FOURTH BIENNIAL UPDATE REPORT OF BRAZIL

TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

Ministry of Foreign Affairs
Ministry of Science, Technology and Innovations

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FEDERATIVE REPUBLIC OF BRAZIL

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Secretariat for Sovereignty and Citizenship Affairs
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NATIONAL CIRCUMSTANCES AND INSTITUTIONAL ARRANGEMENTS

1 NATIONAL CIRCUMSTANCES AND INSTITUTIONAL ARRANGEMENTS

1.1 NATIONAL CIRCUMSTANCES

Country Profile

Brazil is a developing country endowed with extensive land and sea areas. With a population of approximately 212 million inhabitants and a territory of 8,510,295.914 km^2, the country has undergone intense urbanization over the past 50 years and 84% of its population currently lives in urban areas.

Population and urban growth brought the challenge of striking a balance between economic development, environmental conservation, and social inclusion. To this end, Brazil has been making efforts on the sustainability front, and, thanks to investments in research and innovation, has succeeded in expanding its industrial and agricultural production while preserving the environment and fighting poverty, which are pillars of sustainable development. Investments in agricultural production helped Brazil move from a food importing country suffering from severe food insecurity in the 1970s to the second largest food exporter in the world, a major guarantor of food security at the global level.

Brazil has set a global benchmark in sustainable agriculture by establishing a holistic approach to the landscape, adopting sustainable practices in lands that are suitable for farming, and encouraging the environmental regularization of rural properties. The Brazilian Forest Code is one of the most advanced pieces of environmental legislation in the world. The law establishes that at least 80% of the area of rural properties in the Amazon must be allocated to conservation and sustainable use of natural resources, meaning that rural producers are allowed to use a maximum of 20% of the land in their properties. In the Cerrado, this percentage is 35% and 20% in the remaining biomes.

The Brazilian agricultural sector accounted for approximately 21% of the country's total GDP in 2018, with exports reaching a nominal record of US$101.7 billion, an increase of 5.9% compared to 2017 (Cepea[1], 2018), of a total value of the national agricultural production of 343.5 billion BRL, an increase of 8.3% compared to 2017. This corresponds to 227.5 million tons of grains (cereals, pulses and oilseeds), in addition to other agricultural commodities (IBGE 2018[2]).

In addition to its relevance in the GDP, according to Cepea, this sector is fundamental for the balance of trade – it accounts for more than 40% of total exports. The sector accounts for 20% of all existing jobs in Brazil, i.e., 18.2 million workers. It should be pointed out that 45% of workers in this sector work in primary production. According to the Agricultural Census, there are five million Brazilian families involved in the production of food, fiber and power. This clearly reflects the importance of sustainability in its three pillars – environmental, economic and social.

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[1] *Cepea, 2018. Centro de Estudos Avançados em Economia Aplicada da ESALQ/USP. Available in:<https://www.cepea.esalq.usp.br>. Accessed on: 12 December 2018.*

[2] *IBGE, 2018. Produção Agrícola Municipal - PAM1, referentes ao ano civil de 2018. Available in: <https://biblioteca.ibge.gov.br/visualizacao/periodicos/66/pam_2018_v45_br_informativo.pdf> and <https://www.ibge.gov.br/estatisticas-novoportal/economicas/agricultura-e-pecuaria/9117-producao-agricola-municipal-culturas-temporarias-e-permanentes.html>*

By fostering research and technological development for a sustainable tropical agriculture, the Country's strategies have boosted yields per hectare on a par with economic and demographic growth. Adoption of these technologies by rural producers has allowed a steadier supply of food throughout the year, thus ensuring more stable prices for consumers, in addition to higher quality food. In a world of increasing climate uncertainty, Brazil is implementing strategies to ensure national and global food security.

With low greenhouse gas emissions levels, the diversified Brazilian industrial sector also follows sustainable principles, with an increasing share of renewable energies in its energy mix. In 2019, more than half (58%) of the energy consumed in the industrial sector came from renewable sources.

Brazil has the cleanest energy mix and electricity mix among the largest global consumers. The Domestic Energy Supply (OIE for its acronym in Portuguese) in 2019 was 294 million toe (tons of oil equivalent), slightly higher than in 2018, which was 288.4 million toe. A breakdown of the energy mix for 2018 and 2019 shows a significant increase in the renewable sources share, from 45.5% in 2018 to 46.1% in 2019. This accounts for a 2.8% increase in the supply from renewable sources compared to the previous year, compared to a 0.3% increase in non-renewable sources during the same period.

Brazil's share of renewables in its energy mix is currently 4.3 times larger than the average in OECD countries and 3.3 times larger than the average for the rest of the world. A study conducted by the International Energy Agency[3] revealed that Brazil would reach 44.3% of renewable energies in its energy mix by 2023, but the country exceeded that share as early as in 2018.

Regarding the generation of electric energy, in 2018-2019 wind energy supply increased by 15.5% and hydro generation rose by 2.3%. Photovoltaic solar generation deserves special notice, since it reported a significant increase of 92% in this period. Therefore, the country's electricity mix remains primarily based on renewable sources, with the prospect of increasing its share over the next few years given the growing competitiveness of wind and solar sources. Brazil has a share of 83% of renewable sources in its electricity mix, i.e., 2.9 times larger than the average in OECD countries and almost 3.1 times larger than the average for the rest of the world.

As far as bioenergy is concerned, the total supply in 2019 was 93.9 Mtoe, which accounts for 31.9% of the Brazilian energy mix and represents an increase compared to 2018, which was 31.4%. In the transportation sector, a highlight is the increased share of ethanol in the light vehicle segment. In 2019, ethanol production was 35.2 million m^3, up 5.6% over 2018. Biodiesel production in 2019 increased by 10.7% over 2018, thus confirming the growth trend of previous years.

The country has also made progress in national development priorities. There is an incremental improvement in indicators related to access to health, basic sanitation, fighting hunger, poverty, and income inequality. Its improvement is also due to better living conditions and household income as a result of effective social programs. In order to make this a sustained improvement, however, the government is working towards bolstering the production sector and, as a result, creating more jobs and boosting living standards, such as an emphasis on improving urban environmental conditions, with an increase in basic sanitation and proper treatment of solid waste.

[3] https://www.iea.org/reports/renewables-2018

TABLE I: RELEVANT INFORMATION ABOUT BRAZIL[4]

Standard	Characteristic
Territory	Total area of 8,510,295.914 km²; divided into five political-administrative regions – North, Northeast, Midwest, South and Southeast; composed of 26 states and the Federal District.
Population	211.9 million people.
Climate	Five climatic regions: Equatorial (North), Tropical (most of the territory), Semi-arid (Northeast), Tropical of Altitude (Southeast), and Subtropical (South).
Biodiversity	Six biomes[5]: Amazon (49.5%), Cerrado (23.3%), Atlantic Forest (13%), Caatinga (10.1%), Pantanal Wetlands (1.8%), and Pampa (2.3%).
Native vegetation cover	The country has 84% of the Amazon and 60% of the territory preserved.
Protected Areas	Protected areas account for 30.68% of the territory, including Conservation Units (18.1%) and Indigenous Lands (12.48%), in addition to Conservation Units in marine areas (26.62%). The country has over 2,000 terrestrial conservation units, which corresponds to nearly 18% of the Brazilian territory.
Water resources	The country has approximately 12% of the world's surface fresh water. Twelve river basins provide abundant water resources; however, they are unevenly distributed throughout the territory. Currently, the primary use of water in the country is irrigation (in terms of utilized volumes), with more than 900 m³/s.
Energy mix	The percentage of renewable sources in the Brazilian Energy Mix in 2019 was 46.1%, a significantly higher share than the average in OECD countries (10.8%) and the world (14.2%). In the electricity mix, renewable sources accounted for 83% of energy sources for electricity generation in 2019, with the average of OECD countries in 2019 at 28.5% and the world average at 26.7%.

TABLE II: SOCIOECONOMIC INDICATORS IN BRAZIL

Socioeconomic indicators[6]	2000	2010	2013	2015	2016	2017	2018
GDP (in billions of BRL, current values)	1,199	3,886	5,332	5,996	6,267	6,554	6,828
GDP (in billions of USD, constant values from 2011)	1,993	2,861	3,123	3,028	2,928	2,959	2,992
GDP per capita (in thousands of BRL, current values)	6,860	19,855	26,521	29,323	30,399	31,534	32,595
GDP per capita (USD, constant values from 2011)	11,403	14,620	15,536	14,807	14,200	14,236	14,283
Human Development Index (HDI)	0.684	0.726	0.752	0.755	0.757	0.760	0.761
Gini Index (World Bank estimate)	59[(1)]	53.7[(1)]	52.8	51.9	53.3	53.3	53.9
Life expectancy at birth (years) [SDG 3]	70.1	73.6	74.5	75.0	75.2	75.5	75.7
Infant mortality rate (per 1,000 births) [SDG 3.2]	30.4	16.7	14.9	14	14.6	13.2	12.8
Percentage of the population living on less than US$1.9 per day (PPP[7] 2011)	13.4[(1)]	5.4[(1)]	3.1	3.2	3.9	4.4	4.4

[(1)] Data unavailable for the year; last year data repeated.

[4] Data from the Brazilian Institute of Geography and Statistics. Available from the portal < www.ibge.gov.br>. Accessed on: 15 May 2020.

[5] A Biome is defined as life (plant and animal life) comprised of clusters of contiguous and identifiable types of vegetation on a regional scale, with similar geoclimatic conditions and a shared history of changes, resulting in unique biological diversity. (IBGE, 2004). Biome distribution data available in: https://biblioteca.ibge.gov.br/visualizacao/livros/liv101676.pdf

[6] World Bank, 2020. World Bank Open Data. Available in: <https://data.worldbank.org/>. Accessed on: 15 May 2020.

[7] PPP – Purchasing Power Parity. Value outlined according to an assessment of the ideal cutoff line to capture the country's poverty in relation to the rest of the world, but also controlling for its level of development.

Policy Dimensions

The Brazilian Government has developed a set of regulatory frameworks and management instruments aimed at implementing the United Nations Framework Convention on Climate Change (UNFCCC) in the country. These instruments remain in force, and some have been improved since BUR3 was released.

The first such instrument is the National Policy on Climate Change (PNMC for its acronym in Portuguese), enacted through Law No. 12,187, of December 29, 2009[8], which established the legal framework for fighting climate change in Brazil until 2020. It formalized a voluntary national commitment for Nationally Appropriate Mitigation Actions (NAMAs) presented at the Copenhagen Conference (COP-15). NAMAs and PNMC actions have been the main focus of BUR publications so far. Their main features and components can be found in Table III. Decree No. 10,145[9] , of November 2019, established the new climate governance framework, and provides for the Interministerial Committee on Climate Change, which improves the government's coordination of climate affairs.

TABLE III: MAIN ELEMENTS OF THE NATIONAL POLICY ON CLIMATE CHANGE (PNMC)

Legal Framework	Law No. 12,187/2009.
Goals	To promote sustainable development while protecting the climate system; to reduce greenhouse gas emissions from different sources, as well as to strengthen removals of these gases by sinks; to implement measures to adapt to climate change; to preserve, conserve and recover natural resources; to consolidate and expand legally protected areas; and to foster the development of a Brazilian Emissions Reduction Market. The objectives of the National Policy on Climate Change must be in line with sustainable development in order to pursue economic growth, eradication of poverty, and reduction of social inequalities.
National Voluntary Commitment	Expected reduction of greenhouse gas emissions ranging from 36.1% to 38.9% expected for 2020 (BAU - Business As Usual).
Instruments	Instruments under the PNMC include the National Plan on Climate Change; the National Fund on Climate Change; the Action Plans for the Prevention and Control of Deforestation – Amazon, Cerrado; Plans for Mitigation and Adaptation in Agriculture, Energy, and Charcoal, as well as Brazil's National Communication to the UNFCCC. Policy instruments also include, but are not limited to, resolutions of the Interministerial Committee on Climate Change (CIM), fiscal and tax measures, credit and financing facilities, research programs by development agencies, and financial and economic measures related to mitigation and adaptation to climate change.
Regulation	Decree No. 7,390/2010, which sets forth the expected emissions for 2020, and the National Voluntary Sector-Specific Commitment - revoked by Decree No. 9,578/2018.
Governance and institutional arrangements	The institutional instruments, within the governmental scope, are the Interministerial Committee on Climate Change (CIM for its acronym in Portuguese) and the Commission for the Coordination of Meteorology, Climatology and Hydrology Activities (CMCH for its acronym in Portuguese). The current governance of the CIM is provided for by Decree No. 10,145, of November 28, 2019, which establishes, among others, its jurisdiction and composition. The CIM functions on a standing basis and is intended to establish guidelines, design and coordinate public actions and climate change policies. The CIM's deliberative body – the Board of Ministers – is comprised of 9 Ministers of State: I - Chief of Staff of the Presidency of the Republic, who will act as the chair of the Committee; II - Minister of Foreign Affairs; III - Minister of the Economy; IV - Minister of Agriculture, Livestock and Food Supply; V - Minister of Regional Development; VI - Minister of Mines and Energy; VII - Minister of Science, Technology and Innovations; VIII - Minister of the Environment; and IX - Minister of Infrastructure. At the civil society level, the Brazilian Forum on Climate Change (FBMC) and the Brazilian Research Network on Global Climate Change (Rede CLIMA) are also institutional instruments to assist in the implementation of the Convention.

[8] *Source: http://www.planalto.gov.br/ccivil_03/_Ato2007-2010/2009/Lei/L12187.htm*

[9] *Available in: <http://www.planalto.gov.br/ccivil_03/_ato2019-2022/2019/decreto/D10145.htm >*

As the implementation of NAMAs is still ongoing, it should be noted that in September 2016 the country deposited the instrument of ratification of the Paris Agreement, in addition to ratifying the Doha Amendment to the Kyoto Protocol in December 2017. BUR3 provides details on the Nationally Determined Contribution (NDC)[10] which was submitted to the UNFCCC on September 21, 2016.

1.2 INSTITUTIONAL ARRANGEMENTS

To prepare the National Communications of Brazil (NC) on a permanent basis, the General Coordination of Climate Science and Sustainability (CGCL) of the Ministry of Science, Technology and Innovations (MCTI) coordinates the project, whose main objective is to assist the Brazilian Government to develop transparency reports to the UNFCCC. Therefore, the CGCL is responsible for preparing Brazil's National Communications.

National Communication projects were funded through international resources from the Global Environment Facility (GEF), and are supported by the United Nations Development Programme (UNDP) through its role as implementing agency, and rely on the endorsement of the Brazilian Cooperation Agency (ABC).

The NC brings together the inputs of hundreds of national experts from numerous public and private institutions, such as universities, research institutes and bodies, businesses and trade associations that contribute with data directly and perform analyzes. In addition to these, other institutions were indirectly involved – they provided official national data on public platforms. Above all, there is relevant academic engagement from the Brazilian Research Network on Global Climate Change (Rede CLIMA), in collaboration with other researchers who are members of various research groups, with which institutional partnerships are established in order to upgrade and/or improve relevant methodologies, in particular the National GHG Inventory. Advances in the submission and breakdown of information within the scope of the NC have been planned, with a view to incorporating the best available science on an ongoing basis and updating data that will show the sustainability features and the low carbon history of the Brazilian production sector.

The quality assurance and quality control plan (QA/QC) of the National GHG Inventory is established in the initial planning stage of the NC's activities. The project's team of experts performs quality control (QC) of the methodological approach. Quality assurance (QA) includes a public consultation process that is open to anyone, as well as experts not directly involved in the efforts in order to collect insights to improve the results achieved.

In addition, with the mission of helping establish an interface between the Brazilian Government and the UNFCCC, the Environment Division II of the Ministry of Foreign Affairs (MRE) acts as a National Focal Point, so it is responsible for the official submission of National Communications to the Climate Convention. Additionally, the MRE is responsible for the interministerial coordination of the BURs with the support of a task-force that includes members from the Ministry of Science, Technology and Innovations (MCTI); Ministry of the Environment (MMA); Ministry of Agriculture, Livestock and Food Supply (MAPA); Ministry of Mines and Energy (MME), and Ministry of the Economy (ME); as well as the Brazilian Agricultural Research Corporation (Embrapa) and the Brazilian Cooperation Agency (ABC). These institutions work on developing the document, including the provision of updated information in order to comply with the transparency requirements in the BUR pursuant to national capacities.

Since the submission of the first Biennial Update Report to the UNFCCC in December 2014, Brazil has submitted technical annexes on REDD+, which reflect the level of forest emission reductions from deforestation. Such technical submissions regarding Decision 14/CP.19 are prepared by the MMA, which acts as a focal point for REDD+ with the UNFCCC.

[10] *Available in: <https://www4.unfccc.int/sites/NDCStaging/pages/Party.aspx?party=BRA>. Accessed on: 15 May 2020.*

2

NATIONAL INVENTORY OF ANTHROPOGENIC EMISSIONS BY SOURCES AND REMOVAL BY SINKS OF GREENHOUSE GASES NOT CONTROLLED BY THE MONTREAL PROTOCOL

2 NATIONAL INVENTORY OF ANTHROPOGENIC EMISSIONS BY SOURCES AND REMOVAL BY SINKS OF GREENHOUSE GASES NOT CONTROLLED BY THE MONTREAL PROTOCOL

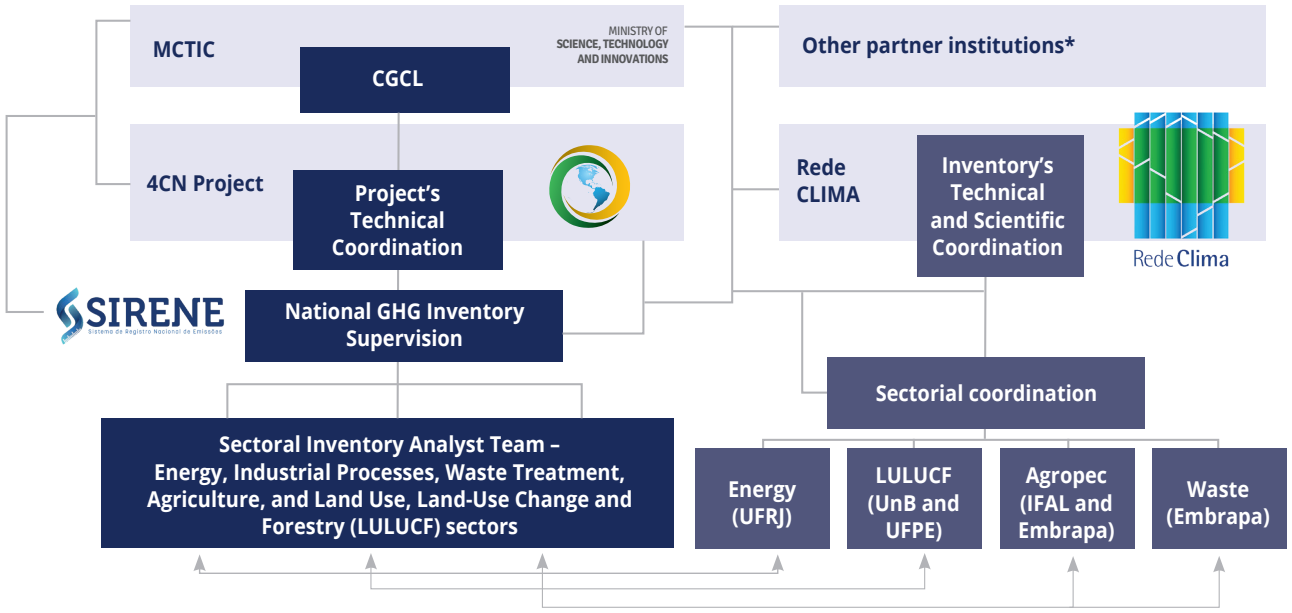
General Aspects

This section presents the historical time series of emissions of the National Inventory of Anthropogenic Emissions by Sources and Removals by Sinks of Greenhouse Gases (GHG) not Controlled by the Montreal Protocol in this BUR, from 1990 to 2016.

This inventory is organized according to the structure suggested by the Intergovernmental Panel on Climate Change (IPCC), and covers the following sectors: Energy; Industrial Processes; Agriculture; Land Use, Land-Use Change and Forestry (LULUCF); and Waste. GHG removals occur in the LULUCF sector as a result of reforestation, growth of secondary vegetation, and protection of natural vegetation, which continue to incorporate carbon in its biomass.

Institutional Arrangements

Preparation of the National GHG Inventory involved significant participation of the Brazilian scientific and business communities, in addition to various government agencies. The Ministry of Science, Technology and Innovations (MCTI) coordinates the preparation of the National Inventory, and is responsible for convening different working groups that help survey sectoral information and to conduct studies to obtain country-specific emission factors (Figure I). The MCTI establishes formal partnerships with various institutions, and also seeks to engage government agencies responsible for official statistics and data. After establishing these partnerships, the technical team in charge of preparing the inventory conducts technical discussions with the partners, monitors the updating and availability of required information, and carries out quality control.



*** Other institutions involved in the preparation of the Inventory**

National Civil Aviation Agency – ANAC
National Terrestrial Transport Agency - ANTT
National Association of Automobile Manufacturers - ANFAVEA
National Agency of Petroleum, Natural Gas and Biofuels – ANP
Beneficient Association of the state of Santa Catarina Coal Industry – SATC
Brazilian Association of Chemical Industry – ABIQUIM
Brazilian UHT Milk Association - ABLV
Brazilian Aluminium Association – ABAL
Brazilian Food Industry Association - ABIA
Brazilian Association of Pork Producers and Exporters - ABIPECS
Brazilian Association of Dairy Cattle Breeders
Brazilian Association of Brown Swiss Cattle Breeders
Brazilian Association of Public Cleaning and Special Waste Companies – ABRELPE
Brazilian Association of Solid Waste Treatment Companies - ABETRE
Brazilian Coal Association - ABCM
Brazilian Association of Holstein Cattle Breeders
Brazilian Association of Motorcycle, Motorbike, and Bicycle Manufacturers ABRACICLO
Brazilian Association of Agricultural Limestone Producers – ABRACAL
Swine Breeding Association of the state of Santa Catarina – ACCS
Swine Breeding Association of Western Paraná
National Association for Fertilizer Diffusion - ANDA
Swine Breeding Association of the state of São Paulo
Swine Breeding Association of the state of Minas Gerains – ASEMG
Clean Coal Technology Center - CTCL
National Supply Company - CONAB
National Steel Company – CSN
National Beef Cattle Council – CNPC
National Department of Mineral Production – DNPM Rio Grande do Sul and Santa Catarina Chapters
Mining Companies of the states of Paraná, Rio Grande do Sul and Santa Catarina
Brazil's National Confederation of Agriculture and Livestock - CNA
Agricultural Research Corporation of the state of Minas Gerais - EPAMIG
Company of Agriculture Research and Rural Extension of the state of Santa Catarina - EPAGRI
Energy Research Company – EPE
Brazil Steel Institute - IABr and affiliates
Brazilian Tree Industry - Ibá
Brazilian Institute of Geography and Statistics - IBGE
Brazilian Institute of the Steel Industry - IBS
Institute of Agricultural and Forest Management and Certification - Imaflora
Zootechnical Institute – APTA
Rio Grande do Sul Rice Institute
P&D Consultoria Empresarial Ltda.
Petrobras
Rima Industrial S.A.
State of Santa Catarina Coal Producers Union - SIECESC
National Cement Industry Union - SNIC
Brazilian Sugarcane Industry Association - UNICA
White Martins
Brazilian Agricultural Research Corporation - Embrapa

Figure I: Institutional arrangements for the preparation of national inventories.

The Brazilian Research Network on Global Climate Change (Rede CLIMA), established by the MCTI had a significant participation in the academic and research contribution to update activity data, parameters and emission factors in the National Inventory. Rede CLIMA contributes by presenting the best available science in support of sectoral studies through experts from different thematic sub-networks from universities and research bodies such as: the Federal University of Rio de Janeiro, which coordinates the updating of data and parameters for the Energy sector; the University of Brasilia for the Land Use, Land-Use Change and Forestry sector; the Federal Institute of Alagoas, for the Agriculture sector; and the Brazilian Agricultural Research Corporation and its several research units, which contribute to the Agriculture and Waste Treatment sectors; among other universities and partner institutions that support updating, publishing and validation of sectoral information.

Quality Control and Quality Assurance

To comply with the good practices requirements for quality control (QC) recommended by the IPCC, the methodology, activity data, parameters, emission factors, and calculations were reviewed by the project team. To this end, validation procedures and activities were established as per the progress of activities until sectoral reference reports were prepared.

The quality assurance (QA) process first consisted of making reports available for public consultation to experts not directly involved in the preparation of the National GHG Inventory. In addition, sectoral reference reports and spreadsheets were made available, including an update of the 2011-2016 historical time series for technical validation by experts in the individual sectors. The resulting comments, suggestions, recommendations, and remarks were captured, replied and incorporated, when relevant.

Archiving and Disclosure

Brazil's national inventories are organized and archived as a set of spreadsheets, in addition to metadata used throughout the process, ranging from scientific articles to the spatial database used in the LULUCF sector, and are stored in the MCTI's institutional network. As reported in BUR3, the sectoral reference reports, which transparently capture methodological details, are also archived with the MCTI and are made publicly available on the website of the National Emissions Registry System (SIRENE). As described in the previous BUR, SIRENE provides security and transparency to the preparation of the National GHG Inventories, and also makes available the results of national emissions.

2.1 METHODOLOGY

The National GHG Emissions Inventory is prepared in accordance with the guidelines for the elaboration of the National Communications of Parties not included in Annex I to the Convention, adopted by decision 17/CP.8.

The methodological approaches and guidance used in the National GHG Inventory were based on the "Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories" (IPCC, 1997); "Good Practice Guidance for Land Use, Land-Use Change and Forestry" (GPG LULUCF, 2003) and "Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories" (GPG, 2000). Some of the estimates already take into account information published in the "2006 IPCC Guidelines for National Greenhouse Gas Inventories" (IPCC,2006).

In some relevant sectors for Brazil, such as Agriculture and Land Use, Land-Use Change and Forestry, no methodologies can be readily applied, given that the emission factors and parameters recommended by the IPCC largely reflect temperate climate developed countries circumstances, not necessarily adequate to Brazilian national characteristics. Brazil has characteristics that are not yet fully mapped and that need to be studied in more detail: its forest cover, agricultural sector and cattle herd are areas where methodological inadequacies will be significantly amplified. Characterization of the vegetation in terms of carbon content, CO_2 removals driven by this vegetation, the special conditions of fertilization used in agriculture, and the accurate description of conditions for raising cattle are some examples of what requires extensive and in-depth research. For the Third

National GHG Inventory, a great effort was made to obtain information corresponding to domestic circumstances, in addition to seeking to use more detailed IPCC methodologies in order to obtain more accurate estimates.

The methodological references employed to obtain a data set for activity data, emission factors, and assumptions adopted for the preparation of this BUR were the same as those stated in Brazil's Third National Communication (TCN, for its acronym in Portuguese). Detailed information for the Energy; Industrial Processes; Agriculture; Land Use, Land-Use Change and Forestry (LULUCF); and Waste Treatment sectors are available in Volume III of the TCN. In order to be able to update emissions beyond the last reported year, i.e., for 2011-2016, estimates were based on national official data from public platforms or yearbooks from different government or private bodies, in addition to information from industrial associations for activity data updates, while maintaining the same parameters and emission factors as those of the TCN. The main sources of information on activity data were the Brazilian Institute of Geography and Statistics (IBGE for its acronym in Portuguese), the Brazilian Agricultural Research Corporation (Embrapa for its acronym in Portuguese), the Energy Research Office (EPE for its acronym in Portuguese), and the National Institute for Space Research (INPE for its acronym in Portuguese). For methodological details, see Appendix II: Methodological summary table applied to the National Inventory.

As set forth in paragraph 12 of Decision 17/CP.8, to the extent possible, the key categories are analyzed to identify the subsectors that should be prioritized in terms of methodological refinement, taking into consideration its contribution to the total emissions result.

2.2 **UNCERTAINTY ANALYSIS**

Uncertainty analysis performed for this Inventory considered characteristics of the individual sectors, the data available and the resources applied in determining emission factors that were most appropriate to Brazilian circumstances.

The following tables present emissions uncertainties estimates for CO_2, CH_4 and N_2O, which account for 99.4% of emissions in the last year reported. The same criteria used for calculating uncertainties for the Third Inventory has been used for year 2016.

TABLE IV: UNCERTAINTIES ASSOCIATED WITH CO_2 EMISSIONS IN 2016

Sector	2016	
	Uncertainty (%)	Emissions (Gg CO_2)
Energy	3	399,798
Fuel combustion	3	382,293
Fugitive Emissions	25	17,505
Coal Mining	32	2,062
Extraction and Transportation of Oil and Natural Gas	28	15,443
Industrial Processes	3	78,094
Cement Production	4	22,415
Lime Production	10	6,392
Other uses of Limestone and Dolomite	21	1,367
Iron and Steel Production	6	37,133
Aluminum Production	6	1,321
Chemical Industry	7	2,952
Other Industries	4	6,514
Land Use, Land-Use Change and Forestry	32	268,962
Waste Treatment	57	231
TOTAL	**12**	**747,085**

TABLE V: UNCERTAINTIES ASSOCIATED WITH CH_4 EMISSIONS IN 2016

Sector	2016	
	Uncertainty (%)	Emissions (Gg CH_4)
Energy	49	604.9
Fuel Combustion	73	386.3
Fugitive Emissions	44	218.6
Coal Mining	73	56.8
Extraction and Transportation of Oil and Natural Gas	54	161.8
Industrial Processes	10	36.4
Iron and Steel Production	15	21.2
Other Metallurgical industries	15	3.3
Chemical Industry	17	11.9
Agriculture	31	13,087.1
Enteric Fermentation	34	11,822.9
Manure Management	38	630.9
Rice Cultivations	45	459.9
Burning of Crop Residues	32	173.4
Land Use, Land-Use Change and Forestry	72	672.0
Waste Treatment	16	2,868.5
Solid Waste	23	1,497.1
Wastewater	23	1,371.4
Industrial	30	817.4
Domestic	35	554.0
TOTAL	**24**	**17,268.9**

TABLE VI: UNCERTAINTIES ASSOCIATED WITH N_2O EMISSIONS IN 2016

Sector	2016	
	Uncertaint (%)	Emissions (Gg N_2O)
Energy	101	32.25
Industrial Processes	10	1.71
Chemical Industry	4	0.70
Metallurgical Industry	16	1.01
Agriculture	48	530.27
Manure Management	43	15.82
Agricultural Soils	50	509.95
Animals on Pasture	81	173.01
Other direct sources	56	141.04
Indirect Emissions	102	195.90
Burning of Crop Residues	51	4.50
Land Use, Land-Use Change and Forestry	101	25.14
Waste Treatment	15	7.79
TOTAL	**44**	**597.16**

TABLE VII: UNCERTAINTIES ASSOCIATED WITH EMISSIONS BY GAS, AND UNCERTAINTIES FROM THE TOTAL RESULT IN 2016

Gas	Emissions 2016	Uncertainty	GWP	Emissions 2016
	(Gg)	(%)		(Gg CO_2e)
CO_2	747,085	12	1	747,085
CH_4	17,269	24	21	362,647
N_2O	597	44	310	185,120
TOTAL		**11**		**1,294,852**

The following tables provide estimates of greenhouse gas emissions for the years 1994, 2000, 2010, 2012, 2015, and 2016, by type of gas and by sector, as suggested by Decision 17/CP.8 22. Since this decision allows so, Brazil chose not to estimate SO_2 emissions as they are not relevant for the country.

TABLE VIII: GREENHOUSE GAS EMISSIONS BY SOURCES FOR THE YEAR 1994, IN GIGAGRAM (Gg)

1994	Gg																
									PFCs		HFCs						
	CO_2 (gross emissions)	CO_2 (removals)	CO_2 (net emissions)	CH_4	N_2O	CO	NO_x	NMVOC	CF_4	C_2F_6	HFC-23	HFC-32_pot	HFC-125_pot	HFC-143a_pot	HFC-152a_pot	HFC-134a	SF_6
ENERGY	**193,669**		**193,669**	**489.5**	**14.83**	**8,974.6**	**1,806.4**	**1,025.5**									
Fuel Combustion	185,665		185,665	403.7	14.77	8,974.6	1,806.4	1,025.5									
Energy Subsector	23,841		23,841	24.4	3.41	1,292.7	258.6	293.9									
Public Service Power Plants	7,455		7,455	0.1	0.05	3.9	61.2	0.9									
Self-Producer Power Plants	2,839		2,839	0.8	0.16	39.3	16.4	0.6									
Charcoal Plants	NO		NO	13.8	1.84	918.5	2.3	275.6									
Other	13,547		13,547	9.7	1.36	331.0	178.7	16.8									
Industrial Subsector	39,443		39,443	17.7	2.97	837.7	159.5	31.7									
Iron and Steel	5,318		5,318	0.2	0.03	3.1	13.1	1.3									
Ferroalloys	105		105	0.0	0.00	0.1	0.2	0.0									
Chemical Industry	9,114		9,114	0.8	0.12	27.5	31.7	2.8									
Non-ferrous Metals	1,380		1,380	0.1	0.02	3.4	2.8	0.2									
Pulp and Paper	2,954		2,954	1.2	0.49	381.4	18.7	8.9									
Food and Beverages	3,642		3,642	9.9	1.69	178.1	39.2	9.4									
Cement	5,060		5,060	2.3	0.10	46.9	13.0	1.7									
Mining	3,216		3,216	0.2	0.03	7.1	9.4	0.8									
Textile	1,338		1,338	0.1	0.04	9.3	2.8	0.4									
Ceramics	2,529		2,529	2.1	0.28	128.5	13.3	3.9									
Other Industries	4,787		4,787	0.8	0.17	52.3	15.3	2.3									
Transport Subsector	91,283		91,283	75.1	4.57	5,534.6	1,208.2	477.5									
Civil Aviation	4,446		4,446	0.0	0.12	35.2	4.4	1.3									
Road Transportation	82,058		82,058	74.7	3.88	5,486.8	1,093.2	471.3									
Railways	1,242		1,242	0.1	0.48	4.2	20.8	1.8									
Domestic Water-borne Navigation	3,537		3,537	0.3	0.09	8.4	89.8	3.1									
Residential Subsector	15,239		15,239	269.4	2.85	1,218.4	27.4	182.8									
Agriculture Subsector	12,332		12,332	13.5	0.93	86.3	142.0	36.4									
Commercial Subsector	1,570		1,570	3.5	0.03	4.0	4.1	2.4									
Public Subsector	1,957		1,957	0.1	0.01	0.9	6.6	0.8									

1994	Gg																
	CO_2 (gross emissions)	CO_2 (removals)	CO_2 (net emissions)	CH_4	N_2O	CO	NO_x	NMVOC	PFCs		HFCs						SF_6
									CF_4	C_2F_6	HFC-23	HFC-32_pot	HFC-125_pot	HFC-143a_pot	HFC-152a_pot	HFC-134a	
Fugitive Emissions	8,004		8,004	85.8	0.06	-	-	-									
Coal Mining	1,348		1,348	42.4	NO	NO	NO	NO									
Oil and Natural Gas	6,656		6,656	43.4	0.06	NE	NE	NE									
INDUSTRIAL PROCESSES	**51,276**		**51,276**	**44.2**	**17.47**	**834.0**	**51.1**	**370.7**	**0.3231**	**0.0279**	**0.1566**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0685**	**0.0140**
Cement Production	10,086		10,086														
Lime Production	4,098		4,098														
Other uses of Limestone and Dolomite	1,480		1,480														
Other Uses of Soda Ash	187		187														
Ammonia Production	1,689		1,689														
Nitric Acid Production					2.01		0.6										
Adipic Acid Production					13.99	0.8	0.3										
Caprolactam Production					0.31												
Calcium Carbide Production	NO		NO														
Methanol Production	59		59	0.5													
Ethylene Production	4		4	5.7				2.7									
Vinyl Chloride Production	120		120					3.5									
Ethylene Oxide Production	85		85	0.3													
Acrylonitrile Production	18		18					0.1									
Carbon Black Production	406		406														
Phosphoric Acid Production	87		87														
Production of Other Chemicals				0.1				24.3									
Iron and Steel Production	29,152		29,152	32.8	1.04	708.1	29.8	20.7									
Ferroalloy Production	178		178	3.7	0.08	73.6	1.9	1.9									
Non-Ferrous Metals Production, except Aluminum	1,279		1,279	1.1	0.04	22.8	10.8	0.7									
Aluminum Production	1,955		1,955						0.3231	0.0279							
Magnesium Production																	0.0099
Pulp and Paper						28.7	7.7	19.0									
Food Production								140.9									
Beverage Production								156.9									
HCFC-22 Production											0.1566						
Use of HFCs, PFCs and SF_6												0.0000	0.0000	0.0000	0.0000	0.0685	0.0041
Non-Energetic Consumption other than that in Chemical Industries	393		393														

1994	Gg																	
	CO_2 (gross emissions)	CO_2 (removals)	CO_2 (net emissions)	CH_4	N_2O	CO	NO_x	NMVOC	PFCs		HFCs							SF_6
									CF_4	C_2F_6	HFC-23	HFC-32_pot	HFC-125_pot	HFC-143a_pot	HFC-152a_pot	HFC-134a		
SOLVENTS AND OTHER PRODUCT USES			-	-	-	-	-	55,789.8										
AGRICULTURE			-	9,880.1	334.66	3,908.1	106.2	-										
Enteric Fermentation			-	8,786.7	-	-	-	-										
Cattle				8,370.5														
Dairy Cattle				1,262.8														
Beef Cattle				7,107.7														
Other Animals				416.2														
Manure Management			-	457.9	11.21	-	-	-										
Cattle				204.6	3.04													
Dairy Cattle				37.6	1.24													
Beef Cattle				167.0	1.80													
Swine				169.4	2.48													
Poultry				61.3	5.39													
Other Animals				22.6	0.30													
Agricultural Soils			-		320.48	-	-	-										
Direct Emissions					201.60													
Animals on Pasture					137.50													
Cattle					116.02													
Other					21.48													
Synthetic Fertilizers					14.74													
Organic Fertilizers					15.87													
Cattle					4.97													
Other					10.90													
Crop Residues					18.94													
Soy Bean					6.07													
Sugarcane					1.15													
Beans					1.17													
Rice					1.21													
Corn					5.29													
Manioc					2.67													
Other					1.38													
Organic Soils					14.55													

