Carbon Transparency Initiative (CTI) – Tool Development for Brazil
(Desenvolvimento da Ferramenta CTI para o Brasil)

Centro Clima / COPPE / UFRJ

June 2022

GENERAL COORDINATION:

Emilio Lèbre La Rovere, D.Sc. (CentroClima/COPPE/UFRJ)

EXECUTIVE COORDINATION:

Carolina Burle Schmidt Dubeux

Sectoral experts:

George Vasconcelos Goes, Daniel Schmitz Gonçalves and Marcio de Almeida D'Agosto (Transport)

Otto Hebeda (Industry)

Claudio Joaquim Martagão Gesteira Neto (Residential and non-Residential)

Erika Carvalho Nogueira and Gabriel Castro (Oil & Gas and Power)

Michele Cotta Walter and Carolina B.S. Dubeux (AFOLU)

Saulo Machado Loureiro (Waste)

Macroeconomics:

William Wills

1) Centro Clima modeling structure[1]

Centro Clima/COPPE uses an integrated modelling approach, where a set of six sectoral models is linked to a CGE model (IMACLIM-BR). The sectoral models consist of four energy demand models (transport, industry, buildings, and agriculture energy demand), an agriculture, forestry and other land use (AFOLU) model and an energy supply model (MATRIZ). GHG emissions estimates from Waste complete the set.

The estimates for energy demand are undertaken using sectoral bottom-up models. The models require similar inputs, such as demographic (population) and macroeconomic (GDP, sectoral GDP) data, as well as activity levels and energy intensity, to provide comparable outputs (e.g., final energy demand in tons of oil equivalent and GHG emissions). However, they may differ broadly in terms of sectoral specification, level of detail and data availability.

The 'Transport-Energy-Emissions Multi-Tier Analysis' (TEMA) model is used to calculate energy use in the Brazilian transport sector. The model was developed by Gonçalves et al. (2019) and applied in studies such as Goes et al. (2020a; 2020b) and Gonçalves et al. (2020). Energy-climate scenarios are designed by simulating the application of climate policies, market trends and user behavior that best represent the transformations of society over the years. Macroeconomic data are used to project transport activity (and modal split) and the consequent use of energy and resulting carbon emissions. In TEMA, road transportation is the mode with the highest level of detail, considering 31 technologies that include vehicle categories (e.g., cars, buses, trucks) and powertrains (e.g., internal combustion engines, battery-powered electric vehicles, hybrid vehicles, etc.). The rail, air, water, and pipeline sectors are modelled in a more aggregate way, due to a lack of technology-level data. In their case, the 'Activity-Structure-Intensity-Fuel' (ASIF) approach is used to compute energy use and GHG emissions.

The ASIF approach is also applied to estimate the energy consumption and GHG emissions of the Brazilian industrial sector disaggregated in eleven segments: (i) Iron and Steel, (ii) Iron alloys, (iii) Cement, (iv) Chemical industry, (v) Non-ferrous metals, (vi) Pulp and Paper, (vii) Food and Beverage, (viii) Textile, (ix) Mining and pelleting, (x) Ceramic, (xi) Other Industries. The estimation of GHG emissions is divided into two: (i) emissions from energy consumption and (ii) emissions from industrial processes and product use (IPPU). Overall, the industrial processes that emit GHG are the production of metals, cement and other mineral products, and chemical products. Product use emissions encompass HFC emissions for refrigeration and air conditioning and SF_6 emissions from electricity transmission and distribution equipment.

GHG emissions from energy demand derived from buildings (residential, commercial and public administration) and agriculture are estimated considering historical trends in energy demand evolution and their continuity through 2050, according to different drivers. In the residential sector, energy demand responds to demographics and per capita income. In the services and agriculture sectors, demand is driven by sectoral GDP growth. Eventual differences across scenarios reflect only minor changes in per capita income and GDP share of agriculture and services.

