Initiative for Climate Action Transparency - ICAT -

Assessment of the emissions estimates up to 2030 (Reference Case Scenario) for pilot states and evaluation of their contribution to the Brazilian NDC targets

Initiative for Climate Action Transparency - ICAT -

Report with the evaluation of historical sectoral emissions and possible trends of the 3 (three) selected states

Deliverable #5

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1. Introduction

Centro Brasil no Clima (CBC), with technical support from Centro Clima/COPPE/UFRJ, and institutional support from the Brazilian Forum on Climate Change (FBMC), has already completed the first phase of a project establishing indicators to monitor the implementation of Brazilian NDC[1], the ICAT1 project. ICAT 2 project focuses on the MRV (measuring/monitoring, reporting and verification) process of Brazilian NDC at the subnational level. It will be based on the key achievements and lessons learned, from a technical point of view, in the ICAT 1 project.

ICAT 1 Project had the objective to develop a methodology to estimate the effect of different sets of mitigation actions (grouped in mitigation scenarios) in terms of avoided GHG emissions to help MRV of the progress achieved in the implementation of quantified commitments of the Brazilian NDC. To do so, the project elaborated three types of indicators: absolute emission indicators, emission driver indicators and intensity indicators.

To broaden national efforts toward the achievement of the NDC targets, the ICAT 2 Project will help subnational governments to understand how they can contribute to achieving the NDC commitments, prioritizing the development of actions and capacities at the state level. This new phase will build on the ICAT 1 Brazil project and will provide sets of state-level MRV indicators, promoting a sectoral mitigation approach to be implemented across the country. These indicators will allow the state governments to further establish an institutional arrangement for the collection, management and analysis of data that will assist them in adjusting and/or increasing their contribution to the Brazilian NDCs. At the same time, the project will support stakeholders, such as the Ministry of Science, Technology and Innovations (MCTI), local governments and civil society, in the task of monitoring and reporting Brazilian emissions and mitigation efforts.

For this purpose, the project has engaged with three states as pilot cases. Following a kick-off workshop involving stakeholders from many states, Rio de Janeiro, Minas Gerais, and Amazonas were those selected as pilot case. The aim of the pilot cases is to develop a process for estimating their potential contribution to the NDC and to develop emissions indicators to monitor their emissions trajectories. It will provide the basis for expanding these analyses to other states in the future.

In this second phase, the project goal is to estimate the potential of three selected states to contribute to the achievement of Brazilian NDC targets and to build MRV indicators (measuring/monitoring, reporting and verification) to follow-up the progress towards this end. To do so, the project uses the scenario building methodology. This tool helps to map a possible set of pathways into different plausible futures. A scenario is a set of hypothetical events set in the future constructed to clarify a possible chain of causal events as well as their decision points (Kahn et al, 1967). They are not predictions about the future but rather similar to simulations of some possible futures. They are a possible future story, an alternative future resulting from a combination of trends and policies. For example, the development of scenarios allows new

[1] Indicators for Progress Monitoring in the Achievement of NDC Targets in Brazil, ICAT/Centro Clima/CBC (2019).

insights into the opportunities and risks involved in making decisions about climate change policies that would have major consequences for the development of a region over the next few decades.

The first step (Output 3) was an assessment of historical sectoral GHG emissions of Rio de Janeiro, Minas Gerais and Amazonas states. The present report is an assessment of the current emissions trends from these states up to 2030 (Reference Case Scenario) and an evaluation of their contribution to the Brazilian NDC targets (Output 5 of the project). This assessment is based on information provided by the state administrations and GHG emissions projections for Brazil up to 2050, based on preliminary results of an undergoing study (DDP-BIICS project – see Appendix for further details). The GHG emissions growth rates by sector were elicited from DDP-BIICS project. Although there was an attempt to standardize the information, the approach used in each state was adapted to the specificities of the available information.

This report accounts for GHG emissions from the three states in the following sectors: AFOLU, Transport, Industry, Other sectors of energy use, Energy supply and Waste.

The Reference Scenario considers the pre-NDC Brazilian commitments to the UNFCCC as well as the current mitigation actions supporting the achievement of NDC targets. This assessment allows a more realistic assumption of a baseline for 2025 and 2030 and the real effort still needed to meet NDC targets. Next step (Output 6) will be a report with an assessment of the mitigation actions that could be implemented in the three selected states in order to increase mitigation levels (Mitigation Scenario) and their potential contribution to meet Brazilian NDC targets.

Future steps include the elaboration of a set of MRV indicators (Output 7) to track down the GHG emissions pathways relevant to each state and consistent with the national indicators proposed in Phase 1 of ICAT Project in Brazil.

2. General Projection Assumptions

Amazonas, Minas Gerais and Rio de Janeiro state sectorial emissions were projected based on each state GHG inventories and the emissions growth rates of each economy sector in Brazil modeled in both ICAT 1 project, for the period of 2015 until 2018, and in the DDP-BIICS project, for the period of 2019 until 2030.

DDP-BIICS is an international project to pool the strengths of governments and the private sector in low-carbon strategies in emerging countries: Brazil, India, Indonesia, and South Africa. The project aims to build decarbonization scenarios for Brazil up to 2050. Besides a Deep Decarbonization Scenario – DDS built to reach climate neutrality in 2050, the study also designed a Reference Case, including the projection into the future of current mitigation policies and measures (a Current Policies Scenario – CPS). The emissions projections used in this report are based on sectoral and macroeconomic results of the Current Policies Scenarios – CPS designed in the DDP-BIICS project (see details in the Appendix).

Recently, Brazil has faced one of the most serious recessions in history. After the strong decline of the economy from 2015 to 2020 due to a political-economic crisis and then the crisis of COVID-19, GDP has fallen by approximately 6% in the last year. Our assumption is that the Brazilian economy will grow again in 2021, but at a slower pace: 3.5% in 2021 and 2.5% per year from 2021 to 2030. Table 1 depicts the average growth rate of Brazilian economy, with projected evolution up to 2030.

Table 1. Real GDP Growth (% per year) – Historic data and projection

Period	Annual GDP growth rate
2015	-3.8%
2016	-3.6%
2017	1.1%
2018	1.3%
2019	1.1%
2020	-5.6%
2021	3.5%
2021 – 2030	2.5%

Source: Ipeadata (2019) and DDP BIICS project.

Brazil is a major player in agricultural commodities production and accounts for one of the largest cattle herds in the world. Pressure on land use is linked to this profile: deforestation is associated to the expansion of agricultural frontiers and demand for pastures. Agriculture and husbandry themselves are high-emitting activities, including non-CO2 gases related mainly to enteric fermentation and others. For each state, agriculture and livestock emissions projections were made based on the average sectorial emissions of the last years available data and following the projection of growth in the sector's emissions for Brazil.

Land use-related emissions dropped drastically from 2004 to 2012, as a result of efforts to curb deforestation (Assunção, Gandour, & Rocha, 2015). In the 2013–2020 period, there was a reversal in the downward trend in the Amazon deforestation levels with high deforestation rates taking place also in the Cerrado biome (INPE, 2020). An increase in protected areas is not expected until 2050, maintaining a size equivalent to that of 2019. Land use-related emissions varied widely over the years. Therefore, for the states LULUCF emission projection, were used the average sectorial emissions of the last years available data and maintained constant until the end of the analysis period (2030).

The Brazilian energy mix is favored by a huge endowment of renewable energy resources. In 2019, they account for 46% of total energy (EPE, 2020). Renewables represent 83% of total electricity supply, in which hydropower stands out (EPE, 2020). The use of renewable biomass also contributes to a relatively clean energy sector. Mandatory blend shares for ethanol in gasoline (27%) and biodiesel in diesel (currently 12%, expected to increase up to 15% in 2023 (CNPE, 2020)) were established, and nearly 10% of the Brazilian steelmaking industry uses charcoal instead of fossil fuels (IABR, 2020). Nonetheless, emissions related to the use of fossil energy have been increasing significantly, from oil products, natural gas and coal, driven by economic growth, the rising urbanization and the dominance of road transportation. Their share in power generation has also been increasing, in order to complement the use of the huge Brazilian hydropower potential (LA ROVERE *et al.*, 2014). Estimates of state emissions in the electricity production supply sector use the growth rates of coal and natural gas thermoelectric generation in Brazil modeled on the DDP-BIICS project. Emissions projections from energy use in industry, transport, agriculture, residential, commercial, and public sectors and fugitive emissions followed the same Brazil's emissions growth rate of each sector in the DDP-BIICS project. Emissions growth rates were applied from the last year of available data.

Brazilian emissions from industrial processes and product use and waste are minor compared to the sectors mentioned above but, they are expected to increase in accordance to urbanization rates, higher income and economic growth (MARTÍNEZ-ZARZOSO and MARUOTTI, 2011; CHEN, TIMILSINA and LANDIS, 2013; LA ROVERE *et al.*, 2014). States' emissions from industrial processes and product use, which are mostly driven by economic growth, were projected using the emissions growth rate of each industrial sector in Brazil. State emissions from urban solid waste and domestic wastewater followed the same Brazil's growth rate for these sectors, while industrial solid waste and wastewater emissions were projected using the emissions growth rate of the Food and Beverages industrial sector in Brazil, because it has higher organic load that contributes to the waste emissions.

3. State of Rio de Janeiro

The historical emissions from the Rio de Janeiro State are from the GHG Emissions Inventory published by the state in 2017, with 2005, 2010 and 2015 data. The inventory used the methodology described in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006) and the GWP of the Fifth Assessment Report – AR5 (IPCC, 2013). From 2016 to 2030, the data for each economy sector were projected based on Rio de Janeiro state historical emissions, specific sectorial assumptions, and the emissions growth rate in each sector in Brazil according to the CPS of DDP-BIICS project.

3.1. Sectorial projections results

a) AFOLU

The Agriculture, Forestry and Other Land Use (AFOLU) describes the GHG emissions from two distinct subsectors: LULUCF (Land Use, Land Use Change and Forestry) and Agriculture. Emissions and removals related to forest and other land use are covered under LULUCF. Agriculture includes emissions from crops (i.e. rice cultivation, prescribed burning of savannas and grassland, and from soils) and livestock (i.e. enteric fermentation, manure management).

I. LULUCF

Historical LULUCF data were obtained from land use and cover maps provided by the State Institute for the Environment of Rio de Janeiro (in Portuguese Instituto Estadual do Meio Ambiente - INEA), so it takes into consideration the emissions from deforestation (loss of biomass due to the suppression of areas of forests, sandbank, pastures and agriculture) and the removals from mangrove areas, reforestation and carbon in the biomass of secondary vegetation in protected areas (Conservation Units and Indigenous Lands). The projections were calculated using the average deforestation and removals of 2010 (-0.2 Mt CO_2e) and 2015 (-0.4 Mt CO_2e) and this value remains constant (-0.3 Mt CO_2e/year) until the end of the analyzed period (2030).

Land Use Land-Use Change and Forestry (LULUCF) subsector includes emissions from land use changes and removals from protected areas and reforestation, reported by INEA. Comparing the years of 2005, 2010 and 2015, it is possible to observe a considerable reduction in GHG emissions from LULUCF in the State. This reduction is mainly due to deforestation reduction and the increase of protected areas, land use emissions started to be negative in 2010 with this carbon removal. LULUCF emissions reduced 106% in 2015 compared to 2005. In general, this indicates a decrease in intensity of anthropic pressure on areas with natural vegetation cover in the State of Rio de Janeiro. Therefore, net emissions remain negative throughout the analyzed period.

Regarding the emissions projection from 2016 until 2030, LULUCF subsector emissions remained constant (-0.3 Mt CO_2e/year) because of the methodology adopted. Therefore, emissions during the entire period reduced 104%, from 2005 to 2025 and 2005 to 2030.

II. Agriculture

GHG agricultural emissions includes emissions from crops and livestock that remained relatively constant with 0.5% increase over the historical period (2005-2015). Projections of GHG emissions from crops and livestock in the period 2016-2030 were based on the average emissions level from 2005 to 2015 (or the most recent period of available data) in each agricultural sector. The same emissions growth rate assumed for Brazil in ICAT 1 project (2016-2018) and in the CPS of DDP-BIICS project (2019-2030). Regarding to the emissions projection from 2016 until 2030, agriculture subsector emissions remained relatively constant, with a slight increase.

Regarding the emissions during the entire analyzed period, agriculture subsector emissions, which includes both crops and livestock, increased 2% from 2005 to 2025 and 1% from 2005 to 2030.

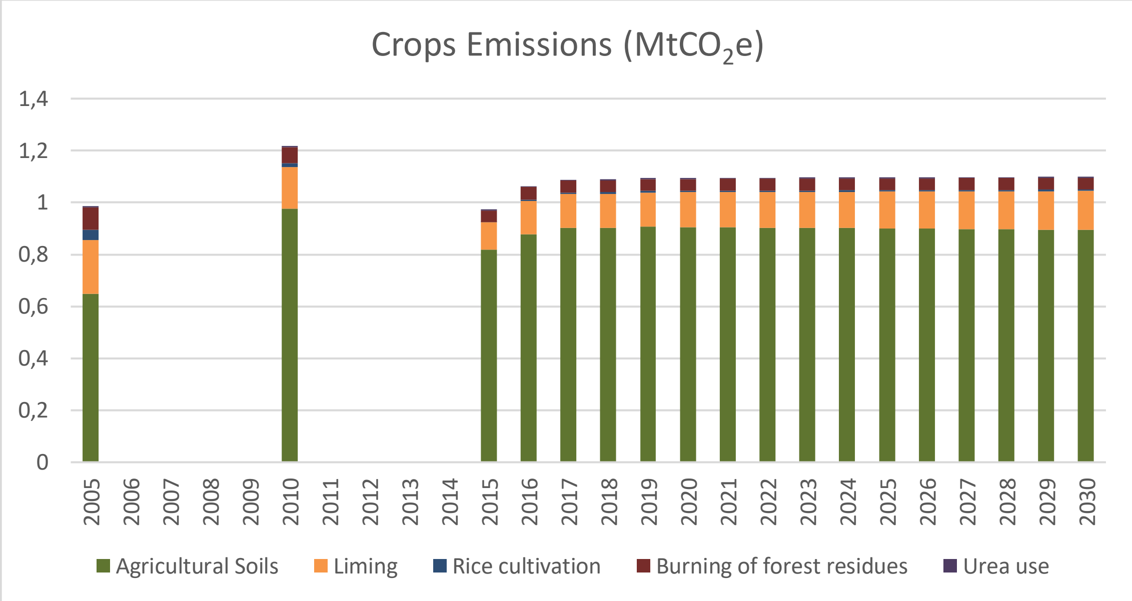
Crops

Crops are the second largest source of emissions in the agriculture sector and the activities associated with agricultural soil are the main emission source in this subsector, which increase 38% in 2030 in relation to 2005 (Table 2 and Figure **1**).

Table 2. Emissions from crops by subsectors from the State of Rio de Janeiro (Mt CO_2e and %)

Sector	2005	2010	2015	2020	2025	2030	2005-2025	2005-2030
	Mt CO_2e						%	
Crops	**0.99**	**1.22**	**0.97**	**1.09**	**1.10**	**1.10**	**11%**	**11%**
Liming	0.21	0.16	0.11	0.13	0.14	0.15	-32%	-28%
Rice cultivation	0.04	0.01	0.001	0.01	0.01	0.01	-86%	-87%
Burning of forest residues	0.09	0.06	0.05	0.05	0.05	0.05	-48%	-49%
Agricultural Soils	0.65	0.98	0.82	0.91	0.90	0.90	39%	38%
Urea fertilization	0.0040	0.0040	0.0040	0.0040	0.0039	0.0039	-1%	-4%

Note: Historical emission data from 2005 to 2015 and projections from 2016 to 2030.



Note: Historical emission data from 2005 to 2015 and projections from 2016 to 2030

Figure 1. Emissions from crops by subsectors from the State of Rio de Janeiro (Mt CO_2e)

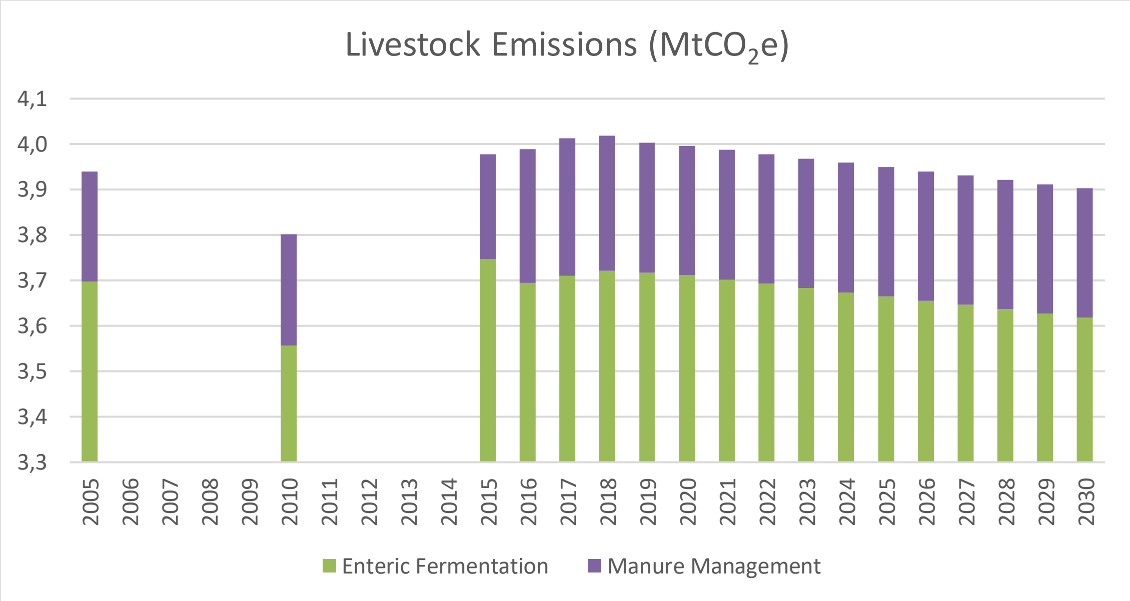
Livestock

Livestock is the main emission source in the agriculture subsector led by enteric fermentation. However, the enteric fermentation emissions are remaining stable during the period, with a 2% reduction from 2005 to 2030 (Table 3 and Figure 2).

Table 3. Emissions from Livestock by subsectors from the State of Rio de Janeiro (Mt CO_2e and %)

Sector	2005	2010	2015	2020	2025	2030	2005-2025	2005-2030
	Mt CO_2e						%	
Livestock	**3.94**	**3.80**	**3.98**	**4.00**	**3.95**	**3.90**	**0.2%**	**-1%**
Enteric Fermentation	3.70	3.56	3.75	3.71	3.66	3.62	-1%	-2%
Manure Management	0.24	0.25	0.23	0.28	0.28	0.28	17%	17%

Note: Historical emission data from 2005 to 2015 and projections from 2016 to 2030.



Note: Historical emission data from 2005 to 2015 and projections from 2016 to 2030.

Figure 2. Emissions from livestock by subsectors from the State of Rio de Janeiro (Mt CO_2e)

III. AFOLU consolidated results

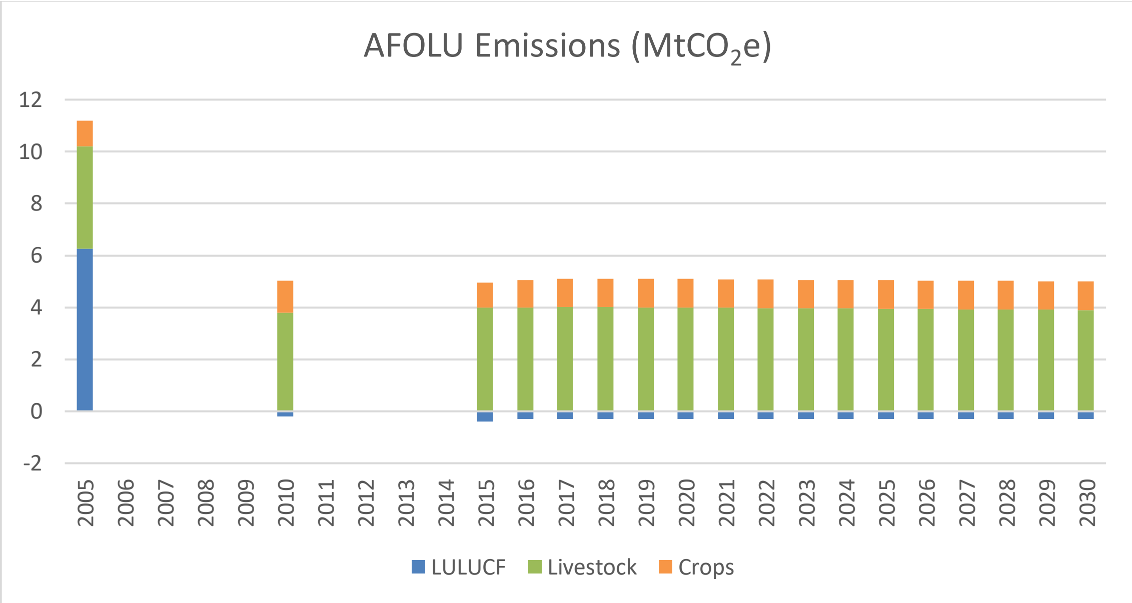
Historical GHG emissions data for the AFOLU sector, in the period 2005-2015, showed a significant drop of 59%. This is mainly due to the contribution of land use (LULUCF) emissions that have been negative since 2010, thanks to the reduction of deforestation rates and the increase of protected areas.

Considering the emissions projections above, from 2016 until 2030, there is an increase of 3% AFOLU emissions in 2030 compared to 2015 (most recent period of available data). Emissions from the AFOLU sector, which includes emissions and removals, decreased compared to 2005 by 58% in 2025 and 58% in 2030. In the whole period, the reduction was mainly due to the contribution of negative land use emissions, because of carbon removals (Table 4 and Figure 3).

Table 4. Emissions from Agriculture, Forestry and Other Land Use (AFOLU) Sector from the State of Rio de Janeiro (Mt CO_2e and %)

Sector	2005	2010	2015	2020	2025	2030	2005-2025	2005-2030
	Mt CO_2e						%	
Land use	6.26	-0.20	-0.40	-0.30	-0.30	-0.30	-105%	-105%
Agriculture	4.93	5.02	4.95	5.09	5.05	5.00	2%	1%
Livestock	3.94	3.80	3.98	4.00	3.95	3.90	0.2%	-1%
Crops	0.99	1.22	0.97	1.09	1.10	1.10	11%	11%
AFOLU	**11.20**	**4.82**	**4.56**	**4.80**	**4.75**	**4.71**	**-58%**	**-58%**

Note: Historical emission data from 2005 to 2015 and projections from 2016 to 2030.



Note: Historical emission data from 2005 to 2015 and projections from 2016 to 2030.

Figure 3. Emissions from Agriculture, Forestry and Other Land Use (AFOLU) Sector from the State of Rio de Janeiro (Mt CO_2e)

b) Transport

Historical emission data from the Transport sector, during 2005 until 2015, showed a significant increase of 33%, road transport being the main one, responsible for about 75% of the total emissions. In this modal the greatest emission comes from diesel oil, mostly used by cargo and mass transportation.

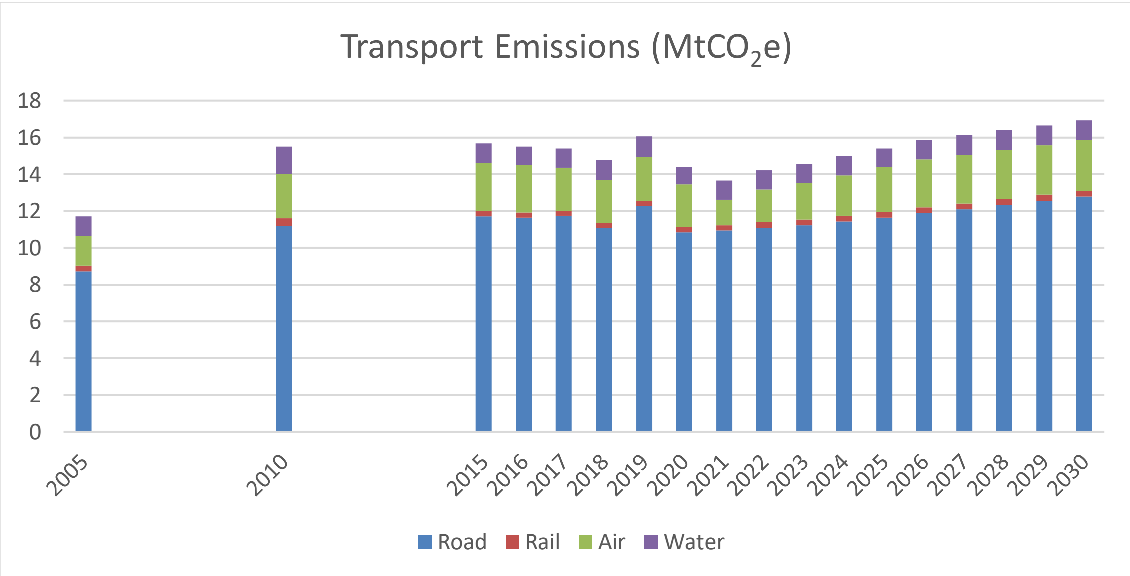
The transport emissions estimate in Rio de Janeiro state were made using the emissions growth rate calculated with data from the National Energy Balance (in Portuguese, Balanço Energético Nacional – BEN) for the period of 2016 until 2018 (years between inventory data and DDP-BIICS estimates), using emissions factors for each fuel type and mode, and using the emissions growth rate in the CPS of DDP-BIICS project for the period of 2019 until 2030, for each modal. From 2018 to 2030 Brazilian transport emissions, according to the CPS of DDP-BIICS project, vary as follows: 0.14% in water, 8% in rail, 15% in air and 15% in road. Emissions growth rates were applied from the last year of available data.

According to this methodology, emissions projection from 2016 until 2030 showed a slight increase. Emissions from transport subsector increase by 31% in 2025 and 43% in 2030 compared to 2005. Road transport remains the largest contribution, corresponding to 75% of the emissions in 2030. However, the transport mode which emissions have increased the most is air transport, with a variation of 71% during the whole period. Table 5 and Figure 4 shows emissions in the analyzed years for all transportation modes.

