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NDC and LTS modelling: opportunities, lessons learnt and roadmaps for Brazil

Katowice, december, 2018

MINISTÉRIO DA CIÊNCIA, TECNOLOGIA, INOVAÇÕES E COMUNICAÇÕES

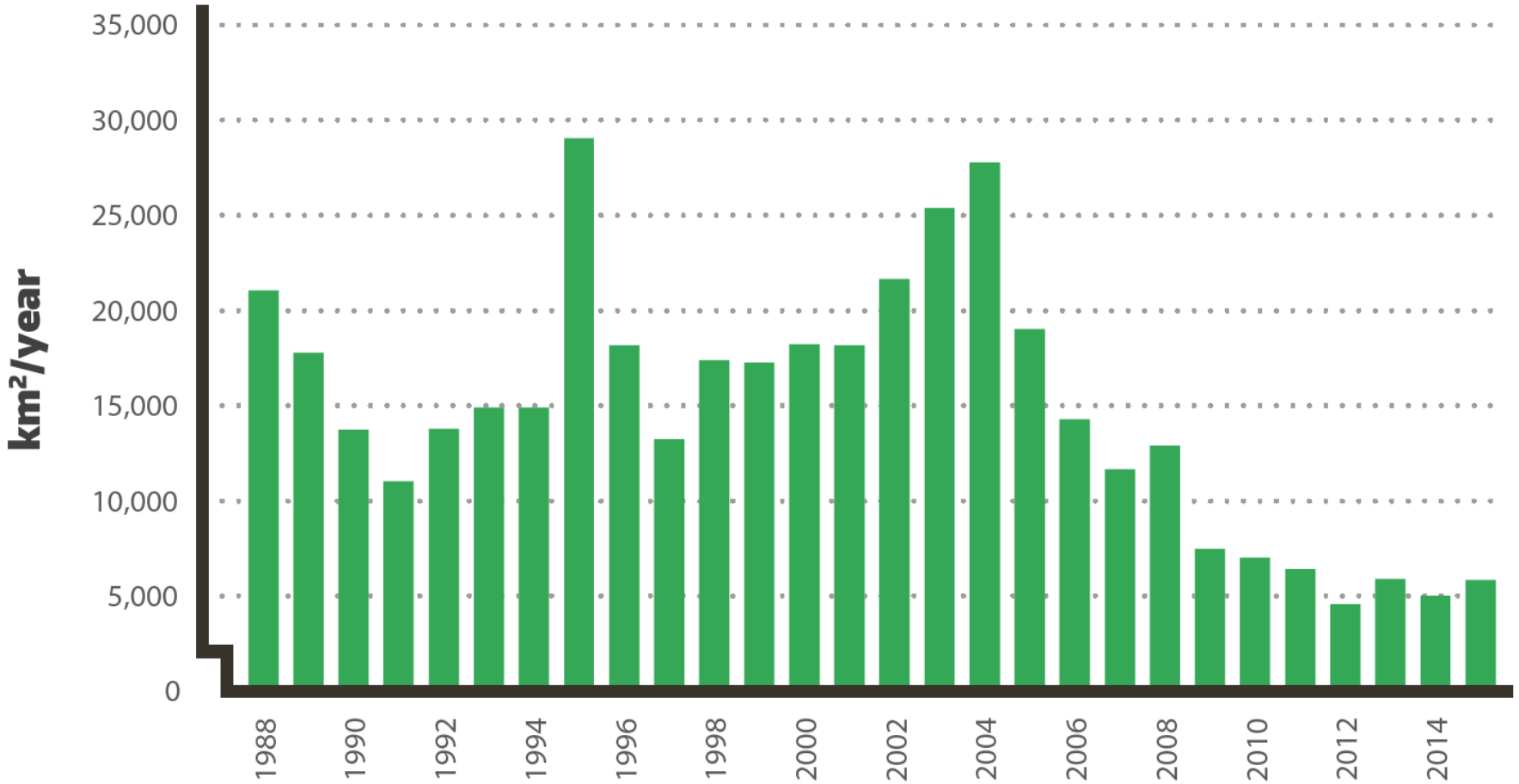
BRASIL GOVERNO FEDERAL

- Climate change – human interference in earth system by changing the composition of the planet's atmosphere, adding to the natural climate variability – is proving a major challenge today.
- Brazil is not immune to climate change and may present significant socioeconomic and environmental vulnerability to it.
- It is therefore imperative **to continue reducing GHG emissions** and also that the possible impact of climate change, projected for this century and beyond is known for every sector, systems and regions of the country.