[1] Apart from the AFOLU and Waste sectors, this section is part of William Wills et al., 2021 (William Wills, Emilio Lebre La Rovere, Carolina Grottera, Giovanna Ferrazzo Naspolini, Gaëlle Le Treut, Frédéric Ghersi, Julien Lefèvre & Carolina Burle Schmidt Dubeux (2021) Economic and social effectiveness of carbon pricing schemes to meet Brazilian NDC targets, Climate Policy, DOI: 10.1080/14693062.2021.1981212)

To estimate the GHG emissions from the Agriculture, Forestry, and Other Land Use sector (AFOLU) we use two different approaches. For LULUCF, as land use is regulated by law, we simulate deforestation rates as a result from a certain level of law enforcement, mainly considering the successes already achieved by specific policies in the past and historical data on annual deforestation rates in each of the six Brazilian biomes. Deforestation does not occur due to agricultural demand for land, as there is already enough land without forest cover. Regarding the other components of LULUCF and agriculture, to estimate the activity level, the model uses econometric functions that correlate GDP growth rates with agriculture output and, when it is the case, the demand for biomass by the other sectoral models. The model includes the following products: soybean, maize, sugarcane, and a group of 14 other crops (cotton, peanuts, rice, oats, rye, barley, peas, broad beans, beans, sunflowers, castor beans, sorghum, wheat, and triticale), meat and wood from commercial forest plantation. When it comes to emissions estimates, the penetration of different agricultural practices to a greater or lesser degree is defined based on the sectoral government policies and plans. Mostly low carbon agriculture practices are prescribed in the national Low Carbon Mitigation Plan – ABC Plan (pasture recovery, biological nitrogen fixation, forest-livestock integration systems, and zero tillage). In terms of land use, these commodities are broadly classified between agricultural land, pasture, and commercial forest areas. . Like the deforestation rate, land set aside as conservation units and indigenous lands are exogenously determined as they depend on political will. The amount of land earmarked for the restoration of native forests varies in the scenarios according to ambition levels considered and based on the assumptions of the success of national government policies and plans (NCD, 2015; Planaveg, 2017)

The MATRIZ model (CEPEL, 2020) is used to represent the Brazilian energy system and detail electricity supply and oil refining sectors. MATRIZ is a linear programming bottom-up model for medium- to long-term energy system planning, similar to MESSAGE and TIMES[2] (IEA-ETSAP, 2020; IIASA, 2020). Considering exogenous final energy demand and availability of resources, its objective function minimizes the present value of the total cost of investment and system operation, choosing the best configuration in terms of capacity expansion and energy supply on the assessed horizon. Energy chains are represented by linking primary, secondary, final, and useful energy levels. A mix of different technologies represents energy conversions and resource extractions. To account for the Brazilian electricity sector complexity, nine operating subsystems are considered. Besides, each period of the analysis is detailed into four seasons, each containing two energy demand levels: peak and non-peak. Such a level of specification is essential for energy security by ensuring that the system meets seasonal and horo-seasonal demands and energy generation, as well as potential periods of critical hydrology. MATRIZ computes GHG emissions endogenously. A penalty is simulated in the objective function specifically for fossil fuel technologies to represent carbon pricing.

Finally, the Waste sector complements the estimates by simulating a level of sanitation policies implementation throughout the scenario timeframe with different levels of mitigation measures penetration for each scenario.

[2] MESSAGE and TIMES are both bottom-up, energy supply models that uses linear-programming to produce a least-cost energy system, optimized according to a number of user constraints, usually over medium to long-term time horizons.

2) Centro Clima scenarios to DDPBIICS[3]: storylines and results

2.1 Presentation

The Brazilian NDC had an economy-wide goal of 37% GHG emission reduction, by 2025 and 43% reduction by 2030, compared with 2005 as the base year. The 2030 target has been recently updated to 50% although considering absolute values no significant change is envisaged due to a revision in the inventoried emissions in the base year. The new target is a total emission of around 1.28 Gt CO2eq in 2030 to be calculated considering the base year value of the same inventory in which the NDC compliance will be evaluated[4]. It also commits the country to carbon neutrality by 2050. Brazil had already made voluntary commitments of emission reductions in 2009 during COP15 (Copenhagen) linked to its NAMAs, corresponding to keeping emissions below a cap of roughly 2 Gt CO_2eq in 2020.

The exercise simulates two GHG emissions scenarios in Brazil until 2050. It provides a framework for an analysis of economy-wide and sectoral indicators of a decarbonization pathway aligned with the general objective of the Paris Agreement (net-zero GHG emissions in 2050). The Current Policies Scenario (CPS) follows the trend of ongoing mitigation actions. Its emissions are of 1.65 Gt CO_2eq in 2030, with no increase in ambition between 2030 and 2050. The Deep Decarbonization Scenario (DDS) reaches 1.0 Gt CO_2eq in 2030, going beyond the NDC target and following a GHG emissions trajectory compatible with the global objective of 1.5ºC, achieving net-zero emissions in 2050.