Table 5.Emissions from the transport modes from the State of Rio de Janeiro (Mt CO_2e and %)

Sector	2005	2010	2015	2020	2025	2030	2005-2025	2005-2030
	Mt CO_2e						%	
Road	8.70	11.20	11.70	10.83	11.65	12.77	34%	47%
Rail	0.32	0.41	0.29	0.28	0.30	0.32	-6%	2%
Air	1.60	2.40	2.60	2.35	2.43	2.74	52%	71%
Water	1.10	1.50	1.10	0.93	1.03	1.09	-6%	-1%
Transport (Total)	**11.80**	**15.60**	**15.70**	**14.39**	**15.41**	**16.92**	**31%**	**43%**

Note: Historical emission data from 2005 to 2015 and projections from 2016 to 2030.



Note: Historical emission data from 2005 to 2015 and projections from 2016 to 2030.

Figure 4. Emissions from the transport modes from the State of Rio de Janeiro (Mt CO_2e)

c) Industry

Historical emission data from the Industry sector, including both IPPU and Energy Use emissions, during the period of 2005 until 2015, showed a significant increase of 44%. Metallurgical is the main industrial sector in terms of GHG emissions in the State of Rio de Janeiro.

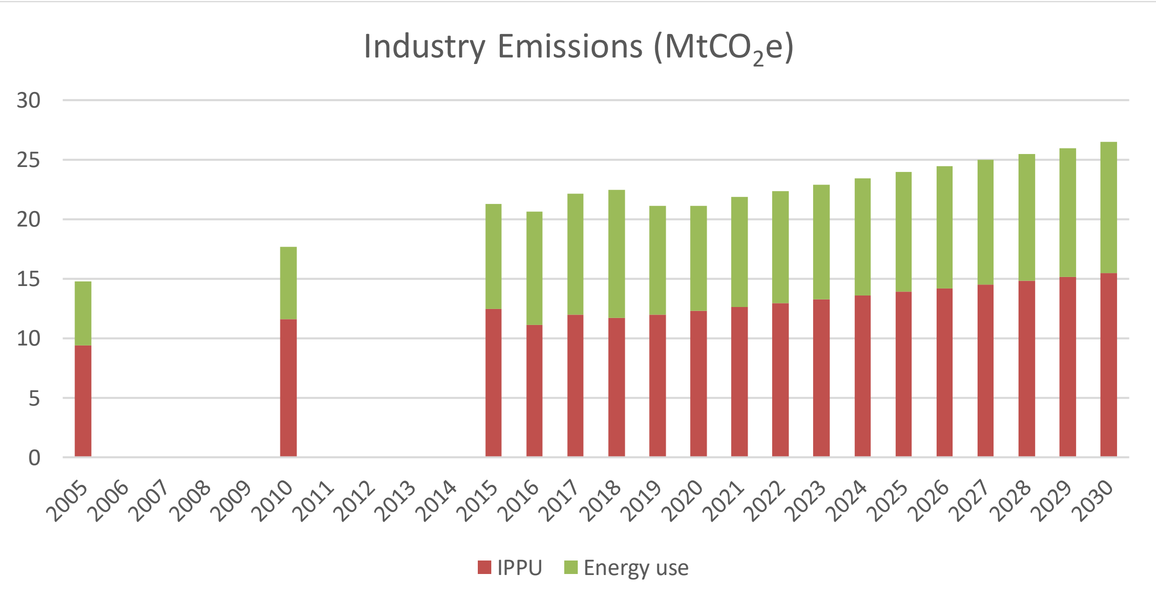
For the period 2016-2030, the industry emissions from the Rio de Janeiro state comprising both IPPU and Energy Use follow the same Brazil's growth rate of each industrial sector available in both ICAT 1 project (2016-2018) and the CPS of DDP-BIICS project (2019- 2030). The estimates include the following sectors: Food and beverage, Cement, Iron and steel, Non-Ferrous and Other Metallurgy, Pulp and paper, Chemical and Rest of industry, which consists of an aggregate of the other existing industries in the state. Emissions growth rates were applied from the last year of available data. The reference scenario follows the trend of historical values presented for the state of Rio de Janeiro, with IPPU representing a greater weight in the emissions when compared to the energy use. Emissions projections from both IPPU and energy use increased during the period of analysis. Total industry emissions increased by 62% in 2025 and 79% in 2030 compared to 2005. Table 6 and Figure 5 shows emissions in the analyzed years for IPPU and energy use.

Table 6.Emissions from Industry Sector - energy use and Industrial Processes and Product Use (IPPU) - from the State of Rio de Janeiro (Mt CO_2e and %)

Source	2005	2010	2015	2020	2025	2030	2005-2025	2005-2030
	Mt CO_2e						%	
IPPU	9.38	11.58	12.48	12.29	13.89	15.48	48%	65%
Energy use[1]	5.42	6.12	8.82	8.84	10.10	11.02	86%	103%
Total	**14.80**	**17.70**	**21.30**	**21.12**	**23.99**	**26.50**	**62%**	**79%**

[1]Scope 1 and 2

Note: Historical emission data from 2005 to 2015 and projections from 2016 to 2030.



Note: Historical emission data from 2005 to 2015 and projections from 2016 to 2030.

Figure 5. Emissions from Industry - energy use and Industrial Processes and Product Use (IPPU) - from the State of Rio de Janeiro (Mt CO_2e)

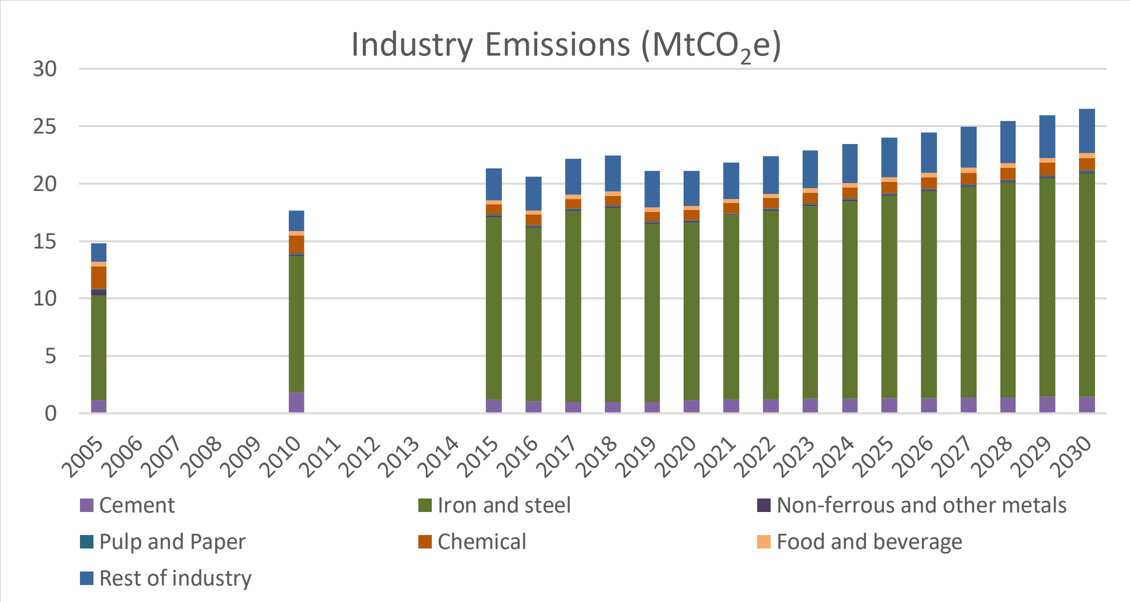
Emissions over the years follow a relatively stable pattern, with iron and steel representing most of the emissions (73% of the emissions in 2030), followed by cement and chemical subsectors.

Iron and steel is the Industry branch that has emitted the most historically and it's emissions are continuously increasing: 94% in 2025 compared to 2005 and 114% in 2030 compared to 2005. Compared to 2005, emissions from the cement industry increase 16% in 2025 and 29% in 2030, whereas emissions from the chemical industry reduce 49% in 2025 and 44% in 2030.Table 7 and Figure 6 show emissions in the analyzed years for all industries of the Rio de Janeiro state.

Table 7. Emissions from Industry Sector- energy use and Industrial Processes and Product Use (IPPU) - from the State of Rio de Janeiro (Mt CO_2e and %)

Source	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2005-2025**	**2005-2030**
	Mt CO_2e						**%**	
Cement	1.13	1.84	1.21	1.15	1.31	1.46	15%	29%
Iron and steel	9.09	11.88	15.88	15.47	17.62	19.44	94%	114%
Non-Ferrous Metals and Other	0.53	0.11	0.11	0.10	0.11	0.12	-80%	-78%
Pulp and Paper	0.10	0.11	0.10	0.10	0.11	0.13	14%	28%
Chemical	1.96	1.52	0.91	0.89	1.00	1.10	-49%	-44%
Food and beverage	0.41	0.40	0.36	0.36	0.40	0.44	-3%	7%
Rest of industry	1.57	1.81	2.77	3.07	3.45	3.82	120%	143%
Total	**14.80**	**17.70**	**21.30**	**21.12**	**23.99**	**26.50**	**62%**	**79%**

Note: Historical emission data from 2005 to 2015 and projections from 2016 to 2030.



Note: Historical emission data from 2005 to 2015 and projections from 2016 to 2030.

Figure 6. Emissions from industry sector - Energy Use and Industrial Processes and Product Use (IPPU) - from the State of Rio de Janeiro (Mt CO_2e)

d) Other sectors of energy use

Historical emission data from energy use in agriculture, residential, commercial, and public sectors, during the period of 2005 until 2015, showed a significant increase of 95%. The residential sector is the largest emitter, followed by the commercial and public sectors. There is a large increase in emissions from the commercial and public sectors in the period. The only sector that has reduced its emissions is agriculture, although the sector's GDP has grown in the period.

Rio de Janeiro state emissions projections from energy use in agriculture, residential, commercial, and public sectors followed the same Brazil's growth rates of each sector in both ICAT 1 project (2016-2018), and the CPS of DDP-BIICS project (2019-2030). Emissions growth rates were applied from the last year of available data.

From 2016 to 2030, agriculture energy use emissions were projected based on the average emissions from 2010 to 2015, using the growth rates of energy-related emissions from the agriculture sector in the CPS of DDP-BIICS project (increase 11% from 2019 to 2030). Emissions from the commercial and public sectors decline following the negative growth rate of Brazilian emissions for these sectors (13% reduction from 2019 to 2030) while residential ones follow the emissions growth rate from Brazilian buildings also according to the CPS of DDP-BIICS project (12% increase from 2019 to 2030).

According to this methodology, emissions projection from 2016 until 2030 presented a very slight variation: residential emissions increased slightly; commercial emissions reduced slightly; public emissions reduced slightly; and agriculture remained almost constant.

From 2005 until 2030, there was a substantial increase in emissions from the use of energy in almost all subsectors, except for agriculture, which reduced its emissions. Compared to 2005, the agricultural sector reduces 29% in 2025 and 35.16% in 2030.

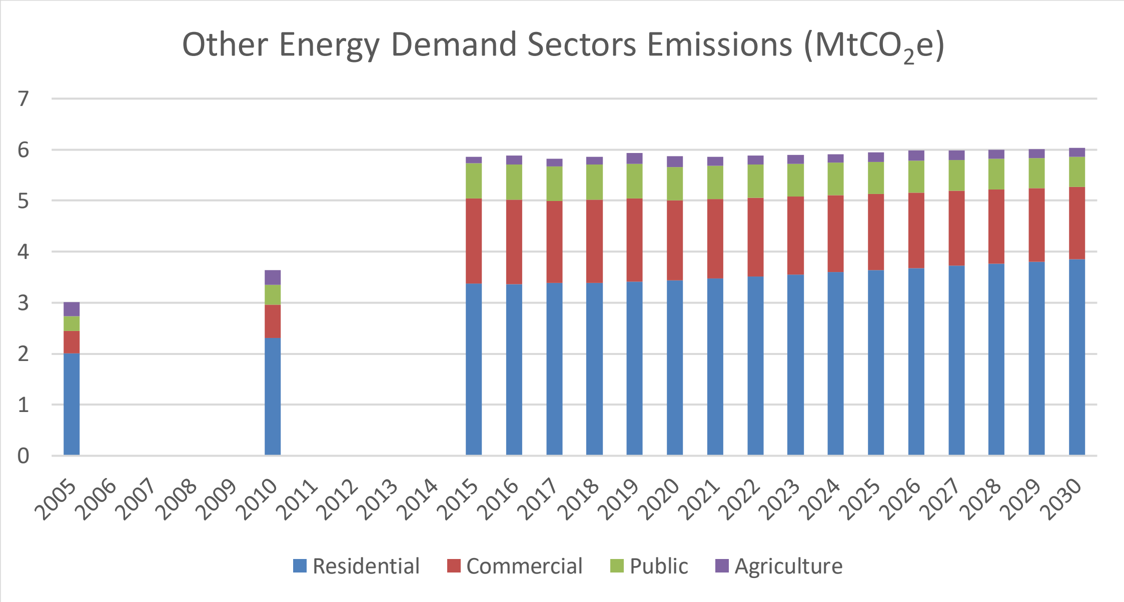
In the residential sector, energy emissions include only the final energy consumption and remains the largest contribution to the total Other sectors of energy use emissions, corresponding to 64% in 2030. Compared to 2005, the residential sector increases 81% in 2025 and 91% in 2030. Nevertheless, the commercial sector represents the sharpest increase, 240% in 2025 and 222% in 2030 compared to 2005. Table 8 and Figure 7 show emissions in the analyzed years for these energy sectors.

Table 8. Emissions from Other sectors of energy use from the State of Rio de Janeiro (Mt CO_2e and %)

Sector	2005	2010	2015	2020	2025	2030	2005-2025	2005-2030
	Mt CO_2e						%	
Residential[1]	2.01	2.31	3.38	3.43	3.64	3.85	81%	91%
Commercial[1]	0.44	0.65	1.66	1.58	1.50	1.42	240%	222%
Public[1]	0.29	0.39	0.69	0.66	0.62	0.59	115%	103%
Agriculture[1]	0.27	0.29	0.13	0.21	0.19	0.18	-29%	-35%
Total	**3.01**	**3.65**	**5.86**	**5.88**	**5.95**	**6.03**	**98%**	**100%**

[1]Scope 1 and 2

Note: Historical emission data from 2005 to 2015 and projections from 2016 to 2030.



Note: Historical emission data from 2005 to 2015 and projections from 2016 to 2030.

Figure 7. Emissions from Other sectors of energy use from the State of Rio de Janeiro (Mt CO_2e)

e) Energy Supply

Historical emission data from the Energy Supply sector, during the period of 2005 until 2015, showed a significant increase of 113%. There is a substantial increase in emissions from thermoelectric generation and in the consumption of the energy sector itself in all the years analyzed.

Rio de Janeiro state emissions projections from energy supply comprise the activities of exploitation, transportation and refining of oil and gas, the transformation centers, and the energy sector's own consumption. Both fuel combustion and fugitive emissions are accounted. Emissions projection followed the same Brazil's growth rates of each sector in both ICAT 1 project (2016-2018) and the CPS of DDP-BIICS project (2019- 2030). Emissions growth rates were applied from the last year of available data of each state inventory. Emissions estimates from power generation for the years with no data provided by the inventory follow the growth rates of coal and natural gas thermoelectric generation in Brazil obtained in the National Energy Balance (in Portuguese, Balanço Energético Nacional – BEN), from 2016-2018, and from the CPS of DDP-BIICS project, from 2019 until 2030. The Energy sector's own consumption estimates assume constant efficiency. In other words, for their own consumption emissions, the 2015 ratio to the Transformation Centers emissions was kept constant until the end of the analyzed period (2030). Fugitive, charcoal production and coke production state emissions projection followed the same Brazil's growth rate of each sector in both ICAT 1 and the CPS of DDP-BIICS project, from 2015 until 2030. Emissions growth rates were applied from the last year of available data.

According to this methodology, emissions projection of the energy sector, from 2016 until 2030, increased. There was a significant drop from 2015 to 2016 and from 2020 to 2030 there was a progressive increase. Considering the different emission sources, during the projected period:

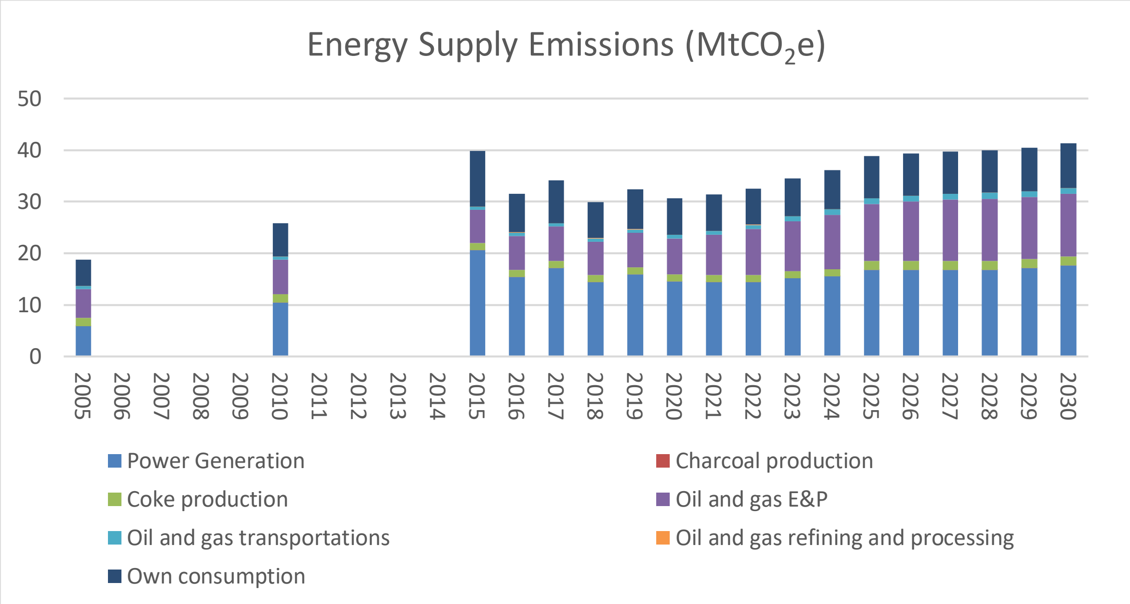
power generation emissions decreased; Oil and gas E&P increased; Own consumption emissions increased; and the others have nearly stabilized.

There is a substantial increase in total energy emissions compared to 2005: 108% in 2025 and 121% in 2030. Electricity generation represents one of the largest emission sources of the energy supply sector and presents the largest increases during the period: 184% in 2025 and 199% in 2030. Fugitive emissions are also significant within the sector, mainly because of the Oil and gas E&P activities, which increased by 99% in 2025 and 117% in 2030 compared to 2005. Table 9 and Figure 8 show emissions in the analyzed years for these energy sectors.

Table 9.Energy supply emissions by sector from the State of Rio de Janeiro in the period 2005-2030 (Mt CO_2e and %)

Sector	2005	2010	2015	2020	2025	2030	2005-2025	2005-2030
	Mt CO_2e						%	
Fugitive	6.18	7.28	7.10	7.69	12.18	13.32	97 %	115%
Oil and gas E&P	5.58	6.62	6.45	6.99	11.08	12.12	99%	117%
Oil and gas transportations	0.56	0.62	0.61	0.67	1.06	1.15	87%	105%
Oil and gas refining and processing	0.04	0.04	0.03	0.03	0.04	0.04	0.7%	13%
Fuel combustion	12.53	18.53	32.69	23.00	26.68	27.98	113%	123%
Power Generation	5.90	10.50	20.60	14.53	16.78	17.65	184%	199%
Charcoal production	0.00	0.00	0.00	0.00	0.00	0.00	40%	75%
Coke production	1.64	1.61	1.39	1.39	1.74	1.74	6%	6%
Own consumption	4.99	6.42	10.70	7.07	8.16	8.59	64%	72%
Total	**18.71**	**25.81**	**39.79**	**30.69**	**38.86**	**41.30**	**108%**	**121%**

Note: Historical emission data from 2005 to 2015 and projections from 2016 to 2030.



Note: Historical emission data from 2005 to 2015 and projections from 2016 to 2030.

Figure 8. Energy supply emissions by sector from the State of Rio de Janeiro in the period 2005-2030 (Mt CO_2e)

f) Waste – Solid waste and wastewater

During the period of 2005 until 2015, historical emission data from the Waste sector reduced 18% because of the implementation of the State Policy on Solid Waste that aimed at implementing a program to create new managed landfills in the state.

Rio de Janeiro state emissions projections from the waste sector followed same Brazil's growth rate of each sector in both ICAT 1project (2016-2018) and CPS of DDP-BIICS project (2019-2030). Projections for urban solid waste and domestic wastewater evolved at the same rates as Brazil's total waste emissions in the CPS of DDP-BIICS projection (increase 5% from 2019 to 2030), while industrial solid waste emissions and industrial wastewater were projected using the emissions growth rate of Food and Beverages industrial sector in Brazil (an increase of 19% from 2019 to 2030). Emissions growth rates were applied from the last year of available data.

According to this methodology, the waste sector's emissions projection increased slightly from 2016 until 2030. The Urban Solid Wastes subsector mainly drove this increase since the other subsectors have nearly stabilized.

GHG emissions from the waste sector increase by 11% between 2005 and 2025 and 14% between 2005 and 2030. The main source of emission is the urban solid wastes, which represent 65% of the emissions in 2030. However, projected emissions are virtually stable: they decreased by 2% between 2005 and 2025 and 1% between 2005 and 2030.

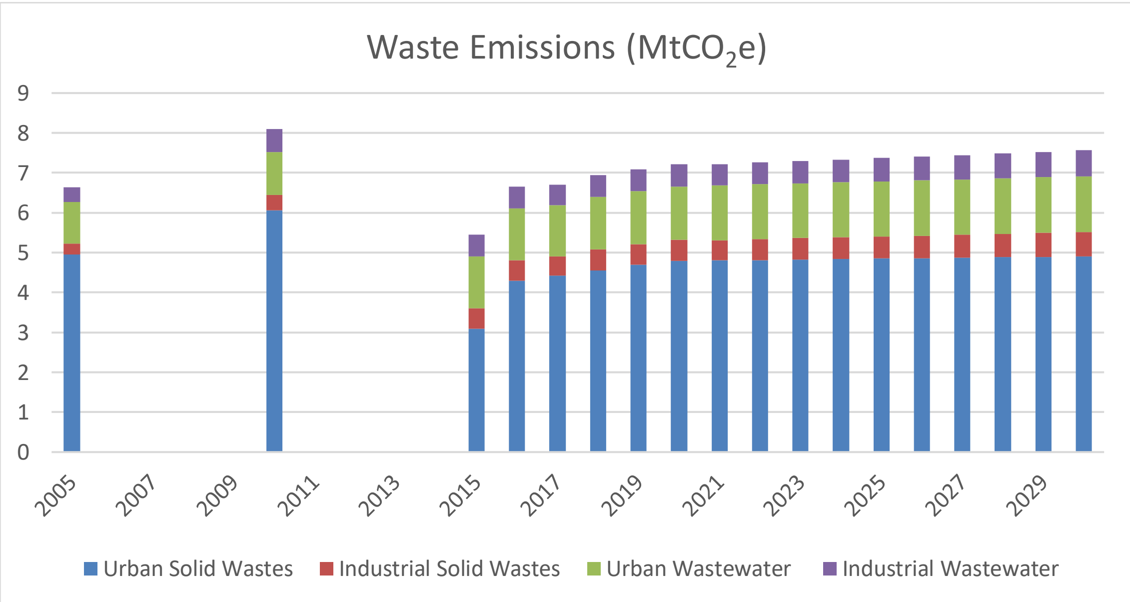
The largest increase in emissions is projected to the industrial solid wastes, which increased by 100% between 2005 and 2025 and 121% between 2005 and 2030, and to the Industrial Wastewater, which increase by 59% between 2005 and 2025 and 76% between 2005 and 2030.

Table 10 and Figure 9 show each subsector's contribution in the total waste emissions and their evolution over the analyzed period.

Table 10. Emissions of the Waste Sector from the State of Rio de Janeiro (Mt CO_2e and %)

Sector	2005	2010	2015	2020	2025	2030	2005-2025	2005-2030
	Mt CO_2e						%	
Urban Solid Wastes	4.95	6.06	3.09	4.79	4.85	4.91	-2%	-1%
Industrial Solid Wastes	0.28	0.38	0.51	0.53	0.55	0.61	100%	121%
Urban Wastewater	1.04	1.08	1.31	1.34	1.38	1.40	33%	34%
Industrial Wastewater	0.37	0.57	0.54	0.55	0.58	0.64	59%	76%
Total	**6.64**	**8.09**	**5.46**	**7.11**	**7.36**	**7.55**	**11%**	**14%**

Note: Historical emission data from 2005 to 2015 and projections from 2016 to 2030.



Note: Historical emission data from 2005 to 2015 and projections from 2016 to 2030.
Figure 9. Emissions of the Waste Sector from the State of Rio de Janeiro (Mt CO_2e)

3.2. Conclusion

Rio de Janeiro's GHG historical data emissions in 2005 accounted for 66.1 MtCO_2e. The projections made show that GHG emissions in the reference scenario – emissions that would occur in the absence of additional mitigation policies and projects– would reach 96.3 Mt CO_2e in 2025, an increase of 46%%, and 103 Mt CO_2e in 2030, an increase of 56% (Table 11 and Figure 10).

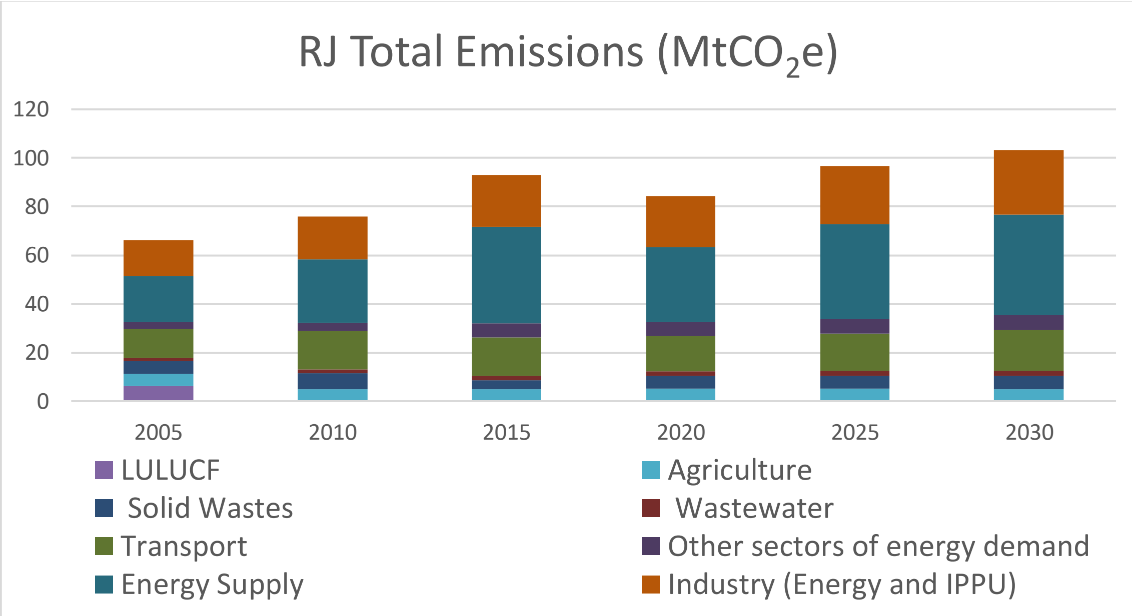
Regarding the evolution of sectoral emissions, three sectors are responsible for 82% of emissions in 2030: transport, energy supply and industry. In 2005 those sectors accounted for 68% of state emissions.