1994	Gg																
	CO_2 (gross emissions)	CO_2 (removals)	CO_2 (net emissions)	CH_4	N_2O	CO	NO_x	NMVOC	PFCs		HFCs						SF_6
									CF_4	C_2F_6	HFC-23	HFC-32_pot	HFC-125_pot	HFC-143a_pot	HFC-152a_pot	HFC-134a	
Indirect Emissions					118.88												
Atmospheric Deposition					24.94												
Synthetic Fertilizers					3.76												
Animal Manure					21.18												
Cattle					16.71												
Other					4.47												
Leaching					93.94												
Synthetic Fertilizers					13.87												
Animal Manure					80.07												
Cattle					62.68												
Other					17.39												
Rice Cultivations			-	520.8	-	-	-	-									
Burning of Crop Residues			-	114.7	2.97	3,908.1	106.2	-									
Cotton				0.5	0.01	16.8	0.5										
Sugarcane				114.2	2.96	3,891.3	105.7										
LAND USE, LAND-USE CHANGE AND FORESTRY	**2,353,400**	**-362,411**	**823,280**	**1,164.9**	**46.65**	**20,412.7**	**566.6**	**-**									
Land-Use Change	1,176,700	-362,411	814,289	1,164.9	46.65	20,412.7	566.6	-									
Liming	1,176,700		1,176,700	-	-	-	-	-									
WASTE TREATMENT	**66**		**66**	**1,446.1**	**4.73**	**-**	**-**	**-**									
Solid Waste	66		66	1,023.6													
Wastewater				422.5	4.73												
Industrial				126.9													
Domestic				295.6	4.73												
TOTAL	**2,598,411**	**-362,411**	**1,068,291**	**13,024.8**	**418.34**	**34,129.4**	**2,530.3**	**57,186.0**	**0.3231**	**0.0279**	**0.1566**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0685**	**0.0140**

Notation keys: NO — Not Occuring; NE — Not Estimated; NA — Not Applicable (cells in gray)

TABLE IX: GREENHOUSE GAS EMISSIONS BY SOURCES FOR THE YEAR 2000, IN GIGAGRAM (Gg)

2000	Gg																
									PFCs		HFCs						
	CO_2 (gross emissions)	CO_2 (removals)	CO_2 (net emissions)	CH_4	N_2O	CO	NO_x	NMVOC	CF_4	C_2F_6	HFC-23	HFC-32_pot	HFC-125_pot	HFC-143a_pot	HFC-152a_pot	HFC-134a	SF_6
ENERGY	**267,057**		**267,057**	**503.6**	**18.18**	**7,647.9**	**2,198.2**	**918.2**									
Fuel Combustion	256,320		256,320	384.6	18.07	7,647.9	2,198.2	918.2									
Energy Subsector	40,484		40,484	20.8	3.01	1,104.7	400.7	249.6									
Public Service Power Plants	19,075		19,075	0.4	0.14	9.1	136.4	2.1									
Self-Producer Power Plants	5,141		5,141	1.4	0.25	63.4	34.3	1.3									
Charcoal Plants	NO		NO	11.7	1.56	777.7	1.9	233.3									
Other	16,268		16,268	7.3	1.06	254.5	228.1	12.9									
Industrial Subsector	58,419		58,419	19.9	3.33	1,036.8	221.5	41.7									
Iron and Steel	4,620		4,620	0.1	0.02	3.2	10.8	1.1									
Ferroalloys	37		37	0.1	0.01	5.0	0.3	0.1									
Chemical Industry	13,938		13,938	1.3	0.13	20.4	59.4	3.3									
Non-ferrous Metals	3,709		3,709	0.1	0.02	1.1	7.3	0.1									
Pulp and Paper	4,320		4,320	1.5	0.60	483.5	23.8	10.2									
Food and Beverages	4,476		4,476	11.1	1.84	187.5	44.6	9.7									
Cement	10,350		10,350	2.3	0.12	114.2	20.6	8.3									
Mining	5,302		5,302	0.3	0.05	7.1	14.9	0.8									
Textile	1,268		1,268	0.1	0.04	7.3	2.5	0.4									
Ceramics	3,382		3,382	2.2	0.31	140.8	17.5	4.2									
Other Industries	7,017		7,017	0.8	0.19	66.7	19.8	3.5									
Transport Subsector	121,748		121,748	67.3	7.86	4,242.7	1,377.8	412.2									
Civil Aviation	6,206		6,206	-	0.17	40.3	6.1	1.7									
Road Transportation	111,337		111,337	66.9	7.13	4,191.1	1,275.7	406.0									
Railways	1,247		1,247	0.1	0.48	4.3	20.9	1.9									
Domestic Water-bome Navigation	2,958		2,958	0.3	0.08	7.0	75.1	2.6									
Residential Subsector	17,179		17,179	261.5	2.85	1,172.3	28.5	175.9									
Agriculture Subsector	14,152		14,152	12.0	0.96	86.9	159.7	35.5									
Commercial Subsector	2,216		2,216	3.1	0.04	3.9	5.3	2.5									
Public Subsector	2,122		2,122	-	0.02	0.6	4.7	0.8									

2000	Gg																
	CO_2 (gross emissions)	CO_2 (removals)	CO_2 (net emissions)	CH_4	N_2O	CO	NO_x	NMVOC	PFCs		HFCs						SF_6
									CF_4	C_2F_6	HFC-23	HFC-32_pot	HFC-125_pot	HFC-143a_pot	HFC-152a_pot	HFC-134a	
Fugitive Emissions	10,737		10,737	119.0	0.11	-	-	-									
Coal Mining	1,291		1,291	43.3	NO	NO	NO	NO									
Oil and Natural Gas	9,446		9,446	75.7	0.11	NE	NE	NE									
INDUSTRIAL PROCESSES	**64,314**		**64,314**	**43.7**	**21.09**	**788.1**	**79.1**	**532.1**	**0.1465**	**0.0117**	**0.0000**	**0.0000**	**0.0071**	**0.0075**	**0.0001**	**0.5023**	**0.0153**
Cement Production	16,047		16,047														
Lime Production	5,008		5,008														
Other uses of Limestone and Dolomite	1,756		1,756														
Other uses of Soda Ash	243		243														
Ammonia Production	1,663		1,663														
Nitric Acid Production					2.09		0.6										
Adipic Acid Production					17.51	1.0	0.3										
Caprolactam Production					0.34												
Calcium Carbide Production	51		51														
Methanol Production	56		56	0.5													
Ethylene Production	5		5	7.9				3.7									
Vinyl Chloride Production	125		125					3.6									
Ethylene Oxide Production	133		133	0.5													
Acrylonitrile Production	20		20					0.1									
Carbon Black Production	457		457														
Phosphoric Acid Production	104		104														
Production of Other Chemicals				0.1				35.6									
Iron ana Steel Production	34,052		34,052	31.0	1.06	674.4	54.9	20.6									
Ferroalloy Production	512		512	3.6	0.07	72.4	3.8	1.8									
Non-Ferrous Metals Production, except Aluminum	1,462		1,462	0.1	0.02	3.1	9.5	0.2									
Aluminum Production	2,116		2,116						0.1465	0.0117							
Magnesium Production																	0.0103
Pulp and Paper						37.2	10.0	24.6									
Food Production								252.8									
Beverage Production								189.1									
HCFC-22 Production											0.0000						
Use of HFCs, PFCs and SF_6												0.0000	0.0071	0.0075	0.0001	0.5023	0.0050
Non-Energetic Consumption other than that in Chemical Industries	504		504														

2000	Gg																	
	CO_2 (gross emissions)	CO_2 (removals)	CO_2 (net emissions)	CH_4	N_2O	CO	NO_x	NMVOC	PFCs		HFCs							SF_6
									CF_4	C_2F_6	HFC-23	HFC-32_pot	HFC-125_pot	HFC-143a_pot	HFC-152a_pot	HFC-134a		
SOLVENTS AND OTHER PRODUCT USES			-	-	-	-	-	78,597.4										
AGRICULTURE			-	10,382.3	355.93	3,576.4	97.2	-										
Enteric Fermentation			-	9,349.5	-	-	-	-										
Cattle				9,005.8														
Dairy Cattle				1,177.9														
Beef Cattle				7,827.9														
Other Animals				343.7														
Manure Management			-	479.7	11.49	-	-	-										
Cattle				215.9	2.98													
Dairy Cattle				34.1	1.09													
Beef Cattle				181.8	1.89													
Swine				166.5	2.06													
Poultry				78.1	6.20													
Other Animals				19.2	0.25													
Agricultural Soils			-		341.72	-	-	-										
Direct Emissions					213.85													
Animals on Pasture					140.12													
Cattle					122.04													
Other					18.08													
Synthetic Fertilizers					21.28													
Organic Fertilizers					15.88													
Cattle					4.87													
Other					11.01													
Crop Residues					21.66													
Soy Bean					8.00													
Sugarcane					1.82													
Beans					1.06													
Rice					1.28													
Corn					5.27													
Manioc					2.52													
Other					1.71													
Organic Soils					14.91													

2000	Gg																
	CO_2 (gross emissions)	CO_2 (removals)	CO_2 (net emissions)	CH_4	N_2O	CO	NO_x	NMVOC	PFCs		HFCs						SF_6
									CF_4	C_2F_6	HFC-23	HFC-32_pot	HFC-125_pot	HFC-143a_pot	HFC-152a_pot	HFC-134a	
Indirect Emissions					127.87												
Atmospheric Deposition					26.53												
Synthetic Fertilizers					4.94												
Animal Manure					21.59												
Cattle					17.49												
Other					4.10												
Leaching					101.34												
Synthetic Fertilizers					19.66												
Animal Manure					81.68												
Cattle					65.59												
Other					16.09												
Rice Cultivations			-	448.1	-	-	-	-									
Burning of Crop Residues			-	105.0	2.72	3,576.4	97.2	-									
Cotton																	
Sugarcane				105.0	2.72	3,576.4	97.2										
LAND USE, LAND-USE CHANGE AND FORESTRY	**1,519,947**	**-385,789**	**1,134,158**	**1,599.2**	**58.96**	**26,956.8**	**657.6**	**-**									
Land-Use Change	1,511,230	-385,789	1,125,441	1,599.2	58.96	26,956.8	657.6	-									
Liming	8,717		8,717	-	-	-	-	-									
WASTE TREATMENT	**95**		**95**	**1,798.8**	**5.68**	**-**	**-**	**-**									
Solid Waste	95		95	1,204.3	0.01												
Wastewater				594.5	5.67												
Industrial				222.8													
Domestic				371.7	5.67												
TOTAL	**1,851,413**	**-385,789**	**1,465,624**	**14,327.6**	**459.84**	**38,969.2**	**3,032.1**	**80,047.7**	**0.1465**	**0.0117**	**0.0000**	**0.0000**	**0.0071**	**0.0075**	**0.0001**	**0.5023**	**0.0153**

Notation keys: NO — Not Occuring; NE — Not Estimated; NA — Not Applicable (cells in gray)

TABLE X: GREENHOUSE GAS EMISSIONS BY SOURCES FOR THE YEAR 2010, IN GIGAGRAM (Gg)

2010	Gg																
									PFCs		HFCs						
	CO_2 (gross emissions)	CO_2 (removals)	CO_2 (net emissions)	CH_4	N_2O	CO	NO_x	NMVOC	CF_4	C_2F_6	HFC-23	HFC-32_pot	HFC-125_pot	HFC-143a_pot	HFC-152a_pot	HFC-134a	SF_6
ENERGY	**348,883**		**348,883**	**620.6**	**29.25**	**7,111.2**	**2,498.1**	**849.9**									
Fuel Combustion	333,669		333,669	439.7	29.04	7,111.2	2,498.1	849.9									
Energy Subsector	58,859		58,859	34.6	5.03	1,620.1	583.6	251.8									
Public Service Power Plants	26,593		26,593	1.2	0.32	19.7	155.2	3.5									
Self-Producer Power Plants	9,446		9,446	6.0	0.94	305.2	54.9	2.6									
Charcoal Plants	NO		NO	10.8	1.45	723.2	1.8	217.0									
Other	22,820		22,820	16.6	2.32	572.0	371.7	28.7									
Industrial Subsector	68,977		68,977	34.3	5.73	1,708.8	287.2	66.3									
Iron and Steel	5,540		5,540	0.2	0.02	3.7	11.4	1.4									
Ferroalloys	102		102	0.1	0.02	7.7	0.6	0.2									
Chemical Industry	13,847		13,847	2.5	0.18	22.5	58.3	3.4									
Non-ferrous Metals	5,476		5,476	0.2	0.03	2.1	9.7	0.2									
Pulp and Paper	3,855		3,855	2.5	1.03	938.9	35.9	18.5									
Food and Beverages	3,965		3,965	23.2	3.52	260.9	81.0	14.5									
Cement	14,708		14,708	1.1	0.12	138.6	28.0	13.6									
Mining	7,289		7,289	0.3	0.07	25.5	21.1	2.7									
Textile	1,015		1,015	0.1	0.04	8.3	1.8	0.4									
Ceramics	5,007		5,007	3.1	0.42	202.3	19.4	6.4									
Other Industries	8,173		8,173	1.0	0.28	98.3	20.0	5.0									
Transport Subsector	168,598		168,598	58.4	13.74	2,348.3	1,384.0	281.5									
Civil Aviation	9,751		9,751	0.0	0.27	38.5	9.3	1.2									
Road Transportation	151,497		151,497	57.8	12.16	2,288.8	1,211.1	271.8									
Railways	2,935		2,935	0.2	1.19	10.5	51.5	4.6									
Domestic Water-borne Navigation	4,415		4,415	0.4	0.12	10.5	112.1	3.9									
Residential Subsector	17,249		17,249	290.1	3.15	1,306.7	30.6	196.1									
Agriculture Subsector	17,348		17,348	18.5	1.33	122.5	208.9	51.1									
Commercial Subsector	1,446		1,446	3.8	0.04	4.6	2.6	2.7									
Public Subsector	1,192		1,192	0.0	0.02	0.2	1.2	0.4									

2010	Gg																
	CO_2 (gross emissions)	CO_2 (removals)	CO_2 (net emissions)	CH_4	N_2O	CO	NO_x	NMVOC	PFCs		HFCs						SF_6
									CF_4	C_2F_6	HFC-23	HFC-32_pot	HFC-125_pot	HFC-143a_pot	HFC-152a_pot	HFC-134a	
Fugitive Emissions	15,214		15,214	180.9	0.21	-	-	-									
Coal Mining	1,846		1,846	39.2	NO	NO	NO	NO									
Oil and Natural Gas	13,368		13,368	141.7	0.21	NE	NE	NE									
INDUSTRIAL PROCESSES	**80,787**		**80,787**	**45.3**	**2.15**	**809.6**	**100.8**	**736.8**	**0.0767**	**0.0059**	**0.0000**	**0.1059**	**0.5012**	**0.4671**	**0.0000**	**2.7362**	**0.0077**
Cement Production	21,288		21,288														
Lime Production	5,950		5,950														
Other uses of Limestone and Dolomite	3,060		3,060														
Other Uses of Soda Ash	396		396														
Ammonia Production	1,739		1,739														
Nitric Acid Production					0.80		0.6										
Adipic Acid Production					0.13	1.4	0.4										
Caprolactam Production				NO													
Calcium Carbide Production	42		42														
Methanol Production	56		56	0.5													
Ethylene Production	6		6	10.6				4.6									
Vinyl Chloride Production	213		213					6.2									
Ethylene Oxide Production	146		146	0.5													
Acrylonitrile Production	22		22					0.1									
Carbon Black Production	647		647				0.1										
Phosphoric Acid Production	112		112														
Production of Other Chemicals				0.2				50.3									
Iron and Steel Production	38,361		38,361	28.6	1.08	633.2	60.1	20.2									
Ferroalloy Production	1,195		1,195	4.8	0.11	96.7	6.2	2.5									
Non-Ferrous Metals Production, except Aluminum	4,332		4,332	0.1	0.03	4.9	13.8	0.3									
Aluminum Production	2,543		2,543						0.0767	0.0059							
Magnesium Production																	0.0000
Pulp and Paper						73.4	19.6	48.5									
Food Production								407.2									
Beverage Production								196.9									
HCFC-22 Production											0.0000						
Use of HFCs, PFCs and SF_6												0.1059	0.5012	0.4671	0.0000	2.7362	0.0077
Non-Energetic Consumption other than that in Chemical Industries	679		679														

2010	Gg																
	CO_2 (gross emissions)	CO_2 (removals)	CO_2 (net emissions)	CH_4	N_2O	CO	NO_x	NMVOC	PFCs		HFCs						SF_6
									CF_4	C_2F_6	HFC-23	HFC-32_pot	HFC-125_pot	HFC-143a_pot	HFC-152a_pot	HFC-134a	
SOLVENTS AND OTHER PRODUCT USES			-	-	-	-	-	152,514.6									
AGRICULTURE			-	12,415.6	472.08	6,313.5	171.6	-									
Enteric Fermentation			-	11,158.0	-	-	-	-									
Cattle				10,798.4													
Dairy Cattle				1,424.0													
Beef Cattle				9,374.4													
Other Animals				359.6													
Manure Management			-	608.1	14.83	-	-	-									
Cattle				258.7	3.46												
Dairy Cattle				44.0	1.38												
Beef Cattle				214.7	2.08												
Swine				214.9	2.35												
Poultry				115.3	8.78												
Other Animals				19.2	0.24												
Agricultural Soils			-		452.45	-	-	-									
Direct Emissions					282.31												
Animals on Pasture					170.24												
Cattle					152.00												
Other					18.24												
Synthetic Fertilizers					35.74												
Organic Fertilizers					21.33												
Cattle					5.77												
Other					15.56												
Crop Residues					39.49												
Soy Bean					16.75												
Sugarcane					5.47												
Beans					1.09												
Rice					1.29												
Corn					9.02												
Manioc					2.73												
Other					3.14												
Organic Soils					15.51												

2010	Gg																
	CO_2 (gross emissions)	CO_2 (removals)	CO_2 (net emissions)	CH_4	N_2O	CO	NO_x	NMVOC	PFCs		HFCs						SF_6
									CF_4	C_2F_6	HFC-23	HFC-32_pot	HFC-125_pot	HFC-143a_pot	HFC-152a_pot	HFC-134a	
Indirect Emissions					170.14												
Atmospheric Deposition					35.65												
Synthetic Fertilizers					9.13												
Animal Manure					26.52												
Cattle					21.71												
Other					4.81												
Leaching					134.49												
Synthetic Fertilizers					33.65												
Animal Manure					100.84												
Cattle					81.41												
Other					19.43												
Rice Cultivations			-	464.2	-	-	-	-									
Burning of Crop Residues			-	185.3	4.80	6,313.5	171.6	-									
Cotton				NO	NO	NO	NO	NO									
Sugarcane				185.3	4.80	6,313.5	171.6										
LAND USE, LAND-USE CHANGE AND FORESTRY	**887,536**	**-626,905**	**260,631**	**606.9**	**24.83**	**10,745.1**	**307.5**	**-**									
Land-Use Change	877,112	-626,905	250,207	606.9	24.83	10,745.1	307.5	-									
Liming	10,424		10,424	-	-	-	-	-									
WASTE TREATMENT	**175**		**175**	**2,411.6**	**7.21**	**-**	**-**	**-**									
Solid Waste	175		175	1,268.5	0.01												
Wastewater				1,143.1	7.20												
Industrial				630.3													
Domestic				512.8	7.20												
TOTAL	**1,317,381**	**-626,905**	**690,476**	**16,100.0**	**535.52**	**24,979.4**	**3,078.0**	**154,101.3**	**0.0767**	**0.0059**	**0.0000**	**0.1059**	**0.5012**	**0.4671**	**0.0000**	**2.7362**	**0.0077**

Notation keys: NO — Not Occuring; NE — Not Estimated; NA — Not Applicable (cells in gray)

TABLE XI: GREENHOUSE GAS EMISSIONS BY SOURCES FOR THE YEAR 2012, IN GIGAGRAM (Gg)

2012	Gg																
									PFCs		HFCs						
	CO_2 (gross emissions)	CO_2 (removals)	CO_2 (net emissions)	CH_4	N_2O	CO	NO_x	NMVOC	CF_4	C_2F_6	HFC-23	HFC-32_pot	HFC-125_pot	HFC-143a_pot	HFC-152a_pot	HFC-134a	SF_6
ENERGY	**396,547**		**396,547**	**584.0**	**31.11**	**6,907.7**	**2,566.2**	**833.6**									
Fuel Combustion	381,786		381,786	409.9	30.95	6,907.7	2,566.2	833.6									
Energy Subsector	70,114		70,114	33.1	4.86	1,587.8	682.9	255.3									
Public Service Power Plants	34,909		34,909	1.7	0.44	27.6	197.2	4.5									
Self-Producer Power Plants	10,365		10,365	6.4	1.00	331.9	61.8	2.9									
Charcoal Plants	NO		NO	11.2	1.49	746.0	1.9	223.8									
Other	24,840		24,840	13.8	1.93	482.3	422.0	24.1									
Industrial Subsector	72,448		72,448	36.1	5.91	1,760.8	304.0	68.9									
Iron and Steel	5,401		5,401	0.1	0.02	3.8	10.9	1.5									
Ferroalloys	238		238	0.1	0.02	6.9	1.4	0.2									
Chemical Industry	14,014		14,014	2.5	0.18	22.0	56.6	3.2									
Non-ferrous Metals	5,900		5,900	0.2	0.03	2.3	10.1	0.2									
Pulp and Paper	3,864		3,864	2.4	1.01	926.2	35.3	17.2									
Food and Beverages	4,267		4,267	24.0	3.64	268.2	86.8	15.0									
Cement	17,112		17,112	2.0	0.17	177.1	34.0	16.2									
Mining	7,277		7,277	0.3	0.07	25.9	25.0	2.8									
Textile	989		989	0.1	0.04	6.7	1.8	0.3									
Ceramics	5,220		5,220	3.3	0.45	221.1	20.9	7.2									
Other Industries	8,166		8,166	1.1	0.28	100.6	21.2	5.1									
Transport Subsector	201,605		201,605	60.6	15.95	2,265.8	1,334.9	281.0									
Civil Aviation	11,218		11,218	0.0	0.31	42.6	10.6	1.4									
Road Transportation	183,199		183,199	60.0	14.30	2,202.4	1,165.5	271.3									
Railways	3,034		3,034	0.2	1.23	10.9	53.3	4.7									
Domestic Water-borne Navigation	4,154		4,154	0.4	0.11	9.9	105.5	3.6									
Residential Subsector	17,598		17,598	258.4	2.85	1,167.1	29.1	175.1									
Agriculture Subsector	17,490		17,490	17.7	1.32	121.2	212.1	50.1									
Commercial Subsector	1,701		1,701	4.0	0.05	4.8	2.4	2.9									
Public Subsector	830		830	0.0	0.01	0.2	0.8	0.3									

2012	Gg																
	CO_2 (gross emissions)	CO_2 (removals)	CO_2 (net emissions)	CH_4	N_2O	CO	NO_x	NMVOC	PFCs		HFCs						SF_6
									CF_4	C_2F_6	HFC-23	HFC-32_pot	HFC-125_pot	HFC-143a_pot	HFC-152a_pot	HFC-134a	
Fugitive Emissions	14,761		14,761	174.1	0.16	-	-	-									
Coal Mining	1,372		1,372	41.0	NO	NO	NO	NO									
Oil and Natural Gas	13,389		13,389	133.1	0.16	NE	NE	NE									
INDUSTRIAL PROCESSES	**86,604**		**86,604**	**44.0**	**1.86**	**795.1**	**104.1**	**734.0**	**0.0655**	**0.0050**	**0.0000**	**0.1286**	**0.5146**	**0.4767**	**0.0000**	**2.9372**	**0.0083**
Cement Production	24,998		24,998														
Lime Production	6,403		6,403														
Other uses of Limestone and Dolomite	1,770		1,770														
Other Uses of Soda Ash	375		375														
Ammonia Production	1,758		1,758														
Nitric Acid Production					0.51		0.9										
Adipic Acid Production					0.12	1.0	0.3										
Caprolactam Production					NO												
Calcium Carbide Production	42		42														
Methanol Production	46		46	0.4													
Ethylene Production	6		6	10.3				4.4									
Vinyl Chloride Production	154		154					6.0									
Ethylene Oxide Production	146		146	0.5													
Acrylonitrile Production	22		22					0.1									
Carbon Black Production	647		647				0.1										
Phosphoric Acid Production	90		90														
Production of Other Chemicals				0.2				48.9									
Iron and Steel Production	40,189		40,189	28.3	1.10	630.8	62.2	20.4									
Ferroalloy Production	1,044		1,044	4.2	0.09	84.9	5.5	2.2									
Non-Ferrous Metals Production. except Aluminum	5,857		5,857	0.1	0.04	6.5	15.9	0.4									
Aluminum Production	2,378		2,378						0.0655	0.0050							
Magnesium Production																	0.0000
Pulp and Paper						71.9	19.2	47.5									
Food Production								407.2									
Beverage Production								196.9									
HCFC-22 Production											0.0000						
Use of HFCs. PFCs and SF_6												0.1286	0.5146	0.4767	0.0000	2.9372	0.0083
Non-Energetic Consumption other than that in Chemical Industries	679		679														

2012	Gg																	
	CO_2 (gross emissions)	CO_2 (removals)	CO_2 (net emissions)	CH_4	N_2O	CO	NO_x	NMVOC	PFCs		HFCs							SF_6
									CF_4	C_2F_6	HFC-23	HFC-32_pot	HFC-125_pot	HFC-143a_pot	HFC-152a_pot	HFC-134a		
SOLVENTS AND OTHER PRODUCT USES			-	-	-	-	-	129,247.4										
AGRICULTURE			-	12,511.7	491.10	5,616.9	152.6	-										
Enteric Fermentation			-	11,287.7	-	-	-	-										
Cattle				10,934.5														
Dairy Cattle				1,435.1														
Beef Cattle				9,499.4														
Other Animals				353.2														
Manure Management			-	610.9	14.95	-	-	-										
Cattle				261.0	3.51													
Dairy Cattle				43.7	1.42													
Beef Cattle				217.3	2.09													
Swine				215.9	2.32													
Poultry				115.3	8.88													
Other Animals				18.7	0.24													
Agricultural Soils			-		471.88	-	-	-										
Direct Emissions					292.69													
Animals on Pasture					170.44													
Cattle					152.82													
Other					17.62													
Synthetic Fertilizers					43.70													
Organic Fertilizers					21.01													
Cattle					5.86													
Other					15.15													
Crop Residues					41.91													
Soy Bean					16.04													
Sugarcane					5.82													
Beans					0.97													
Rice					1.33													
Corn					11.58													
Manioc					2.52													
Other					3.65													
Organic Soils					15.63													

2012	Gg																
	CO_2 (gross emissions)	CO_2 (removals)	CO_2 (net emissions)	CH_4	N_2O	CO	NO_x	NMVOC	PFCs		HFCs						SF_6
									CF_4	C_2F_6	HFC-23	HFC-32_pot	HFC-125_pot	HFC-143a_pot	HFC-152a_pot	HFC-134a	
Indirect Emissions					179.19												
Atmospheric Deposition					37.38												
Synthetic Fertilizers					10.79												
Animal Manure					26.59												
Cattle					21.84												
Other					4.75												
Leaching					141.81												
Synthetic Fertilizers					40.87												
Animal Manure					100.94												
Cattle					81.90												
Other					19.04												
Rice Cultivations			-	448.3	-	-	-	-									
Burning of Crop Residues			-	164.8	4.27	5,616.9	152.6	-									
Cotton				NO	NO	NO	NO	NO									
Sugarcane				164.8	4.27	5,616.9	152.6										
LAND USE. LAND-USE CHANGE AND FORESTRY	**704,257**	**-655,924**	**48,333**	**393.9**	**17.47**	**7,256.8**	**231.6**	**-**									
Land-Use Change	689,294	-655,924	33,370	393.9	17.47	7,256.8	231.6	-									
Liming	14,963		14,963	-	-	-	-	-									
WASTE TREATMENT	**195**		**195**	**2,576.5**	**7.33**	**-**	**-**	**-**									
Solid Waste	195		195	1,365.5	0.01												
Wastewater				1,211.0	7.32												
Industrial				689.6													
Domestic				521.4	7.32												
TOTAL	**1,187,603**	**-655,924**	**531,679**	**16,110.1**	**548.87**	**20,576.5**	**3,054.5**	**130,815.0**	**0.0655**	**0.0050**	**0.0000**	**0.1286**	**0.5146**	**0.4767**	**0.0000**	**2.9372**	**0.0083**

Notation keys: NO — Not Occuring; NE — Not Estimated; NA — Not Applicable (cells in gray)

TABLE XII: GREENHOUSE GAS EMISSIONS BY SOURCES FOR THE YEAR 2015, IN GIGAGRAM (Gg)

2015	Gg																
	CO_2 (gross emissions)	CO_2 (removals)	CO_2 (net emissions)	CH_4	N_2O	CO	NO_x	NMVOC	PFCs		HFCs						SF_6
									CF_4	C_2F_6	HFC-23	HFC-32_pot	HFC-125_pot	HFC-143a_pot	HFC-152a_pot	HFC-134a	
ENERGY	**430,796**		**430,796**	**624.9**	**32.70**	**6,799.4**	**2,513.2**	**774.6**									
Fuel Combustion	413,192		413,192	402.5	32.46	6,799.4	2,513.2	774.6									
Energy Subsector	105,577		105,577	38.6	5.82	1,745.1	794.8	235.3									
Public Service Power Plants	65,342		65,342	2.9	0.76	41.3	224.9	5.2									
Self-Producer Power Plants	11,249		11,249	8.7	1.34	451.3	75.3	3.9									
Charcoal Plants	NO		NO	9.8	1.31	653.9	1.6	196.2									
Other	28,986		28,986	17.2	2.41	598.6	493.0	30.0									
Industrial Subsector	70,136		70,136	32.6	5.57	1,929.9	296.5	66.1									
Iron and Steel	5,484		5,484	0.1	0.02	3.9	10.5	1.4									
Ferroalloys	117		117	0.1	0.01	5.4	1.0	0.1									
Chemical Industry	13,188		13,188	2.4	0.17	21.3	53.9	3.0									
Non-ferrous Metals	5,523		5,523	0.2	0.03	1.9	9.8	0.2									
Pulp and Paper	4,033		4,033	2.6	1.19	1,150.1	41.7	17.6									
Food and Beverages	4,235		4,235	21.0	3.20	247.1	79.9	13.7									
Cement	15,895		15,895	1.6	0.15	162.5	31.4	15.2									
Mining	7,394		7,394	0.4	0.07	27.5	25.6	3.0									
Textile	670		670	0.1	0.03	5.6	1.3	0.3									
Ceramics	5,147		5,147	3.1	0.42	208.4	20.3	6.8									
Other Industries	8,450		8,450	1.0	0.28	96.2	21.1	4.8									
Transport Subsector	198,857		198,857	53.8	16.75	1,841.1	1,161.4	242.0									
Civil Aviation	11,696		11,696	0.0	0.31	36.7	10.7	1.3									
Road Transportation	181,257		181,257	53.3	15.20	1,786.8	1,021.7	233.5									
Railways	2,811		2,811	0.2	1.16	10.3	50.4	4.5									
Domestic Water-borne Navigation	3,093		3,093	0.3	0.08	7.3	78.6	2.7									
Residential Subsector	18,021		18,021	252.9	2.80	1,143.2	29.1	171.6									
Agriculture Subsector	18,370		18,370	20.6	1.47	135.3	228.6	56.5									
Commercial Subsector	1,413		1,413	4.0	0.04	4.6	2.1	2.8									
Public Subsector	818		818	0.0	0.01	0.2	0.7	0.3									

2015	Gg																
									PFCs		HFCs						
	CO_2 (gross emissions)	CO_2 (removals)	CO_2 (net emissions)	CH_4	N_2O	CO	NO_x	NMVOC	CF_4	C_2F_6	HFC-23	HFC-32_pot	HFC-125_pot	HFC-143a_pot	HFC-152a_pot	HFC-134a	SF_6
Fugitive Emissions	17,604		17,604	222.4	0.24	-	-	-									
Coal Mining	1,822		1,822	51.5	NO	NO	NO	NO									
Oil and Natural Gas	15,782		15,782	170.9	0.24	NE	NE	NE									
INDUSTRIAL PROCESSES	**84,853**		**84,853**	**40.7**	**1.86**	**717.4**	**102.2**	**732.1**	**0.0333**	**0.0025**	**0.0000**	**0.1730**	**0.6535**	**0.6075**	**0.0000**	**3.9827**	**0.0092**
Cement Production	25,082		25,082														
Lime Production	6,392		6,392														
Other uses of Limestone and Dolomite	1,604		1,604														
Other Uses of Soda Ash	375		375														
Ammonia Production	1,805		1,805														
Nitric Acid Production					0.51		0.8										
Adipic Acid Production					0.20	0.7	0.2										
Caprolactam Production					NO												
Calcium Carbide Production	42		42														
Methanol Production	32		32	0.3													
Ethylene Production	6		6	10.9				4.4									
Vinyl Chloride Production	154		154					6.0									
Ethylene Oxide Production	146		146	0.5													
Acrylonitrile Production	22		22					0.1									
Carbon Black Production	647		647				0.1										
Phosphoric Acid Production	98		98														
Production of Other Chemicals				0.2				48.9									
Iron and Steel Production	41,064		41,064	25.4	1.05	572.5	65.9	19.1									
Ferroalloy Production	800		800	3.3	0.07	66.7	4.3	1.7									
Non-Ferrous Metals Production, except Aluminum	4,665		4,665	0.1	0.03	5.6	11.7	0.3									
Aluminum Production	1,281		1,281						0.0333	0.0025							
Magnesium Production																	0.0000
Pulp and Paper						71.9	19.2	47.5									
Food Production								407.2									
Beverage Production								196.9									
HCFC-22 Production											0.0000						
Use of HFCs, PFCs and SF_6												0.1730	0.6535	0.6075	0.0000	3.9827	0.0092
Non-Energetic Consumption other than that in Chemical Industries	638		638														

2015	Gg																	
	CO_2 (gross emissions)	CO_2 (removals)	CO_2 (net emissions)	CH_4	N_2O	CO	NO_x	NMVOC	PFCs		HFCs							SF_6
									CF_4	C_2F_6	HFC-23	HFC-32_pot	HFC-125_pot	HFC-143a_pot	HFC-152a_pot	HFC-134a		
SOLVENTS AND OTHER PRODUCT USES			-	-	-	-	-	9,236.7										
AGRICULTURE			-	12,914.4	510.67	5,820.6	158.2	-										
Enteric Fermentation			-	11,620.1	-	-	-	-										
Cattle				11,247.8														
Dairy Cattle				1,410.2														
Beef Cattle				9,837.6														
Other Animals				372.3														
Manure Management			-	631.8	15.74	-	-	-										
Cattle				265.6	3.51													
Dairy Cattle				41.9	1.39													
Beef Cattle				223.7	2.12													
Swine				227.1	2.42													
Poultry				119.6	9.56													
Other Animals				19.5	0.25													
Agricultural Soils			-		490.50	-	-	-										
Direct Emissions					307.71													
Animals on Pasture					172.83													
Cattle					154.41													
Other					18.42													
Synthetic Fertilizers					44.31													
Organic Fertilizers					22.41													
Cattle					5.85													
Other					16.56													
Crop Residues					52.35													
Soy Bean					23.74													
Sugarcane					6.06													
Beans					1.07													
Rice					1.41													
Corn					13.90													
Manioc					2.52													
Other					3.65													

2015	Gg																
	CO_2 (gross emissions)	CO_2 (removals)	CO_2 (net emissions)	CH_4	N_2O	CO	NO_x	NMVOC	PFCs		HFCs						SF_6
									CF_4	C_2F_6	HFC-23	HFC-32_pot	HFC-125_pot	HFC-143a_pot	HFC-152a_pot	HFC-134a	
Organic Soils					15.81												
Indirect Emissions					182.79												
Atmospheric Deposition					38.24												
Synthetic Fertilizers					11.21												
Animal Manure					27.03												
Cattle					22.05												
Other					4.98												
Leaching					144.55												
Synthetic Fertilizers					41.64												
Animal Manure					102.91												
Cattle					82.69												
Other					20.22												
Rice Cultivations			-	491.7	-	-	-	-									
Burning of Crop Residues			-	170.8	4.43	5,820.6	158.2	-									
Cotton				NO	NO	NO	NO	NO									
Sugarcane				170.8	4.43	5,820.6	158.2										
LAND USE, LAND-USE CHANGE AND FORESTRY	**869,547**	**-655,924**	**213,623**	**567.7**	**24.48**	**10,311.7**	**317.2**	**-**									
Land-Use Change	856,065	-655,924	200,141	567.7	24.48	10,311.7	317.2	-									
Liming	13,482		13,482	-	-	-	-	-									
WASTE TREATMENT	**222**		**222**	**2,824.8**	**7.73**	**-**	**-**	**-**									
Solid Waste	222		222	1,448.8	0.01												
Wastewater				1,376.0	7.72												
Industrial				826.4													
Domestic				549.6	7.72												
TOTAL	**1,385,418**	**-655,924**	**729,494**	**16,972.5**	**577.44**	**23,649.1**	**3,090.8**	**99,743.4**	**0.0333**	**0.0025**	**0.0000**	**0.1730**	**0.6535**	**0.6075**	**0.0000**	**3.9827**	**0.0092**

