RIO DE JANEIRO CITY HALL

Marcelo Bezerra Crivella

PEREIRA PASSOS INSTITUTE

Mauro Osório da Silva

Technical Information Coordination

Luiz Roberto Arueira da Silva

Information Coordination

Adriano Reginaldo Alem

Environmental Studies and Climate Change Department

Felipe Cerbella Mandarino (inventario.ipp@rio.rj.gov.br)

Patrícia Turano de Carvalho

Mônica Di Masi

MUNICIPAL SECRETARIAT FOR THE ENVIRONMENT

Marcelo André Cid Heráclito do Porto Queiroz

Climate Change and Sustainable Development Department

José Miguel Carneiro Pacheco

MUNICIPAL SECRETARIAT OF CIVIL OFFICE

Paulo Albino Santos Soares

Undersecretariat of Planning and Results Monitoring

Ana Carla Badaró Moreira Prado

Planning Office

Daniel Mancebo

ACKNOWLEDGEMENTS

Capacity-Building and Professional Certification

World Bank Group
C40 Cities Climate Leadership Group
City Climate Planner Certification Program – Green Business Certification Inc.
ICLEI – Local Governments for Sustainability
Climate Centre Laboratory – COPPE/UFRJ

Internal Data Sources

Municipal Secretariat for the Environment - SMAC
Municipal Company of Urban Cleaning - COMLURB
Fundação Parques e Jardins (Parks and Gardens Foundation)
Fundação Rio-Águas (Rio-Water Foundation)

External Data Sources

Air Liquide Brasil
Ambev Vidros
Agência Nacional do Petróleo – ANP
Companhia Estadual de Águas e Esgotos do Rio de Janeiro – CEDAE
EMATER-RJ
Energyworks/CountorGlobal
FURNAS
Gerdau Aços Brasil
IBG - Indústria Brasileira de Gases
Instituto Estadual do Ambiente - INEA
Light
Linde Gás
MetrôRio
Naturgy
Owens Illinois
Refinaria de Manguinhos
Schott Brasil
Secretaria de Agricultura, Pecuária, Pesca e Abastecimento do Estado do Rio de Janeiro - SEAPPA
Supervia
Ternium
Usina Verde
VLT Carioca
White Martins Gases Industriais Ltda
Zona Oeste Mais

1. Introduction

This document presents the first results of the project Monitoring Emissions of Greenhouse Gas Emissions (GHG) for the City of Rio de Janeiro. The GHG emissions inventories in the city consider the period from 2012 to 2017.

The City Hall of Rio de Janeiro is a pioneer amongst Brazilian cities on the elaboration of GHG inventories. In 2000, its first report of the kind was published, referring to the results from years 1990, 1996, and 1998. In 2011, an inventory was published with results from 2005. In 2013 (with a published review in 2015), the latest available inventory was launched, with the reference year from 2012. Therefore, to this date, there were inventories for 5 different years in the city.

All previous inventories were coordinated by the Municipal Secretariat of Environment (SMAC) and developed with the consultancy of laboratory Centro Clima, which is part of the Alberto Luiz Coimbra Institute for Graduate Studies and Research in Engineering (COPPE) in the Federal University of Rio de Janeiro (UFRJ). This external consultancy was hired because of the need to develop a specific methodology, as well as the lack of technical capacity in the City Hall for all respective sectors.

Now, for the first time, the City Hall of Rio de Janeiro, through the Pereira Passos Institute (IPP), elaborated emission inventories for the city with its own internal teams. IPP sought to qualify and strength its technical body so that it could assume this responsibility. This project became a reality through the collaboration and support of SMAC and the Planning Office from the Undersecretariat for Planning and Results Monitoring (EPL/SUBPAR) within the Municipal Secretariat of Civil Office (CVL).

Thus, the results presented here respond to important commitments from the city:

- **Law 5.248/2011 –** Establishes a Municipal Policy of Climate Change and Sustainable Development and demands the development of inventories every four years since 2012;
- **C40 Cities Climate Leadership Group –** The city's commitment within this network obliges the City Hall to develop inventories of GHG emissions every five years.
- **Global Covenant of Mayors for Climate and Energy –** Through this covenant the city commits to submit an updated inventory of GHG emissions every two years.

This product is also the first delivery of SISCLIMA – Climate Change Monitoring System, a tool created within the Municipal System of Urban Information (SIURB) and the Program City for the Climate. By integrating data governance to climate change governance, this tool will be responsible to supply information and knowledge for planning, implementation and monitoring of actions to face climate change in the city.

From 2018 onwards, as part of this new monitoring system, an annual routine will be adopted to update the inventory of GHG Emissions of the City of Rio de Janeiro. Although not mandatory, the development of annual inventories will facilitate the continuity of data capturing and will also make possible deeper analyses of the impact of projects, variations in the economic scenario and a closer monitoring of the GHG emissions in the city, amongst others.

An important part of this project is the revision of the inventory of GHG emissions from 2012, which was needed due to changes in the methodology used. This was done with the objective of building a historic series that is compatible with the years of the initial inventories, from 2013 to 2017.

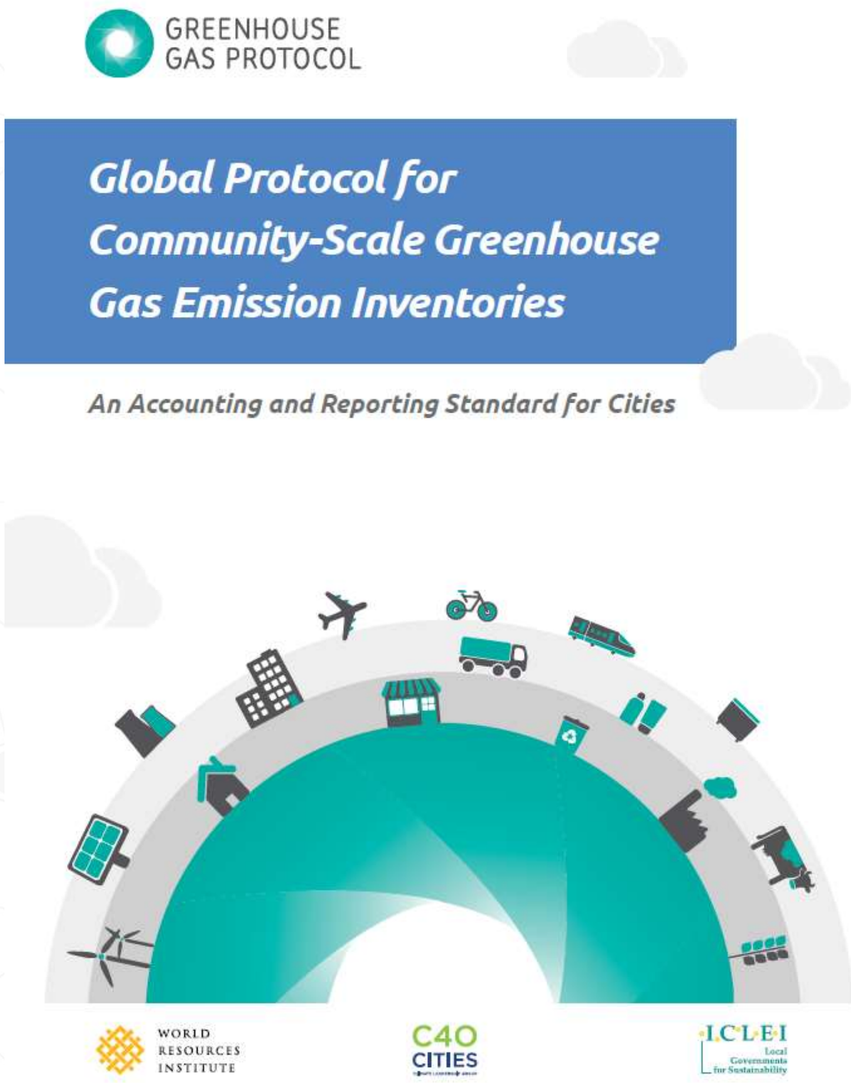
Therefore, the results from 2012 to 2017 will be fully comparable as they will be presented under the same methodology.