Ranking the emissions rate of increase in the period 2005-2030, the energy supply sector stands out with an increase of 120%, followed by the Other sectors of energy use sector (100%) and the Industry sector (79%). The only sector where emissions reduce is LULUCF, a 105% reduction; however, this sector has a small share in the overall calculation.

Table 11. Emissions of the State of Rio de Janeiro by sectors in the period 2005-2030 (Mt CO_2e and %)

Sector	2005	2010	2015	2020	2025	2030	2025/2005	2030/2005
	Mt CO_2e						%	
AFOLU	11.19	4.82	4.56	4.80	4.75	4.71	-58%	-56%
LULUCF	6.26	-0.20	-0.40	-0.30	-0.30	-0.30	-105%	-105%
Agriculture	4.93	5.02	4.95	5.09	5.05	5.00	2%	1%
Transport	11.80	15.60	15.70	14.39	15.41	16.92	31%	43%
Industry (Energy and IPPU)	14.80	17.70	21.30	21.12	23.99	26.50	62%	79%
Other sectors of energy use	3.01	3.65	5.86	5.88	5.95	6.03	98%	100%
Energy Supply	18.71	25.81	39.79	30.69	38.86	41.30	108%	121%
Waste	6.64	8.09	5.46	7.11	7.36	7.55	11%	14%
Solid Wastes	5.23	6.44	3.60	5.32	5.40	5.52	3%	6%
Wastewater	1.41	1.65	1.85	1.89	1.96	2.04	40%	45%
Total	**66.15**	**75.67**	**92.67**	**83.99**	**96.31**	**103.01**	**46%**	**56%**

Note: Historical emission data from 2005 to 2015 and projections from 2016 to 2030.



Note: Historical emission data from 2005 to 2015 and projections from 2016 to 2030.

Figure 10. Emissions of the State of Rio de Janeiro by sectors in the period 2005-2030 (Mt CO_2e and %)

4. State of Minas Gerais

The historical emissions data from Minas Gerais's state are from the GHG Emissions Inventory published in 2016, with data from 2005 util 2014. The inventory used the methodology described in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006) and the GWP proposed by the Second Assessment Report (SAR). From 2015 to 2030, the data for each economy sector were projected based on Minas Gerais state historical emissions, specific sectorial assumptions, and the emissions growth rate in each sector in Brazil according to both ICAT 1project (2015-2018) and CPS of DDP-BIICS project (2019-2030).

4.1. Sectorial projections results

a) AFOLU

The Agriculture, Forestry and Other Land Use (AFOLU) describes the GHG emissions from two distinct subsectors: LULUCF (Land Use, Land Use Change and Forestry) and Agriculture. Emissions and removals related to forest and other land use are covered under LULUCF. Agriculture includes emissions from crops and livestock.

I. LULUCF

The Land Use Change and Forestry (LULUCF) subsector includes emissions from land use changes and removals from protected areas and reforestation, the first being the most relevant. There are no data on LULUCF for the period 2005-2009. Thus, the LULUCF emission and removal values for those years are considered constant and equal to 2010. LULUCF emissions peaked in 2011 and decreased until 2014. Emissions were reduced by 45% in 2014 compared to 2005.

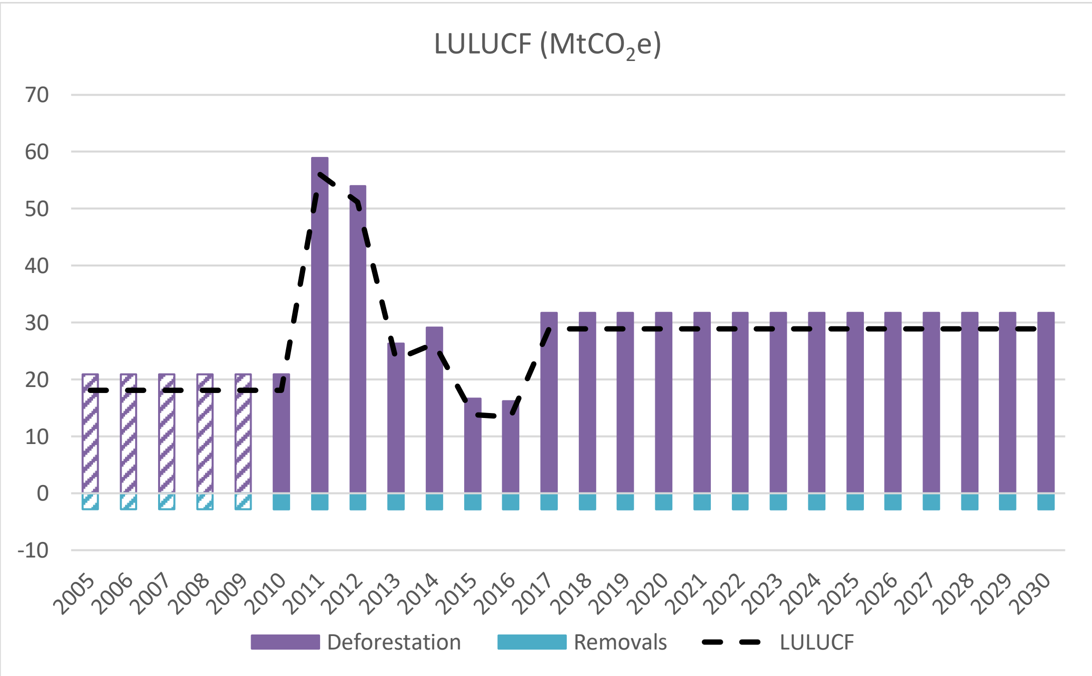
The deforestation and other land use changes emissions projection were calculated by the average emission of deforestation from 2010 to 2016 and this value of 31.71 Mt CO_2e/year remained constant until the end of the analyzed period (2030) (Table 12). LULUCF net emissions are the LULUCF total gross emissions discounted by the removals, which were considered constant throughout the period (-2.8 Mt CO_2e/year).

Emissions projection of the LULUCF sector, from 2015 until 2030, slightly increased. During the entire analyzed period, net emissions from the LULUCF sector increased by 60% in 2025 and 2030 compared to 2005. Figure 11 and Table **12** show the results during the analysed period.

Table 12.Emissions from LULUCF by subsectors from the State of Minas Gerais (Mt CO_2e and %)

Sector	2005	2010	2015	2020	2025	2030	2005-2025	2005-2030
	Mt CO_2e						%	
LULUCF	**18.10**	**18.10**	**13.80**	**28.91**	**28.91**	**28.91**	**60%**	**60%**
Deforestation	20.90	20.90	16.60	31.71	31.71	31.71	52%	52%
Removals	20.90	2.80	2.80	2.80	2.80	2.80	0%	0%

Note: Historical emission data from 2005 to 2014 and projections from 2015 to 2030. LULUCF emission and removal values from 2005-2009 are considered constant and equal to 2010 due to the lack of LULUCF data for this period.



Note: Historical emission data from 2005 to 2014 and projections from 2015 to 2030. LULUCF emission and removal values from 2005-2009 are considered constant and equal to 2010, due to the lack of LULUCF data for this period.

Figure 11. Emissions from LULUCF by subsectors from the State of Minas Gerais (emissions and removals) (Mt CO_2e)

II. Agriculture

Historical data from the Agriculture sector, which includes emissions from crops and livestock, increased by 14% from 2005 until 2014. The increase in the cattle herd mainly justifies this trend. The significant emission reductions resulting from investments in low carbon technologies and agricultural practices (Plano ABC) were not accounted for due to the unavailability of disaggregated data for Minas Gerais.

From 2015 to 2030, agriculture and livestock data were projected based on the average emissions from 2005 to 2014 (the most recent period of available data) in each agricultural sector and emissions growth rate for Brazil in ICAT 1 (2015-2018) and the CPS of DDP-BIICS projects (2019-2030), from 2015 until 2030.

Emissions projection of the Agriculture sector (2015-2030) remained almost constant. Regarding the emissions during the entire analyzed period, agriculture subsector emissions increase 14 % from 2005 to 2025 and 14% from 2005 to 2030.

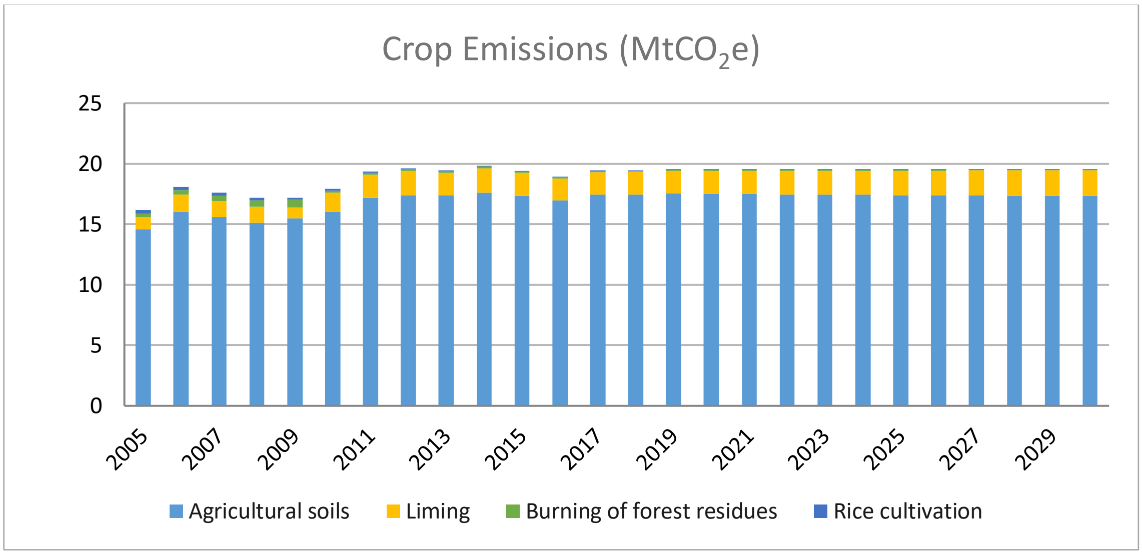
Crops

Crops are the second-largest source of emissions in the agriculture sector, and the activities associated with agricultural soil are the main emission source in this subsector, which increase 19% comparing both 2025 and 2030 to 2005 (Table 13 and Figure 12). Liming emission increases significantly during the period (114% during 2005-2030), but its emissions are still low compared to the Agriculture subsector's total.

Table 13.Emissions from crops by subsectors from the State of Minas Gerais (Mt CO_2e and %)

Sector	2005	2010	2015	2020	2025	2030	2005-2025	2005-2030
	Mt CO_2e						%	
Crops	16.20	17.90	19.42	19.55	19.56	19.57	21%	21%
Liming	0.99	1.63	1.89	1.91	2.02	2.12	104%	114%
Rice cultivation	0.32	0.13	0.06	0.05	0.05	0.04	-86%	-86%
Burning of forest residues	0.29	0.14	0.11	0.09	0.09	0.09	-69%	-69%
Agricultural soils	14.60	16.00	17.36	17.50	17.41	17.31	19%	19%

Note: Historical emission data from 2005 to 2014 and projections from 2015 to 2030.



Note: Historical emission data from 2005 to 2014 and projections from 2015 to 2030.
Figure 12. Emissions from crops by subsectors from the State of Minas Gerais (Mt CO_2e)

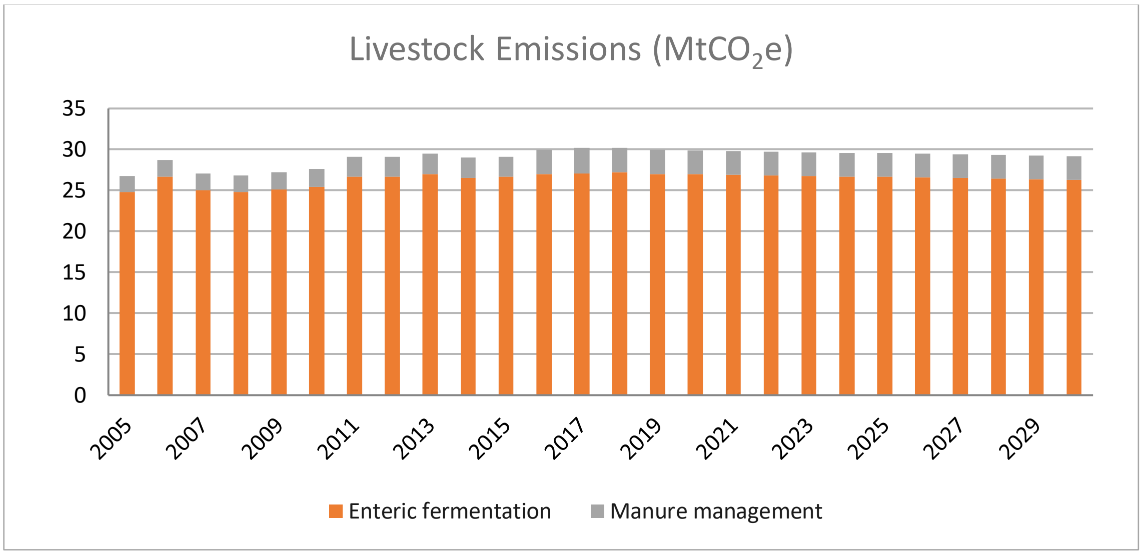
Livestock

Livestock is the main emission source in the agriculture subsector led by enteric fermentation, which shows a slight increase in the period (7% in 2025 and 6% in 2030 compared to 2005) (Table 14 and Figure 13). Manure management emission increase significantly during the period (50% during 2005-2030), but its emissions are still low compared to the total for the Agriculture subsector.

Table 14.Emissions from livestock by subsectors from the State of Minas Gerais (Mt CO_2e and %)

Sector	2005	2010	2015	2020	2025	2030	2005-2025	2005-2030
	Mt CO_2e						%	
Livestock	26.70	27.60	29.09	29.87	29.53	29.18	11%	9%
Enteric fermentation	24.80	25.40	26.67	26.98	26.64	26.30	7%	6%
Manure management	1.92	2.23	2.42	2.89	2.89	2.88	50%	50%

Note: Historical emission data from 2005 to 2014 and projections from 2015 to 2030.



Note: Historical emission data from 2005 to 2014 and projections from 2015 to 2030.

Figure 13. Emissions from Livestock by subsectors from the State of Minas Gerais (Mt CO_2e)

III. AFOLU consolidated results

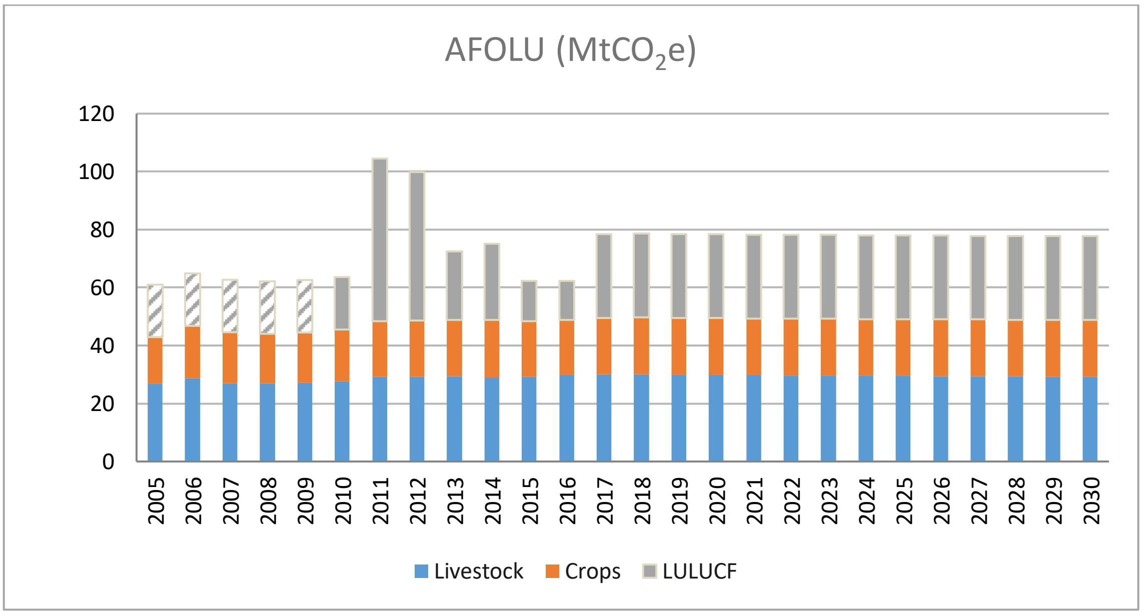
AFOLU emissions increased by 18% over the historical period (2005-2014). Emissions projection of the AFOLU sector follow the same trend and increase from 2015 until 2030. Regarding emissions during the entire analyzed period (2005-2030), net emissions from the AFOLU sector increase by 23% in 2025 and 22% in 2030 compared to 2005. Table 15 and . LULUCF *emission and removal values from 2005-2009 are considered constant and equal to 2010, due to the lack of LULUCF data for this period.*

Figure 14 show the results during the analyzed period.

Table 15.Emissions from Agriculture, Forestry and Other Land Use (AFOLU) Sector from the State of Minas Gerais (Mt CO_2e and %)

Sector	2005	2010	2015	2020	2025	2030	2005-2025	2005-2030
	Mt CO_2e						%	
LULUCF	**18.10**	**18.10**	**13.80**	**28.91**	**28.91**	**28.91**	**60%**	**60%**
Agriculture	**42.90**	**45.50**	**48.51**	**49.42**	**49.09**	**48.75**	**14%**	**14%**
Crops	16.20	17.90	19.42	19.55	19.56	19.57	21%	21%
Livestock	26.70	27.60	29.09	29.87	29.53	29.18	11%	9%
AFOLU	**61.00**	**63.00**	**62.31**	**78.33**	**78.00**	**77.67**	**23%**	**22%**

Note: Historical emission data from 2005 to 2014 and projections from 2015 to 2030. LULUCF emission and removal values from 2005-2009 are considered constant and equal to 2010, due to the lack of LULUCF data for this period.



Note: Historical emission data from 2005 to 2014 and projections from 2015 to 2030. LULUCF emission and removal values from 2005-2009 are considered constant and equal to 2010, due to the lack of LULUCF data for this period.

Figure 14. Emissions from Agriculture, Forestry and Other Land Use (AFOLU) Sector from the State of Minas Gerais (Mt CO_2e)

b) Transport

Historical data from the transport sector, during the period of 2005 until 2014, showed a significant increase of 59%. The road transport is the main one, responsible for most of the emissions.

The transport emissions in Minas Gerais state were made based on the data from the National Energy Balance (in Portuguese, Balanço Energético Nacional – BEN) from 2015 until 2018, using emissions factors for each fuel type and mode, and on the emissions growth rate from the CPS of DDP-BIICS project (2019 until 2030), for each modal. From 2019 to 2030 Brazilian transport emissions, according to CPS of DDP-BIICS project, vary as follows: 0.14% in water, 8% in rail, 15% in air and 15% in road. Emissions growth rates were applied from the last year of available data.

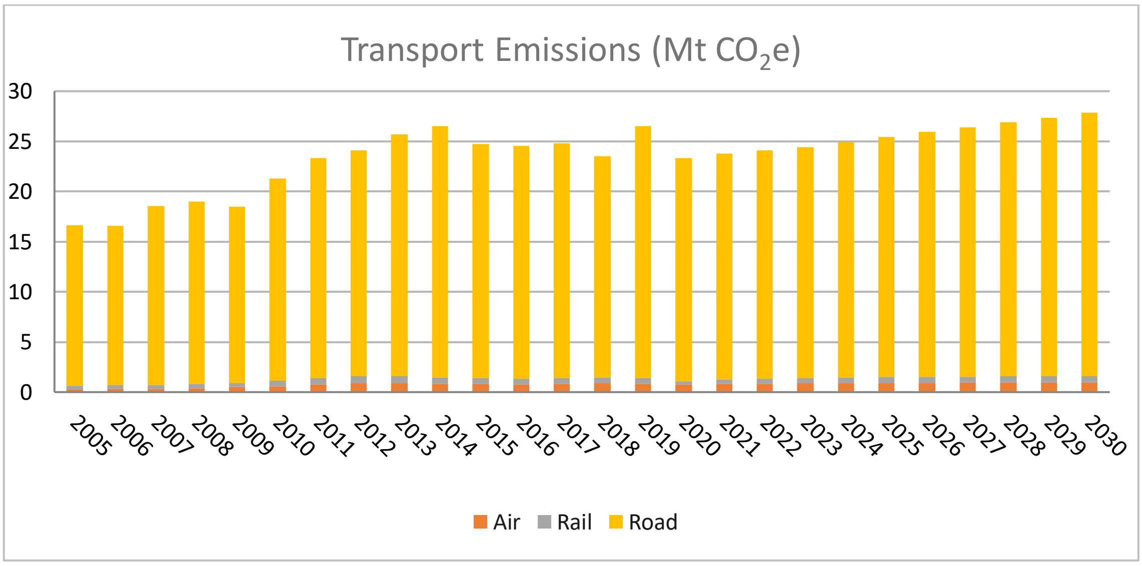
According to this methodology, emissions projection of the transport sector, from 2015 until 2030, increased. This increase was mainly driven by the road modal, since the emissions from the air modal and the rail modal increased slightly and represents a small fraction of the total emissions.

Emissions from the transport subsector increase by 53% in 2025 compared to 2005 and 67% in 2030 compared to 2005. Road transport remains the largest contribution, corresponding to 94% of the emissions in 2030. However, the transport mode which emissions increase the most is air modal, with a variation of 246% during the whole period. Table **16** and Figure 15 show the results during the analyzed period for all transportation modes.

Table 16. Emissions from the transport modes from the State of Minas Gerais (Mt CO_2e and %)

Sector	2005	2010	2015	2020	2025	2030	2005-2025	2005-2030
	Mt CO_2e						%	
Air	0.28	0.60	0.81	0.76	0.90	0.97	221%	246%
Rail	0.36	0.57	0.62	0.32	0.61	0.65	70%	80%
Road	15.99	20.11	23.32	22.23	23.92	26.23	50%	64%
Transport (Total)	**16.63**	**21.28**	**24.75**	**23.31**	**25.43**	**27.84**	**53%**	**67%**

Note: Historical emission data from 2005 to 2014 and projections from 2015 to 2030.



Note: Historical emission data from 2005 to 2014 and projections from 2015 to 2030.

Figure 15. Emissions from the transport modes from the State of Minas Gerais (Mt CO_2e).

c) Industry

Historical data from the Industry sector, during the period of 2005 until 2014, increased 10%, most of the emissions coming from IPPU.

State emissions from industry are mostly driven by economic growth and they were projected using the emissions growth rate of each industrial sector in Brazil. Emissions projections followed the same emissions growth rate of each industrial sector available in both ICAT 1 (2015-2018) and the CPS of DDP-BIICS project (2019-2030): food and beverage, cement, iron and steel, non-ferrous and other metallurgy, pulp and paper, chemical and rest of industry, which consists of an aggregate of the other existing industries in the state. Emissions growth rates were applied from the last year of available data.

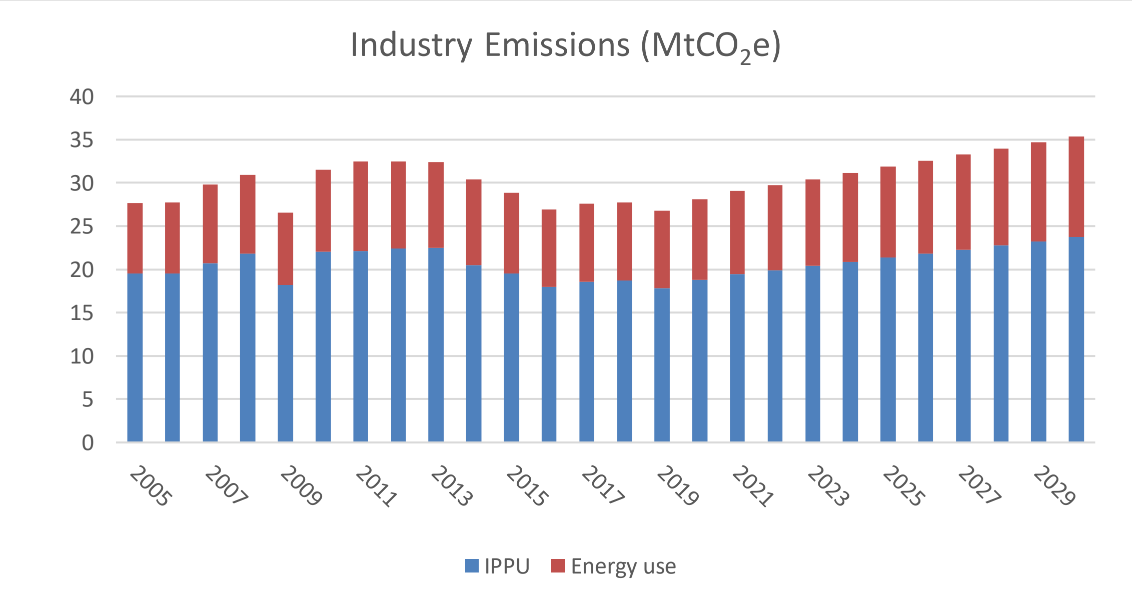
According to this methodology, emissions projection of the industry sector, from 2015 until 2030, increased, with energy use representing a greater weight in the emissions when compared to IPPU. Total industry emissions increase by 15% in 2025 compared to 2005 and 28% in 2030 compared to 2005. Table 17 and Note: *Historical emission data from 2005 to 2014 and projections from 2015 to 2030.*

Figure **16** show emissions in the analyzed years for IPPU and Energy Use.