Notation keys: NO — Not Occuring; NE — Not Estimated; NA — Not Applicable (cells in gray)

TABLE XIII: GREENHOUSE GAS EMISSIONS BY SOURCES FOR THE YEAR 2016, IN GIGAGRAM (Gg)

2016	Gg																
									PFCs		HFCs						
	CO_2 (gross emissions)	CO_2 (removals)	CO_2 (net emissions)	CH_4	N_2O	CO	NO_x	NMVOC	CF_4	C_2F_6	HFC-23	HFC-32_pot	HFC-125_pot	HFC-143a_pot	HFC-152a_pot	HFC-134a	SF_6
ENERGY	**399,798**		**399,798**	**604.9**	**32.25**	**6,504.8**	**2,319.4**	**713.7**									
Fuel Combustion	382,293		382,293	386.3	32.00	6,504.8	2,319.4	713.7									
Energy Subsector	81,643		81,643	34.9	5.19	1,600.7	703.9	203.1									
Public Service Power Plants	42,669		42,669	1.7	0.48	22.6	142.6	2.5									
Self-Producer Power Plants	11,106		11,106	8.8	1.35	459.8	78.4	3.8									
Charcoal Plants	NO		NO	8.4	1.13	562.8	1.4	168.8									
Other	27,868		27,868	16.0	2.23	555.5	481.5	28.0									
Industrial Subsector	64,662		64,662	34.6	5.89	1,962.5	290.9	64.2									
Iron and Steel	4,974		4,974	0.1	0.02	3.6	10.2	1.3									
Ferroalloys	233		233	0.1	0.01	5.3	1.2	0.1									
Chemical Industry	12,938		12,938	2.4	0.17	19.9	51.1	2.8									
Non-ferrous Metals	5,467		5,467	0.2	0.03	1.9	9.7	0.2									
Pulp and Paper	4,065		4,065	2.7	1.26	1,229.1	44.0	18.6									
Food and Beverages	4,109		4,109	23.5	3.54	252.9	86.8	14.3									
Cement	14,227		14,227	1.5	0.14	146.0	28.2	13.7									
Mining	5,566		5,566	0.3	0.05	21.5	22.2	2.4									
Textile	601		601	0.0	0.03	5.4	1.2	0.3									
Ceramics	4,813		4,813	2.8	0.38	187.2	18.3	6.1									
Other Industries	7,669		7,669	1.0	0.26	89.7	18.0	4.4									
Transport Subsector	200,311		200,311	52.0	16.89	1,727.5	1,102.7	229.3									
Civil Aviation	12,074		12,074	0.0	0.29	33.2	9.9	0.8									
Road Transportation	183,118		183,118	51.6	15.40	1,678.6	983.3	222.0									
Railways	2,752		2,752	0.2	1.14	10.1	49.4	4.4									
Domestic Water-borne Navigation	2,367		2,367	0.2	0.06	5.6	60.1	2.1									
Residential Subsector	18,209		18,209	241.9	2.70	1,090.6	28.6	163.7									
Agriculture Subsector	15,232		15,232	19.1	1.28	119.0	190.5	50.4									
Commercial Subsector	1,442		1,442	3.8	0.04	4.4	2.1	2.7									
Public Subsector	794		794	0.0	0.01	0.1	0.7	0.3									

2016	Gg																
	CO_2 (gross emissions)	CO_2 (removals)	CO_2 (net emissions)	CH_4	N_2O	CO	NO_x	NMVOC	PFCs		HFCs						SF_6
									CF_4	C_2F_6	HFC-23	HFC-32_pot	HFC-125_pot	HFC-143a_pot	HFC-152a_pot	HFC-134a	
Fugitive Emissions	17,505		17,505	218.6	0.25	-	-	-									
Coal Mining	2,062		2,062	56.8	NO	NO	NO	NO									
Oil and Natural Gas	15,443		15,443	161.8	0.25	NE	NE	NE									
INDUSTRIAL PROCESSES	**78,094**		**78,094**	**36.4**	**1.71**	**625.0**	**95.4**	**729.4**	**0.0362**	**0.0026**	**0.0000**	**0.1878**	**0.6998**	**0.6511**	**0.0000**	**4,3664**	**0,0095**
Cement Production	22,415		22,415														
Lime Production	6,392		6,392														
Other uses of Limestone and Dolomite	1,367		1,367														
Other Uses of Soda Ash	375		375														
Ammonia Production	1,805		1,805														
Nitric Acid Production					0.51		0.8										
Adipic Acid Production					0.19	0.7	0.2										
Caprolactam Production																	
Calcium Carbide Production	42		42														
Methanol Production	32		32	0.3													
Ethylene Production	6		6	10.9				4.4									
Vinyl Chloride Production	154		154					6.0									
Ethylene Oxide Production	146		146	0.5													
Acrylonitrile Production	22		22					0.1									
Carbon Black Production	647		647				0.1										
Phosphoric Acid Production	98		98														
Production of Other Chemicals				0.2				48.9									
Iron and Steel Production	37,133		37,133	21.2	0.91	482.2	59.0	16.4									
Ferroalloy Production	784		784	3.2	0.07	64.8	4.2	1.7									
Non-Ferrous Metals Production, except Aluminum	4,713		4,713	0.1	0.03	5.4	11.9	0.3									
Aluminum Production	1,321		1,321						0.0362	0.0026							
Magnesium Production																	0,0000
Pulp and Paper						71.9	19.2	47.5									
Food Production								407.2									
Beverage Production								196.9									
HCFC-22 Production											0.0000						
Use of HFCs, PFCs and SF_6												0.1878	0.6998	0.6511	0.0000	4,3664	0,0095
Non-Energetic Consumption other than that in Chemical Industries	642		642														

2016	Gg																
	CO_2 (gross emissions)	CO_2 (removals)	CO_2 (net emissions)	CH_4	N_2O	CO	NO_x	NMVOC	PFCs		HFCs						SF_6
									CF_4	C_2F_6	HFC-23	HFC-32_pot	HFC-125_pot	HFC-143a_pot	HFC-152a_pot	HFC-134a	
SOLVENTS AND OTHER PRODUCT USES			-	-	-	-	-	105,063.0									
AGRICULTURE			-	13,087.1	530.27	5,908.1	160.5	-									
Enteric Fermentation			-	11,822.9	-	-	-	-									
Cattle				11,447.4													
Dairy Cattle				1,295.9													
Beef Cattle				10,151.5													
Other Animals				375.5													
Manure Management			-	630.9	15.82	-	-	-									
Cattle				267.6	3.48												
Dairy Cattle				38.3	1.30												
Beef Cattle				229.3	2.18												
Swine				223.8	2.40												
Poultry				119.8	9.69												
Other Animals				19.7	0.25												
Agricultural Soils			-		509.95	-	-	-									
Direct Emissions					314.05												
Animals on Pasture					173.01												
Cattle					154.51												
Other					18.50												
Synthetic Fertilizers					54.25												
Organic Fertilizers					22.62												
Cattle					5.80												
Other					16.82												
Crop Residues					48.30												
Soy Bean					23.46												
Sugarcane					6.28												
Beans					0.91												
Rice					1.22												
Corn					10.45												
Manioc					2.31												
Other					3.67												
Organic Soils					15.87												

2016	Gg																
	CO_2 (gross emissions)	CO_2 (removals)	CO_2 (net emissions)	CH_4	N_2O	CO	NO_x	NMVOC	PFCs		HFCs						SF_6
									CF_4	C_2F_6	HFC-23	HFC-32_pot	HFC-125_pot	HFC-143a_pot	HFC-152a_pot	HFC-134a	
Indirect Emissions					195.90												
Atmospheric Deposition					41.39												
Synthetic Fertilizers					14.36												
Animal Manure					27.03												
Cattle					22.05												
Other					4.98												
Leaching					154.51												
Synthetic Fertilizers					51.46												
Animal Manure					103.05												
Cattle					82.70												
Other					20.35												
Rice Cultivations			-	459.9	-	-	-	-									
Burning of Crop Residues			-	173.4	4.50	5,908.1	160.5	-									
Cotton				NO	NO	NO	NO	NO									
Sugarcane				173.4	4.50	5,908.1	160.5										
LAND USE, LAND-USE CHANGE AND FORESTRY	**924,886**	**-655,924**	**268,962**	**672.0**	**25.14**	**11,404.8**	**285.1**	**-**									
Land-Use Change	910,261	-655,924	254,337	672.0	25.14	11,404.8	285.1	-									
Liming	14,625		14,625	-	-	-	-	-									
WASTE TREATMENT	**231**		**231**	**2,868.5**	**7.79**	**-**	**-**	**-**									
Solid Waste	231		231	1,497.1	0.01												
Wastewater				1,371.4	7.78												
Industrial				817.4													
Domestic				554.0	7.78												
TOTAL	**1,403,009**	**-655,924**	**747,085**	**17,268.9**	**597.16**	**24,442.7**	**2,860.4**	**106,506.1**	**0.0362**	**0.0026**	**0.0000**	**0.1878**	**0.6998**	**0.6511**	**0.0000**	**4.3664**	**0.0095**

Notation keys: NO — Not Occuring; NE — Not Estimated; NA — Not Applicable (cells in gray)

2.3 **EMISSIONS RESULTS**

Figure II presents the annual time series of GHG emissions in Brazil, by sector, from 1990 to 2016, in carbon dioxide equivalent (GWP SAR – 100 years[11]).

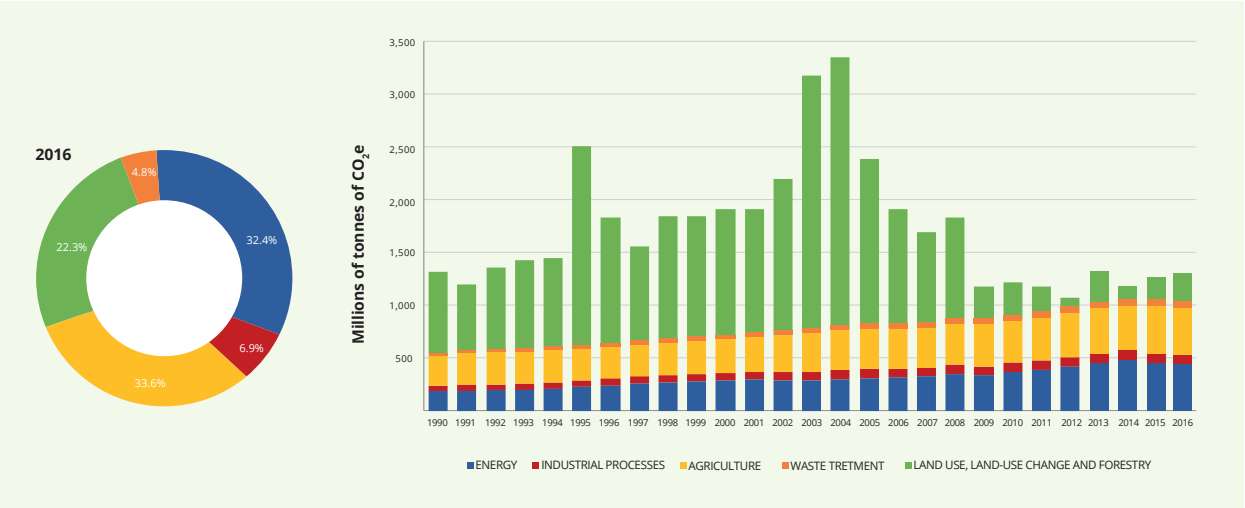


Figure II: Greenhouse gas emissions in CO_2 equivalent (GWP-SAR), by sector, from 1990 to 2016.

As shown in the figure, in recent years the profile of Brazilian emissions has changed (Figure II). Due to a reduction in deforestation, the share of national emissions from the Land Use, Land Use Change and Forestry sector has now decreased. Consequently, the share of other sectors such as Energy and Agriculture has become relatively larger in terms of the country's aggregate emissions.

Most importantly, as a result of the efforts undertaken through the implementation of sectoral mitigation plans, the country has contributed to a significant reduction in its emissions. However, since the methodology for national inventories does not include some of these sectoral actions, these positive results are not reflected explicitly in the historical time series. In order to bridge this information gap, the Brazilian Government has been monitoring its initiatives and making efforts to develop and implement appropriate methodologies to estimate sectoral emission reductions (see section Mitigation actions and their effects).

[11] *GWP – 100 years metric, reference values as per the Second Assessment Report (SAR), IPCC, 1995. Available in: < http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml>. Accessed on: 19 Jul 2018.*

BOX I: NATIONAL GHG EMISSIONS IN CO_2 EQUIVALENT

According to Decision 17/CP.8 under the Climate Convention, the results of the inventory must be presented in absolute gas units. If the country chooses to report its emissions in CO_2 equivalent (CO_2e), it could use the Global Warming Potential (GWP) values, and also the Global Temperature Potential (GTP) for a 100-year time period, published in the IPCC's Second Assessment Report (SAR) (IPCC, 1995). All analyzes and results presented in CO_2e in this Inventory employed the GWP metric in the SAR (100 years).

Although the use of both GWP-SAR and GTP are suggested for inventories from non-Annex I countries, subsequent IPCC assessment reports have provided new values for the GWP of gases. From the IPCC's Fifth Assessment Report (AR5) (IPCC, 2013), the latest publication on the topic, the values for the GTP were presented for the first time, which Brazil considers most relevant for its national context. According to the IPCC, GTP is a metric based on temperature change, i.e., it is related to the change in the average temperature of the global surface, throughout a selected time horizon, in response to an emission pulse. It is, therefore, more consistent with a global temperature limit target.

According to the IPCC (2013), the most appropriate metric and time horizon will depend on which aspects of climate change are considered most important for a particular use. No metric is capable of accurately comparing all the consequences of different emissions, and all of them involve limitations and uncertainties[12]. The IPCC also states that the GTP metric is more suitable for target-based policies, while the GWP is not directly related to a temperature limit[13]. As such, the GTP is the most consistent metric with a contribution to halt the increase in the global average temperature below 2° C compared to pre-industrial levels.

The results discussed in this BUR are based on three sets of weighting values: GWP-SAR, determined by Decision 17/CP.8, GWP-AR5 and GTP-AR5, both based on the most up-to-date science.

[12] IPCC, 2013: Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. SPM D.2 p.15.

[13] See Myhre, G., D. Shindell, F.-M. Bréon, W. Collins, J. Fuglestvedt, J. Huang, D. Koch, J.-F. Lamarque, D. Lee, B. Mendoza, T. Nakajima, A. Robock, G. Stephens, T. Takemura and H. Zhang, 2013: Anthropogenic and Natural Radiative Forcing. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. pp. 710-720.
See also Stocker, T.F., D. Qin, G.-K. Plattner, L.V. Alexander, S.K. Allen, N.L. Bindoff, F.-M. Bréon, J.A. Church, U. Cubasch, S. Emori, P. Forster, P. Friedlingstein, N. Gillett, J.M. Gregory, D.L. Hartmann, E. Jansen, B. Kirtman, R. Knutti, K. Krishna Kumar, P. Lemke, J. Marotzke, V. Masson-Delmotte, G.A. Meehl, I.I. Mokhov, S. Piao, V. Ramaswamy, D. Randall, M. Rhein, M. Rojas, C. Sabine, D. Shindell, L.D. Talley, D.G. Vaughan and S.-P. Xie, 2013: Technical Summary. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. pp. 58-59.

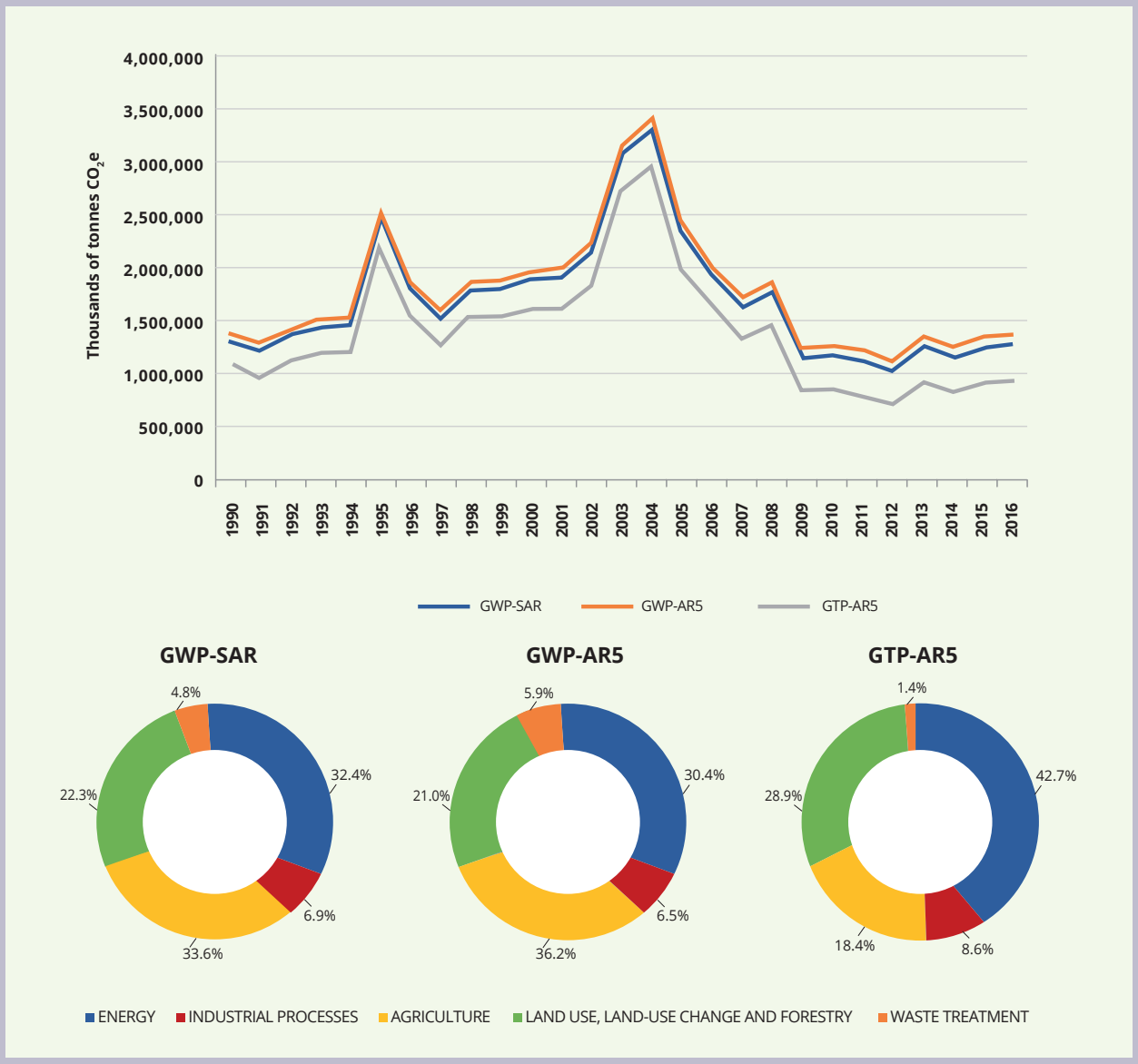


Figure III: Evolution and sectoral participation in net CO_2 equivalent emissions in 2016, by various metrics (GWP-SAR, GWP-AR5 and GTP-AR5).

TABLE XIV: ANTHROPOGENIC EMISSIONS BY SOURCES AND REMOVALS BY SINKS OF GREENHOUSE GASES INTO CO_2e, CONVERTED USING THE GTP AND GWP METRICS, BY SECTOR

GWP-SAR	1994	2000	2010	2012	2015	2016
			Gg CO_2e			
Energy	208,546	283,268	370,983	418,455	454,056	422,498
Industrial Processes	62,233	73,897	89,946	95,929	96,172	90,107
Agriculture	311,227	328,367	407,072	414,987	429,510	439,213
Land Use, Land-Use Change and Forestry	862,204	1,186,019	281,073	62,021	233,134	290,867
Waste Treatment	31,900	39,631	53,054	56,574	61,939	62,884
TOTAL	**1,476,110**	**1,911,181**	**1,202,128**	**1,047,965**	**1,274,810**	**1,305,570**

GWP-AR5	1994	2000	2010	2012	2015	2016
			Gg CO_2e			
Energy	211,477	286,214	374,373	421,491	457,404	425,719
Industrial Processes	61,968	73,317	90,863	96,861	97,256	91,229
Agriculture	365,328	385,026	472,736	480,469	496,930	506,958
Land Use, Land-Use Change and Forestry	868,259	1,194,560	284,204	63,992	236,006	294,440
Waste Treatment	41,810	51,967	69,610	74,279	81,365	82,613
TOTAL	**1,548,842**	**1,991,083**	**1,291,786**	**1,137,093**	**1,368,960**	**1,400,960**

GTP-AR5	1994	2000	2010	2012	2015	2016
			Gg CO_2e			
Energy	199,269	273,564	358,572	406,511	441,392	410,201
Industrial Processes	60,926	71,336	84,621	90,358	89,003	82,457
Agriculture	117,831	124,817	160,127	164,964	171,154	176,430
Land Use, Land-Use Change and Forestry	838,856	1,154,351	268,869	53,997	221,622	277,533
Waste Treatment	6,957	8,619	11,509	12,216	13,330	13,528
TOTAL	**1,223,839**	**1,632,687**	**883,697**	**728,046**	**936,501**	**960,149**

BOX II: REFERENCE APPROACH VS. SECTORAL APPROACH – ENERGY SECTOR

According to 2006 IPCC, it is good practice to apply both a Sectoral Approach (bottom-up methodology) and the Reference Approach (top-down methodology) to estimate CO_2 emissions from fuel combustion and to compare the results of these two independent estimates. The emissions contained in national inventories are those estimated under the Sectoral Approach. The Reference Approach is a straightforward method that can be applied on the basis of energy supply statistics. It is based on the concept of apparent consumption: the production of primary fuels and imports of primary and secondary fuels are added, and the exports of primary and secondary fuels, bunkers[14] and stock change (which can be either positive or negative). Given this result, CO_2 emissions estimates are based on the carbon content of fuels.

For the Sectoral Approach, information on fuel consumption by energy sector is multiplied by the corresponding emission factors. The calculation of CO_2 emissions according to these two approaches can yield different results, but it is used for quality control of the sector's results.

For the Inventory in this BUR, differences above 5% were observed from 1990 to 1999, as shown in Table XV. The main reasons for discrepancies are due to the statistical adjustments made in the Energy Balance and the values considered in the variation of oil stocks, i.e., adjustments made in primary sources that are not reflected in secondary fuels. These findings are being investigated in order to improve the estimates in the next submissions.

TABLE XV: REFERENCE APPROACH VS. SECTORAL APPROACH IN THE ENERGY SECTOR

Year	Reference Approach (A) (Gg CO_2)	Sectoral Approach (B) (Gg CO_2)	Difference (%) ((A-B/B))
1990	174,294	162,431	7.3%
1991	180,109	168,246	7.1%
1992	183,738	171,880	6.9%
1993	189,959	177,436	7.1%
1994	205,524	185,663	10.7%
1995	212,864	201,319	5.7%
1996	231,512	216,775	6.8%
1997	245,608	230,492	6.6%
1998	254,650	239,222	6.4%
1999	262,751	250,096	5.1%
2000	263,630	256,319	2.9%
2001	275,794	264,559	4.2%
2002	270,801	262,362	3.2%
2003	259,947	256,730	1.3%
2004	277,428	271,775	2.1%
2005	283,132	277,143	2.2%
2006	286,847	283,203	1.3%
2007	299,437	296,034	1.1%
2008	317,998	314,236	1.2%
2009	303,551	297,934	1.9%
2010	340,512	333,669	2.1%
2011	353,836	349,252	1.3%
2012	384,690	381,786	0.8%
2013	418,113	413,171	1.2%
2014	449,397	436,996	2.8%
2015	416,516	413,035	0.8%
2016	382,166	382,504	-0.1%

[14] Under the Sectoral Approach, emissions from international bunkers are calculated and reported as memo items, they are not computed towards the country's total (see item 1.3.1.2).

3

MITIGATION ACTIONS AND THEIR EFFECTS

3 MITIGATION ACTIONS AND THEIR EFFECTS

This chapter presents detailed information about Brazil's Nationally Appropriate Mitigation Actions (NAMA) communicated to the UNFCCC via document FCCC/AWGLCA/2011/INF.1. The period varies according to the initial year of each NAMA implementation, going up to 2020, whenever possible. As required by the National Policy on Climate Change (PNMC), all NAMAs are matched with the government's Sector Plans at the national level. The PNMC provides for actions in addition to the NAMAs described in this report.

Brazil was one of the few developing countries to report a Nationally Determined Contribution (NDC) to the Paris Agreement with a mitigation approach based on an absolute reduction in greenhouse gas emissions for the economy as a whole. In addition, prior to 2020, the country steadily and consistently implemented the NAMAs reported to the Convention as described below.

This set of actions contributes to reducing global greenhouse gas emissions. This effort is Brazil's contribution to international endeavors to mitigate climate change.

The Table XVI: Mitigation actions below presents the Brazilian NAMAs according to the guidelines established by Decision 2/CP-17, Annex III, and it includes: name, nature of the action, sector, coordinating institution, gases, general objective, description, period, methodology and assumptions, specific objective, goals, progress indicators, actions/steps taken, and results[15]. This format was adopted when BUR3 was released, and it represents an evolution for the reporting of Brazil's actions based on national progress in monitoring the NAMAs and the lessons learned as part of the international consultation and analysis process (ICA) of the previous BURs.

BOX III - ADDITIONAL EFFORTS

Since 2004 (in the case of the Amazon) and since 2010 (in the case of the Cerrado), the efforts made have shown meaningful results in terms of reducing deforestation rates. Nevertheless, there has been an upward trend in deforestation in the Amazon since 2012, which reflects a certain exhaustion of previous plans, with the need to develop more effective solutions to prevent and counter illegal deforestation. In this context, considering the search for new solutions in addition to those that had been performing well, in 2019 there was a transition to the new Plan for the Control of Illegal Deforestation and Recovery of Native Vegetation, approved by the Commission for the Control of Illegal Deforestation and Recovery of Native Vegetation – CONAVEG (Decree No. 10.142/2019).

The purpose of the new plan is to reduce illegal deforestation and degradation of native vegetation through positive measures that impact on new dynamics and encourage sustainable production models as an alternative to the suppression of native vegetation, thereby bringing together various segments of society to collaborate to fight illegal deforestation.

[15] The estimated reductions informed herein are only indications in view of the difficulties in quantifying mitigation actions results in the country. However, the actions/steps taken and the results reported, together with the recognition of gaps and capacity needs and efforts reported in the section concerning SMMARE and MRV of actions, reflect the efforts that Brazil has been undertaking to quantify greenhouse gas emissions reductions and transparency of this information.

The National Plan for the Control of Illegal Deforestation and Recovery of Native Vegetation provides guidelines for combating deforestation based on three cross-cutting themes: business environment, innovation and technological solutions, and financing for sustainable practices. In order to support coordination and integration of these themes, the Plan was structured in 06 major axes: (i) zero tolerance to deforestation and firefighting, (ii) land tenure regularization, (iii) territorial management, (iv) bio-economy, (v) payment for environmental services, and (vi) recovery of native vegetation.

In addition to strengthening existing institutional actions, the Plan is designed to create new solutions based on the protection of standing forests and robust financial incentives for their conservation. As such, one of the Plan's main strategies is the compensation and appreciation of those who protect and derive their livelihoods from the forests. The objective is to compensate those who carry out activities for the improvement, conservation and recovery of native vegetation that contribute to the protection of biodiversity and soils, greater availability of water resources, reduction of carbon emissions, among other environmental benefits, thereby creating jobs and income. The Plan is intended to improve primary living conditions in the Amazon – one of the least developed regions in the country – by providing effective health care, drinking water, sewage treatment, quality electricity, and digital inclusion.

These activities do not rely solely on the actions undertaken by the federal environmental authorities. In order to make law enforcement actions more effective, coordination among the federal, state and municipal levels is necessary to ensure concerted action in the fight against deforestation. In this context, the Ministry of the Environment has been playing a coordinating role effectively. For instance, a clear achievement of this policy was the joint work for the establishment, in 2019, of an action to ensure law and order enforcement by the Armed Forces ("GLO Ambiental"), which allowed direct action and allocation of resources to the agencies responsible for implementing policies to combat illegal deforestation.

As such, the National Program for Payment for Environmental Services – Floresta+ was also launched with the aim of creating, promoting and consolidating the market for environmental services by recognizing and appreciating the environmental activities conducted and encouraging the respective monetary and non-monetary compensation. The Program focuses exclusively on native vegetation and can be applied to all land categories.

Other initiatives are already underway, such as the creation of an institutional framework for raising international funds based on payments for REDD+ results (the UNFCCC recognized this year the reduction results for the Cerrado, which is the first step for funding), forest carbon credits in the voluntary market, recognized by the Federal Government as an important source of funding, in particular private funds. Other key initiatives include green debentures, impact investments, eco-tourism, and private projects that may incorporate a component of payment for environmental services (PES) in their design. Regulation of the market for environmental services will provide the necessary credibility for projects to have legal certainty, thus ensuring their full development and contributing effectively and sustainably to reduce deforestation.

TABLE XVI: MITIGATION ACTIONS

Name: Sectoral Mitigation and Adaptation Plan to Climate Change for the Consolidation of a Low Carbon Emission Economy in Agriculture (ABC Plan)
Nature of the action: NAMA
Sector: Agriculture
Coordinating Institution: Ministry of Agriculture, Livestock and Food Supply (MAPA)
Gas (es): CH_4, N_2O, CO_2
General Objective: to expand the area under sustainable agricultural production systems that ensure the sustainable development of agriculture and reduce GHG emissions.
Description: Brazil has been investing in research and technology development for its agricultural sector's sustainability for the past five decades. In this context, the ABC Plan was established in 2010 as one of the government's tools to promote sustainable agricultural practices throughout the country. The ABC Plan encourages farmers to adopt a set of technologies toward strengthening resilience and adaptive capacity, as well as increasing productivity and economic profitability of national agricultural systems, with the integration of soil, water and biodiversity conservation and based on an Integrated Landscape Approach (ILA). These technologies have contributed to increasing food production and, therefore, food safety, while making production systems more resilient to climate change and more efficient in controlling GHG emissions related to agricultural activities. According to the Forest Code, the ILA focuses on improving agricultural systems by fostering technologies included in the ABC Plan, without the need to expand the lands currently allocated to agriculture and also by reconciling with the environmental regularization of rural properties. The ABC Plan includes the implementation of the following NAMAs: • Restoration of degraded pasture; • Integrated crop-livestock-forest systems and other modes of agroforestry systems; • No-till farming; • Biological nitrogen fixation; • Along with other courses of action that strengthen the resilience of production systems, goals in the ABC Plan also include actions to foster the expansion of planted forest areas, in support of the Steel Sector Plan, and expansion of treatment facilities for animal waste with a view to reducing emissions from production activities. The additional actions to the NAMAs are the result of the participatory construction of the ABC Plan, and the robust commitment and ambition of the Brazilian agricultural sector given the potential to control its emissions. The expansion of action goals in the ABC Plan is also due to the urgent need to strengthen resilience and the capacity to adapt to climate change in order to counter the substantial threat to food security that the growing climate uncertainty has generated.
Period: 2010-2019
Projected GHG reduction according to NAMAs: • Restoration of pasture: 83 to 104 million tCO_2e by 2020 • Integrated crop-livestock-forestry systems: 18 to 22 million tCO_2e by 2020 • No-till farming: 16 to 20 million tCO_2e by 2020 • Biological nitrogen fixation: 16 to 20 million tCO_2e by 2020

Methodologies and assumptions:
The ABC Plan's central assumption is that the control of GHG emissions inherent to agroecosystems can be achieved through an Integrated Landscape Approach (ILA). The adoption of conservationist agriculture strategies and practices, combined with the integration of production systems, makes it possible to boost the agroecosystems' resilience and their ability to adapt to external, thereby providing even more significant economic gains. These strategies encompass the adequate management and conservation of soil, water, and biodiversity, duly compatible with the use of external inputs, thus intensifying production.
Monitoring of the implementation of mitigation actions in the agricultural sector was based on a strategy that included:
1) Data collection:

- Analyses of satellite images where actions have been implemented;
- Information collected directly from the banking sector (contracts under the financing line established by the ABC Plan);
- Census data from the Brazilian Institute of Geography and Statistics (IBGE), the National Supply Company (Conab) and/or private companies;
- Field surveys or even surveys based on technical plans.

2) Data processing: centralized through the Multi-Institutional Platform of Climate Change and Agriculture (ABC Platform), which involves experts from several institutions for information survey, analysis and validation. These experts are responsible for explaining the reference scenario and establishing calculation methodologies used to account for reductions applicable to the Brazilian ecological and technical conditions. Along with the data on the adoption of ABC technologies, there are data for the decentralized promotion of actions via the coordination of the ABC Plan and the data on credit raising for the adoption of technologies. This data set comprises the information required for monitoring the implementation of the ABC Plan.

Specific Objective: Recovery of Degraded Pastures with an estimated contribution to a reduction of 83 to 104 million tCO_2e by 2020.
Goals: Recovery of 15 million hectares of degraded pastures.
Progress Indicators: Area (ha) of recovered pasture.

Specific Objective: Establishment of Crop-Livestock-Forest Integration Systems (CLFI) and Agroforestry Systems (AFS) with an estimated contribution to a reduction of 18 to 22 million tCO_2e by 2020
Goals: Expansion of the adoption of CLFI by 4 million hectares; Agroforestry Systems (AFS) by 2.76 million hectares.
Progress Indicators: Area (ha) implemented with CLFI and AFS.

Specific Objective: To increase the area cultivated under the no-till farming (NTF) system with an estimated contribution to a reduction of 16 to 20 million tCO_2e by 2020.
Goals: Expansion of the NTF system by 8 million hectares.
Progress Indicators: Area (ha) managed under the NTF system.

Specific Objective: To increase the area cultivated under the biological nitrogen fixation system with an estimated contribution to a reduction of 10 million[16] tCO_2e by 2020.
Goals: To increase the adoption of BNF to 5.5 million hectares of cultivated areas, substituting nitrogen fertilizers.
Progress Indicators: Area (ha) cultivated with BNF and number of inoculant doses traded.

Specific Objective: To promote reforestation actions in the country, expanding the area covered with Planted Forests currently used to produce fibers, wood and cellulose by 3.0 million hectares – from 6.0 million hectares to 9.0 million hectares[16]
Goals: To increase plantation by 3.0 million hectares.
Progress Indicators: Area (ha) with planted forests.

Specific Objective: To broaden the use of treatment technologies for energy generation and production of organic compost, with an estimated contribution to a reduction of 6.9[16] million tCO_2e by 2020.
Goals: To broaden the use of technologies for the treatment of 4.4 million m^3 of manure.
Progress Indicators:

- Volume of processed biogas;
- Volume of methane used for the generation of energy;
- Volume of electric power generated with the use of biogas;
- Tons of organic compost generated.

[16] During the development stage of the ABC Plan, the estimated value of the potential expansion of BNF adoption was revised, and so were the related emission reduction estimates. The reduction result for the agricultural sector was estimated through the relevant set of NAMAs; however, it was remained unchanged, and the adjustment was offset by the addition of new courses of action. These include Animal Waste Treatment, with an additional reduction estimated at 6.9 million tCO_2e by 2020; the increase in the area with planted forests had no estimated emission reduction potential since it is viewed as an action contributed to the Steel Sector Plan.

Specific Objective: To encourage, motivate, and support the agricultural sector in implementing actions to adapt to climate change.
Goals: To strengthen the agriculture sector's capacity to adapt to climate change.
Progress Indicators:

- Number of actions for the adaption of plants and productive systems;
- Area (ha) with adaptation actions in the mapped regions.

Actions/Steps taken: The central action of the ABC Plan is to foster appropriation of information by rural producers so as to encourage the implementation of sustainable production systems. The availability and accessibility of information, confidence in the technology presented, and safety in the process lead the producer to invest in these changes. In addition to private sector initiatives, actions directly taken by the federal government include:

- Over 3,400 capacity-building events;
- Over 42,600 technical workers trained on the technologies in the ABC Plan;
- Training of some 87 thousand producers all over the country;
- 966 Technological Reference Units (URTs) and/or Test and Demonstration Units (UTDs) in the several Brazilian biomes;
- Over BRL 19.4 billion (over US$7.3 billion[17]) passed on contracts throughout the national territory through an innovative credit line, focusing on the structuring of the sustainable production system and conservationist agriculture proposed by the ABC Plan;
- Management and monitoring of 27 State Management Groups and their state ABC Plans, which establish goals and actions in line with the environmental, cultural and institutional characteristics of each Brazilian federal State;
- Initiatives to raise awareness among the most diverse target audiences and dissemination of the ABC Plan in all Units of the Federation;
- Studies were conducted to improve the process of monitoring and defining GHG emission and removal factors, considering, in particular, the diversity of biomes and existing production systems in the country: 1. "Collection of greenhouse gas emission and mitigation factors according to the Brazilian livestock production chains"; 2. "Collection of greenhouse gas emission and mitigation factors according to the Brazilian agricultural production chains"; 3. Diagnosis of degraded pasture areas and recovered pastures in the Brazilian territory; 4. Study and review information regarding the adoption of technologies in the ABC Plan (CLFI, PF, and NTF); 5. Diagnosis of the adoption of Animal Waste Treatment technology 6. "A collection of research studies, case studies, and experiences on production systems in the Brazilian agriculture that demonstrate resilience and adaptive capacity to climate change"; 7. Application of the GHG Protocol calculation tool and the AgroTag System in agricultural production systems, according to the technologies in the ABC Plan; 8. Economic and financial evaluation of the technologies in the ABC Plan; 9. Proposition of a Conceptual Framework for evaluating the progress of actions to adapt Brazilian production systems;
- Establishment of 26 scientific research programs that build on sustainability and add alternatives to the various technological systems proposed;
- Management and equipment of the High-Resolution Phenotyping Laboratory, with a view to characterizing genetic resources for different attributes, which is key for the identification of adaptable cultures to the diverse possible climate conditions;
- Vulnerability analysis;
- Mapping of the main species cultivated according to their ability to adapt to climate projections;
- Development of research projects with integrated systems (CLFI and AFS) considering the mitigation of GHG emissions in production systems and risk reduction through diversification of activities;
- Management of the Governance System of the ABC Plan (SIGABC) and the Multi-Institutional Platform for Monitoring Greenhouse Gas Emission Reduction in Agriculture (ABC Platform);
- Creation of the Brazilian Agricultural Observatory under the MAPA with a view to consolidating national agricultural data gathered from various agricultural databases in order to make it easier for managers to access the diversified agricultural database produced by the Ministry; to make statistics more qualified and georeferenced; to make the decision-making process more streamlined, and to prevent risky situations. The information available includes satellite images and graphs showing economic, trade and national and regional production data.

