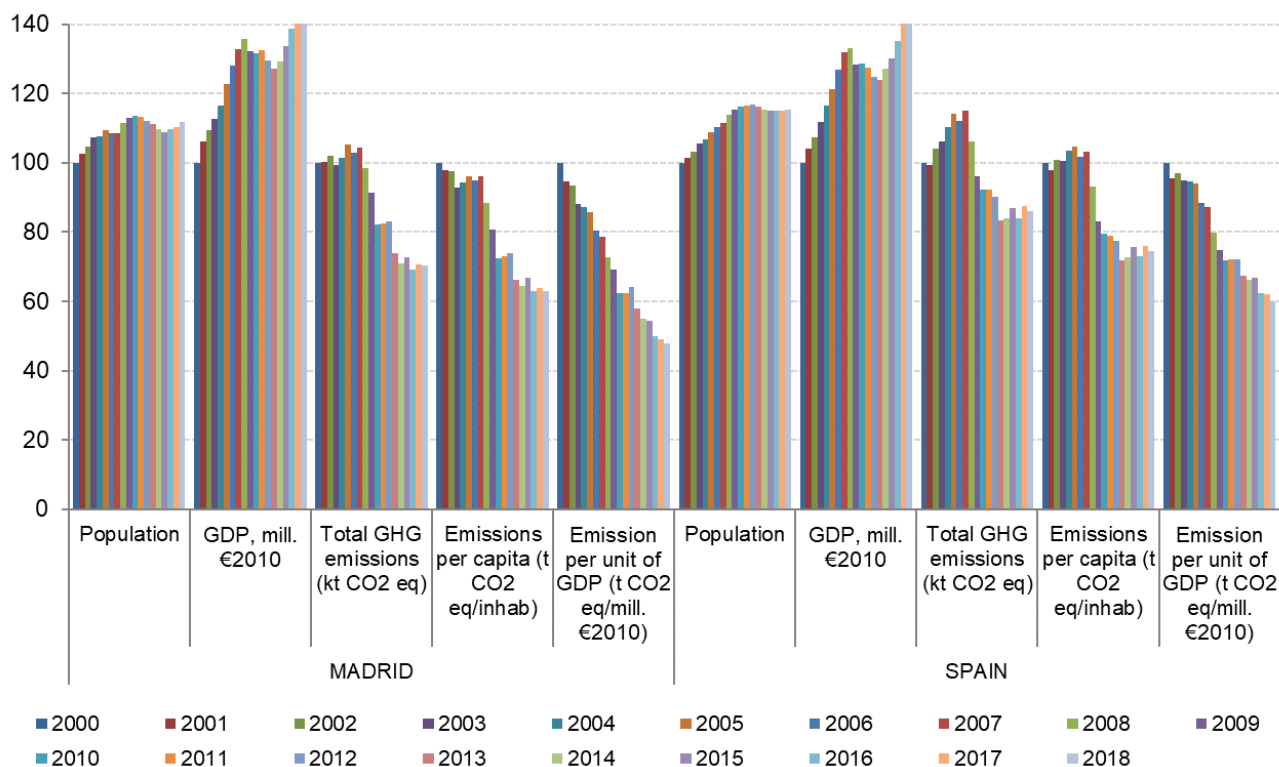


Figure 9. Trends of economic and emission indicators for Madrid and Spain (Year 2000=100)

In 2019, 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 54% lower than that of the national average (3.1 vs. 6.7 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 75% lower than the corresponding national figure (70 vs. 275 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 2019, the decrease in the emission per capita was larger in Madrid than in Spain (44% vs. 30%), due to a relevant reduction in local emissions (36% vs 19% in Spain). The emission per unit of GDP has decreased by 58% in Madrid vs the 45% in Spain. This evolution reflects a higher decrease in local GHG emissions and a higher local GDP growth.

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