Table 17. Emissions from industry - energy use and Industrial Processes and Product Use (IPPU) - from the State of Minas Gerais (Mt CO_2e and %)

Sector	2005	2010	2015	2020	2025	2030	2005-2025	2005-2030
	Mt CO_2e						%	
IPPU	19.52	22.03	19.52	18.79	21.40	23.73	10%	22%
Energy use	8.18	9.49	9.36	9.29	10.51	11.66	28%	43%
Total	**27.70**	**31.52**	**28.88**	**28.08**	**31.90**	**35.40**	**15%**	**28%**

Note: Historical emission data from 2005 to 2014 and projections from 2015 to 2030.



Note: Historical emission data from 2005 to 2014 and projections from 2015 to 2030.

Figure 16. Emissions from industry - energy use and Industrial Processes and Product Use (IPPU) - from the State of Minas Gerais (Mt CO_2e)

I. IPPU

Historical data from the IPPU subsector, during the period of 2005 until 2014, increased 5%. However, it should be noted that throughout this period emissions were not linear, coinciding with a market retraction in 2009 and 2014.

Data regarding IPPU emissions are available for three main industries: Minerals, Metals and Chemical.

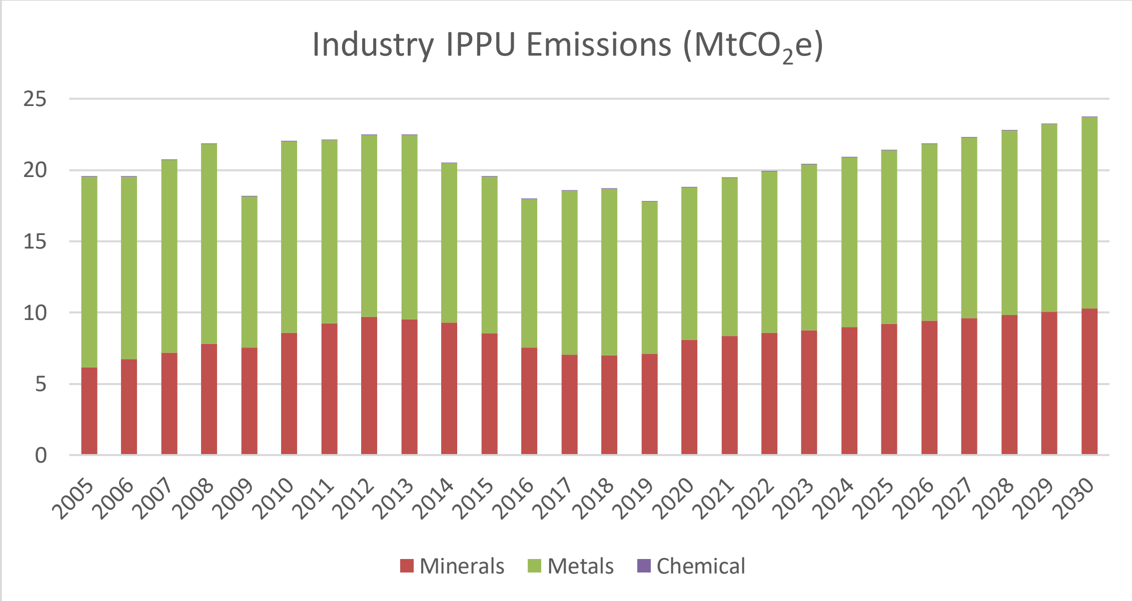
According to this methodology, emissions projection of the IPPU subsector, from 2015 until 2030, increased, with the metals industry being the main source of emissions, followed by the the minerals industry. IPPU emissions increase 10% in 2025 compared to 2005 and 22% in 2030 compared to 2005. Furthermore, the minerals industry is the one that increases the most (67%), followed by the chemical industry (38%) and the metals industry (1%). Over the period there was an increase in emissions, followed by a reduction and a subsequent increase. Table 18 and Note: *Historical emission data from 2005 to 2014 and projections from 2015 to 2030.*

Figure **17** show emissions in the analyzed years for IPPU.

Table 18.Emissions from Industrial Processes and Product Use (IPPU) Sector from the State of Minas Gerais (Mt CO_2e and %)

Sector	2005	2010	2015	2020	2025	2030	2005-2025	2005-2030
	Mt CO_2e						%	
Minerals	6.17	8.58	8.53	8.08	9.20	10.28	49%	67%
Metals	13.34	13.44	10.98	10.70	12.18	13.44	-9%	1%
Chemical	0.01	0.01	0.01	0.01	0.01	0.01	24%	34%
IPPU Total	**19.52**	**22.03**	**19.52**	**18.79**	**21.40**	**23.73**	**10%**	**22%**

Note: Historical emission data from 2005 to 2014 and projections from 2015 to 2030.



Note: Historical emission data from 2005 to 2014 and projections from 2015 to 2030.

Figure 17. Emissions from Industrial Processes and Product Use (IPPU) Sector from the State of Minas Gerais (Mt CO_2e and %)

II. Energy Use

Historical data from the Energy Use subsector, during the period of 2005 until 2014, increased 21%.

According to this methodology, the energy use subsector's emissions projection increases from 2015 until 2030. The most emitting industries branches, in terms of energy use, in the state of Minas Gerais are Cement, Integrated steelwork, and Food and beverage.

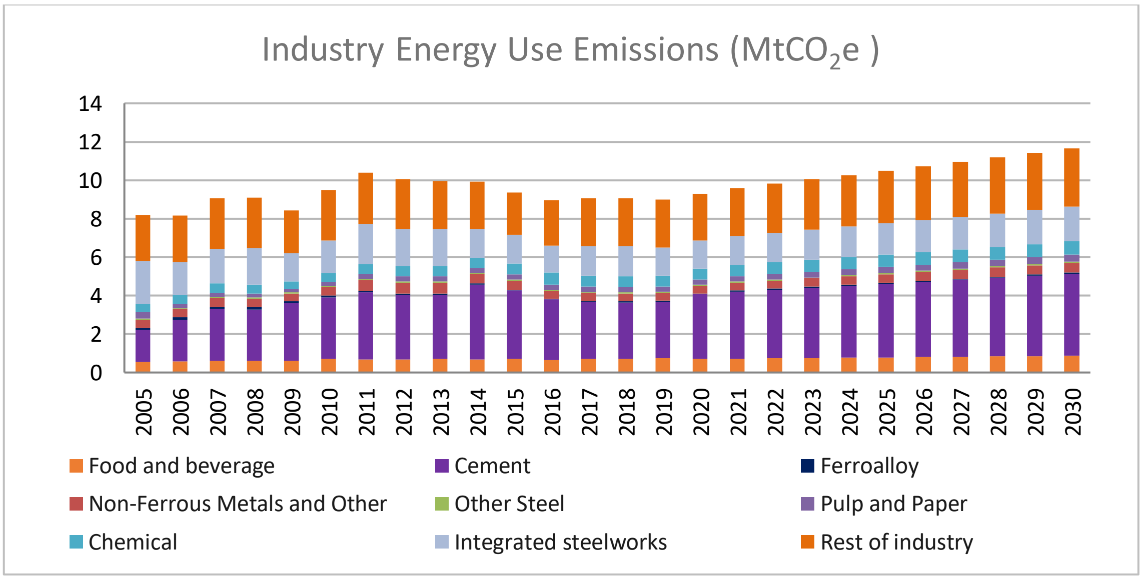
Furthermore, the Cement industry is the one that presents the largest increase during the analyzed period (158%), followed by Chemical (59%), and Food and beverage (57%). Some industries reduced their emissions during the analyzed period, such as Ferroalloy (-45%) and Integrated steelworks (-18%). Total energy use emissions increase 28.43% in 2025 compared to 2005 and 43% in 2030 compared to 2005. Table 19 and Note: *Historical emission data from 2005 to 2014 and projections from 2015 to 2030.*

Figure **18** show emissions in the analyzed years for energy use.

Table 19. Emissions from energy use by Industry branches from the State of Minas Gerais (Mt CO_2e and %)

Sector	2005	2010	2015	2020	2025	2030	2005-2025	2005-2030
	Mt CO_2e						%	
Food and beverage	0.55	0.70	0.71	0.70	0.78	0.86	42%	57%
Cement	1.66	3.19	3.55	3.37	3.83	4.28	131%	158%
Ferroalloy	0.11	0.10	0.05	0.05	0.05	0.06	-50%	-45%
Non-Ferrous Metals and Other	0.43	0.45	0.46	0.40	0.45	0.49	5%	15%
Other Steel	0.06	0.07	0.06	0.06	0.07	0.07	9%	20%
Pulp and Paper	0.33	0.18	0.27	0.27	0.31	0.34	-7%	4%
Chemical	0.44	0.49	0.58	0.56	0.63	0.70	44%	59%
Integrated steelworks	2.23	1.68	1.48	1.44	1.65	1.82	-26%	-19%
Rest of industry	2.39	2.63	2.20	2.44	2.74	3.03	14%	27%
Total	**8.18**	**9.49**	**9.36**	**9.29**	**10.51**	**11.66**	**28%**	**43%**

Note: Historical emission data from 2005 to 2014 and projections from 2015 to 2030.



Note: Historical emission data from 2005 to 2014 and projections from 2015 to 2030.

Figure 18. Emissions from energy use, by Industry branches from the State of Minas Gerais (Mt CO_2e)

d) Other sectors of energy use

Historical emission data from energy use in agriculture, residential, commercial and public sectors, during the period of 2005 until 2014, decreased 11%. The residential sector is the largest emitter, followed by the agriculture sector.

Minas Gerais state emissions projections from energy use in agriculture, residential, commercial and public sectors followed same Brazil's growth rate of each sector available in both ICAT 1 project (2015-2018) and the CPS of DDP-BIICS project (2019-2030). Emissions growth rates were applied from the last year of available data.

From 2015 to 2030, agriculture energy use emissions were projected based on the average emissions from 2010 to 2018, using the growth rates of energy-related emissions from the agriculture sector of the DDP-BIICS project (increase 11% from 2019 to 2030). Emissions from the commercial and public sectors decline following the negative growth rate of Brazilian emissions for these sectors (13% reduction from 2019 to 2030) while residential ones follow the emissions growth rate from Brazilian buildings DDP-BIICS project (12% increase from 2019 to 2030).

According to this methodology, emissions projection from 2015 until 2030 presented a slight increase, mainly because of the residential subsector. Emissions decrease by 6% in 2025 compared to 2005 and increased by 1% in 2030 compared to 2005. In the analysed period, the only sector that presents an increase in emissions from energy use in agriculture increases by 18% in 2025 compared to 2005 and 27% in 2030 compared to 2005. On the other hand, commercial, public, residential and energy supply sectors are reducing their emissions during the analyzed period. Table 20 and Note: *Historical emission data from 2005 to 2014 and projections from 2015 to 2030.*

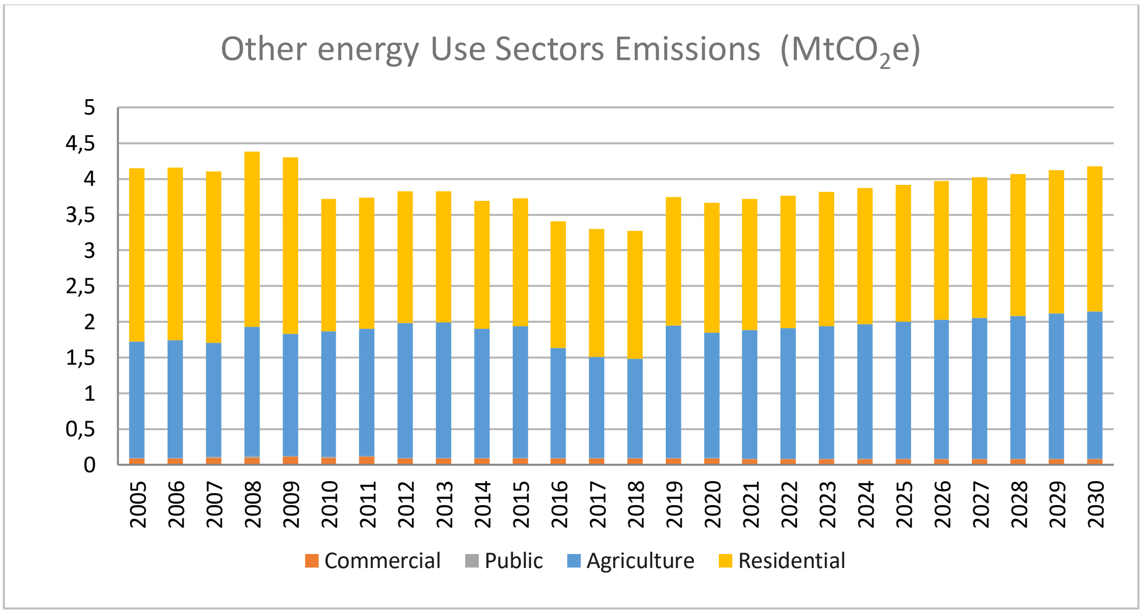
Figure **19** show emissions in the analyzed years for Energy use.

Table 20. Emissions from Other sectors of energy use from the State of Minas Gerais (Mt CO_2e and %)

Sector	2005	2010	2015	2020	2025	2030	2005-2025	2005-2030
	Mt CO_2e						%	
Acriculture	1.62	1.76	1.84	1.76	1.91	2.06	18%	27%
Commercial	0.0900	0.1000	0.0870	0.0826	0.0785	0.0744	-13%	-17%
Public	0.0100	0.0100	0.0097	0.0092	0.0087	0.0083	-13%	-17%
Residential	2.43	1.85	1.79	1.81	1.92	2.03	-21%	-16%
Total	**4.15**	**3.72**	**3.72**	**3.66**	**3.92**	**4.17**	**-6%**	**1%**

[1]Scope 1

Note: Historical emission data from 2005 to 2014 and projections from 2015 to 2030.



Note: Historical emission data from 2005 to 2014 and projections from 2015 to 2030.

Figure 19. Emissions from Other sectors of energy use from the State of Minas Gerais (Mt CO_2e)

e) Energy Supply

Historical emission data from the Energy Supply sector, during the period of 2005 until 2014, increased 16%, mainly because of the emissions of the Self-producer Power Plants and the Public utility Power Plants.

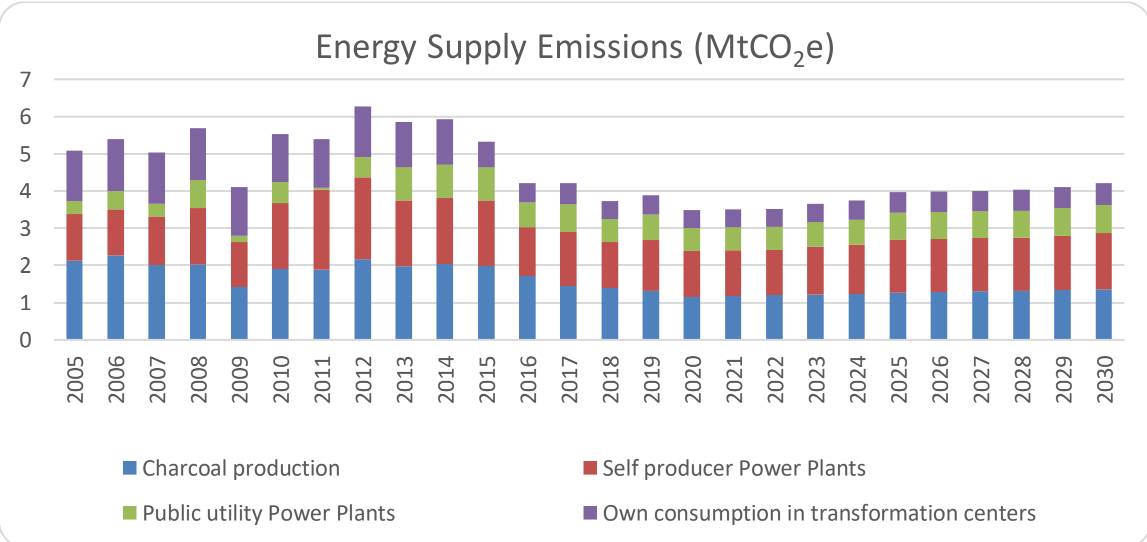
Projections of emissions from energy supply in the state of Minas Gerais comprise the activities of: charcoal production, self-producer power plants, public utility power plants, and own consumption in transformation centers. Minas Gerais self-producer and public utility power plants emissions estimates in this report use the growth rates of coal and natural gas thermoelectric generation in Brazil based on the data from the National Energy Balance (in Portuguese, Balanço Energético Nacional – BEN), from 2015-2018, and from the CPS of DDP-BIICS project, from 2019-2030. Estimates for the state energy sector own consumption assume constant efficiency and use the last year available data. In other words, the 2014 ratio between the energy sector own consumption emissions and the power plants emissions was kept constant until the end of the analyzed period (2030). Charcoal production state emissions projection followed same Brazil's growth rate of each sector in both ICAT 1 and CPS of DDP-BIICS projects, from 2015 until 2030. Emissions growth rates were applied from the last year of available data.

According to this methodology, emissions projection from 2015 until 2030 decreases, mainly because of the reduction of charcoal production emissions. Energy Supply emissions decrease compared to 2005 22% in 2025 and 17% in 2030. Emissions from self-producer's and public utility's power plants increase by 19% and 131% respectively, while the others decrease. In 2030, the most emitting sector was self-producer power plants, followed by charcoal production. Table 21 and Figure 20 shows emissions in the analyzed years for energy supply.

Table 21. Energy supply emissions by sector from the State of Minas Gerais in the period 2005-2030 (Mt CO_2e and %)

Sector	2005	2010	2015	2020	2025	2030	2005-2025	2005-2030
	Mt CO_2e						%	
Fuel combustion	5.10	5.53	5.32	3.49	3.97	4.21	-22%	-17%
Charcoal production	2.13	1.90	2.00	1.14	1.26	1.36	-41%	-36%
Self-producer Power Plants	1.26	1.78	1.75	1.23	1.43	1.50	13%	19%
Public utility Power Plants	0.33	0.56	0.89	0.63	0.72	0.76	120%	131%
Own consumption in transformation centers	1.37	1.29	0.68	0.48	0.56	0.59	-59%	-57%
Total	**5.10**	**5.53**	**5.32**	**3.49**	**3.97**	**4.21**	**-22%**	**-17%**

Note: Historical emission data from 2005 to 2014 and projections from 2015 to 2030.



Note: Historical emission data from 2005 to 2014 and projections from 2015 to 2030.

Figure 20. Energy supply emissions by sector from the State of Minas Gerais in the period 2005-2030 (Mt CO_2e)

f) Waste – Solid waste and wastewater

During the period of 2005 until 2014, historical data from the Waste sector showed a significant increase of 121%. Emissions from urban solid waste and industrial effluents stand out due to the high generation in the State.

Minas Gerais state emissions projections from the waste sector followed same Brazil's growth rate of each sector in both ICAT 1 (2015-2018) and the CPS of the DDP-BIICS project (2019-2030). Projections for urban solid waste and domestic wastewater evolved at the same rates as Brazil's total waste emissions in CPS projection of DDP-BIICS (increase 5% from 2019 to 2030), while industrial solid waste emissions and industrial wastewater were projected using the emissions growth rate of Food and Beverages industrial sector in Brazil (an increase of 19% from 2019 to 2030). Emissions growth rates were applied from the last year of available data.

According to this methodology, emissions projection from 2015 until 2030 increased, mainly because of the industrial wastewater emissions. GHG emissions from the waste sector increase by 142% between 2005 and 2025 and 154% between 2005 and 2030. The largest growth in emissions is projected to the industrial solid wastes, which increased by 208% between 2005 and 2025 and 241% between 2005 and 2030, and to the urban solid waste, which increase by 196% between 2005 and 2025 and 199% between 2005 and 2030.

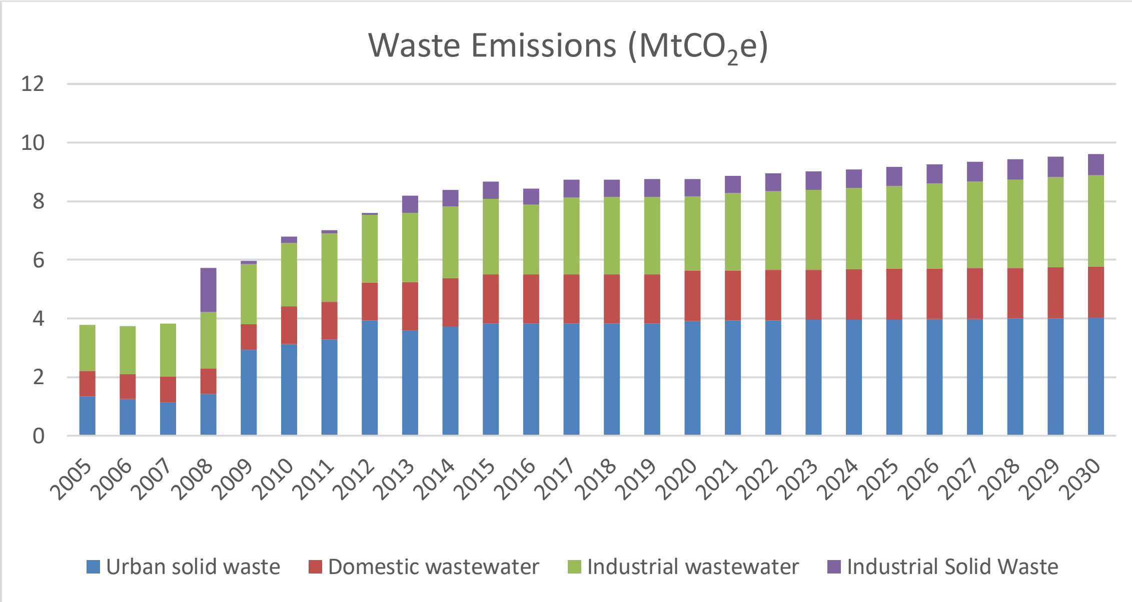
The main source of emission are the urban solid wastes, followed by Industrial wastewater, domestic wastewater and industrial solid waste. Table 22 and Note: *Historical emission data from 2005 to 2014 and projections from 2015 to 2030.*

Figure **21** show each subsectors' contribution in the total waste emissions and their evolution in this period.

Table 22.Emissions of the waste sector from the State of Minas Gerais (Mt CO_2e and %)

Sector	2005	2010	2015	2020	2025	2030	2005-2025	2005-2030
	Mt CO_2e						%	
Urban solid waste	1.34	3.13	3.84	3.92	3.97	4.01	196%	199%
Industrial Solid Waste	0.00	0.21	0.59	0.58	0.65	0.72	208%	241%
Domestic wastewater	0.87	1.29	1.67	1.71	1.73	1.75	99%	101%
Industrial wastewater	1.58	2.16	2.57	2.54	2.83	3.14	79%	99%
Waste Total	**3.79**	**6.79**	**8.67**	**8.75**	**9.17**	**9.61**	**142%**	**154%**

Note: Historical emission data from 2005 to 2014 and projections from 2015 to 2030.



Note: Historical emission data from 2005 to 2014 and projections from 2015 to 2030.

Figure 21. Emissions of the Waste Sector from the State of Minas Gerais (Mt CO_2e)

4.2. Conclusion

In 2005, GHG emissions from the state of Minas Gerais totaled 118.37 Mt CO_2e and the projections show that GHG emissions in the reference scenario would reach 152.39 Mt CO_2e in 2025, an increase of 29% (Table 23 and Note: *Historical emission data from 2005 to 2014 and projections from 2015 to 2030. LULUCF emission and removal values from 2005-2009 are considered constant and equal to 2010, due to the lack of LULUCF data for this period.*

Figure **22**). Over the analyzed period, there is an increase of 34% in state emissions in 2030 (158.91 Mt CO_2e) compared to 2005.

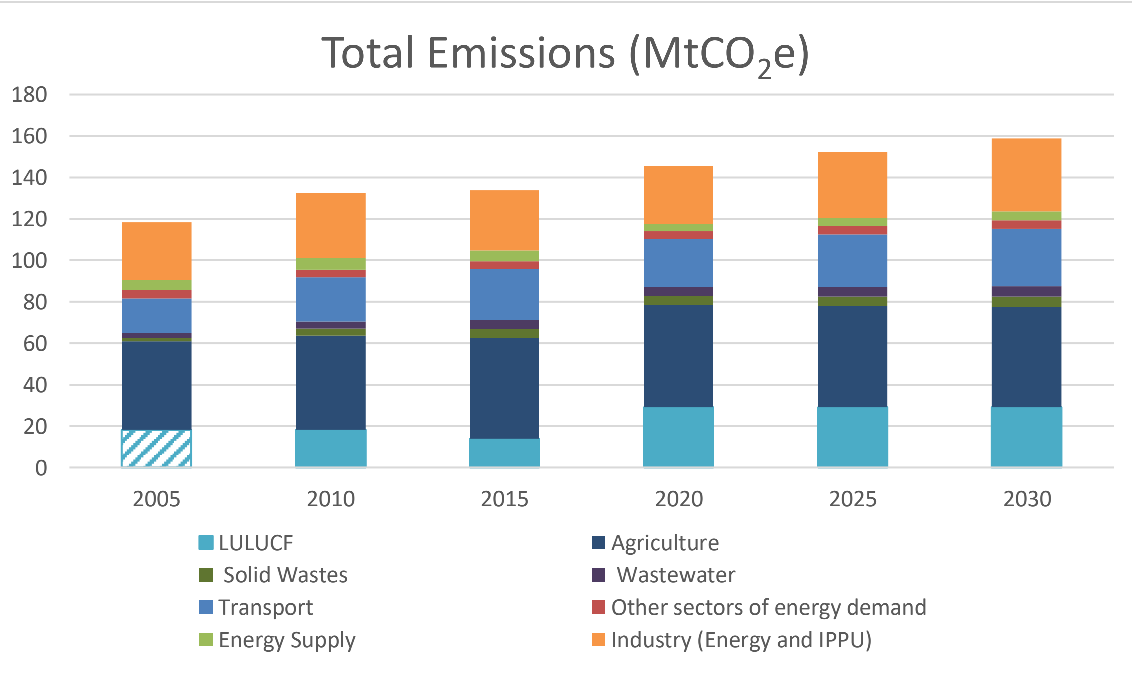
In the ranking of the emissions rate of increase in the period 2005-2030, the waste sector stands out with an increase of 153%, followed by the Transport sector (67%), the industry sector (27%) and the AFOLU sector (27%). Energy supply is the only sector with emissions reduction, with a variation of -17%, while in the Other sectors of energy use emissions remain stable (1%).