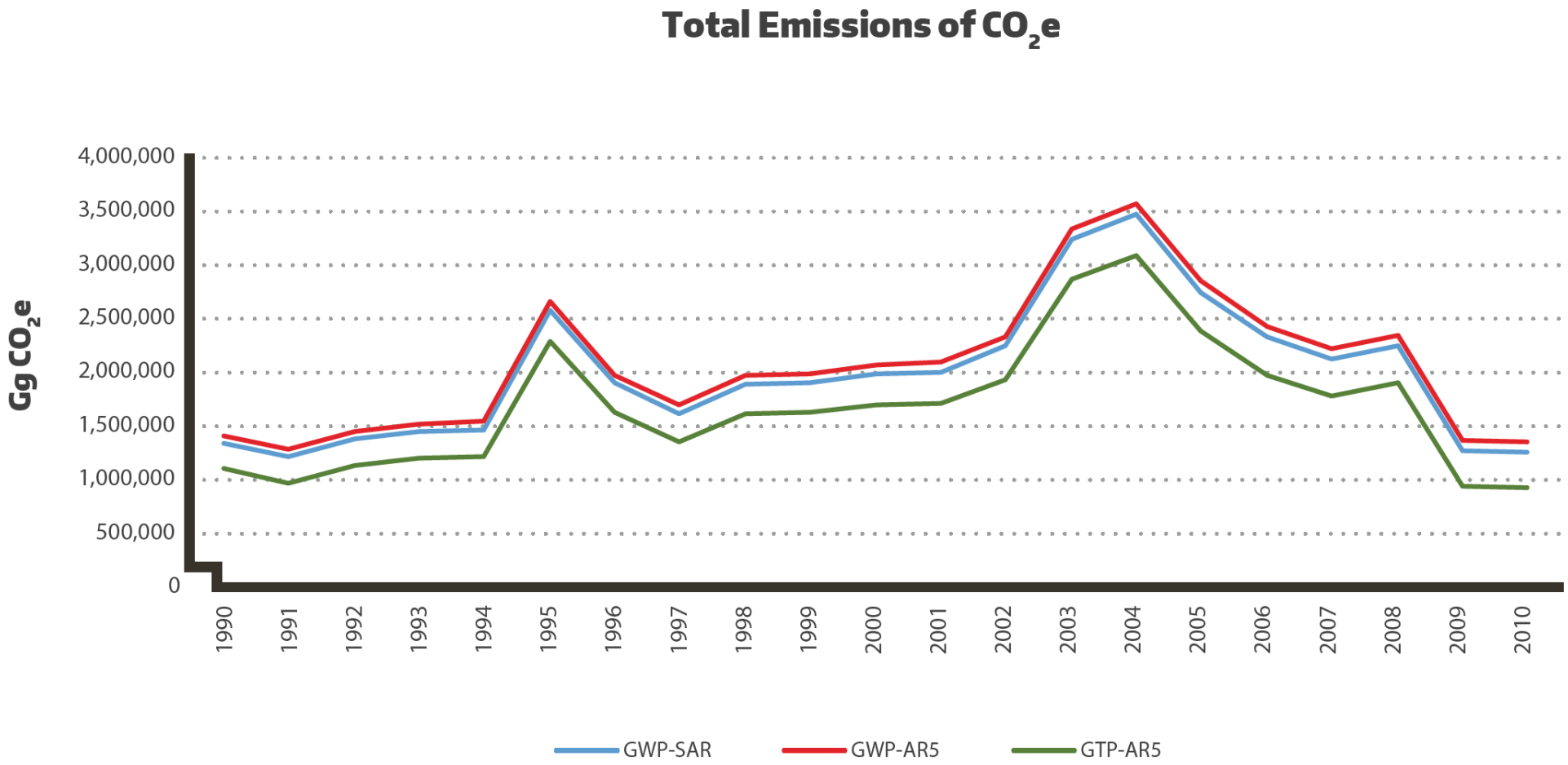
- Achieving the purpose of the United Nations Framework Convention on Climate Change involves global policies to considerably reduce emissions and increase the removal by sinks of greenhouse gases, as reiterated strongly by COP21 results in December 2015 in Paris.
- Brazil has greatly contributed to achieving the primary objective in reducing future risk, emblematically advocated in the 2ºC maximum global temperature rise target and efforts not to exceed 1.5ºC.