The actions under the ABC Plan are implemented in line with other sectoral plans and government actions, in particular:

- Promoting forest planting for the supply of charcoal to steel mills;
- Promoting the adoption of agriculture-livestock-forest integration and agroforestry systems, the sustainable use of areas already open, and the recovery of degraded areas for agricultural production contributing to the reduction of deforestation and forest degradation;
- Contributing to increasing the diversification of renewable energy sources through the production of biomass and the treatment of animal waste;
- Implementation of the Brazilian Forest Code: environmental registration of rural producers and recovery of the environmental deficit of agricultural production properties.

[17] *BRL/USD commercial exchange rate (sale price) in December 2019.*

Outcomes:
From 2010 to 2019, about 49.35 million hectares of production systems have incorporated sustainable practices (see detailed results below). These technologies have been adopted countrywide, and those promoted exclusively by the financing line established by the ABC Plan can be found in 2,949 (53%) Brazilian municipalities, covering all Brazilian states, regions, and biomes. Detailed results:

- According to Manzatto et al. (2020) [18], the estimated results of the ABC Plan consider:
- According to data from the ABC Program, the Agriculture-Livestock-Forest Integration Network, the ABC Platform and IBGE, from 2010 to 2016, the area of adoption of Agriculture-Livestock-Forest Integration expanded by 5.83 million hectares.
- According to data from the Census of Agriculture (2006 and 2017), from 2010 to 2016, the area of adoption of No-Tillage systems increased by 12.72 million hectares and the area of adoption of Biological Fixation of Nitrogen (BFN) expanded by 10.54 million hectares (No-Tillage areas overlap with BFN).
- According to data from the Brazilian Tree Institute (IBA), from 2010 to 2018, the area of forests planted for commercial purposes expanded by 7.84 million hectares.
- The recovered pasture area was estimated at 10.45 million hectares in 2010-2017, considering statistical databases that assume average animal units per area. New studies have made it possible to improve the methodology, including the use of remote sensing and image analysis. These studies indicate that the degraded pasture area recovered in 2010-2018 now exceeds 20 million hectares.
- According to calculations from a study commissioned by MAPA[19], from 2010 to 2019, 341 new animal waste treatment facilities were established, and they process an estimated treatment of 38.34 million m^3 of animal waste.

Name: Action Plan for the Prevention and Control of Deforestation in the Legal Amazon (PPCDAm)[20]
Nature of the action: NAMA
Sector: Land Use, Land-Use Change and Forestry (LULUCF)
Coordinating Institution: Ministry of the Environment
Gas (es): CO_2e
General Objective: Launched in 2004, it aims at reducing deforestation and degradation of native vegetation by promoting the maintenance of ecosystem services through the sustainable use of forest resources and promotion of sustainable agricultural practices.
Description: The fourth implementation stage of the PPCDAm covers the period 2016-2020. This Plan encompasses several policies and actions from the Federal Government and is structured in nine specific objectives distributed into four thematic axes: i) environmental monitoring and control; ii) land tenure regularization and territorial management, iii) fostering sustainable productive activities, and iv) normative and economic instruments. As one of the instruments of National Policy on Climate Change (Law No. 12,187), PPCDAM aims at reducing deforestation. The specific objectives described herein were developed by the Federal Government as a whole when drafting the PPCDAm, not only by the Ministry of the Environment, thus showing that deforestation is a challenge beyond the environmental agenda. Like the PPCerrado, many of its actions are cross-sector in nature.
Period: 2004-2019
Estimated reduction related to the NAMA: 564 million tCO_2e by 2020

[18] http://ainfo.cnptia.embrapa.br/digital/bitstream/item/214365/1/Manzatto-mitigacao-emissoes-2020.pdf

[19] https://mapa.cibiogas.org/

[20] *Because the strategy to reduce deforestation is structured by biomes, some results accounted for under the PPCDAm have national impact and are therefore reported both here and in the section on PPCerrado.*

Specific Objective: To promote land tenure regularization of public lands in the states in the Legal Amazon
Methodologies and assumptions: The significant portion of public land not yet allocated or tenured was identified as a critical cause of deforestation in the Brazilian Amazon.

Goal: 10 million hectares of federal public lands allocated
Progress Indicators: Public federal area effectively allocated (ha).
Actions/Steps taken: The Federal Government, by means of the Legal Tenure Program (PTL for its acronym in Portuguese), has been working since 2009 to promote the tenure of federal public lands. Priority was initially accorded to titling land possessed in these areas. Over time, the initial stage of land allocation also met a series of other highly relevant demands in combating deforestation, such as acknowledging indigenous lands and making areas available for the establishment of conservation areas, among others. The strategic nature of land tenure regularization under the PPCDAm was consolidated during its second stage (2009-2011). Actions were scaled up and accelerated with the creation of the Technical Chamber for the Allocation and Land Tenure Regularization of Federal Rural Public Land in the Legal Amazon in 2013. Since then, over 11 million hectares have been allocated, out of which 7.5 million are protected areas.
Outcomes: 100% of the 60 million hectares of federal public land without allocation or clear land tenure (baseline 2013) have been analyzed by the Technical Chamber, with 47.8 million hectares already processed, i.e., clearly allocated or tenured without overlapping interests between the federal agencies.

Goal: To promote the implementation of the Legal Tenure Program.
Progress Indicators: Number of land tenure titles issued
Actions/Steps taken: Issuance of titles for land tenure regularization regarding public lands. Decrees and rules on land tenure regularization procedures have been enacted, including the issuance of an Occupancy Recognition Certificate (CRO for its acronym in Portuguese) that guarantees access to rural credit facilities by the occupants (Decree No. 9,309/2018 and Decree No. 10,165/2019). Creation of A CRO module in the Land Management System (SIGEF)
Outcomes: By 2019, over 31,600 land tenure titles had been issued by the Federal Government.

Specific Objective: To promote land-use planning, strengthening protected areas.
Methodologies and assumptions: The expansion of protected areas reduces deforestation and protects biodiversity.

Goal: 30% of the Amazon biome under protected areas.
Progress Indicators: Percentage of the biome protected within conservation units.
Actions/Steps taken: Establishment and expansion of conservation units in priority areas for biodiversity conservation; In 2018, the Baixo Rio Branco Extractive Reserve - Jauaperi (581,120 ha) and the Itapetininga Extractive Reserve (16,294 ha) were created. The Lago Cuniã Extractive Reserve has been extended to a total of 75,875 ha.
Outcomes: 28.1% of the Amazon biome protected by Federal, State, and Municipal conservation units, thereby reaching 93.6% of the goal.

Goal: To speed up the acknowledgement of indigenous lands in areas under greater deforestation pressure.
Progress Indicators: Indigenous lands area (ha) listed in declaratory rulings of the Justice Ministry.
Actions/Steps taken: Granting full property rights to indigenous peoples, acknowledging their lands.
Outcomes: Declaratory rulings for approximately 2.1 million hectares of indigenous land in 2016 (Kaxuyana/Tunayana Indigenous Land)

Specific Objective: To promote accountability for environmental crimes and infractions.
Methodologies and assumptions: Increased accountability for environmental crimes and infractions acts as a deterrence mechanism since offenders will fear punished for environmental offenses. The penalty can be in the form of a fine, administrative infraction, or even a criminal sentence.

Goal: To reduce deforestation in the biome and conservation units
Progress Indicator: Deforested area (km²)
Actions/Steps taken: Surveillance of critical deforestation areas, including conservation units:
The following actions were implemented in 2018-2019:

- 434 flora surveillance actions;
- 11,501 notices of infraction issued;
- Over 1 million hectares of embargoed areas;
- 2222 criminal procedures launched;
- 462 surveillance actions conducted in conservation units.

Outcomes:

- In 2019, there was a 63.5% decrease in annual deforested areas in the Legal Amazon in relation to 2004.
- In 2019, there was a 58.9% decrease in deforested areas inside conservation units compared to 2004.

Specific Objective: Effectively implement joint forest management.
Methodologies and assumptions: Environmental and forest management in Brazil is, to a great extent, a responsibility of the States. The Federal Government's role is to unify and make national data on forest and environmental management available, such as is the case of the National System of the Rural Environmental Registry (Sicar) and the National System for the Control of the Origin of Forest Products (Sinaflor), which are fundamental systems for monitoring and controlling deforestation. The Rural Environmental Registry (CAR) is a system for tracking legally protected areas within rural properties, thus allowing for monitoring and a distinction between legal (authorized) and illegal deforestation. Sinaflor is a monitoring system for tracking the transportation of native wood products.

Goals: To implement the National System for the Control of the Origin of Forest Products (Sinaflor).
Progress Indicators: Number of States integrated into Sinaflor.
Actions/Steps taken: Promotion of the integration and interoperability of States' forest-control systems with the National System.
Outcomes: Implementation of Sinaflor in seven of the nine States in the Legal Amazon region (Roraima, Amazonas, Amapá, Rondônia, Acre, Tocantins and Maranhão).

Goals: To register 100% of rural properties in Brazil in the Rural Environmental Registry (CAR).
Progress Indicators: Index of environmental regularity of rural properties (number or area of rural properties in regularization/total real estate).
Actions/Steps taken: Improvement and availability of the modules for analysis and monitoring of the CAR

- Provision and implementation of improvements in the SICAR analysis module for all states using the platform;
- Support for the preparation and submission of simplified proposals for joining the PRA in the 21 states using the SICAR;
- Deployment of the Environmental Reserve Quota regulation (Decree No. 9,640/2018);
- Capacity building actions for the development of simplified proposals for joining the PRA and fostering the recovery of native vegetation in Permanent Preservation Areas – APP and Legal Reserves – RL;
- Integration of systems and platforms with SICAR data, namely SICOR, SINAFLOR, and SIGEF.

Outcomes: 100% (5.5 million) of rural properties and 548,4 million hectares of rural properties registered (at the national level). *Registers are self-declaratory and will go through a validation phase by the relevant state bodies.

Specific Objective: To prevent and combat the incidence of forest fires.
Methodologies and assumptions: The incidence of forest fires in Brazilian biomes results in vegetation degradation and GHG emissions. Understanding the dynamics of fires in Brazilian biomes helps inform policies to reduce degradation and promote conservation through integrated fire management. Federal environmental agencies currently adopt an integrated fire management approach to reduce forest fires that are harmful to biodiversity.

Goals: To reduce the area affected by forest fires.
Progress Indicators: Burned area (ha); number of heat spots.
Actions/Steps taken:

- Regulation of Art. 40 of Law No. 12,651/2012 Elaboration and submission of the Draft Law No. 11,276/2018, which establishes the National Integrated Fire Management Policy. This policy is under review in the House of Representatives as a priority;
- Elaboration of Forest Fire Prevention and Combat Plans in conservation units;
- Prevention and combat action planning in priority conservation units;
- Implementation of the Federal Forest Brigade Program, aiming at reducing the number of forest fires in priority federal areas;
- In 2019, 471 firefighters were hired to cover 30 priority areas (indigenous lands and settlements) and 221 firefighters to cover 25 conservation units. Integrated fire management was implemented in 59 conservation units;
- The 7th International Conference on Forest Fires was held from October 28 to November 1, 2019, in Campo Grande, MS. Under the central theme "Face to face with fire in a changing world: reducing the vulnerability of populations and ecosystems through Integrated Fire Management," the conference brought together more than 1,200 attendees, including government managers and officials, firefighters, researchers, civil society, and the private sector from nearly all states in Brazil and 37 other countries from five continents;
- Also, in 2019, the Law and Order Assurance operation was carried out, which ensured preventive and enforcement actions by the Armed Forces against environmental offenses and the identification and fight against fire outbreaks. A decree placing a ban on the use of fire for sixty days throughout the national territory was also enacted (Decree No. 9,992, of August 28, 2019, amended by Decree No. 9,997, of August 30, 2019).

Outcomes:

- 218.637 heat spots were reported in the Amazon in 2004. In 2019, there were 89,178 heat spots. There was a reduction of 59.2% in relation to 2004;
- The burned area in the Amazon in 2004 affected 157.007 km². In 2019, this was 72,501km². There was a reduction of 53.8% in relation to 2004.

Specific Objective: To improve and strengthen the monitoring of vegetation cover.
Methodologies and assumptions: The real-time deforestation detection system is the main tool used by the environmental surveillance to control deforestation, being improved every year by INPE and Censipam. It is the system that provides daily data to federal environmental agencies to inform law enforcement actions. In addition to the optical sensors, the detection of deforestation is also being carried out in periods of high cloud cover incidence in the Amazon with the use of radar images. In addition to deforestation, INPE monitors and measures the heat sources and burned areas in all biomes, providing essential information to implement policies to reduce forest fires and integrated fire management, especially for environmental conservation within protected areas.

Goals: To improve the deforestation alert system.
Progress Indicators:
Image area worked on per month in the Deter systems (in spatial resolutions of 250m, 60m, and 30m);
Deforestation Alert Index/Image area worked (in spatial resolution between 3 and 6m).
Actions/Steps taken: Implementation of improvements in the area monitored in the Amazon.
Outcomes:

- Systems are fully operational, with INPE's TerraBrasilis platform available online;
- Images already available for federal environmental surveillance;
- Deter/Inpe – Image area worked: in 2017, the monthly average was 3.08; in 2018, it jumped to 4.13; and in 2019, it stood at 4.17 million Km²/month;
- SIPAM/SAR - In 2018, radar monitoring was conducted based on telemetry data, image consumption covered 1,684,303.76 km². In 2019, monitoring involved an orbital and aerial radar, with image consumption covering 2,521,411 km².

Goals: Annual mapping of the burned area in all Brazilian biomes.
Progress Indicators: Monitored area (ha) and digital maps of the burned area (in spatial resolution of 30m and 1km).
Actions/Steps taken:

- Implementation of the annual estimation system of burned area with a spatial resolution of 30 meters and 1km
- Improvement of near-real-time monitoring of vegetation fire outbreaks

Outcomes: Satellite monitoring of vegetation fire outbreaks by INPE's Programa Queimada for all biomes was carried out in low spatial resolution images (1km), with the automatic generation of daily, monthly and annual summaries in the form of maps, charts, and tables, in addition to spot locations of burning

Specific Objective: To promote sustainable forest management.
Methodologies and assumptions: Fostering the development of a forest economy in the Amazon is crucial for the conservation of the forest and the valuation of its environmental assets. Sustainable use of the forest can extract high-value wood and non-timber products while also conserving the forest and promoting the local and regional forest economy, creating employment opportunities and income.

Goals: To increase the volume of marketed timber, non-timber and socio-biodiversity products from Sustainable Forest Management areas.
Progress Indicators: Volume of timber production, non-timber and socio-biodiversity products for trading (t, m³ or other) from areas under sustainable management plans.
Actions/Steps taken:

- Promotion of forest concessions;
- Insert new socio-biodiversity products in the Policy for Guaranteeing a Minimum Price for Biodiversity Products – PGPM-Bio;
- Strengthening of extractive activities (Implementation of the National Plan to Strengthen Extractive and Riparian Communities);
- Promoting Community Forest Management and the strengthening of the management of community undertakings.

Outcomes:

- In 2019, the accumulated area of forest under forest concession reached 1,050,000 ha.
- In 2019, wood production through the federal forest concessions was 250,000m³; in 2018, it was 204,000m³.
- Design and commercialization of socio-biodiversity products: inclusion of management of pirarucu in the PGPM-Bio agenda for the 2020 season; subsidy of 19,000 tons of socio-biodiversity products, with BRL 18.7 million paid to 9,309 extractive producers who sold açaí, andiroba, babassu, natural extractive rubber, native cocoa, juçara, macabá, mangaba, pequi, pinhão, and umbu (various regions).

Specific Objective: To implement economic instruments to control illegal deforestation.
Methodologies and assumptions: Decreasing deforestation and forest degradation also relies on positive incentives. The thematic area of economic and normative instruments consists of an array of Federal Government initiatives to design and implement incentives-based mechanisms to encourage sustainable production, whether through incentives for the adoption of sustainable production technologies and systems or amendments or financial, credit, and tax instruments.
Goals: To enhance the positive incentives to reduce illegal deforestation and foster new production models and sustainable use of the forest.
Progress Indicators: Resource flows to forest conservation.
Actions/Steps taken:

- Increased access to credit for sustainable forest management activities (business, small holders, and community), regularization, and environmental recovery;
- Establishment of progressive credit goal agreements with federal public financial institutions for the sustainable production sector;
- Study and design credit incentives for private rural properties in compliance with the Forest Code, including the extension of the credit limit, without further restrictions and with the monitoring guarantee;
- Foster credit access for community forest management;
- Foster the integration of information systems (SICOR/Bacen, CAR and embargoed areas) to support the verification of environmental compliance in financing contracts;
- Establish socio-environmental progressive application criteria within the scope of credit concessions targeting large forest products consumer chains;
- Proposition of preference criteria for certificate timber or timber from forest concessions and for socio-biodiversity products in public contracts and purchases of federal, state, and municipal governments;
- Expansion of access channels to public purchasing mechanisms through collaborative instruments to socio-biodiversity and agro-ecology products;
- Incentivize socio-biodiversity products through tax breaks and differentiated minimum prices;
- Foster the establishment of the Environmental Reserve Quota regulation (CRA for its acronym in Portuguese);
- Diagnosis of standards and procedures related to issuing authorizations and environmental licensing of sustainable forest management activities. The objective is evaluating its efficiency, the need for harmonization and integration of processes, bridging normative gaps, and distinguishing forest management activities by type (community, business, and smallholders);
- Design and implementation of a Sectoral Pact for the Meat Supply Chain.

Outcomes:

- Enactment of Decree No. 9,640, of December 27, 2018, which regulates the Environmental Reserve Quota;
- Enactment of Decree No. 9,760, of April 11, 2019, which establishes new rules for the conversion of fines and establishment of Ibama's Environmental Conciliation Centers;
- Preparation and approval of the pilot project for payments for environmental services Floresta+, with resources from REDD+ results, in a total of US$ 96 million;
- Cross-sector coordination to change the 2018/2019 Season Plan, which made it possible to finance environmental recovery under the funding and Investment modalities, expansion of financing limits for the recovery of environmentally weak areas in rural properties and reduction of interest rates compared to other facilities. Additionally, the ABC Program, through its environmental subprogram (ABC Ambiental), which allows for financing for the adaptation or regularization of rural properties in light of environmental legislation (recovery of the legal reserve and permanent preservation areas, recovery of degraded production areas, and implementation and improvement of sustainable forest management plans) has been a highlight, since the 2018/2019 season, as the credit facility involving the lowest financial charges among the official investment programs, with an interest rate of 5.25% pa;
- Design and commercialization of socio-biodiversity products: inclusion of management of pirarucu in the PGPM-Bio agenda for the 2020 season; subsidy of 19,000 tons of socio-biodiversity products, with BRL 18.7 million paid to 9,309 extractive producers who sold açaí, andiroba, babassu, natural extractive rubber, native cocoa, juçara, macabá, mangaba, pequi, pinhão, and umbu;
- Amazon Fund: 103 projects supported, totaling BRL 1 billion and BRL 860 million.

Name: Action Plan for the Prevention and Control of Deforestation and Forest Fires in the Cerrado biome[21]
Nature of the action: NAMA
Sector: Land Use, Land-Use Change and Forestry (LULUCF)
Coordinating Institution: Ministry of the Environment
Gas (es): CO_2e
General Objective: PPCerrado aims at reducing deforestation and the degradation of native vegetation by promoting the maintenance of ecosystem services through the sustainable use of forest resources and the promotion of sustainable agricultural systems. The specific objectives for this NAMA were developed by the Government when drafting the PPCerrado, and not only by the Ministry of the Environment, thus showing that deforestation is a challenge beyond the environmental agenda. Like the PPCDAm, many of its actions are at the national level. Because the strategy to reduce deforestation is structured by biomes, some results accounted for under the PPCDAm have national impact and are therefore reported both here and in the section on PPCDAm. **Description:** Launched in 2010, the Action Plan for the Prevention and Control of Deforestation and Fires in the Cerrado biome (PPCerrado) was established as one of the main instruments of the National Policy on Climate Change (Law No. 12,187). The Plan is in its 3rd implementation stage (from 2016 to 2020). PPCerrado encompasses several Federal Government policies and actions and is structured in nine specific objectives distributed into four thematic axes: i) environmental monitoring and control; ii) land tenure regularization and territorial management, iii) incentives for sustainable production activities, and iv) normative and economic instruments.
Period: 2010-2019
Estimated reduction related to the NAMA: 104 million tCO_2e by 2020
Specific Objective: To promote land-use planning, strengthening protected areas. **Methodologies and assumptions:** The expansion of protected areas reduces deforestation and protects biodiversity. **Goals:** 17% of the Cerrado in protected areas as conservation units. **Progress Indicators:** Percentage of the biome protected within conservation units. **Actions/Steps taken:** Establishment of seven (07) Private Natural Heritage Reserves (RPPN for its acronym in Portuguese) covering a total area of 110.51 ha **Outcomes:** 8.3% of the biome protected by Federal, State, and Municipal conservation units
Specific Objective: To promote accountability for environmental crimes and infractions. **Methodologies and assumptions:** Increased accountability for environmental crimes and infractions acts as a deterrence mechanism since offenders will fear punished for environmental offenses. The penalty can be in the form of a fine, administrative infraction, or even a criminal sentence. **Goals:** To reduce deforestation in the biome and conservation units Progress Indicators: Deforested area (km^2) **Actions/Steps taken:** Surveillance of critical deforestation areas, including conservation units: • The following actions were implemented in 2018-2019: • 141 flora surveillance actions; • 2,055 notices of infraction issued; • Over 95 thousand hectares of embargoed areas; • 2080 criminal procedures launched; • 115 surveillance actions conducted in conservation units. **Outcomes**: • In 2019, there was a reduction in annual deforested areas in the Cerrado in relation to 2010. The deforestation rates for 2018 and 2019 were the lowest in the historical time series for the Cerrado. • In 2018, the deforested area within federal conservation units covered 70 km^2. Annual deforested areas had a 53.6% reduction in relation to 2010.

[21] The Cerrado is the second largest biome in South America, occupying an area of 2,036,448 km2, about 22% of the national territory. Its continuous area encompasses the states of Goiás, Tocantins, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Bahia, Maranhão, Piauí, Rondônia, Paraná, São Paulo, and Distrito Federal, and also encraves in the states of Amapá, Roraima, and Amazonas.

Specific Objective: Effectively implement joint forest management.
Methodologies and assumptions: Environmental and forest management in Brazil is, to a great extent, a responsibility of the States. The Federal Government's role is to unify and make national data on forest and environmental management available, such as is the case of the National System of the Rural Environmental Registry (Sicar) and the National System for the Control of the Origin of Forest Products (Sinaflor), which are fundamental systems for monitoring and controlling deforestation. The Rural Environmental Registry (CAR) is an instrument for tracking rural properties and their legally protected areas, thus allowing for monitoring and a distinction between legal (authorized) and illegal deforestation. Sinaflor is a monitoring system for tracking the transportation of native wood products.

Goals: To effectively implement the Rural Environmental Registry (CAR)
Progress Indicators: Index of environmental regularity of rural properties (number or area of rural properties in regularization/total real estate).
Actions/Steps taken:

- Provision and implementation of improvements in the SICAR analysis module for all states that use the platform;
- Support for the preparation and submission of simplified proposals for joining the PRA in the 21 states that chose to use the SICAR;
- Deployment of the Environmental Reserve Quota regulation (Decree No. 9,640/2018);
- Capacity building actions for the development of simplified proposals for joining the PRA and fostering the recovery of native vegetation in Permanent Preservation Areas – APP and Legal Reserves – RL;
- Integration of systems and platforms with SICAR data, namely SICOR, SINAFLOR, and SIGEF.

Outcomes: 100% (5.5 million) of rural properties and 548,4 million hectares of rural properties registered (at the national level). *Registers are self-declaratory and will go through a validation phase by the relevant state bodies.

Goals: To implement the National System for the Control of the Origin of Forest Products (Sinaflor).
Progress Indicators: Number of States integrated into Sinaflor.
Actions/Steps taken: Promotion of the integration and interoperability of States' forest-control systems with the National System
Outcomes: Deployment of Sinaflor in 10 out of the 11 states with Cerrado vegetation.

Specific Objective: To prevent and combat the incidence of forest fires.
Methodologies and assumptions: Understanding the dynamics of fires in Brazilian biomes helps inform the decision-making process and implementation of policies to reduce degradation and promote conservation through integrated fire management, which is particularly important for the Cerrado. Federal environmental agencies currently adopt an integrated fire management approach in order to reduce forest fires that are harmful to biodiversity.
Goals: To reduce the area affected by forest fires.
Progress Indicators: Burned area (ha), number of heat spots
Actions/Steps taken:

- Regulation of Art. 40 of Law No. 12,651/2012 Elaboration and submission of the Draft Law No. 11,276/2018, which establishes the National Integrated Fire Management Policy. This is under review in the House of Representatives as a priority;
- Elaboration of Forest Fire Prevention and Combat Plans in conservation units;
- Prevention and combat action planning in priority conservation units;
- Implementation of the Federal Forest Brigade Programme, aiming at reducing the number of forest fires in priority federal areas;
- In 2019, 745 firefighters were hired to cover 40 priority areas (indigenous lands and settlements) and 459 firefighters to cover 24 conservation units. Integrated fire management was implemented in 36 conservation units;
- The 7th International Conference on Forest Fires was held from October 28 to November 1, 2019, in Campo Grande, MS. Under the central theme "Face to face with fire in a changing world: reducing the vulnerability of populations and ecosystems through Integrated Fire Management," the conference brought together more than 1,200 attendees, including government managers and officials, firefighters, researchers, civil society, and the private sector from nearly all states in Brazil and 37 other countries from five continents;
- Also, in 2019, a decree placing a ban on the use of fire for sixty days throughout the national territory was enacted (Decree No. 9,992, of August 28, 2019, amended by Decree No. 9,997, of August 30, 2019).

Outcomes:

- In 2010, 133,394 heat spots were reported in the Amazon; in 2019, 63,874 heat spots were reported. A 52% reduction in relation to 2010;
- In 2010, the burned area in the Cerrado covered 304,825 km²; in 2019, the burned area affected 148,648 km². A 51% reduction in relation to 2010.

Specific Objective: To improve and strengthen the monitoring of vegetation cover.
Methodologies and assumptions: The real-time deforestation detection system is the main tool used by the environmental surveillance to control deforestation, being improved every year by INPE and providing daily data to federal environmental agencies. In addition to the detection system, it is important to emphasize the national effort to map vegetation cover annually, given its high relevance for the measurement of the goals and impacts for the policies to reduce deforestation.
Goals: Development of an alert system (Deter) for the Cerrado.
Progress Indicators: Image area effectively worked on a monthly basis in the DETER system in the Cerrado.
Actions/Steps taken:
Implementation of a real-time deforestation detection system (Deter-B and C).
Outcomes: Detection is fully operational; data are being sent to enforcement bodies and are publicly available. So far, effectively worked image area indicators have not been made available.

Goals: Mapping of annual deforestation in the Cerrado.
Progress Indicators: Deforestation mapping in the Cerrado by types of physiognomies in the period 2000-2018.
Actions/Steps taken: Construction of the historical series of deforestation in the Cerrado and mapping phytophysiognomies in the period 2000-2019.
Outcomes: Publication of the historical series of deforestation in the Cerrado, from 2001 to 2019.

Goals: Annual mapping of the burned area in all Brazilian biomes.
Progress Indicators: Monitored area (ha) and digital maps of burned area (in spatial resolution of 30m and 1km).
Actions/Steps taken:
- Implementation of the annual estimation system of burned area with a spatial resolution of 30 meters and 1km;
- Improved monitoring of near-real-time vegetation fire outbreaks with satellites.

Outcomes: Satellite monitoring of vegetation fire outbreaks by INPE's Programa Queimada for all biomes was carried out in low spatial resolution images (1km), with the automatic generation of daily, monthly and annual summaries in the form of maps, charts, and tables, in addition to spot locations of burning.

Specific Objective: To promote sustainable forest management.
Methodologies and assumptions: Fostering the development of a forest economy is crucial for the conservation of the biome and valuation of its environmental assets. Sustainable use of the forest can extract high-value products while also conserving biodiversity and promoting the local and regional forest economy, creating employment opportunities and income.
Goals: To increase the volume of marketed non-timber and socio-biodiversity products.
Progress Indicators: Volume of production for trading (t, m^3 or other).
Actions/Steps taken:
- Include new socio-biodiversity products in the Policy for Guaranteeing a Minimum Price (PGPM-Bio);
- Strengthening extractive activity.

Outcomes: Design and commercialization of socio-biodiversity products: inclusion of management of pirarucu in the PGPM-Bio agenda for the 2020 season; subsidy of 19,000 tons of socio-biodiversity products, with BRL 18.7 million paid to 9,309 extractive producers who sold açaí, andiroba, babassu, natural extractive rubber, native cocoa, juçara, macabá, mangaba, pequi, pinhão, and umbu (various regions).

Specific Objective: To implement normative and economic instruments to control illegal deforestation.
Methodologies and assumptions: The thematic area of economic and normative instruments consists of an array of Federal Government initiatives to design and implement incentives-based mechanisms to encourage sustainable production, whether through incentives for the adoption of sustainable production technologies and systems or amendments or financial, credit, and tax instruments.
Goals: To enhance positive incentives to reduce deforestation and encourage new production models and the sustainable use of native vegetation
Progress Indicators: Normative actions adopted and resource flows for positive incentives for conservation in R$ and US$.
Actions/Steps taken:

- Increased access to credit for sustainable forest management activities (business, small holders, and community), regularization, and environmental recovery;
- Establishment of progressive credit goal agreements with federal public financial institutions for the sustainable production sector;
- Study and design credit incentives for private rural properties in compliance with the Forest Code, including the extension of the credit limit, without further restrictions and with the monitoring guarantee;
- Foster the integration of information systems (SICOR/Bacen, CAR and embargoed areas) to support the verification of environmental compliance in financing contracts;
- Foster the establishment of the Environmental Reserve Quota regulation (CRA for its acronym in Portuguese);
- Diagnosis of standards and procedures related to issuing authorizations and environmental licensing of sustainable forest management activities. The objective is evaluating its efficiency, the need for harmonization and integration of processes, bridging normative gaps and distinguishing forest management activities by type (community, business, and smallholders);
- Design and implementation of a Sectoral Pact for the Meat Supply Chain;
- Promotion of the sectoral agreement involving the business sector, government, and civil society in order to achieve the goal of reducing deforestation in the Cerrado.

Outcomes:

- Enactment of Decree No. 9,640, of December 27, 2018, which regulates the Environmental Reserve Quota;
- Enactment of Decree No. 9,760, of April 11, 2019, which establishes new rules for the conversion of fines and establishment of Ibama's Environmental Conciliation Centers;
- Preparation and approval of the pilot project for payments for environmental services Floresta+, with resources from REDD+ results, in a total of US 96 million;
- Cross-sector coordination to change the 2018/2019 Season Plan, which made it possible to finance environmental recovery under the funding and Investment modalities, expansion of financing limits for the recovery of environmentally weak areas in rural properties and reduction of interest rates compared to other facilities. Additionally, the ABC Program, through its environmental subprogram, which allows for financing the adaptation or regularization of rural properties in light of environmental legislation (recovery of the legal reserve and permanent preservation areas, recovery of degraded production areas, and implementation and improvement of sustainable forest management plans) has been a highlight, since the 2018/2019 season, as the credit facility involving the lowest financial charges among the official investment programs, with an interest rate of 5.25% pa.

Name: Sustainable Steel Industry Plan
Nature of the action: NAMA
Sector: Industrial processes; Energy
Coordinating Institution: Ministry of the Environment and Ministry of the Economy
Gas (es): CO_2e
General Objective: To promote sustainable production of charcoal used as an input in the production of pig iron, steel, and ferroalloys. **Description**: The Sustainable Steel Industry Plan seeks to promote the sustainable production of charcoal used as an input in the production of pig iron, steel and ferroalloys, aiming at reducing greenhouse gas emissions and increasing the sector's competitiveness. The Plan, launched in 2010, is in its second phase of implementation (2016-2020), structured in forest preservation and reforestation components, as well as industrial and technological components for increasing efficiency in the carbonization process. The Plan fosters the development of solutions for the adequate supply of sustainable raw material by encouraging the use of wood from planted forests and the development and diffusion of more effective charcoal production technologies that increase the efficiency in the conversion of wood to charcoal, with improved environmental quality and reduced GHG emissions.
Period: 2010 - 2019. BUR4 will focus on the 2016-2019 period. Information on the 2010-2016 period is available in BUR1 and BUR2.
Estimated reduction related to the NAMA: 8 to 10 million tCO_2e by 2020

Specific Objective: The reduction in GHG emissions in the steel industry will be achieved through the following actions:

- Use of planted forests instead of native forests.
- Reduction in emissions from the wood carbonization process.
- Increased use of sustainable charcoal in the pig iron, steel and ferroalloy production sectors, in the context of a low carbon circular economy.

Methodologies and assumptions: GHG emissions may be reduced by replacing sourcing from native forest with sourcing from sustainably-planted forest and updating replacing existing carbonization process for more efficient charcoal-producing technologies. The charcoal sustainably sourced is then used in metallurgical processes for the production of pig iron, steel and ferroalloys, which account for about 95% of the total charcoal consumption of in Brazil.

Goals:

- To increase the incentive to technological innovations and the adoption of more efficient and sustainable production processes to convert wood to charcoal.
- To establish an MRV system platform to monitor the emission reductions of projects implemented

Progress Indicators:

- Number of contracts signed;
- Payments made for the achievement of greenhouse gas emissions reduction;
- Status of the MRV platform;
- Number of Demonstrative Units created;
- Training and capacity building conducted and support material produced.

Methodologies and assumptions: Processes and instruments whose design and implementation will directly or indirectly contribute to reducing GHG emissions by replacing sourcing from native forests with sourcing from sustainably-planted forest, and updating replacing existing carbonization processes with more efficient charcoal-producing technologies. The charcoal sustainably sourced is then used in metallurgical processes for the production of pig iron, steel and ferroalloys, which account for about 95% of the total charcoal consumption in Brazil.

Actions/Steps taken:

In 2016, the pilot project BRA/14/G31 (Sustainable Steel Industry) was initiated, coordinated by the Ministry of the Environment (MMA) and implemented by the United Nations Development Programme (UNDP). The following institutions are members of the Project Monitoring Committee (CAP for its acronym in Portuguese): Ministry of the Economy (ME), Ministry of Science, Technology and Innovations (MCTI), Ministry of Agriculture, Livestock and Food Supply (MAPA), and the Government of the State of Minas Gerais. This project aims at deploying more efficient technologies in existing carbonization processes through a financial incentive mechanism for results-based payments, as well as the establishment of public policies to encourage forest sustainability in the sector. The project is initially focused on the State of Minas Gerais, which houses around 80% of the country's charcoal production, with a projected horizon initially up to the first half of 2020, but it has been extended to the first half of 2021.

Six projects within the results-based payment mechanism were hired through a public bidding process. An MRV Platform has been designed to monitor these activities' progress, assisting in the development of estimates for the reduction of greenhouse gas emissions. Four Demonstration Units (Zona da Mata, Northeast of Minas Gerais, Montes Claros, and Sete Lagoas) were installed for smallholder charcoal producers, which will serve as a basis for the training program.

Consultancy studies were concluded and will be the basis for public policies towards forest sustainability in the sector, as well as a starting point for the ongoing elaboration of the sustainability strategy for the Brazilian pig iron, steel and ferroalloys sector.

For the second phase of the project, which will run until 2021, expansion of the project support to small and medium charcoal producers was planned, with a view to promoting greater reach and providing gains of scale in more efficient technologies for the Brazilian steel sector.

Outcomes:

- 6 signed and ongoing charcoal producer support contracts at the industrial level, with the adoption of the Payment by Results mechanism for charcoal production with the use of more efficient and sustainable production technologies;
- An independent audit hired to verify the results of greenhouse gas emission reduction results by the supported businesses;
- Initial payments made for the reduction of greenhouse gas emissions achieved; MRV system platform fully developed to monitor emission reductions from the implemented projects;
- Selection of the Modular Program for Verifying the Origin of Charcoal (PROMOVE for its acronym in Portuguese) to monitor socio-environmental indicators in the production of charcoal and its use in the steel industry;
- Establishment of Demonstrative Units (UDs), developed in collaboration with the University of Viçosa to educate smallholder independent producers through training courses;

- Production of training materials (such as videos, manuals, booklets) on the sustainable conversion of charcoal for (i) technical training aimed at steel companies, universities, and research institutes; (ii) policymakers and decisionmakers; and (iii) project developers and financiers;
- As of December 2019, over 300 and 50 people had been trained, respectively, in the construction and operation of furnace systems and carbon balance methodologies;
- Delivery of training on business models involving a furnace system and courses on forestry techniques for 100 extension workers;
- Completion of business plans for the adoption of sustainable technologies in Zona da Mata, where hillside kilns predominate, as well as in the Northeast of Minas Gerais, where traditional furnaces (rectangular or "hot tail" kilns) predominate;
- A company hired for the ongoing elaboration of the sustainability strategy for the Brazilian pig iron, steel and ferroalloys sector;
- Execution of a Memorandum of Understanding between the UNDP (project implementing agency) and universities, NGOs, and state federations of industry and agriculture, thereby showing the positive reception of the project by the private sector (charcoal producers and the pig iron, steel and ferroalloy sector) and other stakeholders and partners (academia, local government, sectoral entities, etc.). In addition, a strong relationship was established with other institutions at the national and state levels, including banks, research institutions, and industrial systems;
- Inclusion of charcoal production in the National Plan for the Development of Planted Forests, launched in December 2018. In concrete terms, with the possibility of financing furnaces for wood carbonization.