Regarding the evolution of sectoral emissions, it is worth mentioning that AFOLU subsectors (Agriculture and LULUCF) are responsible for 49% of state emissions in 2030.

Table 23. Emissions of the State of Minas Gerais by sectors in the period 2005-2030 (Mt CO_2e and %)

Sector	2005	2010	2015	2020	2025	2030	2025/2005	2030/2005
	Mt CO_2e						%	
AFOLU	61.00	63.59	62.31	78.33	78.00	77.67	28%	27%
LULUCF	18.10	18.10	13.80	28.91	28.91	28.91	60%	60%
Agriculture	42.90	45.50	48.51	49.42	49.09	48.75	14%	14%
Transport	16.63	21.28	24.75	23.31	25.43	27.84	53%	67%
Industry (Energy and IPPU)	27.70	31.52	28.88	28.08	31.90	35.40	15%	28%
Other sectors of energy use	**4.15**	**3.72**	**3.72**	**3.66**	**3.92**	**4.17**	**-6%**	**1%**
Energy Supply	5.10	5.53	5.32	3.49	3.97	4.21	-22%	-17%
Waste	3.79	6.79	8.67	8.75	9.17	9.61	142%	154%
Solid Wastes	1.34	3.34	4.42	4.50	4.61	4.73	244%	253%
Wastewater	2.45	3.45	4.25	4.25	4.56	4.89	86%	99%
Total	**118.37**	**132.44**	**133.65**	**145.63**	**152.39**	**158.91**	**29%**	**34%**

Note: Historical emission data from 2005 to 2014 and projections from 2015 to 2030. LULUCF emission and removal values from 2005-2009 are considered constant and equal to 2010, due to the lack of LULUCF data for this period.



Note: Historical emission data from 2005 to 2014 and projections from 2015 to 2030. LULUCF emission and removal values from 2005-2009 are considered constant and equal to 2010, due to the lack of LULUCF data for this period.

Figure 22. Emissions of the State of Minas Gerais by sector in the period 2005-2030 (Mt CO_2e)

5. State of Amazonas

As the state does not provide his own inventory report, this study makes use of historical emission data from 2005 to 2018 from the SEEG (Greenhouse Gas Emissions Estimation System) Brazil database. All gases are expressed in carbon dioxide equivalent (CO_2e), using the IPCC AR5 Global Warming Potential (GWP) (IPCC, 1995; 2013). From 2019 to 2030, the estimates for each economic sector were projected based on the Amazonas state historical emissions, specific sectorial assumptions and the emissions growth rate for each Brazilian economic sector according to the CPS of DDP-BIICS project.

5.1. Sectorial projections results

a) AFOLU- Agriculture, Forestry and Other Land Use

The Agriculture, Forestry and Other Land Use (AFOLU) describes the GHG emissions from two distinct subsectors: LULUCF (Land Use, Land Use Change and Forestry) and Agriculture. Emissions and removals related to forest and other land use are covered under LULUCF. Agriculture includes emissions from crops and livestock.

I. LULUCF

Land Use Land-Use Change and Forestry (LULUCF) subsector includes emissions from deforestation and forest residues, and removals in secondary forests and protected areas, the last being the most relevant.

Historical data, from 2005 to 2018, showed LULUCF net emissions have been negative throughout the period, however emissions from deforestation and other land use changes increased significantly in the last four years of available data.

In LULUCF total gross emissions are the sum of deforestation and forest residues emissions and varied widely over the years. Therefore, the deforestation and other land use changes emissions are calculated by the average emission of deforestation from 2016 to 2019 and this value of 84.54 Mt CO_2e/year remains constant until the end of the analyzed period (2030). In 2019 the data about the annual deforested area in the Amazon biome was provided by the project Amazonia deforestation satellite monitoring – PRODES, published by INPE, the deforestation in the Amazonas state is 37.22% higher in 2019 in relation to 2018. Forest residue emissions follow the historical value of 4% in relation to the deforestation value.

LULUCF net emissions are the LULUCF total gross emissions discounted by the removals. LULUCF removals are the sum in secondary forests and protected areas. Removals in secondary forests follow the historical average value from 2016 to 2018 of 13% in relation to the value of deforestation. Removals in protected areas are the sun of removals in indigenous land and conservation units but were considered no variation in the area of protected lands and the 2019 data remains constant until 2030 (-114.60 Mt CO_2e/year).

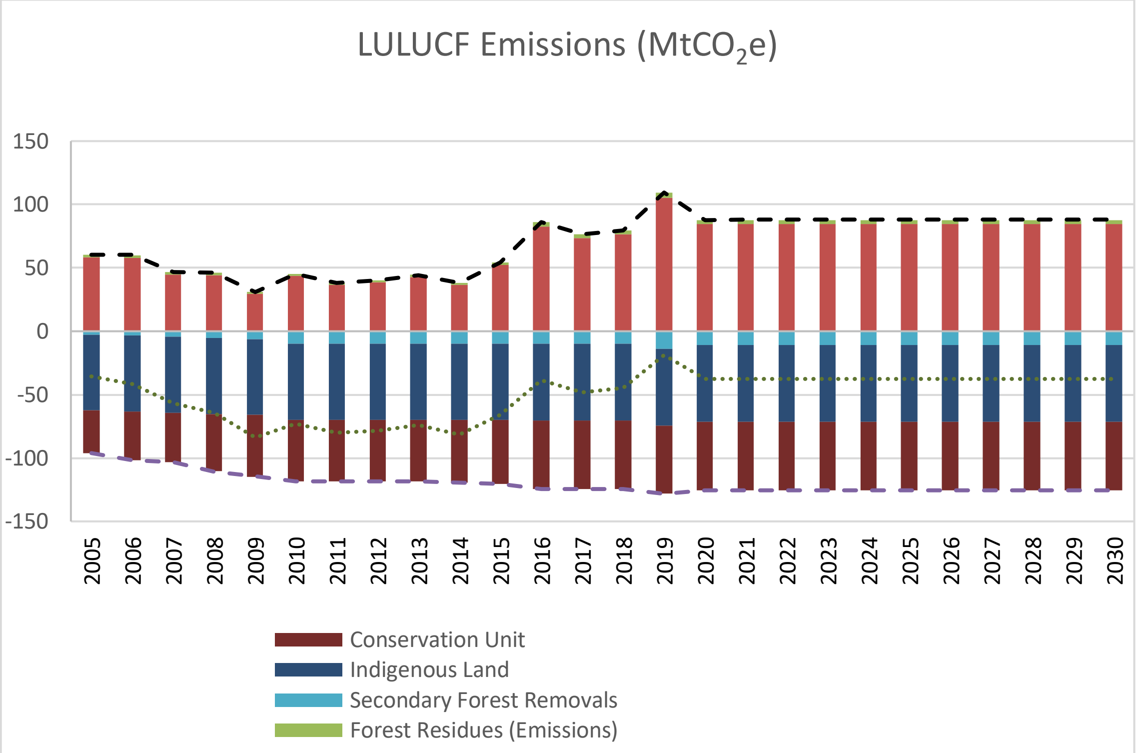
Net LULUCF emissions remain negative throughout the analyzed period, however emissions from deforestation and other land use changes and forest residues, although keeping constant from 2020 to 2030 (87.86 Mt CO_2e/year of LULUCF gross emissions), increase significantly (46%)

comparing both 2025 and 2030 to 2005. In the whole period (2005-2030), the reduction is mainly due to the contribution of negative land use emissions, because of carbon removals. Such accounting considers the natural carbon sequestration that occurs in protected areas (conservation units and indigenous lands). Table 24 and Figure 23 show the results during the analyzed period.

Table 24. Emissions from LULUCF by subsectors from the State of Amazonas (emissions and removals) (Mt CO_2e)

LULUCF								
Sector	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2005-2025**	**2005-2030**
LULUCF (Gross Emissions)	**60.40**	**45.40**	**54.30**	**87.86**	**87.86**	**87.86**	**46%**	**46%**
Deforestation and other Land Use Changes (Emissions)	58.10	43.60	52.20	84.54	84.54	84.54	46%	46%
Forest Residues (Emissions)	2.23	1.72	2.05	3.32	3.32	3.32	49%	49%
LULUCF (Removals)	**96.10**	**118.40**	**120.40**	**125.46**	**125.46**	**125.46**	**31%**	**31%**
Secondary Forest Removals	2.57	10.04	10.04	10.96	10.96	10.96	327%	327%
Removals in Protected Areas	93.60	108.30	110.40	114.60	114.60	114.60	22%	22%
Indigenous Land	59.80	59.80	59.80	60.60	60.60	60.60	1%	1%
Conservation Unit	33.80	48.60	50.60	54.00	54.00	54.00	60%	60%
LULUCF (Net emissions)	**-35.80**	**-73.00**	**-66.10**	**-37.60**	**-37.60**	**-37.60**	**-5%**	**-5%**

Note: Historical emission data from 2005 to 2018 and projections from 2019 to 2030.



Note: Historical emission data from 2005 to 2018 and projections from 2019 to 2030.

Figure 23. Emissions from LULUCF by subsectors from the State of Amazonas (emissions and removals) (Mt CO_2e)

II. Agriculture

Historical data of the agriculture subsector emissions (2005 – 2018), including both crops and livestock, increased throughout the analysed period (90%), with a peak in 2010. This increase was driven by crops, with agricultural soils as the largest source. Livestock emissions from historical data (2005 – 2018), remained relatively constant throughout the period. From 2019 to 2030, there is a small decrease in agriculture emissions following the country emissions growth rate projected in the CPS of DDPBIICS project (reduction of 1.3% in Brazil agriculture sector emission from 2019 to 2030).

From 2019 to 2030, agriculture and livestock data were projected based on the average emissions from 2010 to 2018 (the most recent period of available data) in each agricultural sector and emissions growth rate for Brazil according to the CPS of DDPBIICS project.

Agriculture subsector emissions increase 46% from 2005 to 2025, with a peak of 11.8 Mt CO_2e in 2010. This increase is driven by emissions from Degraded Pasture (Carbon in soil), the largest source. The second largest source of emissions is enteric fermentation, which increase 14% in 2025 and 13% in 2030 compared to 2005.

Crops

Crops is the main emission source in the agriculture subsector and its emissions increase 58% in 2025 compared to 2005 and 57% in 2030 compared to 2005. The main source of emissions is the Carbon in Soil (Degraded Pasture), which shows a slight increase in the period (62% in 2025 and in2030 compared to 2005)

The removals from crops, which are relatively small comparing to its emissions, are reducing significantly over the analysed period: 84% in 2025 compared to 2005 and 97% in 2030 compared to 2005. Table 25 and Figure 24 show the results during the analysed period.

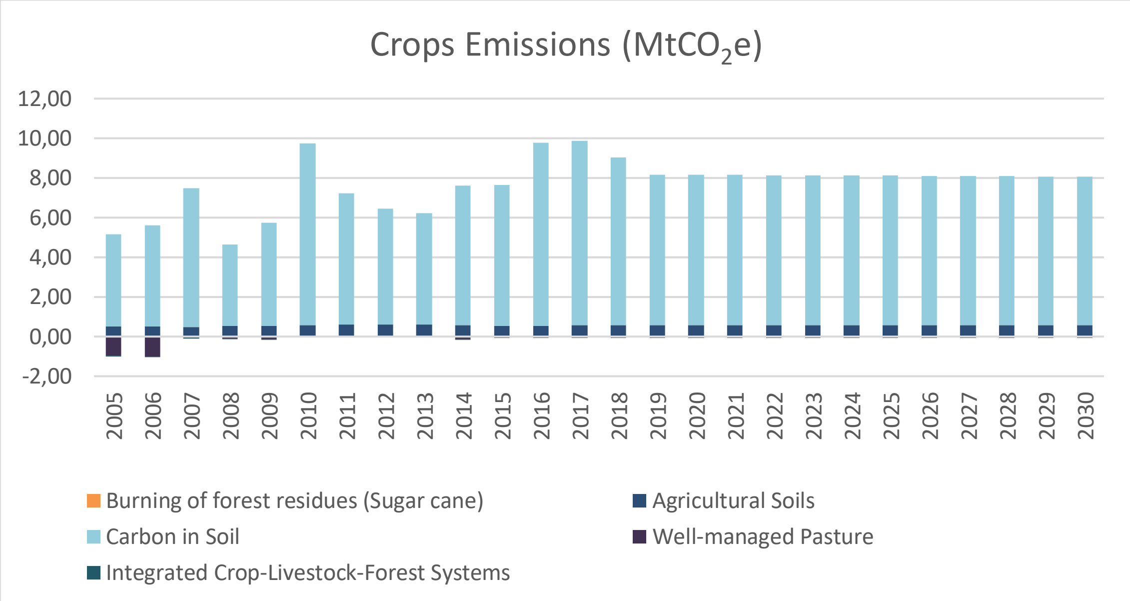
Table 25. Emissions from the crops by subsectors from the State of Amazonas (emissions and removals) (Mt CO_2e).

Agriculture								
Sector	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2005-2025**	**2005-2030**
Crops (Emissions)	**5.15**	**9.73**	**7.65**	**8.16**	**8.11**	**8.07**	**58%**	**57%**
Burning of forest residues (Sugar cane)	0.0050	0.0050	0.0030	0.0037	0.0036	0.0036	-27%	-28%
Agricultural Soils	0.51	0.56	0.54	0.58	0.57	0.57	14%	13%
Application of organic waste	0.0280	0.0220	0.0210	0.0211	0.0210	0.0209	-25%	-25%
Animal	0.0270	0.0210	0.0210	0.0209	0.0208	0.0207	-23%	-23%
Vinasse	0.0002	0.0002	0.0001	0.0002	0.0002	0.0002	7%	7%
Manure deposited on pasture	0.25	0.30	0.29	0.31	0.30	0.30	20%	19%
Synthetic Fertilizers	0.00200	0.00300	0.00300	0.00345	0.00343	0.00341	72%	71%
Agricultural Residues	0.02900	0.02600	0.02600	0.02921	0.02905	0.02888	0.2%	-0.4%
Rice	0.00051	0.00027	0.00013	0.00019	0.00019	0.00019	-63%	-64%

Agriculture								
Sector	2005	2010	2015	2020	2025	2030	2005-2025	2005-2030
Sugar cane	0.00030	0.00030	0.00021	0.00025	0.00024	0.00024	-18%	-19%
Bean	0.00053	0.00040	0.00022	0.00029	0.00029	0.00028	-46%	-46%
Manioc	0.02500	0.02300	0.02300	0.02605	0.02591	0.02577	4%	3%
Corn	0.00150	0.00150	0.00070	0.00097	0.00096	0.00096	-36%	-36%
Other cultures	0.00040	0.00120	0.00120	0.00145	0.00144	0.00143	260%	258%
Soy	0.00033	0.00004	0.00000	0.00001	0.00001	0.00001	-96%	-96%
Organic soils	-	-	-	-	-	-	-	-
Atmospheric Deposition of N	0.04000	0.04400	0.04300	0.04554	0.04529	0.04504	13%	13%
Animal	0.04000	0.04400	0.04200	0.04454	0.04429	0.04405	11%	10%
Synthetic Fertilizers	0.00100	0.00100	0.00100	0.00100	0.00100	0.00099	-0.3%	-0.9%
Leaching (indirect N)	0.151	0.166	0.162	0.171	0.170	0.169	13%	12%
Animal	0.149	0.164	0.159	0.167	0.166	0.165	12%	11%
Synthetic Fertilizers	0.00200	0.00300	0.00300	0.00334	0.00332	0.00330	66%	65%
Vinasse	0.000068	0.000069	0.000042	0.000075	0.000074	0.000074	9%	9%

Agriculture								
Sector	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2005-2025**	**2005-2030**
Carbon in Soil (Degraded Pasture)	4.64	9.17	7.10	7.58	7.54	7.50	62%	62%
Agriculture (Removals)	**0.99**	**1.04**	**0.10**	**0.13**	**0.16**	**0.03**	**-84%**	**-97%**
Carbon in Soil	0.99	1.04	0.10	0.13	0.16	0.03	-84%	-97%
Well-managed Pasture	0.98	1.02	0.08	0.11	0.13	0.00	-87%	-100%
Integrated Crop-Livestock-Forest Systems	0.01	0.01	0.02	0.02	0.02	0.03	140%	180%

Note: Historical emission data from 2005 to 2018 and projections from 2019 to 2030.



Note: Historical emission data from 2005 to 2018 and projections from 2019 to 2030.
Figure 24. Emissions from crops by subsectors from the State of Amazonas (Mt CO_2e)

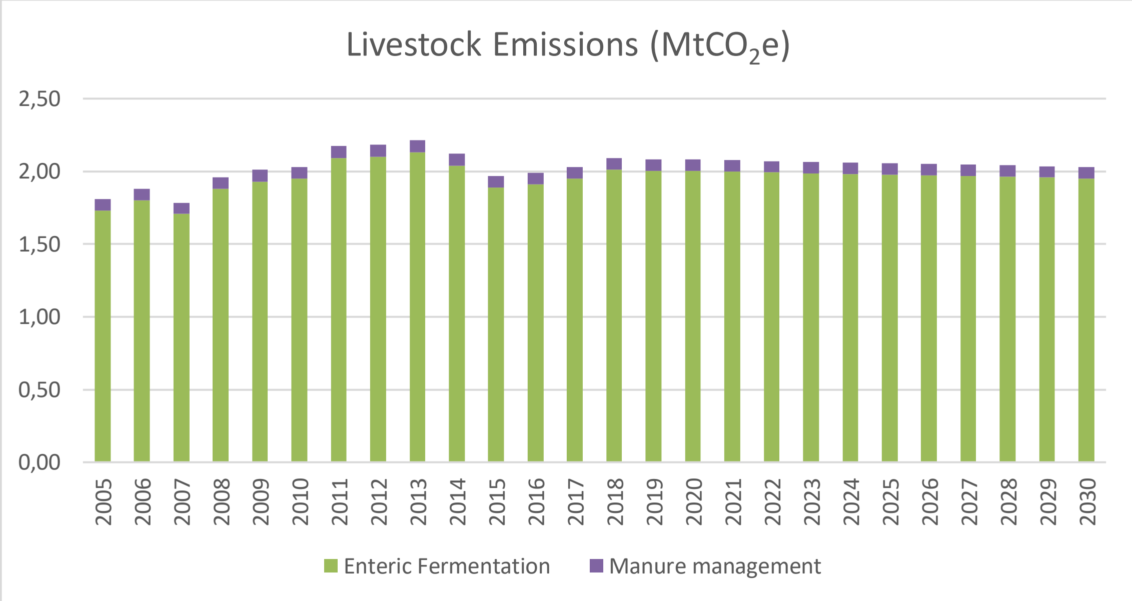
Livestock

Livestock is the second largest source of emissions in the agriculture subsector and its emissions increase 14% in 2025 compared to 2005 and 12% in 2030 compared to 2005. The main source of emissions is enteric fermentation, which shows a slight increase in the period (14% in 2025 and 12% in 2030 compared to 2005). Emissions from manure management remain stable. Table 26 and Figure 25 show the results during the analyzed period.

Table 26. Emissions from livestock by subsectors from the State of Amazonas (emissions and removals) (Mt CO_2e).

Agriculture								
Sector	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2005-2025**	**2005-2030**
Livestock (Emissions)	**1.81**	**2.03**	**1.97**	**2.08**	**2.06**	**2.03**	**14%**	**12%**
Enteric Fermentation	1.73	1.95	1.89	2.00	1.98	1.95	14%	13%
Manure management	0.0780	0.0800	0.0790	0.0791	0.0790	0.0789	1%	1%

Note: Historical emission data from 2005 to 2018 and projections from 2019 to 2030.



Note: Historical emission data from 2005 to 2018 and projections from 2019 to 2030.

Figure 25. Emissions from livestock by subsectors from the State of Amazonas (Mt CO_2e)

III. AFOLU consolidated results

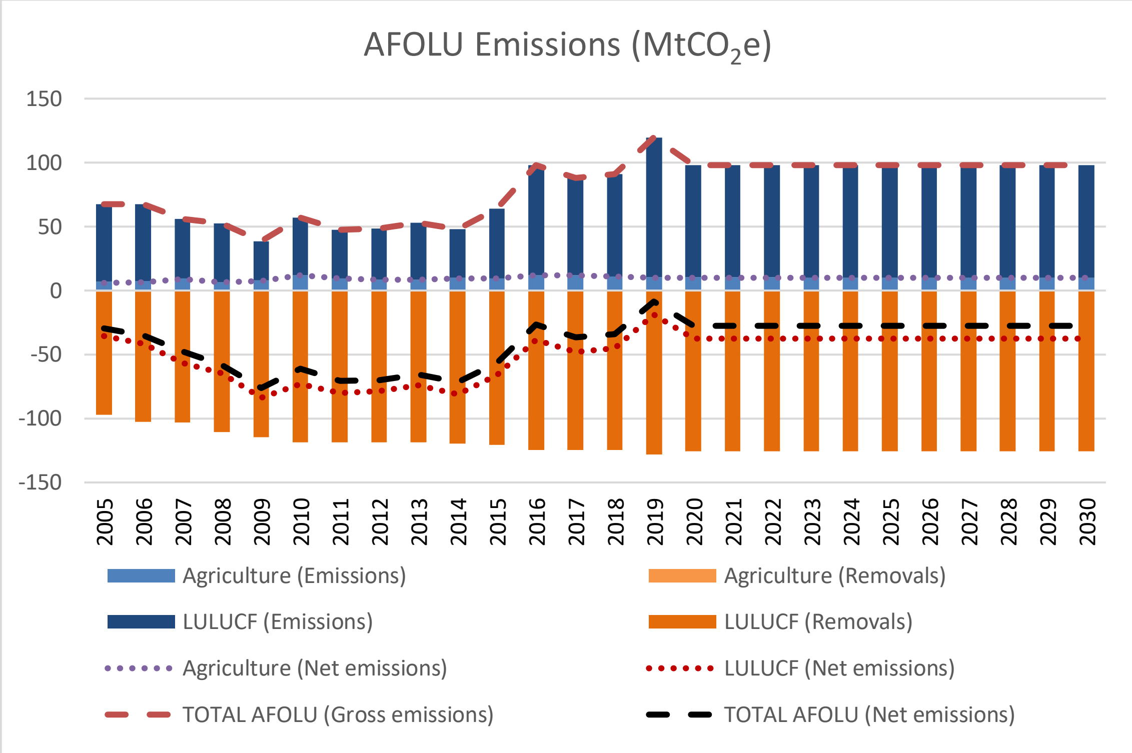
Historical data, from 2005 to 2018, showed that net emissions from the AFOLU sector decreased by 13%. The greatest reduction occurred in the period of 2005-2009, that was mainly due to the contribution of negative land use emissions, because of carbon removals- natural carbon sequestration that occurs in protected areas. From 2019 to 2030, AFOLU emissions remain relatively stable due to the methodological approach.

AFOLU net emissions increase by 8% in 2025 and 8% in 2030 compared to 2005. The reduction from 2005 to 2030 is mainly due to the contribution of negative land use emissions, because of carbon removals. Gross emissions increase significantly: 46% in both 2025 and 2030, compared to 2005. So gross emissions stabilize at 98 Mt CO_2e/year. Table 27 and Figure 26 show the results during the analysed period.

Table 27. Emissions from Agriculture, Forestry and Other Land Use (AFOLU) Sector from the State of Amazonas (Mt CO_2e)

LULUCF								
Sector	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2005-2025**	**2005-2030**
LULUCF (Emissions)	60.40	45.40	54.30	87.86	87.86	87.86	46%	46%
LULUCF (Removals)	96.10	118.40	120.40	125.46	125.46	125.46	31%	31%
LULUCF Net emissions	-35.80	-73.00	-66.10	-37.60	-37.60	-37.60	-5%	-5%
Agriculture								
Sector	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2005-2025**	**2005-2030**
Agriculture (Emissions)	6.96	11.77	9.61	10.24	10.17	10.10	46%	45%
Livestock (Emissions)	1.81	2.03	1.97	2.08	2.06	2.03	13%	12%
Crops (Emissions)	5.15	9.73	7.65	8.16	8.11	8.07	58%	57%
Agriculture (Removals)	0.99	1.04	0.10	0.13	0.16	0.03	-84%	-97%
Agriculture Net emissions	5.97	11.74	9.56	10.17	10.10	10.03	69%	68%
TOTAL AFOLU (Gross emissions)	**67.30**	**57.10**	**63.90**	**98.10**	**98.09**	**98.02**	**46%**	**46%**
TOTAL AFOLU (Net emissions)	**-29.80**	**-61.30**	**-56.60**	**-27.43**	**-27.44**	**-27.52**	**8%**	**8%**

Note: Historical emission data from 2005 to 2018 and projections from 2019 to 2030.



Note: Historical emission data from 2005 to 2018 and projections from 2019 to 2030.

Figure 26. Emissions from Agriculture, Forestry and Other Land Use (AFOLU) Sector from the State of Amazonas (Mt CO_2e)

b) Transport

Historical data emissions (2005 -2018), from the transport subsector increased by 88% in the Amazonas state. Road transport had the largest contribution, with almost 80% in 2018. However, the transport mode which emissions increased the most is water, with a variation of 212% from 2005 until 2018.

The transport emissions projections in the state of Amazonas were made based on the growth rate of each modal type in Brazil (according to the CPS estimates of DDP-BIICS Project). With that information, the emission values were calculated using the emission factor for each fuel. From 2019 to 2030 Brazilian transport emissions, according to the CPS of DDP-BIICS project, vary as follows: 0.14% in water, 8% in rail, 15% in air and 15% in road. Emissions growth rates were applied from the last year of available data.

According to this methodology, emissions from the transport subsector increase by 97% in 2025 and 114% in 2030 compared to 2005. Road transport remains the largest contribution, with 80% in 2030.However, the transport mode which emissions increase the most is water, with a variation of 212% in the entire period.