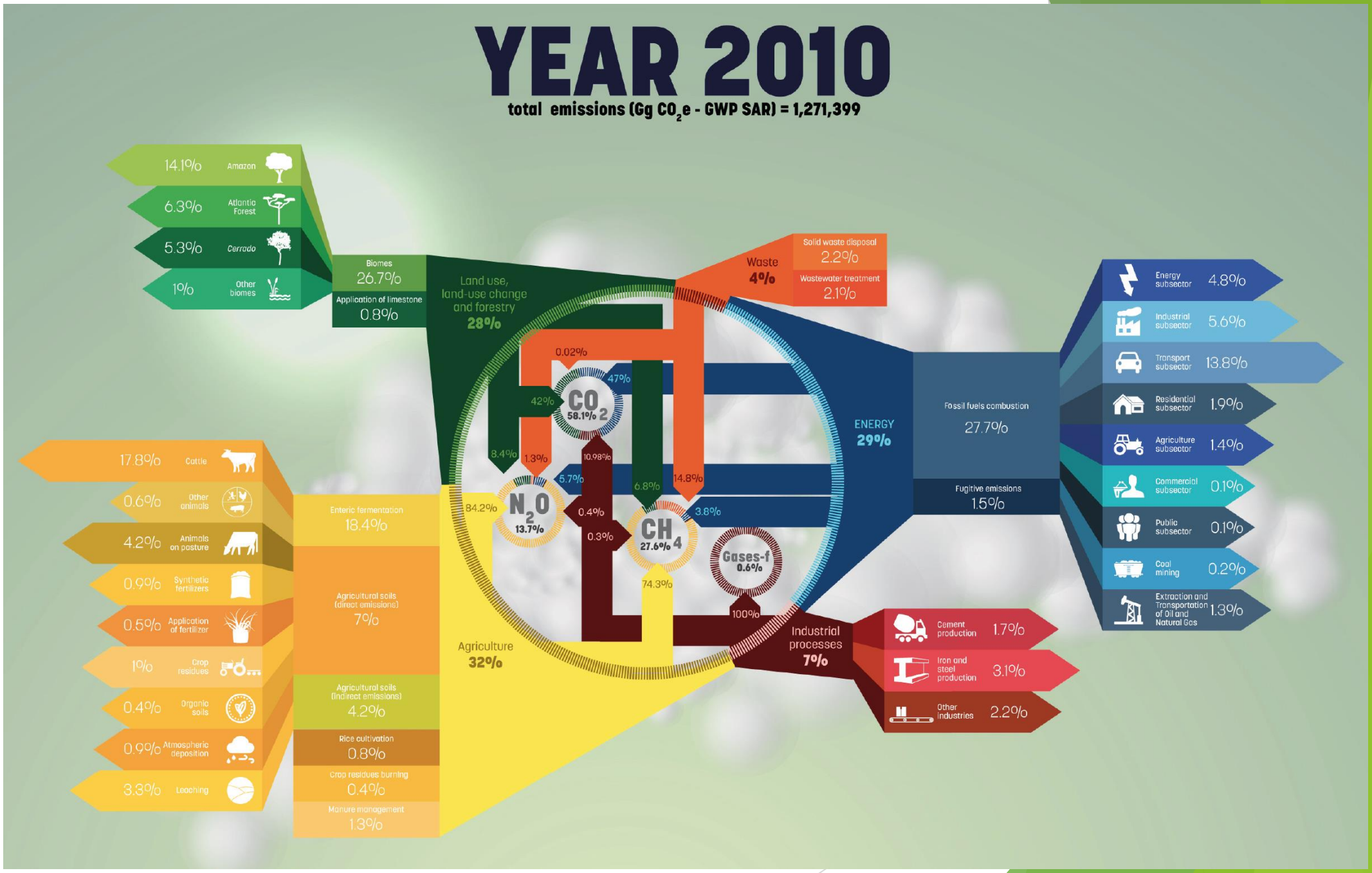
- Due to the significant fall in deforestation rates in the Amazon, Brazil has been managing to steadily reduce its emissions since mid-last decade, and has been implementing sectoral public policies – for instance, the Low Carbon Agriculture Plan – in order to guarantee compliance with its voluntary commitments by 2020. New challenges are imposed for the design of new national mitigation policies, as emission patterns have been rapidly changing towards a more relative contribution from the energy and agriculture sectors.