The sectoral mitigation measures considered in CPS are based on national plans and policies. DDS incorporates more ambitious actions and other available technologies. DDS's main features are a radical reduction in deforestation rates and an increase of carbon sinks. Carbon pricing from 2021 is assumed for a significant share of the emissions (Energy and IPPU), with sectors introducing mitigation actions with costs under the carbon price in each period, starting with the most cost-effective. Carbon prices are introduced through a cap-and trade system in Industry, and a carbon tax on GHG emissions from the combustion of fossil fuels in other sectors. They will grow linearly, reaching 25 USD/tCO_2eq in 2030 and 65 USD/tCO_2eq in 2050. Carbon pricing will be neutral from a fiscal perspective, with 100% of its revenues recycled back into the economy through labour charges reduction aiming to foster employment, and to compensate low-income households for the average price level increase.

Population size increases from 210 million inhabitants in 2019 to about 233 million inhabitants in 2050. In this period, the urban population share grows from 86% to 89%. Following the sharp downturn in the economy from 2015 to 2020 due to a political-economic crisis and the COVID-19 pandemic, Brazilian economy economic recovery is assumed to start on 2021: annual average GDP growth rates would be of 3,5% in 2021; 2,5% from 2021 to 2030; 2,25% from 2031 to 2040; and 2% from 2041 to 2050 (with linear growth assumed within each decade). After the drawback in the 2015-2020 period, Gini index starts to decrease again, but slower than the 2000-2015 record. Household size is projected to decrease slowly while household disposable income as a % of GDP is projected to increase. Trade will become more important to Brazil during the scenario timeframe, and import taxes and protectionism will be reduced, following the global trend.

[3] DDP (2021). *Policy lessons on deep decarbonization in large emerging economies*. Deep Decarbonization Pathways (DDP) Initiative-IDDRI. Paris.

[4] Emissions in 2005 have changed considerably in the second, third, and fourth Brazilian inventories due to problems in LULUCF values in the second inventory that could be solved only in the fourth inventory.

2.2 Scenarios results

2.2.1 Emission profiles

GHG emissions reach 17 Mt CO_2eq in DDS and 1889 in CPS by 2050. Comparing 2050 in both scenarios with 2020 values, DDS is 99% lower, while CPS is 27% higher. **Table 1** presents the figures by sector.

Most GHG emission reductions come from land use change and forestry. Compared to CPS, in 2050 DDS emissions from deforestation are 93% lower, a reduction of 953 Mt CO_2eq. On the top of that, carbon removals increase 76%, equivalent to 451 Mt CO_2eq, thanks to increased forested and protected areas (indigenous lands and conservation units). Transport is the second most relevant sector, with an emission reduction of 126 Mt CO_2eq (53%), followed by the waste sector with a reduction of 120 MtCO_2eq (65%), and livestock activities with 116 Mt CO_2eq (22%). Finally, in industry the reduction is of 84 Mt CO_2eq (31%), and in energy supply added to other energy consumption sectors of 27 Mt CO_2eq (23%). The only activity with a small increase in emissions is cropping, with 4 Mt CO_2eq (4%) more emissions in DDS due to higher biofuels production.

In DDS, only two sectors have higher GHG emissions in 2050 than in the base year 2019: cropping activities increase emissions by 29%; and industry by 14%. In these cases, under the assumption of no major breakthroughs or disruptive technologies, the improvement of technologies currently in use was not sufficient to compensate for the higher production levels.