Name: Increase in energy supply by hydroelectric power plants
Nature of the action: NAMA
Sector: Energy
Coordinating Institution: Ministry of Mines and Energy
Gas (es): CO_2e
General Objective: To increase installed capacity from hydroelectric power plants in the national energy mix
Period: 2010 - 2019. BUR4 will focus on the 2016-2019 period. Information on the 2010-2017 period is available in BUR1, BUR2, and BUR3.
Estimated reduction related to the NAMA: 79 to 99 million tCO_2e by 2020
Specific Objective: To introduce Hydroelectric Power Plants (HPP) to the national electric system. **Goals:** To increase installed capacity of Hydroelectric Power Plants in the national electric system. **Progress Indicators:** Increased installed capacity of Hydroelectric Power Plants. Unit: MW. **Methodologies and assumptions:** Electric energy auctions are instruments for the insertion of new enterprises for the supply of electric energy. The regulation on the trading of electric energy provides that electric power distribution companies must guarantee the attendance of their electric energy market. Thus, auctions are promoted including, but not limited to, the objectives of hiring energy at the lowest possible price and attracting investors for the construction of new plants for the expansion of generation, including hydroelectric plants. **Actions/Steps taken:** In the 2018-2019 period, there were 04 auctions of different formats that included the insertion of hydroelectric power plants, among other sources. **Outcomes**: Additional 8,337 MW of Installed Capacity of Hydroelectric Power Plants in the 2018-2019 period[22].

[22] *Source: MME. Resenha Energética Brasileira, edição 2019, 2020.*
<http://www.mme.gov.br/web/guest/secretarias/planejamento-e-desenvolvimento-energetico/publicacoes/resenha-energetica-brasileira>

Specific Objective: To promote the insertion of Small Hydroelectric Plants (SHPs and HPPs) in the national electric system, including distributed generation.
Goals: To increase installed capacity of Small Hydroelectric Plants in the national electric system.
Progress Indicators: Increased installed capacity of Small Hydroelectric Plants. Unit: MW.
Methodologies and assumptions: Electric energy auctions are instruments for the insertion of new enterprises for the supply of electric energy. The regulation on the trading of electric energy provides that electric power distribution companies must guarantee the attendance of their electric energy market. Thus, auctions are promoted including, but not limited to, the objectives of hiring energy at the lowest possible price and attracting investors for the construction of new plants for the expansion of generation, including small hydroelectric plants. In 2015, ANEEL published Normative Resolution No. 687, providing a set of rules for Distributed Generation that regulates consumers for electricity generation for their use and the surplus supply to the local distribution network.
Actions/Steps taken: In the 2018-2019 period, there were 04 auctions of different formats that included the insertion of hydroelectric generation, among other sources. Implementation of the regulatory framework for distributed generation.
Outcomes: Additional 498 MW of Installed Capacity of Hydroelectric Power Plants in the 2018-2019 period[22].

Name: Alternative Energy Sources
Nature of the action: NAMA
Sector: Energy
Coordinating Institution: Ministry of Mines and Energy
Gas (es): CO_2e
General Objective: Increased installed capacity in solar, wind, and biomass sources in the national energy mix
Period: 2010 - 2019. BUR4 will focus on the 2016-2019 period. Information on the 2010-2017 period is available in BUR1, BUR2, and BUR3.
Estimated reduction related to the NAMA: 26 to 33 million tCO_2e by 2020
Specific Objective: To promote the insertion of wind plants in the national electric system, including distributed generation. **Goals:** To increase installed capacity of wind plants in the national electric system **Progress Indicators:** Increased installed capacity of wind plants. Unit: MW **Methodologies and assumptions:** The regulation electric energy trading provides that electric power distribution companies must guarantee the attendance of their entire electric energy market by holding electric energy auctions. Thus, auctions are promoted including, but not limited to, the objectives of hiring energy at the lowest possible price and attracting investors for the construction of new plants for the expansion of generation, including wind sources. In 2015, ANEEL published Normative Resolution No. 687, providing a set of rules for Distributed Generation that regulates consumers for electricity generation for their use and the surplus supply to the local distribution network. **Actions/Steps taken:** In the 2018-2019 period, there were 04 auctions of different formats that included the insertion of wind generation, among other sources. Implementation of the regulatory framework for distributed generation. **Outcomes:** Additional 3,095 MW of Installed Capacity of Wind Plants in the 2018-2019 period[22].
Specific Objective: To promote the insertion of solar photovoltaic plants in the national electric system, including distributed generation. **Goals:** To increase installed capacity of solar photovoltaic plants in the national electric system. **Progress Indicators:** Increased installed capacity of solar photovoltaic plants. Unit: MW **Methodologies and assumptions:** The regulation on electric energy trading provides that electric power distribution companies must guarantee the attendance of their entire electric energy market by holding electric energy auctions. Thus, auctions are promoted including, but not limited to, the objectives of hiring energy at the lowest possible price and attracting investors for the construction of new plants for the expansion of generation, including solar photovoltaic generation. In 2015, ANEEL published Normative Resolution No. 687, providing a set of rules for Distributed Generation that regulates consumers for electricity generation for their use and the surplus supply to the local distribution network. **Actions/Steps taken:** In the 2018-2019 period, there were 04 auctions of different formats that included the insertion of solar generation, among other sources. Implementation of the regulatory framework for distributed generation. **Outcomes:** Additional 3,346 MW of Installed Capacity of Solar Photovoltaic Plants in the 2018-2019 period[22].

Specific Objective: To promote the insertion of biomass thermal power plants in the national electric system, including distributed generation
Goals: To increase installed capacity of biomass thermal plants in the national electric system.
Progress Indicators: Increased installed capacity of biomass thermal plants. Unit: MW.
Methodologies and assumptions: The regulation on electric energy trading provides that electric power distribution companies must guarantee the attendance of their entire electric energy market by holding electric energy auctions. Thus, auctions are promoted including, but not limited to, the objectives of hiring energy at the lowest possible price and attracting investors for the construction of new plants for the expansion of generation, including biomass thermal power plants. In 2015, ANEEL published Normative Resolution No. 687, providing a set of rules for Distributed Generation that regulates consumers for electricity generation for their use and the surplus supply to the local distribution network.
Actions/Steps taken: In the 2018-2019 period, there were 04 auctions of different formats that included the insertion of biomass thermal plants, among other sources. Implementation of the regulatory framework for distributed generation.
Outcomes: Additional 302 MW of Installed Capacity of Biomass Thermal Plants in the 2018-2019 period[22].

Name: Increase the use of Biofuels
Nature of the action: NAMA
Sector: Energy
Coordinating Institution: Ministry of Mines and Energy
Gas (es): CO_2e
General Objective: To increase the amount of biofuel in the national energy mix.
Period: 2010 - 2019. BUR4 will focus on the 2018-2019 period. Information on the 2010-2017 period is available in BUR1, BUR2, and BUR3.
Estimated reduction related to the NAMA: 48 to 60 million tCO_2e by 2020
Specific Objective: To promote the supply of Ethanol (anhydrous and hydrated alcohol) to replace gasoline. **Goals:** To promote the supply of Ethanol. **Progress Indicators:** Supply of Ethanol. Unit: m³. **Methodologies and assumptions:** The RenovaBio Program aims at promoting the adequate expansion of biofuels in the energy mix, thus promoting the regularity of fuel supply in the market and inducing gains in energy efficiency and reduction of GHG emissions. **Actions/Steps taken:** Establishment of the National Policy on Biofuels (RenovaBio Program) through Law 13,576/2017. **Outcomes:** Supply of 68,400,000 m³ of ethanol added to the fuel mix in the 2018-2019 period[22].
Specific Objective: To promote the supply of biodiesel to replace fossil diesel. **Goals:** To encourage the supply of biodiesel. **Progress Indicators:** Supply of biodiesel. Unit: m³. **Methodologies and assumptions:** Law No. 13,263/2016 determined that the percentages of mandatory blending of biodiesel into diesel oil should be 8% (eight percent) 12 months after the enactment of the Law; 9% (nine percent) 24 months after the enactment of the Law; and 10% 36 months after the enactment of the Law. As of 2019, the biodiesel blending might get to 15% after tests and trials with engines. **Actions/Steps taken:** Establishment of the National Policy on Biofuels (RenovaBio Program) through Law 13,576/2017. Establishment of biodiesel blending percentages in fossil diesel through Law 13,263/2016. **Outcomes:** Supply of 11,274,000 m³ of biodiesel added to the fuel mix in the 2018-2019 period[22].

Name: Energy Efficiency
Nature of the action: NAMA
Sector: Energy
Coordinating Institution: Ministry of Mines and Energy
Gas (es): CO_2e
General Objective: To reduce the use of fossil fuels and electricity through increased energy efficiency in different sectors of the economy
Period: 2010 - 2018. BUR4 will focus on 2018. Information on the 2010-2017 period is available in BUR1, BUR2, and BUR3.
Estimated reduction related to the NAMA: 12 to 15 million tCO_2e by 2020
Specific Objective: To encourage the reduction of electricity consumption through government programs on energy efficiency. **Goals:** To encourage the reduction of electric energy consumption. **Progress Indicators:** Reduction in electric energy consumption. Unit: GWh. **Methodologies and assumptions:** Reducing electricity consumption reduces GHG emissions. The calculation of the results of the PROCEL Program to reduce electricity consumption and ANEEL's energy efficiency projects will be the basis for measuring the progress of this specific objective implementation. **Actions/Steps taken:** Regulation of the use of resources for the PROCEL Program through Law 13,280/2016. Implementation of the PROCEL Resource Application Program. **Outcomes:** Reduction of 44,590 GWh in the country's electricity consumption in the 2018-2019 period[23].
Specific Objective: To encourage the use of highly efficient electrical equipment. **Goals:** To increase the supply of highly efficient electrical equipment. **Progress Indicators:** Number of electrical equipment models bearing the PROCEL label. **Methodologies and assumptions:** Participation in the equipment labeling program is voluntary. The PROCEL label was created to increase the number of certified pieces of equipment with high-energy efficiency levels. The label is a widely publicized award, which contributes to brand recognition. **Actions/Steps taken:** Awarding the PROCEL label for high energy efficiency equipment, with the Brazilian Labeling Program as a reference. **Result:** Supply of 3,627 electrical equipment models with the PROCEL Label in 2018[23].
Specific Objective: To encourage the use of highly efficient vehicles. **Goals:** To increase the supply of highly efficient vehicles. **Progress Indicators:** Number of vehicle models bearing the CONPET label. **Methodologies and assumptions:** Participation in the vehicle labeling program is voluntary. The CONPET label was created to increase the number of certified vehicles with high-energy efficiency levels. The label is a widely publicized award, which contributes to brand recognition. **Actions/Steps taken:** Awarding the CONPET label for high fuel efficiency vehicles, with the Brazilian Labeling Program as a reference. **Result:** Supply of 78 vehicle models with the CONPET Label in 2018; Supply of 59 vehicle models with the CONPET Label in 2019[24].

[23] Source: Procel. Resultados do Procel - Ano Base 2018 <http://www.procelinfo.com.br/main.asp?View={EC4300F8-43FE-4406-8281-08DDF478F35B}> and Aneel. Website: Program Management <https://www.aneel.gov.br/programa-eficiencia-energetica>

[24] Source: Inmetro. Inmetro. Website: PBE Veicular <http://www.inmetro.gov.br/consumidor/tabelas.asp>

3.1 CLEAN DEVELOPMENT MECHANISM (CDM) PROJECTS IN BRAZIL: AN UPDATE

From February 2004 to December 2017, the Executive Board of the Interministerial Commission on Global Climate Change (CIMGC, for its acronym in Portuguese) – the Brazilian Designated National Authority (DNA) for the CDM – received 466 CDM project activity proposals. Out of these, 426 project activities were approved by the CIMGC, one activity was rejected and 39 had their assessment not finalized or canceled at the request of the project participants.

Of the total projects approved by the CIMGC, 344 project activities were registered with the CDM Executive Board, thus accounting for an increase of 2 projects in relation to the latest BUR.

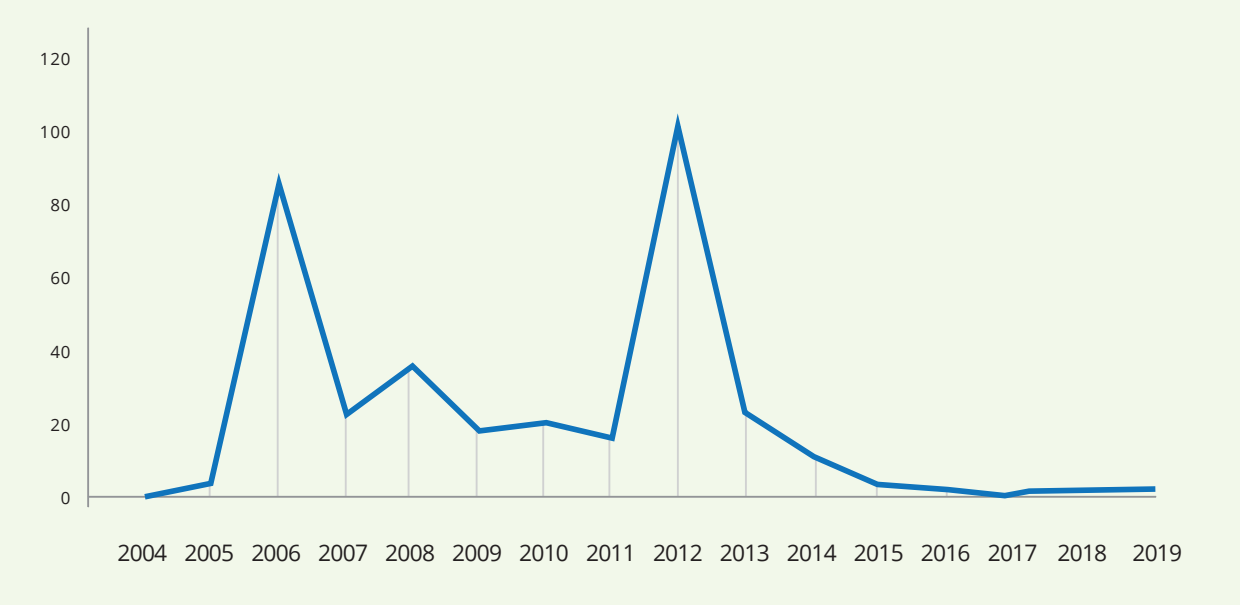


Figure IV: Annual distribution of Brazilian project activities registered with the CDM Executive Board (Nov 2004-Dec 2019).

Most registrations occurred in 2006, when the CDM started to consolidate its position in the carbon market, and in 2012, marking the end of the first commitment period of the Kyoto Protocol. Table XVII shows that 27.7% of the total CDM projects in Brazil registered by December 2019 are related to hydropower plants (96 projects), followed by biogas (18.3%), wind power plants (16.6%), landfill gas (15.1%), and biomass energy (11.9%).

As for the reduction of GHG emissions, the largest contributions result from hydropower plants, landfill gas, decomposition of N_2O and wind power plant project activities, whose estimated combined emission reduction amounts to more than 319 million tCO_2e.

As shown in Table XVII, for projects registered from 2004 to 2019, Brazil has a significant emission reduction potential of 380 million tCO_2e, for the first crediting period.

TABLE XVII: DISTRIBUTION OF CDM PROJECT ACTIVITIES IN BRAZIL PER TYPE OF PROJECT ACTIVITY, REGISTERED BY DECEMBER 2019

Types of project activities	CDM Project Activities		Estimated reduction in GHG emissions for the first crediting period	
	Quantity	% in relation to total	tCO_2eq	% in relation to total
Hydropower	96	27.9	138,805,656	36.5
Biogas	63	18.3	24,861,823	6.5
Wind power	57	16.5	44,306,593	11.7
Landfill gas	52	15.1	91,367,345	24
Biomass energy	41	11.9	16,091,394	4.2
Substitution of Fossil Fuel	9	2.6	2,664,006	0.7
Methane Avoided	9	2.6	8,627,473	2.3
Decomposition of N_2O	5	1.5	44,660,882	11.8
Utilization and heat recovery	4	1.2	2,986,000	0.8
Reforestation and Afforestation	3	0.9	2,408,842	0.6
Use of materials	1	0.3	199,959	0.1
Photovoltaic Solar Energy	1	0.3	6,594	0
Energy Efficiency	1	0.3	382,214	0.1
Replacement of SF_6	1	0.3	1,923,005	0.5
PFC reduction and Replacement	1	0.3	802,860	0.2
Total	**344**	**100**	**380,094,646**	**100**

In terms of the estimated annual reduction of GHG emissions, associated with the CDM project activities registered from 2004 to 2019, Brazil had a reduction potential of 53,043,098 tCO_2e per year, which reflects the significant potential for Brazil's participation in the global effort to fight climate change.

4

CONSTRAINTS AND GAPS, AND RELATED FINANCIAL, TECHNICAL AND CAPACITY NEEDS; INFORMATION ON SUPPORT RECEIVED

4.1 CONSTRAINTS AND GAPS, AND RELATED FINANCIAL, TECHNICAL AND CAPACITY NEEDS; INFORMATION ON SUPPORT RECEIVED

4.1 CONSTRAINTS AND GAPS, AND RELATED FINANCIAL, TECHNICAL AND CAPACITY NEEDS

Due to the country's dimensions and diversity in terms of social, economic and environmental factors, the information presented in this chapter should be considered as provisional, partial and non-exhaustive. There are considerable challenges related to any in-depth consideration and identification of constraints and gaps, and related financial, technical and capacity needs at a comprehensive scale. The table below summarizes technical, capacity building and financial support needs in some areas of interest for further international cooperation, without prejudice to other areas that may be identified further.

TABLE XVIII: CONSTRAINTS AND GAPS, AND RELATED FINANCIAL, TECHNICAL AND CAPACITY NEEDS

Activity	Sector	Related NAMA	Gap	Constraint	Financial needs	Capacity-building-needs	Technology transfer needs
Measurement, reporting and verification of transformation and maintenance actions of resilient and sustainable production systems	Agriculture	ABC Plan	Lack of more detailed on-site data and images for measurement and validation of efforts and results.	Vast territory for verification and validation coverage, and limited resources for the acquisition of supplies and travel throughout the national territory	Financial resources for acquisition or access to images and field trips for measurement and validation of interpretations	NA	NA
Measurement, reporting and verification of transformation and maintenance actions of resilient and sustainable production systems	Agriculture	ABC Plan	Lack of a participatory and integrated system to feed the monitoring system and fluid processes for data input and information output	Highly diverse systems and stakeholders involved in the various States, and dynamic evolution of actions and knowledge, which require an easily accessible, transparent and consistent system. Limited resources for hiring domestic experts in data storage and organization systems, with fluid processes for data input and information output	Financial resources for hiring staff necessary for the development and structuring of a participatory and integrated feeding system for the monitoring system	NA	NA

Activity	Sector	Related NAMA	Gap	Constraint	Financial needs	Capacity-building-needs	Technology transfer needs
Measurement, reporting and verification of transformation and maintenance actions of resilient and sustainable production systems	Agriculture	ABC Plan	Absence of a participatory process and an integrated system for validation and verification of results by experts for monitoring and analysis purposes	Diverse stakeholders involved in the various States, and dynamic evolution of activities, technologies, and knowledge, as well as differences in the behavior of technologies and systems, in the various biomes. Limited resources for hiring domestic experts and travel of stakeholders for consultations, verification, discussion, and data validation.	Financial resources for the development and implementation of an integrated system and a participatory process for validating the results of analyzes		
Measurement, reporting and verification of transformation and maintenance actions of resilient and sustainable production systems	Agriculture	ABC Plan	Limited harmonized preliminary information for the development of a national traceability and certification system	Diverse data and institutions, as well as strategies to ensure the necessary transparency and reliability of a national traceability and certification system. Limited resources for hiring domestic experts and conducting preliminary studies for a traceability and certification system.	Financial resources for establishing an effective traceability and certification system	Training of experts on traceability and certification systems	
Improve the capacity of technical and financial assistance agents	Agriculture	ABC Plan	Knowledge gap in relation to best practices and technologies, and systems that are appropriate to the various biomes	Limited resources to promote the necessary training, consolidation and dissemination of knowledge, taking into consideration the diversity of stakeholders involved in the various States, the dynamic evolution of activities, technologies, and knowledge, as well as differences in behavior of technologies and systems in different Brazilian biomes.	Financial resources to develop Infrastructure and studies, purchase equipment, and promote capacity-building	Support for professional training and dissemination of knowledge	

Activity	Sector	Related NAMA	Gap	Constraint	Financial needs	Capacity-building-needs	Technology transfer needs
Technology research and development	Agriculture	ABC Plan	Increased complexity and uncertainty due to climate change, need for new research in the biological and agricultural domains, statistics and data interpretation, and alternative and innovative solutions	Limited resources for data collection, studies, and technological development	Financial resources for infrastructure, equipment, and studies	Exchange of knowledge and technologies	Exchange of knowledge and technologies
Cooperation between the Federal Government and state governments to improve forest management	LULUCF	PPCDAm e PPCerrado	Shortfalls in the integration of systems for granting vegetation suppression licenses across the various levels of government	Limited resources, including budgetary constraints	Financial resources for technical and institutional cooperation	Awareness of the importance of the initiative for the country's reputation and the development of public policies to combat illegal practices, and promote legal compliance	NA
Strengthening of forest fire prevention and control actions	LULUCF	PPCDAm e PPCerrado	Techniques related to integrated fire management are not yet widely disseminated	Limited resources, including budgetary constraints	Financial resources for the dissemination of techniques for the control and prevention of forest fires	Training on integrated fire management	NA
Promotion of bioeconomy and payment for environmental services	LULUCF	PPCDAm e PPCerrado	Enabling business environment and the absence of legal certainty	Lack of recognition of the importance of the contribution of market mechanisms	NA	Management of quick, efficient, and user-oriented administrative processes	Exchange of technologies for process management
Design and implementation of new pilot projects in regions not covered by the current project	LULUCF and Industry	Sustainable steel industry	Scarce sources of financing for new pilot projects	Limited financial resources	Financial resources for the design and implementation of new pilot projects	Training of stakeholders in regions not covered by the current project	Technology transfer to stakeholders in regions not covered by the current project
Expansion of the results-based payment mechanism for companies not covered by the current project	LULUCF and Industry	Sustainable steel industry	Scarce sources of financing for the extension of the results-based payment mechanism for companies not covered by the current project	Limited financial resources	Financial resources for the extension of the results-based payment mechanism for companies not covered by the current project	Training of stakeholders that are not covered by the current project (e.g. MRV methodology, MRV platform)	NA

Activity	Sector	Related NAMA	Gap	Constraint	Financial needs	Capacity-building-needs	Technology transfer needs
Promotion of gains of scale of the pilot project	LULUCF and Industry	Sustainable steel industry	Scarce sources of financing for gains of scale of the current pilot project	Limited financial resources	Financial resources to promote gains of scale of the current pilot project	Training of stakeholders not currently covered by the pilot project	Technology transfer to stakeholders not currently covered by the pilot project
Training to broaden the insertion of non-conventional renewable sources in the national energy mix	Energy	Alternative energy sources	Need for consolidating and disseminating technologies for energy exploration by concentrated solar thermal plants	Limited resources for consolidation and dissemination of knowledge	Financial resources for the technological development, consolidation, and dissemination of knowledge in concentrated solar thermal plants	Support for professional training and dissemination of knowledge on concentrated solar thermal sources, including seminars, workshops, and exchange of experiences on the topic	Cooperation for technological development in concentrated solar thermal sources
Training to broaden the insertion of energy storage technologies	Energy	Alternative energy sources	Needs related to consolidation and dissemination of energy storage technologies	Limited resources for consolidation and dissemination of knowledge	Financial resources for the technological development, consolidation, and dissemination of knowledge on energy storage	Support for professional training and dissemination of knowledge on energy storage, including seminars, workshops, and exchange of experiences on the topic	Cooperation for technological development in energy storage
Training to promote the consolidation of Monitoring, Reporting and Verification systems (MRV) of energy efficiency programs	Energy	Energy efficiency	Shortfalls in the Monitoring, Reporting and Verification processes of energy efficiency programs	Limited resources for consolidation and dissemination of knowledge	Financial resources for the development and dissemination of methodologies and procedures for the MRV of energy efficiency programs	Support for professional training and dissemination of knowledge on MRV related to energy efficiency, including seminars, workshops, and exchange of experiences on the topic	Cooperation for the development and dissemination of methodologies and procedures for the MRV of energy efficiency programs
Quantification of greenhouse gas emission reductions by the production chain	Agriculture, Energy, LULUCF, and Industry	All	Methodological difficulties in quantifying emissions reductions by the production chain	Lack of awareness of the importance of generating information on emissions/removals by economic activity	NA	Development, implementation, and dissemination of methodologies	Methodologies and technologies for quantifying emission reductions by production chains
Encouragement to technology research and development	Agriculture, Waste, Energy, LULUCF, and Industry	NA	Lack of information and data on activities and shortfalls persist in the scientific and technical production based on the country's reality	Limited resources for technology research and development for climate sciences	Financial resources for infrastructure, equipment, and encouragement of studies and research projects on climate change	Exchanges, webinars, international exchange of experiences, and training on how to transfer technologies and knowledge	Exchange of technologies and knowledge

Activity	Sector	Related NAMA	Gap	Constraint	Financial needs	Capacity-building-needs	Technology transfer needs
Improvement of the emission monitoring, reporting and verification system	Agriculture, Waste, Energy, LULUCF, and Industry	NA	Poor systematization, organization, and availability of official information	Absence of a legal framework establishing responsibilities and operation of a national system for the National GHG Inventory	Financial resources for infrastructure and agencies responsible for systematizing the information	Training on how to structure and assure information for the proper monitoring, reporting and verification of emissions	Exchange of technologies and knowledge
Strengthening of existing institutional arrangements through training and information generation via climate and economic modeling	Agriculture, Waste, Energy, LULUCF, and Industry	NA	Lack of an official information center to inform the climate change decision-making process	Limited resources to structure collaborative modeling of transparency	Financial resources to support the structuring of a platform, for infrastructure, encouragement of studies and research projects to inform a long-term climate change strategy	Exchanges, webinars, international exchange of experiences on information modeling and networking to support the decision-making process	Exchange of technologies and knowledge

4.2 INFORMATION ON SUPPORT RECEIVED

External financing through multilateral and bilateral channels has contributed to support policies to fight climate change and its effects in Brazil in recent years. However, there was a noticeable reduction in the amounts contributed by the cooperating countries and organizations throughout the period covered by this report (2018-2019). For a better assessment of the implementation of public policies and programs for mitigating and adapting to climate change around the world, it is crucial to identify the amount and allocation of these flows, evaluate their outcomes and their contribution to the implementation of national priority actions with a view to identifying challenges and opportunities to optimize the use of resources. In this context, Brazil views the Biennial Update Reports (BURs) as important sources of information.

Following up from the data provided in the previous BURs, this section provides current information on the international support received by the country to implement actions to combat climate change. Public resources committed to Brazilian entities through multilateral and bilateral channels (Parties included in Annex II of the Convention) in 2018 and 2019 are considered. This chapter seeks to provide, in a table format, the information in the most complete, disaggregated, and transparent manner. In addition to maintaining the same BUR3 reporting parameters, which had already represented a breakthrough in relation to the previous reports, this section has retained the parameters related to information about possible technical training component and/or technology transfer and links to the project/contract, allowing the reader reference to detailed information.

In collecting data for this chapter, information from multilateral institutions was more comprehensive and comparable than bilateral flows data. Notwithstanding improvements in the data collected in support of the current BUR, the information provided by some multilateral financing institutions and developed countries still lacks the necessary completeness, transparency, and comparability to allow identification of the projects supported, with a view to their due recognition.

Because of these restrictions, information on bilateral channels only includes resources that have been internalized through a public entity or implemented under the coordination of a public entity (whether federal, state, or municipal). Information on multilateral channels, in turn, also includes resources directed to private companies. Like in the case of BUR2, a decision was made to use the resource commitment date as a reference for inclusion in the listing, thus avoiding any potential duplications. Therefore, projects currently under implementation that were approved or had their resources committed by the relevant institutions before 2018-2019 were not included. As for REDD+ resources, there has been no changes in their reporting rationale since BUR3, where actual amounts for a particular year are reported.

In terms of financial instruments, grants, loans and shareholding information is reported herein. All amounts are in US dollars. When data was available in a currency other than the US dollar, the conversion rate used was based on that of the OECD annual exchange rate for the project commitment year[25]. Funding institutions themselves reported the percentages of climate components shown on the tables. For the identification of technical training and technology transfer components, the criteria used were those adopted under the UNFCCC[26].

The contribution of resources to Brazil in 2018-2019 totaled approximately US$1.874 billion, with less than 6% allocated through bilateral channels. There was a decrease in relation to the bilateral support received in previous biennia, from more than US$437 million in 2016-2017 to about US$100 million in 2018-2019. It should also be noted that multilateral contributions for 2018 and 2019 did not reach 50% of the contributions in 2017.

In view of the importance of international financing in catalyzing climate change action, Brazil has stressed the need for the financial contribution to be adequate, predictable, sustainable, new, and additional. In recalling the developed countries' commitment to contribute with US$ 100 billion per year by 2020, Brazil stresses that the current status of implementation of the commitment is not clear.

[25] *Available in: <https://data.oecd.org/conversion/exchange-rates.htm>*

[26] *Available in: <https://bigpicture.unfccc.int/content/capacity-building.html#content-capacity-building> and <https://unfccc.int/resource/docs/2009/sb/eng/02.pdf>.*

TABLE XIX: SUPPORT RECEIVED BY MULTILATERAL CHANNELS IN 2018

Institution	Type of support (mitigation, adaptation, cross-cutting, other)	Sector (energy, transportation, industry, agriculture, forests, water resources and sanitation, cross-cutting, other, not applicable)	Project name	Total financing (US$ Millions)	Climate-specific component (%)	Climate-specific financing (US$)	Financing instrument	Commitment / receipt date (MM/DD/YYYY)	Capacity-building (1) / Technology transfer (2) / Not applicable (NA)	Source
IaDB	Mitigation	Water resources and sanitation	Tietê River Cleanup Program, Stage IV	$300.00	96 %	$288,000,000	Loan	10/11/2018	1 / 2	https://www.iadb.org/en/project/BR-L1492
CAF	Mitigation	Energy efficiency	Sobral Socioenvironmental Development Program (PRODESOL), State of Ceará	$50.00	100 %	$50,000,000	Loan	11/14/2018	NA	CAF Database (unavailable)
GEF/IaDB	Mitigation	Forests	Conservation, Restoration and Sustainable Management in the Caatinga, Pampa and Pantanal - GEF Terrestre	$32.62	100 %	$32,620,000	Grant	03/12/2018	1/ 2	https://www.iadb.org/en/project/BR-G1004
IFC	Mitigation	Agriculture (Sugar & Ethanol)	Usina Açucareira S. Manoel S.A.	25.00 (+35.00 syndicated loan)	99.51 %	$23,877,500	Loan	June 2018	NA	https://disclosures.ifc.org/#/projectDetail/SII/40264
CTF/IaDB	Mitigation	Urban development	Sustainable Transit-Oriented Development in Brazil	$2.00	100 %	$2,000,000	Grant	12/06/2018	1 / 2	https://www.iadb.org/en/project/BR-T1394
GCF	Mitigation	Cross-cutting	Technology Needs Assessment for the Implementation of Climate Action Plans in Brazil	$0.70	100 %	$700,000	Grant	06/12/2018	NA	https://www.greenclimate.fund/document/strategic-frameworks-support-brazil-through-unep
IaDB	Cross-cutting	NA	Enhancing Brazil's Capacity to Access Green Climate Fund (GCF) Finance for NDC Implementation	$0.25	100 %	$250,000	Grant - technical cooperation	05/30/2018	1	https://mydata.iadb.org/es/widgets/tvpd-d486
IaDB	Adaptation	Agriculture	Agricultural Risk Management and Crop Insurance in Brazil: Climate Risk Monitoring Small-Scale Farmers	$0.22	100 %	$220,000	Grant - technical cooperation	11/28/2018	1 / 2	https://www.iadb.org/en/project/BR-T1404
CAF	Mitigation	Sanitation	Technical assistance program for the municipality of Sobral: solid waste and sustainable transport	$0.20	100 %	$200,000	Grant	02/19/2018	1	CAF Database (unavailable)
CAF	Adaptation	Forests and natural capital	Studies for the establishment of the Fonte dos Padres Linear Park in the municipality of Alagoinhas (BAHIA)	$0.20	100 %	$200,000	Grant	10/26/2018	1	CAF Database (unavailable)
GEF	Cross-cutting	Cross-cutting	Cities-IAP: Promoting Sustainable Cities in Brazil through Integrated Urban Planning and Innovative Technologies Investment	$24.67	63 %	$15,673,000	Grant	March 2018	1 / 2	https://www.thegef.org/project/cities-iap-promoting-sustainable-cities-brazil-through-integrated-urban-planning-and
IBRD	Cross-cutting	Water resources	SABESP - Improving Water Service Access and Security in the Metropolitan Region of São Paulo	$250.00	44.25 %	$110,630,000	Loan	12/18/2018	NA	https://projects.worldbank.org/en/projects-operations/project-detail/P165695

Institution	Type of support (mitigation, adaptation, cross-cutting, other)	Sector (energy, transportation, industry, agriculture, forests, water resources and sanitation, cross-cutting, other, not applicable)	Project name	Total financing (US$ Millions)	Climate-specific component (%)	Climate-specific financing (US$)	Financing instrument	Commitment / receipt date (MM/DD/YYYY)	Capacity-building (1) / Technology transfer (2) / Not applicable (NA)	Source
IaDB	Mitigation	Health	City of São Paulo Health Care Networks Restructuring and Quality Certification Project – Avança Saúde SP	$100.00	43 %	$42,690,000	Loan	10/26/2018	1 / 2	https://www.iadb.org/en/project/BR-L1429
IaDB	Cross-cutting	Urban development	Urban Improvement Program and Citizen Security Program (Phase One of the Sustainable Vitória Action Plan)	$100.00	40 %	$39,660,000	Loan	09/28/2018	1 / 2	https://www.iadb.org/en/project/BR-L1497
Fonplata	Cross-cutting	Transportation, urban mobility, sanitation	Ecological Axis Program - Green Line East Region, Leste Joinville	$40.00	40 %	$16,000,000	Loan	12/27/2018	NA	https://www.fonplata.org/pt/projetos/programa-eixo-ecologico-linha-verde-regiao-leste-joinville
IFC	Mitigation	Industry (Food Industry)	Bauducco	22.14 (9.30 syndicated loan)	38 %	$8,413,200	Loan	May 2018	NA	https://disclosures.ifc.org/#/projectDetail/ESRS/40796
IaDB	Mitigation	Transportation	Public Infrastructure Management Investment Program for Municipal Efficiency	$600.00	33 %	$199,980,000	Loan	11/28/2018	1 / 2	https://www.iadb.org/en/project/BR-L1503
IaDB	Mitigation	Water resources and sanitation	Support for strengthening the National Information System on Solid Waste Management (SINIR) and the Identification and Evaluation of Infrastructure Investment Projects for the Sustainable Management of Solid Waste in Brazil	$0.50	31 %	$155,000	Grant - technical cooperation	11/12/2018	1 / 2	https://www.iadb.org/en/project/BR-T1392
IaDB	Mitigation	Health	Modernization and Quality Improvement of Health Services Networks in Belo Horizonte - BetterHealth-BH	$56.00	24 %	$13,220,000	Loan	11/30/2018	1 / 2	https://www.iadb.org/en/project/BR-L1519
IaDB	Cross-cutting	Urban development	State Program to Support Urban Development and Municipal Infrastructure Improvements: Paraná Urbano III	$118.00	19 %	$22,490	Loan	10/24/2018	1 / 2	https://www.iadb.org/en/project/BR-L1520
IaDB	Adaptation	Agriculture	Program to Modernize and Strengthen Agricultural Health and Food Safety Services (PRODEFESA)	$195.00	17 %	$34,010,000	Loan	12/14/2018	1 / 2	https://www.iadb.org/en/project/BR-L1529
Fonplata	Cross-cutting	Urban mobility, sanitation, others	Itajaí 2040 Program - Modern and Sustainable	$62.50	14.40 %	$9,000,000	Loan	10/30/2018	NA	https://www.fonplata.org/pt/projetos/programa-itajai-2040-moderna-e-sustentavel#edit-group-tab--content

