

FIFTH BIENNIAL
UPDATE REPORT OF BRAZIL
TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE





Ministry of Science, Technology and Innovation

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FEDERATIVE REPUBLIC OF BRAZIL

MINISTRY OF SCIENCE, TECHNOLOGY AND INNOVATION

SECRETARIAT FOR STRATEGIC POLICIES AND PROGRAMMES

DEPARTMENT FOR CLIMATE AND SUSTAINABILITY

GENERAL COORDINATION OF CLIMATE SCIENCE

INTERMINISTERIAL COMMITTEE ON CLIMATE CHANGE

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Office of the President's Chief of Staff; Attorney General's Office; Ministry of Agriculture and Livestock; Ministry of Cities; Ministry of Agrarian Development and Family Farming; Ministry of Development and Social Assistance, Family and Fight Against Hunger; Ministry of Development, Industry, Trade and Services; Ministry of Education; Ministry of Finance; Ministry of Racial Equality; Ministry of Integration and Regional Development; Ministry of the Environment and Climate Change; Ministry of Mines and Energy; Ministry of Women; Ministry of Planning and Budget; Ministry of Indigenous Peoples; Ministry of Foreign Affairs; Ministry of Health; Ministry of Labor and Employment; Ministry of Transportation; and the General Secretariat of the Presidency of the Republic and the Secretariat of Institutional Relations of the Presidency of the Republic.





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NATIONAL CIRCUMSTANCES AND INSTITUTIONAL ARRANGEMENTS



1 NATIONAL CIRCUMSTANCES AND INSTITUTIONAL ARRANGEMENTS

1.1 NATIONAL CIRCUMSTANCES

1.1.1 Country Profile

Brazil is a developing country endowed with extensive land and sea areas. With a population of approximately 203 million inhabitants and a territory of 8,510,417.771 km², the country has undergone intense urbanization over the past 50 years and 87% 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 stepped up its efforts towards sustainable development and, due to investments in research and innovation, has succeeded in increasing its industrial and agricultural production in line with environmental responsibility and with the fight against poverty, which are the pillars of sustainable development. Investment in agricultural production has enabled Brazil to transform itself from a food-importing country with serious food insecurity in the 1970s to the world's second largest food exporter, an important guarantor of the planet's food security.

Brazil is a world reference in sustainable agriculture, using an integrated approach to the landscape as a premise, adopting sustainable practices in areas suitable for agriculture and encouraging the environmental regularization of rural properties. The Brazilian Forest Code is one of the most advanced environmental laws in the world. As a general rule, the law stipulates that at least 80% of the area of rural properties in the Amazon must be allocated for the conservation and sustainable use of natural resources. In the Cerrado, this amounts to 35%, and in the other biomes, it is 20%.

The Brazilian agribusiness sector contributed approximately 24% to the country's total GDP in 2023, accounting for more than 40% of total exports (CEPEA - Center for Advanced Studies in Applied Economics [Centro de Estudos Avançados em Economia Aplicada]/CNA - Brazilian Confederation of Agriculture and Livestock [Confederação da Agricultura e Pecuária do Brasil], 2024a). The sector accounts for 27% of all existing jobs in Brazil, i.e., 28 million workers (CEPEA/CNA, 2024b).

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. The 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.

Brazilian industry is also a fundamental pillar of the national economy and contributed with 25.5% of the country's GDP in 2023. Covering a wide range of segments, from manufacturing to advanced technology, its share of the trade balance is the most significant among all economic sectors, reaching 66.6% through the export of goods and services. From a global point of view, Brazil accounts for 1.5% of the world's industrial production. In 2022, the industry sector share of formal employment was 21.2% (CNI - National Industry Confederation [Confederação Nacional da Indústria], 2024).

With regard to the Brazilian energy matrix, the high use of renewable sources stands out, being well above the global average. In terms of the composition of the energy matrix, comparing 2019 to 2023, there has been an increase in the share of renewable sources, from 46.1% in 2019 to 49.1% in 2023.

The share of renewable sources in the total supply of electricity in the Brazilian matrix reached 89.2% in 2023. Hydroelectric generation, including imported electricity, accounted for 61%. Wind generation grew by 17.4% compared to 2022, consolidating its leadership among wind, biomass, nuclear and solar photovoltaic sources, with 13.2%. Regarding electricity generation, in 2023, the biggest increase was in the solar photovoltaic source, with 68.1% growth compared to 2022 (with a 7% share), coming close to biomass generation (8% in 2023) (EPE – Energy Research Office (Empresa de Pesquisa Energética), 2024a).

With regard to bioenergy, in recent years products derived from sugar cane have stood out, accounting for 16.9% of the share of sources in Brazil’s domestic energy supply in 2023. In the transport sector, ethanol and biodiesel have increased their share. In 2023, ethanol production stood at 32.1 million m³, an increase of 5.4% compared to 2022. Biodiesel production in 2023 increased 19.9% compared to 2022. The mandatory percentage of biodiesel blended into diesel was increased to 12% (in volume) from April 2023 (EPE, 2024a).

The country has also made progress in terms of national development priorities. There has been gradual improvement in the indicators of access to healthcare, basic sanitation, the fight against hunger, poverty and income inequality. This improvement is also due to better living conditions and household income as a result of the effective implementation of 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, with an emphasis on improving urban environmental conditions, with an increase in basic sanitation and proper treatment of solid waste.

TABLE 1.1. RELEVANT INFORMATION ABOUT BRAZIL¹

Parameter	Characteristics
Territory	Total area of 8,510,417.771 km ² ; divided in five political-administrative regions – North, Northeast, Central West, South and Southeast; composed of 26 states and the Federal District.
Population	203,080,756 inhabitants (in 2022).
Climate	Five climatic regions: Equatorial (North), Tropical (most of the territory - 81.4%), Semi-arid (Northeast), Tropical of Altitude (Southeast), and Subtropical (South).
Biodiversity	Six biomes ² Amazon (49.5%), Cerrado (23.3%), Atlantic Forest (13%), Caatinga (10.1%), Pantanal (1.8%), and Pampa (2.3%).
Protected Areas	Terrestrial conservation units make up 18.5% of the Brazilian continental area (1,579,417.53 km ²), while marine conservation units cover an area of 961,248.01 km ² , protecting 26.3% of this biome, in a total of 2,945 Conservation Units at the three administrative levels. With regard to Indigenous Lands, they make up 13.8% of the national territory, in a total of 631 territories.
Water resources	The country has approximately 12% of the planet’s surface fresh water. Twelve river basins provide abundant water resources; however, they are unevenly distributed throughout the territory. Currently, the main use of water in the country, in terms of the quantity used, is irrigation, with more than 900 m ³ /s (ANA – National Water Agency (Agência Nacional de Águas), 2019).
Energy matrix	The percentage of renewable sources in the Brazilian Energy Matrix in 2023 was 49.1%, which is significantly higher than the world average (~15%). In the electricity matrix, renewable sources accounted for 89.2% of domestic electricity supply in 2023.

1 Data from the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística) (available at: www.ibge.gov.br) and EPE (2024); National Register of Conservation Units: <https://cnuc.mma.gov.br/powerbi>; Official data from FUNAI – National Indian Foundation (Fundação Nacional do Índio): <https://www.gov.br/funai/pt-br/atuacao/terras-indigenas/geoprocessamento-e-mapas>.

2 A Biome is defined as a collection of life (plant and animal life) constituted by the grouping of contiguous vegetation types identifiable on a regional scale, with similar geoclimatic conditions and a shared history of changes, which results in a unique biological diversity. (IBGE, 2004). Biome distribution data available at: <https://biblioteca.ibge.gov.br/visualizacao/livros/liv101676.pdf>.

TABLE 1.2. BRAZIL'S SOCIO-ECONOMIC INDICATORS

Socio-economic indicators ³	2012	2014	2016	2018	2020	2022
GDP (trillion BRL, current values)	4.8	5.8	6.3	7	7.6	9.9
GDP Agriculture at current prices (%GDP)	4.9	5.03	5.66	5.15	6.59	6.65
GDP Industry at current prices (%GDP)	26.03	23.79	21.23	21.85	22.51	26.33
GDP Services at current prices (%GDP)	69.07	71.18	73.11	73	70.9	67.02
GDP <i>per capita</i> (thousand BRL)	24.7	29.1	31.1	34.4	37.3	49.6
GDP <i>per capita</i> (thousand USD)	12.6	12.3	8.9	9.4	7.2	9.6
HDI ⁴	0.732	0.753	0.753	0.762	0.758	0.760
Gini Index ⁵	0.54	0.526	0.537	0.545	0.524	0.518
Life expectancy at birth (years) [SDG 3]	74.48	75.11	75.68	76.22	76.21	75.5
Infant mortality rate (per 1,000 births) [SDG 3.2]	17.3	16.3	16.4	15.2	14	15.5
National poverty rate ⁶	34.7	30.8	33.7	33.3	31	31.6
International poverty rate ⁷	6.6	5,2	6.7	7.4	6	5.9

Source: References for this table are provided in the footnote.

1.1.2 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 The Fourth Biennial Update Report (BUR4).

Firstly, the main instrument is the National Policy on Climate Change (PNMC, Política Nacional sobre Mudança do Clima), enacted through Law No. 12,187, of December 29, 2009⁸, which established the legal framework for fighting climate change in Brazil until 2020. It formalized a voluntary national commitment to the Nationally Appropriate Mitigation Actions (NAMAs) presented at the Copenhagen Conference (COP-15). Its main characteristics and components are shown in Table 1.3.

3 Ipea – Institute of Applied Economic Research (Instituto de Pesquisa Econômica Aplicada), 2024. Available at: <http://www.ipeadata.gov.br/Default.aspx>.

4 PNUD, 2024. **Human development summary**. Available at: <https://hdr.undp.org/data-center/specific-country-data#/countries/BRA>.

5 It measures the degree of inequality in the distribution of individuals according to *per capita* household income. Its value is 0 when there is no inequality (the *per capita* household income of all individuals is the same) and tends to 1 as inequality increases.

6 Proportion of the population living below the national poverty line. National poverty line (for monitoring the Sustainable Development Goals - SDGs/IBGE) of USD 5.50 a day, converted at purchasing power parity (PPP-2011) of BRL 1.66 per dollar.

7 Proportion of the population living below the international poverty line. Line of USD 1.90 per day, converted at purchasing power parity (PPP-2011) of BRL 1.66 per dollar.

8 Available at: www.planalto.gov.br/ccivil_03/_Ato2007-2010/2009/Lei/L12187.htm.

TABLE 1.3. 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 strengthening 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	The instruments provided for in the PNMC include the National Plan on Climate Change; the National Climate Change Fund; the Action Plans for the Prevention and Control of Deforestation in the biomes; as well as Brazil's National Communication to the UNFCCC. In addition, policy instruments include the use of fiscal and tax measures, credit and funding lines, research lines by funding agencies, and financial and economic measures relating to climate change mitigation and adaptation, among others.
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	Institutional instruments at government level include the Interministerial Committee on Climate Change (CIM) and the Commission for the Coordination of Meteorological, Climatological and Hydrological Activities (CMCH, Comissão de Coordenação das Atividades de Meteorologia, Climatologia e Hidrologia). The current governance of the CIM is provided for by Decree No. 12,040, of June 05, 2024, which establishes, among others, its duties and composition. In addition to the 23 ministries, representatives appointed by the Social Participation Chamber, one of whom is the Executive Coordinator of the Brazilian Forum on Climate Change - FBMC (Fórum Brasileiro de Mudança do Clima), and representatives appointed by the Interfederative Coordination Chamber and by the Scientific Advisory Chamber are members of the CIM without voting rights. One of the representatives of the Scientific Advisory Chamber is the Scientific Coordinator of the Brazilian Research Network on Global Climate Change (Rede Clima).

The Interministerial Committee on Climate Change (CIM),⁹ the country's main permanent climate governance body, is working on revising the PNMC, a process that began in 2023, with the aim of addressing its objectives, principles, guidelines and institutional instruments, as well as promoting a low greenhouse gas emission economy.

The NAMAs and the PNMC actions are the main object of the BURs so far. As the period for the implementation of the NAMAs draws to a close, it is important to analyze its contributions, challenges and lessons learned. The NAMAs have played a central role in Brazil's trajectory to integrate climate action into its sustainable development agenda. In particular, the lessons learned were decisive for the formulation of the Nationally Determined Contributions (NDCs) submitted by the country under the Paris Agreement. The Brazilian NDC incorporated the principles and objectives of the NAMAs in a more robust way, consolidating long-term commitments. In the latest update of Brazil's first NDC, the country committed to an emissions threshold of 1.32 Gt CO₂ eq and 1.20 GtCO₂ eq (GWP-AR5) in 2025 and 2030, respectively, considering all sectors of the economy. This corresponds to a reduction of 48.4% and 53.1%, respectively, compared to national GHG emissions in 2005. More information will be presented in Chapter 3.

⁹ Decree No. 12,040, dated June 05, 2024.

1.2 INSTITUTIONAL ARRANGEMENTS

In order to prepare Brazil's National Communications (NC) on a permanent basis, the General Coordination of Climate Science and Sustainability (CGCL, Coordenação-Geral de Ciência do Clima e Sustentabilidade) of the Ministry of Science, Technology and Innovation (MCTI, Ministério da Ciência, Tecnologia e Inovação) coordinates the project, whose main objective is to help the country's government prepare the transparency reports to the UNFCCC. Therefore, the CGCL is responsible for preparing Brazil's National Communications, Biennial Update Reports and Biennial Transparency Reports.

The National Communications projects were financed with international resources from the Global Environment Facility (GEF), with the support of the United Nations Development Programme (UNDP), through its role as the implementing agency, and with the agreement of the Brazilian Cooperation Agency (ABC, Agência Brasileira de Cooperação).

The preparation of these reports brings together the contribution of hundreds of national experts linked to several public and private institutions, such as universities, research institutes and bodies, companies and associations that contribute directly to making data available and developing analyses. In addition to these, other institutions were indirectly involved in the work, through the provision of official national data made available on public platforms. Above all, there is relevant academic engagement from the Brazilian Research Network on Global Climate Change (Rede CLIMA), in partnership with other researchers associated with various research groups, with which institutional partnerships are established to update and/or improve relevant methodologies, particularly related to the National Inventory Report of GHG Emissions. Progress in the presentation and detailing of information has been planned, with a view to constantly incorporating the best available science and updating data that highlights the sustainability characteristics and low-carbon emission trajectory of the Brazilian production sector.

The Ministry of Foreign Affairs (MRE, Ministério das Relações Exteriores) is responsible for acting as Brazil's focal point for the UNFCCC and the Intergovernmental Panel on Climate Change (IPCC). The Ministry of Finance (MF, Ministério da Fazenda) acts as the Designated National Authority for the Green Climate Fund, the Operational Focal Point for the Global Environment Facility (GEF) and the Designated Member for the Committees of the Climate Investment Funds (CIF). The Office of the President's Chief of Staff is responsible for coordinating the Interministerial Committee on Climate Change - CIM. The Ministry of the Environment and Climate Change (MMA, Ministério do Meio Ambiente e Mudança do Clima) acts as the CIM's Executive Secretariat. The Ministry of the Environment and Climate Change performs the duties of Designated National Authority and other duties relating to the instruments established in Article 6 of the Paris Agreement under the United Nations Framework Convention on Climate Change, in coordination with the Ministry of Foreign Affairs.

2

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



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

2.1 GENERAL ASPECTS

This section presents the time series of emissions from the National Inventory of Anthropogenic Emissions by Sources and Removals by Sinks of Greenhouse Gases not Controlled by the Montreal Protocol of the this BUR5, from 1990 to 2020.

This Inventory is organized according to the structure suggested by the Intergovernmental Panel on Climate Change (IPCC), covering the following sectors: Energy; Industrial Processes and Product Use (IPPU); Agriculture; Land Use, Land-Use Change and Forestry (LULUCF); and Waste. Greenhouse gas removals occur in the LULUCF sector as a result of forest plantation, the growth of secondary vegetation and the protection of natural formations, which continue to incorporate carbon into their biomass.

2.2 INSTITUTIONAL ARRANGEMENTS

For this BUR5, the same methodological approach as the one used in the Inventory submitted in Brazil's Fourth National Communication (1990-2016) (BRASIL, 2020) was used. The preparation of the National Inventory involved an important portion of the Brazilian scientific and business community, as well as various government sectors.

The Ministry of Science, Technology and Innovation (MCTI) coordinates the preparation of the National Inventories and is responsible for coordinating the different working groups that contribute to gathering sectoral data and developing studies to obtain country-specific emission factors (Figure 2.1).

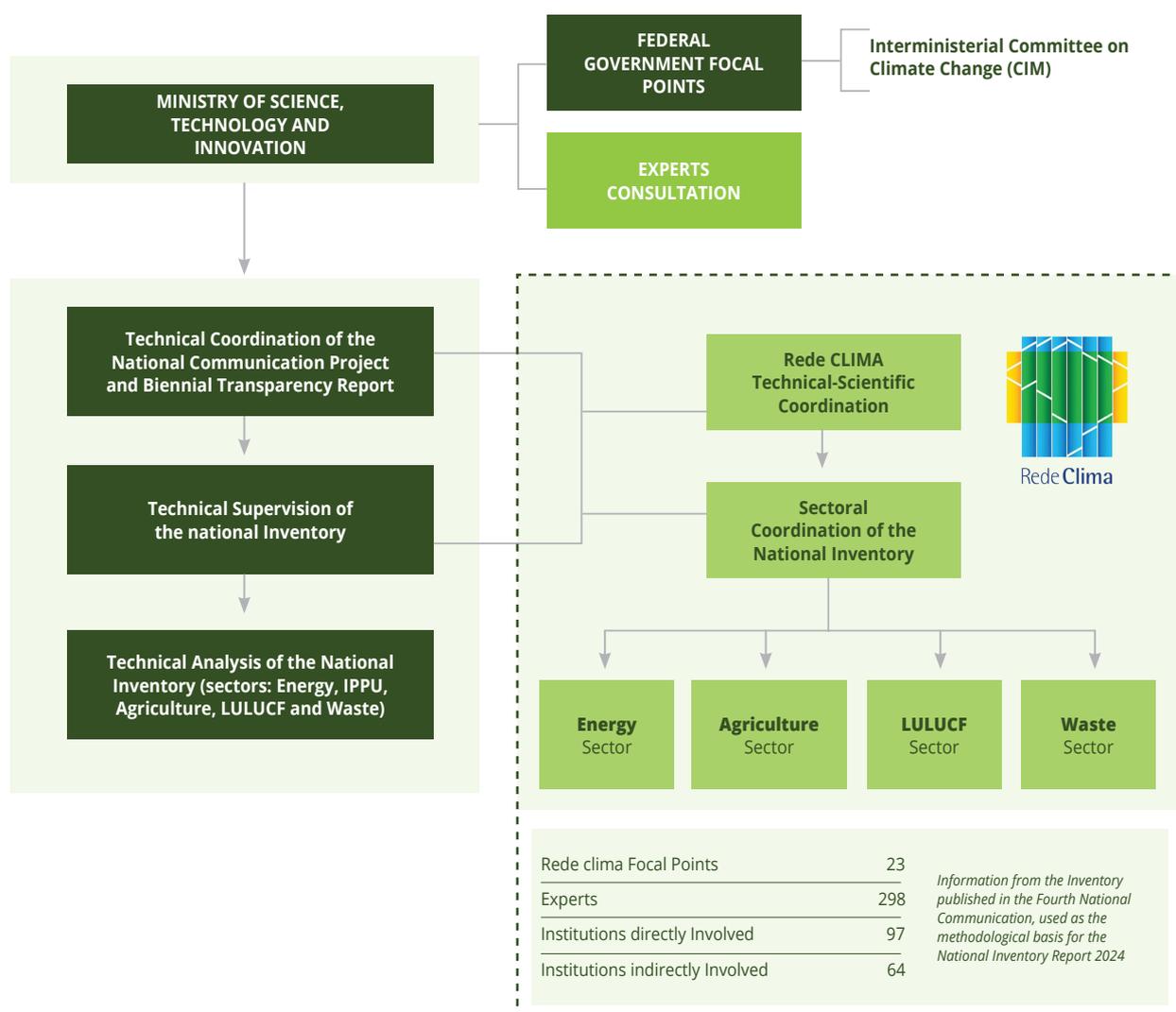


Figure 2.1: Institutional arrangements for the preparation of the National Inventories

The Brazilian Research Network on Global Climate Change (Rede CLIMA), established by the MCTI in 2007, plays a significant role in the academic and research contribution to updating activity data, parameters and emission factors for the National Inventory. The work of Rede CLIMA consists of representing the best available science in Brazilian academia, which is guided by sectoral studies carried out by experts from the different thematic sub-networks, from universities and research bodies.

2.3 QUALITY ASSURANCE AND QUALITY CONTROL

The quality assurance and quality control (QA/QC) plan of the National Greenhouse Gas Inventory is established at the initial planning stage of the activities. In order to meet the criteria for good QC practices recommended by the IPCC, checks are carried out with respect to the methodology used, activity data, parameters, emission factors and calculations. To this end, validation procedures and

activities were established according to the progress of the work, up to the preparation of the sectoral reference reports. The QC of the methodological implementation is carried out by the project's team of experts. Quality assurance (QA) includes the process of consulting experts not directly involved in the work, in order to obtain considerations aimed at improving the results achieved.

Additionally, after the necessary analyses and adjustments were carried out, the consolidated report was shared with the ministries that are members of the Interministerial Committee on Climate Change (CIM). Once approved by the CIM, the report was forwarded for submission by the Ministry of Foreign Affairs (MRE), which acts as the National Focal Point and is responsible for coordinating the Brazilian government's relationship with the UNFCCC.

2.4 ARCHIVING AND DISCLOSURE

The information related to Brazil's National GHG Inventory is archived on MCTI's institutional network. All data, including all disaggregated emission factors and activity data, all documentation on data generation and aggregation, including quality assurance/quality control (QA/QC), the results of the review, as well as metadata used throughout the process, from scientific articles to the spatial database used in the LULUCF sector, are archived.

The sectoral reports prepared in the Fourth National Communication, which transparently describe the methodological details, indicating the data sources and assumptions adopted, are also archived by the MCTI. These reports (in Portuguese) are made publicly available on SIRENE's – National Emissions Registry System (Sistema de Registro Nacional de Emissões) website¹⁰, along with the results of emissions and removals of all GHGs not controlled by the Montreal Protocol.

2.5 METHODOLOGY

The same methodological approach as the one used in the Inventory submitted in Brazil's Fourth National Communication (1990-2016) (BRASIL, 2020) was used in this BUR5. In addition, in the absence of specific information, some assumptions were used according to the national document, the 6th edition of the Annual Estimates of Brazil (BRASIL, 2022).

Since Brazil began its efforts to prepare the BUR5 concurrently with the submission of the First Biennial Transparency Report (BTR1) in 2024, this National GHG Inventory was prepared in accordance with the Annex to Decision 18/CMA.1 and Annex V to Decision 5/CMA.3.

Since the Inventory published in the Fourth National Communication (BRASIL, 2021), Brazil has used the 2006 IPCC Guidelines for National Greenhouse Gas Emissions Inventories, demonstrating its commitment to improving its estimates, which makes it possible to improve the planning and the inputs for decision-making.

The IPCC methodologies for quantifying emissions are divided into three levels (or Tiers) which correspond to the methodological complexity and representation of the specificities of each country.

¹⁰ Available at: <https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/sirene/publicacoes/relatorios-de-referencia-setorial>

Tier 1 is considered the basic method, using default emission factors recommended by the IPCC's own methodology; Tier 2 is intermediate; and Tier 3 is more demanding in terms of the requirements for data obtained nationally. Tiers 2 and 3 are considered to be the most accurate estimation methods.

For this Inventory, different Tiers were used, the application of which for the various categories can be understood in the sectoral breakdown presented in Appendix II.

The estimated GHGs were carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF₆). Other indirect GHGs, such as carbon monoxide (CO), nitrogen oxides (NO_x) and other non-methane volatile organic compounds (NMVOC) have been included whenever possible.

In order to update the activity data, mainly public and official references were consulted. Data that was not published in publications or other media was requested from the institutions responsible for such data, or experts were consulted.

2.6 ANALYSIS OF UNCERTAINTIES

The estimates of anthropogenic emissions and removals of greenhouse gases presented in this Inventory are subject to uncertainties due to various causes, ranging from the inaccuracy of the basic data used to incomplete knowledge of the processes that cause greenhouse gas emissions or removals.

For this Inventory, the accuracy of the estimates varied depending on the characteristics of each sector, the data available and the resources applied in determining the emission factors best suited to the Brazilian circumstances.

The following tables show the uncertainties of CO₂, CH₄ and N₂O emissions, which account for 99.5% of emissions in the last year analyzed (2020).

In order to calculate the uncertainties of the activity data and emission factors, the error propagation method (Approach 1) was used at national level for all sectors, with the exception of the Waste sector, which used the Monte Carlo method (Approach 2), given the possibility of detailing the various parameters involved in this estimate.



TABLE 2.1. UNCERTAINTY ASSOCIATED WITH CO₂ EMISSIONS IN 2020

Sector	2020	
	Uncertainty (%)	Emissions (kt CO ₂)
Energy	3	364,226
Fuel combustion	2	348,751
Fugitive Emissions	3	15,475
Industrial Processes and Product Use	4	87,215
Mineral Industry	1	32,070
Chemical Industry	1	6,682
Metal Industry	3	47,642
Non-Energy Products from Fuels and Solvent Use	1	820
Electronics Industry	-	-
Product Uses as Substitutes for Ozone Depleting Substances	-	-
Other Product Manufacture and Use	-	-
Agriculture	30	26,010
Enteric Fermentation	-	-
Manure management	-	-
Rice cultivation	-	-
Agricultural soils	-	-
Field burning of agricultural residues	-	-
Liming	29	21,593
Urea Application	1	4,417
Land Use, Land-Use Change and Forestry	57	616,679
Forest Land	7	(329,190)
Cropland	11	153,465
Grassland	55	814,172
Wetlands	1	10,155
Settlements	1	4,908
Other Land	1	11,226
Harvested Wood Products	5	(48,056)
Waste	44	548
Solid Waste Disposal	-	-
Biological Treatment of Solid Waste	-	-
Incineration and Open Burning of Waste	44	548
Wastewater Treatment and Discharge	-	-
TOTAL	32	1,094,677

TABLE 2.2. UNCERTAINTY ASSOCIATED WITH CH₄ EMISSIONS, IN 2020

Sector	2020	
	Uncertainty (%)	Emissions (kt CO ₂)
Energy	49	600.5
Fuel combustion	47	423.6
Fugitive Emissions	13	176.9
Industrial Processes and Product Use	85	36.3
Mineral Industry	-	-
Chemical Industry	5	10.7
Metal Industry	85	25.6
Non-Energy Products from Fuels and Solvent Use	-	-
Electronics Industry	-	-
Product Uses as Substitutes for Ozone Depleting Substances	-	-
Other Product Manufacture and Use	-	-
Agriculture	17	14,728.6
Enteric Fermentation	17	13,454.3
Manure management	2	843.8
Rice cultivation	1	420.7
Agricultural soils	-	-
Field burning of agricultural residues	1	9.9
Liming	-	-
Urea Application	-	-
Land Use, Land-Use Change and Forestry	34	1,336.7
Forest Land	2	65.5
Cropland	3	105.2
Grassland	34	1,136.6
Wetlands	1	12.4
Settlements	1	2.7
Other Land	1	14.3
Harvested Wood Products	-	-
Waste	11	3,055.8
Solid Waste Disposal	9	1,779.4
Biological Treatment of Solid Waste	1	1.4
Incineration and Open Burning of Waste	1	24.3
Wastewater Treatment and Discharge	31	1,250.6
TOTAL	13	19,757.9



TABLE 2.3. UNCERTAINTY ASSOCIATED WITH N₂O EMISSIONS IN 2020

Sector	2020	
	Uncertainty (%)	Emissions (kt CO ₂)
Energy	34	33.62
Fuel combustion	34	33.40
Fugitive Emissions	1	0.22
Industrial Processes and Product Use	51	1.15
Mineral Industry	-	-
Chemical Industry	4	0.66
Metal Industry	51	0.49
Non-Energy Products from Fuels and Solvent Use	-	-
Electronics Industry	-	-
Product Uses as Substitutes for Ozone Depleting Substances	-	-
Other Product Manufacture and Use	-	-
Agriculture	65	548.41
Enteric Fermentation	-	-
Manure management	2	15.42
Rice cultivation	-	-
Agricultural soils	65	532.25
Field burning of agricultural residues	1	0.74
Liming	-	-
Urea Application	-	-
Land Use, Land-Use Change and Forestry	41	41.42
Forest Land	2	2.00
Cropland	5	3.74
Grassland	40	34.78
Wetlands	1	0.38
Settlements	1	0.09
Other Land	1	0.43
Harvested Wood Products	-	-
Waste	27	9.91
Solid Waste Disposal	-	-
Biological Treatment of Solid Waste	1	0.09
Incineration and Open Burning of Waste	2	0.37
Wastewater Treatment and Discharge	27	9.45
TOTAL	57	634.51

TABLE 2.4. UNCERTAINTY ASSOCIATED WITH EMISSIONS BY GAS AND UNCERTAINTY OF THE TOTAL RESULT IN 2020

Gas	2020 Emissions	Uncertainty (%)	GWP	2020 Emissions
	(kt)			(kt CO ₂ eq)
CO ₂	1,094,677	32	1	1,094,677
CH ₄	19,758	13	28	553,220
N ₂ O	635	57	265	168,145
TOTAL		20		1,816,042

The following tables show estimates of greenhouse gas emissions for the years 1994, 2000, 2010, 2012, 2015, 2016 and 2020, by type of gas and by sector, as recommended by Decision 17/CP.8. In accordance with this decision, the country has not estimated SO₂ emissions, as they are not significant for the national reality.