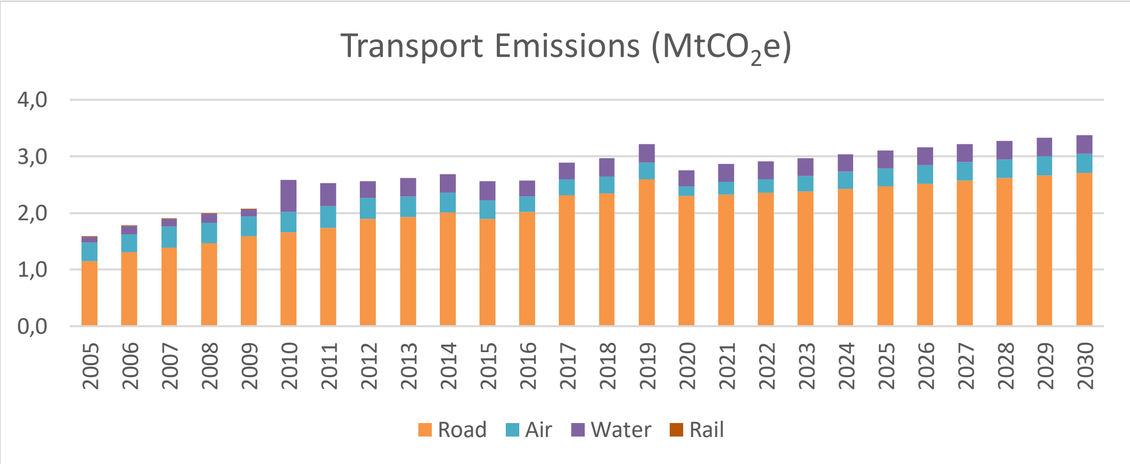
Table 28 and Note: *Historical emission data from 2005 to 2018 and projections from 2019 to 2030.*

Figure **27** show emissions in the analyzed years for all transportation modes.

Table 28. Emissions from the transport modes from the State of Amazonas (Mt CO_2e)

Modal	2005	2010	2015	2020	2025	2030	2005-2025	2005-2030
Road	1.15	1.66	1.90	2.30	2.47	2.71	115%	136%
Air	0.32	0.36	0.32	0.17	0.32	0.34	-0.2%	5%
Water	0.11	0.57	0.34	0.28	0.31	0.33	196%	212%
Rail	0.01	0.00	0.00	0.00	0.00	0.00	-	-
Transport (Total)	**1.58**	**2.59**	**2.56**	**2.75**	**3.10**	**3.38**	**97%**	**114%**

Note: Historical emission data from 2005 to 2018 and projections from 2019 to 2030.



Note: Historical emission data from 2005 to 2018 and projections from 2019 to 2030.

Figure 27. Emissions from the transport modes from the State of Amazonas (Mt CO_2e)

c) Industry

State emissions from industry are mostly driven by economic growth and they were projected using the emissions growth rate of each industrial sector in Brazil. Emissions growth rates were applied from the last year of available data.

Amazonas industrial processes emissions were projected using the emissions growth rate of cement industrial sector in Brazil because SEEG database only have information of IPPU from this industrial sector. Emissions projections from energy use in industry followed the same Brazil's growth rate of each industrial sector in the CPS of DDP-BIICS project. Emissions growth rates were applied from the last year of available data.

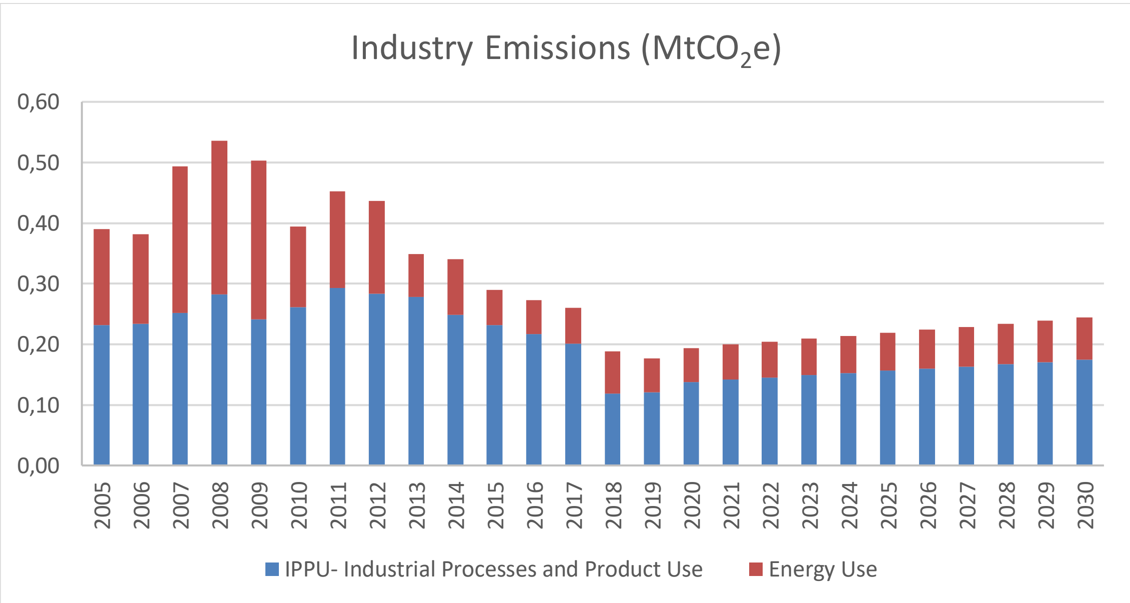
Although emissions grow in our projections (2019-2030), when analyzing the whole period (2005-2030) the industry emissions decrease in the state of Amazonas (-37% from 2005 to 2030). IPPU has greater weight in emissions from this sector (Table 29 and Note: *Historical emission data from 2005 to 2018 and projections from 2019 to 2030.*

Figure **28**).

Table 29. Emissions from industry - energy use and Industrial Processes and Product Use (IPPU) from the State of Amazonas (Mt CO_2e and %)

Sector	2005	2010	2015	2020	2025	2030	2005-2025	2005-2030
IPPU- Industrial Processes and Product Use	0.23	0.26	0.23	0.14	0.16	0.17	-33%	-25%
Energy Use	0.16	0.13	0.06	0.06	0.06	0.07	-60%	-56%
Total Industry	**0.39**	**0.39**	**0.29**	**0.19**	**0.22**	**0.24**	**-44%**	**-37%**

Note: Historical emission data from 2005 to 2018 and projections from 2019 to 2030.



Note: Historical emission data from 2005 to 2018 and projections from 2019 to 2030.
Figure 28. Emissions from Industry - energy use and Industrial Processes and Product Use (IPPU) from the State of Amazonas (Mt CO_2e)

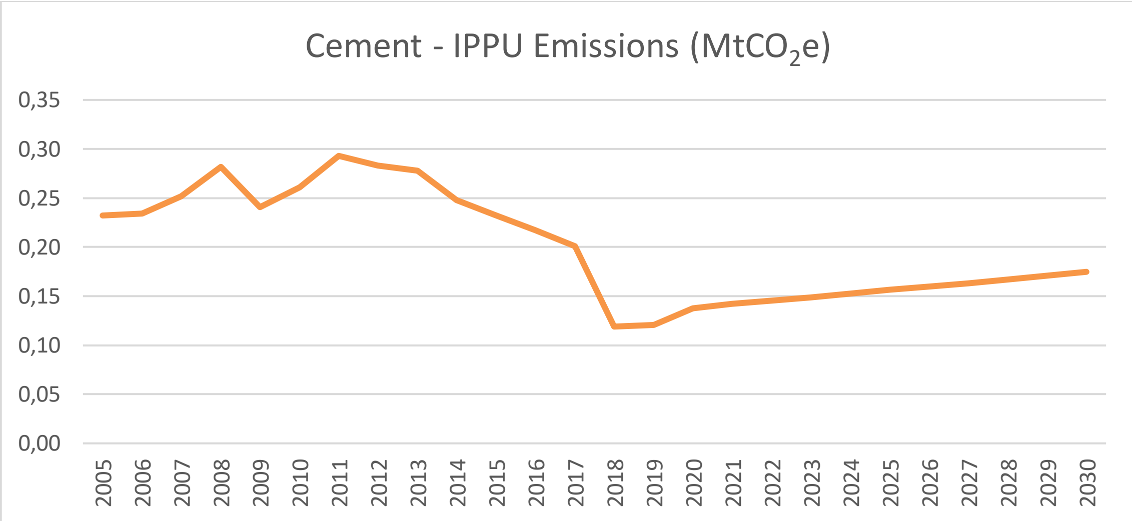
I. IPPU- Industrial Processes and Product Use

Data regarding IPPU emissions are available for the cement industry only. From 2005 to 2018, these emissions had a 489% reduction. It should be noted that throughout this period emissions were not linear, coinciding with a market retraction in 2009 and 2014, and decreasing until the end of the period.

From 2019 to 2030 the projections indicate an increase in IPPU emissions following the growth rate of industrial emissions in Brazil (CPS of DDP-BIICS project).

In 2025, IPPU emissions presents a 32% reduction compared to 2005, totalling 156,313 tCO_2e in 2025 and 174,618 tCO_2e in 2030. It should be noted that from 2019 to 2030, despite the drop in total IPPU emissions from 2005 to 2018, there is an increase in emissions from 2019 to 2030 due to economic growth (Note: *Historical emission data from 2005 to 2018 and projections from 2019 to 2030.*

Figure **29**).



Note: Historical emission data from 2005 to 2018 and projections from 2019 to 2030.
Figure 29. Emissions from Industrial Processes and Product Use (IPPU) Sector from the State of Amazonas (Mt CO_2e)

II. Energy Use

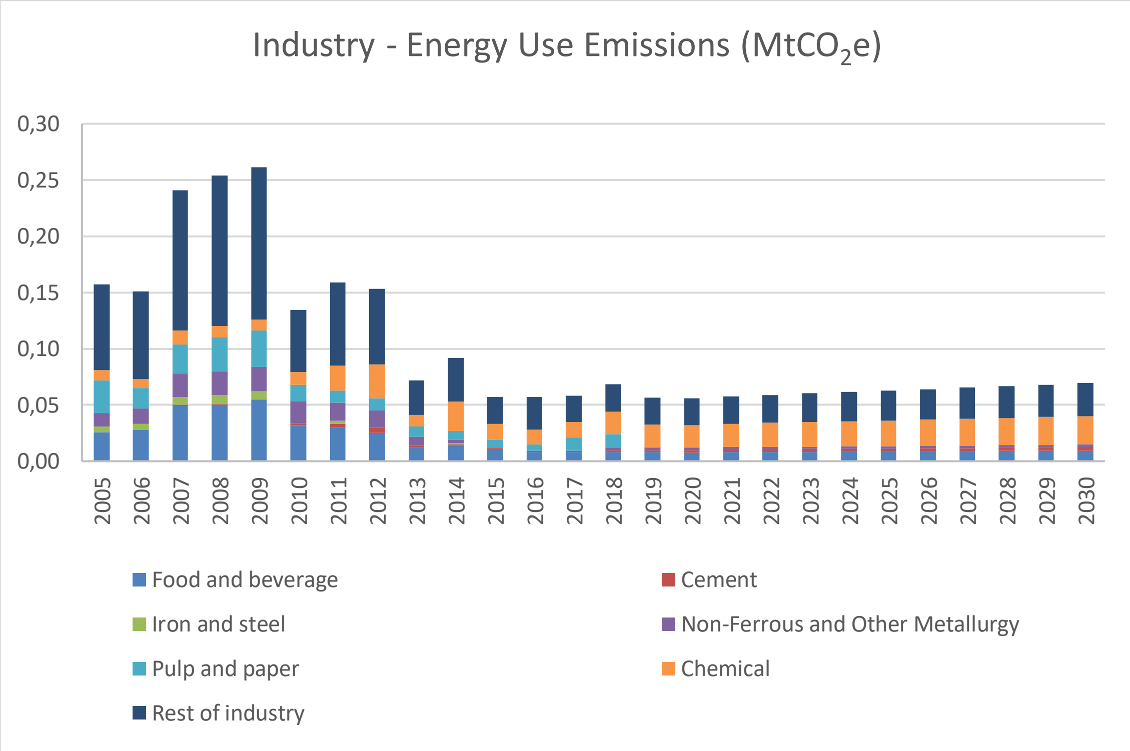
Emissions projections from energy use in industry, followed the same Brazil's growth rate of each industrial sector provided by the CPS of DDP-BIICS project: Food and beverage, Cement, Iron and steel, Non-Ferrous and Other Metallurgy, Pulp and paper, Chemical and others industry (Rest of industry). Each subsector growth rate from DDP-BIICS was applied from the last year of available data.

The most emitting industrial sub-sector due to energy use in the state of Amazonas has undergone changes over the historical data series (2005-2018). At the beginning of the period, Rest of industry, Pulp and Paper, and Food and Beverage were those that emitted the most. However, Chemical and Rest of industry, became the most important in 2018. The entire industrial sector reduced its energy use emissions considerably in the historical period (56% from 2005 to 2018), while the GDP grew 10% between 2005 and 2017 (last year with available GDP values). In 2018, the last year with available emission data, Chemical and Rest of industry were those that emitted the most and this trend continues until 2030.

During the period 2019-2030 emissions increase due to the methodological approach, which follows the industrial emissions growth rate in Brazil (CPS of DDP-BIICS project). So, despite the

60% drop in the total emissions from industrial energy use from 2005 to 2025, there is an increase in emissions in the period from 2019 to 2030 (Note: *Historical emission data from 2005 to 2018 and projections from 2019 to 2030.*

Figure **30**).



Note: Historical emission data from 2005 to 2018 and projections from 2019 to 2030.
Figure 30. Emissions from energy use, by source, in the industry subsectors from the State of Amazonas (Mt CO_2e)

d) Other sectors of energy use

Historical emissions data (2005 -2018) from other sectors of energy use show an increase of 53% in the Amazonas state. Residential has the largest contribution, with almost 63% in 2018. From 2019 to 2030, estimated emissions follow the same trend with residential being the main emission source.

From 2019 to 2030, the emissions projections from energy use in agriculture, residential, commercial, and public sectors in the state of Amazonas followed the same Brazil's growth rate of each subsector in the CPS of DDP-BIICS project and emissions growth rates were applied from the last year of available data. Emissions from fuel consumption in the agricultural, commercial, industrial, residential, and public sectors include those from self-produced power plants and direct fuel consumption in the sectors' activities (final energy consumption). In the residential sector, energy emissions include only the final energy consumption.

From 2019 to 2030, emissions from agriculture energy use were projected based on the average emissions from 2010 to 2018, using the growth rates of energy-related emissions from the agriculture sector of the CPS of DDP-BIICS project (11% increase from 2019 to 2030). Emissions from the commercial and public sectors decline following the negative growth rate of Brazilian emissions for these sectors (13% reduction from 2019 to 2030) while residential ones follow the emissions growth rate from Brazilian buildings also according to the CPS of DDP-BIICS project (12% increase from 2019 to 2030).

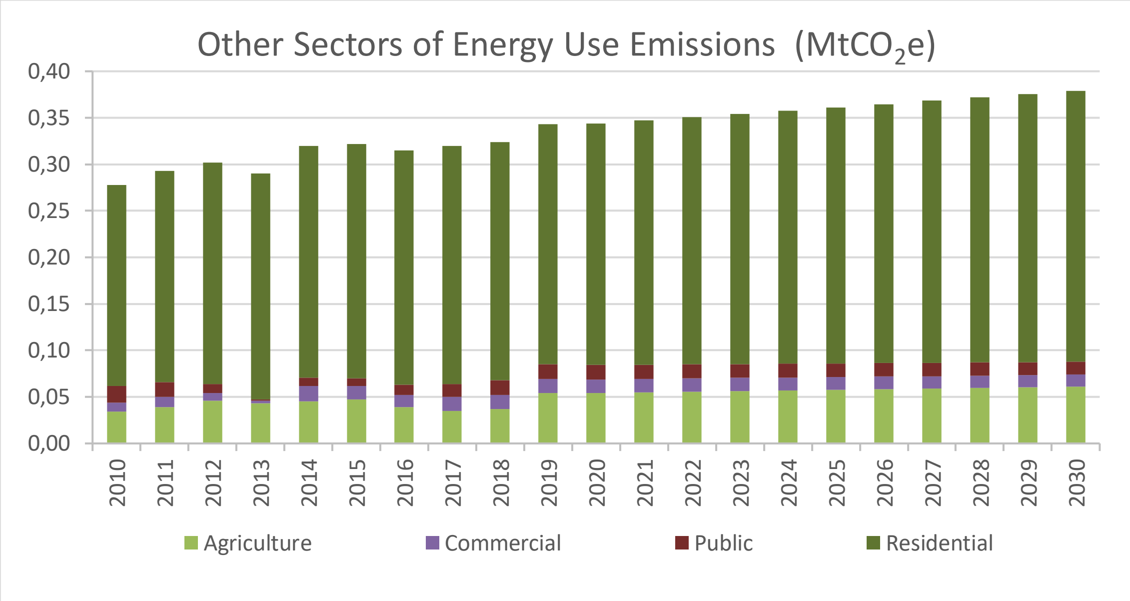
In the analyzed period, there is a substantial increase in emissions from energy use in the agriculture sector, and a decrease in emissions from public and commercial sectors, as can be observed in Table 30 and [1] 2013 data from the residential energy sector is an average of 2012 and 2014, because of the lack of data for in SEEG database.

Note: Historical emission data from 2005 to 2018 and projections from 2019 to 2030.
Figure **31**. In the residential sector, energy emissions include only the final energy consumption and remains the largest contribution to the total Other sectors of energy use emissions, with 77% in 2030.

Table 30. Emissions from Other sectors of energy use from the State of Amazonas (Mt CO_2e and %)

Sector	2005	2010	2015	2020	2025	2030	2005-2025	2005-2030
Agriculture[1]	0.002	0.034	0.047	0.054	0.058	0.061	2783%	2947%
Commercial[1]	0.02	0.01	0.02	0.01	0.01	0.01	-14%	-19%
Public[1]	0.06	0.02	0.01	0.02	0.01	0.01	-76%	-77%
Residential[1]	0.13	0.22	0.25	0.26	0.28	0.29	105%	117%
Total	**0.21**	**0.28**	**0.32**	**0.34**	**0.36**	**0.38**	**70%**	**79%**

[1]Scope 1
Note: Historical emission data from 2005 to 2018 and projections from 2019 to 2030.



[1] 2013 data from the residential energy sector is an average of 2012 and 2014, because of the lack of data for in SEEG database.

Note: Historical emission data from 2005 to 2018 and projections from 2019 to 2030.

Figure 31. Emissions from Other sectors of energy use from the State of Amazonas (Mt CO_2e)

e) Energy Supply

Amazonas state emissions projections from energy supply comprise the activities of exploitation and transportation of oil and gas, the transformation centers and emissions from both fuel combustion and fugitive. Amazonas public utility power plants emissions estimates in this report include the growth rates of coal and natural gas thermoelectric generation in Brazil based on the data from the National Energy Balance (in Portuguese, Balanço Energético Nacional – BEN), from 2015-2018, and from the CPS of DDP-BIICS project, from 2019-2030. The state energy sector own consumption assumes a constant efficiency overtime. In other words, the 2015 ratio between the energy sector own consumption emissions and the power plants emissions were kept constant until the end of the analyzed period (2030). Fuel production and fugitive emissions projections followed the same Brazil's growth rate of each sector in both ICAT 1 and CPS of DDP-BIICS projects, from 2016 until 2030. Emissions growth rates were applied from the last year of available data.

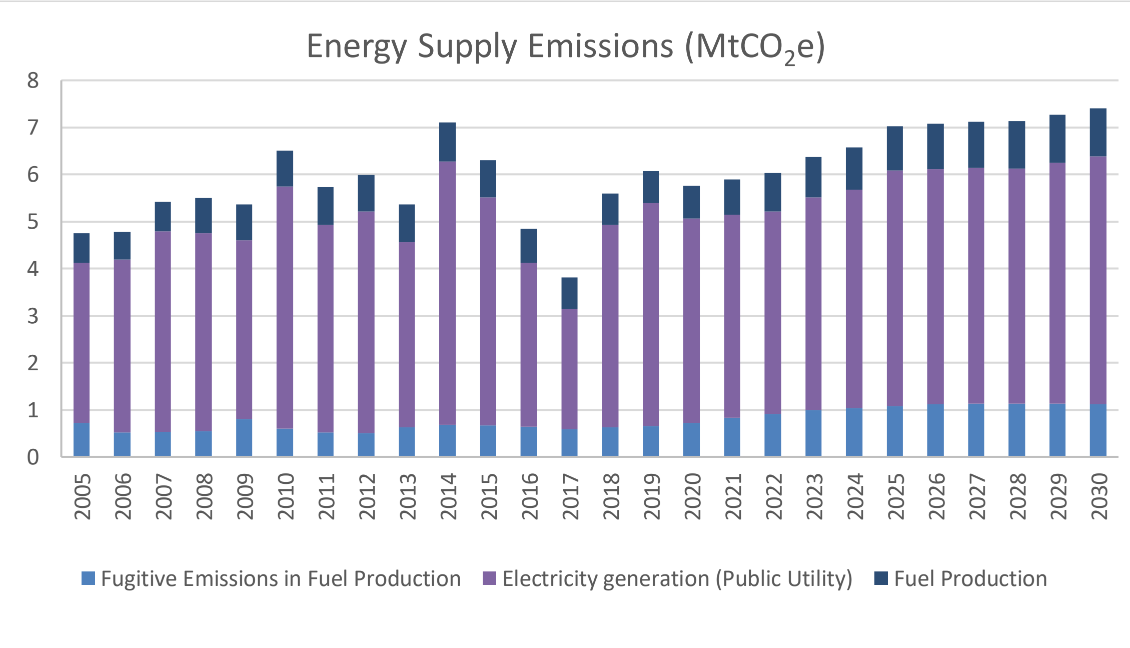
The emissions from 2019 to 2030 follow the same trend of historical data (2005-2018). From 2005 to 2030, there is a substantial increase in emissions from electricity generation, fuel production and fugitive emissions (54 %, 65 % and 55%, respectively), as we can observe in Table 31 and in Note: *Historical emission data from 2005 to 2018 and projections from 2019 to 2030.*

Figure **32**. Electricity generation (public utilities) remains the largest contribution to the total energy supply emissions, with 71% in 2030.

Table 31. Energy supply emissions by sector from the State of Amazonas in the period 2005-2030 (Mt CO_2e and %)

Sector	2005	2010	2015	2020	2025	2030	2005-2025	2005-2030
Fugitive Emissions in Fuel Production	0.72	0.60	0.67	0.73	1.08	1.11	50%	55%
Emissions from Fuel Combustion	5.99	8.90	8.57	7.11	8.20	8.93	37%	49%
Electricity generation (Public Utility)	3.41	5.14	4.85	4.33	5.00	5.26	47%	54%
Fuel Production	0.62	0.76	0.78	0.69	0.94	1.03	50%	65%
Total	4.75	6.50	6.30	5.76	7.02	7.41	48%	56%

Note: Historical emission data from 2005 to 2018 and projections from 2019 to 2030.



Note: Historical emission data from 2005 to 2018 and projections from 2019 to 2030.

Figure 32. Energy supply emissions by sector from the State of Amazonas in the period 2005-2030 (Mt CO_2e)

f) Waste – Solid waste and wastewater

Historical emissions data (2005 -2018) from the waste sector increased by 45 %. Projections (2019 to 2030) followed the same growth trend but at a lower rate. Waste emissions evolve at the same rates as Brazil's emissions from urban solid waste and domestic wastewater in CPS of DDP-BIICS projection (5% increase from 2019 to 2030), while industrial solid waste emissions were projected using the emissions growth rate of the Food and Beverage industrial sector (19%increase from 2019 to 2030). Waste emissions from incineration were projected using the emissions growth rate of industrial waste sector in Brazil. Emissions growth rates were applied from the last year of available data.

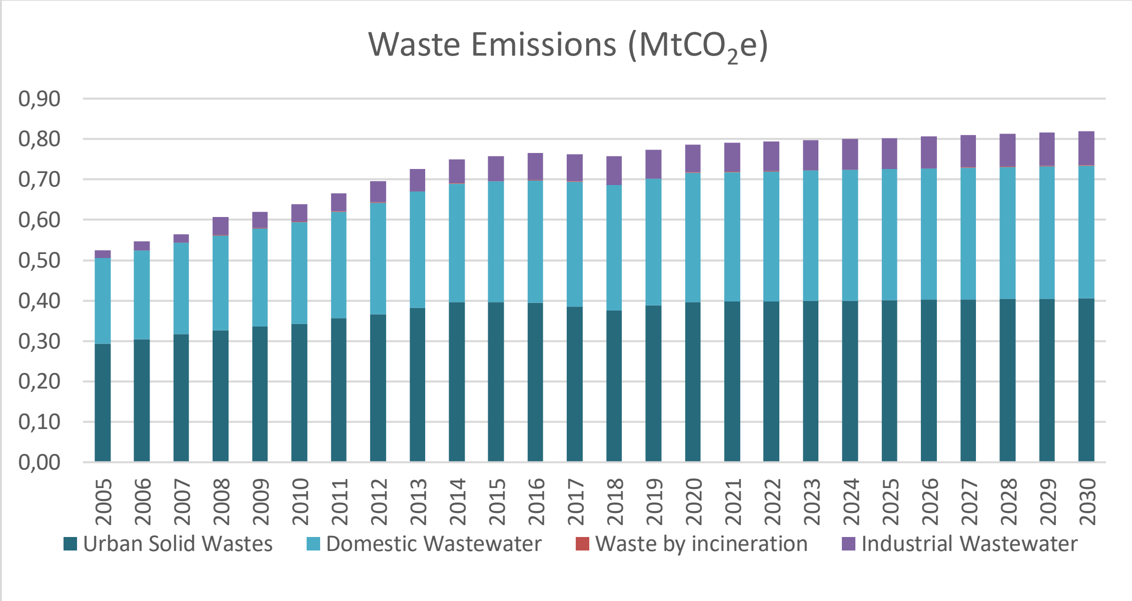
According to the used methodology, GHG emissions from the waste sector increased by 53.17% between 2005 and 2025. Table 32**Erro! Autoreferência de indicador não válida.** presents the results of the estimates and the evolution of GHG emissions in the subsectors in this period. Note: *Historical emission data from 2005 to 2018 and projections from 2019 to 2030.*

Figure **33** shows the contribution of each subsectors in the total waste emissions. There is a substantial increase in emissions from the industrial wastewater and waste disposal in landfill in 2025, compared to 2005 (323% and 85.26%, respectively). The main decrease in emissions occurred in open dump disposal (43%).