TABLE XX: SUPPORT RECEIVED BY BILATERAL CHANNELS IN 2018

Country/ Institution	Type of support (mitigation, adaptation, cross-cutting, other)	Sector (energy, transportation, industry, agriculture, forests, water resources and sanitation, cross-cutting, other, not applicable)	Project name	Total financing	Total financing (US$)	Climate-specific component (%)	Climate-specific financing (US$)	Financing instrument	Commitment / receipt date (MM/DD/YYYY)	Capacity-building (1) / Technology transfer (2) / Not applicable (NA)	Source
Norway	Mitigation	Forests/REDD+	Amazon Fund	$70,311,127	$70,311,127	100 %	$70,311,127	Grant / results-base payment	12/17/2018	NA	http://www.fundoamazonia.gov.br/pt/fundo-amazonia/doacoes/
United Kingdom - BEIS	Mitigation	Forests/REDD+	REDD For Early Movers - Acre Phase II	$9,436,244	$9,436,244	100 %	$9,436,244	Grant / results-base payment	12/26/2018	NA	http://redd.mma.gov.br/en/infohub
Germany - KfW	Mitigation	Forests/REDD+	REDD For Early Movers - Mato Grosso	$5,700,000	$5,700,000	100 %	$5,700,000	Grant / results-base payment	12/27/2018	NA	http://redd.mma.gov.br/en/infohub
Germany - KfW	Mitigation	Forests/REDD+	REDD For Early Movers - Acre Phase II	$2,850,000	$2,850,000	100 %	$2,850,000	Grant / results-base payment	12/26/2018	NA	http://redd.mma.gov.br/en/infohub
EU/EuroClima+	Cross-cutting	Other	Building a national and regional strategy for knowledge management of green technologies	€ 39,100	$46,164	100 %	$46,163	Grant / results-base payment	05/01/2018	1	http://euroclimaplus.org/component/sppagebuilder/297-construccion-de-uma-estrategia-nacional-y-regional-para-la-gestion-de-conocimiento-de-tecnologias-verdes-en-brasil

TABLE XXI: SUPPORT RECEIVED BY MULTILATERAL CHANNELS IN 2019

Institution	Type of support (mitigation, adaptation, cross-cutting, other)	Sector (energy, transportion, industry, agriculture, forests, water resources and sanitation, cross-cutting, other, not applicable)	Project name	Total financing (US$ Millions)	Climate-specific component (%)	Climate-specific financing (US$)	Financing instrument	Commitment / receipt date (MM/DD/YYYY)	Capacity-building (1) / Technology transfer (2) / Not applicable (NA)	Source
CAF	Mitigation	Transportation	São Paulo Metro Network - Line 17 Gold - Monorail System section 1 - Brazil	$220.00	100 %	$220,000,000	Loan	10/07/2019	NA	CAF Database (unavailable)
IFC	Mitigation	Forestry (Pulp & Paper)	Klabin Growth	103 (+177 syndicated loan)	97 %	$100,002,700	Loan	Aug 2019	NA	https://disclosures.ifc.org/#/projectDetail/ESRS/42138
GCF	Mitigation	Forests	REDD-PLUS results-based payments for results achieved by Brazil in the Amazon biome in 2014 and 2015	$96.50	100 %	$96,452,228	Grant	02/28/2019	NA	https://www.greenclimate.fund/project/fp100
IaDB	Cross-cutting	Water resources and sanitation	Tietê River Recovery Project Upstream of the Penha Dam in the State of Sao Paulo - Renasce Tietê	$79.87	100 %	$79,866,302	Loan	12/18/2019	1 / 2	https://www.iadb.org/en/project/BR-L1536
CAF	Mitigation	Sanitation	Sustainable Municipalities Program of the State of Pará	$50.00	100 %	$50,000,000	Loan	02/19/2019	NA	CAF Database (unavailable)
IaDB	Mitigation	Agriculture	Low Carbon Agriculture for Avoided Deforestation and Poverty Reduction in Brazil. Phase II - Sustainable Rural Development in the Cerrado	$15.00	100 %	$15,000,000	Grant - technical cooperation	06/19/2019	1 / 2	https://www.iadb.org/en/project/BR-T1409
IaDB	Mitigation	Agriculture	Low-Carbon Agriculture for Avoided Deforestation and Poverty Reduction in Brazil. Phase II – Sustainable Rural Development in the Caatinga	$5.00	100 %	$5,000,000	Grant - technical cooperation	06/27/2019	1 / 2	https://www.iadb.org/en/project/BR-T1378
IFC	Mitigation	Transportation (last mile logistics)	Loggi	$4.00	100 %	$4,000,000	Equity	Feb 2019	NA	Disclosure Portal IFC (unavailable)
IaDB	Mitigation	Transportation	São Paulo Regional Rail Project	$2.08	100 %	$2,080,000	Grant - technical cooperation	07/12/2019	1 / 2	https://www.iadb.org/en/project/BR-T1418
IaDB	Mitigation	Agriculture	Low Carbon Agriculture for Avoided Deforestation and Poverty Reduction in Brazil. Phase II - Monitoring, Evaluation and Knowledge Management	$1.20	100 %	$1,200,000	Grant - technical cooperation	06/28/2019	1 / 2	https://www.iadb.org/en/project/BR-T1410

Institution	Type of support (mitigation, adaptation, cross-cutting, other)	Sector (energy, transportion, industry, agriculture, forests, water resources and sanitation, cross-cutting, other, not applicable)	Project name	Total financing (US$ Millions)	Climate-specific component (%)	Climate-specific financing (US$)	Financing instrument	Commitment / receipt date (MM/DD/YYYY)	Capacity-building (1) / Technology transfer (2) / Not applicable (NA)	Source
IaDB	Cross-cutting	Cross-cutting	FINEP Clima: Fostering Climate Technology and Innovation to Deliver Brazil's NDCs	$0.75	100 %	$750,000	Grant - technical cooperation	08/20/2019	1 / 2	https://www.iadb.org/en/project/BR-T1412
GCF	Other	NA	Strengthening Brazilian DAEs for the implementation and execution of GCF projects	$0.52	100 %	$515,217	Grant	11/08/2019	1	https://www.greenclimate.fund/document/entity-support-brazil-through-funbio
IaDB	Mitigation	Energy	Support for Innovation in the Energy Sector - Rio Grande do Sul, Paraná and Santa Catarina	$0.25	100 %	$250,000	Grant - technical cooperation	07/31/2019	1 / 2	https://www.iadb.org/en/project/BR-T1422
IaDB	Adaptation	Water resources and sanitation	Support for the Preparation of the TIETÊ River Recovery Program Upstream of the PENHA Dam, in the State of Sao Paulo - RENASCE TIETÊ	$0.20	100 %	$200,000	Grant - technical cooperation	10/07/2019	1 / 2	https://www.iadb.org/en/project/BR-T1429
IaDB	Mitigation	Transportation	Curitiba's Sustainable Urban Mobility Program	$106.70	83 %	$88,200,000	Loan	12/18/2019	1 / 2	https://www.iadb.org/en/project/BR-L1532
IaDB	Cross-cutting	Water resources and sanitation	Environmental Sanitation, Macrodrainage, and Recovery Project for the Igarapés and the Banks of the Parauapebas River/PA	$0.07	77 %	$53,700	Grant - technical cooperation	11/27/2019	1 / 2	https://www.iadb.org/en/project/BR-L1508
IBRD	Cross-cutting	Water resources	Ceará Water Security and Governance	$139.88	75 %	$105,340,000	Loan	08/08/2019	NA	https://projects.worldbank.org/en/projects-operations/project-detail/P165055
IBRD	Cross-cutting	Agriculture & food	Ceara Rural Sustainable Development and Competitiveness Phase II	$100.00	61 %	$60,600,000	Loan	07/18/2019	NA	https://projects.worldbank.org/en/projects-operations/project-detail/P167455
Fonplata	Cross-cutting	Transportation, forests, other	Urban Requalification and Environmental Improvement in Vila Velha/ES	$27.60	40 %	$11,040,000	Loan	12/29/2019	NA	https://www.fonplata.org/pt/projetos/programa-de-reordenamento-urbano-e-melhorias-ambientais-em-vila-velha-es

Institution	Type of support (mitigation, adaptation, cross-cutting, other)	Sector (energy, transportion, industry, agriculture, forests, water resources and sanitation, cross-cutting, other, not applicable)	Project name	Total financing (US$ Millions)	Climate-specific component (%)	Climate-specific financing (US$)	Financing instrument	Commitment / receipt date (MM/DD/YYYY)	Capacity-building (1) / Technology transfer (2) / Not applicable (NA)	Source
IaDB	Cross-cutting	Water resources and sanitation	Support for the Preparation of the Environmental Sanitation Program of the Water Supply Sources of the Metropolitan Region of Salvador and the Operational Improvement of EMBASA	$0.50	33 %	$165,000	Grant - technical cooperation	07/23/2019	1 / 2	https://www.iadb.org/en/project/BR-T1390
IaDB	Cross-cutting	Water resources and sanitation	Program to Expand and Improve Drinking Water Services In the State of Rio Grande do Sul (PROSASUL)	$200.00	18 %	$36,260,000	Loan	03/22/2019	1 / 2	https://www.iadb.org/en/project/BR-L1495
IaDB	Mitigation	Urban development	Urban Upgrade Program In The Western Area Of Aracaju – Building For The Future	$75.20	3 %	$2,610,000	Loan	01/09/2019	1 / 2	https://www.iadb.org/en/project/BR-L1411
IaDB	Mitigation	Health	Program to Strengthen the Care Model in the Paraiba Health Network	$45.20	3 %	$1,400,000	Loan	01/23/2019	1 / 2	https://www.iadb.org/en/project/BR-L1518
IaDB	Adaptation	Transportation	Logistics Efficiency Program of Espirito Santo	$216.80	2 %	$4,336,000	Loan	12/11/2019	1 / 2	https://www.iadb.org/en/project/BR-L1524

TABLE XXII: SUPPORT RECEIVED BY BILATERAL CHANNELS IN 2019

Country/ Institution	Type of support (mitigation, adaptation, cross-cutting, other)	Sector (energy, transportation, industry, agriculture, forests, water resources and sanitation, cross-cutting, other, not applicable)	Project name	Total financing	Total financing (US$)	Climate-specific component (%)	Climate-specific financing (US$)	Financing instrument	Commitment / receipt date (MM/DD/YYYY)	Capacity-building (1) / Technology transfer (2) / Not applicable (NA)	Source
United Kingdom - BEIS	Mitigation	Forests/REDD+	REDD For Early Movers - Mato Grosso	$10,240,000	$10,240,000	100 %	$10,240,000	Grant / results-base payment	07/06/2020	NA	http://redd.mma.gov.br/en/infohub
EU/ EuroClima+	Adaptation	Cross-cutting	BBE/PR/07 - 148: Building global agendas from the local level: ecosystem-based adaptation as a catalyst for municipal actions to achieve global goals.*	€ 631,700	$ 707,391	100 %	$ 707,391	Grant - technical cooperation	02/15/2019	1	http://euroclimaplus.org/en/projects-forest/municipal-actions-in-mexico-and-brazil
EU/ EuroClima+	Cross-cutting	Other	DRR/PR/05: Climate Risk Management in Brazil and Argentina.*	€ 569,875	$ 638,158	100 %	$ 638,158	Grant - technical cooperation	02/18/2019	1	http://euroclimaplus.org/proyectos-riesgo/gestion-del-riesgo-climatico
EU/ EuroClima+	Cross-cutting	Other	BBE/PR/04 - 120: Management and restoration of forests in production environments in Argentina, Paraguay, Brazil and Bolivia. *	€ 373,274	$ 418,000	100 %	$ 418,000	Grant - technical cooperation	01/29/2019	1	https://euroclimaplus.org/en/projects-forest/living-and-producing-in-the-chaco-forest
EU/ EuroClima+	Adaptation	Agriculture	PRA/PR/04: Resilient food production in agro-food value chains. *	€ 327,667	$ 366,928	100 %	$ 366,928	Grant - technical cooperation	06/15/2019	1	http://euroclimaplus.org/en/projects-foods/item/503-resilience-in-agro-food-chains

** The project involves more than one country. The amount reported by the donor institution corresponds to support provided to Brazil.*

5

FUNDS RECEIVED FOR THE PREPARATION OF THE BUR

5 FUNDS RECEIVED FOR THE PREPARATION OF THE BUR

The preparation of this report received financial support from the Global Environment Facility (GEF). These funds were important to ensure the updating of the information provided, without which the data collection could have been affected.

The financial support from the GEF to prepare Biennial Update Reports (BUR) was US$ 500,000 and was made available through a joint project to prepare the Fourth National Communication of Brazil. This project is executed by the Ministry of Science, Technology and Innovations (MCTI) and implemented in partnership with the United Nations Development Programme (UNDP). This project made it possible to develop the Second, Third, and Fourth BURs.

Like in the previous BUR editions, resources for the preparation of the BUR and its technical annexes were not limited to those received from the GEF. The institutions involved had the support and decisive contributions of different agencies and firm engagement of teams from other projects and from the Government. The technical annexes also relied on financial resources from international cooperation projects (PoMuC – Policies on Climate Change and the GEF's Pilot Project on REDD+ Results-Based Payments).

6

INFORMATION ON THE DESCRIPTION OF DOMESTIC MRV (MEASUREMENT, REPORTING AND VERIFICATION) ARRANGEMENTS

6 INFORMATION ON THE DESCRIPTION OF DOMESTIC MRV (MEASUREMENT, REPORTING AND VERIFICATION) ARRANGEMENTS

This section describes, in a non-comprehensive way, the different databases and arrangements involved in the domestic MRV of NAMAs in Brazil.

6.1 MODULAR SYSTEM FOR MONITORING ACTIONS OF GREENHOUSE GAS EMISSIONS REDUCTIONS – SMMARE AND MRV OF ACTIONS

In 2013, a proposal was made to develop the Modular System for Monitoring Actions of Greenhouse Gas Emissions Reductions (SMMARE for its acronym in Portuguese), for which guidelines were established in 2014. However, since then, there has been no progress in any modular computer system nor in the full engagement of the line ministries to produce that information[27].

In order to avoid duplication of work and any increased costs, among other obstacles, the Government is waiting for the conclusion of the New Enhanced Transparency Framework under the Paris Agreement in order to, if appropriate, resume implementation of a transparency arrangement, but no longer for NAMAs, which will be discontinued as of 2020.

In addition to the international environment within the scope of the Convention considered above, Decree No. 10,145, of November 28, 2019 needs to be taken into account. It regulates the Interministerial Committee on Climate Change (CIM) under the new governance of the National Policy on Climate Change.

According to this Decree, among other actions required to achieve the objectives of the country's public actions and policies related to climate change, it is incumbent on the CIM to deliberate on the country's strategies for the design, implementation, financing, monitoring, evaluation, and updating of climate change policies, plans, and actions. Monitoring of transparency activities and provision of information in compliance with the decisions under the Convention also depend on the deliberation of the Committee.

Unlike NAMAs, the NDC in Brazil does not have a sectoral rationale; rather, it is geared to the economy as a whole, with some indicative mitigation actions listed in its annex. Avoiding duplicated efforts and potential cost increases means taking this entire picture into perspective.

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[27] The gaps and needs associated with the quantification of the results of the mitigation actions were identified and recognized in the session "Constraints and gaps, and related financial, technical and capacity needs". Both developed and developing countries recognize that this type of estimate still has a long way to go.

Regarding the latest approach to reporting emission reductions, it should be noted that, initially, it aggregated data for mitigating greenhouse gas emissions from the LULUCF and Agriculture sectors, with some emission reduction estimates up to 2018. Running in parallel to this, the need for an information dissemination tool that would allow for the monitoring of the main mitigation and adaptation actions to climate change continued to be met and enhanced through the Educaclima portal (www.educaclima.mma.gov.br). The portal was launched in early 2018 and provides some preliminary data on the reporting of emissions reduction mentioned above.

Regardless of the potential inclusion of modules in specific systems, whether SMMARE or others, different databases and arrangements described in the items below have also contributed to the continuous improvement and strengthening of domestic MRV arrangements.

6.1.1 **Actions in Land Use, Land-Use Change and Forestry**

Given its extensive native vegetation coverage and land use and tenure dynamics, Brazil has been implementing a number of systems to monitor and implement actions in the LULUCF sector (Figure VI). These systems allow for the monitoring of the LULUCF NAMAs and the MRV process for REDD+ results.

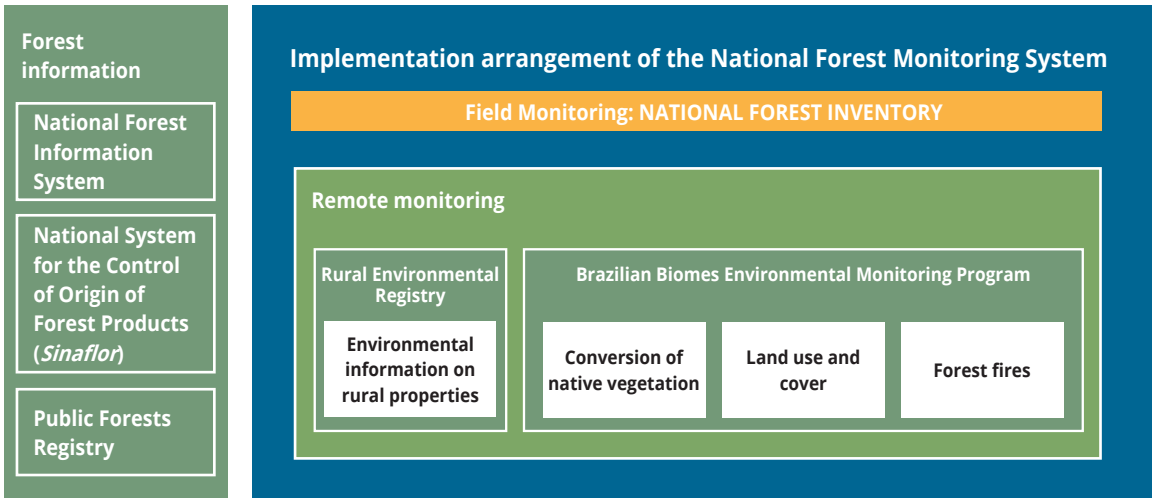

Figure V: Main systems for monitoring and implementation of actions in the LULUCF sector.

The forest information systems displayed in the figure above provide contributions to the implementation and monitoring of LULUCF NAMAs, as well as to the MRV process for REDD+ results, in addition to those designed to provide and organize forest information[28].

[28] *For more information on:*
National Forest Information System, go to http://snif.florestal.gov.br/pt-br/
National System for the Control of the Origin of Forest Products, go to. http://www.ibama.gov.br/
Public Forest Registry, go to http://www.florestal.gov.br/cadastro-nacional-de-florestas-publicas

In addition to the systems described above, the Ministry of the Environment, through support to the National System for the Control of the Origin of Forest Products (Sinaflor), and the National Fire Information System (Sisfogo), has been adopting measures to systematize and process information on authorized areas of vegetation suppression and authorized burning. The main characteristics and purposes of the initiatives that make up the conceptual model of the implementation arrangement of a national forest monitoring system are described below.

National Forest Inventory (NFI)

The NFI's main purpose is to generate information on forest resources, both natural and planted, based on a 5-year measurement cycle, to support the formulation of public policies aiming at forest resources use and conservation. The NFI will produce information on forest stocks, composition, health, and vitality, as well as the patterns of change of these aspects over time. The NFI also includes the development of allometric equations to estimate wood volume and biomass for different forest physiognomies, in partnership with universities and research institutes. These estimates will support the design of public policies for sustainable use of the forest resources and the development of future GHG inventories for the LULUCF sector.

Environmental Monitoring of Brazilian Biomes

INPE has developed several mapping products in partnership with universities and other research institutions. The different land use and land cover data can be accessed through the Terra Brasilis platform[29]. Information on the occurrence of vegetation burning is available on the Queimadas portal[30]. Additional information on land use is available TerraClass Cerrado and TerraClass Amazônia [31].

The Technical Annexes on REDD+ presents additional information on satellite monitoring of deforestation by clear-cutting in the Legal Amazon (PRODES), as well as information on annual deforestation rates.

Rural Environmental Registry System (SICAR)

The Rural Environmental Registry System (SICAR for its acronym in Portuguese) was created to manage, at the national level, environmental information on rural properties. Today, the System encompasses 5.6 million properties registered throughout the country, totaling 548.4 million hectares registered and monitored. This information will inform national MRV reports and provide important inputs both for combating deforestation and for mapping registered rural properties.

6.1.2 **Steel Industry (charcoal)**

The Emissions Reduction Plan for the Charcoal Steel Industry, launched by the Federal Government in 2010, aims at contributing to the reduction of greenhouse gas emissions under the NAMAs, in addition to promoting the modernization of the charcoal production needed to consolidate the sustainability of steel and pig iron production based on this renewable resource. The strategy for

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[29] *Terra Brasilis Platform, go to: http://terrabrasilis.info/composer/DETER-B*

[30] *INPE's portal on forest fires, go to: http://www.inpe.br/queimadas*

[31] *TerraClass Cerrado, go to: http://www.dpi.inpe.br/tccerrado/ and TerraClass Amazon, go to: http://www.inpe.br/cra/projetos_pesquisas/dados_terraclass.php*

the actions included in the Plan has been implemented primarily via a pilot project called "Sustainable Steel industry", funded by the Global Environment Facility (GEF). This project, coordinated by the Ministry of the Environment and the United Nations Development Programme (UNDP), acts as the implementing agency. The following institutions also participate in the Project Monitoring Committee (CAP): Ministry of the Economy (ME), Ministry of Science, Technology and Innovations (MCTI), Ministry of Agriculture, Livestock and Food Supply (MAPA), and the Government of the State of Minas Gerais. Project implementation started in 2016.

In order to follow up on the development of this action, a simplified MRV system was developed to support the preparation of estimates of greenhouse gas emissions reductions associated with the Project's actions.

Within the "Sustainable Steel Industry" project, support is underway for six initiatives by steel companies, which were selected through a public bidding process, to participate in the payment mechanism for results achieved and verified in terms of the reduction of greenhouse gas emissions. Following education and training efforts, the MRV methodology is now being applied by these companies.

It should also be mentioned that an independent audit has been hired to verify the greenhouse gas emission reduction results by the supported businesses under the results-based payment mechanism.

For the second phase of the project, which will run until 2021, expansion of the project support to small and medium charcoal producers will be expanded, with a view to promoting greater reach and providing gains of scale in more efficient technologies for the Brazilian steel sector and the resulting reduction in GHG emissions.

6.1.3 **SIGABC Agriculture and ABC Platform**

Measurement, Reporting and Verification of the ABC Plan is being implemented through the creation of the Integrated Information System of the Sector Plan for the Consolidation of a Low Carbon Economy in Agriculture (SIN-ABC for its acronym in Portuguese). SIN-ABC merges the Governance System of the ABC Plan (SIGABC), Rural Credit and Proagro Operations System (Sicor), and the Multi-Institutional Platform for Monitoring Greenhouse Gas Emission Reduction in Agriculture (ABC Platform). It will be responsible for consolidating and systematizing the results of the ABC Plan implementation.

The SIGABC is the system for the governance and management of actions in progress to implement the ABC Plan. Coordinated by MAPA, it registers the results of the actions of dissemination, training, implementation of Technological Reference Units (URTs) and/or Test and Demonstration Units (UTDs), and data related to financial credit agreements granted by the banking system that implements the line of credit designed for the ABC Plan, among others. The implementation data for the ABC Program will be extracted from the Sicor. This is the credit facility designed to support the adoption of technologies in the ABC Plan, through borrowing activities (credit contracts) by rural producers.

The ABC Platform is the MRV instrument instituted in the context of the ABC Plan. It aims at developing and validating a broad and integrated identification, qualification, and monitoring system towards the adoption of technologies by the ABC Plan and their contribution to GHG mitigation. The assessment methodologies follow international GHG emissions monitoring protocols and the guidelines issued by the Intergovernmental Panel on Climate Change (IPCC), together with national scientific data at the state, municipal, or biome levels.

Consolidated data from the ABC Platform, SIGABC, and Sicor/ABC Program will be consolidated by the SIN-ABC and submitted to the Technical Committee for Monitoring the Sector Plan for the Consolidation of a Low Carbon Economy in Agriculture, in the monitoring and evaluation actions of the ABC Plan (CTABC) to be further evaluated together with the stakeholders, that comprise the CTABC under a draft decree. The results officially approved by CTABC are submitted to the National Coordination of the ABC Plan (CENABC), located within the MAPA, which is responsible for the official disclosure of the results achieved by the Brazilian agricultural sector in its efforts to control GHG emissions, adapt to climate change, and contribute to the achievement of Brazilian commitments to the UNFCCC.

6.2 NATIONAL EMISSIONS REGISTRY SYSTEM - SIRENE

The National Emissions Registry System (SIRENE)[32] has been recognized by the Government as the domestic emissions MRV, and was established as an official instrument for the dissemination of the results of the country's greenhouse gas emissions[33]. As reported in the previous BURs[34], the Ministry of Science, Technology and Innovations (MCTI) developed this system to protect information and accessibility to the results of the National Inventory of Anthropogenic Emissions by Sources and Removals by Sinks of Greenhouse Gases not Controlled by the Montreal Protocol.

The MCTI is responsible for coordinating, managing and maintaining SIRENE, and it has sought to improve the system. The layout of this public platform has undergone improvements in order to make it more user-friendly and accessible. In addition, results of scenarios up to 2050 and of emissions by type of technology for key sectors have been made available at SIRENE, including information on financial investments, lifespan, and emission reduction potential. Additional and more complex improvements related to the system's development for the analysis of indicators and inclusion of additional data are underway. However, given the significant volume of information to be processed and the effort required to develop IT solutions appropriately, this stage is expected to be completed in the long term.

Although the implementation of these improvement measures is part of a phased approach, it provides a positive contribution to the operation of the current system. Thus, SIRENE continues to be accessed by a diverse audience, primarily for academic use. In addition, the relevance of SIRENE is recognized for supporting government agencies in monitoring trends in emissions and for the development of studies on mitigation.

[32] *SIRENE, go to: http://sirene.mctic.gov.br*

[33] *Decree No. 9,172/2017*

[34] *More information on SIRENE's mission and scope is presented in the Second and Third Biennial Update Reports.*

APPENDIX I

HISTORICAL SERIES OF GREENHOUSE GAS EMISSIONS

CO_2

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
	Gg																										
Total CO_2	**972,418**	**851,230**	**990,268**	**1,058,595**	**1,068,291**	**2,037,774**	**1,410,890**	**1,135,368**	**1,392,712**	**1,395,241**	**1,465,624**	**1,467,982**	**1,676,706**	**2,550,817**	**2,757,344**	**1,812,458**	**1,426,141**	**1,162,334**	**1,284,028**	**676,670**	**690,476**	**625,872**	**531,679**	**747,934**	**645,232**	**729,494**	**747,085**
Energy	**169,985**	**175,607**	**179,327**	**185,011**	**193,669**	**208,832**	**224,595**	**239,097**	**248,685**	**260,220**	**267,057**	**276,281**	**273,578**	**267,928**	**282,615**	**291,019**	**296,083**	**309,501**	**328,441**	**316,368**	**348,883**	**363,372**	**396,547**	**429,805**	**454,783**	**430,796**	**399,798**
Fuel Combustion	162,431	168,246	171,882	177,435	185,665	201,318	216,774	230,493	239,222	250,097	256,320	264,560	262,360	256,729	271,775	277,142	283,201	296,032	314,234	297,934	333,669	349,252	381,786	413,171	437,141	413,192	382,293
Energy Subsector	21,271	20,860	22,802	22,867	23,841	25,281	27,799	31,218	32,221	39,121	40,484	44,838	39,777	39,450	45,372	47,400	47,967	47,494	58,435	47,617	58,859	53,744	70,114	93,517	111,089	105,577	81,643
Industrial Subsector	35,558	37,042	37,612	38,308	39,443	42,776	47,601	50,482	51,352	54,785	58,419	57,515	57,852	55,628	56,346	59,551	60,174	66,089	66,230	63,276	68,977	73,712	72,448	73,487	73,654	70,136	64,662
Iron and Steel	4,436	4,606	4,905	5,154	5,423	5,388	5,352	5,201	4,594	4,302	4,657	4,510	4,759	4,891	4,975	5,526	5,491	6,012	5,811	4,543	5,642	5,482	5,639	5,552	5,671	5,601	5,207
Chemical Industry	8,606	8,811	9,080	8,578	9,114	10,057	11,493	13,352	12,343	13,547	13,938	13,926	14,157	13,503	14,320	14,479	14,880	15,598	14,283	14,446	13,847	14,479	14,014	13,576	12,868	13,188	12,938
Other Industries	22,516	23,625	23,627	24,576	24,906	27,331	30,756	31,929	34,415	36,936	39,824	39,079	38,936	37,234	37,051	39,546	39,803	44,479	46,136	44,287	49,488	53,751	52,795	54,359	55,115	51,347	46,517
Transport Subsector	79,338	83,405	83,708	86,899	91,283	100,457	107,864	114,496	121,389	120,217	121,748	124,867	128,029	127,081	135,200	135,991	140,648	146,421	151,984	150,448	168,598	184,788	201,605	208,223	213,670	198,857	200,311
Civil Aviation	4,232	4,606	3,854	4,180	4,446	4,732	4,509	5,324	5,857	6,017	6,206	6,626	6,677	5,871	6,193	6,316	6,563	7,220	7,325	8,330	9,751	10,863	11,218	10,978	11,344	11,696	12,074
Road Transportation	70,094	73,931	74,786	77,159	82,058	90,916	97,772	105,030	111,067	109,634	111,337	113,548	115,889	116,036	123,083	123,519	127,773	131,881	136,953	134,811	151,497	166,726	183,199	190,075	194,611	181,257	183,118
Other Transportation	5,012	4,868	5,068	5,560	4,779	4,809	5,583	4,142	4,465	4,566	4,205	4,693	5,463	5,174	5,924	6,156	6,312	7,320	7,706	7,307	7,350	7,199	7,188	7,170	7,715	5,904	5,119
Residential Subsector	13,842	14,220	14,717	15,257	15,239	15,942	16,598	16,619	16,760	17,095	17,179	17,247	16,675	15,532	15,863	15,591	15,616	16,123	16,530	16,738	17,249	17,487	17,598	17,994	18,002	18,021	18,209
Agriculture Subsector	9,846	10,272	10,569	11,676	12,332	13,222	13,803	14,342	13,824	14,496	14,152	15,579	15,207	15,291	15,075	14,964	15,162	16,096	17,478	16,790	17,348	16,816	17,490	17,520	18,225	18,370	15,232
Other Sectors	2,576	2,447	2,474	2,428	3,527	3,640	3,109	3,336	3,676	4,383	4,338	4,514	4,820	3,747	3,919	3,645	3,634	3,809	3,577	3,065	2,638	2,705	2,531	2,430	2,501	2,231	2,236
Fugitive Emissions	7,554	7,361	7,445	7,576	8,004	7,514	7,821	8,604	9,463	10,123	10,737	11,721	11,218	11,199	10,840	13,877	12,882	13,469	14,207	18,434	15,214	14,120	14,761	16,634	17,642	17,604	17,505
Coal Mining	1,353	1,316	1,200	1,247	1,348	920	654	902	1,004	1,150	1,291	1,936	1,151	1,208	1,429	1,381	1,246	1,510	1,658	1,758	1,846	1,506	1,372	2,006	1,901	1,822	2,062
Extraction and Transportation of Oil and Natural Gas	6,201	6,045	6,245	6,329	6,656	6,594	7,167	7,702	8,459	8,973	9,446	9,785	10,067	9,991	9,411	12,496	11,636	11,959	12,549	16,676	13,368	12,614	13,389	14,628	15,741	15,782	15,443
Industrial Processes	**43,551**	**49,037**	**47,440**	**50,584**	**51,276**	**54,373**	**57,767**	**60,268**	**61,490**	**60,214**	**64,314**	**61,836**	**64,282**	**64,956**	**67,118**	**65,750**	**65,238**	**71,166**	**73,490**	**64,844**	**80,787**	**86,107**	**86,604**	**86,836**	**86,680**	**84,853**	**78,094**
Cement Production	11,062	11,776	9,770	10,164	10,086	11,528	13,884	15,267	16,175	16,439	16,047	15,227	14,390	13,096	13,273	14,349	15,440	17,200	18,884	19,031	21,288	22,845	24,998	26,652	26,908	25,082	22,415
Lime Production	3,688	3,755	3,948	4,241	4,098	4,104	4,248	4,338	4,141	4,352	5,008	4,811	4,956	5,064	5,505	5,356	5,410	5,666	5,690	5,060	5,950	6,337	6,403	6,486	6,278	6,392	6,392
Ammonia Production	1,683	1,478	1,516	1,684	1,689	1,785	1,754	1,829	1,718	1,943	1,663	1,396	1,567	1,690	1,934	1,922	1,968	1,866	1,811	1,576	1,739	1,995	1,758	1,805	1,805	1,805	1,805
Iron and Steel Production	21,601	26,118	26,417	28,048	29,152	29,886	30,418	31,756	32,272	30,313	34,052	33,403	35,788	36,700	37,574	35,349	33,916	37,136	37,440	29,828	38,361	41,594	40,189	39,177	39,833	41,064	37,133
Ferroalloy Production	116	119	197	191	178	202	223	167	562	451	512	575	534	922	938	932	942	1,080	1,142	1,018	1,195	1,070	1,044	957	891	800	784
Non-Ferrous Metals Production, except Aluminum	897	857	803	1,518	1,279	1,749	2,109	1,378	1,127	1,217	1,462	1,319	1,436	1,622	1,685	1,749	1,798	2,003	1,778	1,882	4,332	5,949	5,857	5,636	5,544	4,665	4,713
Aluminum Production	1,574	1,901	2,011	1,946	1,955	1,965	1,981	1,975	2,007	2,079	2,116	1,879	2,176	2,198	2,408	2,472	2,646	2,739	2,753	2,544	2,543	2,375	2,378	2,156	1,589	1,281	1,321
Other Industries	2,930	3,033	2,778	2,792	2,839	3,154	3,150	3,558	3,488	3,420	3,454	3,226	3,435	3,664	3,801	3,621	3,118	3,476	3,992	3,905	5,379	3,942	3,977	3,967	3,832	3,764	3,531
Land Use, Land-Use Change and Forestry	**758,863**	**626,555**	**763,447**	**822,939**	**823,280**	**1,774,491**	**1,128,450**	**835,925**	**1,082,453**	**1,074,719**	**1,134,158**	**1,129,770**	**1,338,747**	**2,217,816**	**2,407,491**	**1,455,561**	**1,064,684**	**781,512**	**881,938**	**295,290**	**260,631**	**176,207**	**48,333**	**231,089**	**103,556**	**213,623**	**268,962**
Land-Use Change	753,760	621,836	756,667	814,289	814,289	1,769,096	1,121,579	828,419	1,075,353	1,067,985	1,125,441	1,121,816	1,328,941	2,206,172	2,395,910	1,448,087	1,057,270	771,761	871,390	286,895	250,207	163,292	33,370	215,516	87,331	200,141	254,337
Amazon Biome	437,574	297,413	440,481	498,103	498,103	1,459,071	811,554	518,394	765,328	757,960	815,416	811,791	1,018,916	1,638,185	1,827,923	1,128,545	738,993	530,643	630,272	199,576	162,888	89,543	-56,903	47,758	-21,937	72,813	206,494
Cerrado Biome	241,511	241,511	241,511	241,511	241,511	212,958	212,958	212,958	212,958	212,958	212,958	212,958	212,958	474,641	474,641	226,196	226,196	149,037	149,037	72,638	72,638	61,902	61,902	135,258	88,670	106,382	4,601
Other Biomes	74,675	82,912	74,675	74,675	74,675	97,067	97,067	97,067	97,067	97,067	97,067	97,067	97,067	93,346	93,346	93,346	92,081	92,081	92,081	14,681	14,681	11,847	28,371	32,500	20,598	20,946	43,242
Liming	5,103	4,719	6,780	8,650	8,991	5,395	6,871	7,506	7,100	6,734	8,717	7,954	9,806	11,644	11,581	7,474	7,414	9,751	10,548	8,395	10,424	12,915	14,963	15,573	16,225	13,482	14,625
Waste Treatment	**19**	**31**	**54**	**61**	**66**	**78**	**78**	**78**	**84**	**88**	**95**	**95**	**99**	**117**	**120**	**128**	**136**	**155**	**159**	**168**	**175**	**186**	**195**	**204**	**213**	**222**	**231**
Memory only items:																											
International Bunkers	6,086	5,584	6,239	6,914	7,298	8,667	10,077	10,835	12,105	13,881	13,639	15,545	15,823	14,094	14,362	14,766	15,150	16,347	19,998	15,461	18,550	20,076	19,049	17,834	18,133	20,091	17.133
International Aviation	4,366	3,147	3,610	3,619	3,539	4,520	5,541	5,911	6,621	5,397	4,626	5,388	4,381	4,035	4,303	4,707	4,543	4,936	5,675	5,167	5,784	6,410	6,896	6,972	7,006	6,816	6.194
International Water-borne Navigation	1,720	2,437	2,629	3,295	3,759	4,147	4,536	4,924	5,484	8,484	9,013	10,157	11,442	10,059	10,059	10,059	10,607	11,411	14,323	10,294	12,766	13,666	12,153	10,862	11,127	13,275	10.919
CO_2 Emissions from Biomass	166,035	166,454	165,295	163,296	173,888	168,791	171,036	177,229	177,266	180,877	166,435	174,763	190,567	207,531	219,888	228,295	242,178	263,113	285,378	281,439	302,848	287,410	290,772	303,834	312,226	324,299	321.562