1994		kt																			
		CO ₂ (gross emissions)	CO ₂ (removals) ²	CO ₂ (net emissions)	CH ₄	N ₂ O	CO	NOx	NMVOc	PFCs		HFCs						SF ₆			
										CF ₄	C ₂ F ₆	HFC-23	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-152a	HFC-227ea	HFC-365mfc		
	Other transportation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Other sectors	31,608		31,608	286.4	3.84	1,310.2	183.9	222.7												
	Commercial/institutional	3,580		3,580	3.6	0.05	4.9	10.9	3.2												
	Residential	15,374		15,374	269.3	2.85	1,217.9	27.4	182.7												
	Agriculture/forestry/fishing	12,654		12,654	13.5	0.95	87.4	145.6	36.7												
	Not specified	746		746	0.0	0.02	0.5	0.7	0.0												
	Fugitive emissions from fuels	6,645	-	6,645	89.0	0.06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Solid fuels	-	-	-	44.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Coal mining and handling	NO		NO	44.9																
	Spontaneous Combustion and Landfills for Burning	NO		NO	NO	NO	NO	NO	NO												
	Coal	NO		NO	NO	NO	NO	NO	NO												
	Fuel transformation	6,645		6,645	44.1	0.06	NE	NE	NE												
	Oil and natural gas	52,508	-	52,508	40.4	17.11	1,160.0	27.8	1,967.9	0.3231	0.0279	0.1566	-	-	-	-	-	-	-	-	0.0152
	INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)	14,595		14,595	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Mineral industry	10,086		10,086	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Cement production	3,892		3,892	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Lime production	115		115	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Glass production	502		502	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Other process uses of carbonates	4,712	-	4,712	6.7	16.46	0.8	1.3	30.5	-	-	0.1566	-	-	-	-	-	-	-	-	-
	Chemical industry	287		287	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Ammonia production																				
	Nitric acid production					2.01		1.0													
	Adipic acid production					13.99	0.8	0.3													
	Caprolactam, glyoxal and glyoxylic acid production					0.46															
	Carbide production	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Titanium dioxide production																				
	Soda ash production	NO		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	Petrochemical and carbon black production	4,425		4,425	6.7			0.0	7.3												
	Fluorochemical production											0.1566									
	Other Chemicals				-	-			23.2												

1994		kt																			
		CO ₂ (gross emissions)	CO ₂ (removals)	CO ₂ (net emissions)	CH ₄	N ₂ O	CO	NO _x	NMVOC	PFCs		HFCs						SF ₆			
										CF ₄	C ₂ F ₆	HFC-23	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-152a	HFC-227ea	HFC-365mfc	SF ₆	
Sheep					92.3																
Swine					35.1																
Other Animals					288.7																
Manure management					594.1			9.77													
Cattle					269.7			3.43													
Beef Cattle					200.2			0.35													
Dairy Cattle					69.5			3.08													
Sheep					3.1			NO													
Swine					284.9			1.38													
Other Animals					36.4			0.42													
Indirect N ₂ O Emissions								4.54													
Rice cultivation					403.4			-													
Irrigated					403.4			IE													
Rain-fed					NO			NO													
Agricultural soils					-			- 294.55													
Direct N ₂ O Emissions from managed soils								229.39													
Inorganic N Fertilizers								18.49													
Organic N Fertilizers								8.80													
Animal manure deposited by grazing animals								143.36													
Crop Residues								50.36													
Mineralization/immobilization associated with loss/gain of soil organic matter								2.90													
Cultivation of Organic Soils								5.47													
Indirect N ₂ O Emissions from managed soils								65.16													
Atmospheric Deposition								24.96													
Nitrogen leaching and run-off								40.20													
Field burning of agricultural residues								3.02													
Liming					40.5			64.9													
Urea Application								-													
LAND USE, LAND-USE CHANGE AND FORESTRY (LULUCF)																					
Forest Land								52.07													
Forest Land Remaining								26,187.4													
Forest Land								2.30													
Forest Land Remaining								1,184.4													
Forest Land								18.8													
Forest Land Remaining								1,170.3													
Forest Land								2.25													
Forest Land Remaining								18.0													

		kt																							
1994		CO ₂ (gross emissions)	CO ₂ (removals) ²	CO ₂ (net emissions)	CH ₄	N ₂ O	CO	NOx	NMVOC	PFCs		HFCs							SF ₆						
										CF ₄	C ₂ F ₆	HFC-23	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-152a	HFC-227ea		HFC-365mfc					
	Waste Incineration	41		41		0.01																			
	Open Burning of Waste	527		527	21.1	0.30																			
	Wastewater Treatment and Discharge	-	-	-	660.5	5.62	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Domestic Wastewater Treatment				590.9	5.62																			
	Industrial Wastewater Treatment				69.6	NE																			
	TOTAL	1,935,519	-878,119	1,057,400	15,539.6	397	37,933	2,192	3,588	0.3231	0.0279	0.1566	-	-	-	-	-	-	-	-	-	-	-	0.0152	

Notations:

NA (Not applicable) – Activity in a given source/sink category that occurs in the country, but did not result in emissions or removals of a specific gas;

IE (Included elsewhere) – Included in another location/category of emissions or removals;

NO (Not occurring) – Categories and processes that do not occur in the country;

NE (Not estimated) – Activity data and/or emissions by sources and removals by sinks of GHG that have not been estimated, but for which a corresponding activity may occur in the country.

		kt																					
2000		CO ₂ (gross emissions)	CO ₂ (removals)	CO ₂ (net emissions)	CH ₄	N ₂ O	CO	NO _x	NMVOC	PFCs		HFCs							SF ₆				
										CF ₄	C ₂ F ₆	HFC-23	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-152a	HFC-227ea		HFC-365mfc			
	Commercial/institutional	4,357		4,357	3.1	0.06	4.5	10.0	3.3														
	Residential	17,195		17,195	261.4	2.85	1,171.8	28.4	175.8														
	Agriculture/forestry/fishing	14,193		14,193	12.0	0.96	87.1	160.3	35.6														
	Not specified	1,152		1,152	0.0	0.03	0.8	1.1	0.0														
	Fugitive emissions from fuels	9,434	-	9,434	124.0	0.11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Solid fuels	-	-	-	47.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Coal mining and handling	NO		NO	47.4																		
	Spontaneous Combustion and Landfills for Burning Coal	NO		NO	NO	NO	NO	NO	NO														
	Fuel transformation	NO		NO	NO	NO	NO	NO	NO														
	Oil and natural gas	9,434		9,434	76.6	0.11	NE	NE	NE														
	INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)	69,165	-	69,165	41.0	20.73	1,154.9	29.3	2,507.8	0.1465	0.0117	-	0.0014	0.3805	0.0016	0.0001	-	-	-	-	-	0.0168	
	Mineral industry	21,702	-	21,702	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Cement production	16,047		16,047	-																		
	Lime production	4,756		4,756	-																		
	Glass production	193		193	-																		
	Other process uses of carbonates	706		706	-																		
	Chemical industry	6,321	-	6,321	9.0	20.11	1.0	1.3	43.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Ammonia production	283		283	-																		
	Nitric acid production					2.09		0.9															
	Adipic acid production					17.51	1.0	0.3															
	Caprolactam, glyoxal and glyoxylic acid production					0.50																	
	Carbide production	51		51																			
	Titanium dioxide production																						
	Soda ash production	NO		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	Petrochemical and carbon black production	5,988		5,988	9.0			0.0	9.7														
	Fluorochemical production																						
	Other Chemicals								33.3														
	Metal Industry	40,517	-	40,517	32.0	0.62	1,116.7	18.1	15.3	0.1465	0.0117	-	-	-	-	-	-	-	-	-	-	-	0.0103
	Iron and Steel Production	37,794		37,794	31.8	0.62	613.0	15.3	15.3														

2000	kt																					
	CO ₂ (gross emissions)	CO ₂ (removals)	CO ₂ (net emissions)	CH ₄	N ₂ O	CO	NOx	NMVOC	PFCs		HFCs							SF ₆				
									CF ₄	C ₂ F ₆	HFC-23	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-152a	HFC-227ea		HFC-365mfc			
Waste Incineration	46		46		0.01																	
Open Burning of Waste	880		880	25.3	0.38																	
Wastewater Treatment and Discharge	-	-	-	769.6	6.63	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Domestic Wastewater Treatment				679.9	6.63																	
Industrial Wastewater Treatment				89.6	NE																	
TOTAL	2,380,854	-919,239	1,461,615	16,686.6	444.13	42,731	2,616	3,730	0.1465	0.0117	-	-	0.0014	0.3805	0.0016	0.0001	-	-	-	-	0.0168	

Notations:

NA (Not applicable) – Activity in a given source/sink category that occurs in the country, but did not result in emissions or removals of a specific gas;

IE (Included elsewhere) – Included in another location/category of emissions or removals;

NO (Not occurring) – Categories and processes that do not occur in the country;

NE (Not estimated) – Activity data and/or emissions by sources and removals by sinks of GHG that have not been estimated, but for which a corresponding activity may occur in the country.

kt																		
2010	CO ₂ (gross emissions)	CO ₂ (removals)	CO ₂ (net emissions)	CH ₄	N ₂ O	CO	NOx	NMVOC	PFCS		HFCS							SF ₆
									CF ₄	C ₂ F ₆	HFC-23	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-152a	HFC-227ea	
Field burning of agricultural residues	-	-	-	42.3	3.17	1,832.1	68.0	-	-	-	-	-	-	-	-	-	-	-
Liming	11,292	-	11,292	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Urea Application	2,406	-	2,406	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LAND USE, LAND-USE CHANGE AND FORESTRY (LULUCF)	1,382,764	-1,143,463	239,301	1,042.2	32.68	16,364.4	293.0	-	-	-	-	-	-	-	-	-	-	-
Forest Land	108,171	-508,561	-400,391	34.3	1.09	541.3	9.9	-	-	-	-	-	-	-	-	-	-	-
Forest Land Remaining Forest Land	43,881	-361,087	-317,206	33.0	0.97	505.1	7.8	-	-	-	-	-	-	-	-	-	-	-
Land Converted to Forest Land	64,290	-147,474	-83,184	1.3	0.12	36.3	2.2	-	-	-	-	-	-	-	-	-	-	-
Cropland	74,137	-4,204	69,933	68.9	2.30	1,110.2	22.6	-	-	-	-	-	-	-	-	-	-	-
Cropland Remaining Cropland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Converted to Cropland	74,137	-4,204	69,933	68.9	2.30	1,110.2	22.6	-	-	-	-	-	-	-	-	-	-	-
Grassland	747,182	-147,277	599,905	928.7	28.96	14,549.0	257.4	-	-	-	-	-	-	-	-	-	-	-
Grassland Remaining Grassland	30,490	-34,945	-4,455	26.6	2.43	751.8	45.1	-	-	-	-	-	-	-	-	-	-	-
Land Converted to Grassland	716,692	-112,331	604,361	902.1	26.53	13,797.1	212.3	-	-	-	-	-	-	-	-	-	-	-
Wetlands	6,145	-	6,145	5.5	0.18	87.8	1.7	-	-	-	-	-	-	-	-	-	-	-
Wetland Remaining Wetland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Converted to Wetland	6,145	-	6,145	5.5	0.18	87.8	1.7	-	-	-	-	-	-	-	-	-	-	-
Settlements	4,321	-	4,321	2.3	0.07	36.2	0.7	-	-	-	-	-	-	-	-	-	-	-
Settlements Remaining Settlements	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Converted to Settlements	4,321	-	4,321	2.3	0.07	36.2	0.7	-	-	-	-	-	-	-	-	-	-	-
Other Land	2,431	-	2,431	2.6	0.08	39.9	0.7	-	-	-	-	-	-	-	-	-	-	-
Other Land Remaining Other Land	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Converted to Other Land	2,431	-	2,431	2.6	0.08	39.9	0.7	-	-	-	-	-	-	-	-	-	-	-
Harvested Wood Products	440,377	-483,420	-43,044	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WASTE	1,154	-	1,154	2,449.3	8.82	-	-	-	-	-	-	-	-	-	-	-	-	-
Solid Waste Disposal	-	-	-	1,410.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Managed Waste Disposal Sites	-	-	-	625.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-

		kt																				
2012		CO ₂ (gross emissions)	CO ₂ (removals)	CO ₂ (net emissions)	CH ₄	N ₂ O	CO	NOx	NMVOC	PFCs		HFCs							SF ₆			
										CF ₄	C ₂ F ₆	HFC-23	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-152a	HFC-227ea	HFC-365mfc			
	Other Product Manufacture and Use	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0108
	Electrical Equipment									NO	NO											0.0108
	Other	-	-	-	-	-	71.9	19.2	709.9	-	-	-	-	-	-	-	-	-	-	-	-	-
	Pulp and Paper Industry						71.9	19.2	47.5													
	Food and Beverage Industry								662.4													
	AGRICULTURE	18,932	-	18,932	14,148.5	471.06	1,221.9	45.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Enteric Fermentation	-	-	-	12,943.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Cattle				12,590.4																	
	Beef Cattle				10,614.4																	
	Dairy Cattle				1,976.0																	
	Sheep				83.9																	
	Swine				38.8																	
	Other Animals				230.4																	
	Manure management	-	-	-	792.1	15.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Cattle				388.6	4.90																
	Beef Cattle				249.4	1.37																
	Dairy Cattle				139.3	3.53																
	Sheep				3.0	NO																
	Swine				356.5	2.34																
	Other Animals				44.0	0.76																
	Indirect N ₂ O Emissions					7.50																
	Rice cultivation	-	-	-	384.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Irrigated				384.6	IE																
	Rain-fed				NO																	
	Agricultural soils	-	-	-	-	453.44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Direct N ₂ O Emissions from managed soils					350.61																
	Inorganic N Fertilizers					54.49																
	Organic N Fertilizers					15.80																
	Animal manure deposited by grazing animals					182.50																

		kt																								
2015		CO ₂ (gross emissions)	CO ₂ (removals)	CO ₂ (net emissions)	CH ₄	N ₂ O	CO	NOx	NMVOC	PFCs		HFCs							SF ₆							
										CF ₄	C ₂ F ₆	HFC-134a	HFC-125	HFC-134a	HFC-143a	HFC-152a	HFC-227ea	HFC-365mfc								
	Domestic Navigation	4,189		4,189	0.4	0.11	9.9	106.4	3.7																	
	Other transportation	1,817		1,817	0.0	0.00	2.7	36.0	0.2																	
	Other sectors	39,111		39,111	277.6	4.36	1,286.7	262.8	231.4																	
	Commercial/institutional	2,781		2,781	4.0	0.07	5.3	5.3	3.1																	
	Residential	18,021		18,021	252.9	2.80	1,143.2	29.1	171.6																	
	Agriculture/forestry/fishing	18,309		18,309	20.7	1.49	138.1	228.4	56.7																	
	Not specified	714		714	0.0	0.02	0.4	0.6	0.0																	
	Fugitive emissions from fuels	15,391	-	15,391	188.6	0.23	-	-	-																	
	Solid fuels	-	-	-	53.0	-	-	-	-																	
	Coal mining and handling	NO		NO	53.0																					
	Spontaneous Combustion and Landfills for Burning Coal	NO		NO	NO	NO	NO	NO	NO																	
	Fuel transformation	NO		NO	NO	NO	NO	NO	NO																	
	Oil and natural gas	15,391		15,391	135.6	0.23	NE	NE	NE																	
	INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)	88,253	-	88,253	38.0	1.36	883.6	39.5	2,431.4	0.0354	0.0027	0.0540	0.0653	3.9407	0.0134	-	0.0041	-	0.0050	0.0120						
	Mineral industry	32,297	-	32,297	-	-	-	-	-																	
	Cement production	23,903		23,903	-																					
	Lime production	6,071		6,071	-																					
	Glass production	280		280	-																					
	Other process uses of carbonates	2,044		2,044	-																					
	Chemical industry	7,688	-	7,688	11.6	0.85	0.7	1.2	57.2																	
	Ammonia production	555		555	-																					
	Nitric acid production					0.65		0.9																		
	Adipic acid production					0.20	0.7	0.2																		
	Caprolactam, glyoxal and glyoxylic acid production					-																				
	Carbide production	42		42																						
	Titanium dioxide production																									
	Soda ash production	NO		NO	NO	NO	NO	NO	NO																	

kt																		
2015	CO ₂ (gross emissions)	CO ₂ (removals)	CO ₂ (net emissions)	CH ₄	N ₂ O	CO	NOx	NMVOC	PFCs		HFCs							SF ₆
									CF ₄	C ₂ F ₆	HFC-125	HFC-134a	HFC-143a	HFC-152a	HFC-227ea	HFC-365mfc		
Other	-	-	-	-	-	90.3	24.2	682.4	-	-	-	-	-	-	-	-	-	-
Pulp and Paper Industry	-	-	-	-	-	90.3	24.2	59.6	-	-	-	-	-	-	-	-	-	-
Food and Beverage Industry	-	-	-	-	-	-	-	622.8	-	-	-	-	-	-	-	-	-	-
AGRICULTURE	17,538	-	17,538	14,530.4	495.49	577.3	21.4	-	-	-	-	-	-	-	-	-	-	-
Enteric Fermentation	-	-	-	13,257.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cattle	-	-	-	12,886.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Beef Cattle	-	-	-	11,030.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dairy Cattle	-	-	-	1,856.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sheep	-	-	-	92.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Swine	-	-	-	39.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other Animals	-	-	-	239.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manure management	-	-	-	832.2	16.13	-	-	-	-	-	-	-	-	-	-	-	-	-
Cattle	-	-	-	411.7	4.90	-	-	-	-	-	-	-	-	-	-	-	-	-
Beef Cattle	-	-	-	260.4	1.50	-	-	-	-	-	-	-	-	-	-	-	-	-
Dairy Cattle	-	-	-	151.3	3.40	-	-	-	-	-	-	-	-	-	-	-	-	-
Sheep	-	-	-	3.4	NO	-	-	-	-	-	-	-	-	-	-	-	-	-
Swine	-	-	-	370.9	2.47	-	-	-	-	-	-	-	-	-	-	-	-	-
Other Animals	-	-	-	46.2	0.83	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect N ₂ O Emissions	-	-	-	-	7.93	-	-	-	-	-	-	-	-	-	-	-	-	-
Rice cultivation	-	-	-	427.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Irrigated	-	-	-	427.4	IE	-	-	-	-	-	-	-	-	-	-	-	-	-
Rain-fed	-	-	-	NO	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agricultural soils	-	-	-	-	478.36	-	-	-	-	-	-	-	-	-	-	-	-	-
Direct N ₂ O Emissions from managed soils	-	-	-	-	370.21	-	-	-	-	-	-	-	-	-	-	-	-	-
Inorganic N Fertilizers	-	-	-	-	55.51	-	-	-	-	-	-	-	-	-	-	-	-	-
Organic N Fertilizers	-	-	-	-	17.19	-	-	-	-	-	-	-	-	-	-	-	-	-
Animal manure deposited by grazing animals	-	-	-	-	185.00	-	-	-	-	-	-	-	-	-	-	-	-	-
Crop Residues	-	-	-	-	101.97	-	-	-	-	-	-	-	-	-	-	-	-	-
Mineralization/immobilization associated with loss/gain of soil organic matter	-	-	-	-	4.18	-	-	-	-	-	-	-	-	-	-	-	-	-

2015	kt																				
	CO ₂ (gross emissions)	CO ₂ (removals)	CO ₂ (net emissions)	CH ₄	N ₂ O	CO	NOX	NMVOC	PFCs			HFCs						SF ₆			
									CF ₄	C ₂ F ₆	HFC-23	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-152a	HFC-227ea		HFC-365mfc		
Cultivation of Organic Soils					6.36																
Indirect N ₂ O Emissions from managed soils					108.15																
Atmospheric Deposition					39.47																
Nitrogen leaching and run-off					68.68																
Field burning of agricultural residues				13.3	1.00	577.3	21.4														
Liming	14,606		14,606																		
Urea Application	2,932		2,932																		
LAND USE LAND-USE CHANGE AND FORESTRY (LULUCF)	1,397,544	-1,059,710	337,834	972.4	30.95	15,365.0	284.3														
Forest Land	113,083	-461,810	-348,727	55.1	1.72	864.6	15.4														
Forest Land Remaining Forest Land	57,327	-370,345	-313,018	53.5	1.57	817.5	12.6														
Land Converted to Forest Land	55,755	-91,465	-35,709	1.7	0.15	47.1	2.8														
Cropland	145,512	-1,122	144,390	111.7	3.93	1,843.6	41.6														
Cropland Remaining Cropland																					
Land Converted to Cropland	145,512	-1,122	144,390	111.7	3.93	1,843.6	41.6														
Grassland	645,177	-87,790	557,386	786.6	24.70	12,358.5	222.1														
Grassland Remaining Grassland	32,782	-29,942	2,840	25.3	2.31	716.4	43.0														
Land Converted to Grassland	612,395	-57,848	554,547	761.2	22.39	11,642.1	179.1														
Wetlands	7,284		7,284	8.3	0.26	130.2	2.3														
Wetland Remaining Wetland																					
Land Converted to Wetland	7,284		7,284	8.3	0.26	130.2	2.3														
Settlements	4,609		4,609	2.5	0.08	40.4	0.8														
Settlements Remaining Settlements																					
Land Converted to Settlements	4,609		4,609	2.5	0.08	40.4	0.8														

2015	kt																		
	CO ₂ (gross emissions)	CO ₂ (removals)	CO ₂ (net emissions)	CH ₄	N ₂ O	CO	NOX	NMVOC	PFCs		HFCs							SF ₆	
									CF ₄	C ₂ F ₆	HFC-23	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-152a	HFC-227ea		HFC-365mfc
Other Land	7,048	-	7,048	8.3	0.25	127.7	2.1	-	-	-	-	-	-	-	-	-	-	-	-
Other Land Remaining Other Land	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Converted to Other Land	7,048	-	7,048	8.3	0.25	127.7	2.1	-	-	-	-	-	-	-	-	-	-	-	-
Harvested Wood Products	474,832	-508,988	-34,157	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WASTE	1,153	-	1,153	2,755.9	9.49	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Solid Waste Disposal	-	-	-	1,593.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Managed Waste Disposal Sites	-	-	-	774.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unmanaged Waste Disposal Sites	-	-	-	IE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uncategorized Waste Disposal Sites	-	-	-	818.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biological Treatment of Solid Waste	-	-	-	1.4	0.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Composting	-	-	-	1.4	0.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anaerobic digestion at biogas facilities	NO	-	NO	IE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Incineration and Open Burning of Waste	1,153	-	1,153	32.5	0.49	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Waste Incineration	108	-	108	-	0.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Open Burning of Waste	1,045	-	1,045	32.5	0.46	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wastewater Treatment and Discharge	-	-	-	1,128.3	8.91	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Domestic Wastewater Treatment	-	-	-	929.2	8.91	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Industrial Wastewater Treatment	-	-	-	199.1	NE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	1,956,458	-1,059,710	876,747	18,873.6	571.0	23,485	2,718	3,302	0.0354	0.0027	0.0000	0.0540	0.0653	3.9407	0.0134	-	0.0041	0.0050	0.0120

Notations:

NA (Not applicable) – Activity in a given source/sink category that occurs in the country, but did not result in emissions or removals of a specific gas;

IE (Included elsewhere) – Included in another location/category of emissions or removals;

NO (Not occurring) – Categories and processes that do not occur in the country;

NE (Not estimated) – Activity data and/or emissions by sources and removals by sinks of GHG that have not been estimated, but for which a corresponding activity may occur in the country.

		kt																
2016		CO ₂ (gross emissions)	CO ₂ (removals)	CO ₂ (net emissions)	CH ₄	N ₂ O	CO	NOx	NMVOC	PFCs		HFCs						SF ₆
										CF ₄	C ₂ F ₆	HFC-134a	HFC-143a	HFC-152a	HFC-227ea	HFC-365mfc		
	Domestic Navigation	3,825		3,825	0.4	0.10	9.1	97.1	3.3									
	Other transportation	2,260		2,260	0.0	0.00	3.3	44.7	0.2									
	Other sectors	38,888		38,888	265.0	4.20	1,226.9	256.1	220.3									
	Commercial/institutional	2,758		2,758	3.8	0.07	5.2	5.0	3.0									
	Residential	18,209		18,209	241.9	2.70	1,090.6	28.6	163.7									
	Agriculture/forestry/fishing	17,921		17,921	19.3	1.43	131.1	222.5	53.7									
	Not specified	693		693	0.0	0.02	0.4	0.6	0.0									
	Fugitive emissions from fuels	15,840	-	15,840	185.6	0.23	-	-	-	-	-	-	-	-	-	-	-	
	Solid fuels	-	-	-	48.1	-	-	-	-	-	-	-	-	-	-	-	-	
	Coal mining and handling	NO		NO	48.1													
	Spontaneous Combustion and Landfills for Burning Coal	NO		NO	NO	NO	NO	NO	NO									
	Fuel transformation	NO		NO	NO	NO	NO	NO	NO									
	Oil and natural gas	15,840		15,840	137.5	0.23	NE	NE	NE									
	INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)	86,285	-	86,285	34.5	1.27	800.5	39.5	2,441.7	0.0381	0.0028	0.0730	0.0848	4.1226	0.0140	0.0054	0.0061	0.0123
	Mineral industry	29,715	-	29,715	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Cement production	21,412		21,412	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Lime production	6,071		6,071	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Glass production	263		263	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Other process uses of carbonates	1,970		1,970	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Chemical industry	7,904	-	7,904	12.2	0.85	0.7	1.2	59.9	-	-	-	-	-	-	-	-	-
	Ammonia production	456		456	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Nitric acid production					0.65		0.9										
	Adipic acid production					0.19	0.7	0.2										
	Caprolactam, glyoxal and glyoxylic acid production					-												
	Carbide production	42		42														
	Titanium dioxide production																	

2016	kt																							
	CO ₂ (gross emissions)	CO ₂ (removals)	CO ₂ (net emissions)	CH ₄	N ₂ O	CO	NOx	NMVOC	PFCs		HFCs							SF ₆						
									CF ₄	C ₂ F ₆	HFC-23	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-152a	HFC-227ea		HFC-365mfc					
Soda ash production	NO		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO				
Petrochemical and carbon black production	7,407		7,407	12.2			0.1	11.3																
Fluorochemical production																								
Other Chemicals				-				48.5																
Metal Industry	47,903	-	47,903	22.3	0.43	702.1	12.1	10.4	0.0381	0.0028	-	-	-	-	-	-	-	-	-	-	-			
Iron and Steel Production	43,806		43,806	22.3	0.43	417.0	10.4																	
Ferrous alloys production	798		798	-																				
Aluminum Production	1,317		1,317			285.1	1.7		0.0381	0.0028														
Magnesium Production	140		140																					
Lead Production	IE		IE																					
Zinc Production																								
Other (non-ferrous metals, except aluminum and magnesium)	1,843		1,843																					
Non-Energy Products from Fuels and Solvent Use	763	-	763	-	-	-	-	1,670.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Lubricant Use	642		642																					
Paraffin Wax Use	IE		IE																					
Other	121		121					1,670.2																
Electronics Industry	-	-	-	-	-	-	-	-	0.0000	-	0.0000	-	-	-	-	-	-	-	-	-	-	-	-	
Product Uses as Substitutes for Ozone Depleting Substances	-	-	-	-	-	-	-	-	-	0.0730	0.0848	4.1226	0.0140	-	0.0054	0.0061	-	-	-	-	-	-	-	
Refrigeration and Air Conditioning										0.0730	0.0848	4.0523	0.0140	-	-	-	-	-	-	-	-	-	-	
Foam Blowing Agents												0.0135								0.0005			0.0061	
Fire Protection																				0.0049			-	
Aerosols												0.0568												
Solvents																								
Other Applications																								



		kt																									
2016		CO ₂ (gross emissions)		CO ₂ (removals)		CO ₂ (net emissions)	CH ₄	N ₂ O	CO	NO _x	NMVOC	PFCs		HFCs							SF ₆						
						CF ₄						C ₂ F ₆	HFC-23	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-152a	HFC-227ea	HFC-365mfc							
	Other Product Manufacture and Use	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0123
	Electrical Equipment	-	-	-	-	-	-	-	-	-	-	-	NO	NO	-	-	-	-	-	-	-	-	-	-	-	-	0.0123
	Other	-	-	-	-	-	-	97.7	26.2	26.2	701.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Pulp and Paper Industry	-	-	-	-	-	-	97.7	26.2	64.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Food and Beverage Industry	-	-	-	-	-	-	-	-	636.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	AGRICULTURE	19,732	-	19,732	-	14,711.8	511.26	498.3	18.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Enteric Fermentation	-	-	-	-	13,461.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Cattle	-	-	-	-	13,087.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Beef Cattle	-	-	-	-	11,350.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Dairy Cattle	-	-	-	-	1,736.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Sheep	-	-	-	-	92.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Swine	-	-	-	-	39.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Other Animals	-	-	-	-	242.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Manure management	-	-	-	-	839.9	15.85	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Cattle	-	-	-	-	416.0	4.67	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Beef Cattle	-	-	-	-	266.5	1.44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Dairy Cattle	-	-	-	-	149.5	3.23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Sheep	-	-	-	-	3.4	NO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Swine	-	-	-	-	373.9	2.49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Other Animals	-	-	-	-	46.6	0.83	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Indirect N ₂ O Emissions	-	-	-	-	-	7.85	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Rice cultivation	-	-	-	-	398.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Irrigated	-	-	-	-	398.5	IE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Rain-fed	-	-	-	-	NO	NO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Agricultural soils	-	-	-	-	-	494.55	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Direct N ₂ O Emissions from managed soils	-	-	-	-	-	380.77	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Inorganic N Fertilizers	-	-	-	-	68.61	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Organic N Fertilizers	-	-	-	-	17.25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Animal manure deposited by grazing animals	-	-	-	-	186.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Crop Residues	-	-	-	-	97.52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

		kt																			
		CO ₂ (gross emissions)	CO ₂ (removals)	CO ₂ (net emissions)	CH ₄	N ₂ O	CO	NOx	NMVOc	PFCs		HFCs						SF ₆			
2016										CF ₄	C ₂ F ₆	HFC-23	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-152a	HFC-227ea	HFC-365mfc		
Mineralization/ immobilization associated with loss/gain of soil organic matter					4.18																
Cultivation of Organic Soils					6.40																
Indirect N ₂ O Emissions from managed soils					113.78																
Atmospheric Deposition					42.87																
Nitrogen leaching and run-off					70.92																
Field burning of agricultural residues	-	-	-	11.5	0.86	498.3	18.5														
Liming	15,844	-	15,844	-	-	-	-														
Urea Application	3,888	-	3,888	-	-	-	-														
LAND USE, LAND-USE CHANGE AND FORESTRY (LULUCF)	1,501,352	-1,102,982	398,370	1,052.1	32.89	16,499.6	293.6														
Forest Land	118,063	-465,619	-347,556	57.5	1.77	895.5	15.4														
Forest Land Remaining Forest Land	63,634	-374,818	-311,184	56.2	1.65	858.8	13.2														
Land Converted to Forest Land	54,429	-90,801	-36,373	1.3	0.12	36.8	2.2														
Cropland	136,104	-1,122	134,982	97.2	3.41	1,601.1	35.8														
Cropland Remaining Cropland	-	-	-	-	-	-	-														
Land Converted to Cropland	136,104	-1,122	134,982	97.2	3.41	1,601.1	35.8														
Grassland	714,870	-87,792	627,078	874.4	27.01	13,644.7	236.3														
Grassland Remaining Grassland	27,490	-29,944	-2,453	20.9	1.91	590.7	35.4														
Land Converted to Grassland	687,380	-57,848	629,531	853.5	25.10	13,054.0	200.8														
Wetlands	8,391	-	8,391	9.8	0.30	152.3	2.6														
Wetland Remaining Wetland	-	-	-	-	-	-	-														
Land Converted to Wetland	8,391	-	8,391	9.8	0.30	152.3	2.6														

2016	kt																		
	CO ₂ (gross emissions)	CO ₂ (removals)	CO ₂ (net emissions)	CH ₄	N ₂ O	CO	NOx	NMVOC	PFCs		HFCs							SF ₆	
									CF ₄	C ₂ F ₆	HFC-23	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-152a	HFC-227ea		HFC-365mfc
Settlements	5,046	-	5,046	2.9	0.09	46.7	0.9	-	-	-	-	-	-	-	-	-	-	-	-
Settlements Remaining Settlements	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Settlements	5,046	-	5,046	2.9	0.09	46.7	0.9	-	-	-	-	-	-	-	-	-	-	-	-
Other Land	8,627	-	8,627	10.3	0.31	159.3	2.6	-	-	-	-	-	-	-	-	-	-	-	-
Other Land Remaining Other Land	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Converted to Other Land	8,627	-	8,627	10.3	0.31	159.3	2.6	-	-	-	-	-	-	-	-	-	-	-	-
Harvested Wood Products	510,252	-548,449	-38,198	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WASTE	507	-	507	2,811.8	9.42	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Solid Waste Disposal	-	-	-	1,635.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Managed Waste Disposal Sites	-	-	-	786.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unmanaged Waste Disposal Sites	-	-	-	IE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Waste Disposal Sites	-	-	-	849.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biological Treatment of Solid Waste	-	-	-	1.3	0.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Composting	-	-	-	1.3	0.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anaerobic digestion at biogas facilities	NO	-	NO	IE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Incineration and Open Burning of Waste	507	-	507	24.0	0.36	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Waste Incineration	109	-	109	-	0.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Open Burning of Waste	398	-	398	24.0	0.32	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wastewater Treatment and Discharge	-	-	-	1,150.9	8.99	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Domestic Wastewater Treatment	-	-	-	941.4	8.99	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Industrial Wastewater Treatment	-	-	-	209.5	NE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	2,007,835	-1,102,982	904,853	19,167.8	587.9	24,222	2,547	3,254	0.0381	0.0028	0.0848	4.1226	0.0140	0.0054	0.0061	0.0123	0.0054	0.0061	0.0123

Notations:

NA (Not applicable) – Activity in a given source/sink category that occurs in the country, but did not result in emissions or removals of a specific gas;

IE (Included elsewhere) – Included in another location/category of emissions or removals;

NO (Not occurring) – Categories and processes that do not occur in the country;

NE (Not estimated) – Activity data and/or emissions by sources and removals by sinks of GHG that have not been estimated, but for which a corresponding activity may occur in the country.