Annual deforestation rate in the Legal Amazon

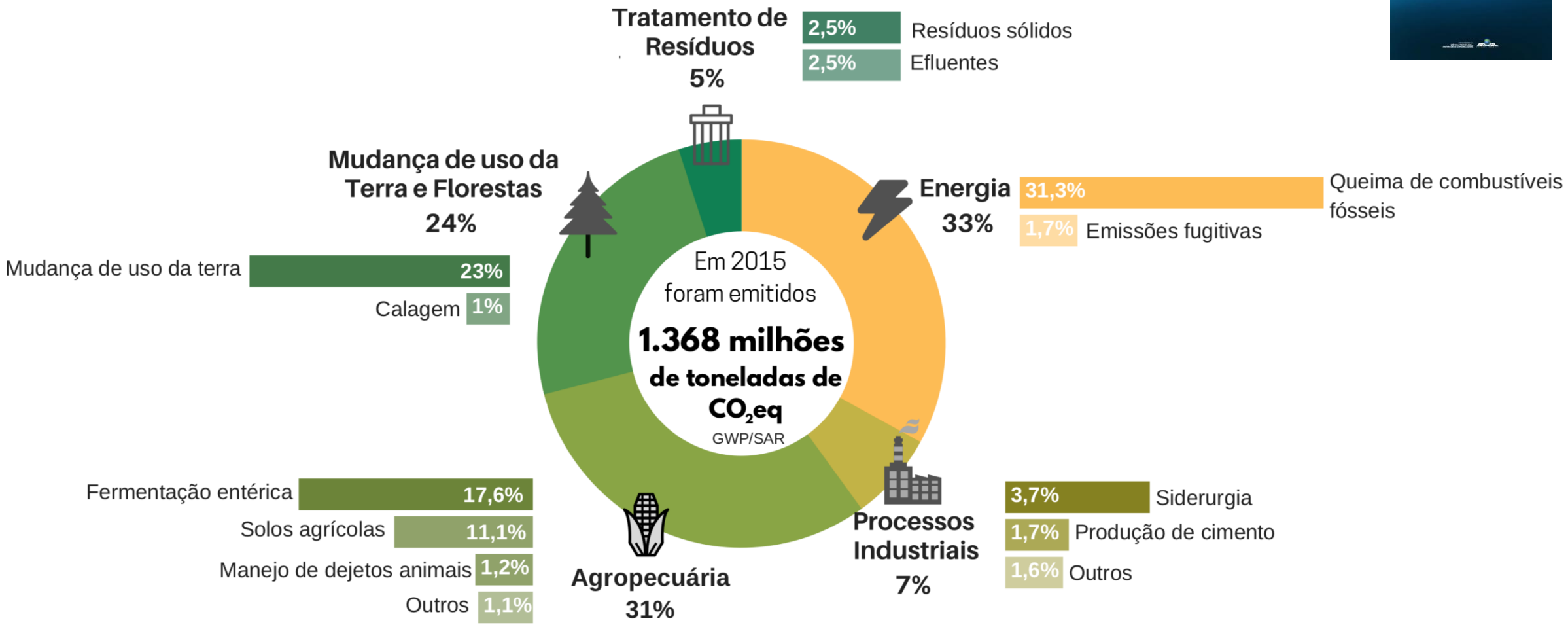


Evolution of CO_2e emissions by different metrics, from 1990 to 2010




YEAR 2010
total emissions (Gg CO_2e - GWP SAR) = 1,271,399
14.1% Amazon
6.3% Atlantic Forest
5.3% Cerrado
1% Other biomes
Biomes 26.7%
Application of limestone 0.8%
Land use, land-use change and forestry 28%
Waste 4%
Solid waste disposal 2.2%
Wastewater treatment 2.1%
0.02%
47%
42%
CO_2 58.1% 2
8.4%
1.3%
10.98%
5.7%
6.8%
14.8%
84.2%
N_2O 13.7%
0.4%
0.3%
CH_4 27.6% 4
3.8%
Gases-1 0.6%
74.3%
100%
ENERGY 29%
Fossil fuels combustion 27.7%
Fugitive emissions 1.5%
Energy subsector 4.8%
Industrial subsector 5.6%
Transport subsector 13.8%
Residential subsector 1.9%
Agriculture subsector 1.4%
Commercial subsector 0.1%
Public subsector 0.1%
Coal mining 0.2%
Extraction and Transportation of Oil and Natural Gas 1.3%
Industrial processes 7%
Cement production 1.7%
Iron and steel production 3.1%
Other industries 2.2%
Agriculture 32%
17.8% Cattle
0.6% Other animals
4.2% Animals on pasture
0.9% Synthetic fertilizers
0.5% Application of fertilizer
1% Crop residues
0.4% Organic soils
0.9% Atmospheric deposition
3.3% Leaching
Enteric fermentation 18.4%
Agricultural soils (direct emissions) 7%
Agricultural soils (indirect emissions) 4.2%
Rice cultivation 0.8%
Crop residues burning 0.4%
Manure management 1.3%


ESTIMATIVAS ANUAIS


Tratamento de Resíduos
5%
2,5% Resíduos sólidos
2,5% Efluentes
Mudança de uso da Terra e Florestas
24%
Mudança de uso da terra 23%
Calagem 1%
Energia
33%
31,3% Queima de combustíveis fósseis
1,7% Emissões fugitivas
Em 2015 foram emitidos
1.368 milhões
de toneladas de CO_2eq
GWP/SAR
Fermentação entérica 17,6%
Solos agrícolas 11,1%
Manejo de dejetos animais 1,2%
Outros 1,1%
Agropecuária
31%
Processos Industriais
7%
3,7% Siderurgia
1,7% Produção de cimento
1,6% Outros

- Brazil have a relevant role in the Paris Agreement
- The Brazilian NDC established absolute emissions targets of 1.3 GtCO2eq by 2025 and of 1.2 GtCO2eq by 2030 (GWP-100, AR5), corresponding to reductions of 37% and 43%, respectively, compared to 2005, leading to per capita emissions of 6.2 GtCO2eq in 2025 and of 5.4 GtCO2eq in 2030. These percentage reductions are relative to reported emissions of 2.1 GtCO2eq (GWP-100, AR5) in 2005, according to the Brazilian NDC.

- Summary of measures included in the Brazilian NDC.

LULUCF	Forestry	Strengthen Forest Code
		Zero illegal deforestation in Amazonia by 2030, with sequestrations compensating for emissions from legal suppression of vegetation.
		Enhancing sustainable forest management practices
		Restoring and reforesting 12 million hectares of forests by 2030
Agriculture		Strengthen Low Carbon Agriculture plan (Plano ABC)
		Restore 15 million hectares of degraded pastures by 2030
		Five million hectares of integrated cropland-livestock-forestry systems by 2030

- Summary of measures included in the Brazilian NDC.

Energy	Primary Energy[1]	45% renewables by 2030 Non-hydro renewables to 28-33% by 2030
	Electricity generation	Non-hydro renewables at least 23% by 2030 10% efficiency gains by 2030
	Transportation	Promote efficiency measures
		Improve public transport infrastructure
	Biofuels	18% biofuels in primary energy[1] mix by 2030
	Industry	Promote new standards of clean technology
		Enhance efficiency measures and low-carbon infrastructure

Mitigation Options of Greenhouse Gas Emissions in Key Sectors in Brazil

- In this context, this project proposed to evaluate a set of long-term scenarios, using Integrated Assessment Models (IAM) approach, with emphasis on the Brazilian role on climate change mitigation, identifying key variables that affect the development of the energy and the land-use sectors under the accomplishment of Brazilian NDC targets

- MACROECONOMIC MODELLING
  - Dynamic Stochastic General Equilibrium (DSGE) model was used, together with a Computable General Equilibrium (CGE). While the DSGE model provided the boundary conditions for macroeconomic aggregates, the CGE model generated detailed and consistent sectoral information.
  - The DSGE model considered interactions among five different economic agents: households, firms, financial sector, government, and the rest of the world.
  - The model calculated endogenously the carbon price, or cost of emission reductions, by imposed GHG emissions targets. Or, more conventionally, the effects of imposing a carbon price in the economy.

- ENERGY SYSTEM MODELLING
  - The GHG emissions scenarios for energy system were performed using the MESSAGE (Model for Energy Supply Strategy Alternatives and Their General Environmental Impacts), an optimization software in linear programming for energy systems developed by IIASA and completely reconfigured, starting from MESSAGE-BRAZIL version, to ensure a better detailing of the regional breakdown as well as endogenous energy efficiency and GHG mitigation options in the end-use sectors (industrial, energy, transport, residential, agricultural and waste manegement).