CH_4

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
	Gg																										
Total CH_4	12,086.6	12,285.3	12,676.9	12,802.0	13,024.8	14,523.8	13,366.2	13,229.1	13,692.8	13,917.9	14,327.6	14,785.0	15,530.2	17,173.2	18,032.7	17,281.0	16,597.0	15,770.2	16,167.8	15,850.4	16,100.0	16,350.0	16,110.1	16,599.5	16,622.0	16,972.5	17,268.9
Energy	543.7	546.8	531.5	494.9	489.5	467.4	456.7	469.3	479.3	491.1	503.6	533.6	563.5	559.2	596.0	675.5	641.0	628.7	632.8	680.6	620.6	572.7	584.0	599.7	622.0	624.9	604.9
Fuel Combustion	453.2	452.3	446.5	406.2	403.7	381.9	381.4	383.2	385.1	388.9	384.6	394.4	431.7	451.4	462.2	469.3	471.7	459.5	459.9	440.6	439.7	408.8	409.9	383.2	398.3	402.5	386.3
Energy Subsector	25.6	24.7	23.0	23.3	24.4	23.1	22.5	23.4	21.1	21.4	20.8	20.7	22.3	25.8	28.4	29.2	29.9	32.6	36.7	30.3	34.6	32.1	33.1	36.3	37.7	38.6	34.9
Industrial Subsector	15.7	14.8	15.3	15.5	17.7	18.1	19.2	19.3	20.5	21.8	19.9	22.1	23.9	26.0	27.9	28.4	31.7	32.9	32.9	31.9	34.3	35.4	36.1	35.3	33.8	32.6	34.6
Iron and Steel	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2
Other Industries	15.5	14.6	15.1	15.3	17.5	17.9	19.0	19.1	20.4	21.6	19.7	21.9	23.7	25.8	27.7	28.2	31.5	32.7	32.7	31.7	34.0	35.2	35.9	35.1	33.6	32.4	34.4
Residential Subsector	70.4	74.5	72.4	72.4	75.1	79.6	83.8	81.8	79.9	74.5	67.3	63.8	64.7	65.1	66.2	65.1	61.6	62.4	61.3	56.6	58.4	59.7	60.6	59.3	58.9	53.8	52.0
Agriculture Subsector	318.4	316.8	316.9	277.4	269.4	243.7	238.6	241.5	247.2	255.3	261.5	272.8	304.9	316.7	321.1	327.6	329.0	311.1	307.1	300.8	290.1	259.7	258.4	229.0	244.2	252.9	241.9
Other Sectors	23.1	21.5	18.9	17.6	17.1	17.4	17.3	17.2	16.4	15.9	15.1	15.0	15.9	17.8	18.6	19.0	19.5	20.5	21.9	21.0	22.3	21.9	21.7	23.3	23.7	24.6	22.9
Fugitive Emissions	90.5	94.5	85.0	88.7	85.8	85.5	75.3	86.1	94.2	102.2	119.0	139.2	131.8	107.8	133.8	206.2	169.3	169.2	172.9	240.0	180.9	163.9	174.1	216.5	223.7	222.4	218.6
Coal Mining	49.7	54.3	44.2	47.0	42.4	41.1	25.5	32.6	33.0	34.0	43.3	60.0	44.0	41.0	48.0	49.1	48.3	54.9	58.6	52.3	39.2	43.4	41.0	60.1	54.2	51.5	56.8
Extraction and Transportation of Oil and Natural Gas	40.8	40.2	40.8	41.7	43.4	44.4	49.8	53.5	61.2	68.2	75.7	79.2	87.8	66.8	85.8	157.1	121.0	114.3	114.3	187.7	141.7	120.5	133.1	156.4	169.5	170.9	161.8
Industrial Processes and Product Use (IPPU)	47.1	42.1	39.6	43.0	44.2	41.1	37.9	38.2	36.0	40.0	43.7	40.0	41.4	47.8	55.5	54.9	56.4	58.3	56.4	39.2	45.3	47.2	44.0	41.6	41.0	40.7	36.4
Chemical Industry	5.1	5.1	5.3	5.9	6.5	6.4	6.4	7.3	7.8	8.2	8.9	8.5	8.2	8.8	9.2	9.2	12.2	12.5	11.3	11.7	11.6	12.9	11.2	11.7	11.7	11.7	11.7
Metals Production	42.0	37.0	34.3	37.1	37.7	34.7	31.5	30.9	28.2	31.8	34.8	31.5	33.2	39.0	46.3	45.7	44.2	45.8	45.1	27.5	33.7	34.3	32.8	29.9	29.3	29.0	24.7
Agriculture	9,192.1	9,484.5	9,651.2	9,694.6	9,880.1	10,070.0	9,742.2	9,887.9	9,963.9	10,111.9	10,382.3	10,757.6	11,121.3	11,666.8	12,195.7	12,357.7	12,293.0	11,707.1	11,955.4	12,166.2	12,415.6	12,659.5	12,511.7	12,613.8	12,691.6	12,914.4	13,087.1
Enteric Fermentation	8,223.9	8,470.3	8,596.8	8,625.8	8,786.7	8,957.1	8,738.7	8,899.2	8,979.5	9,057.6	9,349.5	9,713.3	10,050.1	10,574.9	11,049.3	11,213.8	11,162.0	10,573.0	10,730.3	10,908.0	11,158.0	11,362.6	11,287.7	11,383.9	11,440.8	11,620.1	11,822.9
Cattle	7,808.9	8,049.5	8,175.2	8,218.7	8,370.5	8,534.3	8,413.3	8,572.9	8,650.5	8,722.2	9,005.8	9,368.0	9,708.9	10,228.3	10,698.6	10,855.7	10,801.9	10,220.4	10,376.3	10,555.6	10,798.4	10,996.1	10,934.5	11,027.3	11,079.9	11,247.8	11,447.4
Dairy Cattle	1,197.7	1,245.1	1,279.3	1,258.3	1,262.8	1,297.1	1,081.0	1,123.9	1,136.7	1,143.1	1,177.9	1,206.7	1,236.6	1,268.8	1,320.5	1,371.4	1,396.3	1,296.8	1,331.4	1,384.6	1,424.0	1,457.5	1,435.1	1,461.4	1,475.9	1,410.2	1,295.9
Beef Cattle	6,611.2	6,804.4	6,895.9	6,960.4	7,107.7	7,237.2	7,332.3	7,449.0	7,513.8	7,579.1	7,827.9	8,161.3	8,472.3	8,959.5	9,378.1	9,484.3	9,405.6	8,923.6	9,044.9	9,171.0	9,374.4	9,538.6	9,499.4	9,565.9	9,604.0	9,837.6	10,151.5
Other Animals	415.0	420.8	421.6	407.1	416.2	422.8	325.4	326.3	329.0	335.4	343.7	345.3	341.2	346.6	350.7	358.1	360.1	352.6	354.0	352.4	359.6	366.5	353.2	356.6	360.9	372.3	375.5
Manure Management	421.6	435.5	443.0	447.1	457.9	471.6	431.0	442.3	448.8	461.1	479.7	500.5	500.6	519.6	533.0	543.9	545.6	558.0	575.4	593.3	608.1	618.6	610.9	603.1	616.2	631.8	630.9
Cattle	191.2	197.6	200.4	201.2	204.6	208.7	200.3	204.7	207.0	209.0	215.9	224.4	223.6	235.9	248.5	254.0	252.9	245.3	249.0	253.4	258.7	263.0	261.0	262.0	263.1	265.6	267.6
Dairy Cattle	35.9	37.5	38.4	37.7	37.6	38.5	31.1	32.6	33.0	33.2	34.1	34.7	35.5	36.4	38.5	39.7	40.4	40.6	41.5	43.1	44.0	44.6	43.7	43.9	44.2	41.9	38.3
Beef Cattle	155.3	160.1	162.0	163.5	167.0	170.2	169.2	172.1	174.0	175.8	181.8	189.7	188.1	199.5	210.0	214.3	212.5	204.7	207.5	210.3	214.7	218.4	217.3	218.1	218.9	223.7	229.3
Swine	159.5	161.8	161.9	164.4	169.4	173.7	146.4	149.1	152.2	158.6	166.5	174.5	176.7	180.5	178.4	178.7	179.8	188.5	196.0	207.2	214.9	218.4	215.9	205.8	212.1	227.1	223.8
Poultry	48.4	53.3	57.8	59.2	61.3	66.3	65.9	69.9	70.9	74.6	78.1	82.4	81.2	83.8	86.6	91.5	93.2	104.9	111.2	113.7	115.3	117.8	115.3	116.4	121.9	119.6	119.8
Other Animals	22.5	22.8	22.9	22.3	22.6	22.9	18.4	18.6	18.7	18.9	19.2	19.2	19.1	19.4	19.5	19.7	19.7	19.3	19.2	19.0	19.2	19.4	18.7	18.9	19.1	19.5	19.7
Rice Cultivations	440.1	473.3	503.0	525.2	520.8	522.6	456.0	430.3	416.2	479.9	448.1	431.7	451.4	440.6	477.3	463.7	438.8	423.5	474.2	486.0	464.2	502.7	448.3	451.5	462.5	491.7	459.9
Burning of Crop Residues	106.5	105.4	108.4	96.5	114.7	118.7	116.5	116.1	119.4	113.3	105.0	112.1	119.2	131.7	136.1	136.3	146.6	152.6	175.5	178.9	185.3	175.6	164.8	175.3	172.1	170.8	173.4
Land Use, Land-Use Change and Forestry	1,054.6	914.5	1,105.0	1,174.1	1,164.9	2,442.4	1,568.1	1.213.5	1,539.8	1,532.5	1,599.2	1,600.6	1,869.8	2,885.0	3,128.2	2,067.4	1,415.7	1,127.9	1,242.0	659.0	606.9	539.0	393.9	567.6	452.4	567.7	672.0
Waste Treatment	1,249.1	1,297.4	1,349.6	1,395.4	1,446.1	1,502.9	1,561.3	1.620.2	1,673.8	1,742.4	1,798.8	1,853.2	1,934.2	2,014.4	2,057.3	2,125.5	2,190.9	2,248.2	2,281.2	2,305.4	2,411.6	2,531.6	2,576.5	2,776.8	2,815.0	2.824.8	2,868.5
Solid Waste	898.9	929.4	961.9	992.5	1,023.6	1,052.9	1,084.3	1,117.4	1,147.3	1,177.3	1,204.3	1,233.6	1,266.1	1,295.3	1,280.1	1,299.2	1,316.8	1,291.3	1,249.8	1,234.3	1,268.5	1,349.3	1,365.5	1,462.2	1,449.8	1,448.8	1,497.1
Wastewater	350.2	368.0	387.7	402.9	422.5	450.0	477.0	502.8	526.5	565.1	594.5	619.6	668.1	719.1	777.2	826.3	874.1	956.9	1,031.4	1,071.1	1,143.1	1,182.3	1,211.0	1,314.6	1,365.2	1,376.0	1,371.4
Industrial	82.6	94.3	107.3	115.3	126.9	145.7	163.1	176.2	186.0	209.6	222.8	235.6	271.5	309.6	354.3	389.7	423.4	491.8	550.8	574.6	630.3	665.1	689.6	774.2	820.1	826.4	817.4
Domestic	267.6	273.7	280.4	287.6	295.6	304.3	313.9	326.6	340.5	355.5	371.7	384.0	396.6	409.5	422.9	436.6	450.7	465.1	480.6	496.5	512.8	517.2	521.4	540.4	545.1	549.6	554.0
Memory only items:																											
International Bunkers	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.2	0.1	0.2	0.1
International Water-borne Navigation	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.2	0.1	0.2	0.1

N_2O

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
	Gg																										
Total N_2O	**377.04**	**383.96**	**397.34**	**406.54**	**418.34**	**462.80**	**412.37**	**412.11**	**437.52**	**440.49**	**459.84**	**468.01**	**497.48**	**568.55**	**597.59**	**559.14**	**546.21**	**527.05**	**534.15**	**516.16**	**535.52**	**555.79**	**548.87**	**570.25**	**576.67**	**577.44**	**597.16**
Energy	**14.36**	**14.38**	**14.23**	**14.14**	**14.83**	**15.20**	**15.95**	**16.96**	**17.66**	**18.20**	**18.18**	**19.09**	**20.65**	**21.74**	**23.19**	**23.93**	**24.70**	**26.04**	**27.51**	**26.66**	**29.25**	**29.64**	**31.11**	**32.16**	**33.29**	**32.70**	**32.25**
Fuel Combustion	14.30	14.33	14.17	14.08	14.77	15.14	15.88	16.89	17.58	18.11	18.07	18.98	20.53	21.62	23.08	23.72	24.54	25.89	27.34	26.37	29.04	29.46	30.95	31.96	33.06	32.46	32.00
Industrial Subsector	2.54	2.53	2.59	2.65	2.97	2.97	3.02	3.15	3.42	3.60	3.33	3.60	3.82	4.07	4.33	4.42	4.90	5.18	5.19	5.27	5.73	5.74	5.91	5.88	5.71	5.57	5.89
Transport Subsector	4.02	4.17	4.15	4.27	4.57	5.30	6.05	6.73	7.42	7.61	7.86	8.30	9.11	9.34	10.08	10.43	10.63	11.45	12.16	12.21	13.74	14.86	15.95	16.66	17.44	16.75	16.89
Other Sectors	7.74	7.63	7.43	7.16	7.23	6.87	6.81	7.01	6.74	6.90	6.88	7.08	7.60	8.21	8.67	8.87	9.01	9.26	9.99	8.89	9.57	8.86	9.09	9.42	9.91	10.14	9.22
Fugitive Emissions	0.06	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.08	0.09	0.11	0.11	0.12	0.12	0.11	0.21	0.16	0.15	0.17	0.29	0.21	0.18	0.16	0.20	0.23	0.24	0.25
Industrial Processes	**11.83**	**14.56**	**13.60**	**17.28**	**17.47**	**18.57**	**14.67**	**13.17**	**20.07**	**20.02**	**21.09**	**17.33**	**21.44**	**19.90**	**27.42**	**24.22**	**26.12**	**4.36**	**3.70**	**1.96**	**2.15**	**2.19**	**1.86**	**1.81**	**2.02**	**1.86**	**1.71**
Chemical Industry	10.69	13.46	12.55	16.14	16.31	17.45	13.62	12.12	19.07	18.98	19.94	16.25	20.29	18.62	25.99	22.83	24.78	2.94	2.28	1.01	0.93	0.93	0.63	0.66	0.88	0.71	0.70
Nitric Acid Production	1.81	1.93	1.89	2.00	2.01	2.05	2.07	2.12	2.06	2.06	2.09	2.06	2.14	2.14	2.21	2.24	2.20	2.07	1.58	0.79	0.80	0.75	0.51	0.52	0.52	0.51	0.51
Adipic Acid Production	8.63	11.25	10.41	13.84	13.99	15.08	11.22	9.66	16.75	16.62	17.51	13.90	17.80	16.19	23.48	20.29	22.31	0.57	0.37	0.14	0.13	0.18	0.12	0.14	0.36	0.20	0.19
Other productions	0.25	0.28	0.25	0.30	0.31	0.32	0.33	0.34	0.26	0.30	0.34	0.29	0.35	0.29	0.30	0.30	0.27	0.30	0.33	0.08	-	-	-	-	-	-	-
Metals Production	1.14	1.10	1.05	1.14	1.16	1.12	1.05	1.05	1.00	1.04	1.15	1.08	1.15	1.28	1.43	1.39	1.34	1.42	1.42	0.95	1.22	1.26	1.23	1.15	1.14	1.15	1.01
Agriculture	**303.54**	**311.28**	**320.00**	**323.47**	**334.66**	**340.15**	**318.97**	**329.47**	**337.23**	**339.71**	**355.93**	**366.75**	**382.25**	**412.38**	**425.07**	**428.97**	**433.03**	**445.43**	**448.06**	**453.87**	**472.08**	**494.38**	**491.10**	**503.48**	**513.48**	**510.67**	**530.27**
Manure Management	10.03	10.57	10.93	10.92	11.21	11.48	10.61	10.89	10.87	11.16	11.49	11.88	11.79	12.16	12.44	12.82	12.93	13.70	14.31	14.65	14.83	15.16	14.95	14.95	15.52	15.74	15.82
Cattle	2.90	2.96	3.00	3.01	3.04	3.07	2.83	2.89	2.92	2.93	2.98	3.05	3.13	3.22	3.29	3.29	3.29	3.27	3.33	3.40	3.46	3.53	3.51	3.55	3.53	3.51	3.48
Swine	2.43	2.47	2.49	2.43	2.48	2.53	1.94	1.97	1.99	2.04	2.06	2.11	2.02	2.04	2.12	2.17	2.20	2.22	2.24	2.30	2.35	2.36	2.32	2.22	2.29	2.42	2.40
Poultry	4.40	4.83	5.13	5.18	5.39	5.58	5.60	5.79	5.72	5.95	6.20	6.47	6.40	6.65	6.78	7.11	7.19	7.97	8.50	8.71	8.78	9.02	8.88	8.94	9.46	9.56	9.69
Other Animals	0.30	0.31	0.31	0.30	0.30	0.30	0.24	0.24	0.24	0.24	0.25	0.25	0.24	0.25	0.25	0.25	0.25	0.24	0.24	0.24	0.24	0.25	0.24	0.24	0.24	0.25	0.25
Agricultural Soils	290.75	297.98	306.26	310.05	320.48	325.59	305.34	315.57	323.27	325.61	341.72	351.96	367.37	396.81	409.10	412.62	416.30	427.77	429.20	434.58	452.45	474.67	471.88	483.99	493.50	490.50	509.95
Direct Emissions	184.07	188.19	193.71	195.05	201.60	205.28	191.67	198.00	202.19	204.21	213.85	221.03	230.01	247.99	255.29	257.09	259.54	266.16	269.13	271.45	282.31	294.97	292.69	300.98	306.42	307.71	314.05
Animals on Pasture	129.73	133.73	135.65	135.36	137.50	140.20	130.03	132.95	134.44	135.85	140.12	144.62	150.82	158.19	164.86	167.45	166.82	162.37	164.36	166.83	170.24	172.59	170.44	170.89	171.68	172.83	173.01
Synthetic Fertilizers	9.81	9.79	10.94	12.52	14.74	14.27	14.98	16.23	18.06	17.16	21.28	20.70	23.09	27.95	28.31	27.51	28.83	34.64	31.33	32.11	35.74	42.14	43.70	46.26	48.19	44.31	54.25
Organic Fertilizers	14.90	15.31	15.77	15.63	15.87	16.40	14.76	15.30	15.56	15.65	15.88	16.00	16.12	16.64	17.30	17.81	18.14	18.94	20.15	21.30	21.33	21.88	21.01	20.85	21.92	22.41	22.62
Crop Residues	15.32	14.99	16.92	17.05	18.94	19.80	17.23	18.79	19.34	20.70	21.66	24.74	24.95	30.12	29.67	29.11	30.48	34.88	37.90	35.76	39.49	42.79	41.91	47.29	48.88	52.35	48.30
Organic Soils	14.31	14.37	14.43	14.49	14.55	14.61	14.67	14.73	14.79	14.85	14.91	14.97	15.03	15.09	15.15	15.21	15.27	15.33	15.39	15.45	15.51	15.57	15.63	15.69	15.75	15.81	15.87
Indirect Emissions	106.68	109.79	112.55	115.00	118.88	120.31	113.67	117.57	121.08	121.40	127.87	130.93	137.36	148.82	153.81	155.53	156.76	161.61	160.07	163.13	170.14	179.70	179.19	183.01	187.08	182.79	195.90
Burning of Crop Residues	2.76	2.73	2.81	2.50	2.97	3.08	3.02	3.01	3.09	2.94	2.72	2.91	3.09	3.41	3.53	3.53	3.80	3.96	4.55	4.64	4.80	4.55	4.27	4.54	4.46	4.43	4.50
Land Use, Land-Use Change and Forestry	**42.97**	**39.31**	**44.98**	**47.02**	**46.65**	**84.05**	**57.85**	**47.39**	**57.23**	**57.02**	**58.96**	**59.05**	**67.06**	**108.15**	**115.42**	**75.41**	**55.64**	**44.39**	**47.92**	**26.59**	**24.83**	**22.31**	**17.47**	**25.20**	**20.22**	**24.48**	**25.14**
Waste Treatment	**4.34**	**4.43**	**4.53**	**4.63**	**4.73**	**4.83**	**4.93**	**5.12**	**5.33**	**5.54**	**5.68**	**5.79**	**6.08**	**6.38**	**6.49**	**6.61**	**6.72**	**6.83**	**6.96**	**7.08**	**7.21**	**7.27**	**7.33**	**7.60**	**7.66**	**7.73**	**7.79**
Memory only items:																											
International Bunkers	0.14	0.11	0.13	0.13	0.14	0.17	0.20	0.22	0.25	0.25	0.24	0.27	0.26	0.23	0.23	0.24	0.25	0.27	0.32	0.27	0.31	0.31	0.32	0.32	0.31	0.33	0.28
International Aviation	0.12	0.09	0.10	0.10	0.10	0.13	0.15	0.16	0.18	0.15	0.13	0.15	0.13	0.12	0.12	0.13	0.13	0.14	0.16	0.15	0.17	0.18	0.20	0.20	0.20	0.19	0.18
International Water-borne Navigation	0.02	0.02	0.03	0.03	0.04	0.04	0.05	0.06	0.07	0.10	0.11	0.12	0.13	0.11	0.11	0.11	0.12	0.13	0.16	0.12	0.14	0.13	0.12	0.12	0.11	0.14	0.10

CO

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
	Gg																										
Total CO	**32,187.8**	**30,190.7**	**32,899.9**	**33,500.7**	**34,129.4**	**53,651.0**	**40,167.3**	**34,472.4**	**39,290.1**	**38,723.0**	**38,969.2**	**38,814.7**	**43,363.4**	**61,921.1**	**66,172.6**	**47,996.3**	**37,994.7**	**33,284.3**	**35,893.2**	**25,185.0**	**24,979.4**	**23,356.0**	**20,576.5**	**23,990.0**	**21,903.1**	**23,649.1**	**24,442.7**
Energy	**9,025.3**	**9,201.1**	**8,927.8**	**8,817.2**	**8,974.6**	**8,915.5**	**9,044.5**	**8,796.7**	**8,519.7**	**8,197.0**	**7,647.9**	**7,289.1**	**7,418.4**	**7,547.9**	**7,752.3**	**7,656.1**	**7,416.9**	**7,450.0**	**7,504.8**	**6,836.8**	**7,111.2**	**6,948.7**	**6,907.7**	**6,819.2**	**6,952.9**	**6,799.4**	**6,504.8**
Fuel Combustion	9,025.3	9,201.1	8,927.8	8,817.2	8,974.6	8,915.5	9,044.5	8,796.7	8,519,7	8,197.0	7,647.9	7,289.1	7,418.4	7,547.9	7,752.3	7,656.1	7,416.9	7,450.0	7,504.8	6,836.8	7,111.2	6,948.7	6,907.7	6,819.2	6,952.9	6,799.4	6,504.8
Energy Subsector	1,402.4	1,308.2	1,215.1	1,250,3	1,292.7	1,208.7	1,149.1	1,171.6	1,065.3	1,099,2	1,104.7	1,083.8	1,149.0	1,347.9	1,499.3	1,528.7	1,536.7	1,653.7	1,779.1	1,415.0	1,620.1	1,570.2	1,587.8	1,665.0	1,713.4	1,745.1	1,600.7
Industrial Subsector	758.1	749.5	735.6	792.2	837.7	815.1	858.3	852.2	916.2	998.9	1,036.8	1,035.1	1,059.6	1,160.2	1,223.3	1,283.5	1,363.3	1,448.5	1,541.4	1,558.8	1,708.8	1,770.6	1,760.8	1,839.9	1,916.0	1,929.9	1,962.5
Iron and Steel	2.5	2.7	2.8	4.0	3.2	3.2	4.8	6.4	6.2	7.1	8.2	7.3	8.7	9.8	11.0	11.4	11.5	12.2	12.3	9.5	11.4	10.8	10.7	10.2	9.8	9.3	8.9
Food and Beverages	182.3	185.7	170.6	172.0	178.1	175.8	179.7	179.3	186.7	191.9	187.5	189.8	191.8	192.5	200.3	204.8	214.8	223.8	230.5	236.8	260.9	263.6	268.2	262.0	256.1	247.1	252.9
Other Industries	573.3	561.1	562.2	616.2	656.4	636.1	673.8	666.5	723.3	799.9	841.1	838.0	859.1	957.9	1,012.0	1,067.3	1,137.0	1,212.5	1,298.6	1,312.5	1,436.5	1,496.2	1,481.9	1,567.7	1,650.1	1,673.5	1,700.7
Transport Subsector	5,331.2	5,619,4	5,463.0	5,430.4	5,534,6	5,698.3	5,868,7	5,590.4	5,336.0	4,861,4	4,242.7	3,852.6	3,749.5	3,516.9	3,483.9	3,268.1	2,934.4	2,834.3	2,675.5	2,379.7	2,348.3	2,310.1	2,265.8	2,151.0	2,081.7	1,841.1	1,727.5
Road Transportation	5,284.7	5,575,2	5,422.6	5,385.7	5,486,8	5,652.4	5,819,4	5,540.0	5,281.8	4,809,4	4,191.1	3,801.9	3,699.6	3,470.5	3,434.0	3,219.9	2,887.2	2,783.3	2,620.8	2,324.6	2,288.8	2,249.8	2,202.4	2,087.5	2,016.9	1,786.8	1,678.6
Other Transport	46.5	44.2	40.4	44.7	47.8	45.9	49.3	50.4	54.2	52.0	51.6	50.7	49.9	46.4	49.9	48.2	47.2	51.0	54.7	55.1	59.5	60.3	63.4	63.5	64.8	54.3	48.9
Residential Subsector	1,443.2	1,433.6	1,427.2	1,254,8	1,218.4	1,098.7	1,072.1	1,084.7	1,107.6	1,142.1	1,172.3	1,221.8	1,361.6	1,418.9	1,439.1	1,468.4	1,472.8	1,397.7	1,382.2	1,361.6	1,306.7	1,173.4	1,167.1	1,031.9	1,106.2	1,143.2	1,090.6
Other Sectors	90.4	90.4	86.9	89.5	91.2	94.7	96.3	97.8	94.6	95.4	91.4	95.8	98.7	104.0	106.7	107.4	109.7	115.8	126.6	121.7	127.3	124.4	126.2	131.4	135.6	140.1	123.5
Industrial Processes	**900.8**	**810.4**	**759.8**	**819.3**	**834.0**	**777.5**	**714.0**	**706.3**	**651.9**	**722.6**	**788.1**	**721.3**	**761.3**	**884.0**	**1,034.9**	**1,019.6**	**994.4**	**1,034.8**	**1,024.8**	**663.6**	**809.6**	**825.0**	**795.1**	**735.1**	**719.7**	**717.4**	**625.0**
Iron and Steel Production	775.0	669.2	628.1	686.0	708.1	655.9	577.1	602.5	557.1	622.3	674.4	635.8	660.1	743.0	885.7	864.9	833.9	862.8	846.8	506.3	633.2	659.0	630.8	576.0	566.1	572.5	482.2
Ferroalloy Production	60.8	81.9	69.6	84.2	73.6	64.1	97.2	65.2	54.9	60.8	72.4	44.6	56.4	90.1	94.8	96.7	97.6	104.5	106.7	82.5	96.7	86.6	84.9	79.7	74.2	66.7	64.8
Production of Non-ferrous Metals	44.4	36.1	36.2	21.8	22.8	27.5	8.4	6.5	5.6	2.4	3.1	3.0	3.5	3.9	4.1	4.2	4.5	4.8	4.8	4.6	4.9	6.0	6.5	6.5	6.7	5.6	5.4
Other productions	20.6	23.2	25.9	27.3	29.5	30.0	31.3	32.1	34.3	37.1	38.2	37.9	41.3	47.0	50.3	53.8	58.4	62.7	66.5	70.2	74.8	73.4	72.9	72.9	72.7	72.6	72.6
Agriculture	**3,627.6**	**3,590.2**	**3,696.5**	**3,289.4**	**3,908.1**	**4,045.8**	**3,968.2**	**3,957.5**	**4,067.1**	**3,861.7**	**3,576.4**	**3,818.0**	**4,060.8**	**4,485.9**	**4,637.8**	**4,644.4**	**4,996.6**	**5,198.4**	**5,980.4**	**6,095.2**	**6,313.5**	**5,984.4**	**5,616.9**	**5,973.4**	**5,863.2**	**5,820.6**	**5,908.1**
Burning of Cotton Residues	128.4	114.8	80.0	31.9	16.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Burning of Sugarcane Residues	3,499.2	3,475.4	3,616.5	3,257.5	3,891.3	4,045.8	3,968.2	3,957.5	4,067.1	3,861.7	3,576.4	3,818.0	4,060.8	4,485.9	4,637.8	4,644.4	4,996.6	5,198.4	5,980.4	6,095.2	6,313.5	5,984.4	5,616.9	5,973.4	5,863.2	5,820.6	5,908.1
Land Use, Land-Use Change and Forestry	**18,634.1**	**16,589.0**	**19,515.8**	**20,574.8**	**20,412.7**	**39,912.2**	**26,440.6**	**21,011.9**	**26,051.4**	**25,941.7**	**26,956.8**	**26,986.3**	**31,122.9**	**49,003.3**	**52,747.6**	**34,676.2**	**24,586.8**	**19,601.1**	**21,383.2**	**11,589.4**	**10,745.1**	**9,597.9**	**7,256.8**	**10,462.3**	**8,367.3**	**10,311.7**	**11,404.8**
Memory only items:																											
International Bunkers	1.9	1.2	1.4	1.6	1.5	2.2	3.0	3.6	4.4	4.8	5.5	5.8	5.8	5.1	5.4	5.5	5.4	5.6	6.8	5.9	6.5	4.4	4.2	5.4	4.7	5.6	3.4
International Aviation	0.9	0.6	0.7	0.7	0.7	0.9	1.1	1.1	1.3	1.1	0.9	1.1	0.9	0.8	1.1	1.2	1.0	0.9	1.2	1.0	1.1	1.2	1.3	1.3	1.3	1.3	1.2
International Water-borne Navigation	1.0	0.6	0.7	0.9	0.8	1.3	1.9	2.5	3.1	3.7	4.6	4.7	4.9	4.3	4.3	4.3	4.4	4.7	5.6	4.9	5.4	3.2	2.9	4.1	3.4	4.3	2.2

NOx

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
	Gg																										
Total NOx	**2,262.7**	**2,304.7**	**2,385.2**	**2,453.4**	**2,530.3**	**2,927.9**	**2,824.8**	**2,819.3**	**2,977.6**	**3,046.7**	**3,032.1**	**3,073.4**	**3,156.1**	**3,645.9**	**3,813.5**	**3,355.6**	**3,200.4**	**3,171.0**	**3,359.6**	**2,989.7**	**3,078.0**	**3,022.4**	**3,054.5**	**3,245.4**	**3,234.9**	**3,090.8**	**2,860.4**
Energy	**1,591.7**	**1,656.5**	**1,688.2**	**1,745.2**	**1,806.4**	**1,904.6**	**2,017.9**	**2,091.6**	**2,157.5**	**2,226.8**	**2,198.2**	**2,233.5**	**2,236.5**	**2,196.6**	**2,293.6**	**2,292.7**	**2,294.6**	**2,385.0**	**2,518.3**	**2,400.5**	**2,498.1**	**2,473.4**	**2,566.2**	**2,648.7**	**2,703.4**	**2,513.2**	**2,319.4**
Fuel Combustion	1,591.7	1,656.5	1,688.2	1,745.2	1,806.4	1,904.6	2,017.9	2,091.6	2,157.5	2,226.8	2,198.2	2,233.5	2,236.5	2,196.6	2,293.6	2,292.7	2,294.6	2,385.0	2,518.3	2,400.5	2,498.1	2,473.4	2,566.2	2,648.7	2,703.4	2,513.2	2,319.4
Energy Subsector	218.1	229.7	248.5	251.3	258.6	269.1	291.6	335.1	344.1	391.5	400.7	422.7	388.8	422.0	456.4	486.9	497.9	507.7	592.8	564.4	583.6	589.9	682.9	774.0	850.5	794.8	703.9
Industrial Subsector	134.8	138.4	140.9	146.1	159.5	169.3	179.7	192.3	200.3	216.8	221.5	221.7	225.9	228.0	234.9	241.9	254.1	276.8	270.4	269.8	287.2	301.2	304.0	308.9	307.2	296.5	290.9
Iron and Steel	10.4	11.1	12.3	12.9	13.3	12.3	10.7	11.5	10.4	10.4	11.1	10.5	10.8	10.6	10.6	12.1	11.8	11.9	11.4	9.8	12.0	11.9	12.3	11.9	12.2	11.5	11.4
Other Industries	124.4	127.3	128.6	133.2	146.2	157.0	169.0	180.8	189.9	206.4	210.4	211.2	215.1	217.4	224.3	229.8	242.3	264.9	259.0	260.0	275.2	289.3	291.7	297.0	295.0	285.0	279.5
Transport Subsector	1,087.5	1,132.3	1,140.0	1,177.7	1,208.2	1,277.8	1,353.8	1,364.4	1,417.6	1,414.2	1,377.8	1,375.8	1,408.3	1,333.7	1,390.2	1,354.2	1,330.3	1,377.6	1,411.2	1,329.2	1,384.0	1,345.5	1,334.9	1,322.1	1,290.6	1,161.4	1,102.7
Road Transportation	970.3	1,018.1	1,021.8	1,046.8	1,093.2	1,162.7	1,218.4	1,262.7	1,307.8	1,301.9	1,275.7	1,262.6	1,281.7	1,215.0	1,254.7	1,214.0	1,188.5	1,211.2	1,233.6	1,159.4	1,211.1	1,175.6	1,165.5	1,153.2	1,106.4	1,021.7	983.3
Other Transport	117.2	114.2	118.2	130.9	115.0	115.1	135.4	101.7	109.8	112.3	102.1	113.2	126.6	118.7	135.5	140.2	141.8	166.4	177.6	169.8	172.9	169.9	169.4	168.9	184.2	139.7	119.4
Residential Subsector	29.2	29.3	29.6	27.8	27.4	26.3	26.5	26.8	27.2	27.9	28.5	29.2	30.6	30.6	31.1	31.3	31.3	30.8	31.0	30.9	30.6	29.1	29.1	27.6	28.7	29.1	28.6
Other Sectors	122.1	126.8	129.2	142.3	152.7	162.1	166.3	173.0	168.3	176.4	169.7	184.1	182.9	182.3	181.0	178.4	181.0	192.1	212.9	206.2	212.7	207.7	215.3	216.1	226.4	231.4	193.3
Industrial Processes	**42.1**	**42.5**	**41.8**	**47.7**	**51.1**	**50.7**	**53.5**	**58.4**	**65.5**	**72.5**	**79.1**	**77.2**	**84.7**	**98.9**	**105.4**	**106.0**	**106.5**	**114.5**	**117.7**	**98.4**	**100.8**	**107.1**	**104.1**	**100.1**	**102.8**	**102.2**	**95.4**
Metals Production	36.0	35.8	34.3	39.7	42.5	42.0	44.5	49.2	55.7	61.9	68.2	66.4	73.0	85.7	91.3	90.9	90.2	97.1	99.1	78.8	80.1	86.7	83.6	79.7	82.4	81.9	75.1
Other productions	6.1	6.7	7.5	8.0	8.6	8.7	9.0	9.2	9.8	10.6	10.9	10.8	11.7	13.2	14.1	15.1	16.3	17.4	18.6	19.6	20.7	20.4	20.5	20.4	20.4	20.3	20.3
Agriculture	**98.6**	**97.5**	**100.5**	**89.4**	**106.2**	**109.9**	**107.8**	**107.5**	**110.5**	**104.9**	**97.2**	**103.8**	**110.3**	**121.9**	**126.0**	**126.2**	**135.8**	**141.3**	**162.5**	**165.6**	**171.6**	**162.6**	**152.6**	**162.3**	**159.3**	**158.2**	**160.5**
Burning of Cotton Residues	3.5	3.1	2.2	0.9	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Burning of Sugarcane Residues	95.1	94.4	98.3	88.5	105.7	109.9	107.8	107.5	110.5	104.9	97.2	103.8	110.3	121.9	126.0	126.2	135.8	141.3	162.5	165.6	171.6	162.6	152.6	162.3	159.3	158.2	160.5
Land Use, Land-Use Change and Forestry	**530.3**	**508.2**	**554.7**	**571.1**	**566.6**	**862.7**	**645.6**	**561.8**	**644.1**	**642.5**	**657.6**	**658.9**	**724.6**	**1,228.5**	**1,288.5**	**830.7**	**663.5**	**530.2**	**561.1**	**325.2**	**307.5**	**279.3**	**231.6**	**334.3**	**269.4**	**317.2**	**285.1**
Memory only items:																											
International Bunkers	12.5	8.1	8.8	11.0	9.6	16.1	22.5	28.8	35.2	41.9	51.4	53.1	55.1	48.9	49.0	49.1	49.9	53.3	63.6	55.2	61.6	38.2	35.2	47.8	40.0	49.6	27.3
International Aviation	1.3	0.9	1.0	1.1	1.0	1.3	1.6	1.7	1.9	1.6	1.4	1.6	1.3	1.2	1.3	1.4	1.4	1.5	1.7	1.6	1.8	2.0	2.1	2.1	2.1	2.1	1.9
International Water-borne Navigation	11.2	7.2	7.8	9.9	8.6	14.8	20.9	27.1	33.3	40.3	50.0	51.5	53.8	47.7	47.7	47.7	48.5	51.8	61.9	53.6	59.8	36.2	33.1	45.7	37.9	47.5	25.4