2020	kt																		
	CO ₂ (gross emissions)	CO ₂ (removals)	CO ₂ (net emissions)	CH ₄	N ₂ O	CO	NO _x	NMVOC	PFCs		HFCs							SF ₆	
									CF ₄	C ₂ F ₆	HFC-23	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-152a	HFC-227ea		HFC-365mfc
Domestic Navigation	3,651		3,651	0.3	0.10	8.7	92.7	3.2											
Other transportation	2,642		2,642	0.1	0.00	3.9	52.3	0.2											
Other sectors	40,668		40,668	313.1	4.88	1,437.1	288.8	258.2											
Commercial/institutional	2,386		2,386	3.4	0.06	4.5	4.4	2.7											
Residential	18,855		18,855	286.3	3.15	1,278.4	31.4	191.8											
Agriculture/forestry/fishing	19,427		19,427	23.5	1.67	154.1	253.0	63.7											
Not specified	677		677	0.0	0.02	0.4	0.6	0.0											
Fugitive emissions from fuels	15,475	-	15,475	176.9	0.22	-	-	-											
Solid fuels	-	-	-	39.9	-	-	-	-											
Coal mining and handling	NO		NO	39.9															
Spontaneous Combustion and Landfills for Burning Coal	NO		NO	NO	NO	NO	NO	NO											
Fuel transformation	NO		NO	NO	NO	NO	NO	NO											
Oil and natural gas	15,475		15,475	136.9	0.22	NE	NE	NE											
INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)	87,215	-	87,215	36.3	1.15	835.4	43.9	3,045.6	0.0335	0.0025	0.0002	0.1747	0.1900	5.3760	0.0181	-	0.0219	0.0116	0.0138
Mineral industry	32,070	-	32,070	-	-	-	-	-											
Cement production	23,843		23,843	-															
Lime production	5,924		5,924	-															
Glass production	235		235	-															
Other process uses of carbonates	2,068		2,068	-															
Chemical industry	6,682	-	6,682	10.7	0.66	0.8	1.2	60.7	-	-	-	-	-	-	-	-	-	-	-
Ammonia production	-		-	-															
Nitric acid production					0.66		0.9												
Adipic acid production					0.00	0.8	0.3												
Caprolactam, glyoxal and glyoxylic acid production					-														
Carbide production	42		42																
Titanium dioxide production																			
Soda ash production	NO		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

2020	kt																						
	CO ₂ (gross emissions)	CO ₂ (removals)	CO ₂ (net emissions)	CH ₄	N ₂ O	CO	NOx	NMVOC	PFCs		HFCs							SF ₆					
									CF ₄	C ₂ F ₆	HFC-23	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-152a	HFC-227ea		HFC-365mfc				
Petrochemical and carbon black production	6,640		6,640	10.7			0.1	11.4															
Fluorochemical production																							
Other Chemicals				-				49.2															
Metal Industry	47,642	-	47,642	25.6	0.49	725.3	13.5	12.0	0.0335	0.0025	-	-	-	-	-	-	-	-	-	-	-		
Iron and Steel Production	43,694		43,694	25.6	0.49	481.3	12.0	12.0															
Ferrous alloys production	695		695	-																			
Aluminum Production	1,143		1,143			244.1	1.5		0.0335	0.0025													
Magnesium Production	132		132																				
Lead Production	IE		IE																				
Zinc Production																							
Other (non-ferrous metals, except aluminum and magnesium)	1,978		1,978																				
Non-Energy Products from Fuels and Solvent Use	820	-	820	-	-	-	-	2,320.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Lubricant Use	707		707																				
Paraffin Wax Use	IE		IE																				
Other	113		113					2,320.2															
Electronics Industry	-	-	-	-	-	-	-	-	0.0000	0.0002	-	-	-	-	-	-	-	-	-	-	-	-	-
Product Uses as Substitutes for Ozone Depleting Substances	-	-	-	-	-	-	-	-	-	-	0.1747	0.1900	5.3760	0.0181	0.0219	0.0116	-	-	-	-	-	-	-
Refrigeration and Air Conditioning											0.1747	0.1900	5.2928	0.0181	-	-	-	-	-	-	-	-	-
Foam Blowing Agents													0.0135								0.0009		0.0116
Fire Protection																						0.0210	
Aerosols													0.0697										
Solvents																							
Other Applications																							



		kt																						
2020		CO ₂ (gross emissions)	CO ₂ (removals)	CO ₂ (net emissions)	CH ₄	N ₂ O	CO	NOx	NMVOC	PFCs		HFCs							SF ₆					
										CF ₄	C ₂ F ₆	HFC-23	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-152a	HFC-227ea		HFC-365mfc				
	Other Product Manufacture and Use	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0138	
	Electrical Equipment										NO	NO												0.0138
	Other	-	-	-	-	-	109.2	29.3	652.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Pulp and Paper Industry						109.2	29.3	72.2															
	Food and Beverage Industry								580.5															
	AGRICULTURE	26,010	-	26,010	14,728.6	548.41	427.7	15.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Enteric Fermentation	-	-	-	13,454.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Cattle				13,044.7																			
	Beef Cattle				11,578.6																			
	Dairy Cattle				1,466.2																			
	Sheep				103.1																			
	Swine				41.2																			
	Other Animals				265.3																			
	Manure management	-	-	-	843.8	15.42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Cattle				404.8	3.91																		
	Beef Cattle				262.1	1.43																		
	Dairy Cattle				142.8	2.48																		
	Sheep				3.9	NO																		
	Swine				384.3	2.56																		
	Other Animals				50.8	0.92																		
	Indirect N ₂ O Emissions					8.04																		
	Rice cultivation	-	-	-	420.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Irrigated				420.7	IE																		
	Rain-fed				NO																			
	Agricultural soils	-	-	-	-	532.25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Direct N ₂ O Emissions from managed soils					409.53																		
	Inorganic N Fertilizers					82.59																		
	Organic N Fertilizers					17.93																		
	Animal manure deposited by grazing animals					184.76																		
	Crop Residues					113.50																		

2020	kt																		
	CO ₂ (gross emissions)	CO ₂ (removals)	CO ₂ (net emissions)	CH ₄	N ₂ O	CO	NOx	NMVOC	PFCs			HFCs						SF ₆	
									CF ₄	C ₂ F ₆	HFC-23	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-152a	HFC-227ea		HFC-365mfc
Settlements	4,908	-	4,908	2.7	0.09	43.6	0.9	-	-	-	-	-	-	-	-	-	-	-	-
Settlements Remaining Settlements	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Converted to Settlements	4,908	-	4,908	2.7	0.09	43.6	0.9	-	-	-	-	-	-	-	-	-	-	-	-
Other Land	11,226	-	11,226	14.3	0.43	220.7	3.6	-	-	-	-	-	-	-	-	-	-	-	-
Other Land Remaining Other Land	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Converted to Other Land	11,226	-	11,226	14.3	0.43	220.7	3.6	-	-	-	-	-	-	-	-	-	-	-	-
Harvested Wood Products	520,440	-568,496	-48,056	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WASTE	548	-	548	3,055.8	9.91	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Solid Waste Disposal	-	-	-	1,779.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Managed Waste Disposal Sites	-	-	-	1,340.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unmanaged Waste Disposal Sites	-	-	-	IE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uncategorized Waste Disposal Sites	-	-	-	438.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biological Treatment of Solid Waste	-	-	-	1.4	0.09	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Composting	-	-	-	1.4	0.09	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anaerobic digestion at biogas facilities	NO	-	NO	IE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Incineration and Open Burning of Waste	548	-	548	24.3	0.37	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Waste Incineration	112	-	112	-	0.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Open Burning of Waste	436	-	436	24.3	0.33	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wastewater Treatment and Discharge	-	-	-	1,250.6	9.45	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Domestic Wastewater Treatment	-	-	-	1,034.0	9.45	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Industrial Wastewater Treatment	-	-	-	216.6	NE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	2,221,936	-1,127,259	1,094,677	19,757.9	634.5	28,991	2,571	3,912	0.0335	0.0025	0.0002	0.1747	0.1900	5.3760	0.0181	-	0.0219	0.0116	0.0138

Notations:

NA (Not applicable) – Activity in a given source/sink category that occurs in the country, but did not result in emissions or removals of a specific gas;

IE (Included elsewhere) – Included in another location/category of emissions or removals;

NO (Not occurring) – Categories and processes that do not occur in the country;

NE (Not estimated) – Activity data and/or emissions by sources and removals by sinks of GHG that have not been estimated, but for which a corresponding activity may occur in the country.

2.7 EMISSIONS RESULTS

Figure 2.2. shows the annual time series of GHG emissions in Brazil, by sector, from 1990 to 2020, in carbon dioxide equivalent (GWP AR5 - 100 years¹¹)

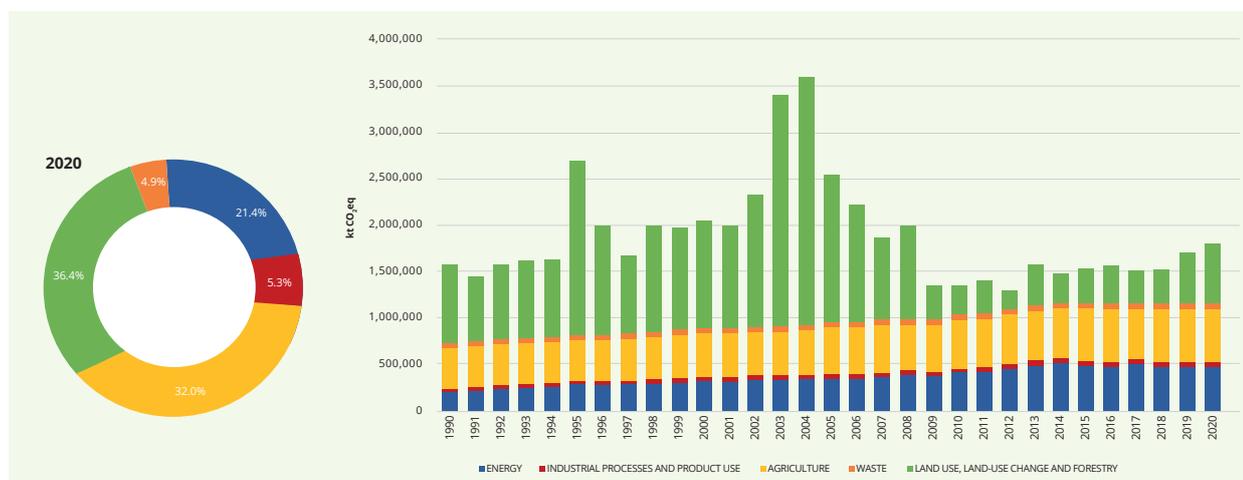


Figure 2.2. Greenhouse gas emissions, in CO₂ equivalent (GWP-AR5), by sector, from 1990 to 2020

It can be seen that the profile of Brazilian emissions has changed in recent years (Figure 2.2.). Due to the reduction in deforestation, the Land Use, Land-Use Change and Forestry (LULUCF) sector started accounting for a smaller share of national emissions. As a result, other sectors, such as Energy and Agriculture, started accounting for a relatively larger share of the country's aggregate emissions.

It should be noted that, above all, as a result of the efforts made to implement the sectoral mitigation plans, the country has contributed to a significant reduction in its emissions (see Chapter 3).

¹¹ Metric GWP - 100 years, reference values obtained from the Fifth Assessment Report (AR5) (IPCC, 2013).

BOX 2.1. NATIONAL GHG EMISSIONS IN CO₂ EQUIVALENT

The results of Brazil's previous inventories were presented in CO₂ equivalent units, taking into account the GWP values for a 100-year time horizon published in the IPCC's Second Assessment Report (SAR) (IPCC, 1995), in accordance with Decision 17/CP.8.

In this BUR5, Brazil has opted to use a more recent metric that complies with Decision 18/CMA.1. The analyses and results presented in kt CO₂ eq in this BUR5 used the Global Warming Potential (GWP) metric for a 100-year time horizon from the IPCC Fifth Assessment Report (GWP AR5) (IPCC, 2013).

The IPCC's Fifth Assessment Report presented values for the Global Temperature Change Potential (GTP), which Brazil also considers relevant. According to the IPCC, the GTP is characterized by being a metric based on temperature change, i.e., it is related to the variation in the average temperature of the global surface, over a selected time horizon, in response to a GHG emission pulse.

According to the IPCC (2013), "the most appropriate metric and time horizon will depend on which aspects of climate change are considered to be the most important for a particular use. No metric is capable of accurately comparing all the consequences of different emissions and they all have limitations and uncertainties."

Below are the results using three sets of weighting values: GWP-SAR, determined by Decision No. 17/CP.8, GWP-AR5 and GTP-AR.

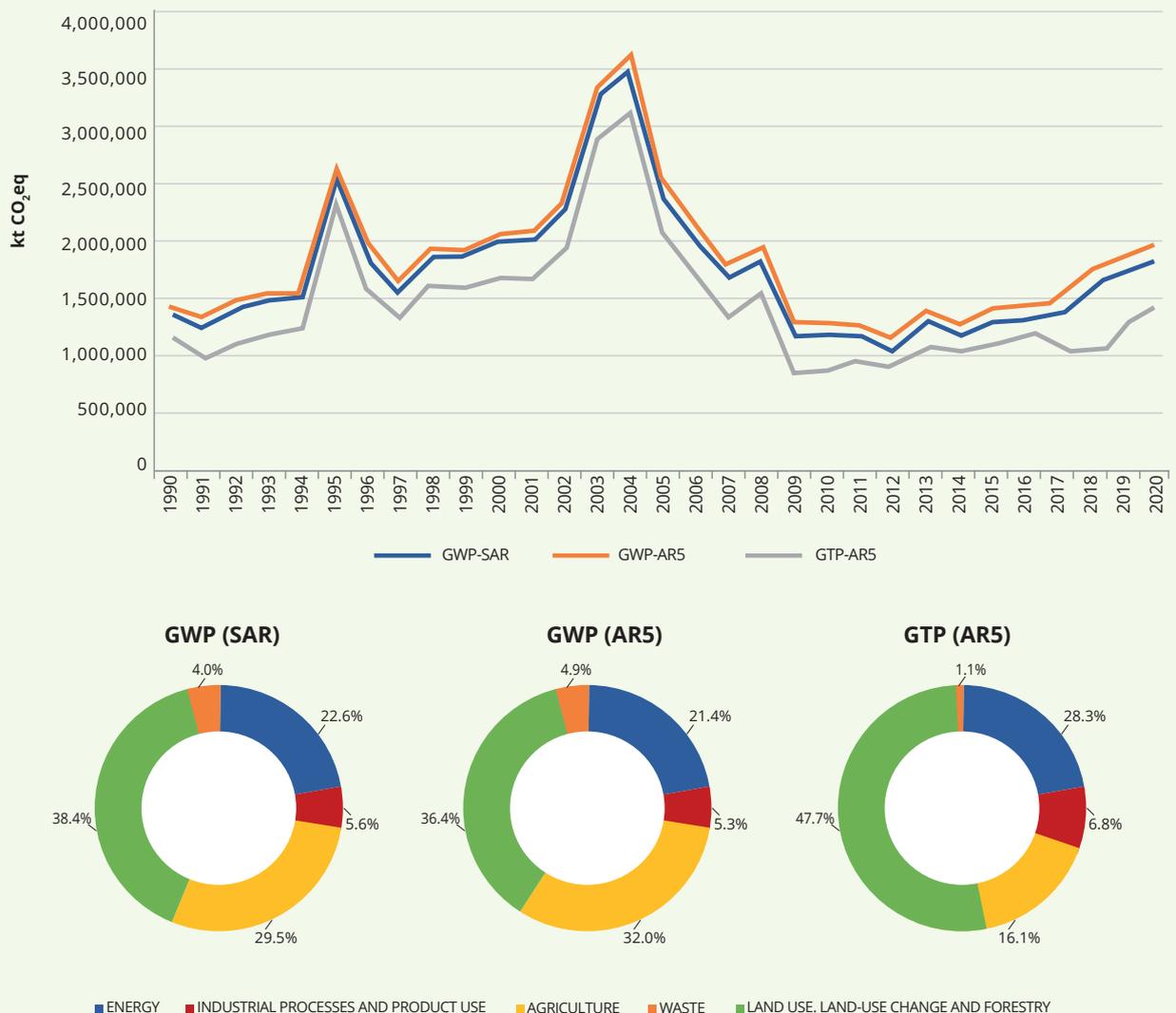


Figure 2.3. Evolution and sectoral share of net CO₂ equivalent emissions in 2020, by different metrics (GWP-SAR, GWP-AR5 and GTP-AR5)

TABLE 2.12. ANTHROPOGENIC EMISSIONS BY SOURCES AND REMOVALS BY SINKS OF GREENHOUSE GASES IN CO₂ EQ, CONVERTED USING THE GTP AND GWP METRICS, BY SECTOR

GWP-SAR	1994	2000	2010	2012	2015	2016	2020
	kt CO ₂ eq						
ENERGY	214,841	288,791	374,531	420,992	454,526	421,915	387,257
INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)	63,215	78,418	87,101	95,207	95,421	93,693	96,690
AGRICULTURE	356,891	370,335	458,343	462,078	476,279	487,170	505,318
LAND USE, LAND-USE CHANGE AND FORESTRY (LULUCF)	844,745	1,172,613	271,319	168,774	367,850	430,662	657,591
WASTE	31,647	41,523	55,325	56,518	61,969	62,476	67,790
TOTAL	1,511,338	1,951,680	1,246,619	1,203,570	1,456,044	1,495,917	1,714,646

GWP-AR5	1994	2000	2010	2012	2015	2016	2020
	kt CO ₂ eq						
ENERGY	217,727	291,613	377,678	423,887	457,340	424,610	390,210
INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)	62,926	77,809	87,353	95,464	95,670	93,931	96,992
AGRICULTURE	426,689	440,797	538,559	539,920	555,694	567,146	583,740
LAND USE, LAND-USE CHANGE AND FORESTRY (LULUCF)	854,112	1,184,464	277,144	172,897	373,264	436,546	665,084
WASTE	41,121	54,006	72,073	73,636	80,833	81,735	88,735
TOTAL	1,602,577	2,048,689	1,352,807	1,305,805	1,562,802	1,603,968	1,824,760

GTP-AR5	1994	2000	2010	2012	2015	2016	2020
	kt CO ₂ eq						
ENERGY	205,583	279,136	362,151	409,107	442,452	410,202	374,757
INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)	62,066	76,070	84,057	91,312	90,281	88,375	89,684
AGRICULTURE	130,435	137,463	178,593	185,754	191,604	198,215	213,252
LAND USE, LAND-USE CHANGE AND FORESTRY (LULUCF)	812,346	1,131,765	251,117	154,384	348,966	410,276	631,719
WASTE	7,532	9,896	13,016	13,280	14,397	13,960	15,089
TOTAL	1,217,962	1,634,330	888,934	853,838	1,087,700	1,121,027	1,324,500



BOX 2.2. COMPARISON BETWEEN THE REFERENCE APPROACH AND THE SECTORAL APPROACH - ENERGY SECTOR

The calculation of GHG emissions from the burning of fossil fuels should be based on two approaches, according to the IPCC 2006: Reference Approach (top-down methodology) and Sectoral Approach (bottom-up methodology). The emissions accounted for in the national inventories are those calculated using the Sectoral Approach. The more simplified Reference Approach consists of calculations made based on aggregate data on fuel supply. To this end, the concept of apparent consumption is used: we add up the production of primary fuels and the import of primary and secondary fuels and subtract the export of primary and secondary fuels, of bunkers¹² and the stock change (which can be positive or negative). Based on this result, CO₂ emissions are estimated based on the carbon content of the fuels.

For the Sectoral Approach, information on fuel consumption by energy sector is used and multiplied by the corresponding emission factors. Calculating CO₂ emissions with the two approaches can lead to different results, but is used as a quality control of the sector's results.

For the Inventory of this BUR5, no differences of more than 5% were found, according to Table 2.13.

TABLE 2.13. COMPARISON BETWEEN THE REFERENCE APPROACH AND THE SECTORAL APPROACH IN THE ENERGY SECTOR

Year	Reference Approach (A) (kt CO ₂)	Sectoral Approach (B) (kt CO ₂)	Difference (%) ((A-B/B))
1990	174,697	170,856	2.25%
1991	180,552	174,530	3.45%
1992	184,171	179,832	2.41%
1993	190,501	185,033	2.96%
1994	199,495	193,480	3.11%
1995	213,954	210,029	1.87%
1996	232,839	226,661	2.73%
1997	246,978	241,644	2.21%
1998	256,452	248,249	3.30%
1999	264,585	257,247	2.85%
2000	266,758	263,366	1.29%
2001	279,446	270,664	3.24%
2002	273,967	267,971	2.24%
2003	264,383	261,198	1.22%
2004	280,315	276,075	1.54%
2005	285,261	281,048	1.50%
2006	288,392	287,021	0.48%
2007	301,577	300,178	0.47%
2008	319,733	318,588	0.36%
2009	304,380	301,945	0.81%
2010	344,436	339,460	1.47%
2011	356,328	354,216	0.60%
2012	386,688	385,814	0.23%
2013	420,907	416,786	0.99%
2014	444,453	440,670	0.86%
2015	419,704	416,579	0.75%
2016	382,936	384,118	-0.31%
2017	396,044	391,894	1.06%
2018	375,686	369,152	1.77%
2019	370,609	368,224	0.65%
2020	346,069	348,751	-0.77%

12 In the Sectoral approach, emissions from international bunkers must be calculated and reported, however they are not included in the country's total, and they are only reported.

3



MITIGATION ACTIONS AND THEIR EFFECTS



3 MITIGATION ACTIONS AND THEIR EFFECTS

This chapter presents an analysis of the implementation period and the main results obtained by Brazil's Nationally Appropriate Mitigation Actions (NAMAs)¹³ communicated to the Convention in document FCCC/AWGLCA/2011/INF.1. As determined by the National Policy on Climate Change (PNMC), all NAMAs correspond to Sectoral Plans established by the government at national level.

The NAMAs have played a central role in Brazil's trajectory to integrate climate action into its sustainable development agenda. Since their introduction, NAMAs have enabled the country to structure initiatives in strategic sectors such as energy, agriculture, forest management and transportation. Emblematic programs, such as the ABC Plan (Sectoral Climate Change Mitigation and Adaptation Plan for the Consolidation of a Low Carbon Emission Economy in Agriculture), which promotes low-emission agricultural practices, and the expansion of renewable sources in the energy matrix, have demonstrated Brazil's ability to balance economic growth with mitigation of GHG emissions. These initiatives have also strengthened the technical and institutional expertise needed to sustain more ambitious climate action.

However, a review of the actions implemented within the scope the NAMAs in Brazil showed significant challenges, such as difficulties in securing adequate funding and technical limitations in specific sectors. Despite these barriers, the results achieved have laid a solid foundation for improving the country's climate policies. The transition from NAMAs to the Nationally Determined Contribution (NDC) represented an important milestone in the evolution of Brazilian climate governance.

Brazil was one of the few developing countries to report an NDC to the Paris Agreement with a mitigation modality based on an absolute reduction in GHG emissions for the economy as a whole¹⁴. While the NAMAs were largely voluntary and based on sectoral initiatives, the NDC brought an integrated vision, encompassing more ambitious goals and an international commitment.

The PNMC, National Policy on Climate Change, established the voluntary commitment to adopting mitigation actions with a view to reducing the country's GHG emissions by between 36.1% and 38.9% in relation to the emissions projected for 2020. In absolute values, this target consisted of GHG emissions of between 1,977 and 2,068 Mt CO₂ eq (GWP SAR) in 2020, with the projected value in the reference scenario for 2020 being of 3,236 Mt CO₂ eq (GWP-SAR).

The legacy of the NAMAs is clearly reflected in the NDC's sectoral approach. In addition, the monitoring and transparency mechanisms developed during the implementation of the NAMAs have been essential for the development of instruments that support the implementation and tracking of the progress of the NDC targets under the Paris Agreement. The lessons learned with the NAMAs continue to inform the development of future strategies and the pursuit of greater intersectoral coordination and international support for robust and effective mitigation actions.

The progress made in implementing the mitigation actions adopted by Brazil was reported through the four Brazilian BURs, submitted between 2014 and 2020. In BUR4, the country reported on the progress of mitigation actions up to 2019. Due to the start of the Brazilian NDC implementation period in 2020, Brazil's mitigation actions are reported in section 3.4 of the BTR1.

¹³ Available at: <https://unfccc.int/sites/default/files/resource/docs/2011/awglca14/eng/inf01.pdf>.

¹⁴ Available at: <https://unfccc.int/NDCREG>

BUR5 presents the consolidation of the results of the targets communicated to the Convention in document FCCC/AWGLCA/2011/INF.1 and the PNMC's voluntary commitment to reducing the country's GHG emissions by between 36.1% and 38.9% in relation to projected emissions for 2020.

3.1 INITIATIVES AND RESULTS ACHIEVED IN THE IMPLEMENTATION OF NAMAS IN BRAZIL

In order to support Brazil in achieving its commitment to tackling climate change, the National Policy on Climate Change (PNMC) stands out as an instrument for implementing and complying with mitigation actions.

Following the legal definition of the first national mitigation commitment, two regulatory decrees were issued (Decrees No. 7,390/2010 and No. 9,578/2018), defining the action plans for the prevention and control of deforestation in the biomes and sectoral plans for climate change mitigation and adaptation, which are listed below:

- ▶ Action Plan for the Prevention and Control of Deforestation in the Legal Amazon - PPCDAm (Plano de Ação para Prevenção e Controle do Desmatamento na Amazônia);
- ▶ Action Plan for the Prevention and Control of Deforestation and Fires in the Cerrado - PPCerrado (Plano de Ação para Prevenção e Controle do Desmatamento e das Queimadas no Cerrado);
- ▶ Ten-Year Energy Expansion Plan - PDE (Plano Decenal de Energia) (revoked by Decree No. 11,075, of 2022);
- ▶ Sectoral Climate Change Mitigation and Adaptation Plan for the Consolidation of a Low Carbon Emission Economy in Agriculture (ABC Plan); and
- ▶ Steel Sector Emissions Reduction Plan.

The **Action Plans for the Prevention and Control of Deforestation in the Legal Amazon (PPCDAm) and of Fires in the Cerrado (PPCerrado)** are coordinated by the MMA – Ministry of the Environment (Ministério do Meio Ambiente) and have the general objective of reducing deforestation and degradation of native vegetation while promoting the maintenance of ecosystem services, through a sustainable model for the use of forest resources and agricultural practices. The PPCDAm began in 2004 and the PPCerrado began in 2010. However, in 2019, they were revoked by Decree No. 10,142/2019. With the publication of Decree No. 11,367/2023, the PPCDAm and PPCerrado were resumed, along with plans for the other biomes.

The PPCDAm and the PPCerrado are considered instruments for implementing the PNMC, with a focus on mitigating GHG emissions related to land use, land-use change and forestry (LULUCF). They also contribute to the implementation of the National Strategy for the Reduction of Greenhouse Gas Emissions Resulting from Deforestation and Forest Degradation; Sustainable Management of Forests; and Conservation and Enhancement of Forest Carbon Stocks (ENREDD+ – National Strategy for REDD+). The main national instrument for funding REDD+ mitigation actions is the Amazon Fund (Fundo Amazônia), a pioneering Brazilian payment-by-results initiative, led by an inter-institutional committee chaired by the Ministry of the Environment and Climate Change (MMA), in partnership with the Brazilian Bank for Economic and Social Development (BNDES, Banco Nacional de Desenvolvimento Econômico e Social), among others.



The National Plans for the Control of Deforestation and Fires are also instruments of the National Policy to Combat Desertification and Mitigate the Effects of Drought, in line with the National Plan for the Recovery of Native Vegetation (PLANAVEG, Plano Nacional de Recuperação da Vegetação Nativa) and the National Biodiversity Policy (PNB, Política Nacional de Biodiversidade). In this way, they act in a cross-cutting way, contributing to different national and international environmental commitments.

The actions of the Action Plans for the Prevention and Control of Deforestation and Fires included (i) regularizing the ownership of public lands in the states of the Legal Amazon; (ii) land-use regulation, strengthening protected areas; (iii) ensuring liability for environmental crimes and offenses; (iv) implementing shared forest management; (v) preventing and combating wildfires; (vi) improving and strengthening the monitoring of vegetation cover; (vii) promoting sustainable forest management; and (viii) implementing economic instruments to control illegal deforestation.

As a result of these actions, in 2020 the deforestation rate in the Legal Amazon fell by 45% compared to the average for the period between 1996 and 2005, and the deforested area in the Cerrado fell by 63% compared to the average for the period between 2001 and 2008.

The **Sectoral Climate Change Mitigation and Adaptation Plan for the Consolidation of a Low Carbon Emission Economy in Agriculture (ABC Plan)** is one of the main instruments of Brazilian agricultural policy for promoting sustainability, including the reduction of GHG emissions. The ABC Plan was the result of work initially coordinated by the Office of the President's Chief of Staff, the Ministry of Agriculture, Livestock and Supply (MAPA, Ministério da Agricultura, Pecuária e Abastecimento) and the Ministry of Agrarian Development (MDA, Ministério do Desenvolvimento Agrário).

The ABC Plan was structured in such a way as to include the promotion of a set of sustainable production systems, practices, products and processes, called “ABC technologies” (BOX 3.1.), with a solid technical and scientific basis, including: No-till Farming System (NTFS); Recovery of Degraded Pastures (RDP); Integrated Crop-Livestock-Forestry (ICLF); Biological Nitrogen Fixation (BNF); Planted Forests (PF), and; Manure Treatment (MT). As a whole, the “ABC technologies” aimed to expand the total areas destined for their implementation by 35.5 million hectares, with the purpose of, in addition to the mitigation and adaptation related to climate change, raising farmers’ income and increasing environmental, economic and social sustainability in the agriculture sector.

BOX 3.1. TECHNOLOGIES USED BY THE ABC PLAN (2010-2020)

Recovery of Degraded Pastures (RDP)

Pasture degradation is the process of loss of vigor, productivity and the capacity for natural recovery to sustain animal production, impacting on the production system's ability to overcome the harmful effects of pests, diseases and invasive plant species, due to inadequate management. As pasture degradation progresses, there is a loss of vegetation cover and a reduction in the soil's organic matter content, leading to an increase in CO₂ emissions into the atmosphere. Recovering degraded pastures while maintaining their productivity helps to mitigate greenhouse gas emissions.

Integrated Crop-Livestock-Forestry (ICLF) and Agroforestry Systems (AFS)

ICLF is a sustainable production strategy that integrates agricultural, livestock or forestry activities carried out in the same area, in intercropping, succession or rotation farming systems, seeking synergistic effects between the components of the agroecosystem. AFS, on the other hand, are systems of land use and land occupation in which perennial woody plants are managed in association with herbaceous plants, shrubs, trees, agricultural crops and forage, in the same management unit, according to the spatial and temporal arrangement, with a high diversity of species and interactions between these components.

ICLF and AFS contribute to the recovery of degraded areas, the maintenance and reconstitution of forest cover, the promotion and generation of employment and income, the adoption of good agricultural practices (GAP), the improvement of social conditions, the adaptation of the production unit to environmental legislation and the enhancement of the environmental services offered by agrosystems, such as: conservation of water and soil resources; shelter for pollinating agents and natural control of insect pests and diseases; carbon and nitrogen fixation; reduction of greenhouse gas emissions; nutrient recycling; soil bioremediation; maintenance and sustainable use of biodiversity. The ICLF strategy and the Agroforestry Systems include four modalities of systems, characterized as follows: Integrated Crop-Livestock (Agropastoral); Integrated Crop-Livestock-Forestry (Agrosilvipastoral); Integrated Livestock-Forestry (Silvipastoral) and Integrated Crop-Forestry (Silviagricultural).

No-till Farming System (NTFS)

The NTFS is a complex of technological processes designed to exploit productive agricultural systems, employing tillage only in the sowing line or pit, permanent maintenance of soil cover, diversification of species and minimization or suppression of the time interval between harvesting and sowing. This system is associated with conservation agriculture in order to contribute to soil and water conservation, increasing fertilizer efficiency, increasing soil organic matter content, increasing the benefit/cost ratio, reducing fossil energy consumption and pesticide use, mitigating greenhouse gas emissions and contributing to increasing soil resilience.

Biological Nitrogen Fixation (BNF)

Increased agricultural production is particularly dependent on the supply of nitrogen, one of the main factors that limit productivity in tropical and subtropical soils. Approximately 78% of the atmosphere is made up of nitrogen (N₂), which is unavailable to most organisms. Only a limited number of microorganism species have the ability to convert N₂ into reactive nitrogen (assimilated by plants) through Biological Nitrogen Fixation (BNF). This process is indispensable for maintaining life on the planet and is strategic for sustainability in agriculture. BNF is widely recognized for reducing production costs, reducing environmental risks by reducing greenhouse gas emissions, increasing organic matter content (carbon sequestration) and improving soil fertility.

Planted Forests (PF)

The production of (economic) planted forests on rural properties has four basic objectives: to provide a long-term source of income for the farmer's family; to increase the supply of wood for industrial purposes (pulp and paper, furniture and wood panels), energy (charcoal and fuelwood), construction and other uses; to reduce the pressure on native forests; and to capture CO₂ from the atmosphere, reducing the effects of global warming. To promote forest plantation actions in the country, expanding the reforested area for the production of fibers, wood and pulp by 3.0 million hectares.

Manure Treatment (MT)

The correct disposal of manure and effluents from the rearing of confined animals is an important factor in the environmental compliance of rural properties. The proper treatment of these effluents and manure contributes to reducing methane emissions, as well as increasing farmers' income, either through the organic compost generated or through the generation of automotive, thermal and electrical energy through the use of biogas. Biodigestion and composting processes are already well known and reduce production costs by avoiding energy consumption and chemical inputs, reducing environmental risks and GHG emissions. It includes providing farmers, cooperatives and associations that work in the swine, cattle and poultry farming chains with the appropriate and necessary investments and infrastructures.

One of the crucial operational instruments for implementing the ABC Plan was the credit line created specifically to support farmers to adopt ABC technologies, the Program for Reducing Greenhouse Gas Emissions in Agriculture (ABC Program), approved by Central Bank Resolution No. 3,896, of August 17, 2010. During the first decade of the ABC Plan, the ABC Program provided BRL 32.27 billion to fund ABC technologies, implemented through 38,300 contracts. Nevertheless, many farmers have adopted ABC technologies with their own resources, or with sources of funding other than the ABC Program.

In the period from 2010 to 2020, the area of application of these technologies (excluding manure treatment, which is addressed in volume) was increased to 54.03 million hectares, exceeding the overall target set at 52%. On the other hand, emission mitigation, estimated at 193.67 Mt CO₂ eq, exceeded the upper limit of the target by 19%, i.e., 163 Mt CO₂ eq (Table 3.1.).