Table 1. Total GHG Emissions per Sector, 2005-2050, under CPS and DDS (Mt CO2eq)

$MtCO_2eq$		2005	2010	2019	2020	2030	2005-2030	2040	2050	CPS-DDS (2050)
Land Use Change (LUC) – gross emissions	CPS	2,171	668	948	1,018	1,024	-53%	1,024	1,024	-93%
	DDS					614	-72%	201	71	
Removals (LUC, Forest, Protected Areas and Other)	CPS	-249	-313	-574	-591	-556	123%	-576	-593	76%
	DDS					-695	179%	-794	-1042	
Agriculture (crops + energy)	CPS	146	161	92	92	97	-34%	101	115	4%
	DDS					99	-32%	106	119	
Livestock	CPS	329	329	433	432	466	42%	485	529	-22%
	DDS					453	38%	444	413	
Transport	CPS	139	173	196	175	209	50%	220	240	-53%
	DDS					167	20%	139	114	
Industry (energy + IPPU)	CPS	139	162	162	166	194	40%	232	268	-31%
	DDS					172	23%	180	184	
Energy (supply + demand from households and services)	CPS	100	111	121	95	127	27%	115	120	-23%
	DDS					120	21%	100	93	
Waste	CPS	61	69	100	102	105	71%	145	186	-65%
	DDS					76	25%	78	65	
Total	CPS	2,837	1,361	1,479	1,488	1,665	-41%	1,745	1,889	-99%
	DDS					1,005	-65%	454	17	

2.2.2 Mitigation actions and costs

In DDS, besides the huge effort to curb down deforestation and increase removals, the carbon pricing policy supplies the complementary mitigation actions in other sectors required to reach net-zero emissions in 2050. **Table 2** presents the cumulative avoided GHG emissions per decade (Mt CO_2eq).

Table 2. Cumulative avoided emissions (CPS-DDS) per mitigation actions, per decade (Mt CO_2eq)

Cumulative avoided emissions per decade (Mt CO_2eq)	Decades		
	2021 – 2030	2031 – 2040	2041 – 2050
Total Mitigation Actions	3,629	10,069	16,103
Carbon Pricing Policy	1,013	2,618	5,254
AFOLU	619	1,483	3,281
Native forest restoration in public areas (through government concession)	38	302	1,291
Native forest restoration in private areas (offsets)	121	322	572
Planted forests (homogeneous and integrated crop-livestock- forest systems)	196	244	275
Agriculture	39	76	38
Livestock (restoration of degraded pastures, intensification, other)	225	538	1,105
Transport (freight and passenger)	233	639	1,064
Modal shift	132	169	271
Electromobility	-	346	520
Biofuels	98	124	273
Industry	126	387	694
Energy intensive industries	86	257	451
Light industry (rest of industry)	40	129	243
Energy Supply	35	110	216
Power generation	8	42	107
Self-consumption and fugitive emissions	28	68	109
Other Mitigation Policies	2,616	7,451	10,849
AFOLU	2,461	6,957	9,887
Reducing annual deforestation rate	2,252	6,367	8,940
Increasing conservation units, indigenous lands and other protected areas	209	590	947
Waste	155	494	963

Source: the authors.

Command and control policies combined with constraining the access of farmers and ranchers to public credits (subject to conformity with environmental laws and regulations) achieve 59% of total cumulative GHG emission reductions up to 2050, through the sharp reduction of annual deforestation rate. The 2004-2012 record has already shown the potential of these measures that can be successfully adopted again. Command-and-control measures also allow to avoid deforestation through the increase of the number and the surface of conservation areas (e.g., permanent preservation areas, indigenous land demarcation, and other legal reserves).

The carbon pricing policy can supply 30% of total cumulative avoided emissions up to 2050 in different sectors: AFOLU (18%), Transport (6.5%), Industry (4%), and Energy supply (1%). Native vegetation restoration in public and private areas have a significant abatement potential and lower costs than the other sectors. It allows to remove 2,647 Mt CO2eq up to 2050, when native vegetation restoration will reach 30.18 million ha. Private areas present more attractive costs in comparison with public areas (7 versus 17 USD/t CO2eq in 2021, 8 versus 28 in 2031, and 9 versus 31 in 2041). Considering the enforcement of Forest Code compliance, private areas provide higher cumulative avoided emissions in 2021-2030 (121 versus 38 Mt CO2eq) and in 2031-2040 (322 versus 302 Mt CO2eq) than public areas. However, in the last decade, the bulk of removals will come from public areas thanks to a better cost-effectiveness, and thus its contribution to cumulative avoided GHG emissions throughout the whole 2020-2050 period will be of 1,6311 against 1,015 Mt CO2eq from private areas.

The abatement cost assessment indicates the pathway of carbon prices. Costs for a given mitigation option may vary throughout the three decades due to increasing economies of scale and variations in cost assumptions (e.g., decreasing costs for electric vehicles and renewable electricity). Table 3 presents the cumulative avoided emissions per mitigation cost range (US$/t CO_2eq) in each decade.