The team that compiled the Inventory came from the Management of Environmental Studies and Climate Change at the Technical Information Coordinating Body of the Pereira Passos Institute. The three civil servants that compose the team are certified as *Urban Greenhouse Gas Inventory Specialists*. This certification was created by the World Bank in partnership with C40, World Resources Institute (WRI) and ICLEI – Local Governments for Sustainability. Currently, it is managed by Green Business Certification Inc. (GBCI) and is part of the *City Climate Planner Certificate Program*, which seeks to recognize and increase the qualification of professionals that work with climate planning in cities.

IPP's team conducted this project partnered with the Secretariat of Environment through its Climate Change and Sustainable Development Department, as well as the Secretariat of Civil Office (CVL), through EPL/SUBPAR. The city hall also had technical support from C40 and all the City Hall departments, specially regarding data collection.

2. Methodology

The methodology adopted for this project was the GPC – Global Protocol for Community-Scale Greenhouse Gas Emissions Inventories. It was developed by C40, WRI and ICLEI to sort issues due to the GHG emission estimates at the subnational levels (specially concerning frontiers) and allow the comparation and aggregation of inventories from different cities, states, etc. The basis of GPC methodology are the manuals for national GHG inventories published by the Intergovernmental Panel on Climate Change – IPCC. It also adds guidance for the accountability of emissions in the local scale.



Picture 1. GPC methodology manual

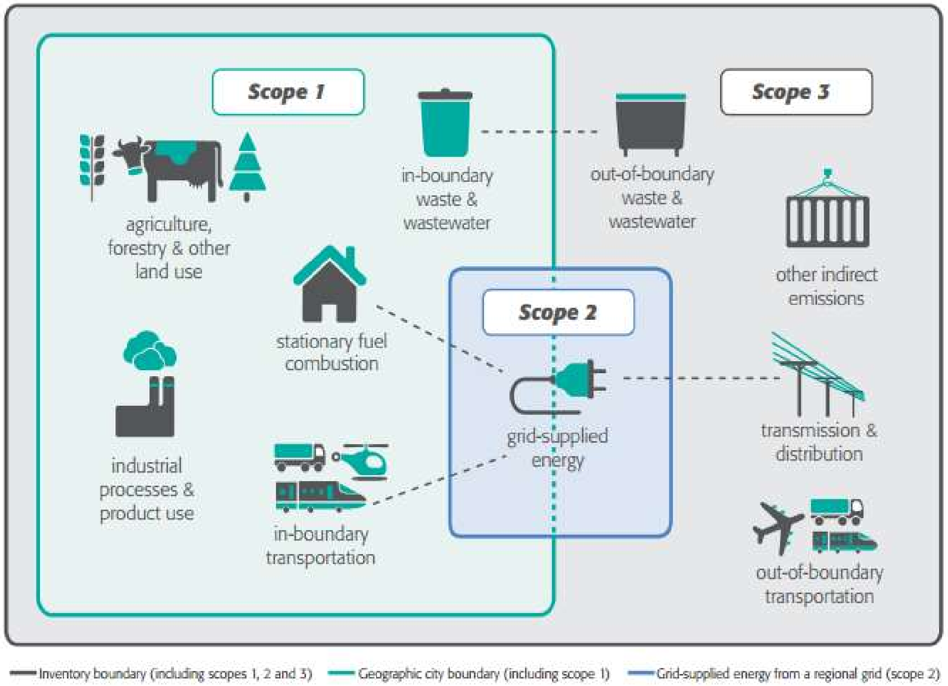
GPC methodology is widely adopted by cities, networks and reporting platforms around the world. It allows emissions to be calculated according to a basic level of reporting (Basic), contemplating emissions from Stationary Energy, Transport, and Waste or an extended basic reporting (Basic+), which also includes the sectors of Agriculture, Forestry and Other Land Use (AFOLU), and Industrial Processes and Product Use (IPPU). Basic+ also includes the calculation and reporting of all relevant emission sources in the city.

Table 1. Reporting levels in GPC methodology

REPORTING SECTORS AND LEVELS
Stationary Energy (Basic)
Transportation (Basic)
Waste (Basic)
Agriculture, Forestry and Other Land Use - AFOLU (Basic+)
Industrial Processes and Product Use - IPPU (Basic+)

Since its first inventory, the city of Rio de Janeiro calculated the emissions for the sectors corresponding to Basic+ level. Throughout this process, inventories at Basic+ level were compiled, having been verified and approved by C40 according to this level of GPC methodology.

In order to deal with the challenges imposed by the issue of frontiers in calculating subnational emissions, GPC methodology introduces the classification of sources of emissions in scopes (1, 2, or 3), according to their geographic location. Emissions from scope 1 are those that happen inside the city's frontier. Emissions from scope 2 are exclusively derived from the electric energy grid, supplied by interlinked distribution systems (grid), as is the case in Brazil with its National Interlinked System (SIN), which can happen inside or outside the city. Scope 3 emissions are those that happen from sources located outside the city boundaries, but due to activities that are part of the city's direct responsibility, for example emissions from landfills in waste treatment centres in neighboring cities, such as Seropédica.