TABLE 3.1. ABC PLAN RESULTS BY TECHNOLOGY

ABC Technology	Physical target (2010-2020)	GHG reduction target (2010-2020)	Physical target level (2010-2020)	GHG reduction target level (2010-2020)
Recovery of Degraded Pastures	15 million ha	104 Mt CO ₂ eq	26.8 million ha (179%)	36.1 Mt CO ₂ eq (35%)
Integrated Crop-Livestock-Forestry and Agroforestry Systems	4 million ha	18 to 22 Mt CO ₂ eq	10.76 million ha (269%)	40.78 Mt CO ₂ eq (185%)
No-till Farming System	8 million ha	16 to 20 Mt CO ₂ eq	14.59 million ha (182%)	26.7 Mt CO ₂ eq (133%)
Biological Nitrogen Fixation	5.5 million ha	10 Mt CO ₂ eq	11.78 million ha (214%)	21.56 Mt CO ₂ eq (216%)
Planted Forests	3 million ha	-	1.88 million ha (63%)	8.82 Mt CO ₂ eq
Manure Treatment	4.4 million m ³	6.9 Mt CO ₂ eq	38.34 million m ³ (871%)	59.81 Mt CO ₂ eq (867%)

Source: Brasil, 2023.

The mitigation outcomes resulting from the adoption of ABC Plan technologies were estimated based on a literature review, databases and repositories from official government institutions (Brazilian Institute of Geography and Statistics (IBGE, Instituto Brasileiro de Geografia e Estatística) MAPA – Ministry of Agriculture, Livestock and Supply (Ministério da Agricultura, Pecuária e Abastecimento) and MCTI), sectoral estimates (Brazilian Tree Industry) and emission factors from the National GHG Inventory of Brazil’s Third National Communication to the United Nations Framework Convention on Climate Change (MANZATTO *et al.*, 2020).

The ABC Plan was renamed as the “Sectoral Plan for Adaptation to Climate Change and Low Carbon Emissions in Agriculture and Livestock, with a view to Sustainable Development (ABC+)”, or in its short form “Plan for Adaptation and Low Carbon Emissions in Agriculture (ABC+)”.

The ABC+ implementation period covers the years from 2021 to 2030, with the aim of consolidating national agriculture based on sustainable, resilient and productive systems, as science-based adaptation and mitigation solutions. In order to support the agriculture sector by offering lines of credit, incentives and agricultural policies, the Harvest Plan (Plano Safra) stands out. It is a public policy of the Brazilian government that has been part of the ABC+ Plan since 2023. The ABC+ Plan provides relevant support for the implementation of the NDC, and, for this reason, it is reported in the First Biennial Transparency Report of Brazil.

The **Steel Sector Emissions Reduction Plan** was implemented with the aim of promoting the sustainable production of charcoal used as an input in the production of pig iron, steel and ferroalloys, in order to reduce GHG emissions and increase the sector's competitiveness. Launched in 2010 and completed in 2021, this plan was structured around forest preservation and forest plantation components, as well as industrial and technological components related to increasing efficiency in the carbonization process.

The Plan provided for encouraging the development of solutions for the adequate supply of sustainable feedstocks, encouraging the use of wood obtained by planting forests; and the development and dissemination of more efficient charcoal production technologies that increase the efficiency of converting wood into charcoal with improved environmental quality and reduced emissions by (i) replacing the use of native forest with planted forest; (ii) wood carbonization processes; and (iii) increasing the use of sustainable charcoal in the pig iron, steel and ferroalloys production sectors, in the context of a low-carbon circular economy.

The pilot project BRA/14/G31 - Sustainable Steelmaking, coordinated by the MMA, implemented by the UNDP and financed by the GEF, began to be implemented in 2016. The following institutions were members of the Project Monitoring Committee (PMC): Ministry of Development, Industry, Trade and Services (MDIC, Ministério do Desenvolvimento, Indústria, Comércio e Serviços), Ministry of Science, Technology and Innovation (MCTI), Ministry of Agriculture and Livestock (MAPA) and the Government of Minas Gerais. The main objectives of the project were to contribute to the dissemination of more efficient technologies in current carbonization processes, with the financial incentive mechanism of payment-by-results as a key element, as well as to contribute to the establishment of public policies to encourage forest sustainability in the sector.

Six projects were contracted under the payment-by-results mechanism. The development of an MRV Platform to track the progress of these activities was completed to support the production of greenhouse gas emission reduction estimates. For the small charcoal producer, 4 Demonstration Units were set up (Zona da Mata, Northeast Minas Gerais, Montes Claros and Sete Lagoas), which served as the basis for the capacity-building programme.

Consultancy studies were completed which served as the basis for public policies to encourage forest sustainability in the sector, as well as the starting point for the ongoing development of the sustainability strategy for the Brazilian pig iron, steel and ferroalloys sector.

The added value of the project consists of the sustainable production of charcoal, with a reduction in gas emissions and the production of better quality, denser, less thin and more resistant products, which may attract new markets. Technological development activities have been started by industries in the sector, consultancies and research institutes, on topics such as improving kilns, capturing by-products, using heat for drying wood, logistics, scale benefits, operating costs, capturing exhaust gases for burning and cogeneration.

Effective results have been achieved in reducing GHG emissions through innovative technological solutions. The innovation also stands out in terms of support mechanism - a pioneering approach for the Federal Government, GEF and UNDP. These include:

- ▶ Six support contracts for industrial-scale charcoal producers have been signed and are in progress, under the payment-by-results mechanism for charcoal production, with the adoption of more efficient and sustainable production technologies. An independent audit carried out in 2019 found a reduction of 102,156 t CO₂ eq as a result of these contracts. The first payments were, then, made for greenhouse gas emission reduction results achieved in 2019 and 2020;

- ▶ In 2020, 11.2% of national raw steel production was obtained through the charcoal route. Of this total, 84% of the wood used to produce charcoal came from self-owned forests, 13% from forests planted by third parties and 2% from legalized forest waste;
- ▶ The “kiln-furnace” (“*forno-fornalha*”) technology, developed by the Federal University of Viçosa (UFV, Universidade Federal de Viçosa), has been validated as being technically and economically viable for charcoal production. The gravimetric yield obtained was very positive, as it went from a baseline of 26% to an average of 33% (target of 32%), and the associated reduction in GHG emissions was estimated at 46.2%.

By December 2019, more than 300 people had been trained in the construction and operation of the kiln-furnace systems and carbon balance methodologies.

In addition to the sectoral plans described previously, the country has also invested **in other initiatives in the energy sector**, with regard to expanding the supply of hydroelectricity, alternative renewable sources, and increasing energy efficiency.

Brazil already has one of the most renewable matrices in the world. The policies implemented in recent decades have played an important role in promoting a cleaner and more sustainable energy matrix, and have reinforced the need to diversify and expand renewable sources, with a focus on wind, solar and biomass power.

Hydroelectric power remained the main source of electricity generation in the country, with 65.2% in 2020 (EPE – Energy Research Office (Empresa de Pesquisa Energética), 2021) and installed capacity of approximately 103 GW in 2020 (EPE, 2024b).

Wind power has had a remarkable growth. In 2010, the installed capacity was approximately 930 MW (EPE, 2011). In 2020 it reached around 17.2 GW (EPE, 2024b). This progress was driven by incentive policies and specific tenders for contracting wind power.

Photovoltaic solar power has also expanded significantly. Although its share of the electricity matrix was modest in 2010, installed capacity increased to 7.9 GW in 2020 (EPE, 2024b). This growth was boosted by reductions in installation costs and incentive programs for distributed generation.

Biomass, especially from sugar cane bagasse, has remained an important source of renewable energy. In 2020, biomass accounted for 9.1% of domestic electricity supply (EPE, 2021), contributing to the diversification of the energy matrix.

In addition to the initiatives described above, Table 3.2. shows, as a record of the progress made in the implementation of the NAMAs, the results of the plans implemented to achieve the targets, considering the time horizon up to 2020.

It should be noted that, in addition to the specific results of the physical and emission reduction targets, **Brazil fulfilled its voluntary commitment in 2020**, provided for in the PNMC, **with an overall emission reduction of 47%**, surpassing the established target of 36.1% to 38.9%, and the **emission of 1,715 Mt CO₂ eq (GWP-SAR)**, compared to the value projected in the reference scenario of 3,236 Mt CO₂ eq (GWP-SAR).

TABLE 3.2. CONSOLIDATION OF INFORMATION RELATED TO THE NATIONAL COMMITMENT TO MITIGATION ACTIONS IN BRAZIL BY 2020

NAMAs (FCCC/AWGLCA/2011/INF.1)	GHG emission reduction target in 2020 (FCCC/AWGLCA/2011/INF.1)	Sectoral Targets for 2020 ¹⁵	Results of sectoral physical targets in 2020	Achievement of the Sectoral Targets	GHG emission reduction results in 2020	Compliance with NAMAs
a) Reduction of Deforestation in the Amazon	564 Mt CO ₂ eq	80% reduction in annual deforestation rates in the Legal Amazon compared to the average between 1996 and 2005 (1,953,500 hectares).	Deforestation rate of 1,085,100 hectares, which is equivalent to a 44% reduction in relation to the average for the period between 1996 and 2005. ^a	Partial achievement of 55% of the target	421.26 Mt CO ₂ eq ^b	Partial achievement of 75% of the target
b) Reduction of Deforestation in the Cerrado	104 Mt CO ₂ eq	A 40% reduction in annual deforestation rates in the Cerrado Biome compared to the average between 1999 and 2008 (1,570,000 hectares).	Deforestation rate of 709,516 hectares. Which is equivalent to a 50% reduction compared to the average for the period between 1999 and 2008 ^a	Yes	160.34 Mt CO ₂ eq ^b	Yes
c) Recovery of Degraded Pastures	83 to 104 Mt CO ₂ eq	Recovery of 15 million hectares of degraded pastures	Recovery of 26.8 million hectares of degraded pastures	Yes	36.1 Mt CO ₂ eq ^c	Partial achievement of 43% of the target
d) Integrated Crop-Livestock-Forestry	18 to 22 Mt CO ₂ eq	Expansion of the crop-livestock-forestry integration system by 4 million hectares	Expansion of the crop-livestock-forestry integration system by 10.76 million hectares	Yes	40.78 Mt CO ₂ eq ^c	Yes
e) No-till Farming System	16 to 20 Mt CO ₂ eq	Expansion of no-till farming over straw by 8 million hectares	Expansion of no-till farming by 14.59 million hectares	Yes	26.7 Mt CO ₂ eq ^c	Yes
f) Biological Nitrogen Fixation	16 to 20 Mt CO ₂ eq	Expansion of biological nitrogen fixation by 5.5 million hectares of cultivated areas, replacing the use of nitrogen fertilizers.	Expansion of biological nitrogen fixation by 11.78 million hectares.	Yes	21.56 Mt CO ₂ eq ^c	Yes
g) Energy efficiency.	12 to 15 Mt CO ₂ eq	Expansion of the hydroelectric supply, the supply of alternative renewable sources, notably wind farms, small hydroelectric plants and bioelectricity, the supply of biofuels, and an increase in energy efficiency.	Expansion from 44.7% to 48.7% of renewable energies in the energy matrix, with solar and wind power expanding from 0.2 to 2.3%. The share of sustainable biofuels in the energy matrix increased from 27.1% to 28.1% between 2010 and 2020. Reduction of 22,020 GWh in the country's electricity consumption in 2020.	Yes	Not estimated	Not estimated
h) Increased use of biofuels.	48 to 60 Mt CO ₂ eq				Not estimated	Not estimated
i) Increased energy supply from hydroelectric plants.	79 to 99 Mt CO ₂ eq				Not estimated	Not estimated
j) Increase in alternative energy.	26 to 33 Mt CO ₂ eq				Not estimated	Not estimated

15 Established via Decree No. 7390/2010, later revoked by Decree No. 9,578/2018.

NAMAs (FCCC/ AWGLCA/2011/ INF.1)	GHG emission reduction target in 2020 (FCCC/ AWGLCA/2011/ INF.1)	Sectoral Targets for 2020 ¹⁵	Results of sectoral physical targets in 2020	Achievement of the Sectoral Targets	GHG emission reduction results in 2020	Compliance with NAMAs
k) Iron and Steel - replacement of charcoal obtained from wood from deforestation with wood from planted forests	8 to 10 Mt CO ₂ eq	Increase in the use of charcoal from planted forests in the steel industry and improvement in the efficiency of the carbonization process	11.2% of national raw steel production was obtained through the charcoal route. Of this total, 84% of the wood used to produce charcoal came from self-owned forests, 13% from forests planted by third parties and 2% from legalized forest waste.	Yes	Not estimated	Not estimated

Notes:

a Obtained from [Prodes - Project for Satellite Monitoring of Deforestation in the Legal Amazon \(Projeto de Monitoramento do Desmatamento na Amazônia Legal por Satélite\)](#) data, compared to the rates projected in Decree No. 7390/2010.

b Calculated based on the deforestation rates presented in Prodes and the calculation parameters (e.g., carbon stock) from Decree No. 7390/2010.

c Information obtained from the ABC Plan.

The results of GHG emissions indicated as “Not estimated” are due to the lack of specific parameters for an accurate estimate that can relate the actions implemented to emission reductions for the period.

3.2 CLEAN DEVELOPMENT MECHANISM (CDM) PROJECTS IN BRAZIL: UPDATING

In Brazil, there was no change in the number of projects received by Brazil's Designated National Authority (DNA) under the Clean Development Mechanism (CDM) or in the number of projects registered with the CDM Executive Board compared to the BUR4. The halt in the demand for CDM projects was due to the uncertainties generated by the declaration of the end of the CDM and the creation of a new mechanism under the Paris Agreement.

As of November 2021, in order to meet the requirements of the decisions adopted regarding the operation of the CDM and the establishment of the rules, modalities and procedures of the Paris Agreement Crediting Mechanism, Brazil's DNA decided, through an inter-ministerial agreement, to suspend the receipt of requests for the issuance of letters of approval for projects to be submitted under the CDM.

After the opening of the process to request the transition of CDM projects to the Paris Agreement crediting mechanism, 101 CDM projects in Brazil requested the transition. Those are currently being assessed.

4

**GAPS, BARRIERS,
RELATED FINANCIAL,
CAPACITY BUILDING,
TECHNICAL AND
TECHNOLOGICAL NEEDS;
AND INFORMATION ON
SUPPORT RECEIVED**

4 GAPS, BARRIERS, RELATED FINANCIAL, CAPACITY BUILDING, TECHNICAL AND TECHNOLOGICAL NEEDS; AND INFORMATION ON SUPPORT RECEIVED

4.1 GAPS, BARRIERS, RELATED FINANCIAL, CAPACITY BUILDING, TECHNICAL AND TECHNOLOGICAL NEEDS

Due to the size of the country and its diversity in terms of social, economic and environmental factors, the information presented in this chapter should be considered provisional, partial and not detailed. There are important challenges relating to an in-depth reflection on all aspects relevant to the identification of constraints and gaps, and the financial, technical and capacity-building needs on a comprehensive scale.

The Nationally Appropriate Mitigation Actions (NAMAs) implemented in Brazil until 2020 faced significant challenges related to data gaps, structural barriers and constraints in financial, technical and capacity-building resources.

By analyzing the information segmented by sectors of the GHG Inventory and the specific initiatives related to the NAMAs, it is possible to consolidate some points:

Agriculture Sector - ABC Plan

Within the scope of the ABC Plan, one of the gaps that stood out was the lack of detailed data obtained *in loco* and through images, which is essential for validating and measuring results related to the adoption of sustainable and resilient production systems. Furthermore, the lack of participatory and integrated systems for monitoring, tracking and validating information has compromised the efficiency of the tracking of the actions implemented. Another relevant gap was the lack of harmonized preliminary information for the creation of a national tracking and certification system, which is fundamental for guaranteeing the transparency and reliability of data on emissions in the agriculture sector.

In addition, the great diversity of biomes and actors present in different Federative Units/States represented a significant barrier, making it difficult to standardize and integrate monitoring systems. This complexity has been exacerbated by the dynamic evolution of agricultural technologies and practices and by limited financial resources for travel, expert consultations and the development of monitoring infrastructure. In addition, the technical knowledge lag with regard to the best practices and technologies applicable to the various biomes has made it difficult to implement more effective actions on a large scale.

In this context, the main needs include financial resources for acquiring high-resolution images, developing integrated monitoring systems and hiring experts for technical support and capacity building. It is essential to promote the training of professionals in tracking and certification, as well as encouraging the dissemination of technologies adapted to regional circumstances. Fostering research and technological development is also necessary, including investment in infrastructure and international cooperation to expand the exchange of knowledge and innovation in the sector.

Land Use, Land-Use Change and Forestry Sector (LULUCF) - PPCDAm and PPCerrado

In the LULUCF sector, one of the most evident gaps was the lack of integration between the various federal entities with regard to the systems for granting vegetation suppression licenses. In addition, there has been limited dissemination of integrated fire management techniques, which are essential for preventing and controlling forest fires. Another gap was the lack of legal certainty to promote payment for environmental services and the bioeconomy, which affects the business environment and hinders the attraction of sustainable investments.

The lack of financial resources and budget constraints was the main barrier identified, limiting the integration of systems and the dissemination of sustainable practices. Another challenge was the lack of widespread recognition of the importance of market mechanisms for combating unlawful actions and promoting legal and sustainable actions. The complexity of the initiatives, combined with the diversity of actors and biomes, has made it difficult to move forward with more consistent programs in the sector. The needs to overcome these barriers include the allocation of financial resources for the integration of state and federal systems, the strengthening of institutions to promote forest governance and training in fire management techniques. In addition, it is essential to promote recognition of the importance of environmental services and of the bioeconomy, guaranteeing incentives and legal certainty to attract investors and strengthen market mechanisms.

Energy Sector

In the energy sector, the main gap was the lack of consolidation and dissemination of emerging technologies, such as concentrated solar thermal power plants and energy storage systems. Furthermore, limitations were identified in the Measurement, Reporting and Verification (MRV) processes in energy efficiency programs, compromising the proper measurement of the results obtained. Barriers include insufficient financial resources for the development and dissemination of these technologies, as well as a lack of technical training to implement innovative practices in the sector. The complexity of implementing robust MRV systems and the need to standardize methodologies have hindered the progress of energy efficiency programs.

The main needs include financial investments for research, development and consolidation of innovative technologies, as well as the promotion of seminars, workshops and exchanges to train professionals in the sector. It is essential to boost international cooperation in order to speed up technological development and facilitate the transfer of knowledge. In addition, it is important to strengthen MRV systems with robust methodologies and resources for technical capacity building.

Industrial Processes and Product Use Sector - Sustainable Steelmaking

In sustainable steelmaking, gaps were identified related to the shortage of funding for new pilot projects and the expansion of the payment-by-results mechanism, which is restricted to companies that are already covered. This has limited the potential for expansion and the positive impact of existing initiatives.

Limited financial resources and the lack of capacity building and technology transfer to regions and companies outside the projects were the main barriers. This has made it difficult to include new actors and to scale up successful projects. The needs include raising financial resources for the expansion of pilot projects and payment by results, as well as capacity-building programmes in MRV methodologies and low-carbon technologies. It is also essential to promote the transfer of technologies to regions that are not yet served, ensuring the inclusion and strengthening of sustainable actions in the sector.



Finally, although the NAMAs have contributed to important advances in various sectors, significant gaps still need to be addressed. Barriers such as the lack of integration between systems, limited financial resources and insufficient technical capacity building hinder the achievement of their full potential. In order to overcome these challenges, it is essential to prioritize investments in technologies, research and development, professional capacity building and international cooperation. Enhancing governance and systematizing information are also key to ensuring the effectiveness of Brazil's climate actions in the context of the NAMAs and global commitments.

4.2 INFORMATION ON THE SUPPORT RECEIVED

Climate financing from external multilateral and bilateral sources plays a key role in advancing climate action in Brazil. This financing contributes significantly to the implementation of public policies and programmes. It mobilizes private resources for investments aimed at low carbon emissions and at increasing climate resilience, including to support initiatives by civil society organizations. However, since 2018, as reported in Brazil's last two Biennial Update Reports (BUR), there has been a reduction in the amounts provided by cooperating countries and entities.

The Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) highlights the importance of increasing finance for developing countries, such as Brazil, in order to promote and accelerate actions that help achieve global climate targets, while promoting local and regional benefits. Through public funding and clear signals to investors, governments can reduce economic barriers and direct essential resources to mitigation and adaptation actions in these countries. Private investors and banks, as well as national and international companies committed to environmental and social sustainability standards, play a crucial role in promoting a sustainable transition. In addition, political commitment, policy coordination, international cooperation, effective ecosystem management and inclusive governance are key to effective and equitable climate action. Sharing appropriate technologies, knowledge and policies, together with adequate funding, will allow all communities to participate in reducing emissions and avoiding processes and products with a high carbon footprint. Substantial investments in adaptation are also essential to prevent or mitigate growing risks, especially for vulnerable groups and regions.

Given the importance of international finance in catalyzing action for climate change, Brazil has stressed the need for the financial contribution to be adequate, predictable, sustainable, new and additional. Recalling the commitment established in the Paris Agreement by developed countries to mobilizing 100 billion dollars a year by 2020, Brazil stresses that there is little transparency about the current state of compliance with this commitment.

Due to the size of the country and its diversity in terms of social, economic and environmental factors, the information presented in this chapter should be considered non-exhaustive, since there is still a need for a structured reflection on the issue in the country and the strengthening of arrangements for gathering information, considering all aspects that are relevant to the identification of constraints and gaps, and related financial, technical and capacity-building needs.

The contribution of resources to Brazil in the 2020-2022 period totaled approximately 516 million dollars. The information on the financial support received was gathered through the contribution of the General Coordination of Sustainable Finance, from the Ministry of Finance's Undersecretariat for Financing Sustainable Development.

The data was collected and is available in Table 4.1., in the common tabular format established in accordance with Decision 5/CMA.3. The table shows Climate Investment Fund initiatives, in the amount of 196 million dollars, as well as resources received or planned from the Green Climate Fund (GCF) and the GEF, which amounts to approximately 214 million dollars and 106 million dollars, respectively.

Some partners in the promotion of sustainable development in Brazil through bilateral cooperation were not included in the tables due to different approaches used in the accounting of the support and cooperation received, which could not be efficiently assessed or were not included in the above criteria.

When collecting data, the information from multilateral institutions proved to be more transparent, accessible, complete and comparable than the data available from bilateral flows. It becomes challenging, for example, to identify and access information about a flow of climate finance from a bilateral donor to a civil society organization when there is no Federal Government involvement. Due to these constraints, 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).

In terms of the climate relevance of individual projects, the percentage of the climate component for multilateral resources was based on the criteria of the funding institution.

It should be noted that resources destined to the private sector and external resources received directly by sub-national entities are not included.

Compared to the provision of resources in the 2018-2019 period (1.879 billion dollars), reported in BUR4, there has been a 72% reduction in the financial support received by the country.



INFORMATION ON FINANCIAL SUPPORT RECEIVED

TABLE 4.1. INFORMATION ON THE FINANCIAL SUPPORT RECEIVED BY DEVELOPING COUNTRY PARTIES

Exchange Rate used: 1 USD = BRL 5

Climate-specific amount received															
Title of the programme, project or other	Programme/project description	Channel	Recipient entity	Implementing entity:	Domestic currency (BRL)	USD	Implementation time frame	Financial instrument	Status	Type of support	Sector	Contribution to technology development and transfer objectives	Contribution to capacity-building objectives	Status	Additional information
<i>Global Subnational Climate Fund (Global SnCF)</i>	The <i>Global SnCF</i> catalyzes long-term sub-national climate investments, attracting mainly private capital for mitigation and adaptation solutions.	Green Climate Fund	Medium-sized projects	Pegasus Capital Advisors	17,857,142.86	3,571,428.57	15 years	Equity	UA	Mitigation	Cities, energy and forests	UA	UA	Ongoing	This is a global programme involving 42 countries. The amount for Brazil was estimated by dividing the amount of the programme equally between all the countries. The figures mentioned are for GCF funding only, not including co-funding
<i>Global Subnational Climate Fund (Global SnCF) Global - Technical Assistance</i>	The <i>Global SnCF</i> catalyzes long-term sub-national climate investments, attracting mainly private capital for mitigation and adaptation solutions.	Green Climate Fund	Medium-sized projects	Pegasus Capital Advisors	2,202,380.95	440,476.19	7 years	Grant	UA	Mitigation	Cities, energy and forests	UA	UA	Ongoing	This is a global programme involving 42 countries. The amount for Brazil was estimated by dividing the amount of the programme equally between all the countries. The figures mentioned are for GCF funding only, not including co-funding
<i>Planting Climate Resilience in Rural Communities of the Northeast (PCRP)</i>	The project aims to increase the resilience of vulnerable farmers in northeastern Brazil.	Green Climate Fund	Women, young people and traditional communities	International Fund for Agricultural Development	497,500,000.00	99,500,000.00	8 years	Grant and Loan	UA	Cross-cutting	Cities, ecosystems, forests, health and water and communities.	UA	UA	Ongoing	The project only includes Brazil. Figures are only for GCF funding. There is also co-funding, which is not included in these figures.
<i>Amazon Bioeconomy Fund</i>	It seeks to reduce the impacts of climate change on the Amazon, prioritizing natural capital and climate benefits.	Green Climate Fund	UA	Inter-American Development Bank	232,500,000.00	46,500,000.00	7 years	Grant, Loan and Equity	UA	Cross-cutting	Ecosystems, forests and communities.	UA	UA	Ongoing	This is a regional programme involving 6 countries. The amount for Brazil was estimated by dividing the amount of the programme equally between all the countries. The figures mentioned are for GCF funding only, not including co-funding

Climate-specific amount received															
Title of the activity, programme, project or other	Programme/project description	Channel	Recipient entity	Implementing entity	Domestic currency (BRL)	USD	Implementation time frame	Financial instrument	Status	Type of support	Sector	Contribution to technology development and transfer objectives	Contribution to capacity-building objectives	Status	Additional information
CRAFT - Catalytic Capital for First Private Investment Fund for Adaptation Technologies in Developing Countries	Private investment fund for climate adaptation. It mobilizes capital to expand climate-resilience technologies in developing countries.	Green Climate Fund	UA	Pegasus Capital Advisors	83,333,333.33	16,666,666.67	12 years	Equity	UA	Adaptation	Water and health, infrastructure and communities.	UA	UA	Ongoing	This is a regional programme involving 6 countries. The amount for Brazil was estimated by dividing the amount of the programme equally between all the countries. The figures mentioned are for GCF funding only, not including co-funding.
Coral Reefs	It is a Blue Economy Fund, which will create a private equity fund to protect coral reefs, encouraging sustainable investments in 17 countries.	Green Climate Fund	UA	Pegasus Capital Advisors	36,764,705.88	7,352,941.18	UA	Equity	UA	Adaptation	Ecosystems, water and health, infrastructure and communities.	UA	UA	Ongoing	This is a global programme involving 17 countries. The amount for Brazil was estimated by dividing the amount of the programme equally between all the countries. The figures mentioned are for GCF funding only, not including co-funding.
Climate Investor Two (CI2)	It is a fund that supports the private sector for the development of climate-resilient infrastructure in developing countries in the areas of water, sanitation and oceans.	Green Climate Fund	UA	FMO - Nederlandse Financierings-Maatschappij voor Ontwikkelingslanden	38,157,894.74	7,631,578.95	20 years	Reimbursable Grant	UA	Cross-cutting	Cities, ecosystems, energy, forests, health and water and infrastructure.	UA	UA	Ongoing	This is a global programme involving 19 countries. The amount for Brazil was estimated by dividing the amount of the programme equally between all the countries. The figures mentioned are for GCF funding only, not including co-funding.
GGC	Guarantees for climate bonds with significant adaptation and mitigation impacts. It mobilizes global funds for climate projects in developing countries, mitigating risks and facilitating access to international capital.	Green Climate Fund	UA	MUFG Bank, Ltd.	25,312,500.00	5,062,500.00	10 years	Equity	UA	Cross-cutting	Cities, energy, health and water, infrastructure and transportation	UA	UA	Ongoing	This is a global programme involving eight countries. The amount for Brazil was estimated by dividing the amount of the programme equally between all the countries. The figures mentioned are for GCF funding only, not including co-funding.

Climate-specific amount received															
Title of the activity, programme, project or other	Programme/project description	Channel	Recipient entity	Implementing entity:	Domestic currency (BRL)	USD	Implementation time frame	Financial instrument	Status	Type of support	Sector	Contribution to technology development and transfer objectives	Contribution to capacity-building objectives	Status	Additional information
&Green Fund	promotes the sustainable production of commodities and greater agricultural productivity in countries with tropical forests, reducing the pressure for deforestation.	Green Climate Fund	UA	FMO – Nederlandse Financierings-Maatschappij voor Ontwikkelingslanden	86,068,181.82	17,213,636.36	3 years	Grant, Loan	UA	Adaptation	Ecosystems, water and health, forests, communities.	UA	UA	Ongoing	This is a global programme involving 11 countries. The amount for Brazil was estimated by dividing the amount of the programme equally between all the countries. The figures mentioned are for GCF funding only, not including co-funding
Marajó Resiliente	It aims at increasing the resilience of small farming communities in the Marajó archipelago by promoting diversified agroforestry systems (DAS).	Green Climate Fund	UA	Fundación Avina	49,444,615.00	9,888,923.00	5 years	Grant	UA	Adaptation	Ecosystems, water and health, communities.	UA	UA	Ongoing	The project only includes Brazil.
Promoting zero-emission buildings in Brazil through climate technologies and policies (Edinova)	The project aims to decarbonize Brazil's construction sector, promoting net-zero buildings through innovative technologies and public policies.	Global Environment Facility	UA	UN Environment Programme	505,750,000.00	101,150,000.00	4 years	Grant	UA	Cross-cutting	Cities	Yes	Yes	Planned	The project only includes Brazil.
Restoration of Wetlands and other important Amazonia Ecosystems - Capacity-building, innovation, development and technological transfer for ecological restoration and climate change mitigation	The project aims to restore wetland ecosystems in the Amazon, focusing on floodplains and mangroves, as a nature-based solution to mitigate climate change and preserve biodiversity.	Global Environment Facility	UA	FAO - Food and Agriculture Organization of the United Nations	27,375,000.00	5,475,000.00	4 years	Grant	UA	Cross-cutting	Forests	Yes	Yes	Planned	The project only includes Brazil.

Climate-specific amount received															
Title of the programme, project or other	Programme/project description	Channel	Recipient entity	Implementing entity	Domestic currency (BRL)	USD	Implementation time frame	Financial instrument	Status	Type of support	Sector	Contribution to technology development and transfer objectives	Contribution to capacity-building objectives	Status	Additional information
	FIP enables developing countries to manage their natural resources in a way that achieves the triple win of being good for forests, good for development and good for the climate. The program aims to reverse the impacts of human actions and climate change on our forest ecosystems.	Climate Investment Funds	UA	IBRD - International Bank for Reconstruction and Development - Interamerican Bank; IFC - International Finance Corporation	633,500,000.00	126,700,000.00	UA	Concessional loan and grant	UA	Cross-cutting	Forests	UA	UA	Ongoing	The programme is divided into 8 projects, with different budgets, schedules and recipients.
Renewable Energy Integration Program (REI)	The program works through national and regional investment plans that address the technical, political and market barriers that prevent greater penetration of renewable energies in the grid. It promotes specific investments in enabling technologies, infrastructures or business models that can demonstrate the benefits of such an approach in developing countries. In addition, a dedicated private sector window can allow investments in countries or regions where the regulatory framework and market structure support direct investments in flexibility and innovations.	Climate Investment Funds	UA	BNB - Banco do Nordeste do Brasil	350,000,000.00	70,000,000.00	7 years	Concessional loan and grant	UA	Mitigation	Energy	UA	UA	Ongoing	

Notations: NA = Not applicable; UA = Information not available at the time of reporting.



5



FUNDS RECEIVED FOR THE PREPARATION OF THE BUR



5 FUNDS RECEIVED FOR THE PREPARATION OF THE BUR

The preparation of the BUR5 was made possible by the financial support received from the Global Environment Facility (GEF), through a project to prepare Brazil's Fifth National Communication and the first three Biennial Transparency Reports (BTRs). This project is executed by the Ministry of Science, Technology and Innovation (MCTI) and implemented in partnership with the United Nations Development Programme (UNDP).

This support is important to ensure the updating of the information provided, without which the data collection could be compromised.

It should be clarified that the resources for the preparation of this document are not restricted to those received from the GEF. The institutions involved have significant support and contributions from different bodies and a great deal of engagement from teams from other projects and from the government itself.

The Brazilian government has prepared this BUR5 with a view to consolidating information, enhancing the transparency of its data, demonstrating its commitment to contributing to the global exercise, in order to facilitate and accelerate the understanding of the challenges and needs for combating climate change.

6

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



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

The Measurement, Reporting and Verification (MRV) of NAMAs in Brazil required a comprehensive structure, involving different databases and institutional arrangements to ensure the collection of information.

This section describes, in a non-exhaustive way, some of the initiatives involved in the national MRV of the NAMAs in Brazil.

6.1 MEASUREMENT AND REPORTING OF GREENHOUSE GAS EMISSIONS

In October 2017, Brazil established the National Emissions Registry System (SIRENE, Sistema de Registro Nacional de Emissões)¹⁶ through Decree No. 9,172/2017. SIRENE is a computerized system developed by the MCTI, whose main objective is to make available the results of the national inventory of anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol. SIRENE aims to provide security and transparency to the process of drawing up inventories of greenhouse gas emissions.