Table 32. Emissions of the Waste Sector from the State of Amazonas (Mt CO_2e and %)

Sector	2005	2010	2015	2020	2025	2030	2005-2025	2005-2030
Wastewater Treatment and Discharge	**0.230**	**0.294**	**0.359**	**0.389**	**0.400**	**0.412**	**74%**	**79%**
Domestic Wastewater	0.212	0.252	0.299	0.320	0.324	0.328	53%	55%
Industrial Wastewater	0.018	0.042	0.061	0.069	0.076	0.085	323%	370%
Solid Waste	**0.293**	**0.344**	**0.397**	**0.397**	**0.402**	**0.407**	**37%**	**39%**
Urban Solid Wastes	0.293	0.343	0.396	0.397	0.401	0.406	37%	39%
Disposal in unmanaged deep sites	0.062	0.074	0.089	0.090	0.092	0.093	48%	49%
Disposal at landfill	0.139	0.198	0.251	0.255	0.258	0.261	85%	87%
Disposal in unmanaged shallow sites	0.092	0.071	0.057	0.052	0.052	0.053	-43%	-43%
Waste by incineration	0.00100	0.00100	0.00100	0.00097	0.00107	0.00119	7%	19%
Waste (Total)	**0.524**	**0.638**	**0.757**	**0.786**	**0.803**	**0.819**	**53%**	**56%**

Note: Historical emission data from 2005 to 2018 and projections from 2019 to 2030.



Note: Historical emission data from 2005 to 2018 and projections from 2019 to 2030.

Figure 33. Emissions of the Waste Sector from the State of Amazonas (Mt CO_2e)

5.2. Conclusion

Historical data from 2005 to 2018 show that emissions decreased in sharply. During that period, total net emissions reduced and then increased again, remaining relatively constant during the entire period. The agriculture sector has the largest emissions in the state of Amazonas, followed by energy and transport.

It is also important to note that LULUCF emissions are negative because of carbon removals in indigenous lands and protected areas. However, LULUCF sector is responsible for a significant part of emissions, mainly because of deforestation. From 2019 to 2030, LULUCF is the main emission source (80% of total gross emissions in 2030), while carbon uptakes remain constant.

In the state of Amazonas from 2005 to 2030 there is an increase of 31% in total net emissions and 47% in total gross emissions. Total net emissions are still negative, but the increase in removals from LULUCF (31%) was not sufficient to reduce the total emissions in the state. There is a significant increase in emissions from transport (114%), other sectors of energy use (79%), energy supply (56%) and waste (56%).

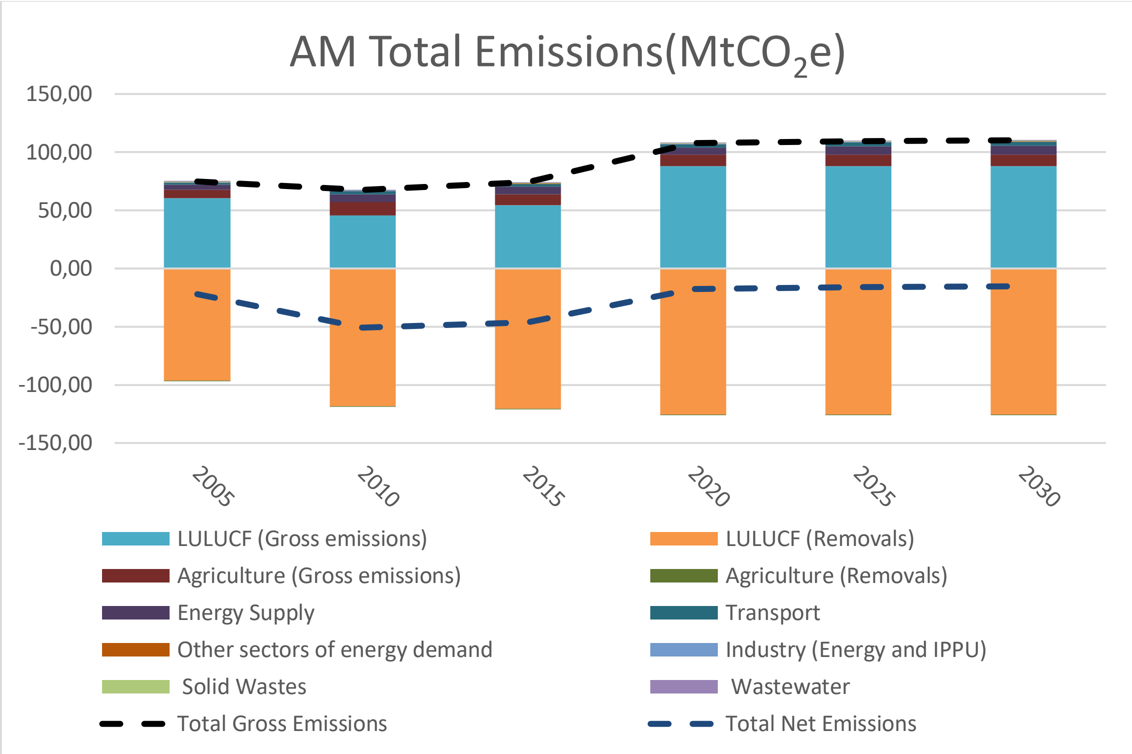
The aggregate emissions from the Amazonas sectors and variations overtime are shown in Table 33 e and Note: *Historical emission data from 2005 to 2018 and projections from 2019 to 2030.*

Figure **34**.

Table 33. Emissions from the State of Amazonas by sectors in the period 2005-2030 (Mt CO_2e and %)

Sector	2005	2010	2015	2020	2025	2030	2025/2005	2030/2005
	Mt CO_2e						%	
AFOLU (Gross emissions)	67.30	57.10	63.90	98.10	98.09	98.02	46%	46%
AFOLU (Net emissions)	-29.80	-61.30	-56.60	-27.43	-27.44	-27.52	-8%	-8%
LULUCF (Net Emissions)	-35.70	-73.00	-66.10	-37.60	-37.54	-37.54	5%	5%
LULUCF (Gross emissions)	60.40	45.40	54.30	87.86	87.92	87.92	46%	46%
LULUCF (Removals)	96.10	118.40	120.40	125.46	125.46	125.46	31%	31%
Agriculture (Net Emissions)	5.97	11.74	9.55	10.17	10.10	10.03	69%	68%
Agriculture (Gross emissions)	6.96	11.77	9.61	10.24	10.17	10.10	46%	45%
Agriculture (Removals)	0.99	0.03	0.06	0.07	0.07	0.08	-93%	-92%
Transport	1.58	2.59	2.56	2.75	3.10	3.38	97%	114%
Industry (Energy and IPPU)	0.39	0.39	0.29	0.19	0.22	0.24	-44%	-3%
Other sectors of energy use	0.21	0.28	0.32	0.34	0.36	0.38	70%	79%
Energy Supply	4.75	6.50	6.30	5.76	7.02	7.41	48%	56%
Waste	0.52	0.64	0.76	0.79	0.80	0.82	53%	56%
Solid Wastes	0.29	0.34	0.40	0.40	0.40	0.41	3%	39%
Wastewater	0.23	0.29	0.36	0.39	0.40	0.41	74%	79%
Total Gross Emissions	**74.83**	**67.57**	**74.14**	**107.93**	**109.60**	**110.25**	**47%**	**47%**
Total Net Emissions	**-22.27**	**-50.86**	**-46.32**	**-17.60**	**-15.93**	**-15.29**	**28%**	**31%**

Note: Historical emission data from 2005 to 2018 and projections from 2019 to 2030.



Note: Historical emission data from 2005 to 2018 and projections from 2019 to 2030.

Figure 34. Emissions from the State of Amazonas by sectors in the period 2005-2030 (Mt CO_2e)

6. Comparative Analysis of the Results of the States' Reference Scenario

The Reference Scenario represents GHG emission trends up to 2030 in each selected state (Rio de Janeiro, Minas Gerais and Amazonas) under the current performance of ongoing mitigation actions that contribute to achieving Brazilian NDC targets. The assessment of an expected performance of current mitigation policies and measures according to recent trends has allowed for a realistic assumption of a baseline for 2025 and 2030, and the identification of additional efforts still needed to meet the targets.

In this chapter, we compare GHG emissions of each economic sector of the three selected states in the period 2016-2030 with the past record, and with economy-wide results for Brazil. Some comparative analysis across states is also allowed, under a methodological caveat: the GHG emissions inventory available for each state has followed slightly different approaches: GHG emissions data for Rio de Janeiro and Amazonas states are expressed in the GWP values of the Fifth Assessment Report (AR5) (IPCC, 2013), while for the Minas Gerais state, the GWP values of the Second Assessment Report (SAR) (IPCC, 1996) were adopted. Given that the results are not split by each GHG – what would allow a precise conversion to the AR5 GWP values -, the comparison between total states' values is not accurate.

Nevertheless, to make the estimates comparison possible, the following Minas Gerais emissions inventory data were converted to the AR5 GWP: methane emissions from rice cultivation and enteric fermentation in AFOLU and from waste subsectors. As a result, total emissions of this state in 2014 (last year with available data) increase from 124 MtCO_2e with SAR GWP to around 134 Mt CO_2e using AR5 GWP, an average increase of approximately 10%.

Besides that, given that each state inventory follows a slightly different guideline and/or protocol, sectoral emissions differ due to the distinct allocation of emissions in the inventory report/dataset. The disaggregation of energy emissions presents specificities regarding the activities accounted for in their respective inventory reports/dataset. Table 34 shows the peculiarities in states' allocation of relevant GHG emissions sources.

Table 34. Allocation of energy emission sources in each state

Setor	Activity	RJ	MG	AM	Estimates
Energy Sector (Supply)	Public utility Power Plants	Scope 1	Scope 1	Scope 1	Growth rate of total supply of Coal and Natural Gas for Brazil in CPS (DDP-BIICS)
	Self-generation Power Plants	Scope 1	Scope 1	Scope 1 for each subsector	
Other sectors of energy use	Sectors of energy use	Scope 1 + Scope 2 with grid emission factor	Scope 1	Scope 1	Growth rate of sectorial emissions in CPS (DDP-BIICS)

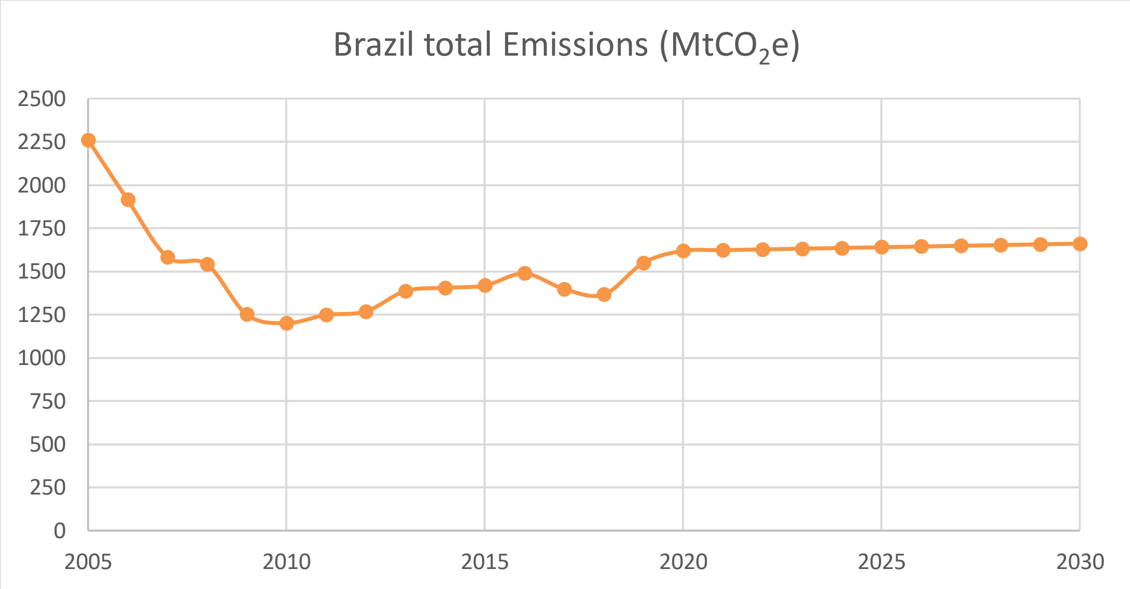
Regarding scope, Scope 1 includes direct emissions that occur in the State's territory and Scope 2 includes emissions from energy generation imported from the national electricity grid. In the state of Rio de Janeiro alone, Scope 2 emissions were accounted for.

Emissions from self-generation power plants are accounted for in the energy sector (supply) in the states of Rio de Janeiro and Minas Gerais, while Amazonas accounts for these emissions where they take place, in each of the respective consumption sector (industry, public, agriculture and commercial). Regarding coke production, Rio de Janeiro accounts for its emissions in the energy sector, while Minas Gerais and Amazonas in the industrial sector.

A comparative analysis across the three selected states allows decision makers and other stakeholders to understand the potential and the relevance of the sectoral mitigation actions in each state to be discussed in the next report. The states GHG emissions pathways have to be considered within a broader storyline of economy-wide Brazilian emissions, from the recent record to future scenarios, as well as the expert judgment about the performance of ongoing climate mitigation policies.

Regarding the record of GHG emissions in Brazil, there was a sharp reduction in emissions from 2005 to 2010, followed by a period of small growth until 2016. Considering future projections, emissions would continue to increase, but at a lower growth rate. In 2030, Brazilian economy-wide emissions are estimated to be 27% lower than in 2005. However, they would be 38% higher than in 2010. Therefore, despite the efforts to reduce GHG emissions in the last decade, the country continues to steadily increase its level of emissions (Note: *From 2020 on, GHG emission projections are based on CPS (DDP-BIICS project) assumptions*

Figure **35**).



Note: From 2020 on, GHG emission projections are based on CPS (DDP-BIICS project) assumptions
Figure 35. Brazilian total GHG emissions in the period 2005-2030 (Mt CO_2e/year)
Source: SEEG (2020)

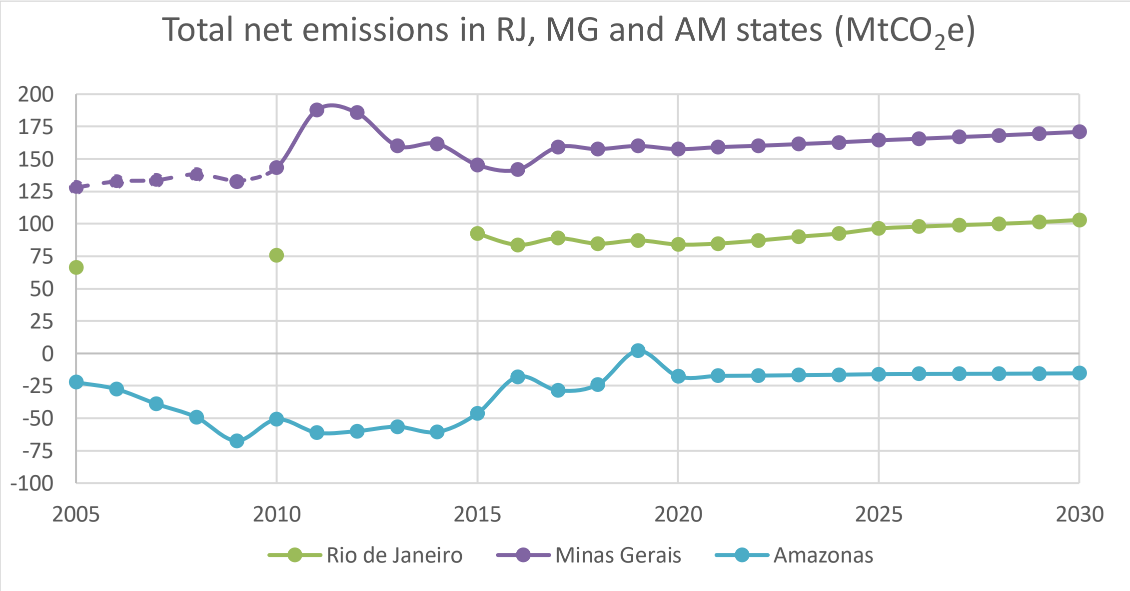
Regarding the emissions of individual states, absolute GHG emissions levels vary strongly according to their specificities, such as population concentration and main economic activities. In 2030, economy-wide emissions in Rio de Janeiro, Minas Gerais and Amazonas are estimated to be 56%, 33% and 31% higher than in 2005, respectively (Note: *For Rio de Janeiro, period 2005-2015 corresponds to historical data and period 2016-2030 to projections; for Minas Gerais, period 2005-2014 corresponds to historical data and period 2015-2030 to projections. LULUCF emission and removal values from 2005-2009 are considered constant and equal to 2010, due to the lack of LULUCF data for this period; and for the Amazonas, period 2005-2018 corresponds to historical data and period 2019-2030 to projections. From 2019 on, all figures are projections based on CPS (DDP-BIICS project) assumptions and specific assumptions for each state.*

Figure **36**).

The state of Amazonas is a very special case with total net negative GHG emissions thanks to the removals (carbon sinks) in LULUCF. Total net GHG emissions were increasingly negative from 2005 to 2009 (minimum absolute level recorded). From 2010 to 2015, total net emissions have nearly stabilized (from -51 to -46 MtCO_2e/year). From 2016, a further increase has led to another quasi-stabilization in the period up to 2018, followed by a peak in 2019, when total net emissions were no longer negative. Emissions projection assumptions have led to a quasi-stabilization (from -18 to -15 MtCO_2e/year) of emissions throughout the period 2020-2030.

In the state of Minas Gerais, LULUCF emission and removal values from 2005 to 2009 are considered constant and equal to 2010, due to the lack of LULUCF data for that period. The analyzed period starts with stabilized emissions from 2005 to 2010. After that, emissions show a significant increase in 2011 and 2012 when starts to decrease and only grow again in 2016. From 2017 onwards, emissions show a slight upward trend until the end of the period (2030).

On the other hand, in the state of Rio de Janeiro, there was an increase of emissions from 2005 to 2015, followed by a slight reduction until 2020. In the Reference Scenario, emissions are projected to increase until the end of the period, at lower growth rates.



Note: For Rio de Janeiro, period 2005-2015 corresponds to historical data and period 2016-2030 to projections; for Minas Gerais, period 2005-2014 corresponds to historical data and period 2015-2030 to projections. LULUCF emission and removal values from 2005-2009 are considered constant and equal to 2010, due to the lack of LULUCF data for this period; and for the Amazonas, period 2005-2018 corresponds to historical data and period 2019-2030 to projections. From 2019 on, all figures are projections based on CPS (DDP-BIICS project) assumptions and specific assumptions for each state.

Figure 36. Rio de Janeiro, Minas Gerais and Amazonas total GHG emissions in the period 2005-2030 (Mt CO_2e/year)

Source: Rio de Janeiro: State GHG inventory (SEA, 2017); Minas Gerais: State GHG inventory (FEAM,2016); Amazonas: SEEG (2020)

Note: For Rio de Janeiro, period 2005-2015 corresponds to historical data and period 2016-2030 to projections; for Minas Gerais, period 2005-2014 corresponds to historical data and period 2015-2030 to projections- LULUCF emission and removal values from 2005-2009 are considered constant and equal to 2010, due to the lack of LULUCF data for this period; and for the Amazonas, period 2005-2018 corresponds to historical data and period 2019-2030 to projections. From 2019 on, all figures are projections based on CPS (DDP-BIICS project) assumptions and specific assumptions for each state.

Figure 37 shows total net GHG emissions first in 2005 (base year of Brazilian NDC), then in the last year with available data for each state, and finally in the scenario time horizon, 2020-2030. Its analysis shows the trend of increasing emissions in each of the states and in the country, as previously noted. Pathways differ across states, however. For example, in the state of Rio de Janeiro emissions have steadily grown between 2005 and 2015, but the projected growth rate in the period 2016-2030 is quite lower. The same pattern is observed in the state of Minas Gerais, with substantial emissions growth between 2005 and 2014, and a much slower annual growth rate projected for 2015-2030. On the other hand, in the state of Amazonas the picture is radically different: net emissions are negative throughout the whole period and get even more negative between 2005 and 2009; but the trend is reversed from 2010 to 2018, and a quasi-stabilization is projected for the period 2019-2030. The negative emissions in Amazonas have contributed to the overall mitigation efforts and present a great potential to contribute even more in the future to the achievement of NDC targets.

Note: For Rio de Janeiro, period 2005-2015 corresponds to historical data and period 2016-2030 to projections; for Minas Gerais, period 2005-2014 corresponds to historical data and period 2015-2030 to projections- LULUCF emission and removal values from 2005-2009 are considered constant and equal to 2010, due to the lack of LULUCF data for this period; and for the Amazonas, period 2005-2018 corresponds to historical data and period 2019-2030 to projections. From 2019 on, all figures are projections based on CPS (DDP-BIICS project) assumptions and specific assumptions for each state.

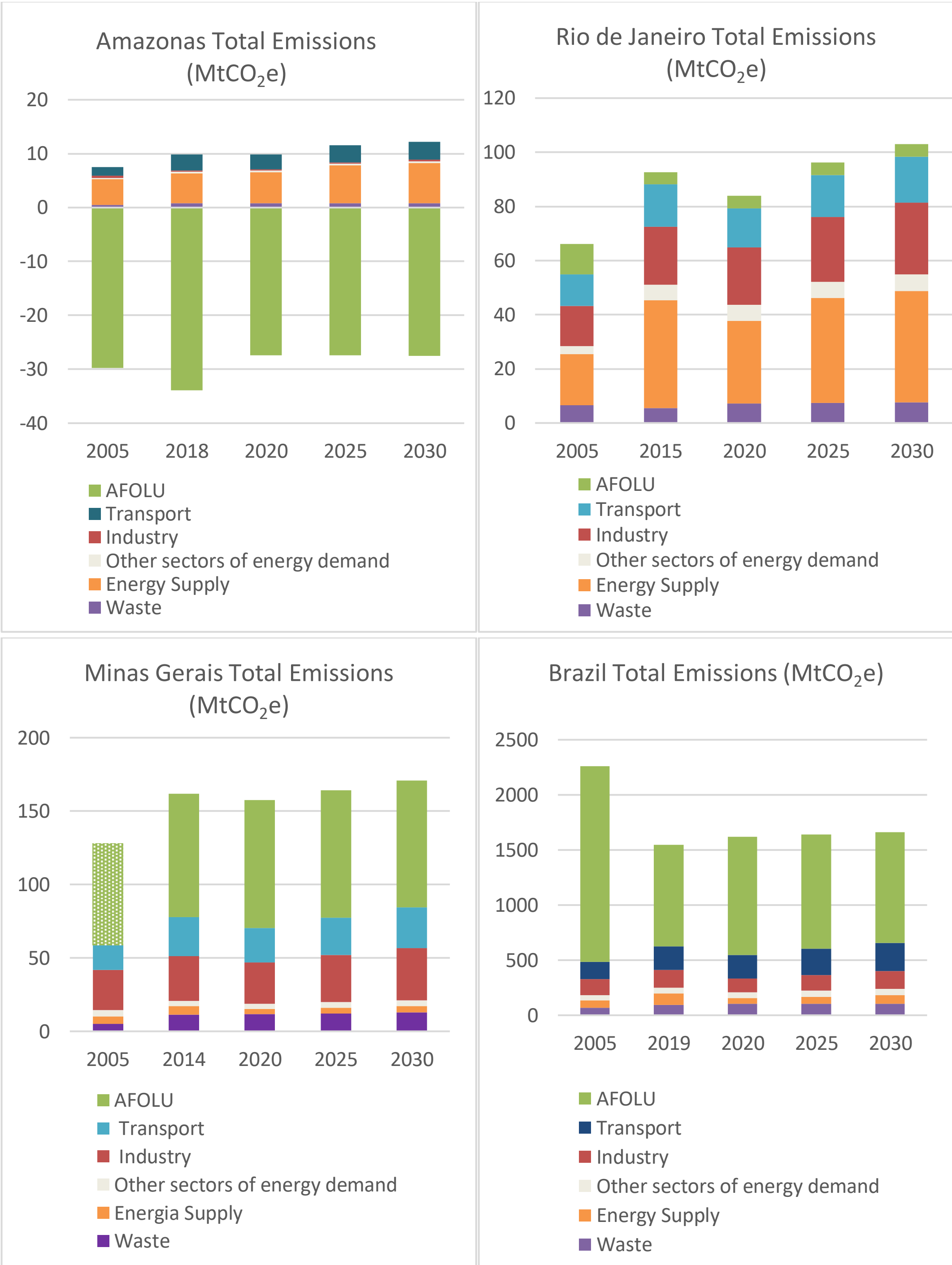
Figure 37. Net emissions from the three states and from Brazil in the period 2005-2030 (Mt CO_2e/year)
Sources: Rio de Janeiro: State GHG inventory (SEA, 2017); Minas Gerais: State GHG inventory (FEAM,2016); Amazonas: SEEG (2020), Brazil: SEEG (2020). From 2019, all figures are projections based on DDP-BIICS project estimates.

The assessment of state emissions by sector allows for a preliminary identification of sectors with potential to mitigate emissions, as illustrated by Note: *For Rio de Janeiro, period 2005-2015 corresponds to historical data and period 2016-2030 to projections; for Minas Gerais, period 2005-2014 corresponds to historical data and period 2015-2030 to projections- LULUCF emission and removal values from 2005-2009 are considered constant and equal to 2010, due to the lack of LULUCF data for this period; and for the Amazonas, period 2005-2018 corresponds to historical data and period 2019-2030 to projections. From 2019 on, all figures are projections based on CPS (DDP-BIICS project) assumptions and specific assumptions for each state. LULUCF emission values for 2005 are not available for the state of Minas Gerais.*

Figure **38**. The state of Amazonas stands out for the negative emissions related to AFOLU, mainly due to the large extension of protected areas in the state, which contribute to the fulfilment of the decarbonization goals. On the other hand, the intensity of deforestation in the state leads to significant gross emissions that compensate for a high share of emission removals. Another key sector for the state of Amazonas is energy supply, due to a high share of power generation from fossil fuels.

In the state of Rio de Janeiro, emissions are mainly concentrated in the energy supply, industry and transport sectors. This is justified by the fact that Rio de Janeiro is the third most populous state in the country and has a large concentration of industrial plants and commerce activities. Another specificity of the state is the relevance of oil and gas exploration, production, transport and refining, an important share of its economy.

In Minas Gerais, the second most populous state in the country, emissions are mainly concentrated in AFOLU, industry and transport sectors. Besides the magnitude of economic activities, as in the case of the state of Rio de Janeiro, its distinctive feature is the relevance of agricultural activity and deforestation. Contrarily to the situation observed in the other two states, LULUCF emissions are positive and relevant in the state of Minas Gerais, due to the high annual deforestation rate. Coupled with the large agricultural production, they contribute to making AFOLU the top emitting sector, with around half of the state's total emissions. Many energy-intensive industries are also important in Minas Gerais, such as metallurgy, mining, and cement.