Picture 2. Description of emissions according to each scope, extracted from the GPC manual

2.1. Estimated Gases and global warming potential

The estimated value of the emissions of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) was calculated by the city's inventories.

The gases in consideration have different levels of potential concerning global warming (*Global Warming Potential – GWP*). For reporting purposes it is common to convert them into CO_2 equivalent (tCO_2e), multiplying the estimated volume of each gas by its warming potential. Thus, it is possible to add all emissions and present a global value as if all emissions were CO_2.

The multiplying values that were used were established by IPCC's fifth Assessment Report (AR-5): 1 for CO_2, 28 for CH_4 and 265 for N_2O.

2.2. Data collection and treatment

One of the most demanding and time-consuming tasks working with GHG inventories is the collection of data from emission activities.

The first step taken was to list all possible sources of gases causing the greenhouse effect, and in line with the methodology used, list the data that was needed to measure each activity. A revision of previous inventories was also an important development in this process.

The creation of the Municipal System of Urban Information (SIURB) – which has the role to gather, manage, integrate, and update the set information about the city of Rio de Janeiro – was a decisive factor to conduct the process of collection, reception, control quality, and treatment of data.

The institutional support from the Municipal Secretariat for the Environment (SMAC) was also important in this phase, through the formal requests and contacts with the external data sources.

2.3. Emission calculation

Once having the data related to the activities of GHG emissions, Emission Factors were selected for each activity. The emission factors reflect the mass of greenhouse gases related to an unit of activity. In the case of electricity, for example, it depends on technology and the fuel being used on its generation. The total amount of emissions will be obtained by multiplying the activity data (energy consumption) by the emission factor (amount of emission by gases per unit of generated energy).

The emission factors must be relevant to the geographical limits of the inventory, specific to the activity being measured, and supplied by reliable sources such as the government, industry, or academia. If it is not possible to obtain the specific regional or national emission factors, the standard values made available by the IPCC (or other international references related to the local context) should be used.

The tool *City Inventory Reporting and Information System – CIRIS* was used for the calculation and reporting of emissions, and it is openly made available by C40 Group.

3. Results

On this session, the results from the project Monitoring GHG Emissions in the City of Rio de Janeiro 2012– 2017 will be presented. On the following tables, the emissions are classified by sector, as well as the relative participation of each sector on an yearly basis.

Table 2. Greenhouse Gas Emissions (tCO2e) for the city of Rio de Janeiro by year and sector - 2012 to 2017

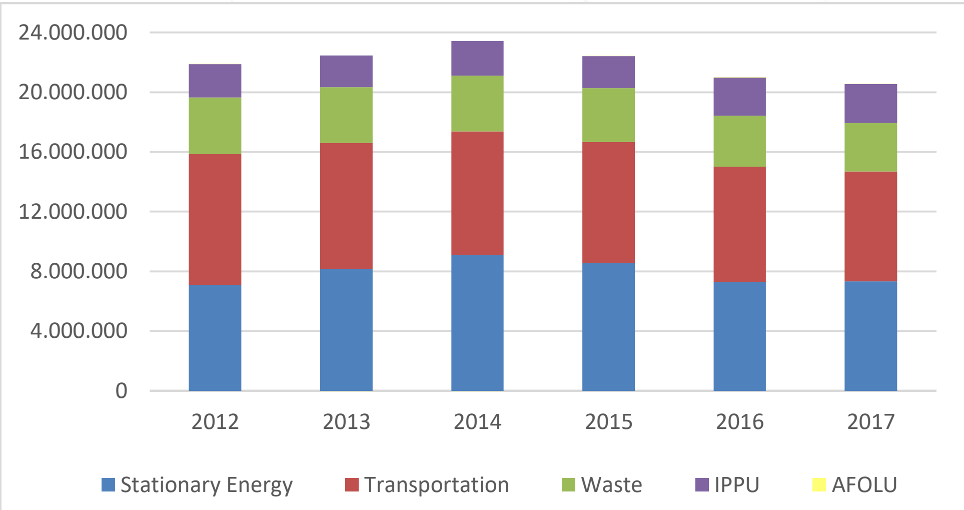
Sectors	2012	2013	2014	2015	2016	2017
Stationary Energy	7.090.875	8.142.034	9.117.677	8.584.932	7.285.039	7.322.993
Transport	8.747.170	8.462.554	8.247.844	8.069.471	7.716.763	7.371.963
Waste	3.812.844	3.729.773	3.740.275	3.608.363	3.422.093	3.245.174
IPPU	2.232.524	2.117.397	2.311.917	2.154.950	2.542.901	2.600.950
AFOLU	3.599	-2.886	-3.346	13.682	19.729	20.821
Total Emissions	21.887.010	22.448.871	23.414.367	22.431.397	20.986.525	20.561.902

Table 3. Relative participation of sectors in total GHG emissions in the city of Rio de Janeiro - 2012 to 2017

Sectors	2012	2013	2014	2015	2016	2017
Stationary Energy	32,4%	36,3%	38,9%	38,3%	34,7%	35,6%
Transport	40,0%	37,7%	35,2%	36,0%	36,8%	35,9%
Waste	17,4%	16,6%	16,0%	16,1%	16,3%	15,8%
IPPU	10,2%	9,4%	9,9%	9,6%	12,1%	12,6%
AFOLU	0,0%	0,0%	0,0%	0,1%	0,1%	0,1%
Total Emissions	100%	100%	100%	100%	100%	100%

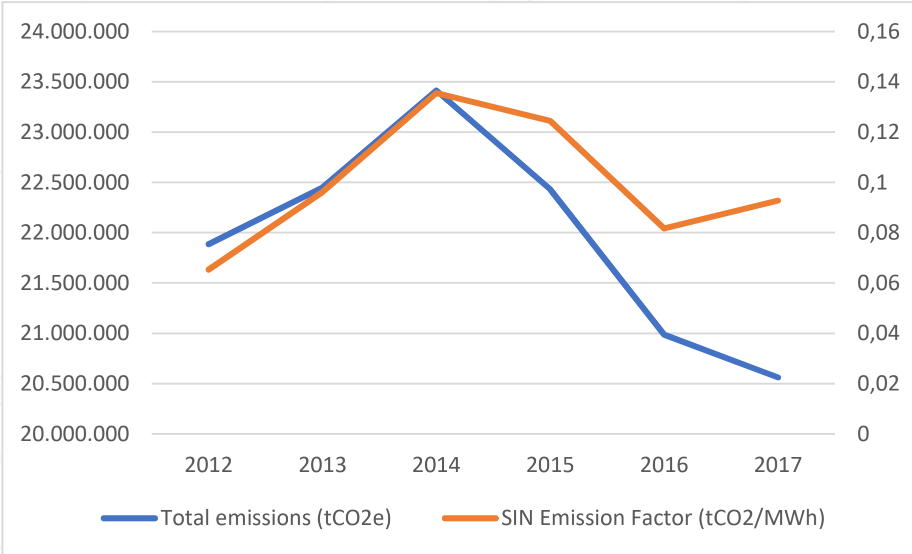
The inventories demonstrate a variation in total emissions. At first there is an increase until 2014, and then it decreases after 2015, as shown in the graph below.