SIRENE provides charts and tables of national emissions, which can be exported in an editable format based on filters selected by the user. In addition, all official publications and transparency reports are made available to society on the platform. SIRENE also provides emissions and energy scenarios for 2012-2050, which are generated based on information from the “Options for Mitigating Greenhouse Gas Emissions in Key Sectors in Brazil” project, a GEF project previously implemented by the MCTI with the support of the United Nations Environment Programme (UNEP). It also provides a breakdown of GHG emissions and removals by federative unit/state, based on data from the Fourth National Communication.

This system also includes a free public platform, developed with the purpose of providing visibility and transparency to the voluntary submission of greenhouse gas (GHG) emissions and removals inventory results by organizations in general, called Organizational SIRENE (SIRENE Organizacionais).¹⁷

The Organizational SIRENE module was developed in a collaborative process with various public and private institutions. The initiative establishes some standardized requirements for the accounting of GHG emissions throughout the country, guaranteeing the security and robustness of the data; it stimulates the management and awareness of organizations regarding data collection, preparing them for carbon trading markets and scenarios; it supports the production sector, decision-makers and Brazilian public managers in the development and prioritization of policies and actions to achieve the NDC targets.

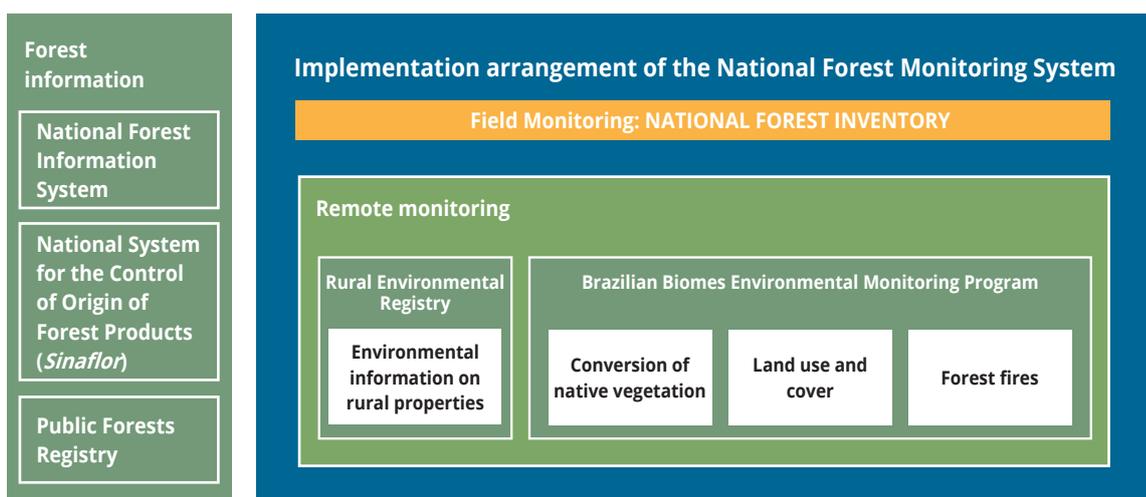
¹⁶ Available at: <https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/sirene>

¹⁷ Available at: <https://sireneorganizacionais.mcti.gov.br/>

6.2 ACTIONS RELATED TO LAND USE, LAND-USE CHANGE AND FORESTRY

Due to its extensive coverage of native vegetation and the dynamics of land use and occupation, Brazil has implemented a series of systems for monitoring and implementing actions in the LULUCF sector (Figure 6.1) which together support the monitoring of LULUCF's NAMAs and the REDD+ results MRV process.

FIGURE 6.1. MAIN SYSTEMS FOR MONITORING AND IMPLEMENTING ACTIONS IN THE LULUCF SECTOR



The forest information systems shown in Figure 6.1 provide inputs for the implementation and monitoring of LULUCF's NAMAs, as well as for the REDD+ results MRV process, in addition to those designed to provide and organize forest information¹⁸.

In addition to the systems described previously, the MMA, through its support for the National System for Controlling the Origin of Forest Products - Sinaflor (Sistema Nacional de Controle da Origem dos Produtos Florestais) and the National Fire Information System - Sisfogo (Sistema Nacional de Informações sobre o Fogo), has been adopting measures to systematize and verify 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 arrangement for the implementation of the national forest monitoring system are described below.

National forest inventory - NFI

The main objective of the NFI is to produce information on forest resources, from natural and planted forests, every 5 years, to support the formulation of public policies aimed at the use and conservation of forest resources. The NFI produces information on forest stocks, composition, health and vitality, as well as the patterns of change in these aspects over time. The NFI also includes the development

¹⁸ For more information, please see:
 National Forestry Information System (Sistema Nacional de Informações Florestais) available at: <http://snif.florestal.gov.br/pt-br>
 National System for Controlling the Origin of Forest Products (Sistema Nacional de Controle da Origem dos Produtos Florestais.) Available at: www.ibama.gov.br
 Register of Public Forests (Cadastro de Florestas Públicas) Available at: www.florestal.gov.br/cadastro-nacional-de-florestas-publicas

of allometric equations to estimate the volume of wood and the biomass for different forest types, in partnership with universities and research institutes. These estimates will support the formulation of public policies for the sustainable use of forest resources, as well as the preparation of future GHG inventories for the LULUCF sector.

Environmental Monitoring of Brazilian Biomes

Several mapping products have been developed by INPE – National Institute for Space Research (Instituto Nacional de Pesquisas Espaciais) in partnership with universities and other research institutions. The different land-use and land-cover data can be accessed through the Terra Brasilis website¹⁹. Information on the occurrence of the burning of vegetation is accessible at “Queimadas” (Fires)²⁰, while more information on land use is available at TerraClass Cerrado and TerraClass Amazônia²¹.

Information on annual deforestation rates can also be found through the Project for Satellite Monitoring of Deforestation in the Legal Amazon (Projeto de Monitoramento do Desmatamento na Amazônia Legal por Satélite) (PRODES).

National Rural Environmental Registry System - SICAR (Sistema Nacional de Cadastro Ambiental Rural)

The National Rural Environmental Registry System (SICAR) was created to manage environmental information on rural properties on a national basis. By October 2023²², the system had 7.2 million registered properties across the country, totaling approximately 672 million hectares already registered and monitored. This information is an important input both for combating deforestation and for mapping registered rural properties.

6.3 REPORTING OF SECTORAL GREENHOUSE GAS EMISSION REDUCTION IN AGRICULTURE

The ABC Platform is the MRV instrument set up in the context of the ABC Plan and aims to develop and validate a broad and integrated system for identifying, qualifying and monitoring the adoption of ABC Plan technologies and their contribution to GHG mitigation. The assessment methodologies follow internationally established GHG emissions monitoring protocols and IPCC guidelines, in addition to national scientific data at state, municipal or biome level.

The ABC+ Integrated Information System (SINABC, Sistema Integrado de Informações do ABC+) is an automated platform set up via a technical cooperation agreement between the Department of Innovation, Sustainable Development, Irrigation and Cooperativism of the Ministry of Agriculture and Livestock (MAPA) and the Federal Data Processing Service (SERPRO, Serviço Federal de Processamento de Dados).

19 Terra Brasilis Website Available at: <https://terrabrasilis.dpi.inpe.br/>

20 INPE's website on fires. Available at: <https://terrabrasilis.dpi.inpe.br/app/dashboard/fires/biomes/aggregated/>

21 TerraClass Cerrado. Available at: www.dpi.inpe.br/tccerrado;
TerraClass Amazônia. Available at: www.inpe.br/cra/projetos_pesquisas/dados_terraclass.php

22 Newsletter. Available at: https://www.car.gov.br/manuais/Boletim_Informativo_Outubro_de_2023.pdf

The SINABC Platform has three pillars:

- ▶ The Governance System of the ABC Plan - SIGABC (Sistema de Governança do Plano ABC) with public access to be fed by the State Management Groups (GGEs, Grupos Gestores Estaduais) of the ABC+ Plan. These groups are responsible for coordinating and guiding the Plan's actions within the scope of each Brazilian federative unit/state. Currently, State Management Groups (GCEs) have been formally established in 23 federative units/states, and are structured in 20 of them, through the establishment of partnerships with federal, state and municipal government institutions, as well as non-governmental institutions and the private sector;
- ▶ The Rural Credit and Proagro – Agricultural Activity Guarantee Program (Programa de Garantia da Atividade Agropecuária) Operations System - SICOR (Sistema de Operações do Crédito Rural e do Proagro), including the development of a business intelligence panel based on cross-referencing the rural credit operations databases of the Central Bank of Brazil (SICOR), the Ministry of the Environment and Climate Change (MMA), rural properties (SICAR – National Rural Environmental Registry System (Sistema Nacional de Cadastro Ambiental Rural)) and the Brazilian Institute of Geography and Statistics (IBGE, Instituto Brasileiro de Geografia e Estatística); and
- ▶ The Multi-institutional Platform for Monitoring Greenhouse Gas Emissions Reductions in Agriculture - ABC Platform, which consists of the development of a technological solution for the sustainable practices of ABC+, starting with Degraded Pasture Recovery Practices (DPRP) and, in the next stages, Management of Livestock Production Waste (MLPW) and Intensive Finishing (IF).





APPENDIX I



TIME SERIES OF GREENHOUSE GAS EMISSIONS



Unit: kt	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	2017	2018	2019	2020	
Total CO₂ ENERGY	1,088,844	920,331	1,027,063	1,068,763	1,057,400	2,146,245	1,472,553	1,177,249	1,438,686	1,399,186	1,461,615	1,413,775	1,615,521	2,847,804	2,846,200	1,851,592	1,508,936	1,200,578	1,325,164	705,454	688,969	764,130	654,557	916,999	794,590	876,747	904,853	797,899	825,521	1,017,289	1,094,677	
	177,047	180,564	186,066	191,352	200,125	216,612	233,814	249,332	256,693	266,202	272,800	280,437	278,023	271,139	285,472	293,505	298,663	312,132	331,120	319,495	352,767	366,887	399,308	430,732	456,341	431,970	399,958	406,956	384,137	383,453	364,226	
Fuel combustion	170,856	174,530	179,832	185,033	193,480	210,029	226,661	241,644	248,249	257,247	263,366	270,664	267,971	261,198	276,075	281,048	287,021	300,178	318,588	301,945	339,460	354,216	385,814	416,786	440,670	416,579	384,118	391,894	369,152	368,224	348,751	
Energy industries and construction	23,707	21,893	23,753	23,805	24,953	26,258	28,323	31,438	32,384	38,831	40,429	44,239	38,726	39,437	44,752	46,801	46,902	46,974	56,211	46,800	57,271	51,394	66,364	89,362	106,814	101,467	76,691	81,671	71,110	70,502	65,652	
Manufacturing industries and construction	36,470	38,428	39,897	40,582	41,744	45,149	50,684	53,525	54,305	58,045	61,798	61,093	61,835	59,338	60,378	63,308	64,389	64,389	70,142	71,573	67,430	74,807	79,725	78,596	79,136	79,692	69,248	69,315	65,819	64,674	59,928	
Iron and steel	4,725	4,946	5,449	5,774	5,766	5,763	5,852	5,726	5,350	5,341	5,660	5,619	6,084	6,235	6,556	6,876	6,888	7,588	8,073	6,168	7,299	7,487	7,487	7,720	7,540	7,231	6,816	7,577	7,809	7,427	7,045	
Non-ferrous metals	1,374	1,330	1,438	1,667	1,640	1,936	2,832	2,886	3,322	3,859	4,254	3,977	4,179	4,997	5,264	5,402	5,628	6,001	5,665	4,665	8,544	9,714	9,533	9,578	9,968	8,976	8,956	8,986	6,226	6,691	7,073	
Chemicals	8,932	9,650	10,356	9,667	9,998	11,080	12,800	14,562	13,332	14,577	15,001	15,070	15,326	14,584	15,395	15,192	15,892	16,194	15,519	15,448	14,187	15,548	15,270	14,588	13,980	14,353	14,008	14,706	13,932	14,110	11,562	
Pulp, paper and print	2,551	2,822	3,334	3,202	3,308	3,811	4,468	4,149	4,425	4,720	4,746	4,575	4,772	4,466	4,219	4,572	3,997	4,085	4,449	4,085	4,449	4,085	4,596	4,507	4,480	4,847	4,743	4,886	4,774	5,167	4,789	4,932
Food processing, beverages and tobacco	3,273	3,283	3,586	3,665	3,694	4,132	4,603	4,179	4,377	4,469	4,530	4,501	4,425	4,278	4,119	4,102	3,704	4,120	4,187	4,142	4,548	4,570	4,562	4,439	4,869	4,869	4,505	4,373	4,354	4,369	4,205	
Non-metallic minerals	7,543	8,430	7,460	7,696	7,665	8,716	9,807	11,420	12,495	13,140	13,795	14,172	13,708	12,286	11,663	12,926	13,837	15,647	17,079	18,312	19,727	20,863	21,007	21,753	21,723	19,791	17,513	16,880	16,490	16,746	16,681	
Manufacturing of transport equipment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Manufacturing of machinery	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mining (excluding fuels)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quarrying and mining	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wood and Wood Products	2,440	2,415	2,678	2,831	3,445	3,352	3,841	3,765	3,929	4,623	5,535	5,495	5,602	5,586	6,002	6,889	7,120	8,210	7,622	5,619	7,585	7,901	7,591	7,611	7,792	7,763	5,904	5,522	5,513	4,819	3,981	
Construction	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Textile and leather	1,620	1,549	1,552	1,645	1,383	1,357	1,481	1,282	1,297	1,187	1,319	1,210	1,284	1,086	1,187	1,181	1,180	1,309	1,174	1,121	1,055	1,076	1,021	1,012	850	714	645	697	669	631	528	
Not specified	4,012	4,092	4,044	4,435	4,844	5,002	5,000	5,557	5,779	6,130	7,017	6,534	6,454	5,818	5,974	6,169	6,164	6,989	7,805	7,913	7,428	7,970	7,493	7,955	8,121	7,126	6,147	5,867	5,638	5,093	3,921	
Transport	82,338	86,104	86,863	90,077	94,429	104,408	112,668	119,486	125,665	123,095	124,241	126,750	129,455	126,958	135,129	135,398	140,082	145,763	151,081	149,650	168,873	184,832	201,702	208,924	213,793	200,086	198,598	199,752	191,379	191,898	181,826	
Domestic aviation	5,151	5,390	5,067	5,351	5,493	6,376	6,807	7,661	8,395	7,825	8,327	8,561	8,201	5,868	6,261	5,889	6,150	6,695	6,621	7,769	9,157	10,434	10,616	10,187	10,281	10,407	9,733	9,733	9,954	8,951	5,148	
Road transportation	72,062	75,747	76,624	79,956	84,065	93,129	100,172	107,604	112,758	110,683	111,702	113,496	115,798	115,917	122,945	123,355	127,626	131,779	136,758	134,572	151,266	166,445	182,871	189,747	194,226	180,873	180,035	181,483	171,072	173,177	167,469	
Railways	1,642	1,630	1,674	1,701	1,274	1,367	1,258	1,021	1,085	1,084	1,251	1,419	2,146	2,118	2,414	2,556	2,830	3,009	3,055	2,959	2,925	3,027	3,003	3,003	2,943	2,800	2,746	2,963	3,234	3,021	2,916	
Domestic Navigation	3,484	3,337	3,498	3,969	3,597	3,537	4,431	3,200	3,427	3,503	3,274	3,315	3,315	3,054	3,508	3,598	3,476	4,280	4,648	4,351	4,414	4,239	4,153	4,158	4,319	4,189	3,825	3,980	4,134	3,747	3,651	
Other transportation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Other sectors	26,728	27,366	28,198	29,835	31,608	33,343	34,059	34,865	34,568	36,206	35,745	37,390	36,817	34,696	34,988	34,398	34,559	36,116	37,848	36,890	37,365	37,350	37,943	38,306	39,137	39,111	38,888	40,263	39,737	40,006	40,668	
Not specified	1,612	739	1,121	734	746	871	926	2,330	1,326	1,070	1,152	1,192	1,137	770	828	1,144	1,089	1,182	1,874	1,175	1,144	914	1,209	1,057	1,234	714	693	894	1,107	1,144	677	
Fugitive emissions from fuels	6,191	6,034	6,234	6,319	6,645	6,583	7,154	7,688	8,443	8,955	9,434	9,773	10,053	9,941	9,396	12,457	11,642	11,954	12,532	16,550	13,307	12,671	13,494	13,947	15,670	15,391	15,840	15,063	14,984	15,229	15,475	
INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)	48,558	52,481	50,583	52,316	52,508	57,189	58,588	62,528	65,742	64,131	69,165	66,984	70,002	71,000	72,379	72,795	72,510	82,971	80,998	72,337	82,049	88,312	89,258	90,387	87,625	88,253	86,285	89,608	90,619	86,118	87,215	
Mineral Industry	15,170	15,980	14,060	14,777	14,595	16,149	18,690	20,292	20,958	21,392	21,702	20,641	19,905	18,771	19,400	20,444	21,715	23,755	25,562	25,045	28,359	29,664	31,780	34,041	33,624	32,297	29,715	28,757	28,910	29,154	32,070	
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	22,176	24,157	25,803	25,533	23,903	21,412	20,306	20,559	20,841	23,843	
Lime production	3,502	3,566	3,749	4,028	3,892	3,897	4,034	4,119	3,993	4,133	4,756	4,568	4,707	4,809	5,228	5,087	5,137	5,381	5,404	4,805	5,651	6,018	6,080	6,159	5,962	6,071	6,071	6,071	6,071	5,924	5,924	
Glass production	145	145	105	126	115	139	141	153	153	174	193	194	223	223	245	250	213	220	222	222	246	284	265	309	292	280	263	271	281	277	235	
Other process uses of carbonates	462	494	435	459	502	586	631	753	697	646	706	651	585	643	655	759	924	960	1,054	987	1,175	1,185	1,277	1,769	1,837	2,044	1,970	2,109	1,999	2,112	2,068	
Chemical Industry	3,875	3,690	3,842	4,361	4,712	4,684	4,703	5,249	5,496	5,885	6,321	5,906	5,867	6,236	6,535	6,844																

Unit: kt	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	2017	2018	2019	2020					
Total CO ₂	1,088,844	920,331	1,027,063	1,068,763	1,057,400	2,146,245	1,472,553	1,777,249	1,438,686	1,399,186	1,461,615	1,413,775	1,615,521	2,647,804	2,848,200	1,851,592	1,509,936	1,200,975	1,325,164	705,454	688,969	764,130	654,557	915,999	794,590	876,747	904,853	797,899	825,521	1,077,889	1,094,677					
ENERGY	177,047	180,564	186,066	191,352	200,125	216,612	233,814	249,332	256,693	266,202	272,800	280,437	278,023	271,139	285,472	293,505	298,663	312,132	331,120	318,495	352,167	366,887	399,308	430,732	456,341	431,970	399,956	406,956	384,137	383,453	364,226					
Petrochemical and carbon black production	3,589	3,439	3,584	4,075	4,425	4,377	4,382	4,906	5,170	5,515	5,988	5,627	5,547	5,900	6,166	6,287	6,626	6,984	6,487	6,760	7,134	7,765	6,924	7,297	7,030	7,092	7,407	7,563	7,307	6,812	6,640					
Fluorochemical production	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
Other Chemicals	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Metal Industry	23,992	32,300	32,298	32,755	32,745	35,886	34,617	36,341	38,688	36,269	40,517	39,869	43,561	45,343	45,781	44,846	43,278	51,307	48,081	39,662	45,418	49,723	49,525	48,076	45,977	47,516	47,903	51,880	53,183	49,265	47,642					
Iron and Steel Production	27,091	30,243	30,043	30,029	30,239	32,904	31,452	33,980	36,072	33,654	37,794	37,259	40,752	41,789	42,119	41,108	39,340	47,055	43,736	35,495	40,930	44,508	44,252	43,079	41,271	43,391	43,806	47,667	49,172	45,242	43,694					
Ferroalloys production	122	125	208	201	188	227	250	180	558	487	550	616	581	954	960	949	959	1,099	1,165	1,036	1,214	1,090	1,063	974	906	814	798	876	892	882	695					
Aluminium 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	1,317	1,337	1,108	1,090	1,143					
Magnesium Production	29	30	36	52	50	52	50	65	51	50	53	48	52	55	62	74	85	93	103	103	112	92	108	119	121	129	140	136	140	144	132					
Lead Production	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Zinc Production	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Other (non-ferrous metals, except aluminum and magnesium)	176	-	-	527	312	738	885	140	-	-	5	67	-	347	232	243	247	319	324	474	636	1,658	1,724	1,749	2,089	1,902	1,843	1,864	1,871	1,907	1,978					
Non-Energy Products from Fuels and Solvent Use	520	512	383	424	457	470	578	646	610	584	624	569	670	649	662	661	588	685	824	661	800	846	777	871	788	751	763	800	801	846	820					
Lubricant Use	428	412	342	377	393	414	437	459	450	468	505	453	567	502	515	525	461	561	698	541	679	744	679	769	665	638	642	670	665	721	707					
Paraffin Wax Use	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Other	92	100	41	47	64	56	141	187	160	115	120	115	103	147	147	135	126	124	126	120	120	102	98	102	123	113	121	130	137	124	113					
Electronics Industry	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Product Uses as Substitutes for Ozone Depleting Substances	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Other Product Manufacture and Use	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
AGRICULTURE	9,141	8,673	7,344	9,371	9,741	5,845	7,444	8,132	7,691	7,295	9,444	8,617	10,623	12,614	12,546	8,097	8,032	10,563	11,427	9,094	11,292	13,992	16,179	15,955	16,863	14,606	15,844	17,594	20,454	20,638	21,599					
Enteric Fermentation	631	655	674	950	988	920	1,012	1,131	1,311	1,320	1,201	1,291	1,342	1,808	1,784	1,878	1,894	2,260	2,106	2,094	2,406	2,835	2,753	3,159	3,408	2,932	3,888	3,693	3,599	3,661	4,417					
Manure management	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Rice cultivation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agricultural soils	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Field burning of agricultural residues	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Liming	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Urea Application	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LAND USE, LAND-USE CHANGE AND FORESTRY (LULUCF)	852,933	677,409	781,818	814,233	793,470	1,865,091	1,171,025	855,406	1,106,491	1,059,365	1,108,080	1,055,515	1,254,553	2,290,325	2,475,108	1,474,209	1,127,836	791,594	898,182	302,308	299,301	290,990	145,895	374,537	229,019	337,834	398,370	279,490	326,175	522,863	616,679					
Forest Land	-46,138	-68,871	-121,928	-143,493	-156,246	-80,960	-134,291	-160,191	-148,211	-180,850	-185,076	-192,802	-191,990	-201,022	-200,377	-271,356	-274,484	-336,567	-330,428	-392,308	-400,391	-348,280	-363,651	-342,142	-356,665	-348,728	-347,557	-359,631	-355,309	-338,176	-329,190					
Cropland	75,950	73,183	76,170	77,225	77,141	109,489	96,577	91,416	95,763	95,633	96,645	89,029	92,674	260,677	272,564	188,921	119,813	102,885	105,268	72,546	69,933	129,871	119,960	159,851	134,384	144,391	134,983	120,529	125,259	138,039	153,465					
Grassland	828,009	681,831	837,102	891,870	886,450	1,845,499	1,220,250	939,177	1,174,299	1,162,818	1,217,144	1,184,180	1,380,217	2,246,847	2,421,196	1,585,136	1,314,869	1,058,826	1,152,829	648,026	599,905	532,104	414,022	575,603	470,761	557,386	627,078	540,536	580,168	742,074	814,172					
Wetlands	6,158	6,056	6,160	6,202	6,202	10,164	9,269	9,076	9,239	9,234	9,272	6,934	7,070	15,171	15,487	11,844	10,308	9,371	9,464	6,949	6,145	7,088	5,957	7,453	6,389	7,284	8,391	7,232	7,643	9,495	10,155					
Settlements	6,711	6,441	6,716	6,827	6,827	9,673	8,375	7,868	8,295	8,283	8,382	7,499	7,858	8,556	8,774	6,905	6,407	5,827	5,951	4,457	4,321	4,287	4,303	4,974	4,380	4,609	5,046	4,166	4,227	4,713	4,908					
Other Land	1,226	1,069	1,230	1,294	1,294	2,327	1,648	1,351	1,601	1,594	1,652	1,532	1,741	6,168	6,580	4,808	4,528	3,889	4,158	2,641	2,431	7,134	5,484	6,862	5,917	7,048	8,627	7,575	8,111	10,521	11,226					
Harvested Wood Products	-13,984	-22,299	-23,633	-25,692	-28,199	-31,100	-30,804	-33,291	-34,496	-37,347	-39,939	-40,856	-43,008	-46,072	-49,115	-52,050	-53,603	-52,637	-49,060	-40,003	-43,044	-41,234	-39,582	-38,063	-36,147	-34,157	-38,198	-40,917	-43,924	-43,804	-48,056					
WASTE	535	549	578	540	568	587	671	719	758	873	926	930	967	919	912	1,108	1,001	1,054	1,332	1,125	1,154	1,114	1,164	1,230	1,335	1,153	507	558	538	557	548					

Memo items	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	201
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Unit: kt	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	2017	2018	2019	2020					
Total CH₄	14,304.4	14,560.1	15,026.3	15,261.0	15,539.6	17,151.2	15,441.5	15,281.8	15,885.4	16,154.7	16,686.6	17,266.3	17,883.4	20,039.4	21,043.6	20,043.4	19,338.4	18,195.0	18,616.6	18,275.1	18,549.6	18,266.8	18,009.4	18,448.2	18,384.2	18,873.6	19,167.8	18,560.2	19,065.4	19,378.9	19,757.9					
ENERGY	543.3	545.7	530.8	493.7	487.4	463.9	452.3	465.5	475.0	484.2	495.7	524.1	551.1	541.0	580.6	604.4	630.8	615.9	622.1	669.9	609.6	561.2	575.9	551.7	567.5	576.9	557.7	568.3	586.4	591.7	600.5					
Fuel combustion	449.9	448.4	442.9	402.2	398.3	375.0	373.6	375.2	375.5	377.9	372.7	381.3	415.8	426.6	443.3	450.1	454.2	444.4	445.9	429.3	426.5	392.9	393.1	367.2	381.9	388.3	372.1	392.1	419.3	416.1	423.6					
Energy industries	24.9	23.9	22.6	22.9	24.0	22.5	21.8	22.8	20.4	20.5	19.9	19.8	21.0	23.7	27.0	27.7	28.4	30.9	35.1	28.5	31.5	28.8	30.8	34.3	35.7	36.4	33.3	37.2	38.9	37.4	37.4					
Manufacturing industries and construction	16.3	15.5	15.8	16.0	18.1	18.5	19.7	19.9	21.4	22.6	20.6	23.1	25.1	28.0	29.4	30.0	33.2	34.9	34.7	34.1	37.7	38.7	38.7	37.9	36.4	35.1	36.9	36.6	31.4	30.8	37.5					
Iron and steel																																				
Non-ferrous metals																																				
Chemicals																																				
Pulp, paper and print																																				
Food processing, beverages and tobacco																																				
Non-metallic minerals																																				
Manufacturing of transport equipment																																				
Manufacturing of machinery																																				
Mining (excluding fuels) and quarrying																																				
Wood and Wood Products																																				
Construction																																				
Textile and leather																																				
Not specified																																				
Transport	67.3	70.8	68.9	68.5	69.8	73.0	76.2	73.9	70.0	63.5	55.7	50.6	48.9	46.4	47.2	45.8	44.0	47.0	47.1	44.9	45.0	43.6	43.5	42.7	41.7	39.2	36.9	37.3	36.8	38.3	35.6	35.6				
Domestic aviation																																				
Road transportation																																				
Railways																																				
Domestic Navigation																																				
Other transportation																																				
Other sectors	341.4	338.2	335.6	294.9	286.4	261.0	255.9	258.6	263.6	271.3	276.6	287.8	320.9	334.5	339.7	346.6	348.6	331.6	329.0	321.9	312.3	281.7	280.2	252.4	268.0	277.6	265.0	284.7	313.9	308.1	313.1	313.1				
Not specified	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Fugitive emissions from fuels	93.4	97.3	87.8	91.5	89.0	88.9	78.7	90.3	97.6	106.3	124.0	142.8	135.3	108.4	137.3	210.2	176.6	171.6	176.2	240.5	183.1	168.4	182.7	184.4	185.6	188.6	185.6	176.2	177.1	175.6	176.9	176.9				
INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)	42.9	37.1	35.3	38.8	40.4	37.7	33.8	35.8	35.9	38.0	41.0	38.7	39.6	44.4	52.0	51.1	52.7	54.4	52.4	36.0	41.9	44.1	41.0	38.9	37.8	38.0	34.5	35.9	36.8	37.0	36.3	36.3				
Mineral industry																																				
Chemical industry																																				
Metal industry																																				
Non-Energy Products from Fuels and Solvent Use																																				
Electronics industry																																				
Product Uses as Substitutes for Ozone Depleting Substances																																				
Other Product Manufacture and Use																																				
Other																																				
AGRICULTURE	11,102.2	11,470.7	11,655.7	11,745.5	11,947.0	12,179.6	11,344.3	11,514.8	11,679.4	11,857.4	12,208.4	12,744.1	12,933.5	13,583.8	14,226.5	14,352.9	14,297.5	13,526.2	13,785.5	14,037.7	14,406.5	14,263.4	14,148.5	14,167.4	14,238.7	14,530.4	14,711.8	14,933.8	14,438.5	14,506.5	14,728.6	14,728.6				
Enteric Fermentation	10,177.9	10,498.8	10,646.4	10,722.7	10,908.9	11,113.0	10,416.8	10,598.6	10,759.9	10,883.9	11,222.3	11,712.6	11,907.7	12,537.1	13,112.5	13,243.7	13,178.1	12,437.9	12,644.7	12,874.7	13,250.1	13,006.3	12,943.6	12,965.0	13,013.6	13,257.5	13,461.9	13,255.5	13,190.4	13,256.4	13,454.3	13,454.3				
Cattle	9,762.9	10,078.0	10,224.8	10,315.6	10,492.8	10,690.1	10,091.4	10,272.3	10,430.9	10,528.5	10,878.6	11,367.3	11,566.5	12,190.5	12,761.8	12,885.7	12,817.9	12,085.4	12,290.7	12,522.3	12,890.5	12,639.8	12,590.4	12,608.6	12,655.0	12,886.2	13,087.3	12,876.7	12,803.2	12,857.9	13,044.7	13,044.7				
Sheep	100.2	100.6	99.8	90.2	92.3	91.7	73.6	72.7	71.3	72.0	73.9	73.2	71.4	72.8	75.3	77.9	80.1	81.2	83.2	84.1	86.9	88.3	83.9	86.5	88.1	92.1	92.0	93.0	94.7	99.9	103.1	103.1				
Swine	33.7	34.3	34.5	34.3	35.1	36.1	29.2	29.6	30.0	30.8	31.6	32.6	31.9	32.3	33.1	34.1	35.2	35.9	36.8	38.0	39.0	39.3	38.8	36.7	37.9	39.8	39.9	41.4	41.2	40.6	41.2	41.2				
Other Animals	281.0	285.9	287.3	282.6	288.7	295.1	222.6	224.0	227.6	232.5	238.2	239.5	237.9	241.5	242.3	246.1	244.9	235.4	234.0	230.3	233.8	238.9	230.4	233.2	234.6	239.4	242.7	244.4	251.2	258.0	265.3	265.3				
Manure management	553.6	572.6	584.2	577.0	594.1	612.9	529.2	538.5	544.6	559.4	581.1	612.7	610.2	639.2	663.6	675.7	687.3	669.6	688.8	706.1	728.6	790.0	792.1	785.2	803.9	832.2	839.9	834.8	836.1	834.0	843.8	843.8				
Cattle	248.2	257.1	263.0	262.2	269.7	277.9	275.8	278.9	281.2	287.1	300.4	315.6	320.1	339.9	361.2	367.8	371.1	353.3	366.4	377.1	391.7	382.3	388.6	400.3	406.3	411.7	416.0	396.6	396.3	399.5	404.8	404.8				
Sheep	3.4	3.4	3.4	3.1	3.1	3.1	2.6	2.6	2.5	2.6	2.6	2.6	2.6	2.6	2.7	2.8	2.9	2.9	3.0	3.0	3.2	3.2	3.0	3.1	3.2</											