- ENERGY SYSTEM MODELLING
  - The model adopt an optimization under a minimum overall cost perspective, then it provide results that reflect the optimal conformation of an energy system in a perfect competition, which does not occur in reality.
  - Constrains were imposed into production and capacity expansion and made the model resemble market imperfections.

- AFOLU MODELLING
  - The GHG emissions scenarios for AFOLU sector were performed using the OTIMIZAGRO, a nationwide, spatially-explicit model that simulates land use, land use change, forestry, deforestation, regrowth, and associated carbon emissions under various scenarios of agricultural land demand and deforestation policies for Brazil.

- AFOLU MODELLING
  - It was calculated the net cost of the implantation of GHG mitigation options for the land use and agriculture sector. This involved calculating the investment and operating costs and revenue of planted forests, agriculture, cattle ranching, forest restoration and deforestation reduction policies in the reference and low carbon scenarios. In this processes it was also considered the emissions and removals of GHG derived from agricultural activities. This involved methane emissions from enteric fermentation and fertilizers, and removals from pasture restoration and direct plantation.

- INTEGRATED ASSESSMENT APPROACH
  - The integrated modeling of GHG emissions scenarios started with boundary conditions from a macroeconomic consistency model that generated data for the EFES Model. The key variables used for the construction of sectoral scenarios of energy supply and demand, as well as land use and land use changes, were projected at EFES, including: Gross Domestic Product (GDP), gross value of production, value added, staff employed, work income, etc.

Main assumptions of REF and LC scenarios.

Subsector	Main assumptions	
	Reference scenario	Low carbon scenario
Agriculture	80% of crop areas as soybean, corn, cotton, rice, beans ans wheat with conservationist systems.	90% of crop areas as soybean, corn, cotton, rice, beans ans wheat with conservationist systems.
	ABC Plan's goal for the area occupied with integrated systems until 2020 and maintenance of the proportion adopted between 2021 e 2050.	ABC Plan's goal until 2020, and increase of 50% in the occupied area target between 2021 and 2050.
	Application of biological nitrogen fixation (BNF) in 100% of soybean planted areas and 10% in crop areas of rice, beans, corn and wheat.	30% increase of BNF in crop areas of rice, beans, corn, wheat and sugarcane.

- Main assumptions of REF and LC scenarios.

Subsector	Main assumptions	
	Reference scenario	Low carbon scenario
Livestock	Projection of cattle ranching aiming to meeting the expected demand for meat, according to Agribusiness Projections: 2013/2014 to 2023/2024, with growth reduction from 2031 to 2050.	Maintenance of meat production, but with higher productivity of the herd through confinement.
Planted forests	53% of sectoral demand for native forest firewood in the period.	Decrease in the proportion of native forest firewood by 10% in 2050.

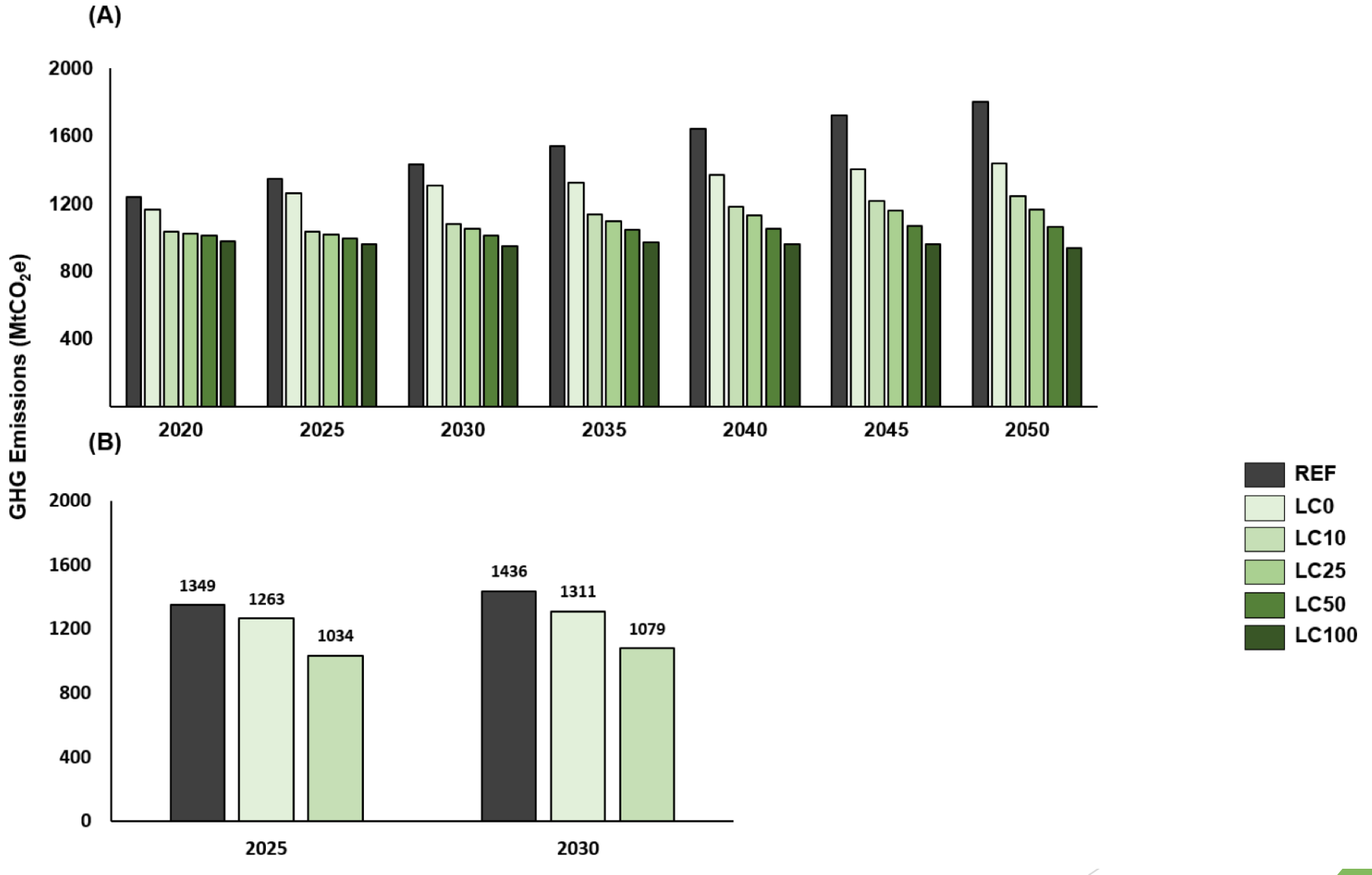
Main assumptions of REF and LC scenarios.