Graph 1. Total GHG Emissions (tCO_2e) per sector from 2012 to 2017



The sectors that show a reduction in emissions are Waste and Transport. The Stationary Energy sector fluctuates in a similar way to the SIN emission factor, demonstrating the importance of the carbon footprint of the electric energy consumed in the city and its influence in the result of total emissions in Rio de Janeiro, as shown in the graph below.

Graph 2. Total GHG Emissions and Emission Factor of electric energy provided by SIN



The steel industry has considerable emissions in the city. These emissions are represented both in the Stationary Energy sector and in IPPU, which shows a significant growth in the historic series.

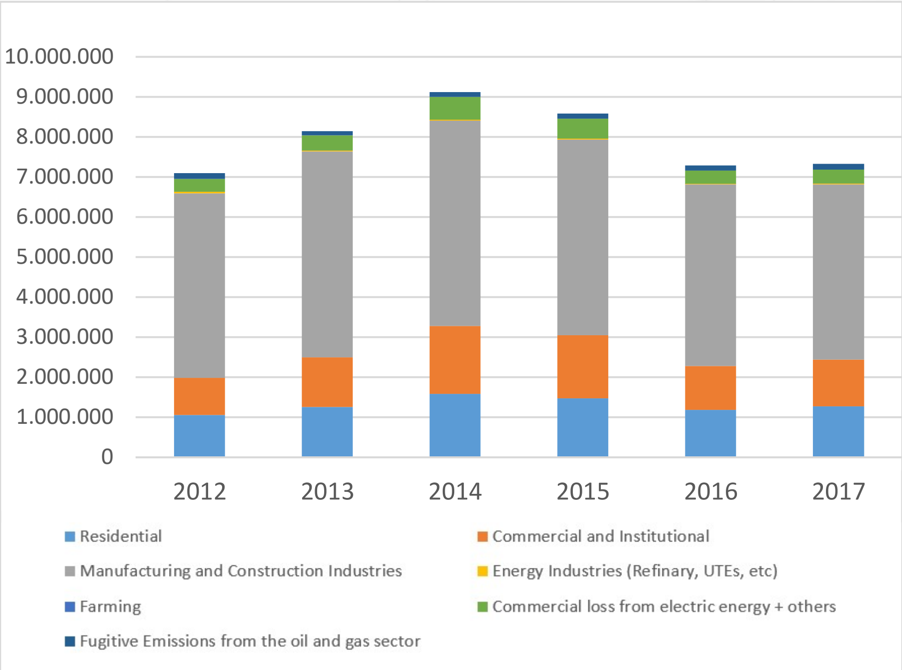
AFOLU emissions are almost non-significant in absolute terms, however they are under a tendency of growth. It is important to highlight the key role of reforestation and urban afforestation projects from the municipal government, which in 2013 and 2014 managed to compensate all sources from this sector, generating a negative amount of emissions.

From here onwards, emissions will be analyzed by sectors, showing their evolution in time and classification by subsectors, as well as their allocation in scopes 1, 2 and 3. The values per subsector and scope for each year can be found on Annex 1.

Stationary Energy

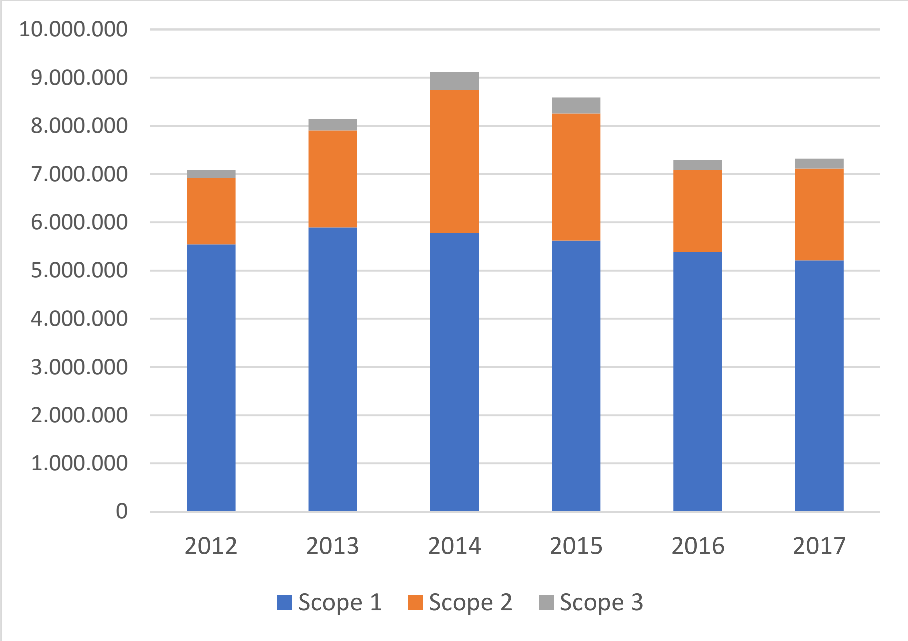
These are basically emissions from the consumption of fuel and electric energy in buildings, industries, and rural activities, as well as in the generation of electricity and energy transformation, such as in oil. The fugitive emissions from the distribution and transmission of electric energy and activities related to oil and gas are also included. This sector is classified on the subsectors of the graph below, considering the disaggregation of data supplied by different sources.

Graph 3. GHG Emissions (tCO_2e) of Stationary Energy classified by subsector



Emissions regarding fuel consumption inside the municipal boundaries in different subsectors, as well as fugitive emissions, are reported in scope 1. Emissions due to electric energy consumption supplied by the National Interlinked System (SIN) are reported on scope 2, and the losses in transmission networks and electricity distribution on scope 3.