Unit: kt	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	2017	2018	2019	2020
Total CH₄ ENERGY	14,304.4	14,560.1	15,026.3	15,261.0	15,539.6	17,151.2	15,441.5	15,281.8	15,885.4	16,154.7	16,886.6	17,266.3	17,883.4	20,059.4	21,043.6	20,043.4	19,338.4	18,950.0	18,616.6	18,275.1	18,549.6	18,266.8	18,009.4	18,448.2	18,384.2	18,873.6	19,167.8	19,065.4	19,376.9	19,175.9	
Indirect N ₂ O Emissions	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Rice cultivation	331.1	360.3	385.6	411.2	403.4	412.1	357.4	336.8	333.0	394.3	388.2	359.4	373.7	361.2	402.6	385.6	380.6	362.2	387.3	409.0	385.5	432.5	384.6	391.8	399.2	427.4	398.5	403.8	402.3	406.3	420.7
Agricultural soils	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Field burning of agricultural residues	39.6	39.0	39.4	34.6	40.5	41.7	40.9	40.8	41.9	39.9	36.8	39.4	41.9	46.3	47.9	48.0	51.5	56.4	54.7	47.8	42.3	34.6	28.2	25.3	22.0	13.3	11.5	9.7	9.6	9.9	9.9
Liming	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Urea Application	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LAND USE, LAND-USE CHANGE AND FORESTRY (LULUCF)	1,520.1	1,343.2	1,580.0	1,668.5	1,673.0	2,996.2	2,062.9	1,660.3	2,030.3	2,023.9	2,111.6	2,050.8	2,352.7	3,778.9	4,043.0	2,752.2	2,040.3	1,888.6	1,815.1	1,106.0	1,042.2	911.9	740.9	1,006.9	843.1	972.4	1,052.1	930.7	991.5	1,221.5	1,336.7
Forest Land	688	58.0	71.6	76.8	77.0	157.4	102.2	78.5	100.0	99.5	104.6	97.3	114.9	78.8	81.2	63.1	65.4	58.5	60.6	34.4	34.3	50.1	44.1	59.4	49.4	55.1	57.5	49.2	51.8	61.5	65.5
Cropland	89.5	88.3	92.8	94.2	94.5	131.4	114.4	108.2	115.2	115.2	116.9	109.3	114.4	289.0	302.6	205.7	121.6	103.2	105.6	72.6	68.9	96.9	88.7	125.4	104.0	111.7	97.2	89.0	92.8	98.2	105.2
Grassland	1,348.4	1,183.8	1,401.7	1,483.3	1,487.3	2,683.3	1,825.8	1,454.2	1,794.6	1,788.4	1,889.2	1,827.7	2,106.0	3,379.8	3,026.7	2,459.9	1,827.7	1,508.9	1,630.3	987.2	928.7	746.5	593.3	802.9	673.5	786.6	874.4	772.9	826.1	1,033.9	1,136.6
Wetlands	70	71	73	73	74	128	11.5	11.3	11.6	11.6	11.7	8.5	8.7	17.7	18.1	13.2	11.1	9.8	10.0	6.6	5.5	7.9	6.4	8.5	7.1	8.3	9.8	8.3	8.9	11.3	12.4
Settlements	50	49	52	53	54	86	7.1	6.6	7.1	7.1	7.3	6.2	6.6	5.9	6.0	4.5	4.3	3.8	3.9	2.4	2.3	2.3	2.2	2.8	2.3	2.5	2.9	2.2	2.3	2.7	2.7
Other Land	1.3	1.2	1.4	1.5	1.5	2.9	1.9	1.6	1.9	1.9	2.0	1.8	2.1	7.8	8.3	5.9	5.3	4.4	4.8	2.8	2.6	8.2	6.1	8.0	6.7	8.3	10.3	9.0	9.7	12.9	14.3
Harvested Wood Products	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WASTE	1,095.8	1,163.4	1,224.4	1,314.5	1,391.8	1,473.7	1,548.3	1,605.4	1,668.6	1,751.1	1,828.8	1,928.7	2,006.5	2,091.4	2,141.5	2,226.7	2,317.0	2,310.0	2,341.5	2,425.5	2,449.3	2,486.1	2,503.2	2,683.3	2,697.2	2,755.9	2,811.8	2,921.5	3,002.2	3,022.2	3,055.8
Solid Waste Disposal	470.9	522.7	584.4	647.2	709.5	770.7	830.6	873.4	921.8	984.0	1,033.0	1,100.3	1,160.3	1,221.5	1,244.5	1,273.5	1,327.3	1,347.7	1,320.5	1,388.4	1,410.5	1,417.0	1,418.2	1,518.2	1,543.0	1,593.8	1,655.7	1,637.4	1,734.5	1,748.7	1,779.4
Biological Treatment of Solid Waste	0.4	0.5	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.9	1.0	1.0	1.0	1.1	1.1	1.1	1.3	1.1	1.0	1.1	1.2	1.2	1.3	1.4	1.3	1.3	1.3	1.4	1.4
Incineration and Open Burning of Waste	19.1	18.3	19.9	20.5	21.1	21.7	22.4	23.0	23.5	24.1	25.3	24.5	24.4	25.1	25.5	28.1	25.3	26.7	31.9	25.9	26.3	26.9	28.9	30.6	30.6	32.5	24.0	25.5	24.1	24.8	24.3
Wastewater Treatment and Discharge	605.4	621.8	619.6	646.2	660.5	680.6	694.5	708.3	722.5	742.2	769.6	803.0	820.9	843.8	890.5	924.0	953.3	947.4	967.8	1,010.2	1,011.5	1,041.1	1,055.0	1,133.3	1,122.3	1,128.3	1,150.9	1,257.2	1,242.2	1,247.4	1,250.6

Memo items

International Bunkers	0.2	0.2	0.2	0.3	0.4	0.4	0.4	0.4	0.5	0.7	0.8	1.0	1.0	0.9	0.9	1.0	1.0	1.0	1.3	1.1	1.2	1.2	1.1	1.0	1.0	1.0	1.1	1.0	0.8	1.0	1.1
International Aviation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
International Water-borne Navigation	0.2	0.2	0.2	0.3	0.4	0.4	0.4	0.4	0.5	0.7	0.8	1.0	1.0	0.9	0.9	1.0	1.0	1.0	1.3	1.1	1.2	1.2	1.1	1.0	1.0	1.0	1.1	1.0	0.8	1.0	1.1
CO₂ Emissions from Biomass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-



Unit:kt	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	2017	2018	2019	2020		
Total N₂O	357.89	361.30	376.03	386.04	396.95	443.57	397.26	395.17	422.16	426.44	444.13	451.89	481.54	560.87	588.25	548.69	534.71	515.91	527.79	510.31	530.33	541.90	595.94	561.73	567.06	570.97	587.91	594.05	589.05	602.74	634.51		
ENERGY	14.05	14.04	13.93	13.82	14.46	14.93	15.80	16.86	17.57	18.11	17.94	18.77	20.13	21.12	22.47	23.15	23.81	25.17	26.94	26.41	28.91	29.38	30.94	32.37	33.77	33.68	33.05	33.80	33.40	33.98	33.62		
Fuel combustion	13.99	13.98	13.87	13.77	14.40	14.87	15.73	16.78	17.48	18.01	17.83	18.66	20.01	21.00	22.36	22.94	23.66	25.02	26.77	26.12	28.71	29.20	30.77	32.20	33.55	33.45	32.83	33.58	33.19	33.77	33.40		
Energy industries	3.42	3.29	3.11	3.15	3.31	3.12	3.04	3.18	2.87	2.90	2.84	2.86	3.01	3.37	3.84	3.94	4.05	4.36	4.97	4.01	4.51	4.10	4.47	5.12	5.39	5.47	4.92	5.00	5.41	5.65	5.42		
Manufacturing industries and construction	2.66	2.65	2.69	2.76	3.05	3.08	3.15	3.28	3.57	3.78	3.48	3.80	4.03	4.40	4.56	4.71	5.17	5.49	5.93	5.65	6.26	6.30	6.34	6.32	6.19	6.03	6.31	6.31	5.65	5.58	6.48		
Iron and steel	0.03	0.03	0.04	0.04	0.04	0.03	0.03	0.03	0.02	0.03	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.05	0.06	0.06	0.06	0.08	0.07	0.06	0.07	0.07	0.07	0.07		
Non-ferrous metals	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.05	0.05	0.05	0.06	0.05	0.05	0.05	0.04	0.04	0.05		
Chemicals	0.12	0.12	0.11	0.12	0.12	0.12	0.11	0.12	0.12	0.13	0.14	0.14	0.15	0.16	0.18	0.18	0.19	0.20	0.19	0.19	0.18	0.19	0.19	0.18	0.17	0.18	0.17	0.18	0.18	0.17	0.15		
Pulp, paper and print	0.43	0.43	0.48	0.51	0.54	0.54	0.51	0.51	0.60	0.63	0.66	0.67	0.69	0.75	0.79	0.84	0.90	0.95	1.02	1.05	1.13	1.13	1.11	1.18	1.22	1.30	1.37	1.41	1.48	1.43	1.45		
Food processing, beverages and tobacco	1.38	1.40	1.48	1.48	1.72	1.75	1.80	1.92	2.13	2.27	1.91	2.25	2.46	2.72	2.78	2.84	3.22	3.41	3.30	3.47	3.89	3.84	3.91	3.78	3.60	3.46	3.78	3.75	3.03	3.03	3.94		
Non-metallic minerals	0.41	0.40	0.35	0.37	0.38	0.38	0.43	0.43	0.42	0.43	0.44	0.42	0.39	0.40	0.42	0.44	0.46	0.49	0.55	0.52	0.56	0.62	0.64	0.67	0.68	0.60	0.53	0.53	0.52	0.52	0.54		
Manufacturing of transport equipment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Manufacturing of machinery	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Mining (excluding fuels) and quarrying	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.05	0.05	0.05	0.05	0.06	0.07	0.07	0.08	0.07	0.05	0.07	0.07	0.07	0.07	0.07	0.07	0.05	0.05	0.05	0.04	0.04		
Wood and Wood Products	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Construction	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Textile and Leather	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	
Not specified	0.19	0.19	0.15	0.16	0.17	0.17	0.17	0.18	0.18	0.18	0.19	0.18	0.17	0.20	0.22	0.21	0.22	0.23	0.25	0.25	0.27	0.28	0.27	0.28	0.28	0.27	0.25	0.24	0.25	0.24	0.22	0.22	
Transport	3.67	3.80	3.82	3.94	4.17	5.00	5.87	6.57	7.28	7.46	7.61	7.99	8.59	8.69	9.33	9.61	9.70	10.52	11.55	11.87	13.37	14.54	15.69	16.72	17.73	17.57	17.38	17.71	17.29	17.73	16.59		
Domestic aviation	0.14	0.15	0.14	0.15	0.15	0.15	0.19	0.21	0.23	0.22	0.23	0.24	0.23	0.16	0.17	0.16	0.17	0.18	0.18	0.21	0.25	0.28	0.29	0.28	0.28	0.28	0.28	0.26	0.26	0.27	0.24	0.14	
Road transportation	2.81	2.94	2.95	3.03	3.44	4.20	5.08	5.89	6.54	6.74	6.82	7.07	7.44	7.63	8.14	8.37	8.35	9.06	10.04	10.36	11.82	12.95	14.07	15.12	16.13	16.01	15.88	16.11	15.53	16.09	15.10		
Railways	0.63	0.63	0.65	0.66	0.49	0.53	0.49	0.39	0.42	0.42	0.42	0.48	0.55	0.83	0.82	0.93	0.99	1.09	1.17	1.21	1.18	1.20	1.23	1.22	1.20	1.16	1.13	1.23	1.37	1.29	1.26		
Domestic navigation	0.09	0.09	0.09	0.10	0.09	0.09	0.12	0.08	0.09	0.09	0.08	0.09	0.09	0.08	0.09	0.09	0.09	0.11	0.12	0.11	0.12	0.11	0.11	0.11	0.11	0.11	0.10	0.11	0.10	0.10	0.10		
Other transportation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Other sectors	4.22	4.22	4.22	3.89	3.84	3.66	3.65	3.71	3.73	3.84	3.86	4.04	4.37	4.52	4.60	4.66	4.70	4.60	4.69	4.57	4.54	4.23	4.24	4.01	4.23	4.36	4.20	4.53	4.81	4.79	4.88		
Not specified	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02	
Fugitive emissions from fuels	0.06	0.06	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	0.20	0.19	0.17	0.17	0.23	0.23	0.23	0.21	0.21	0.22	0.22	0.22	
INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)	11.55	14.23	13.26	16.93	17.11	18.21	14.31	12.84	19.71	19.71	20.73	16.98	21.06	19.47	26.97	23.79	25.70	3.90	3.63	1.65	1.51	1.53	1.34	1.32	1.53	1.36	1.27	1.54	1.43	1.16	1.15		
Mineral industry	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Chemical industry	10.81	13.60	12.67	16.30	16.46	17.60	13.78	12.29	19.20	19.14	20.11	16.40	20.46	18.78	26.14	22.98	24.91	3.09	2.84	1.18	0.93	0.93	0.77	0.80	1.02	0.85	0.85	1.09	0.96	0.66	0.66		
Metal industry	0.74	0.62	0.58	0.64	0.66	0.60	0.53	0.55	0.50	0.58	0.62	0.58	0.61	0.69	0.83	0.81	0.79	0.81	0.79	0.46	0.57	0.60	0.57	0.52	0.51	0.51	0.43	0.45	0.48	0.50	0.49		
Non-Energy Products from Fuels and Solvent Use	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Electronics Industry	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Product Uses as Substitutes for Ozone Depleting Substances	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other Product Manufacture and Use	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AGRICULTURE	279.66	285.56	294.19	297.69	307.34	312.69	297.20	307.41	315.60	319.36	333.27	345.68	360.81	396.21	406.50	409.06	413.72	426.39	432.14	438.81	458.41	473.30	471.06	486.48	495.36	495.49	511.26	519.72	513.45	520.02	548.41		
Enteric Fermentation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manure management	8.68	9.14	9.42	9.42	9.77	10.13	8.79	9.06	9.13	9.50	10.12	10.21	10.21	10.51	11.11	11.44	11.77	12.36	12.85	13.60	13.92	15.44	15.50	15.76	16.12	16.13	15.85	15.39	15.38	15.25	15.42	15.42	
Cattle	3.12	3.25	3.33	3.31	3.43	3.58	2.96	3.12	3.12	3.19	3.39	3.38	3.41	3.49	3.74	3.75	3.83	3.98	4.07	4.36	4.43	4											

Unit:kt	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	2017	2018	2019	2020		
Total	35789	36130	37603	38604	39695	44357	39726	39517	42216	42644	44413	45189	48154	56087	58825	54869	53471	51591	52729	51031	53033	54190	53594	56173	56706	57097	58791	59405	58905	60274	63451		
ENERGY	1405	1404	1399	1382	1446	1499	1580	1686	1757	1811	1794	1877	2013	2112	2247	2315	2381	2517	2694	2641	2891	2938	3094	3237	3377	3368	3305	3380	3340	3396	3362		
Field burning of agricultural residues	279	276	284	255	302	313	307	306	314	299	276	295	314	347	359	360	387	423	410	359	317	260	212	190	165	100	086	073	072	074	074		
Liming	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Urea Application	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LAND USE, LAND-USE CHANGE AND FORESTRY (LULUCF)	4743	4221	4929	5193	5207	9147	6363	5163	6269	6250	6512	6329	7230	11666	12459	8469	6344	5251	5633	3458	3268	2878	2362	3225	2698	3095	3289	2919	3101	3775	4142		
Forest Land	205	173	214	229	230	468	304	234	298	297	312	290	342	254	262	202	206	184	190	109	109	156	138	187	155	172	177	152	159	187	200		
Cropland	320	318	332	336	337	454	403	385	406	407	412	386	401	929	971	658	403	341	349	240	230	341	312	442	367	393	341	313	326	347	374		
Grassland	4176	3688	4340	4584	4596	8149	5591	4483	5500	5483	5724	5601	6431	10382	11123	7535	5670	4669	5035	3071	2896	2324	1866	2535	2126	2470	2701	2395	2552	3158	3478		
Wetlands	022	022	022	022	023	039	035	034	035	035	035	026	027	057	058	042	036	031	032	021	018	025	020	027	022	026	030	026	027	035	038		
Settlements	017	016	017	018	018	028	023	021	023	023	024	021	022	019	020	014	014	012	012	008	007	007	007	009	008	008	008	009	007	007	009	009	
Other Land	004	004	004	004	004	009	006	005	006	006	006	005	006	023	025	018	016	014	015	009	008	025	018	024	020	020	025	031	027	029	039	043	
Harvested Wood Products	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
WASTE	520	526	535	566	597	628	633	643	659	676	708	716	724	742	773	799	805	793	825	866	882	891	899	931	941	949	942	980	975	984	991		
Solid Waste Disposal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Biological Treatment of Solid Waste	002	003	003	004	004	004	004	004	005	005	005	005	006	006	006	007	006	007	008	006	006	006	007	007	008	008	008	008	008	008	008	009	
Incineration and Open Burning of Waste	030	028	030	031	031	032	034	035	035	037	040	039	039	039	040	045	041	043	051	043	043	044	046	049	050	049	036	038	036	037	037		
Wastewater Treatment and Discharge	487	495	502	532	562	592	595	604	619	634	663	672	679	697	726	747	757	744	765	837	833	840	845	875	884	891	899	934	931	938	945		
Memo Items																																	
International Bunkers	009	011	011	013	015	017	018	019	022	029	030	032	036	036	036	041	039	042	052	045	049	053	050	048	050	047	046	044	049	040			
International Aviation	004	004	004	004	005	006	007	007	008	007	006	005	006	010	010	012	012	013	014	014	016	018	019	020	021	021	019	018	020	021	009		
International Water-borne Navigation	005	006	007	009	010	011	011	012	014	021	024	027	030	026	026	028	028	030	037	031	033	035	032	028	029	033	028	028	024	028	031		
CO₂ Emissions from Biomass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	



Unit/kt	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	2017	2018	2019	2020
Total CO₂	35,998.9	35,077.3	36,400.2	37,482.1	37,993.2	38,129.4	43,673.4	37,198.6	42,888.9	42,008.1	42,730.6	41,412.1	46,321.3	60,059.0	73,615.1	53,448.4	42,609.7	37,609.7	39,582.0	27,329.3	26,425.4	23,836.5	20,820.5	24,770.1	22,025.0	23,484.8	24,222.4	22,443.5	23,611.0	27,187.2	28,990.9
ENERGY	9,001.3	9,163.7	8,879.1	8,745.4	8,833.2	8,692.3	8,702.3	8,403.9	7,983.7	7,602.7	7,051.8	6,656.0	6,706.6	6,848.7	7,084.2	7,057.5	7,005.3	7,256.9	7,362.2	6,818.8	7,028.7	6,768.7	6,719.6	6,645.5	6,765.6	6,658.8	6,424.0	6,581.5	6,855.1	6,889.7	6,842.5
Fuel combustion	9,001.3	9,163.7	8,879.1	8,745.4	8,833.2	8,692.3	8,702.3	8,403.9	7,983.7	7,602.7	7,051.8	6,656.0	6,706.6	6,848.7	7,084.2	7,057.5	7,005.3	7,256.9	7,362.2	6,818.8	7,028.7	6,768.7	6,719.6	6,645.5	6,765.6	6,658.8	6,424.0	6,581.5	6,855.1	6,889.7	6,842.5
Energy industries	1,372.1	1,275.1	1,200.9	1,234.0	1,275.9	1,190.3	1,123.6	1,142.5	1,090.9	1,057.6	1,071.0	1,036.2	1,094.1	1,241.1	1,434.0	1,453.5	1,466.1	1,570.0	1,704.7	1,328.7	1,459.1	1,406.3	1,460.6	1,555.4	1,602.0	1,627.3	1,514.6	1,526.8	1,691.0	1,753.8	1,707.3
Manufacturing industries and construction	787.6	781.0	750.0	806.6	854.8	835.9	887.6	884.9	953.4	1,042.7	1,074.4	1,085.1	1,119.0	1,275.1	1,304.2	1,372.1	1,457.8	1,555.2	1,646.8	1,695.6	1,905.9	1,960.5	1,908.2	1,984.3	2,057.2	2,065.4	2,085.6	2,124.6	2,162.4	2,096.5	2,205.0
Transport	5,306.8	5,582.6	5,412.9	5,359.4	5,391.8	5,471.1	5,521.1	5,188.2	4,794.4	4,264.1	3,642.1	3,216.4	3,032.2	2,808.8	2,799.5	2,654.4	2,497.3	2,616.2	2,499.5	2,309.1	2,227.5	2,101.7	2,054.9	1,939.7	1,860.9	1,679.1	1,596.5	1,621.9	1,564.3	1,625.7	1,492.8
Other sectors	1,534.1	1,524.4	1,514.5	1,344.9	1,310.2	1,194.3	1,169.3	1,183.5	1,202.5	1,237.6	1,263.5	1,317.3	1,460.4	1,523.1	1,546.0	1,576.7	1,583.4	1,514.8	1,510.3	1,484.8	1,435.7	1,299.6	1,295.3	1,165.5	1,244.9	1,286.7	1,307.7	1,436.8	1,413.2	1,437.1	
Not specified	0.7	0.5	0.9	0.5	0.5	0.6	0.7	4.7	2.5	0.8	0.8	0.9	0.8	0.6	0.6	0.6	0.7	0.7	1.0	0.6	0.6	0.5	0.7	0.6	0.7	0.4	0.4	0.5	0.6	0.6	0.4
Fugitive emissions from fuels	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)	1,095.4	1,085.5	1,076.6	1,131.2	1,160.0	1,106.4	1,028.4	1,048.2	1,011.5	1,101.1	1,154.9	1,062.8	1,167.2	1,254.0	1,433.1	1,430.3	1,448.6	1,485.8	1,473.3	1,092.9	1,200.2	1,211.4	1,165.5	1,077.8	955.2	886.6	800.5	828.7	787.4	807.5	835.4
Mineral industry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chemical industry	0.5	0.7	0.6	0.8	0.8	0.9	0.7	0.6	1.0	1.0	1.0	0.8	1.1	1.0	1.4	1.2	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.0	0.8	0.7	0.7	1.0	0.9	0.8
Metal industry	1,075.8	1,062.3	1,050.8	1,103.9	1,130.5	1,076.4	997.1	1,016.1	977.3	1,064.0	1,116.7	1,024.9	1,126.0	1,207.0	1,382.9	1,376.5	1,390.2	1,423.0	1,406.8	1,022.7	1,125.5	1,138.0	1,092.6	998.8	869.1	792.6	702.1	726.0	676.4	704.0	725.3
Non-Energy/Products from Fuels and Solvent Use	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electronics industry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Product Uses as Substitutes for Ozone Depleting Substances	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Product Manufacture and Use	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other	20.1	22.5	25.3	26.5	28.7	29.1	30.6	31.5	33.3	36.1	37.2	37.1	40.2	46.0	48.9	52.6	57.1	61.3	65.1	68.8	73.4	72.0	71.9	78.0	85.3	90.3	97.7	101.7	110.0	102.5	109.2
AGRICULTURE	1,631.7	1,659.0	1,687.8	1,489.0	1,752.6	1,805.6	1,773.9	1,767.2	1,816.4	1,727.6	1,596.2	1,705.5	1,815.7	2,065.5	2,075.0	2,078.4	2,232.6	2,444.9	2,368.6	2,072.9	1,832.1	1,499.8	1,221.9	1,058.8	952.3	577.3	498.3	419.5	417.0	427.1	427.7
Enteric Fermentation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Manure management	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rice cultivation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agricultural soils	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Field burning of agricultural residues	1,631.7	1,659.0	1,687.8	1,489.0	1,752.6	1,805.6	1,773.9	1,767.2	1,816.4	1,727.6	1,596.2	1,705.5	1,815.7	2,065.5	2,075.0	2,078.4	2,232.6	2,444.9	2,368.6	2,072.9	1,832.1	1,499.8	1,221.9	1,058.8	952.3	577.3	498.3	419.5	417.0	427.1	427.7
Liming	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Urea Application	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LAND USE, LAND-USE CHANGE AND FORESTRY (LULUCF)	23,819.4	21,109.1	24,756.6	26,116.5	26,187.4	46,525.2	32,168.8	25,979.3	31,675.3	31,576.6	32,927.7	31,987.9	36,651.7	58,949.8	65,022.7	42,877.2	31,923.1	26,422.2	28,377.9	17,344.7	16,364.4	14,356.7	11,713.5	15,951.1	13,351.8	15,365.0	16,899.6	14,613.8	15,551.4	19,063.0	20,885.2
Forest Land	1,058.9	892.0	1,101.5	1,181.2	1,184.4	2,418.3	1,570.8	1,208.1	1,537.1	1,530.7	1,608.7	1,495.6	1,765.7	1,252.8	1,290.2	999.0	1,028.9	919.5	952.0	541.9	541.3	783.2	692.1	948.8	777.2	864.6	895.5	767.1	807.0	954.0	1,017.5
Cropland	1,487.7	1,472.5	1,543.0	1,564.0	1,568.3	2,150.6	1,888.8	1,795.4	1,902.8	1,904.0	1,929.7	1,807.6	1,886.0	4,586.4	4,797.2	3,256.1	1,954.0	1,657.3	1,644.5	1,166.7	1,110.2	1,599.1	1,463.6	2,071.2	1,718.1	1,843.6	1,601.1	1,488.2	1,530.6	1,632.7	1,744.9
Grassland	21,061.7	18,538.1	21,893.1	23,148.3	23,211.1	41,577.5	28,388.1	22,672.3	27,912.1	27,818.6	29,061.2	28,425.2	32,706.1	52,616.3	56,422.7	38,251.4	28,614.9	23,561.5	25,437.6	15,449.5	14,549.0	11,686.8	9,326.7	12,643.5	10,603.5	12,358.5	13,644.7	12,075.4	12,889.8	16,058.6	17,666.5
Wetlands	109.4	110.2	113.4	114.2	114.5	197.3	177.7	174.5	179.9	180.2	181.5	131.8	135.0	281.0	287.8	208.8	175.7	155.5	157.8	104.3	87.8	124.3	101.0	138.2	111.4	130.2	152.3	129.3	138.1	176.0	192.1
Settlements	81.0	78.3	84.1	86.0	86.2	137.4	113.5	105.0	113.9	113.9	116.0	99.5	106.3	93.6	96.4	70.7	67.6	59.3	61.2	38.3	36.2	36.0	35.7	44.7	37.1	40.4	46.7	35.3	36.2	43.0	43.6
Other Land	20.7	18.1	21.5	22.9	22.9	44.0	29.9	23.9	29.4	29.3	30.6	28.2	32.7	119.7	128.6	91.2	81.9	69.1	74.7	44.0	39.9	127.4	94.4	123.5	104.4	127.7	159.3	138.5	149.7	198.6	220.7
Harvested Wood Products	0.0	0.0	0.0	0.0																											

Unit/kt	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	2017	2018	2019	2020
Total NO_x	1,954.2	1,965.6	2,063.6	2,128.7	2,192.3	2,598.2	2,470.8	2,488.9	2,566.1	2,622.8	2,615.8	2,628.9	2,693.9	3,068.1	3,233.3	2,889.5	2,725.8	2,734.4	2,885.5	2,883.3	2,678.6	2,634.4	2,642.0	2,811.3	2,837.8	2,718.0	2,547.1	2,538.7	2,548.8	2,595.6	2,571.5
ENERGY	1,444.7	1,500.6	1,538.8	1,587.4	1,638.4	1,720.7	1,824.9	1,890.9	1,925.6	1,984.5	1,959.3	1,984.7	1,969.8	1,941.0	2,032.9	2,037.5	2,042.3	2,137.7	2,259.0	2,163.2	2,279.1	2,279.6	2,341.7	2,434.1	2,514.1	2,372.8	2,195.6	2,220.2	2,212.7	2,207.4	2,147.5
Fuel combustion	1,444.7	1,500.6	1,538.8	1,587.4	1,638.4	1,720.7	1,824.9	1,890.9	1,925.6	1,984.5	1,959.3	1,984.7	1,969.8	1,941.0	2,032.9	2,037.5	2,042.3	2,137.7	2,259.0	2,163.2	2,279.1	2,279.6	2,341.7	2,434.1	2,514.1	2,372.8	2,195.6	2,220.2	2,212.7	2,207.4	2,147.5
Energy Industries	221.3	231.2	248.6	251.5	258.4	267.8	289.9	331.8	339.0	384.3	390.9	409.8	372.4	403.8	444.4	471.0	480.8	489.1	566.8	538.6	554.2	549.6	599.9	699.9	809.8	763.3	646.3	645.1	629.0	604.4	561.3
Manufacturing industries and construction	140.2	145.1	149.6	155.3	170.3	181.3	194.4	207.6	215.3	233.2	238.3	239.6	246.1	249.5	255.2	264.9	277.6	303.0	303.1	298.0	326.6	341.9	343.3	344.8	348.2	338.5	332.7	340.8	312.1	316.8	319.1
Transport	926.4	964.3	975.4	1,006.4	1,025.1	1,078.4	1,142.8	1,193.0	1,171.8	1,159.9	1,130.3	1,120.7	1,136.3	1,073.7	1,119.8	1,089.3	1,069.6	1,119.5	1,141.0	1,086.1	1,153.1	1,149.1	1,151.5	1,143.3	1,096.9	1,007.6	959.9	957.9	993.9	1,003.0	977.6
Other sectors	154.9	159.4	162.0	173.6	183.9	192.5	197.0	204.1	198.1	206.1	198.7	213.5	214.0	213.4	212.7	211.2	213.4	225.0	246.3	239.4	244.2	238.2	245.9	245.2	257.1	262.8	256.1	275.7	276.8	282.2	288.8
Not specified	0.0	0.0	3.1	0.7	0.7	0.8	0.9	8.3	1.4	1.0	1.1	1.1	1.0	0.7	0.8	1.0	1.0	1.1	1.7	1.1	1.0	0.8	1.1	0.9	1.1	0.6	0.6	0.8	1.0	1.0	0.6
Fugitive emissions from fuels	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)	26.5	24.8	24.6	26.4	27.8	26.6	25.0	25.8	25.2	27.8	29.3	28.1	30.0	33.5	38.2	38.9	39.6	41.5	42.1	34.6	38.5	38.4	37.6	37.6	38.5	39.5	39.5	41.1	43.7	42.1	43.9
Mineral industry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chemical industry	0.9	0.9	0.9	1.0	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.4	1.5	1.3	1.4	1.5	1.5	1.5	1.5	1.5	1.5	1.4	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.2
Metal industry	20.3	17.8	16.9	18.3	18.8	17.5	15.5	16.1	15.0	16.9	18.1	16.8	17.7	19.9	23.7	23.3	22.9	23.5	23.2	14.7	17.4	17.7	17.1	15.5	14.5	14.2	12.1	12.7	13.0	13.5	13.5
Non-Energy Products from Fuels and Solvent Use	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electronics industry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Product Uses as Substitutes for Ozone Depleting Substances	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Product Manufacture and Use	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other	5.4	6.0	6.8	7.1	7.7	7.8	8.2	8.4	8.9	9.7	10.0	9.9	10.8	12.3	13.1	14.1	15.3	16.4	17.4	18.4	19.6	19.3	19.2	20.9	22.8	24.2	26.2	27.2	29.5	27.5	29.3
AGRICULTURE	61.1	60.4	61.8	54.9	64.9	67.0	65.8	65.6	67.4	64.1	59.2	63.3	67.4	74.4	77.0	77.1	82.8	90.7	87.9	76.9	68.0	55.6	45.3	40.7	35.3	21.4	18.5	15.6	15.5	15.8	15.9
Enteric Fermentation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Manure management	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rice cultivation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agricultural soils	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Field burning of agricultural residues	61.1	60.4	61.8	54.9	64.9	67.0	65.8	65.6	67.4	64.1	59.2	63.3	67.4	74.4	77.0	77.1	82.8	90.7	87.9	76.9	68.0	55.6	45.3	40.7	35.3	21.4	18.5	15.6	15.5	15.8	15.9
Liming	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Urea Application	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LAND USE, LAND-USE CHANGE AND FORESTRY (LULUCF)	421.9	379.8	438.4	460.0	461.3	783.9	555.0	465.7	547.9	546.4	568.0	552.7	626.8	1,019.2	1,085.2	736.0	561.0	464.6	496.6	308.6	293.0	260.7	217.4	299.0	249.9	284.3	293.6	261.8	276.9	330.3	364.2
Forest Land	16.9	14.2	17.5	18.8	18.8	38.3	25.0	19.3	24.4	24.3	25.6	23.8	28.0	239	246	18.7	18.6	16.6	17.1	9.9	9.9	13.7	12.4	16.9	14.0	15.4	13.2	13.8	16.0	17.1	
Cropland	34.4	34.5	35.7	36.0	36.1	46.8	42.6	41.3	43.0	43.1	43.5	41.0	42.2	86.7	90.2	60.9	39.2	33.2	33.8	23.4	22.6	36.0	32.9	46.8	38.8	41.6	35.8	33.0	34.3	36.4	40.0
Grassland	366.8	373.3	381.2	401.2	402.2	692.1	481.8	390.8	474.7	473.3	493.2	483.2	551.5	899.5	961.0	649.7	497.2	409.6	440.3	271.8	257.4	206.0	168.0	290.0	192.6	221.1	236.3	210.5	223.2	270.9	299.4
Wetlands	1.9	1.9	1.9	1.9	1.9	3.2	2.9	2.9	3.0	3.0	3.0	2.2	2.3	5.3	5.4	3.9	3.3	2.9	3.0	2.0	1.7	2.2	1.8	2.4	2.0	2.3	2.6	2.2	2.4	3.0	3.2
Settlements	1.6	1.6	1.7	1.7	1.7	2.7	2.2	2.0	2.2	2.3	2.0	2.2	1.8	1.9	1.3	1.3	1.3	1.1	1.1	0.7	0.7	0.7	0.7	0.9	0.7	0.8	0.9	0.7	0.8	0.9	
Other Land	0.3	0.3	0.3	0.4	0.4	0.7	0.5	0.4	0.5	0.5	0.5	0.5	0.5	2.0	2.1	1.5	1.4	1.2	1.3	0.7	0.7	2.1	1.6	2.0	1.7	2.1	2.6	2.3	2.4	3.2	3.6
Harvested Wood Products	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WASTE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Memo items	2019	2020
International Bunkers	0.8	0.9
International Aviation	0.4	0.4
International Water-borne Navigation	0.4	0.4
CO₂ Emissions from Biomass	0.0	0.0