Subsector	Main assumptions	
	Reference scenario	Low carbon scenario
Native forests	Deforestation reduction targets of 80% and 40% in the Amazon and Cerrado biomes, respectively, applied to the deforestation target verified in the period from 2002 to 2010, and prohibition of the suppression of native vegetation in the Atlantic Forest.	Same as reference scenario, with legal deforestation only in the Amazon and application of a 40% reduction target in the deforestation of the Caatinga, Pampas and Pantanal biomes.
	Recovery of 12.5 million hectares regarding environmental liability in the next 20 years and additional recovery of 6.5 million hectares between 2035 and 2050.	21 million hectares expansion of native vegetation restoration until 2050.

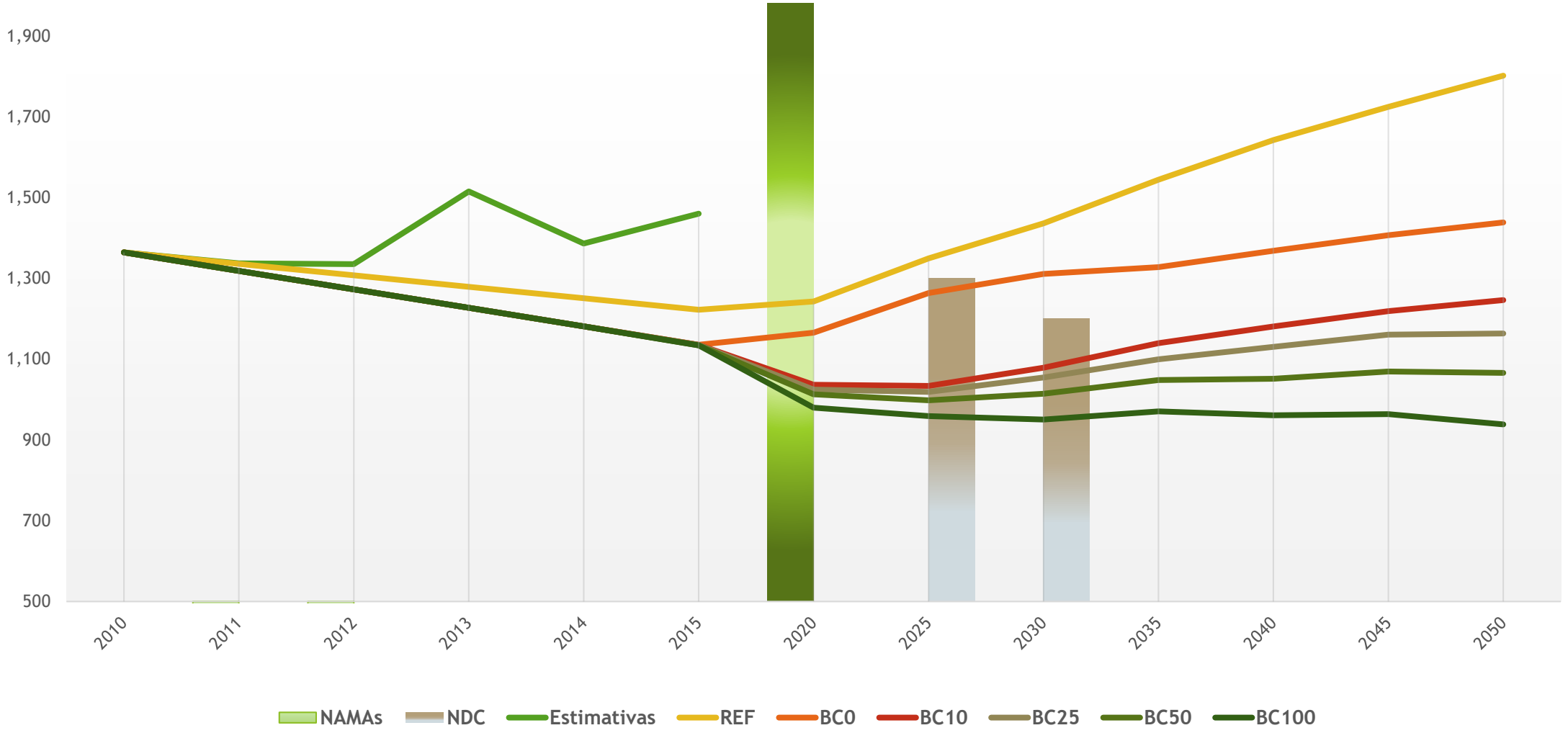
Main assumptions of REF and LC scenarios.