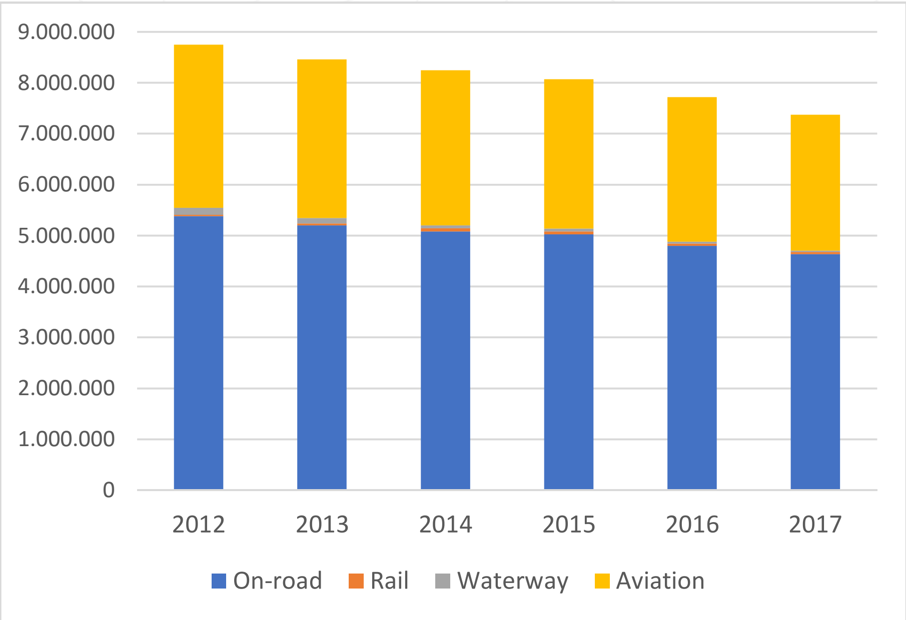
Graph 4. GHG Emissions(tCO_2e) of Stationary Energy classified by scope



Transportation

Emissions from the transportation sector come from burning fossil fuels (gasoline, ethanol, diesel, natural gas, etc.) in the motors of vehicles that circulate inside the city, as well as the consumption of electric energy from metro, trains, VLT and other electric modals. The consumption of fossil fuels for the waterway and air transport are also considered under this sector. The historic series of this sector's emissions, classified by subsectors, can be seen in the graph below.

Graph 5. GHG Emissions (tCO_2e) for Transportation classified by subsector

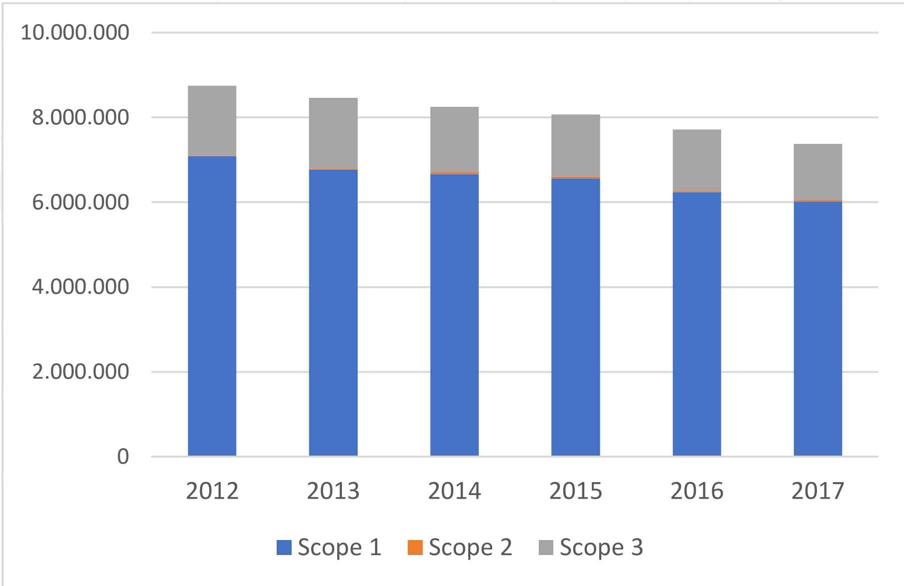


The calculation of relative emissions to road transport in the city of Rio de Janeiro is done through the data of fuel sales in gas stations located inside the municipal boundaries, reported on scope 1.

The consumption of electric energy from SIN for the transport sector is concentrated in railway transportation, such as metro, train and Light Rail Vehicles (VLT), and has its emissions reported on scope 2. On this subsector, the emissions reported on scope 1 refer to the consumption of fuel in cargo trains, also calculated according to their sales data. Emissions for scope 3 cover the losses in transmission and distribution of consumed electricity.

Waterway transport includes ships, ferries and other boats. The aviation sector includes emissions from helicopters and flights that depart from city airports. Considering the availability of data for the calculation and allocation of these sources, the emissions for air and waterway transport in a national level are reported on scope 1, while those from international flights are reported on scope 3.

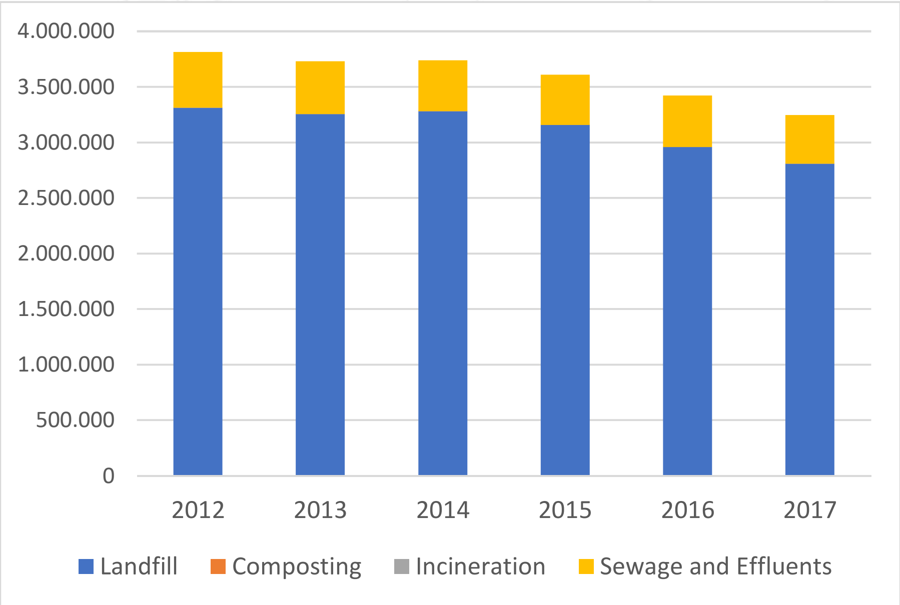
Graph 6. GHG Emissions (tCO_2e) for Transportation classified by scope



Waste

This sector refers to the treatment and/or disposal of solid waste and effluents. The emissions generated by solid waste depend on the kind of treatment that they are submitted to. Basically, they can be disposed in landfills, incinerated, burnt in open air, recycled or composted. The disposal in landfill is the main destination of solid waste generated in the city. However, the Waste Treatment Center in Seropédica, which receives most of the city's waste, and the Gramacho Landfill, whose activities have already been ceased, both have a biogas capture system.