NMVOG

Unit: kt	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	2017	2018	2019	2020
Total NMVOC	3,478.8	3,256.9	3,277.8	3,360.9	3,588.1	3,635.4	3,653.9	3,595.2	3,747.5	3,648.9	3,729.7	3,670.6	3,534.8	3,455.3	3,833.5	3,761.2	4,427.3	2,997.9	4,381.3	4,016.7	4,022.9	3,884.7	3,942.1	3,974.7	3,997.2	3,301.7	3,253.8	3,345.9	3,524.4	3,454.8	3,911.5
ENERGY	1,695.9	1,703.7	1,639.9	1,616.0	1,620.1	1,595.6	1,567.1	1,489.9	1,396.2	1,319.5	1,221.9	1,134.5	1,131.6	1,141.0	1,187.4	1,164.2	1,133.3	1,164.0	1,153.7	998.4	1,008.4	977.2	959.6	910.9	906.2	870.3	812.1	840.9	869.0	885.9	865.9
Fuel combustion	1,695.9	1,703.7	1,639.9	1,616.0	1,620.1	1,595.6	1,567.1	1,489.9	1,396.2	1,319.5	1,221.9	1,134.5	1,131.6	1,141.0	1,187.4	1,164.2	1,133.3	1,164.0	1,153.7	998.4	1,008.4	977.2	959.6	910.9	906.2	870.3	812.1	840.9	869.0	885.9	865.9
Energy Industries	337.6	299.7	276.1	289.1	294.0	271.8	244.0	238.1	216.8	232.5	249.4	233.9	244.8	287.1	330.4	328.4	322.5	332.2	337.0	227.5	250.8	262.3	255.0	243.9	243.9	238.9	212.4	218.4	238.9	245.5	245.1
Manufacturing industries and construction	31.6	31.2	30.0	30.3	32.0	31.9	31.5	31.3	34.6	40.1	43.2	45.0	44.4	46.5	47.6	50.3	53.9	58.6	61.5	60.5	68.4	70.9	69.8	71.4	69.4	67.0	64.6	64.9	63.1	63.5	65.6
Transport	1,069.0	1,116.8	1,080.8	1,069.1	1,071.5	1,085.8	1,089.2	1,015.3	988.0	834.9	714.6	632.0	596.1	550.1	547.5	518.7	488.4	513.5	493.5	454.0	498.8	414.7	406.2	384.6	369.0	333.0	314.7	319.6	310.5	322.7	297.0
Other sectors	257.7	255.8	252.8	227.5	222.7	206.1	202.4	204.8	206.7	212.0	214.7	223.5	246.2	257.2	261.8	266.7	268.4	259.8	261.8	256.3	250.4	229.2	228.6	211.1	223.8	231.4	220.3	238.0	256.5	254.2	258.2
Not specified	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fugitive emissions from fuels	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
INDUSTRIAL PROCESSES AND PRODUCT USE (IPU)	1,782.9	1,553.2	1,637.9	1,744.9	1,967.9	2,039.8	2,086.8	2,105.3	2,351.4	2,329.4	2,507.8	2,586.1	2,408.2	2,314.3	2,646.1	2,597.0	3,294.0	1,833.9	3,227.6	3,018.3	3,014.5	2,907.5	2,882.4	3,063.8	3,091.0	2,431.4	2,441.7	2,505.0	2,653.4	2,568.9	3,045.6
Mineral industry	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chemical industry	26.3	21.3	24.6	28.7	30.5	31.3	30.4	32.7	33.8	36.4	43.0	40.8	42.4	45.5	49.4	49.2	52.5	53.2	48.9	56.2	55.5	57.8	56.2	57.6	57.5	57.2	59.9	65.1	64.3	60.5	60.7
Metal industry	18.3	15.4	14.4	15.7	16.3	14.9	12.9	13.6	12.4	14.2	15.3	14.4	14.9	17.0	20.5	20.1	19.4	20.0	19.6	11.4	14.1	14.6	14.0	12.6	12.4	12.5	10.4	11.0	11.6	12.1	12.0
Non-Energy Products from Fuels and Solvent Use	1,441.5	1,220.0	1,294.1	1,378.5	1,600.7	1,616.6	1,653.8	1,652.3	1,882.1	1,826.1	1,978.8	2,036.8	1,864.0	1,727.4	2,020.3	1,984.9	2,552.8	1,144.0	2,513.6	2,300.0	2,274.4	2,069.9	2,202.3	2,281.7	2,328.2	1,679.3	1,670.2	1,678.4	1,831.8	1,857.7	2,320.2
Electronics industry	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Product Uses as Substitutes for Ozone Depleting Substances	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other Product Manufacture and Use	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other	296.8	296.5	304.8	321.9	320.5	376.9	389.7	406.8	413.1	452.7	470.6	444.1	481.9	524.3	555.8	542.8	669.4	616.7	645.5	650.8	670.5	765.1	709.9	711.8	692.9	682.4	750.6	745.7	638.6	652.7	
AGRICULTURE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LAND USE, LAND-USE CHANGE AND FORESTRY (LULUCF)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WASTE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Memo items	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	2017	2018	2019	2020
International Bunkers	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.3	0.4	0.2	0.1	
International Aviation	0.0	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-	-
International Water-borne Navigation	0.0	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	
CO₂ Emissions from Biomass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

F - GASES

Unit: kt

	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	2017	2018	2019	2020					
HCF-23																																				
HFC-22 Production	0.1202	0.1375	0.1636	0.1723	0.1566	0.1530	0.0890	0.0953	0.0130	0.0972	-	-	-	-	-	-	-	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0002	0.0002	0.0002					
HFC-32																																				
Use of HFCs, PFCs and SF ₆																						0.0031	0.0093	0.0192	0.0340	0.0540	0.0730	0.0958	0.1126	0.1397	0.1747					
HCF-125																																				
Use of HFCs, PFCs and SF ₆																							0.0088	0.0166	0.0278	0.0443	0.0653	0.0848	0.1070	0.1265	0.1541	0.1900				
HCF-134a																																				
Use of HFCs, PFCs and SF ₆																							2.1809	2.5866	3.3207	3.6879	3.9407	4.1226	4.4874	4.7754	5.0975	5.3760				
HCF-143a																																				
Use of HFCs, PFCs and SF ₆																							0.0041	0.0047	0.0052	0.0068	0.0086	0.0102	0.0121	0.0134	0.0140	0.0157	0.0164	0.0171	0.0181	
HCF-152a																																				
Use of HFCs, PFCs and SF ₆																																				
HFC-227ea																																				
Use of HFCs, PFCs and SF ₆																																				
HFC-365mit																																				
Use of HFCs, PFCs and SF ₆																																				
CF ₄																																				
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	0.1226	0.0875	0.0822	0.0682	0.0704	0.0915	0.0444	0.0354	0.0881	0.0390	0.0352	0.0335	0.0335	0.0335	0.0335	0.0335		
C ₂ F ₆																																				
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	0.0102	0.0069	0.0064	0.0054	0.0055	0.0048	0.0035	0.0027	0.0028	0.0029	0.0025	0.0024	0.0025	0.0025	0.0025	0.0025		
SF ₆																																				
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	0.0054	0.0052	0.0052	0.0053	0.0053	0.0053	0.0054	0.0054	0.0062	0.0063	0.0065	0.0067	0.0069	0.0073	0.0077	0.0080	0.0082	0.0083	0.0083	0.0105	0.0097	0.0101	0.0105	0.0108	0.0112	0.0116	0.0120	0.0123	0.0127	0.0131	0.0135	0.0138	0.0138	0.0138		
Total SF ₆	0.0112	0.0110	0.0122	0.0154	0.0152	0.0154	0.0151	0.0182	0.0162	0.0161	0.0168	0.0161	0.0191	0.0220	0.0248	0.0270	0.0297	0.0343	0.0365	0.0227	0.0101	0.0105	0.0108	0.0112	0.0116	0.0120	0.0123	0.0127	0.0131	0.0135	0.0138	0.0138	0.0138	0.0138		





APPENDIX II



METHODOLOGICAL SUMMARY APPLIED TO THE NATIONAL INVENTORY



DATAFRAME 1. METHODOLOGICAL LEVELS APPLIED BY GAS AND REFERENCES OF THE ENERGY SECTOR

Sub-sector	Category	Subcategories	ESTIMATED GASES AND METHODOLOGIES							REFERENCES			
			CO ₂	CH ₄	N ₂ O	CO	NO _x	NMVOG	Activity data	Emission factors			
1.A. Energy Industries	1.A.1. Energy Industries	1.A.1.a. Public Electricity and Heat Production	T2	T2	T2	T2	T2	T2	T2		<p>National Energy Balance - BEN (Balanço Energético Nacional) (EPE, 2020); Useful Energy Balance - BEU (Balanço de Energia Útil) (1983, 1993 and 2004) (MME - Ministry of Mines and Energy (Ministério de Minas e Energia), 2005).</p> <p>Volume 2, Chapter 2 (IPCC, 2006); Volume 2 (IPCC, 1997); EMEP/EEA <i>Air Pollutant Emission Inventory Guidebook</i> (EMEP/EEA, 2013 and 2017); specific for fuelwood and charcoal for CH₄ and N₂O (BRASIL, 2020). EMEP/EEA Air Pollutant Emission Inventory Guidebook (EMEP/EEA, 2013 and 2017) for CO, NO_x and NMVOC.</p>		
			T2	T2	T2	T2	T2	T2	T2				
			T2	T2	T2	T2	T2	T2	T2				
			1.A.2. Manufacturing Industries and Construction	1.A.2.a. Iron and Steel	T2	T2	T2	T2	T2	T2		T2	
		T2			T2	T2	T2	T2	T2	T2			
		T2			T2	T2	T2	T2	T2	T2			
			1.A.2. Manufacturing Industries and Construction	1.A.2.b. Non-ferrous Metals	T2	T2	T2	T2	T2	T2		T2	
		T2			T2	T2	T2	T2	T2	T2			
		T2			T2	T2	T2	T2	T2	T2			
			1.A.2. Manufacturing Industries and Construction	1.A.2.c. Chemicals	T2	T2	T2	T2	T2	T2		T2	
		T2			T2	T2	T2	T2	T2	T2			
		T2			T2	T2	T2	T2	T2	T2			
	1.A.2. Manufacturing Industries and Construction	1.A.2.d. Pulp, Paper and Print	T2	T2	T2	T2	T2	T2	T2				
T2			T2	T2	T2	T2	T2	T2					
T2			T2	T2	T2	T2	T2	T2					
	1.A.2. Manufacturing Industries and Construction	1.A.2.e. Food Processing, Beverages and Tobacco	T2	T2	T2	T2	T2	T2	T2				
T2			T2	T2	T2	T2	T2	T2					
T2			T2	T2	T2	T2	T2	T2					
	1.A.2. Manufacturing Industries and Construction	1.A.2.f. Non-metallic Minerals	T2	T2	T2	T2	T2	T2	T2				
T2			T2	T2	T2	T2	T2	T2					
T2			T2	T2	T2	T2	T2	T2					
	1.A.2. Manufacturing Industries and Construction	1.A.2.g.ii. Manufacturing of Transport Equipment	T2	T2	T2	T2	T2	T2	T2				
T2			T2	T2	T2	T2	T2	T2					
T2			T2	T2	T2	T2	T2	T2					
	1.A.2. Manufacturing Industries and Construction	1.A.2.g.iii. Mining (excluding fuels) and Quarrying	T2	T2	T2	T2	T2	T2	T2				
T2			T2	T2	T2	T2	T2	T2					
T2			T2	T2	T2	T2	T2	T2					
	1.A.2. Manufacturing Industries and Construction	1.A.2.i. Textile and Leather	T2	T2	T2	T2	T2	T2	T2				
T2			T2	T2	T2	T2	T2	T2					
T2			T2	T2	T2	T2	T2	T2					
1.A. FUEL COMBUSTION ACTIVITIES	1.A.3. Transport	1.A.3.a. Domestic Aviation	T3a	T3a	T3a	T3a	T3a	T3a	T3a		<p>Air Traffic Movement Database (BIMTRA, Banco de Informações de Movimento de Tráfego Aéreo); average times for each stage of the LTO cycle (ICAO, 2011); FOI (Swedish Defense Research Agency), 2013); average APU standard operating times for aircrafts (ACRP, 2019); National Energy Balance - BEN (EPE, 2020).</p> <p>Volume 2, Chapter 3 (IPCC, 2006); ANAC – National Civil Aviation Agency (Agência Nacional de Aviação Civil) (2020).</p>		
			T2	T3	T3	T3	T3	T3	T3				
			T2	T3	T3	T3	T3	T3	T3				
			1.A.3. Transport	1.A.3.b. Road Transportation	T2	T1	T1	T1	T1	T1		T1	
		T2			T1	T1	T1	T1	T1	T1			
		T2			T1	T1	T1	T1	T1	T1			
			1.A.3. Transport	1.A.3.c. Railways	T2	T1	T1	T1	T1	T1		T1	
		T2			T1	T1	T1	T1	T1	T1			
		T2			T1	T1	T1	T1	T1	T1			
			1.A.3. Transport	1.A.3.d. Domestic Navigation	T2	T2	T2	T2	T2	T2		T2	
		T2			T2	T2	T2	T2	T2	T2			
		T2			T2	T2	T2	T2	T2	T2			
	1.A.3. Transport	1.A.3.e. Other Transportation	T2	T2	T2	T2	T2	T2	T2				
T2			T2	T2	T2	T2	T2	T2					
T2			T2	T2	T2	T2	T2	T2					
1.A.4. Other Sectors	1.A.4.a. Commercial/institutional	1.A.4.a. Commercial/institutional	T2	T2	T2	T2	T2	T2	T2		<p>National Energy Balance - BEN (Balanço Energético Nacional) (EPE, 2020); Useful Energy Balance - BEU (Balanço de Energia Útil) (1983, 1993 and 2004) (MME - Ministry of Mines and Energy (Ministério de Minas e Energia), 2005).</p> <p>Volume 2, Chapter 2 (IPCC, 2006); Volume 2 (IPCC, 1997); EMEP/EEA <i>Air Pollutant Emission Inventory Guidebook</i> (EMEP/EEA, 2013 and 2017); specific for fuelwood and charcoal for CH₄ and N₂O (BRASIL, 2020); EMEP/EEA Air Pollutant Emission Inventory Guidebook (EMEP/EEA, 2013 and 2017) for CO, NO_x and NMVOC.</p>		
			T2	T2	T2	T2	T2	T2	T2				
			T2	T2	T2	T2	T2	T2	T2				
			T2	T2	T2	T2	T2	T2	T2				
			T2	T2	T2	T2	T2	T2	T2				
	1.A.4. Other Sectors	1.A.4.b. Residential	T2	T2	T2	T2	T2	T2	T2				
T2			T2	T2	T2	T2	T2	T2					
T2			T2	T2	T2	T2	T2	T2					
	1.A.4. Other Sectors	1.A.4.c. Agriculture/Forestry/ Fishing	T2	T2	T2	T2	T2	T2	T2				
T2			T2	T2	T2	T2	T2	T2					
1.A.5. Other (Not specified elsewhere)	1.A.5.a. Stationary	1.A.5.a. Stationary	T2	T2	T2	T2	T2	T2	T2				
			T2	T2	T2	T2	T2	T2	T2				
			T2	T2	T2	T2	T2	T2	T2				
	1.A.5. Other (Not specified elsewhere)	1.A.5.b. Mobile	T2	T2	T2	T2	T2	T2	T2				
T2			T2	T2	T2	T2	T2	T2					
	1.A.5.c. Multilateral Operations	1.A.5.c. Multilateral Operations	NO	NO	NO	NO	NO	NO	NO				

1.B. FUGITIVE EMISSIONS FROM FUELS	1.B.1. Solid Fuels	1.B.1.a. Coal Mining and Handling	NO	T1	NA	NA	NA	NA	Coal production data from the Brazilian Mineral Coal Association (Associação Brasileira do Carvão Mineral) and the Santa Catarina State Coal Extraction Industry Union (SIECESC, Sindicato da Indústria de Extração de Carvão do Estado de Santa Catarina, 2023).	Volume 2, Chapter 4 (IPCC, 2006).	
		1.B.1.b. Fuel Transformation	NO	NO	NO	NO	NO	NO			
	1.B.2. Oil and Natural Gas	1.B.1.c. Spontaneous Combustion and Landfills for Burning Coal	NO	NO	NO	NO	NO	NO	NO		
		1.B.2.a. Oil	T2/T3	T2/T3	T2/T3	NE	NE	NE	NE	GHG emissions results from Petrobras; Production and upgrading data from the National Agency of Petroleum, Natural Gas and Biofuels (ANP, Agência Nacional do Petróleo, Gás Natural e Biocombustíveis, 2024); Volume of cargo processed from the National Energy Balance (EPE, 2020).	Industry protocols and emission sources for the categories.
		1.B.2.b. Natural Gas	T2/T3	T2/T3	T2/T3	NE	NE	NE	NE		
1.C. CO₂ TRANSPORT AND STORAGE	1.C.1. Transport of CO ₂	NO	NO								
	1.C.2. Injection and Storage	NO	NO								
	1.C.3. Other	NO	NO								

Note: Methodological levels (IPCC, 2006) - T1: Tier 1; T2: Tier 2; T3: Tier 3; T3a: Tier 3a

Notations:

NA - Not applicable - Activity in a given source/sink category that occurs in the country, but did not result in emissions or removals of a specific gas;

IE - Included elsewhere - Included in another location/category of emissions or removals;

NO - Not occurring - Categories and processes that do not occur in the country;

NE - Not estimated - Activity data and/or emissions by sources and removals by sinks of GHG that have not been estimated, but for which a corresponding activity may occur in the country.



DATAFRAME 2. METHODOLOGICAL LEVELS APPLIED BY GAS AND REFERENCES OF THE INDUSTRIAL PROCESSES AND PRODUCT USE SECTOR

Sub-sector	Category	ESTIMATED GASES AND METHODOLOGIES											REFERENCES		
		CO ₂	CH ₄	N ₂ O	CO	NO _x	NMVOG	HFCs	PFCs	SF ₆	Activity data	Emission factors			
2.A. MINERAL INDUSTRY	2.A.1. Cement Production	T3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Total clinker and cement production (SNIC – National Cement Industry Union (Sindicato Nacional da Indústria do Cimento), 2024).	Data from SNIC (2013), with emission factors last calculated in 2010. For the 2011-2020 period, the implicit factor was informed by SNIC.	
	2.A.2. Lime Production	T2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Production of quicklime and hydrated lime (ABPC - Brazilian Lime Producers Association (Associação Brasileira dos Produtores de Cal), 2014; MME, 2020). Average composition of lime according to the variation allowed by Brazilian standards.	Volume 3, Chapter 2 (IPCC, 2006).	
	2.A.3. Glass Production	T3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Glass production from the Statistical Yearbook - Non-Metallic Transformation Sector (MME, 2006; 2007; 2009; 2013; 2020).	Stoichiometry of chemical processes, based on the average composition of the feedstock of the glass, according to the Yearbook, with emission factors from Volume 3, Chapter 2 (IPCC, 2006).	
	2.A.4. Other Process Uses of Carbonates	T2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Ceramics Production (IBGE, 2020), distribution of national production by the Statistical Yearbook of the Non-Metallic Transformation Sector (MME, 2020); Soda ash: Production, import and export (ABIQUIM – Brazilian Chemical Industry Association (Associação Brasileira da Indústria Química), 2014), with extrapolation for 2015 to 2022; Magnesite: Data from Mineral Summary (BRASIL, 2016) and Mineral Sector Bulletin (MME, 2020), with maintenance of the 2019 production for 2020.	For the Ceramics sub-sector, publications that differentiated the parameters according to the characteristics of the various states and regions of the country were considered. Stoichiometry of chemical processes; Volume 3, Chapter 2 (IPCC, 2006).	
2.B. CHEMICAL INDUSTRY	2.B.1. Ammonia Production	T3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Ammonia production (ABIQUIM, 2020); Urea (IBGE, 2017b; 2020), combined with data from the yearbooks and personal contact with ABIQUIM for 1990 to 2020.	Country-specific factor, deducting CO ₂ emissions from urea.	
	2.B.2. Nitric Acid Production	NA	NA	T3/T1	NA	NA	NA	NA	NA	NA	NA	NA	Production up to 2007 (ABIQUIM, 2009). Then, from CDM projects monitoring (UNFCCC, 2020).	Data from Abiquim (2009) and CDM projects monitoring (UNFCCC, 2020) IPCC (1997) for precursor gases.	
	2.B.3. Adipic Acid Production	NA	NA	T3	T1	T1	NA	NA	NA	NA	NA	NA	Production up to 2010 (ABIQUIM, 2009; 2012). Then, from CDM projects monitoring (UNFCCC, 2020).	Data from Abiquim (2012) and CDM projects monitoring (UNFCCC, 2020) IPCC (1997) for precursor gases.	
	2.B.4. Caprolactam, Glyoxal and Glyoxylic Acid Production	NA	NA	T1/NO	NA	NA	NA	NA	NA	NA	NA	NA	ABIQUIM (2020).	Volume 3, Chapter 3 (IPCC, 2006).	
	2.B.5. Carbide Production	T1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Plant-specific information up to 2007, with additions up to 2010 (ABIQUIM, 2012); repeated until 2020.	Plant-specific information until 2007; 2008 to 2010 ABIQUIM (2012); repeated up to 2016.	
	2.B.6. Titanium Dioxide Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2.B.7. Soda Ash Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	2.B.8. Petrochemical and Carbon Black Production	T1	T1	NA	NA	T1	T1	NA	NA	NA	NA	NA	NA	ABIQUIM (2020).	Volume 3, Chapter 3 (IPCC, 2006). IPCC (1997) for precursor gases.
	2.B.9. Fluorochemical Production	NA	NA	NA	NA	NA	NA	T1	NA	NA	NA	NA	NA	PROZON - Interministerial Executive Committee for the Protection of the Ozone Layer (Comitê Executivo Interministerial para Proteção da Camada de Ozônio) (1999).	Volume 3, Chapter 3 (IPCC, 2006).
	2.B.10. Other	NA	NA	NA	NA	NA	T1	NA	NA	NA	NA	NA	NA	ABIQUIM (2020).	Volume 3, Chapter 3 (IPCC, 2006). IPCC (1997) for precursor gases.

Sub-sector	Category	ESTIMATED GASES AND METHODOLOGIES										REFERENCES		
		CO ₂	CH ₄	N ₂ O	CO	NO _x	NMVOG	HFCs	PFCs	SF ₆	Activity data	Emission factors		
2.C. METAL INDUSTRY	2.C.1. Iron and Steel Production	T2	T1	T1	T1	T1	T1	NA	NA	NA	NA	Brazil Steel Institute (Instituto Aço Brasil) (IABR, 2020) for emissions up to 2016 and BEN (EPE, 2020) for energy, with emissions from 2017 to 2020 accounted for proportionally to raw steel production by IABR (2020).	CO ₂ : carbon balance (IABR, 2020); non-CO ₂ : Volume 2, Chapter 2 (IPCC, 2006).	
	2.C.2. Ferroalloys Production	T2	T1	NA	NA	NA	NA	NA	NA	NA	NA	National Energy Balance - BEN (EPE, 2020) and MME (2020) for the sector's production.	Volume 3, Chapter 4 (IPCC, 2006).	
	2.C.3. Aluminum Production	T1/T2/T3	NA	NA	T1	T1	NA	NA	NA	T1/T2/T3	NA	ABAL - Brazilian Aluminum Association (Associação Brasileira do Alumínio) (2019), ALBRAS - Alumínio Brasileiro S.A. (2020), CBA - Companhia Brasileira de Alumínio (2020) and IBGE (2020).	CO ₂ and PFCs: ABAL (2019); IPCC (1997) for precursor gases.	
	2.C.4. Magnesium Production	T1	NA	NA	NA	NA	NA	NA	NA	NA	T1	RIMA Industrial (2009). Then, after 2005, CDM projects monitoring (UNFCCC, 2020).	Volume 3, Chapter 4 (IPCC, 2006).	
	2.C.5. Lead Production	IE	NA	NA	NA	NA	NA	NA	NA	NA	NA	Considered in category 2.C.7.		
	2.C.6. Zinc Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA			
	2.C.7. Other (non-ferrous metals, except aluminum and magnesium)	T1	NA	NA	NA	NA	NA	NA	NA	NA	NA	National Energy Balance - BEN (EPE, 2019; 2020) and BEU (EPE, 2005).	Volume 3, Chapter 4 (IPCC, 2006).	
2.D. Non-Energy Products from Fuels and Solvent Use	2.D.1. Lubricant Use	T1	NA	NA	NA	NA	NA	NA	NA	NA	NA	National Energy Balance - BEN (EPE, 2020).	Volume 3, Chapter 5 (IPCC, 2006).	
	2.D.2. Paraffin Wax Use	IE	NA	NA	NA	NA	NA	NA	NA	NA	NA	Considered in category 2.D.3.		
	2.D.3. Other	T1	NA	NA	NA	NA	T1	NA	NA	NA	NA	National Energy Balance - BEN (EPE, 2020).	IPCC (1997) for precursor gases.	
2.E. ELECTRONICS INDUSTRY	2.E.1. Integrated Circuit or Semiconductor	NA	NA	NA	NA	NA	NA	NA	NA	NA	IE	IE	NA	Considered in category 2.E.5.
	2.E.2. TFT Flat Panel Display TFT	NA	NA	NA	NA	NA	NA	NA	NA	NA	IE	IE	NA	Considered in category 2.E.5.
2.E. ELECTRONICS INDUSTRY	2.E.3. Photovoltaics	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	NE	NA	
	2.E.4. Heat Transfer Fluid	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	NE	NA	
	2.E.5. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	T2a	T2a	NA	Foreign trade statistics - Comex Stat (MDIC - Ministry of Development, Industry, Trade and Services (Ministério do Desenvolvimento, Indústria, Comércio e Serviços), 2020)



		ESTIMATED GASES AND METHODOLOGIES											REFERENCES	
Sub-sector	Category	CO ₂	CH ₄	N ₂ O	CO	NO _x	NMVOG	HFCs	PFCs	SF ₆	Activity data	Emission factors		
2.F. PRODUCT USES AS SUBSTITUTES FOR OZONE DEPLETING SUBSTANCES	2.F.1. Refrigeration and Air Conditioning	NA	NA	NA	NA	NA	NA	T2a	NA	NA	Foreign trade statistics - Comex Stat (MDIC, 2020), IBGE (2020), ELETROS - National Association of Manufacturers of Electrical and Electronic Products (Associação Nacional de Fabricantes de Produtos Eletroeletrônicos), (2019), ABRAVA - Brazilian Refrigeration, Air Conditioning, Ventilation and Heating Association (Associação Brasileira de Refrigeração Ar Condicionado, Ventilação e Aquecimento), (2020).	Volume 3, Chapter 7 (IPCC, 2006).		
	2.F.2. Foam Blowing Agents	NA	NA	NA	NA	NA	NA	T2a	NA	NA	Foreign trade statistics - Comex Stat (MDIC, 2020)	Volume 3, Chapter 7 (IPCC, 2006).		
	2.F.3. Fire Protection	NA	NA	NA	NA	NA	NA	T2a	NA	NA	Foreign trade statistics - Comex Stat (MDIC, 2020).	Volume 3, Chapter 7 (IPCC, 2006).		
	2.F.4. Aerosols	NA	NA	NA	NA	NA	NA	T2a	NA	NA	Foreign trade statistics - Comex Stat (MDIC, 2020)	Volume 3, Chapter 7 (IPCC, 2006).		
	2.F.5. Solvents	NA	NA	NA	NA	NA	NA	NE	NE	NA				
	2.F.6. Other Applications	NA	NA	NA	NA	NA	NA	NA	NO	NO	NA			
2.G. Other Product Manufacture and Use	2.G.1. Electrical Equipment	NA	NA	NA	NA	NA	NA	NA	NO	T1	National survey MCT – Ministry of Science and Technology (Ministério da Ciência e Tecnologia) (2009).	Volume 3, Chapter 8 (IPCC, 2006).		
	2.G.2. SF ₆ and PFCs from Other Product Uses	NA	NA	NA	NA	NA	NA	NA	NO	NO				
	2.G.3. N ₂ O from Product Uses	NA	NA	NE	NA	NA	NA	NA	NA	NA				
	2.G.4. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO				
2.H. OTHER	2.H.1. Pulp and Paper Industry	NA	NA	NA	T1	T1	T1	NA	NA	NA	IBÁ - Brazilian Tree Industry (Indústria Brasileira de Árvores) (2020).	IPCC (1997) for precursor gases.		
	2.H.2. Food and Beverage Industry	NA	NA	NA	NA	NA	T1	NA	NA	NA	Food in general and beers: IBGE (2020); Sugar: UNICA – Brazilian Sugarcane Industry Association (União da Indústria de Cana-de-Açúcar) (2020); Wines: IBRAVIN - Brazilian Wine Institute (Instituto Brasileiro do Vinho) (2020), after 2004 (IBGE, 2020). Breads and flour: ABITRIGO - Brazilian Wheat Industry Association (Associação Brasileira da Indústria do Trigo) (2020) and ABIP - Brazilian Bakery and Confectionery Industry Association (Associação Brasileira da Indústria de Panificação e Confeitaria) (2020).	IPCC (1997) for precursor gases.		
	2.H.3. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA				

Note: Methodological levels (IPCC, 2006) - T1: Tier 1; T2: Tier 2; T3: Tier 3; T3a: Tier 3a

Notations:

NA - Not applicable - Activity in a given source/sink category that occurs in the country, but did not result in emissions or removals of a specific gas;

IE - Included elsewhere - Included in another location/category of emissions or removals;

NO - Not occurring - Categories and processes that do not occur in the country;

NE - Not estimated - Activity data and/or emissions by sources and removals by sinks of GHG that have not been estimated, but for which a corresponding activity may occur in the country.