Subsector	Main assumptions	
	Reference scenario	Low carbon scenario
Energy System	Energy system expansion at minimum cost. Insertion of available technologies on baseline. Non adoption of additional mitigation policies. Sectoral perspective prevalence on modelling. Short-term trajectory expansion (current and planned) of the energy system.	Expansion of the energy system considering different levels of carbon value. Insertion of best available technologies and productive practices. Internalization of different levels of carbon value in the economy. Freedom to select the evolution of the technological and optimization profile from energy system, according to the logic of GHG emissions mitigation.

- Total emission scenarios for AFOLU and energy sectors.



Total emissions – Tg CO_2e (GWP-100 – AR5)



Main mitigation options to AFOLU sector.

Activity	Main mitigation options	Mitigation potential ($MtCO_2e$)[1]	
		LC0 (2025)	LC10 (2030)
Agriculture	Expansion of no-tillage systems, 90% of crop areas for soybean, corn, rice, cotton, beans and wheat until 2050, corresponding to 33 and 34 million hectares in 2025 and 2030, respectively.	2.0	2.1
Agriculture	Expansion of 200 thousands hectares/year for integrated cropland-livestock-forestry systems, from 2021 to 2050, corresponding to an expansion of 83% and 84% in 2025 and 2030, respectively.	0.4	0.5
Agriculture	Increase biological nitrogen fixation (BNF) using inoculants, reaching 39 and 40 million hectares in 2025 and 2030, respectively. (47 million hectares in 2050)	0.3	0.4

- Main mitigation options to AFOLU sector.

Activity	Main mitigation options	Mitigation potential ($MtCO_2e$)[1]	
		LC0 (2025)	LC10 (2030)
Livestock	Intensification of livestock production through cattle confinement, reaching a production of 8.2 and 10.5 million animals in 2025 and 2030, respectively. (19 million animals in 2050)	NA[2]	47.6
Livestock	Recovery of 24 and 33.2 million hectares of degraded pastures in 2025 and 2030, respectively. (74 million hectares until 2050)	NA[2]	7.4

Mitigation Options of Greenhouse Gas Emissions in Key Sectors in Brazil

Main mitigation options to AFOLU sector.

Activity	Main mitigation options	Mitigation potential ($MtCO_2e$)[1]	
		LC0 (2025)	LC10 (2030)
Land use change	Deforestation reduction in Amazon (90% in relation to historical average) and implementation of 40% deforestation reduction on Caatinga and Pantanal biomes and 58% to Pampas biome.	NA[2]	47.7
Land use change	Nine and ten million hectares of commercial planted forests in 2025 and 2030, respectively. (14 million hectares in 2050)	25.3	23.6
Land use change	Native vegetation recovery of 6.2 e 9.3 million hectares in 2025 and 2030, respectively. (21 million hectares in 2050)	NA[2]	9.5
Indirect emission/removals caused by low-carbon activities on other sectors[3]		-2.5	7.0
Total		25.5	145.8

Mitigation Options of Greenhouse Gas Emissions in Key Sectors in Brazil

Main mitigation options to Energy system.

Activity	Main mitigation options	Mitigation potential ($MtCO_2e$)[1]	
		LC0 (2025)	LC10 (2030)
Industry (Others)	Efficiency on heat and steam recovery	7.0	7.1
Industry (Cement)	Efficiency on heat and steam recovery	3.2	2.8
Industry (Others)	Efficiency on ovens and processes optimization	2.4	2.2
Industry (Chemistry)	Efficiency on heat recovery	1.2	1.4
Industry (Chemistry)	Efficiency on steam recovery	0.9	1.1
Industry (Cement)	Fuel substitution	0.7	1.0
Industry (Steel)	Efficiency on heat recovery	0.2	14.7
Industry (Steel)	Fuel substitution	NA[2]	4.1
Industry (Others)	Fuel substitution	NA[2]	2.2

Mitigation Options of Greenhouse Gas Emissions in Key Sectors in Brazil

Main mitigation options to Energy system.

Activity	Main mitigation options	Mitigation potential ($MtCO_2e$)[1]	
		LC0 (2025)	LC10 (2030)
Energy (Oil and gas E&P)	Flare reduction and installation of steam recovery units	7.2	22.3
Energy (Oil refining)	Efficiency on heat and steam recovery	2.9	6.9
Energy (Oil refining)	Efficiency on hydrogen consumption	NA[2]	3.9
Energy (Oil refining)	Electric efficiency in motors	NA[2]	1.2
Energy (Electricity)	Substitution of coal by sugarcane bagasse on thermal plants	NA[2]	23.1
Energy (Electricity)	Repowering hydroelectric plants	1.8	2.9

Mitigation Options of Greenhouse Gas Emissions in Key Sectors in Brazil

- Main mitigation options to Energy system.

Activity	Main mitigation options	Mitigation potential ($MtCO_2e$)[1]	
		LC0 (2025)	LC10 (2030)
Transport (Road)	Efficiency of trucks and buses powered by diesel	NA[2]	5.3
Transport (Cargo)	Modal shift (from highway to waterway and railway)	8.3	3.8
Transport (Passenger)	Modal shift (from individual to collective transportation)	5.6	15.0
Transport	Expansion of biofuels (Ethanol) consumption/production ????	?	?
Household and Services (Residential)	LPG cookers efficiency	0.1	0.4

Mitigation Options of Greenhouse Gas Emissions in Key Sectors in Brazil

- Main mitigation options to Energy system.