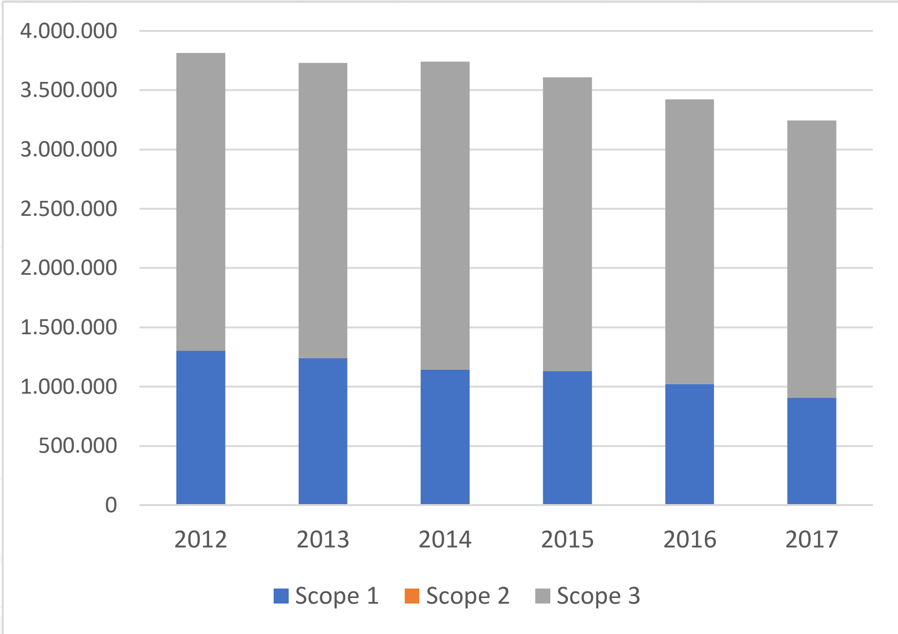
Graph 7. GHG Emissions (tCO_2e) for Waste classified by subsector



Emissions also differ according to the treatment given to the effluents. Part of the sewage collected in the city goes through a biological treatment at the Sewage Treatment Stations (ETE) of CEDAE and Zona Oeste Mais.

Another part of the sewage is disposed in the sea through the Ipanema and Barra da Tijuca emissaries, after a preliminary and primary treatment. Other forms of disposal are in water bodies and cesspools.

Graph 8. GHG Emissions (tCO_2e) for Waste classified by scope



Emissions from the disposal of solid waste located outside the city are reported as scope 3, since they are generated outside the city boundaries, but are the city's responsibility. Any other sources are reported on scope 1.

Industrial Processes and Product Use - IPPU

IPPU accounts for the emissions generated during industrial processes, such as the use of fossil fuels as raw material for the fabrication of products, as well as other processes in the production of ammonia, cement, glass, etc. As for the use of products, these emissions are considered mostly from the use of lubricants, greases, paraffins, and the use of nitrous oxide gas (N_2O) in industry and hospitals.

Graph 9. GHG Emissions (tCO_2e) for IPPU classified by subsector

It is important to clarify that the emissions from the industry occur both in consumption and in the generation of energy, heat, and work, as well as in the productive processes themselves, however the emissions related to consumption and generation of energy, heat or work are considered specifically in the Stationary Energy sector.

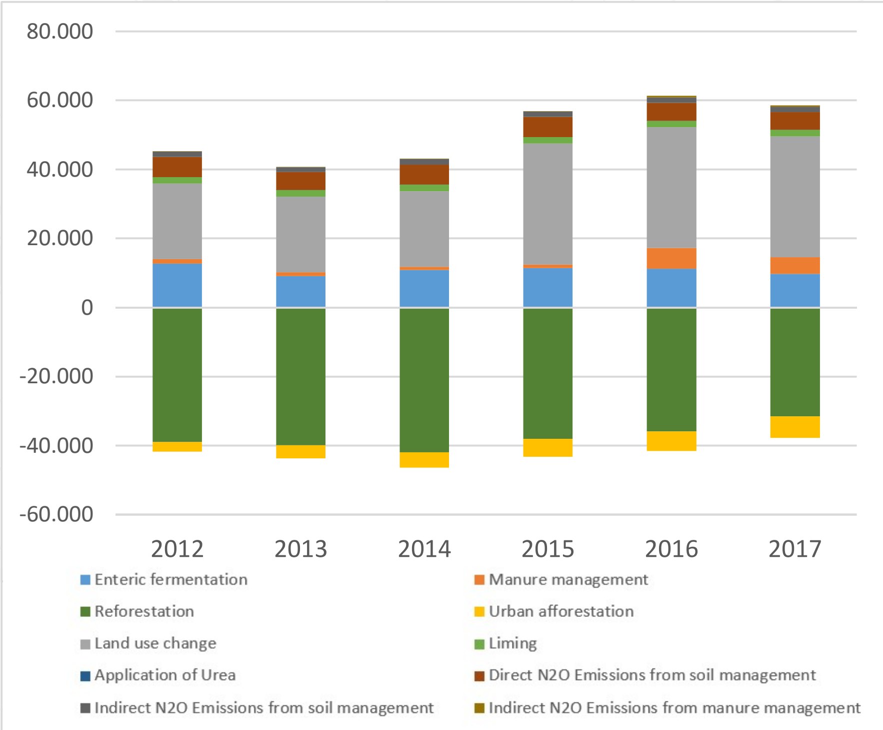
Amongst the typologies of industries with emissions in the municipal territory the only ones identified were steel and glass industries. All emissions under this sector are reported on scope 1.

Agriculture, Forestry and Other Land Use - AFOLU

In AFOLU the emissions are accounted due to changes in the use of soil, including the loss and gain of vegetal cover, through deforestation or reforestation and natural regeneration. Emission activities related to agriculture and livestock are also considered. All emissions under this sector are reported on scope 1.

On this category, there are subsectors with the removal of CO_2 (negative values shown in the graph below), which correspond to tree planting, be it by reforestation or urban afforestation. These actions compensated the emissions of land use variations during all years in the historic series, and in 2013-14 the total value of emissions of this sector was negative.