DATAFRAME 3. METHODOLOGICAL LEVELS APPLIED BY GAS AND REFERENCES OF THE AGRICULTURE SECTOR

Sub-sector	Category	Subcategory	ESTIMATED GASES AND METHODOLOGIES							REFERENCES	
			CO ₂	CH ₄	N ₂ O	CO	NO _x	Activity data	Emission factors		
3-A. ENTERIC FERMENTATION	3.A.1. Cattle	3.A.1.a. Beef cattle	NA	T2	NA	NA	NA	NA	Animal population data from the Municipal Livestock Survey (PPM, Pesquisa da Pecuária Municipal), by Federative Unit/State from 1990 to 2020 (IBGE, 2020); Agricultural Census (IBGE, 2006) and Anualpec - Brazilian livestock yearbook (Anuário da pecuária brasileira) (FNP Institute, 1997; 2001; 2005; 2013). Breakdown of the herd by purpose, sex, age and weight.	Volume 4, Chapter 10 (IPCC, 2006) with calculation of Tier 2, emission factor. Taking into account national and international bibliographical references of the parameters applied.	
		3.A.1.b. Dairy cattle	NA	T2	NA	NA	NA	NA			
	3.A.2. Sheep	3.A.2.a. Breeding	NA	T1	NA	NA	NA	NA		Volume 4, Chapter 10 (IPCC, 2006).	
		3.A.2.b. Suckling/Nursery	NA	T1	NA	NA	NA	NA			
	3.A.3. Swine	3.A.3.a. Finishing	NA	T1	NA	NA	NA	NA	Animal population data from the Municipal Livestock Survey (PPM, Pesquisa da Pecuária Municipal), by Federative Unit/State from 1990 to 2020 (IBGE, 2020).	Volume 4, Chapter 10 (IPCC, 2006).	
		3.A.3.b. Buffaloes	NA	T1	NA	NA	NA	NA			
		3.A.3.c. Goats	NA	T1	NA	NA	NA	NA			
		3.A.3.d. Horses	NA	T1	NA	NA	NA	NA			
		3.A.3.e. Mules	NA	T1	NA	NA	NA	NA			
	3.A.4. Other animals	3.A.4.a. Asses	NA	T1	NA	NA	NA	NA		Volume 4, Chapter 10 (IPCC, 2006).	
		3.A.4.b. Beef cattle	NA	T2	NA	NA	NA	NA			
		3.A.4.c. Dairy cattle	NA	T2	NA	NA	NA	NA			
		3.A.4.d. Breeding	NA	T2	NA	NA	NA	NA			
		3.A.4.e. Suckling/Nursery	NA	T2	NA	NA	NA	NA			
	3-B. MANURE MANAGEMENT	3.B.1. Cattle	3.B.1.a. Beef cattle	NA	T2	T2	NA	NA	NA	Animal population data from the Municipal Livestock Survey (PPM, Pesquisa da Pecuária Municipal), by Federative Unit/State from 1990 to 2020 (IBGE, 2020); Agricultural Census (IBGE, 1996; 2006) and Anualpec - Brazilian livestock yearbook (Anuário da pecuária brasileira) (FNP Institute, 1997; 2001; 2005; 2013). Data from SESI - Industry Social Service (Serviço Social da Indústria) (2019) and ABPA - Brazilian Animal Protein Association (Associação Brasileira de Proteína Animal) (2019) were also used for the swine,	cattle and poultry categories: Volume 4, Chapter 10 (IPCC, 2006). The calculation of the emission factor for each category of cattle, swine and poultry was based on national and international bibliographical references for each federative unit/state and year for the following parameters: weight, digestibility, excretion rate, type of manure management for each animal category, etc.
3.B.1.b. Dairy cattle			NA	T2	NO	NA	NA	NA			
3.B.2. Sheep		3.B.2.a. Breeding	NA	T1	NO	NA	NA	NA		Other animals: Volume 4, Chapter 10 (IPCC, 2006)	
		3.B.2.b. Suckling/Nursery	NA	T1	NO	NA	NA	NA			
3.B.3. Swine		3.B.3.a. Finishing	NA	T1	NO	NA	NA	NA		cattle and poultry categories: Volume 4, Chapter 10 (IPCC, 2006). The calculation of the emission factor for each category of cattle, swine and poultry was based on national and international bibliographical references for each federative unit/state and year for the following parameters: weight, digestibility, excretion rate, type of manure management for each animal category, etc.	
		3.B.3.b. Buffaloes	NA	T1	NO	NA	NA	NA			
		3.B.3.c. Goats	NA	T1	NO	NA	NA	NA			
		3.B.3.d. Horses	NA	T1	NO	NA	NA	NA			
		3.B.3.e. Mules	NA	T1	NO	NA	NA	NA			
3.B.4. Other Animals		3.B.4.a. Asses	NA	T1	NO	NA	NA	NA		Other animals: Volume 4, Chapter 10 (IPCC, 2006)	
	3.B.4.b. Poultry	NA	T1	T1	NA	NA	NA				
	3.B.4.c. Cattle	NA	NA	T1	NA	NA	NA				
3.B.5. Indirect N ₂ O Emissions	3.B.5.a. Cattle	NA	NA	T1	NA	NA	NA		Other animals: Volume 4, Chapter 10 (IPCC, 2006)		
	3.B.5.b. Other	NA	NA	T1	NA	NA	NA				
3-C. RICE CULTIVATION	3.C.1. Irrigated	3.C.1.a. Continuously flooded	NA	T1, T2	IE	NA	NA	NA	Data on rice cultivation area, by Federative Unit/State and year (stratified by water regime): EMBRAPA ARROZ E FEIJAO (Embrapa - Brazilian Agricultural Research Corporation (Empresa Brasileira de Pesquisa Agropecuária) Rice and Beans (2018) and DCI/(Commercial and Industrial Department [Departamento Comercial e Industrial]/IRGA (Rio Grande do Sul Rice Institute [Instituto Rio Grandense do Arroz]) (IRGA, 2018); Cultivation period, by federative unit/state and year (stratified by seeding system): EMBRAPA (2018). Note: Regional data was used only for the state of Santa Catarina: Cultivated area (stratified by water regime) from EMBRAPA ARROZ E FEIJAO (2018) and EPAGRI (Agricultural Research and Rural Extension Company of Santa Catarina [Empresa de Pesquisa Agropecuária e Extensão Rural de Santa Catarina]) (2019). Cultivation period (stratified by cultivar cycle) from EPAGRI (2019).	Volume 4, Chapter 5 (IPCC, 2006); EMBRAPA ARROZ E FEIJAO (2018); YAN <i>et al.</i> (2005); EPAGRI (2019).	
		3.C.1.b. Intermittently flooded	NA	T1, T2	IE	NA	NA	NA			
3.C.2. Rain-fed			NA	NO	NA	NA	NA				



Sub-sector	Category	Subcategory	ESTIMATED GASES AND METHODOLOGIES						REFERENCES	
			CO ₂	CH ₄	N ₂ O	CO	NO _x	Activity data	Emission factors	
3.D. AGRICULTURAL SOILS	3.D.1. Direct Emissions	3.D.1.a. Inorganic N Fertilizers	NA	NA	T2	NA	NA	<p>The amount of N in urea was disaggregated from the total nitrogen fertilizer data based on national import, export, production and stock data for each federative unit/state from 1990 to 2020, from ANDA – National Association for the Diffusion of Fertilizers (Associação Nacional para Difusão de Adubos) (ANDA, 2020).</p> <p>Note: For the estimation of N in the form of inorganic N Fertilizers applied in irrigated rice cultivation areas, it was considered that only urea is applied in irrigated rice, and that only the southern region of the country has areas with significant production and productivity, to consider that there has been a significant application of inorganic N Fertilizers (ANDA, 2020; Embrapa Arroz e Feijão, 2018, IRGA, 2018 and IBGE, 2019)</p>	Volume 4, Chapter 11 (IPCC, 2006).	
		3.D.1.b. Organic N Fertilizers	NA	NA	T1, T2	NA	NA	<p>Data on ethanol and sugar production from by-products of vinasse and filter cake, produced in the country by federative unit/state and year, was obtained from the Sugarcane Industry Association (UNICA, União da Indústria de Cana-de-Açúcar) 2020);</p> <p>Animal population data from the Municipal Livestock Survey - PPM, by federative unit/state from 1990 to 2020 (IBGE, 2020) and the Agricultural Census (IBGE, 1996; 2006); Anualpec (FNP, 1997; 2001; 2005; 2013); SESI (2019) and ABPA (2019).</p>	Volume 4, Chapter 11 (IPCC, 2006); PAREDES <i>et al.</i> (2014); Parameters for estimating the amount of N in vinasse and filter cake: ELIA NETO (2016); GURGEL (2012); BERNARDINHO <i>et al.</i> (2018); BONASSA <i>et al.</i> (2015) and EMBRAPA (2019); Direct emission factors of N ₂ O from vinasse and filter cake applied to soil cultivated with Sugar cane OLIVEIRA <i>et al.</i> (2013); SIQUEIRA NETO <i>et al.</i> (2016); SOUSA NETO (2012). The definition of the weight, excretion factor and disposal of the manure for each animal category was based on various national bibliographical references, for each federative unit/state and year.	
		3.D.1.c. Animal manure deposited by grazing animals	NA	NA	T1, T2	NA	NA	<p>Animal population data from the Municipal Livestock Survey (PPM, Pesquisa da Pecuária Municipal), by Federative Unit/State from 1990 to 2020 (IBGE, 2020) and Agricultural Census (IBGE, 1996; 2006); Anualpec (FNP, 1997; 2001; 2005; 2013); SESI (2019) and ABPA (2019).</p>	Volume 4, Chapter 11 (IPCC, 2006). Bastos (2018). The definition of the weight, excretion factor and disposal of the manure for each animal category was based on various national bibliographical references, for each federative unit/state and year.	
		3.D.1.d. Crop Residues	NA	NA	T1, T2	NA	NA	<p>Productivity and harvested area data for the main agricultural crops in the country, by federative unit/state and year from the Municipal Agricultural Production - PAM (Produção Agrícola Municipal) from 1990 to 2020 (IBGE, 2020); Rice cultivation data (by FU/state and year): Embrapa (2018); DCI/IRGA (IRGA, 2018); Activity data for Grassland Remaining Grassland and Grassland converted to other uses, and the respective amounts of biomass considered (by FU/state and year) included in BRASIL (2020).</p>	Volume 4, Chapter 11 (IPCC, 2006). Parameters used to calculate the amount of N in grassland renewal CARVALHO <i>et al.</i> (1991); OLIVEIRA <i>et al.</i> (2004); PICCOLO <i>et al.</i> (2005); SANTOS <i>et al.</i> (2007); FABRICE <i>et al.</i> (2014).	
		3.D.1.e. Mineralization of N associated with loss of C in soil	NA	NA	T2	NA	NA	<p>Mineralized N was calculated by multiplying 1/R by the amount of soil organic carbon lost due to the use conversion (considering the C:N ratio associated with each land-cover class of the initial use class), based on the maps generated by the Land Use, Land-Use Change and Forestry (LULUCF) sector in BRASIL (2020).</p>	Volume 4, Chapter 11 (IPCC, 2006).	
		3.D.1.f. Cultivation of Organic Soils	NA	NA	T2	NA	NA	<p>Brazil's soil maps, IBGE (2001). In addition to the areas of organic soils, maps showing areas with different land uses of the Land Use, Land-Use Change and Forestry (LULUCF) sector were also used (BRASIL_2020).</p>	Volume 4, Chapter 11 (IPCC, 2006).	

ESTIMATED GASES AND METHODOLOGIES						REFERENCES			
Sub-sector	Category	Subcategory	CO ₂	CH ₄	N ₂ O	CO	NO _x	Activity data	Emission factors
3.D. AGRICULTURAL SOILS	3.D.2. Indirect Emissions	3.D.2.a. Atmospheric Deposition	NA	NA	T1, T2	NA	NA	Same as the information for the Inorganic N Fertilizers categories (3.D.1.a.), Organic N Fertilizers Directly to the Soil (3.D.1.c.), Crop Residues (3.D.1.d.) and Mineralization/immobilization associated with loss/gain of soil organic matter (3.D.1.e.). Development of maps containing areas where the excessive rainfall in relation to ETP exceeded the of soils' AWC, based on data from INMET – National Institute of Meteorology (Instituto Nacional de Meteorologia) (2019) and XAVIER (2019).	Volume 4, Chapter 11 (IPCC, 2006).
		3.D.2.b. Nitrogen leaching and run-off	NA	NA	T1, T2	NA	NA	Same as the information for the Inorganic N Fertilizers categories (3.D.1.a.), Organic N Fertilizers Directly to the Soil (3.D.1.c.), Crop Residues (3.D.1.d.) and Mineralization/immobilization associated with loss/gain of soil organic matter (3.D.1.e.). Development of maps containing areas where the excessive rainfall in relation to ETP exceeded the of soils' AWC, based on data from INMET – National Institute of Meteorology (Instituto Nacional de Meteorologia) (2019) and XAVIER (2019).	Volume 4, Chapter 11 (IPCC, 2006).
3.E. PRESCRIBED BURNING OF SAVANNAHS			NE	NE	NE	NE	NE		
3.F. FIELD BURNING OF AGRICULTURAL RESIDUES	3.F.1. Sugar cane		NA	T2	T2	T2	T2	Mass available for combustion (MB): Value specific to each municipality and reference year, calculated based on data from the Municipal Agricultural Production - PAM (IBGE, 2020); Varieties cultivated: BRAGA <i>et al.</i> (2017); RIDESA (2018); straw to stalks ratio - average values by FU/state: HASSUANI <i>et al.</i> (2005); FRANCO <i>et al.</i> (2007); TASSO JUNIOR <i>et al.</i> (2011); MARQUES; PINTO (2013); and IVO <i>et al.</i> (2015).	- Combustion factor (Cf): Volume 4, Chapter 5 (IPCC, 2006). - Emission factor (Gef): CH ₄ : YOKELSON <i>et al.</i> (2008) / CO: YOKELSON <i>et al.</i> (2008); LOPES; CARVALHO (2009); and FRANCA <i>et al.</i> (2012) / NO: FRANCA <i>et al.</i> (2012) / N ₂ O: IPCC (2006); ANDREAE; MERLET (2001).
		3.F.2. Cotton	NA	T1	T1	T1	T1	Mass available for combustion (MB): Annual value specific to each FU/state and reference year (BRASIL, 2016). Limestone production and consumption data for each federative unit/state from 1990 to 2020, from the Brazilian Limestone Producers Association (ABRACAL, Associação Brasileira dos Produtores de Calcário), 2020).	Combustion factor (Cf) and Emission factor (Gef): Volume 4, Chapter 5 (IPCC, 2006).
3.G. LIMING			T1	NA	NA	NA	NA		Volume 4, Chapter 11 (IPCC, 2006).
3.H. UREA APPLICATION			T1	NA	NA	NA	NA	The amount of N in urea was disaggregated from the total nitrogen fertilizer data based on national import, export, production and stock data for each federative unit/state from 1990 to 2020, from ANDA – National Association for the Diffusion of Fertilizers (Associação Nacional para Difusão de Adubos) (ANDA, 2020).	Volume 4, Chapter 11 (IPCC, 2006).
			NO	NA	NA	NA	NA		

Note: Methodological levels (IPCC, 2006) - T1: Tier 1; T2: Tier 2; T3: Tier 3; T3a: Tier 3a

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IE - Included elsewhere - Included in another location/category of emissions or removals;

NO - Not occurring - Categories and processes that do not occur in the country;

NE - Not estimated - Activity data and/or emissions by sources and removals by sinks of GHG that have not been estimated, but for which a corresponding activity may occur in the country.



DATAFRAME 4. METHODOLOGICAL LEVELS APPLIED BY GAS FOR THE LULUCF SECTOR CATEGORIES

SUB-SECTOR	CATEGORY	SUBCATEGORY	ESTIMATED GASES AND METHODOLOGIES					
			CO ₂	CH ₄	N ₂ O	CO	NO _x	NMVOG
4.A. FOREST LAND	4.A.1. Forest Land Remaining Forest Land	4.A.2.a. Cropland Converted to Forest Land	T1/T2	T1/T2	T1/T2	T1/T2	T1/T2	NA
		4.A.2.b. Grassland Converted to Forest Land	T1/T2	NA	NA	NA	NA	NA
		4.A.2.c. Wetlands Converted to Forest Land	T1/T2	T1/T2	T1/T2	T1/T2	T1/T2	NA
		4.A.2.d. Settlements Converted to Forest Land	NO	NA	NA	NA	NA	NA
		4.A.2.e. Other Land Converted to Forest Land	T1/T2	NA	NA	NA	NA	NA
4.B. CROPLAND	4.B.1. Cropland Remaining Cropland	4.B.2.a. Forest Land Converted to Cropland	NE	IE	IE	IE	IE	NA
		4.B.2.b. Grassland Converted to Cropland	T1/T2	T1/T2	T1/T2	T1/T2	T1/T2	NA
		4.B.2.c. Wetlands Converted to Cropland	T1/T2	NA	NA	NA	NA	NA
		4.B.2.d. Settlements Converted to Cropland	NO	NA	NA	NA	NA	NA
		4.B.2.e. Other Land Converted to Cropland	T1/T2	NA	NA	NA	NA	NA
4.C. GRASSLAND	4.C.1. Grassland Remaining Grassland	4.C.2.a. Forest Land Converted to Grassland	T1/T2	NA	NA	NA	NA	NA
		4.C.2.b. Cropland Converted to Grassland	T1/T2	NA	NA	NA	NA	NA
		4.C.2.c. Wetlands Converted to Grassland	NO	NA	NA	NA	NA	NA
		4.C.2.d. Settlements Converted to Grassland	NO	NA	NA	NA	NA	NA
		4.C.2.e. Other Land Converted to Grassland	T1/T2	NA	NA	NA	NA	NA
4.D. WETLANDS	4.D.1. Wetland Remaining Wetland	4.D.2.a. Forest Land Convert to Wetland	NA	NA	NA	NA	NA	NA
		4.D.2.b. Cropland Converted to Wetland	T1/T2	T1/T2	T1/T2	T1/T2	T1/T2	NA
		4.D.2.c. Grassland Converted to Wetland	T1/T2	NA	NA	NA	NA	NA
		4.D.2.d. Settlement Converted to Wetland	NA	NA	NA	NA	NA	NA
		4.D.2.e. Other Land Converted to Wetland	NA	NA	NA	NA	NA	NA

SUB-SECTOR	CATEGORY	SUBCATEGORY	ESTIMATED GASES AND METHODOLOGIES					
			CO ₂	CH ₄	N ₂ O	CO	NO _x	NMVOG
4.E. SETTLEMENTS	4.E.1. Settlements remaining Settlements	4.E.2.a. Forest Land Converted to Settlements	NA	NA	NA	NA	NA	NA
		4.E.2.b. Cropland Converted to Settlements	T1/T2	T1/T2	T1/T2	T1/T2	T1/T2	NA
	4.E.2. Land Converted to Settlements	4.E.2.c. Grassland Converted to Settlements	T1/T2	NA	NA	NA	NA	NA
		4.E.2.d. Wetlands Converted to Settlements	T1/T2	T1/T2	T1/T2	T1/T2	T1/T2	NA
		4.E.2.e. Other Land Converted to Settlements	NA	NA	NA	NA	NA	NA
4.F. OTHER LAND	4.F.1. Other Land remaining Other Land	4.F.2.a. Forest Land Converted to Other Land	T1/T2	NA	NA	NA	NA	NA
		4.F.2.b. Cropland Converted to Other Land	T1/T2	T1/T2	T1/T2	T1/T2	T1/T2	T1/T2
		4.F.2.c. Grassland Converted to Other Land	T1/T2	NA	NA	NA	NA	NA
		4.F.2.d. Wetlands Converted to Other Land	T1/T2	T1/T2	T1/T2	T1/T2	T1/T2	T1/T2
		4.F.2.e. Settlements Converted to Other Land	NA	NA	NA	NA	NA	NA
4.G. HARVESTED WOOD PRODUCTS		T1	T1	T1	T1	T1	T1	

Note: Methodological levels (IPCC, 2006) - T1: Tier 1; T2: Tier 2; T3: Tier 3; T3a: Tier 3a

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- IE - Included elsewhere - Included in another location/category of emissions or removals;
- NO - Not occurring - Categories and processes that do not occur in the country;
- NE - Not estimated - Activity data and/or emissions by sources and removals by sinks of gHG that have not been estimated, but for which a corresponding activity may occur in the country.



DATAFRAME 5. METHODOLOGICAL SUMMARY AND REFERENCES TO ACTIVITY DATA, EMISSION FACTORS, ASSUMPTIONS AND OTHER PARAMETERS FOR ESTIMATING EMISSIONS AND REMOVALS FROM THE LULUCF SECTOR

LAND-USE AND LAND-COVER CHANGE - CO₂ EMISSIONS AND REMOVALS

Method: IPCC 2006, Approach 3: All land-use and land-cover categories and their changes are considered spatially across the entire territory. The parameters and emission/removal factors for each carbon pool of the different land uses and covers were estimated based on studies carried out in the country (Tier 2) and, in the absence of national data, default IPCC data (Tier 1) was used.

Activity data	Emission factor (EF) and other parameters	Other assumptions or parameters for the estimated years
<p>Land-use and land-cover conversion matrices obtained from cross-referencing the mapping of all Brazilian biomes for the years of 1994, 2002, 2005 (for the Amazon only), 2010 and 2016, based on images from the Landsat and Resourcesat-1 satellites at a scale of 1:250,000 and a minimum area of 6 ha. The classes considered were Managed Forest Land (MFL), Unmanaged Forest Land (UFL), Secondary Forest (SecF), Selective Logging (SL, only for the Amazon biome), Forest Plantation (FP), Managed Grassland (MG), Unmanaged Grassland (UG), Secondary Grassland (SecG), Pasture (P), Cropland (C), Settlement (S), Water (W, rivers and lakes), Artificial reservoirs (Res), Rock Outcrop (MRO, URO), Dunes (MD, UD), Bare Soil (BS), Mining (Min) and Areas Not Observed (NO, areas covered by clouds and/or shadows). The land-use and land-cover maps were also cross-referenced with other layers of information: biome boundary map (IBGE, 2004), municipal boundary map (IBGE, 2017), past natural vegetation map* adapted from (IBGE, 2019) by SFB – Brazilian Forest Service (Serviço Florestal Brasileiro) and Rede Clima, soil organic carbon map (adapted from BERNHOUX <i>et al.</i>, 2002) and protected areas map (FUNAI – National Indian Foundation (Fundação Nacional do Índio), 2010; (CMBio – Chico Mendes Biodiversity Conservation Institute (Instituto Chico Mendes de Conservação da Biodiversidade), 2016).</p>	<p>The association of the land-use and land-cover conversion matrices with the IPCC 2006 carbon loss and gain equations and the factors described below, allowed us to generate the matrices of gross vegetation emissions, vegetation removals, net soil emissions/removals and net emissions/removals, by biome and period.</p> <p>Vegetation carbon: biomass carbon values for each pool were associated with the physiognomies of the map of past natural vegetation of each biome: above ground (AGB); below ground (BGB) and dead organic matter (DOM, consisting of standing and fallen dead wood and litter), based on field data and scientific literature from IPCC 2003 and BGB from IPCC, 2006). The carbon content of dry forest biomass was 47% for all pools, with the exception of litter (46%) (IPCC, 2006; OMETTO <i>et al.</i>, 2006). For grassland vegetation and other wooded land, 47% was considered for AGB and BGB, 50% for dead wood and 40% for litter (IPCC, 2006).</p> <p>Vegetation emission/removal factors: the increase in vegetation biomass/carbon was estimated based on scientific literature and, in some cases, IPCC default values were used in relation to BGB (IPCC, 2006).</p> <p>Other parameters: stock and/or increase of grassland and cropland were estimated based on scientific literature and IPCC 2006 default values. Classes such as Urban Area, Exposed Soil, Mining, Reservoir, Dunes and Rocky Outcrop had their carbon stocks associated with zero.</p> <p>Soil organic carbon stock: the methodology developed by BERNHOUX <i>et al.</i> (2002) was adapted, which estimates the amount of soil organic carbon according to soil type and vegetation type, both classified by the authors into 6 and 15 large groups, respectively.</p> <p>Soil organic carbon change factors: Carbon change factors due to land-use and land-cover change (FLU), management regime (FMG) and additions (FI) were developed for reforestation, crop cultivation (no-till vs. conventional tillage) and pastures (natural/planted in good condition/planted in poor condition/degraded). The latter two were applied considering the proportions by FU/state from IBGE (2017).</p>	<p>Annualization of emissions (categories 4.A. to 4.E.): for the annualization of gross CO₂ emissions between the mapped years, annualization rates based on the annual deforestation of each biome were calculated to distribute gross emissions over the assessed period, when available; INPE's – National Institute for Space Research (Instituto Nacional de Pesquisas Espaciais) PRODES – Program to Calculate Deforestation in the Legal Amazon Region (Sistema de Monitoramento do Desmatamento na Amazônia Legal) (2024a) for the Amazon, Atlas of Forest Remnants of the Atlantic Forest for the Atlantic Forest (SOS Atlantic Forest Foundation) (Fundação SOS Mata Atlântica); INPE, 2020), PRODES Cerrado for the Cerrado (INPE, 2020), Atlas of Vegetation Cover Monitoring in the Upper Paraguay River Basin (SOS PANTANAL, 2020) and PMDBBS – Project of Satellite Deforestation Monitoring of the Brazilian Biomes (Projeto de Monitoramento do Desmatamento nos Biomas Brasileiros por Satélite) for Caatinga, Pampa (MMA – Ministry of the Environment (Ministério do Meio Ambiente), 2012). In the absence of annual deforestation data, the arithmetic average of emissions for the period was used. To estimate net emissions by biome, annualized gross CO₂ emissions were added to net soil emissions/removals and vegetation removals were subtracted (both distributed equally by year, with the exception of removals from natural formations within protected areas⁵)</p> <p>Emissions for the period from 2017 to 2022 (sub-sectors 4.A. to 4.E.): Gross CO₂ emissions were estimated using the surrogate data method (IPCC 2006⁶), based on annual deforestation data up to 2020 for the Amazon (INPE, 2020), Cerrado (INPE, 2020) and Atlantic Forest (SOS ATLANTIC FOREST FOUNDATION; INPE, 2020); up to 2019 for the Pantanal (SOS PANTANAL, 2020); and up to 2011 for the Caatinga and Pampa (MMA, 2012). In the absence of data for the years from 2017 to 2020, the values for the last year with available data were replicated.</p> <p>The 2016 data for removals from vegetation and soil emissions/removals were replicated. Net emissions by biome consisted of the sum of gross CO₂ emissions and net soil emissions/removals, minus the removals from vegetation.</p>
<p>Biomass burning associated with land-use and land-cover change – Emissions of Non-CO₂ gases</p> <p>Method: Emissions due to biomass burning associated with the conversion of natural formations to other uses were calculated using the 2006 IPCC Guidelines, Tiers 1 and 2. Emissions from fires have not been accounted for.</p>	<p>Combustion factors for each biome and vegetation structure were obtained from literature review. IPCC 2006 default EF (CH₄, N₂O, NO_x and CO) per ton of dry matter burnt, taking into account the differentiation between forestland, grassland and other wooded land.</p>	<p>Other assumptions or parameters for the estimated years</p>
<p>Activity data</p> <p>Based on gross CO₂ emissions from deforestation, it was possible to estimate the original dry matter of the vegetation before it was converted to other uses. From this original dry matter, the values for fuelwood and roundwood from wood harvesting were obtained (IBGE, 2020), thus, obtaining the dry matter remaining in the field and available for burning.</p> <p>Harvested Wood Products (HWP) (sub-sector 4.G)</p> <p>Method: IPCC 2006 atmospheric flow approach.</p>	<p>Emission factor (EF) and other parameters</p> <p>The unit conversion factors (density, carbon fraction and carbon factor) for i) roundwood, industrial roundwood; sawnwood, pulpwood, chips, particles, fuelwood, wood waste; ii) charcoal; iii) wood panels; iv) paper and paperboard, pulp, recycled fiber pulp and recycled paper were the IPCC 2006 default values.</p>	<p>Other assumptions or parameters for the estimated years</p>
<p>Activity data</p> <p>Production, imports and exports of sawnwood, wood panels, Paper and paperboard (FAO, 2024). Waste from wood, Paper and paperboard and waste from parks and gardens.</p>	<p>Emission factor (EF) and other parameters</p>	<p>Other assumptions or parameters for the estimated years</p>

DATAFRAME 6. METHODOLOGICAL LEVELS APPLIED BY GAS AND REFERENCES OF THE WASTE SECTOR

Sub-sector	Category	ESTIMATED GASES AND METHODOLOGIES			REFERENCES				
		Subcategories	CO ₂	CH ₄	N ₂ O	Activity data	Emission factors		
5.A SOLID WASTE DISPOSAL	5.A.1. Managed Waste Disposal Sites		NA	T2	NA	Population data: Demographic Census (1970; 1980; 1991; 2000; 2010; 2022); Population Estimates (1992 to 1995; 1997 to 1999; 2001 to 2009; 2011 to 2021) and Population Count (1996; 2007) (IBGE, 2010; 2015); Estimated gap for the 1970s and 1980s and 1994, using a degree 2 polynomial model; Public Cleaning and Garbage Removal (IBGE, 1980a; 1980b; 1988); National Sanitation Information System - SNIS (2003 to 2020) (MICID, 2020); National Basic Sanitation Survey - PNSB (Pesquisa Nacional de Saneamento Básico) (IBGE, 1994; 2000a; 2008b; 2017a); National Solid Waste Management Information System - SINIR (Sistema Nacional de Informações sobre a Gestão dos Resíduos Sólidos) (2015); PNAD - National Household Sample Survey (Pesquisa Nacional por Amostra de Domicílios) (1992; 1993; 1995; 1996-1999; 2001-2015) (IBGE, 2019b; 2019c) and PNADC (2016; 2017; 2018; 2019) (IBGE, 2020); recovered CH ₄ - Clean Development Mechanism (CDM) projects (UNFCCC, 2020).			Total population data (urban and rural) with waste collection from the National Sanitation Information System - SNIS (MICID, 2020) and the Brazilian Institute of Geography and Statistics - IBGE (IBGE, 1980; 1983; 2008). Degree 2 polynomial model based on data from IBGE (1980; 1983; 2008) and SNIS (2003 to 2020; MICID, 2018) on the total population served by Municipal Solid Waste (MSW) collection and the mass collected; The type of landfill in each municipality was obtained from information on the final disposal unit of all municipalities in Brazil (MMA - Ministry of the Environment (Ministério do Meio Ambiente), 2020) and the year in which landfills began operating (MICID, 2018); Average municipal data on mean annual temperature (MAT), mean annual precipitation (MAP) and potential evapotranspiration (PET) (INMET, 1970 to 2010); Gravimetric composition: Review of academic literature (scientific articles, congress annuals, books and theses) and states' solid waste plans (1963-2018); Volume 5, Chapter 3 (IPCC, 2006).
	5.A.2. Unmanaged Waste Disposal Sites		NA	IE	NA				
	5.A.3. Uncategorized Waste Disposal Sites		NA	T2	NA				
5.B. BIOLOGICAL TREATMENT OF SOLID WASTE	5.B.1. Composting		NA	T1	T1	Same as the information for the Solid Waste Disposal sub-sector (5.A).	Volume 5, Chapter 4 (IPCC, 2006).		
	5.B.2. Anaerobic Digestion at Biogas Facilities		NO	IE	NA	Energy generation from the burning of biogas: National Energy Balance (BEN, Balanço Energético Nacional)	Volume 5, Chapter 4, Table 4.1 (IPCC, 2006; v. 5, chap. 4, p. 4.6); Emissions in this category are allocated to the Energy sector (1.A) in the energy generation from biogas activities.		
5.C. INCINERATION AND OPEN BURNING OF WASTE	5.C.1. Waste Incineration	5.C.1.a. Biogenic	T1	NA	T1	Quantity of incinerated clinical waste obtained from the population of municipalities served with collection and mass collected from the National Basic Sanitation Survey - PNSB (IBGE, 1994; 2000a; 2008b)	Volume 5, Chapter 5 (IPCC, 2006)		
		5.C.1.b. Non-biogenic	T1	NA	T1		Volume 5, Chapter 5 (IPCC, 2006).		
	5.C.2. Open Burning of Waste		T2a	T1	T1	Population data from the Population Census (1991, 2000, 2010); National Household Sample Survey - PNAD (1992; 1993; 1995; 1996-1999; 2001-2015) (IBGE, 2019b; 2019c) and PNADC (2016; 2017; 2018; 2019) (IBGE, 2020); (years in between the Censuses); Gravimetric composition: Review of academic literature (scientific articles, congress annuals, books and theses) and states' solid waste plans (1963-2018).	Volume 5, Chapter 5 (IPCC, 2006).		
5.D. WASTEWATER TREATMENT AND DISCHARGE	5.D.1. Domestic Wastewater Treatment		NA	T2	T1	The states' urban population was estimated annually by simple bivariate linear regression for the years in between the population censuses (IBGE, 1970; 1980; 1991; 2000; 2010). The rural population was estimated by the difference between the total and the urban population. The treatment system data was obtained from PNAD (1992; 1993; 1995; 1996-1999; 2001-2015) (IBGE, 2019b; 2019c) and PNADC (2016; 2017; 2018; 2019) (IBGE, 2020) and the Population Census (1991, 2000; 2010). The fraction of the population served by each treatment technology was estimated using data from the National Basic Sanitation Plan - PNSB (IBGE, 2008).	Classification of treatment systems used in Brazil in the PNSB (IBGE, 2000a; 2008b; 2017a), with simple linear interpolation between periods, according to default values (IPCC, 2006) and Von Sperling (2015); Protein consumption from the World Food and Agriculture - Statistical Yearbook (FAO, 2009; 2022; 2023); S-DWW (ANDREOLI; VON SPERLING; FERNANDES, 2001); Volume 5, Chapter 6 (IPCC, 2006).		
	5.D.2. Industrial Wastewater Treatment		NA	T2	NE	Industrial production data: Sugar and Alcohol (UNICA - Brazilian Sugarcane Industry Association (União da Indústria de Cana-de-Açúcar) 2020); Raw milk (PPM - Municipal Livestock Research (Pesquisa da Pecuária Municipal) - IBGE 2020); Pasteurized Milk (ABLV - Brazilian Long-Life Milk Association (Associação Brasileira da Indústria de Leite Longa Vida), 2020); Pulp (IBA - Brazilian Tree Industry (Indústria Brasileira de Arvores), 2020); Beer, Poultry slaughtering, cattle and swine slaughtering (PIA - Annual Industrial Survey (Pesquisa Industrial Anual) IBGE, 2020).	Organic load (kg BOD/ton of product): Sugar (CTC, 1995; ELIA NETO <i>et al.</i> , 2009); Alcohol (ELIA NETO <i>et al.</i> , 2009); Cellulose (Michael <i>et al.</i> , 2015); Raw milk, Pasteurized milk, Beer, Poultry slaughtering, Cattle and swine slaughtering (BRASIL, 2015); S-DWW (ANDREOLI; VON SPERLING; FERNANDES, 2001); Volume 5, Chapter 6 (IPCC, 2006).		

Note: Methodological levels (IPCC, 2006) - T1: Tier 1; T2: Tier 2; T3: Tier 3; T3a: Tier 3a

Notations:

- NA - Not applicable - Activity in a given source/sink category that occurs in the country, but did not result in emissions or removals of a specific gas;
- IE - Included elsewhere - Included in another location/category of emissions or removals;
- NO - Not occurring - Categories and processes that do not occur in the country;
- NE - Not estimated - Activity data and/or emissions by sources and removals by sinks of GHG that have not been estimated, but for which a corresponding activity may occur in the country.



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