NMVOC

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
	Gg																										
Total NMVOC	**51,470.6**	**45,711.8**	**57,984.9**	**50,943.9**	**57,186.0**	**60,823.7**	**62,733.1**	**65,124.4**	**86,195.7**	**68,735.6**	**80,047.7**	**67,764.3**	**82,218.4**	**61,753.4**	**76,684.7**	**82,192.4**	**110,514.1**	**101,949.7**	**123,341.4**	**114,267.9**	**154,101.3**	**130,726.5**	**130,815.0**	**135,606.7**	**157,412.2**	**99,743.4**	**106,506.1**
Energy	**1,075.9**	**1,062.7**	**1,025.1**	**1,014.0**	**1,025.5**	**1,005.4**	**991.5**	**972.7**	**945.3**	**939.8**	**918.2**	**888.6**	**920.5**	**955.4**	**1.005.9**	**994.4**	**965.1**	**967.6**	**966.2**	**822.1**	**849.9**	**843.7**	**833.6**	**793.3**	**797.5**	**774.6**	**713.7**
Fuel Combustion	1,075.9	1,062.7	1,025.1	1,014.0	1,025.5	1,005.4	991.5	972.7	945.3	939.8	918.2	888.6	920.5	955.4	1.005.9	994.4	965.1	967.6	966.2	822.1	849.9	843.7	833.6	793.3	797.5	774.6	713.7
Energy Subsector	337.6	299.9	276.0	289.2	293.9	271.6	243.9	238.1	216.8	232.7	249.6	234.3	245.3	287.8	330.9	329.1	323.0	333.0	337.8	228.4	251.8	263.5	255.3	239.0	237.1	235.3	203.1
Industrial Subsector	31.2	30.8	29.7	29.8	31.7	31.2	30.5	30.2	33.5	38.8	41.7	43.5	42.9	44.7	46.1	48.6	52.5	56.9	59.7	58.9	66.3	69.7	68.9	70.6	68.7	66.1	64.2
Iron and Steel	1.1	1.2	1.2	1.3	1.3	1.3	1.2	1.3	1.3	1.2	1.2	1.2	1.2	1.4	1.4	1.4	1.4	1.4	1.4	1.3	1.6	1.7	1.7	1.6	1.6	1.5	1.4
Food and Beverages	9.2	9.4	8.9	8.9	9.4	9.2	9.4	9.4	9.9	10.2	9.7	10.0	10.3	10.4	10.9	11.1	11.9	12.6	12.8	13.2	14.5	14.6	15.0	14.7	14.2	13.7	14.3
Other Industries	20.9	20.2	19.6	19.6	21.0	20.7	19.9	19.5	22.3	27.4	30.8	32.3	31.4	32.9	33.8	36.1	39.2	42.9	45.5	44.4	50.2	53.4	52.2	54.3	52.9	50.9	48.5
Transport Subsector	449.7	476.4	466.8	467.7	477.5	496.8	515.0	500.0	488.5	456.5	412.2	387.3	386.2	365.7	367.1	350.1	321.3	318.1	307.1	278.7	281.5	281.5	281.0	272.7	268.1	242.0	229.3
Road Transportation	443.1	469.9	460.3	460.6	471.3	490.5	508.1	494.3	482.2	450.2	406.0	380.6	378.4	358.4	358.8	341.9	312.9	308.9	297.3	269.4	271.8	271.9	271.3	263.0	257.9	233.5	222.0
Other Transport	6.6	6.5	6.5	7.1	6.2	6.3	6.9	5.7	6.3	6.3	6.2	6.7	7.8	7.3	8.3	8.2	8.4	9.2	9.8	9.3	9.7	9.6	9.7	9.7	10.2	8.5	7.3
Residential Subsector	216.5	215.1	214.1	188.3	182.8	164.9	160.9	162.8	166.2	171.4	175.9	183.3	204.3	212.9	215.9	220.3	221.0	209.7	207.4	204.3	196.1	176.1	175.1	154.9	166.0	171.6	163.7
Other Sectors	40.9	40.5	38.5	39.0	39.6	40.9	41.2	41.6	40.3	40.4	38.8	40.2	41.8	44.3	45.9	46.3	47.3	49.9	54.2	51.8	54.2	52.9	53.3	56.1	57.6	59.6	53.4
Industrial Processes	**345.0**	**340.9**	**347.7**	**369.4**	**370.7**	**426.1**	**437.0**	**456.8**	**463.0**	**506.6**	**532.1**	**501.1**	**541.4**	**589.9**	**628.7**	**615.8**	**745.1**	**694.6**	**723.5**	**717.4**	**736.8**	**734.8**	**734.0**	**732.3**	**732.1**	**732.1**	**729.4**
Chemical Industry	26.6	24.8	24.7	27.8	30.6	31.4	31.4	33.7	35.0	37.5	43.0	40.7	42.3	45.3	49.1	49.1	53.9	56.3	56.6	59.5	61.2	59.4	59.4	59.4	59.4	59.4	59.4
Metals Production	24.3	22.5	21.2	22.9	23.3	21.9	20.3	20.4	19.0	20.5	22.6	20.8	22.1	25.2	29.0	28.3	27.4	28.8	28.4	18.4	23.0	23.7	23.0	21.3	21.1	21.1	18.4
Pulp and Paper	13.3	14.9	16.7	17.5	19.0	19.2	20.2	20.8	22.0	23.9	24.6	24.5	26.6	30.4	32.3	34.8	37.7	40.5	43.0	45.5	48.5	47.6	47.5	47.5	47.5	47.5	47.5
Food Production	110.5	115.1	128.2	137.5	140.9	179.7	188.2	202.0	204.0	238.8	252.8	223.1	255.5	291.3	317.4	338.8	331.0	374.8	386.6	386.8	407.2	407.2	407.2	407.2	407.2	407.2	407.2
Beverage Production	170.3	163.6	156.9	163.7	156.9	173.9	176.9	179.9	183.0	185.9	189.1	192.0	194.9	197.7	200.9	164.8	295.1	194.2	208.9	207.2	196.9	196.9	196.9	196.9	196.9	196.9	196.9
Solvent Use	**50,049.7**	**44,308.2**	**56,612.1**	**49,560.5**	**55,789.8**	**59,392.2**	**61,304.6**	**63,694.9**	**84,787.4**	**67,289.2**	**78,597.4**	**66,374.6**	**80,756.5**	**60,208.1**	**75,050.1**	**80,582.2**	**108,803.9**	**100,287.5**	**121,651.7**	**112,728.4**	**152,514.6**	**129,148.0**	**129,247.4**	**134,081.1**	**155,882.6**	**98,236.7**	**105,063.0**
Memory only items:																											
International Bunkers	2.9	4.4	4.7	5.9	6.8	7.3	7.9	8.3	9.1	14.4	14.9	17.1	19.2	16.9	16.9	16.9	17.9	19.3	24.2	17.1	21.4	24.0	21.3	18.5	19.3	22.8	19.4
International Aviation	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
International Water-borne Navigation	2.7	4.2	4.5	5.7	6.6	7.1	7.6	8.0	8.8	14.1	14.7	16.8	19.0	16.7	16.7	16.7	17.7	19.1	24.0	16.9	21.2	23.8	21.1	18.3	19.1	22.6	19.2

HCF-23 | HCF-32 | HCF-125 | HCF-134a | HCF-143a | HCF-152a | CF_4 | C_2F_6 | SF_6

HCF-23	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
HCFC-22 Production	0.1202	0.1375	0.1636	0.1723	0.1566	0.1530	0.0890	0.0953	0.0130	0.0972	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HCF-32	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Use of HFCs, PFCs and SF_6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0718	0.0420	0.0872	0.1059	0.1138	0.1286	0.1434	0.1582	0.1730	0.1878
HCF-125	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Use of HFCs, PFCs and SF_6	-	-	-	-	-	-	-	-	-	-	0.0071	0.0392	0.0508	0.0548	0.1207	0.1249	0.2517	0.2850	0.3021	0.3587	0.5012	0.4683	0.5146	0.5609	0.6072	0.6535	0.6998
HCF-134a	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Use of HFCs, PFCs and SF_6	0.0004	0.0009	0.0042	0.0080	0.0685	0.0028	0.0476	0.1653	0.2823	0.3829	0.5023	0.6355	0.7745	0.9119	1.0608	1.2365	1.4584	1.7330	2.0314	2.3501	2.7362	2.6239	2.9372	3.2681	3.6166	3.9827	4.3664
HCF-143a	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Use of HFCs, PFCs and SF_6	-	-	-	-	-	-	-	-	-	-	0.0075	0.0271	0.0398	0.0500	0.1037	0.0929	0.2157	0.2520	0.3074	0.3209	0.4671	0.4331	0.4767	0.5203	0.5639	0.6075	0.6511
HCF-152a	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Use of HFCs, PFCs and SF_6	-	-	-	-	-	-	-	-	-	-	0.0001	0.0295	0.0081	0.0238	0.0543	0.1748	0.2800	-	-	-	-	-	-	-	-	-	-
CF_4	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Aluminum Production	0.3022	0.3365	0.3565	0.3348	0.3231	0.3060	0.2976	0.2027	0.2276	0.2013	0.1465	0.1147	0.1351	0.1362	0.1241	0.1239	0.1219	0.1174	0.1145	0.0823	0.0767	0.0631	0.0655	0.0569	0.0416	0.0333	0.0362
C_2F_6	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Aluminum Production	0.0263	0.0290	0.0311	0.0290	0.0279	0.0264	0.0261	0.0157	0.0172	0.0154	0.0117	0.0092	0.0117	0.0115	0.0100	0.0104	0.0104	0.0099	0.0096	0.0064	0.0059	0.0049	0.0050	0.0044	0.0032	0.0025	0.0026
SF_6	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Magnesium Production	0.0058	0.0058	0.0070	0.0101	0.0099	0.0101	0.0097	0.0127	0.0101	0.0098	0.0103	0.0095	0.0122	0.0147	0.0170	0.0191	0.0216	0.0260	0.0260	0.0130	-	-	-	-	-	-	-
Use of HFCs, PFCs and SF_6	0.0042	0.0040	0.0040	0.0040	0.0041	0.0041	0.0041	0.0042	0.0047	0.0049	0.0050	0.0051	0.0053	0.0056	0.0060	0.0061	0.0063	0.0064	0.0081	0.0075	0.0077	0.0080	0.0083	0.0086	0.0089	0.0092	0.0095
Total SF_6	**0.0100**	**0.0098**	**0.0110**	**0.0141**	**0.0140**	**0.0142**	**0.0138**	**0.0169**	**0.0148**	**0.0147**	**0.0153**	**0.0146**	**0.0175**	**0.0203**	**0.0230**	**0.0252**	**0.0279**	**0.0324**	**0.0341**	**0.0205**	**0.0077**	**0.0080**	**0.0083**	**0.0086**	**0.0089**	**0.0092**	**0.0095**

Unit: Gg

APPENDIX II

METHODOLOGICAL SUMMARY TABLE APPLIED TO THE NATIONAL INVENTORY

BOX 1: METHODOLOGICAL LEVELS BY GAS AND REFERENCES FROM THE ENERGY SECTOR

Sector	Method	Source of Data		
		Activity Data	Emission Factor (EF) and other parameters	Other assumptions or parameters for years estimated beyond the Third Inventory
ENERGY				
Fuel Combustion	Sectoral Approach (Bottom-up): Tiers 1 and 2 – IPCC (2006)	Fuel consumption obtained by the National Energy Balance – BEN (EPE, 2017); for road transport, information on the fleet was obtained from the National Association of Motor Vehicle Manufacturers (ANFAVEA, 2018) and the Brazilian Association of Motorcycle Manufacturers (ABRACICLO, 2018); and information on fuel consumption and intensity of use obtained from CETESB (2017) and MMA (2014); for air transportation, the data used were obtained from the National Agency of Petroleum, Natural Gas and Biofuels (ANP) and the National Agency of Civil Aviation (ANAC).	Default CO_2 emission factors (EFs) were used, as per IPCC guidelines (2006), except in some cases where specific national factors were applied such as for firewood, charcoal and piped gas; For non-CO_2 gases, default EF were used (Tiers 1 and 2), applied to each fuel consumed as per end use, references for those EFs are: IPCC (1997; 2006) and EMEP/EEA (2013); In order to determine the energy end use allocation coefficients, the Useful Energy Balance (BEU) was used; Specific EFs were used for fuels consumed in road transport, these vary annually, and were calculated from data obtained from the Environmental Company of the State of São Paulo (CETESB).	Data activity updated up to 2016. For variable road transport EF, non-CO_2 gases were recalculated and updated based on new vehicle sales data by ANFAVEA; for air transport, the same implied EF were used for non-CO_2 gases, and consumption data were updated, maintaining the allocation between domestic and international data for Jet Kerosene, according to the proportion obtained based on the last 10 years of the historical series.
	Reference Approach (Top-Down) – IPCC (2006)	Data used to determine the apparent consumption of energy inputs were obtained from the National Energy Balance (BEN). In the case of air transport, in addition to BEN data, ANP and ANAC data were used.	IPCC (2006) EFs were used. In the case of wet natural gas, dry natural gas factor was adopted, as the former is not listed by the IPCC; For excluded carbon: the annualized values of the BEU were used as a reducer; As raw material of the chemical industry, the BEN values attributed to "Non-Energy Consumption" were considered; Non-Energy Use Products were fully transferred to Industrial Processes, where the carbon fraction stored in the product and the emitted fraction were calculated as per the IPCC (2006).	Data activity updated up to 2016.
Fugitive Emissions	Oil and Natural Gas: Tiers 1, 2 and 3 were used, depending on the activities or periods considered (IPCC, 1997; 2006)	For Oil and Gas activities the following data were used: national oil, condensed oil and LNG production data (from 1990 and 2000) obtained from Petrobras; for the period from 2000 to 2012, besides these, data obtained by the National Agency of Petroleum, Natural Gas and Biofuels (ANP) were used; The cargo processed at refineries was obtained from the ANP and the cargo volume was obtained from the National Energy Balance (BEN).	Annual implied EF for oil and gas EF (from 2003 to 2012) were calculated for the following Sectors: Exploration, Production and Refining, based on emission data (by gas) and production and processing data (barrels/day) obtained from Petrobras. These factors were also considered for the annual volume of other companies in Brazil. An average EF was used for estimates from previous years (2003 to 2008).	For CO_2 emission in E&P, the annual oil production was considered, based on BEN, multiplied by the average of the past three months of the ratio production vs. emission. For CH_4 and N_2O, the proportion of emissions related to the result of the last available year was considered; For Refining, the annual oil refining obtained from BEN was considered and multiplied by the trend value for the years 2008-2012 of the ratio between production and emission of each gas; For Transport, the gross domestic supply of dry natural gas obtained from BEN was considered and multiplied by the trend value from 2003 to 2012 of the ratio production vs. CO_2 emission. For CH_4 and N_2O, the emission ratio related to the last available year's result was considered.
	Coal Mining: Tier 1 Method was used (IPCC, 1997).	For Coal Production activity, data for run-of-mine (ROM) and processed coal production were obtained from the National Department of Mineral Production (DNPM) and Annual Mining Reports (RAL).	Default EF were used for coal production (IPCC, 1997).	Data activity updated up to 2016. For the CO_2 emissions estimates, originated from uncontrolled combustion, the correlation between emissions and gross coal production (ROM) from 1990 to 2011 was used.

BOX 2: METHODOLOGICAL LEVELS BY GAS AND REFERENCES FROM THE IPPU SECTOR

Sector	Method	Source of Data		
		Activity Data	Emission Factor (EF) and other parameters	Other assumptions or parameters for years estimated beyond the Third Inventory
INDUSTRIAL PROCESSES				
Cement	Tier 3 – IPCC (2006)	Clinker and cement production from sector aggregated data (obtained from the National Cement Industry Union – SNIC).	Implied EF ranging from 0.541 to 0.564 t CO_2 / t clinker. In some cases, when it was not possible to apply Tier 3, the EF used was 0.536 t CO_2/ t clinker.	The trend of the past five years' inventory implied EF (2006-2010) was used, with national clinker production data up to 2015.
Lime	Tier 2 – IPCC (1997)	Lime production by type, based on data from the Brazilian Lime Producers Association (ABPC).	Default EF (IPCC, 1997) applied considering the three typical lime compositions (calcitic, magnesian and dolomitic) and the water percentage in hydrated lime.	Data activity updated up to 2016.
Other uses of limestone and dolomite	Tier 1 – IPCC (2006)	For the steel sector: data on limestone and dolomite consumption; and percentages of limestone and dolomite for glass production, according to the Metallurgical Sector Statistical Yearbook of the Ministry of Mines and Energy (MME, 2017). For dolomite used in magnesium production, emissions were based on data from CDM project reports.	Default EF (IPCC, 2006): limestone – 0.440 t CO_2/t; dolomite – 0.477 t CO_2/t; dolomite for the production of magnesium – 5.13 t CO_2/t primary Mg.	Data activity updated up to 2016. For activity data on glass production, the national production growth since 2011 (IBGE-Sidra) was used; for magnesium production, CDM project documentation was used.
Other Uses of soda ash	Tier 1 – IPCC (1997)	Consumption data from the Chemical Industry Yearbook of the Brazilian Chemical Industry Association (Abiquim).	Default EF (IPCC, 1997): 0.415 t CO_2/t Na2CO3	Data activity updated up to 2016.
Steel industry	Tier 1 – IPCC (2006)	The consumption of fuels identified as reducers was used by crossing information from the Useful Energy Balance (BEU) and the National Energy Balance (BEN) (EPE, 2017), in order to avoid double counting with the Energy Sector. For the calculation of CO_2, the carbon contained in the steel was discounted.	Default EF CO_2 and non CO_2 (IPCC, 2006).	Data activity updated up to 2016.

Sector	Method	Source of Data		
		Activity Data	Emission Factor (EF) and other parameters	Other assumptions or parameters for years estimated beyond the Third Inventory
Aluminum	Tier 1, Tier 2 and Tier 3 – IPCC (2006)	Data on Brazilian aluminum production by type of technology were obtained from the Brazilian Aluminum Association (Abal).	Each plant used the best possible approach (Tier) for the calculation of emissions from their processes. The information is aggregated. Due to the lack of specific information to each plant, from 2008 onwards the implicit EFs of 2007 were used.	Data activity updated up to 2016.
Chemical products	IPCC (2006): Tier 1: calcium carbide, methanol, ethylene and vinyl chloride/ Tier 2: Ethylene oxide, acrylonitrile and carbon black / Tier 3: ammonia, nitric acid, adipic acid and caprolactam	Consumption data obtained from the Brazilian Chemical Industry Yearbook of the Brazilian Chemical Industry Association (Abiquim) and the National Energy Balance (BEN).	Default EF IPCC (2006): calcium carbide, methanol, ethylene, vinyl chloride, ethylene oxide, acrylonitrile, and carbon black. An average EF was calculated for ammonia, according to the mass balance of the manufacturers and without the discount of the participation of urea production (1.46 t CO_2 / t produced); for nitric acid: plants with CDM projects used the specific EF and the others used the Default EF IPCC (2006); adipic acid: plant specific EF with a CDM project; caprolactam: plant specific EF with activity up to 2009.	Activity data updated up to 2015 and specific EF based on CDM projects. For nitric acid production, only one of the factories was updated, the others had repeated values since 2012, due to lack of CDM monitoring.
HFCs production and consumption and SF_6 consumption	IPCC (2006): Tier 2a – bottom-up for HFC-134a/ Tier 1b – potential emissions for other HFC gases / Tier 2b for SF_6.	Activity data for refrigeration and air conditioning, foams and aerosols sub-sectors were obtained through consultation with industry experts. The stock of equipment installed using SF_6 was assessed until 2008, and the extrapolation of this capacity until 2010 considered the average growth in the previous ten years. For magnesium production, SF_6 was used up to 2009, and its use was replaced by another gas due to a CDM project.	Default EF IPCC (2006): For assembly and operation of equipment. For SF_6 – Annual EF of 2% of installed capacity.	Gases were estimated by linear extrapolation of their trend lines for the historical series.

BOX 3: METHODOLOGICAL LEVELS APPLIED BY GAS AND REFERENCES FROM THE AGRICULTURAL SECTOR

Sector/ Subsector	Method	Source of Data		
		Activity Data	Emission Factor (EF) and other parameters	Other assumptions or parameters for years estimated beyond the Third Inventory
AGRICULTURE				
Enteric Fermentation	Tier 1 and Tier 2 – IPCC (1997) and IPCC (2000)	Population of dairy cattle (number of head), beef cattle, buffalo, sheep, goats, horses, mules, donkeys, swine and poultry from Municipal Livestock Production – IBGE by Federation Unit from 1990 to 2016 (IBGE, 2018) and 2006 IBGE Agricultural Census (IBGE, 2006). Beef cattle data were obtained by the difference between total cattle and dairy cows, according to the IBGE – Agricultural Census, taking into consideration male, female and young census data by state (Agricultural Census 2006, IBGE). **Note**: **The poultry population** was considered only for the Manure Management subsector.	• Dairy and beef cattle: data on live weight, average daily feed intake and fat content, digestibility, and pregnancy rates were based on literature and experts and default values for Latin America (IPCC, 1997) by region and year; • Swine, buffalo, sheep, horses, mules, donkeys: default emission factors (IPCC, 1997).	Data activity updated up to 2016. For donkeys and mules, due to lack of data from 2013 to 2016, an average of 5 years reduction was taken (trend line, by the average variation from 2008 to 2012 – last year of the series).
Manure Management			• Swine and cattle: the fraction of livestock category using each manure management system was obtained taking into account the default values (IPCC, 1997) for Latin America; EPAGRI (EPAGRI, 1995); 2006 Agricultural Census (IBGE, 2006) and expert information. The maximum methane producing capacity and ash content fraction in the manure were based on default values (IPCC, 1997) and expert information. • Buffalo, sheep, horses, mules, donkeys, and poultry: default emission factors were used (IPCC, 1997).	Data activity updated up to 2016.
Rice cultivations	Tiers 1 and 2 – IPCC (1997) and IPCC (2000)	Rice harvested area data by Federation Unit and year (stratified by water supply regime): Embrapa Arroz e Feijão (2018) and DCI/IRGA (IRGA, 2018);	Seasonally integrated emission factor for continuous flooded irrigated crops with incorporation of organic material in the conventional and early tillage systems were determined through field experiments with methane flow evaluation, following the method proposed in IPCC (1997) and IPCC (2000), with data from BAYER et al. (2013), for the state of Rio Grande do Sul. The IPCC (1997) default value was used for the other producing regions in Brazil, associated with scaling factors of 1.5 (organic material input) and 1.0 or 0.8, for Continuously flooded and Intermittently flooded with multiple aeration regimes, respectively (IPCC, 1997). Information on the water supply regimes adopted for irrigated rice cultivation in producing states was obtained from consultations with experts from national and state institutions.	Data activity updated up to 2016.

Sector/ Subsector	Method	Source of Data		
		Activity Data	Emission Factor (EF) and other parameters	Other assumptions or parameters for years estimated beyond the Third Inventory
Burning of Crop Residues	Tiers 1 and 2 – IPCC (1997)	• **Sugarcane (1990 - 2016)**: Planted area, harvested area, amount produced and average yield from the Systematic Survey of Agricultural Production (LSPA) - IBGE (IBGE, 2018a). • **Herbaceous cotton (1990-1995)**: Planted area, harvested area, amount produced and average yield from the Systematic Survey of Agricultural Production (LSPA) - IBGE (IBGE, 2018a).	EF for burnt dry biomass was based on default values (IPCC, 1996 and IPCC, 2006). The effectively oxidized dry biomass fraction followed the standard value suggested by the IPCC (2006). Data of dry biomass, fresh biomass and rattan production/stem production ratio for the main sugarcane varieties planted in Brazil were obtained through weighted average from different sources (national references).	Data activity updated up to 2016. Due to the absence of data and indications provided by experts regarding the gradual fractions of mechanization occurrence, it was assumed that from 2012 onwards the burned area fractions were kept equal to the last year in which the data were updated (2011).
Agricultural Soils	Tier 1 and Tier 2 – IPCC (1997), IPCC (2000) and IPCC (2006)	Nitrogen fertilizer data were based on values provided by the National Association for Fertilizer Diffusion (ANDA), from 1990 to 2016 (ANDA, 2018). Population of dairy cattle, beef cattle, buffalo, sheep, goats, horses, mules and donkeys were obtained from Municipal Livestock Production (PPM) by Federation Unit from 1990 to 2016 (IBGE, 2018). Data on ethanol production were obtained from the Sugarcane Industry Union (UNICA) from 1990 to 2016 (UNICA, 2018). Planted area of temporary and permanent culture, from the IBGE Municipal Agricultural Production (PAM), from 1990 to 2016 (IBGE, 2018b); For the survey of the soils, the Brazilian soil map prepared by IBGE (IBGE, 2009). For the estimation of management, the 1994 and 2002 land use maps, which are included in the Land Use Change and Forests report in the Second National Communication, were used.	Fraction of the amount of N fertilizer consumed as urea and other sources (IPCC 1996 and Lara-Cabezas et al. 1997). N percentages of volatilized fertilizer in the form of NH_3 were obtained from national references. Default emission factor applied to the amounts of N added to soils, for direct N_2O emission (IPCC, 1997). Annual amount of N excreted directly in pastures (IPCC, 1997). Nitrogen excreted by the different categories of the national herd (IPCC, 1997 and IPCC, 2000). Dry matter to dry waste ratio and N fractions in aerial waste (National references). N_2O direct emission factor (IPCC, 2006). Direct N_2O emission factors from fertilized treated soils for different crops in different locations, and types of soils in Brazil (National references). N_2O emission factor for management systems used (IPCC, 2000).	Data activity updated up to 2016. For organic soils, the same estimate for the period from 1990 to 2010 was considered, based on the land use maps of 1994 and 2002, assuming a linearity in the increment of the used area estimated for 1994 and 2002, i.e., the same trend observed in this range lasts until 2016.

BOX 4: METHODOLOGICAL LEVELS BY GAS AND REFERENCES FROM THE LULUCF SECTOR

Sector	Method	Source of Data		
		Activity Data	Emission Factor (EF) and other parameters	Other assumptions or parameters for years estimated beyond the Third Inventory
LAND USE, LAND-USE CHANGE AND FORESTRY				
Land-Use Change – CO_2 Emissions and Removals	IPCC Approach 3 (2006): All land use or cover categories and their changes are considered spatially throughout the territory. The parameters and emission/removal factors for each carbon compartment of the different categories were estimated from studies carried out within the country (Tiers 2, 3) and, in the absence of specific data, IPCC default ratios were used (Tier 1).	Mappings of all Brazilian biomes for the years 1994, 2002, 2005 (Amazon only), and 2010, from TM/Landsat-5 and LISS-3/ Resoucesat-1 satellite images (30 and 22,5m spatial resolution) at a 1:125,000 scale and minimum area of 6 ha. The classes considered were Managed Forest (MF, i.e. forest vegetation within Conservation Units or Indigenous Lands), Unmanaged Forest (UMF), Secondary Forest (FSec), Selective Logging (CS, Amazon Biome only), Reforestation (Ref, Planted Forest), Managed Grassland (GM), Unmanaged Grassland (GNM), Secondary Grassland (GSec), Pasture (Ap), Agriculture (Ac), Settlement (S), Water (A, Rivers and Lakes), Artificial Reservoirs (Res), Other (O, such as mining and dunes) and Not Observed (NO, cloud and/or shadow covered areas). The division of territory took into consideration the following information: biome boundaries (IBGE, 2004), municipal boundaries (IBGE, 2010), map of past natural vegetation (IBGE, 2004; MMA, 2002), soil carbon stock (BERNOUX et al., 2002), and protected areas (FUNAI, 2010; ICMBio, 2010). As a result, land use conversion and cover matrices, gross vegetation emissions, vegetation removals, soil emissions and removals, and net emissions by biome and period were obtained. For the annualization of emissions between the mapped years, annualization indices based on the deforestation areas of each biome were calculated to distribute gross emissions over the assessed period: INPE PRODES (2015) for the Amazon, Forest Remnant Atlas for the Atlantic Forest (SOS Mata Alântica Foundation; INPE, 2015), FREL Cerrado for the Cerrado (MMA, 2016), and PMDBBS for Caatinga, Pampa and Pantanal (IBAMA, 2015). In order to estimate net emissions per biome, annualized gross vegetation emissions were added to soil emissions and removals and vegetation removals were taken out (both equally distributed per year).	**Vegetation biomass and carbon**: For each biome, a map was constructed that took into account the phytophysiognomies of the map of past vegetation. Values were estimated for each pool: above ground (AGB); below ground (BGB) and dead organic matter (DOM, consisting of standing and fallen dead wood and litter), based on field data, scientific literature, expansion factors and, in the absence of information, ratios and/or IPCC default values (IPCC deadwood, 2003 and IPCC BGB, 2006). The carbon content of dry forest biomass was 47% for all pools (IPCC, 2006). For Grassland, 47% was considered for AGB and BGB, 50% for dead wood and 40% for litter (IPCC, 2006). **Vegetation emission/ removal factors**: the increase in vegetation biomass/carbon was estimated from the scientific literature and, in some cases, IPCC default values in relation to BGB were used (IPCC, 2006). **Other parameters**: stock and increment of pasture and agriculture were estimated from IPCC (2003) default values, taking into account the Brazilian climate zone. Classes such as Settlement, Other Land and Wetland had their stock associated with zero. Soil organic carbon stock: adapted from the methodology developed by Bernoux et al. (2002), which estimates the amount of soil organic carbon as a function of soil type and vegetation type, both classified by the authors into 6 and 15 large groups, respectively. Soil carbon emission factors: carbon change factors due to land use change (fLU), management regime (fMG) and additions (fI) were selected from IPCC (2003).	Extrapolation of gross emissions for the following years (2011 to 2015) was carried out through annualization indices calculated based on the deforestation areas of each biome, when available. Thus, only for the Amazon and Atlantic Forest biomes was it possible to extend it this way. For the other biomes, the 2010 value was repeated until the end of the series. Soil emission values were also replicated. Specifically, for removals, the 2010 value was fully added by removals from managed forests and managed grasslands.

Sector	Method	Source of Data		
		Activity Data	Emission Factor (EF) and other parameters	Other assumptions or parameters for years estimated beyond the Third Inventory
Land-Use Change – Non CO_2 Emissions	Emissions due to biomass burning associated with deforestation were calculated using the IPCC guidelines (2003), Tier 1 and 2. Emissions due to biomass burning not associated with deforestation have not yet been incorporated into results since the methology for these estimates is still being developed.	From the gross emissions from deforestation, it was possible to estimate the original dry matter of vegetation before being converted to other uses. From this original dry matter, the values of firewood used for coal (BEN, 2015), forestry and vegetal extraction (IBGE, 2015) were extracted, obtaining the remaining dry matter in the field and available for burning.	Default EF (CH_4, N_2O, NO_X and CO) IPCC (2006) per ton of dry matter burned, taking into account the differentiation between forest and grassland categories. The oxidation factors for each biome and category were obtained from literature review.	The extrapolation of gross emissions from 2011 to 2015 was explained in the previous item. The same method was used, with only wood extraction values being updated.
Liming	Tiers 1 and 2 – IPCC (2003).	Apparent limestone consumption data, in tons, by state, were obtained from the Brazilian Association of Agricultural Limestone Producers (ABRACAL, 2016).	Default EF (IPCC, 2006): 0.44 t CO_2/ t of applied limestone ($CaCO_3$).	Data activity updated up to 2016.

BOX 5: METHODOLOGICAL LEVELS APPLIED BY GAS AND REFERENCES FROM THE WASTE SECTOR

Sector/ Subsector	Method	Source of Data		
		Activity Data	Emission Factor (EF) and other parameters	Other assumptions or parameters for years estimated beyond the Third Inventory
WASTE TREATMENT				
Solid Waste Disposal	Tiers 1 and 2 – IPCC (1997) and some IPCC parameters (2006).	Population: Demographic Census for the urban populations of 1970, 1980, 1991, 2000, and 2010, and interpolation between years without the Census (IBGE, 1970; 1980; 1991; 2000, and 2010). In 2016, the urban population was estimated using data from IBGE - Resident Population Estimates in Brazil, with the percentage of urban population from IBGE - 2010 Population Census; Waste generation rate (CETESB, 1998, and ABRELPE, 2009; 2010; 2011; 2012; 2013; 2014; 2015; 2016); Climatological data (INMET, 2010); National guidelines for determining the gravimetric composition of solid waste, by Federative Unit and year.	The amount of municipal solid waste (MSW) was calculated based on the Urban Population data (IBGE, 1970; 1980; 1991; 2000; 2010; and 2016) and per capita waste generation rate (MSW Rate), which was calculated by linear interpolation between the years 1970 and 2008 (national MSW rate), and from 2008 to 2016 data from angular and linear coefficients of waste generation were used for the N, NE, CO, S, and SE regions (CETESB, 1998, and ABRELPE, 2009; 2010; 2011; 2012; 2013; 2014; 2015; 2016). In addition, cities with more than 500,000 inhabitants had their data estimated separately. Temperature, evapotranspiration and mean annual rainfall data were based on INMET data for the periods from 1970 to 1990, from 1991 to 2000 and from 2001 to 2010 (INMET, 2010). For the determination of degradable organic carbon (DOCt) more than 100 analyzes of MSW for different cities between 1970 and 2010 were carried out, determining the coefficients that describe the variation of the DOCt of each state or region. Default values (IPCC 2006) were used for the decomposing DOC fraction (DOCf), waste disposal site management for the methane correction factor (MCF), and fraction of CH_4 generated in the landfill gas. Recovered methane data was based on landfill CDM project monitoring reports for the years 1990-2016, published on the UNFCCC website (UNFCCC, 2019).	Data activity updated up to 2016. The per capita waste generation rate was calculated through a linear interpolation of angular coefficient data for each region of Brazil, provided by the 2016 ABRELPE Waste Panorama. Methane reductions up to 2015 were updated as recorded in the monitoring reports for each of the landfill projects included in the CDM.
Domestic Wastewater	Tiers 1 and 2 – IPCC (1997) and some IPCC parameters (2006).	Population: IBGE Estimates of Resident Population in Brazil and Federation Units from 1990 to 2016) - IBGE (IBGE, 2018c); Permanent private housing units by sanitation, occupation condition and location: IBGE Demographic Census (1991 - Table 441, 2000 - Table 1444 and 2010 - Table 1394) (IBGE, 1991; 2010); Volume of sewage collected and treated in Brazil daily: National Survey of Basic Sanitation (PNSB) - IBGE (1989 - Table 5; 2000 - Table 1825; 2008 - Table 55) (IBGE, 1989; 2000a; 2008); Sewage treatment by system type - National Survey of Basic Sanitation (PNSB) - IBGE (1989 - Table 4, 2000 - Table 1815 and 2008 - Table 1300). For protein consumed per capita: FAO (2012).	In order to obtain the wastewater fraction treated using each type of treatment system, a list of IBGE Demographic Census and PNSB data was made. For uncollected wastewater, data from the IBGE Demographic Census (IBGE 1991; 2000; 2008) were used - Permanent private housing units by sanitation, occupation condition and situation. For the collected wastewater, data from IBGE PNSB (IBGE, 1989, 2000 and 2008) were used. The methane correction factor (MCF) for each system type was made with an interpolation of the 1989, 2000 and 2008 PNSB data and default data (IPCC, 2006). Household Wastewater Degradable Organic Component (Ddom) and Maximum Methane Production Capacity (B0) data were based on default values (IPCC, 2006). For the calculation of N_2O, default vales (IPCC, 2006) were used for protein N fraction and N_2O EF parameters.	Data activity updated up to 2016. The collected and uncollected sewage fractions were extrapolated for 2016 from the values provided by the Third Inventory, as there is no more current data for the other years analyzed. The CH_4 Conversion Factor (each system type was made with an interpolation of the 1989, 2000 and 2008 IBGE – PNSB data and IPCC default data (2006). The same efficiency of burners for anaerobic reactors and digesters of activated sludge systems was considered.

Sector/ Subsector	Method	Source of Data		
		Activity Data	Emission Factor (EF) and other parameters	Other assumptions or parameters for years estimated beyond the Third Inventory
Industrial Wastewater	Tiers 1 and 2 – IPCC (1997) and some IPCC parameters (2006).	Annual agricultural production data: sugar (UNICA, 2018), raw milk (ABIA, 2018), beer (ABIA, 2014), alcohol (UNICA, 2018), pulp (IBA, 2018), poultry, cattle and swine slaughtering (IBGE, 2018), pasteurized milk (ABLV, 2014), paper (IBA, 2018).	Industrial production values (Pi) were found out from the observation of the most important sectors in 2005 and the expert judgment for the period between 1990 and 2010. In order to obtain the industrial degradable organic component (Dind), as recommended by the IPCC (2000), a panel of experts was consulted to define the most appropriate Dind to be applied. Values of Maximum Methane Production Capacity (B0) were based on IPCC default data (2000). The Fraction of wastewater treated by certain each treatment/discharge pathway or system (WSi, x) and methane correction factor (MCF) were defined after consultation by an expert panel and default IPCC value (2000), due to the absence of an official survey regarding the technology employed and each treatment/discharge pathway or system fraction in the Brazilian industry.	Data activity updated up to 2016. In order to obtain beer production, in the absence of available data, an average of the last 5 years was made. Pasteurized milk values took into account the variation according to total raw milk. The treated anaerobic fraction of each Sector (MCF) was calculated from an extrapolation of the weighted MCF interpolation data presented in the Third National Inventory.
Waste Incineration	Tiers 1 and 2 – IPCC (1997) and some IPCC parameters (2006).	Data on the amount of waste incinerated from SNIS (2006) and private companies (2009); ABRELPE (2004, 2007, 2008, 2009, 2010) and ABETRE (2006) were used.	The amount of waste incinerated from 1990 to 2010 was defined based on installed capacity data and assumptions of operating incinerator usage rate from different sources such as SNIS, ABETRE and ABRELPE (SNIS, 2006. ABRELPE, 2004; 2007; 2008; 2009; 2010; and ABETRE, 2006) for different types of waste. Fraction of carbon content in waste (CCW), Fraction of fossil carbon in the waste (FCF), and Burn out efficiency of combustion of incinerators for waste (EF) values were used from the IPCC 2006. The EF value for N_2O used was the default value (IPCC, 2006).	Data activity updated up to 2016. In order to determine the amount of incinerated waste, the values presented in the Third Inventory were extrapolated from installed capacity data and operating incinerator usage rate from different sources such as SNIS, ABETRE and ABRELPE, for different types of waste.

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