Gráfico 10. Emissões de GEE (tCO_2e) de AFOLU classificadas por subsetores

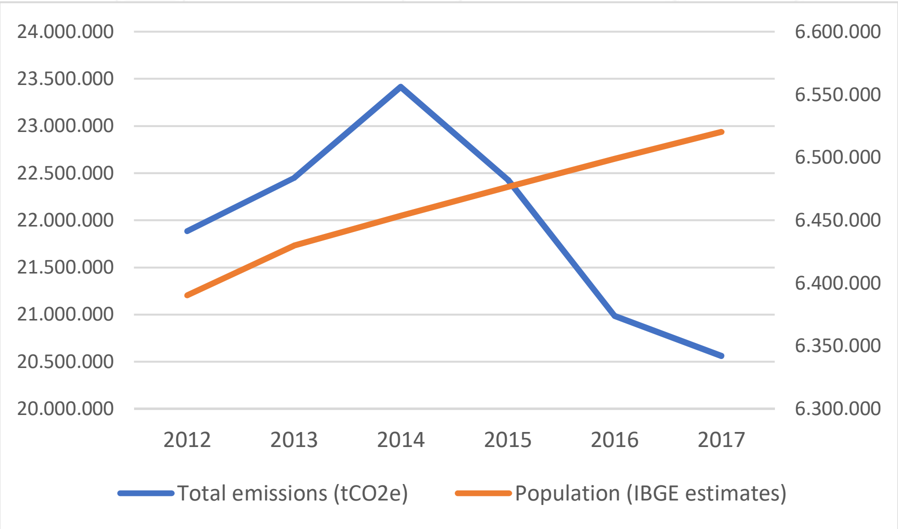


Conclusions

The trajectory of GHG emissions in the city of Rio de Janeiro from 2012 to 2017 presents a picture of stability, with fluctuations influenced by external and internal factors and by the municipal administration. A more detailed analysis of the results is being produced and will be part of a Technical Report that will be launched in the beginning of the second semester of 2019.

It is important to note that, despite the populational growth, the city's emission curve does not follow necessarily the same trajectory, as shown in the graph below. It is possible to dissociate the emissions trajectory and the rising trend of populational growth and municipal GDP.

Graph 11. Total GHG Emissions and the Population of Residents in the city



A significant indicator that is commonly used to compare GHG emissions between cities of different sizes is emissions per capita. The following table compares emissions per capita from Rio de Janeiro with other cities that have developed inventories according to GPC methodology, and mentions contextual information regarding the reporting level and year of reference.

Table 4. Emissions per capita in different cities

CITY	EMISSIONS PER CAPITA (tCO_2e/per capita)	YEAR OF REFERENCE
Rio de Janeiro (Basic+)	3,2	2017
Belo Horizonte (Basic)	2,1	2015
Curitiba (Basic+)	2,5	2013
Fortaleza (Basic)	2,0	2014
Buenos Aires (Basic+)	4,5	2015
Mexico City (Basic+)	4,6	2016
Medellin (Basic)	3,5	2015
London (Basic+)	4,2	2015
Paris (Basic+)	3,5	2014
New York (Basic)	6,1	2016
Seoul (Basic+)	4,5	2015
Hong Kong (Basic+)	5,6	2015
Lagos (Basic+)	1,5	2015
Amman (Basic)	2,2	2016
Tel-Aviv (Basic)	6,1	2017

Source: elaborated by the authors based on the Carbon Disclosure Project (CDP)

This product will initiate a routine of annual updating of the GHG emission inventories in the city. This will allow the creation of a robust historic series that will enhance the knowledge and the elaboration of additional studies on the impact of mitigation projects on climate change, as well as the construction of emission scenarios.

Different aggregations and disaggregations of results are possible depending on the aspect that one pretends to analyze. Thus, this project does not intend to exhaust the possibilities of analyses, but enrich the knowledge and promote the debate about the management of GHG emissions in the city of Rio de Janeiro.

Annex 1

GHG Emissions (tCO2e) of the City of Rio de Janeiro classified by subsector and scope, 2012 to 2017