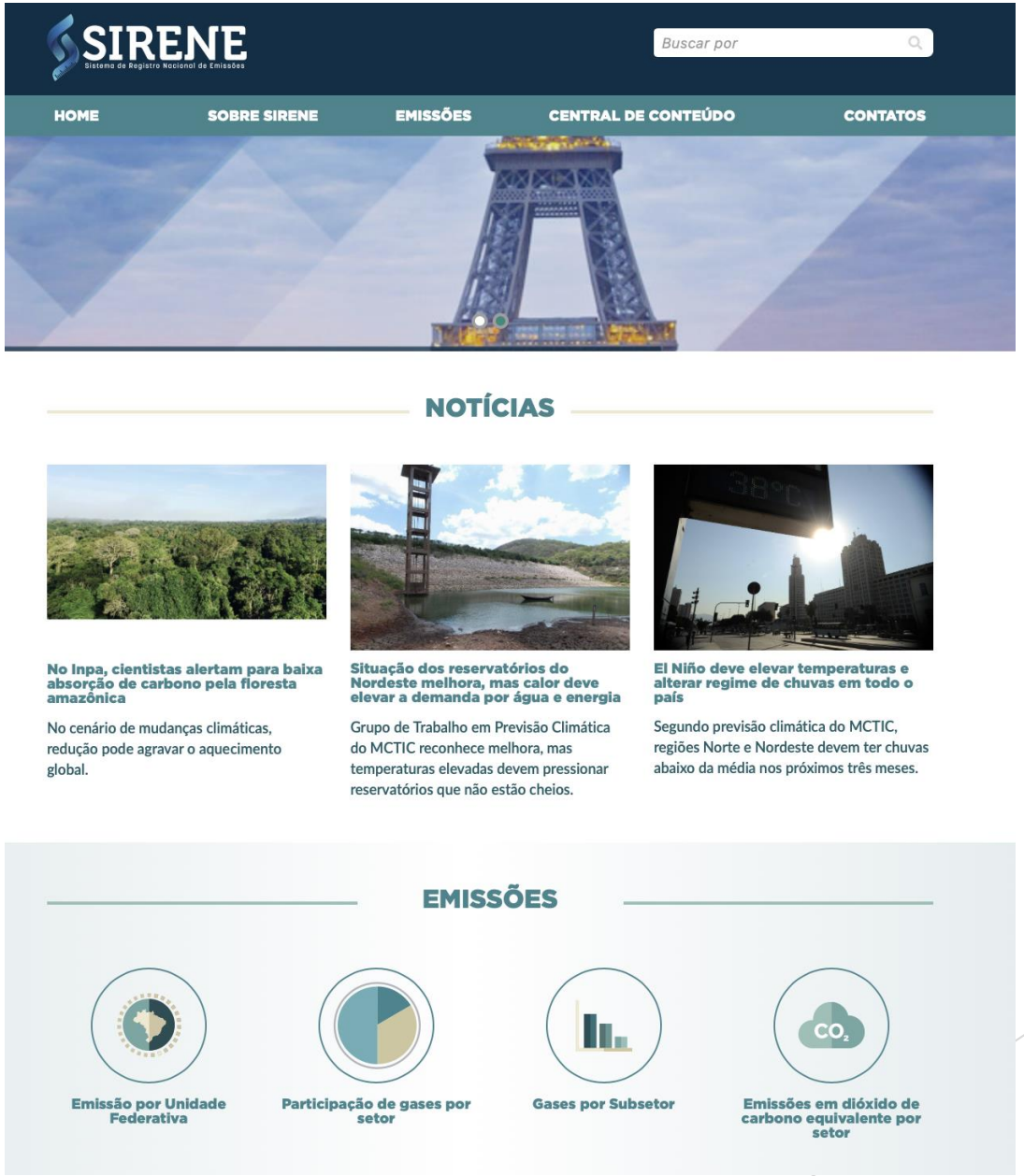
Activity	Main mitigation options	Mitigation potential ($MtCO_2e$)[1]	
		LC0 (2025)	LC10 (2030)
Waste Management (Urban solid waste)	Flaring landfill biogas	5.4	20.8
Waste Management (Urban solid waste)	Exploitation of landfill biogas for biomethane production	2.2	8.2
Waste Management (Urban solid waste)	Exploitation of landfill biogas for electric generation	1.8	6.7
Waste Management (Effluents)	Exploitation of biogas from sewage treatment station to generate electricity	1.3	5.0
Waste Management (Urban solid waste)	Biomethane production by biodigestion	0.6	2.1

- Main mitigation options to Energy system.

Activity	Main mitigation options	Mitigation potential ($MtCO_2e$)[1]	
		LC0 (2025)	LC10 (2030)
Waste Management (Urban solid waste)	Incineration	0.3	1.0
Waste Management (Urban solid waste)	Biomethane production by biodigestion	0.2	0.9
Waste Management (Urban solid waste)	Recycling 7% of total urban solid waste	NA[2]	0.4
Other mitigation options less representatives regarding sectorial emissions reduction		7.1[3]	44.6[4]
Total		60.4	211.1

Mitigation Options of Greenhouse Gas Emissions in Key Sectors in Brazil

http://sirene.mctic.gov.br



Thank you!


+55 (61) 2033-7923


cgcl@mctic.gov.br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