Note: For Rio de Janeiro, period 2005-2015 corresponds to historical data and period 2016-2030 to projections; for Minas Gerais, period 2005-2014 corresponds to historical data and period 2015-2030 to projections- LULUCF emission and removal values from 2005-2009 are considered constant and equal to 2010, due to the lack of LULUCF data for this period; and for the Amazonas, period 2005-2018 corresponds to historical data and period 2019-2030 to projections. From 2019 on, all figures are projections based on CPS (DDP-BIICS project) assumptions and specific assumptions for each state. LULUCF emission values for 2005 are not available for the state of Minas Gerais.

Figure 38. Net emissions, by sector, from the three states and from Brazil in the period 2005-2030 (Mt CO_2e/year)

Sources: Rio de Janeiro: State GHG inventory (SEA, 2017); Minas Gerais: State GHG inventory (FEAM,2016); Amazonas: SEEG (2020), Brazil: SEEG (2020). From 2019, all figures are projections based on DDP-BIICS project estimates.

Regarding GHG emissions per capita (Table 35), the state of Minas Gerais has the highest average in the entire period, closely followed by Rio de Janeiro, while the figure is negative for Amazonas. In Amazonas, average GHG emissions per capita are strongly influenced by GHG emissions from AFOLU and particularly from LULUCF that has negative values. Between 2005 and 2010, there is a sharp reduction in GHG emissions per capita in Amazonas due to deforestation drop and that trend can also be noticed in Brazil emissions per capita. Since 2015, Minas Gerais per capita emission are close to that in the country, after the great reduction in emissions from deforestation between 2005 and 2010 that took place in Brazil. From 2020 onwards, all the three states, Rio de Janeiro, Amazonas and Minas Gerais, and Brazil have stabilized their emissions per capita. These trends are illustrated in Figure 40.

The state of Rio de Janeiro, on the other hand, has lower GHG emissions per capita (around 30% below in average) when compared to the state of Minas Gerais and Brazil, during the whole period, mainly thanks to the absence of high annual deforestation rates: emissions from LULUCF are even slightly negative in the state.

Amazonas is the state with the lowest GHG emissions per capita, being negative throughout the period thanks to the overall negative balance from LULUCF, with the magnitude of removals from large, protected areas, more than compensating for the gross emissions caused by high annual deforestation rates. Quantitative indicators are detailed in Table 35. GHG Emissions, population and GHG emissions per capita indicators from the three states and from Brazil in the period 2005-2030 (t CO2e/capita) and illustrated in Figure 39 and

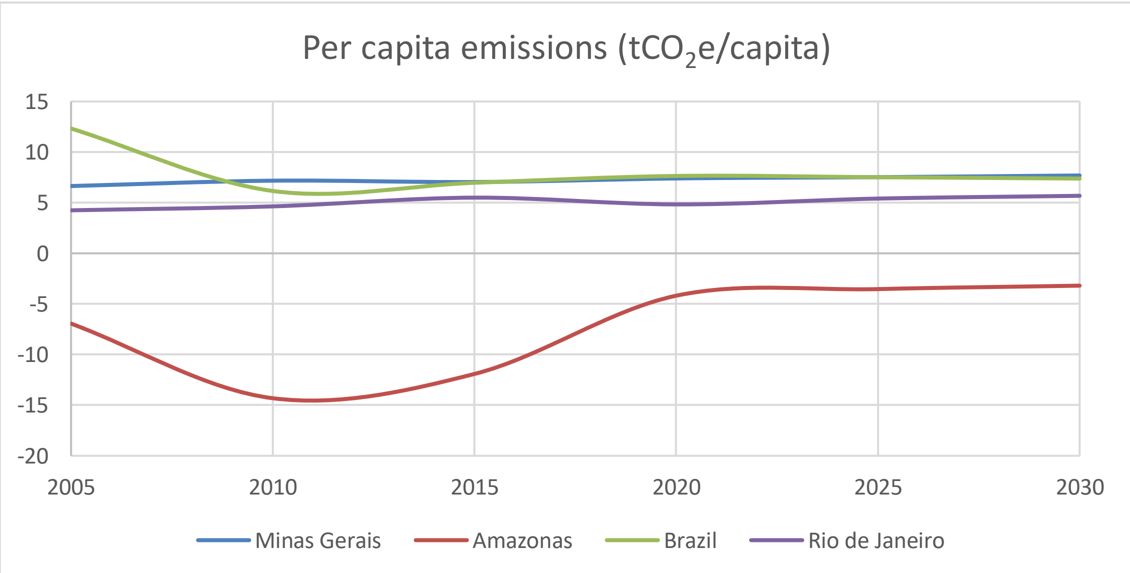


Figure **40**.

Table 35. GHG Emissions, population and GHG emissions per capita indicators from the three states and from Brazil in the period 2005-2030 (t CO_2e/capita)

Indicators		2005	2010	2015	2020	2025	2030	2005-2025 %	2005-2030 %
Rio de Janeiro	Emission (Mt CO_2e)	66.15	75.67	92.67	83.99	96.31	103.01	46%	56%
	Population (Million people)	15.56	16.30	16.84	17.37	17.81	18.12	14%	16%
	Emission per capita (tCO_2e/inhab)	4.25	4.64	5.50	4.84	5.41	5.68	27%	34%
Minas Gerais	Emission (Mt CO_2e)	128.03*	143.24	145.45	157.55	164.35	170.89	28%	33%
	Population (Million people)	19.26	19.96	20.65	21.29	21.83	22.22	13%	15%
	Emission per capita (tCO_2e/inhab)	6.65	7.18	7.04	7.40	7.53	7.69	13%	16%
Amazonas	Emission (Mt CO_2e)	-22.27	-50.86	-46.32	-17.60	-15.93	-15.29	28%	31%
	Population (Million people)	3.21	3.55	3.89	4.21	4.51	4.79	41%	49%
	Emission per capita (tCO_2e/inhab)	-6.94	-14.31	-11.91	-4.18	-3.53	-3.19	49%	54%
Brazil	Emission (Mt CO_2e)	2260.77	1200.94	1418.14	1619.06	1639.99	1660.92	-27%	-27%
	Population (Million people)	183.38	194.89	203.48	211.76	218.03	224.87	19%	23%
	Emission per capita (tCO_2e/capita)	12.33	6.16	6.97	7.65	7.52	7.39	-39%	-40%

* *LULUCF emission and removal values from 2005-2009 in Minas Gerais state are considered constant and equal to 2010, due to the lack of LULUCF data for this period.*

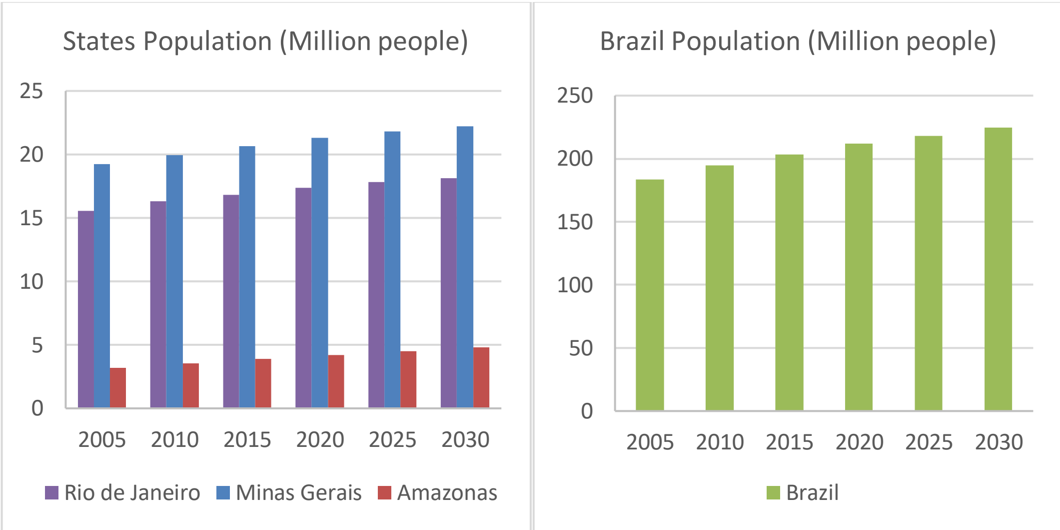


Figure 39. Population of the three states and of Brazil from 2005 to 2030
Sources: IBGE, 2020

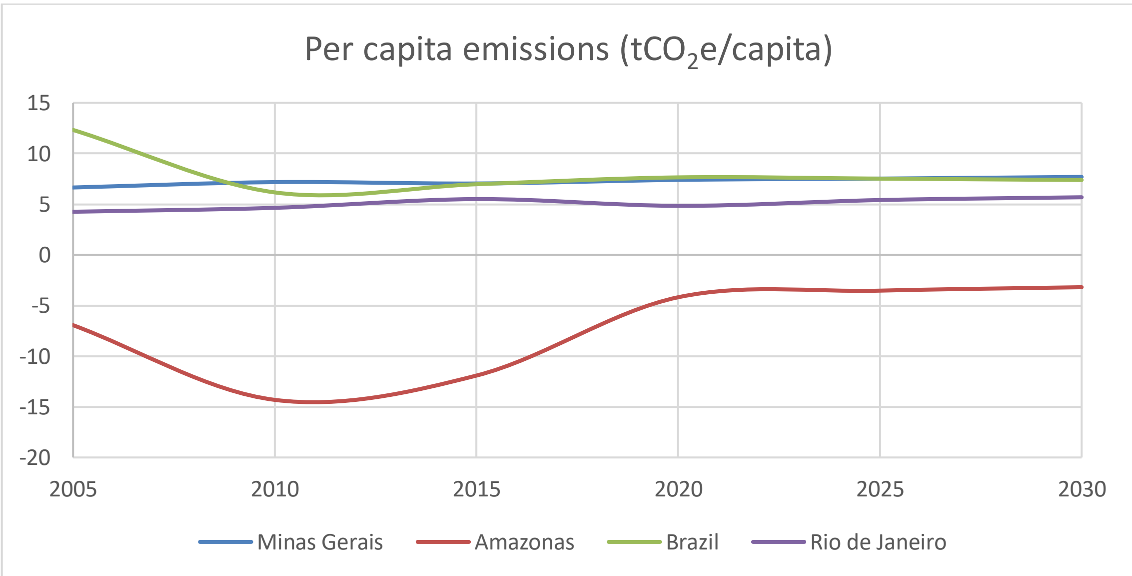


Figure 40: Emission per capita from the three states and from Brazil from 2005 to 2030 (tCO_2e/capita)

7. Conclusion

The Brazilian Nationally Determined Contribution (NDC), presented in 2015, had an economy-wide goal of 37% GHG emission reduction in 2025, and an intended 43% reduction in 2030, compared to 2005 as the base year. In its annex "for clarification purposes" it is specified that these goals would translate into an aggregate limit of 1.3 Gt CO_2e in 2025 and 1.2 Gt CO_2e in 2030 (GWP-100, IPCC AR5) - based on 2005 Brazil emission level (2.1 $GtCO_2e$).

The annex also presents some quantified sectorial goals in energy, land use and forests, and agriculture:

i) in the energy sector, achieve 45% of renewables in the energy mix by 2030, including:

- expanding the use of renewable energy sources other than hydropower in the total energy mix to between 28% and 33% by 2030;
- increasing the share of sustainable biofuels in the Brazilian energy mix to approximately 18% by 2030, by expanding biofuel consumption, increasing ethanol supply, including by increasing the share of advanced biofuels (second generation), and increasing the share of biodiesel in the diesel mix;
- expanding the use of non-fossil fuel energy sources domestically, increasing the share of renewables (other than hydropower) in the power supply to at least 23% by 2030, including the increase of the share of wind, biomass and solar;
- achieving 10% efficiency gains in the electricity sector by 2030.

ii) in land use change and forests:

- strengthening policies and measures with aiming to achieve zero illegal deforestation in the Brazilian Amazon region by 2030 and compensating for greenhouse gas emissions from legal suppression of vegetation by 2030;
- restoring and reforesting 12 million hectares of forests by 2030, for multiple purposes.

iii) in the agriculture sector:

- strengthen the Low Carbon Emission Agriculture Program (ABC) as the main strategy for sustainable agriculture development, including by restoring an additional 15 million hectares of degraded pasturelands by 2030 and enhancing 5 million hectares of integrated cropland-livestock-forestry systems (ICLFS) by 2030.

Some generic unquantified commitments are presented for some sectors:

- in land use change and forests: strengthening and enforcing the implementation of the Forest Code, at federal, state and municipal levels; enhancing sustainable native forest management systems, through georeferencing and tracking systems applicable to native forest management, with a view to curbing illegal and unsustainable practices;
- in the industry sector: promote new standards of clean technology and further enhance energy efficiency measures and low carbon infrastructure; and

- in the transportation sector: promote further efficiency measures and improve infrastructure for transport and public transportation in urban areas.

The new Brazilian 1st NDC, submitted to the UN (United Nations Framework Convention on Climate Change - UNFCCC) in 2020, has an economy-wide goal of 37% GHG emission reduction in 2025 and a 43% reduction in 2030 compared to 2005 as the base year from the Third National Communication from Brazil to the United Nations Framework Convention on Climate Change, of 2016 (country's emissions amounted 2.8 $GtCO_2e$ in 2005). This new Brazilian 1st NDC confirms the previous indicative target for 2030 as a firm commitment. These goals translate into an aggregate limit of 1.8 Gt CO_2e in 2025 and 1.6 Gt CO_2e in 2030 (GWP-100, IPCC AR5).

However, the absolute levels of emission targets for 2025 and 2030 will have to be changed again to 1.5 and 1.4 $GtCO_2e$/year, to reflect the new figure of 2.4 $GtCO_2e$/year for 2005 presented in the Brazilian Fourth National Communication to the UNFCCC, submitted in January 2021.

Table 36. GHG net emissions in Brazil, 2005-2015 and Targets for 2025 and 2030 in billions of tons of carbon dioxide equivalent ($GtCO_2e$)

GHG Brazilian Emissions	2005	2010	2015	2025	2030
NDC (2015)	**2.1**			**1.3**	**1.2**
New 1st NDC (2020)	**2.8**			**1.8**	**1.6**
Fourth National Communication of Brazil (2021)	**2.4**	1.2	1.5	**1.5**	**1.4**
%	**100%**			**2005 Value -37%**	**2005 Value -43%**

Souces: Brazil (2015); Brazil (2016); Brazil (2021)

Brazilian NDC mitigation targets are economy wide and there is no specific target for subnational instances. Therefore, individual states do not need to comply with any national mitigation target, so far. However, total net emissions for the three states increase rather than decrease from 2005 to 2025 and 2030. Even in the state of Amazonas, where total net emissions are negative, this small contribution to meet Brazilian NDC targets has slightly decreased. Therefore, the results obtained in the analysis of the performance presented by current mitigation actions reflected in the Reference Scenario led to the need of identifying additional policies and measures to foster mitigation actions in the three states. This requirement will be addressed in the next stage of the study: the elaboration of a Mitigation Scenario.

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Appendix

The DDP-BIICS Project (Deep Decarbonization Pathways) – Current Policy Scenario Storyline.

DDP-BIICS is a project coordinated by IDDRI[2], designed to conduct a detailed analysis of the implications of national development pathways consistent with the Paris Agreement, that aim at keeping global average temperature increase below 2o C, ideally at 1.5oC. The DDP-BIICS project assumes global, national, and sectorial pathways in order to build up consistent scenarios for each country joining the initiative (Brazil, India, Indonesia and South Africa). The global narrative is somehow a collective construction (mainly regarding availability of technologies) while the national and sectorial narratives, although compatible with the global storyline, follow each country specificities and are locally designed.

To do so, we use an integrated modelling approach that Centro Clima has developed to better address the need to provide reliable insights and analysis on long term mitigation policy scenarios. The models can be separated in two categories: Bottom-Up (BU), or sectorial models, and Top-down (TD), or macroeconomic models. In the BU category we use MATRIZ for energy supply simulation, (which is a Markal-type model developed by the Electrical Energy Research Center - CEPEL), and simulation models for the energy demand sectors – Transport, Industry, Households, Services and Agriculture – and the sectors of AFOLU and Waste (all BUs are developed in ad-hoc excel sheets). These BU models provide emissions estimates and other parameters and are interconnected through soft links to the TD model IMACLIM-BR (Wills, 2013; Lefevre, 2016). IMACLIM-BR is a hybrid CGE model designed to assess medium to long-term macroeconomic impacts of aggregate price or quantity-based carbon policies, in an accounting framework where economic and physical flows (with a special focus on energy balances) are equilibrated.

The Brazilian DDP-BIICS national current policy scenario (CPS) narratives supporting the ICAT reference scenario for the states of Rio de Janeiro, Minas Gerais and Amazonas is described below. Although DDP-BIICS time horizon runs until 2050, we assumed its short-term projections for 2030 in our estimates.

a) GLOBAL NARRATIVES (general assumptions)

The global scenario follows the UN population projection (2019) in which total world population will reach 9.7 Billion persons in 2050. The world real GDP growth declines from 3.4% in 2019 to 2.4% in 2050, following a long-term scenario from EPE/MME (2018). International finance supply for investment and innovation will grow throughout the period to promote the improvement of good quality education, health, and infrastructure, allowing labour productivity in developing countries to grow faster and overcome part of the productivity gap to developed countries. The

[2] Institut du développement durable et des relations internationales, a think tank based on France.

result comes in a significant improvement of investment flows to developing countries. Living standards continue to improve in all countries; inequalities will reduce slowly; developing countries get closer to developed countries at varying degrees and this scenario considers a liberal trade regime. In this scenario, the world is NOT committed to meet the 1.5ºC target of the Paris agreement and governments won´t make additional mitigation efforts after the current NDC goals are reached by 2030.

b) NATIONAL NARRATIVES (general assumptions)

- **Description of cross-cutting elements of national narrative:** Living standards in Brazil will improve slowly and the distance to developed countries will be reduced by 2050, following the global trend. Brazil will meet the 2030 NDC target and then no additional efforts in mitigation will be pursued by the government. Population will increase from 210 million inhabitants in 2019 to about 233 million in 2050 and then start to reduce slowly. After the strong decline in the economy from 2015 to 2020 due to a political/economic crisis and then the COVID-19 pandemic, Brazilian economy will return to grow in 2021 but at a slower pace: 3,5% in 2021; 2,5% from 2021 to 2030; 2,25% from 2031 to 2040; 2% from 2041 to 2050.

- **Related to national energy system:** a substantial growth in E&P activities is due to an important increase in offshore oil and gas production from the pre-salt layer. Increasing shares of oil production are progressively directed towards exports as production costs are kept low and remain competitive in the world market. Electricity consumption and supply growth rates resume after 2021. The reduction of the energy load in the short term due to COVID-19 and economic slowdown contributes to a return to safer water levels in reservoirs of hydropower plants. Historically, electricity production in Brazil relies on renewable sources, mainly hydropower plants. Recently, new technologies are being introduced such as wind, solar photovoltaic and biomass power plants. The old thermopower plants are decommissioned and replaced by renewable power plants (intermittent sources: wind, PV and biomass) due to lower costs. Nevertheless, GHG emissions grow at the end of the analyzed period due to the expansion of natural gas power plants to meet peak demand due to the penetration of the intermittent power sources, and especially during dry months when hydropower is less available.

- **Related to national urban and infrastructure system, with a focus on transport and building sectors:** society experiences new configurations of mobility in the initial decades after the Covid-19 pandemic. In this scenario, active transport increases its share from 3.4% in 2020 to 4.9% in 2050 in passenger transportation. Tele activities are responsible for small changes in the pattern of passenger and cargo transportation, as some trips are avoided and others are encouraged (for example, last mile deliveries), but without significant effects on transport activity. Metropolitan areas become more important as urbanization continues to grow worldwide, increasing last mile delivery trips and increasing mobility per capita. The market's dependence on imported products and components represents a barrier to the penetration of electric vehicles at the pace of major international players. Nonetheless, the reduction in the relationship between price and energy density of batteries is responsible for reducing the average prices of electric vehicles. Government incentives encourage sales of electric vehicles, especially buses and light trucks. Investments in charging stations on highways that connect major cities are responsible for electrifying a fraction of heavy trucks. There is a reduction in bureaucracy in public concessions and tax incentives, especially for energy efficient transport modes such as railways and waterways. Metro systems are still restricted to some of the main capitals, as well as Bus Rapid Service (BRS) and Bus Rapid Transit (BRT).

Production costs for biofuels decrease due to the development of new generations of ethanol (fourth and above) and biodiesel, in addition to new planting areas in the Midwest and north of Brazil. HVO blended with mineral diesel oil and biodiesel is partially adopted in Brazil. Ethanol is not competitive with gasoline (which is blended with 27% anhydrous ethanol during all the period), although government incentives are still employed. Thus, users choose hydrated ethanol over gasoline to fuel flex fuel vehicles only 35% of the time. Biodiesel blended with mineral diesel oil increases up to 20% by 2025, remaining at that level up to 2050. Other biofuels, such as bio-oil, biogas and biokerosene, are not implemented due to higher production and distribution costs. The energy efficiency of light cars is improved by reducing the average age and by increasing the scrap rate of vehicles equipped with internal combustion engines. In turn, private initiatives, such as eco-labeling strategies, are responsible for a marginal increase in the energy efficiency of trucks. By 2030, Brazil reaches maturity in standards and regulations, concession models, training, financing, and business model, stimulating electromobility. As a result, most of intensively used vehicles in the major metropolitan areas such as taxis and app-based ride hailing, as well as last mile commercial vehicles and light trucks will be electric by 2040. Most of new freight railways will be electric, while the remaining diesel railways are gradually modernized and electrified via contractual additional requirements in their respective concessions. Concerning buildings, the government maintains the PROCEL program to promote higher electricity efficiency. There are improvements in the legislative framework for stimulating decentralized photovoltaic generation and a progressive drop in the cost of thermal solar panels, with fiscal incentives. Finally, there is a high impact of widespread home charging of electric vehicles on domestic power consumption.

In this scenario, electromobility does not advance at the pace of the main international players, although some advances are observed. By 2030, electromobility will be restricted to buses and light trucks in large cities, while biofuels will be the majority in cars and medium and heavy trucks.

- **Related to national industrial system, with a focus on GHG-intensive sectors:** The Brazilian economic crisis had a huge impact on industry, reducing its GDP by 12% between 2013 and 2017. With the Brazilian economic recovery, the industrial production is expected to resume growth. Besides the economic recovery, population growth and GDP per capita increases will push forward industrial production.

  The energy intensity of the heavy industry has dropped over the years. In the production of iron and steel, energy intensity decreased by 9% between 2005 and 2015. The cement industry and the chemical industry performed similarly. This trend is expected to continue over the years, also influenced by the use of idle capacity generated by the economic crisis. Some of the main GHG emitters in the sector (for example, Cement and Chemicals) have had their emissions reduced over the years. The cement industry reduced the proportion of clinker / cement by 15% between 1990 and 2010 and its emissions intensity accordingly. The aluminum industry has implemented process improvements to reduce PFC emissions. Overall, the GHG intensity in the sector is expected to decrease slightly over the years, continuing this current trend.

- **Related to national land and ecosystems:** the agricultural sector has performed well in terms of productivity growth in the last years. According to FAO (2020) the impacts of the COVID-19 pandemic have been felt at varying degrees across all food sectors. Although COVID-19 has posed a serious threat to food security, overall, some analyses show that from the global perspective, agricultural commodity markets are proving to be more resilient to the pandemic than many other sectors. The determinants of demand for agricultural products by 2050 are the global population and the growth of Brazilian income. The sector is considered to have the capacity to meet the world growing demand, given the favorable conditions in relation to climate, land availability and technology. It is worth mentioning that significant yield increases are projected for the main agricultural activities, including livestock. Agricultural production grows while the agricultural area expands in the period 2020-2050. Experience within Brazil shows that agriculture productivity can continue to grow without depleting natural capital nor further increasing GHG emissions.

  Additional efforts to reduce the deforestation rate are not foreseen. The trend in the Brazilian environmental agenda has been left aside from governmental priorities. Deforestation in the Brazilian Amazon has been reaching high levels not seen since the mid-2000s, according to data released by Brazil's National Space Research Institute. The annual deforestation rate in 2019 in the Amazon doubled compared to 2012 and was 30% higher than in 2018 (INPE,2020). The AFOLU CPS assumptions consider that efforts to contain deforestation will resume only after 2023, considering the possibility of government changing or due to international pressure. We consider that the annual deforestation rate will decrease 10% in 2025 and 15% in 2030, compared to 2019 and will remain at the 2030 level until the year 2050. An increase in protected areas (conservation units and indigenous lands) is not expected until 2050, maintaining an equivalent size as in 2019. Forest plantations (eucalyptus and pine) will meet the demand for biomass from the energy, paper and cellulose and other industries (sawn wood, plywood, panels); The adoption of sustainable practices in land management, such as integrated forest systems, recovered pastures, no-till and biological nitrogen fixation, will increase, but below the targets established by the NDC.

  The maintenance of high deforestation rates and the increase of agricultural production mainly related to the livestock sector (cattle ranching) will drive an increase of CO_2 emissions from AFOLU by 2050. Agricultural soils and enteric fermentation are the main sources of emissions in the agriculture sector.

- **Waste**

  This scenario considers the goals of the national solid waste policy (PNRS) and the national sanitation plan (PNSB). Regarding solid waste, the percentage of collection goes from the current 90% to 100% in 2030. Adequate final disposal goes from 40% to 95% in 2050, with sanitary landfills as the technical option considered. Recycling level is kept at 3%. Biogas capture and methane destruction in landfills remains at a constant rate of 15% throughout the period. Sewage collection rates go from the current 53% to 84% in 2050, with anaerobic treatment plants treating 21% of the collected volume. From the methane generated in these plants, the destruction rate goes from 40% in 2020 to 55% in 2050.

c) RESULTS

The storylines above were then translated into technical parameters and used to run the bottom-up sectoral models and the top-down general economic equilibrium CGE model (IMACLIM-BR). Besides a Deep Decarbonization Scenario – DDS built to reach climate neutrality in 2050, the study also designed a Reference Case, including the projection into the future of current mitigation policies and measures (a Current Policies Scenario – CPS). The emissions projections used in this report are based on sectoral and macroeconomic results of the Current Policies Scenarios – CPS designed in the DDP-BIICS project. The model outputs provided GHG emissions estimates for Brazil in the short, medium, and long term up to 2050. The DDP-BIICS project results will be published in early 2022 only. The results for the CPS until 2030 were used in this project to estimate the reference emissions scenario for the three states.