	2012				2013				2014				2015				2016				2017			
	Scope 1	Scope 2	Scope 3	Total	Scope 1	Scope 2	Scope 3	Total	Scope 1	Scope 2	Scope 3	Total	Scope 1	Scope 2	Scope 3	Total	Scope 1	Scope 2	Scope 3	Total	Scope 1	Scope 2	Scope 3	Total
Stationary Energy	5.539.818	1.380.538	170.519	**7.090.875**	5.891.607	2.014.985	235.442	**8.142.034**	5.782.478	2.961.528	373.672	**9.117.677**	5.618.761	2.634.933	331.238	**8.584.932**	5.384.700	1.694.811	205.528	**7.285.039**	5.211.224	1.900.982	210.787	**7.322.993**
Residential	623.619	373.297	58.407	**1.055.323**	621.185	552.701	79.552	**1.253.438**	615.671	833.953	130.487	**1.580.111**	606.678	746.318	115.678	**1.468.674**	631.385	482.001	71.935	**1.185.321**	632.453	562.842	76.824	**1.272.120**
Commercial and Institutional	273.857	562.071	87.338	**923.266**	262.763	858.440	122.851	**1.244.054**	247.100	1.253.008	194.736	**1.694.843**	249.882	1.153.126	177.390	**1.580.398**	240.781	742.090	109.834	**1.092.705**	239.405	817.683	110.426	**1.167.513**
Manufacturing and Construction Industries	4.431.369	157.573	24.654	**4.613.596**	4.879.599	228.647	32.910	**5.141.156**	4.774.275	307.248	48.075	**5.129.598**	4.604.312	244.042	37.826	**4.886.180**	4.351.292	157.846	23.557	**4.532.696**	4.179.672	170.899	23.327	**4.373.898**
Energy Industries (Refinary, UTEs, etc)	36.976	606	95	**37.677**	19.079	189	27	**19.295**	22.885	37	6	**22.928**	21.438	15	2	**21.455**	17.591	74	11	**17.676**	20.789	108	15	**20.912**
Farming	63	165	26	**253**	0	703	101	**804**	0	2.357	369	**2.725**	0	2.206	342	**2.548**	1	1.278	191	**1.469**	0	1.437	196	**1.634**
Commercial loss from electric energy + others	29.664	286.825	0	**316.489**	6.665	374.306	0	**380.971**	2.853	564.924	0	**567.778**	1.208	489.226	0	**490.435**	12.559	311.522	0	**324.082**	1.043	348.013	0	**349.056**
Fugitive Emissions from the oil and gas sector	144.271			**144.271**	102.316			**102.316**	119.694			**119.694**	135.243			**135.243**	131.091			**131.091**	137.861			**137.861**
Transports	7.079.178	17.053	1.650.938	**8.747.170**	6.763.323	31.058	1.668.173	**8.462.554**	6.658.248	47.056	1.542.540	**8.247.844**	6.560.237	43.056	1.466.177	**8.069.471**	6.238.120	29.717	1.448.926	**7.716.763**	6.019.406	33.346	1.319.210	**7.371.963**
On-road	5.385.383	0	0	**5.385.383**	5.198.232	0	0	**5.198.232**	5.083.949	0	0	**5.083.949**	5.021.792	0	0	**5.021.792**	4.800.764	0	0	**4.800.764**	4.632.390	0	0	**4.632.390**
Rail	3.675	17.053	4.178	**24.907**	3.936	31.058	6.047	**41.041**	4.437	47.056	9.994	**61.487**	4.662	43.056	9.302	**57.021**	5.016	29.717	5.937	**40.671**	4.601	33.346	6.478	**44.425**
Waterway	10.439	0	127.099	**137.538**	7.748	0	95.960	**103.708**	17.639	0	39.629	**57.268**	22.256	0	34.729	**56.985**	30.398	0	5.373	**35.771**	24.009	0	774	**24.783**
Aviation	1.679.680	0	1.519.661	**3.199.341**	1.553.408	0	1.566.165	**3.119.574**	1.552.222	0	1.492.918	**3.045.140**	1.511.528	0	1.422.145	**2.933.673**	1.401.942	0	1.437.616	**2.839.558**	1.358.407	0	1.311.958	**2.670.365**
Waste	**1.302.156**		**2.510.688**	**3.812.844**	**1.240.792**		**2.488.980**	**3.729.773**	**1.144.375**		**2.595.900**	**3.740.275**	**1.129.478**		**2.478.885**	**3.608.363**	**1.020.880**		**2.401.213**	**3.422.093**	**905.439**		**2.339.735**	**3.245.174**
Landfill	799.934		2.510.688	**3.310.622**	765.008		2.488.980	**3.253.988**	684.695		2.595.900	**3.280.595**	677.557		2.478.885	**3.156.441**	555.804		2.401.213	**2.957.017**	468.300		2.339.735	**2.808.035**
Composting	618		0	**618**	318		0	**318**	494		0	**494**	2.067		0	**2.067**	771		0	**771**	228		0	**228**
Incineration	229		0	**229**	1.117		0	**1.117**	216		0	**216**	18		0	**18**	0		0	**0**	976		0	**976**
Sewage and Effluents	501.375		0	**501.375**	474.350		0	**474.350**	458.970		0	**458.970**	449.837		0	**449.837**	464.304		0	**464.304**	435.935		0	**435.935**
Industrial Processes and Product Use	**2.232.524**			**2.232.524**	**2.117.397**			**2.117.397**	**2.311.917**			**2.311.917**	**2.154.950**			**2.154.950**	**2.542.901**			**2.542.901**	**2.600.950**			**2.600.950**
Glass production	54.524			54.524	47.646			47.646	59.526			59.526	55.760			55.760	64.179			64.179	63.228			63.228
Iron and steel production	2.098.709			2.098.709	2.006.840			2.006.840	2.190.389			2.190.389	2.032.122			2.032.122	2.407.398			2.407.398	2.470.919			2.470.919
Use of lubricants and paraffins	23.018			23.018	23.461			23.461	23.793			23.793	25.529			25.529	27.752			27.752	23.773			23.773
Use of nitrous oxide	56.273			56.273	39.449			39.449	38.208			38.208	41.539			41.539	43.572			43.572	43.030			43.030
Agriculture, Forestry, and Other Land Use	**3.599**			**3.599**	**-2.886**			**-2.886**	**-3.346**			**-3.346**	**13.682**			**13.682**	**19.729**			**19.729**	**20.821**			**20.821**
Enteric fermentation	12.726			12.726	9.093			9.093	10.826			10.826	11.425			11.425	11.195			11.195	9.766			9.766
Manure management	1.313			1.313	1.083			1.083	993			993	1.055			1.055	6.052			6.052	4.777			4.777
Reforestation	-39.009			-39.009	-39.941			-39.941	-41.949			-41.949	-38.008			-38.008	-35.935			-35.935	-31.519			-31.519
Urban afforestation	-2.707			-2.707	-3.732			-3.732	-4.480			-4.480	-5.214			-5.214	-5.674			-5.674	-6.211			-6.211
Land use change	21.913			21.913	21.913			21.913	21.913			21.913	34.995			34.995	34.995			34.995	34.995			34.995
Liming	1.786			1.786	1.931			1.931	1.923			1.923	1.918			1.918	1.875			1.875	1.924			1.924
Application of Urea	22			22	23			23	23			23	23			23	22			22	22			22
Direct N2O Emissions from soil management	5.858			5.858	5.253			5.253	5.736			5.736	5.794			5.794	5.124			5.124	5.097			5.097
Indirect N2O Emissions from soil management	1.562			1.562	1.387			1.387	1.603			1.603	1.622			1.622	1.579			1.579	1.577			1.577
Indirect N2O Emissions from manure management	134			134	104			104	67			67	72			72	498			498	393			393
TOTAL	**16.157.274**	**1.397.591**	**4.332.145**	**21.887.010**	**16.010.232**	**2.046.043**	**4.392.595**	**22.448.871**	**15.893.671**	**3.008.584**	**4.512.112**	**23.414.367**	**15.477.108**	**2.677.990**	**4.276.300**	**22.431.397**	**15.206.330**	**1.724.528**	**4.055.667**	**20.986.525**	**14.757.840**	**1.934.328**	**3.869.733**	**20.561.901**
Generation of energy exported to the SIN	4.055.705			**4.055.705**	4.539.298			**4.539.298**	5.318.967			**5.318.967**	5.624.714			**5.624.714**	5.211.721			**5.211.721**	5.774.783			**5.774.783**

Emission sources required for Basic inventories
Additional Emission sources required for Basic+ inventories
Non-Applicable or non-requested emission sources for Basic+ inventories
Emission sources not added for Basic+ inventories, but reported under the territorial perspective

Annex 2

Review log

Version 0.0 - Prior to publication, revised by the C40 Cities Climate Leadership Group for validation of GPC methodology requirements, including the specific obligations of the Basic + reporting level. New estimates have been added for some sources and the entire inventory series has been certified as Basic +.

Version 1.0 - Published only in Portuguese on the release date, 06/26/2019, with the revisions mentioned above.

Version 1.1 (current) - Published on 07/11/2019, after revision of the allocation of part of the emissions of the Stationary Energy sector, subsector Manufacturing and construction industries. Sub-sector, sector and total emissions decreased. This revision is justified by a change in the understanding of the place of consumption of the electric energy generated in a industry located within the municipality: there is a greater amount of this energy being exported to the SIN and a smaller quantity being consumed within the borders of the municipality. For greater transparency, the emissions resulting from the generation of electric energy within the municipality and exported to the SIN were added in the table in Annex 1.