A significant share of avoided emissions can be obtained at negative costs. Modal shifts in the freight transport sector (e.g., from roads to railways and waterways), a wide range of energy efficiency measures in industry and sustainable agricultural practices (e.g., no-till systems, biological fixation of nitrogen) can be implemented at negative costs up to 2050. In the last decade, this share is reduced to 13%.

A pathway towards net-zero GHG emissions in 2050 can be reached with a carbon price of 25, 45 and 65 USD/t CO_2eq, respectively, in each decade. AFOLU remains the key sector to this end, since it presents the largest mitigation potential with a low cost per avoided GHG emission. Energy efficiency measures in industry, and electromobility in passenger transport also provide relevant contributions. The identified portfolio of mitigation actions presents a significant decline of marginal returns after 35 USD/t CO_2eq. Therefore, a much more cost-effective trajectory of carbon prices (such as 25, 30 and 35 USD/t CO_2eq in each decade, for example) can deliver an ambitious mitigation target in 2050, not ensuring but getting close to climate neutrality, as it would provide 100%, 87% and 94% of the DDS cumulative avoided emissions in each decade. This is mainly due to the underlying assumption of counting upon available technologies only. It illustrates the huge mitigation potential ready to be tapped at low costs in Brazil even before the deployment of new disruptive technologies expected to come on stream up to 2050.

Table 3. Cumulative avoided GHG emissions (CPS-DDS) per cost range of mitigation actions, per decade

Mitigation action cost ranges (USD / t CO_2eq)	2021 – 2030		2031 – 2040		2041 - 2050	
	Mt CO_2eq	% Mt CO_2eq / period	Mt CO_2eq	% Mt CO_2eq / period	Mt CO_2eq	% Mt CO_2eq / period
up to 0	167	16%	478	18%	661	13%
up to 5	198	20%	582	22%	986	19%
up to 10	659	65%	1,613	62%	2,236	43%
up to 15	659	65%	1,613	62%	3,299	63%
up to 20	963	95%	1,619	62%	3,299	63%
up to 25	1,013	100%	1,619	62%	3,299	63%
up to 30			2,282	87%	3,308	63%
up to 35			2,309	88%	4,916	94%
up to 40			2,319	89%	4,916	94%
up to 45			2,618	100%	4,916	94%
up to 65					5,254	100%

Note: costs in present value of the first year of each decade (at 8% discount rate).

Source: the authors.

2.2.3 Macroeconomic and social implications

DDS allows to reach carbon neutrality while keeping slightly better economic and social development results than in CPS. Throughout the period up to 2050, GDP and GDP per capita are slightly higher, unemployment rate is slightly lower and the average disposable income for the poorest household income class is slightly higher, compared to CPS. Tables 4 and 5 compare the macroeconomic and social results of the two scenarios.

Table 4. Main macroeconomic results

Scenario	2015	2020	CPS (2030)	CPS (2050)	DDS (2030)	DDS (2050)
Population	203	212	225	233	225	233
GDP (Billion 2015 USD)	1,896	1,852	2,385	3,547	2,391	3,552
GDP variation in relation to CPS	-	-	-	-	0.3%	0.1%
GDP per capita (Thousand 2015 USD)	9.32	8.75	10.60	15.23	10.63	15.25
Trade Balance (% of GDP)	-0.4%	-1.0%	-0.4%	-0.2%	-0.5%	-0.9%
Unemployment rate (%)	9.5%	7.6%	6.9%	7.4%	6.8%	7.2%
Price index in relation to CPS (CPS=1)	-	-	-	-	1.01	1.04
Total net emissions (Gt CO_2eq)	1,518	1,488	1,665	1,889	1,005	17
Per capita emissions (t CO_2eq)	7.48	7.03	7.40	8.11	4.47	0.07
Carbon price (2015 USD/t CO_2eq)	-	-	-	-	25	65
Carbon pricing revenues (Billion 2015 USD)	-	-	-	-	12.9	34.6

Source: the authors.

Table 5. Disposable income of households by scenario and per household income class, 2015-2050

Scenario	2015	2020	CPS (2030)	CPS (2050)	DDS (2030)	DDS (2050)
Disposable income_HH1 (2015=1) (poorest 20% of households)	1.00	1.05	1.44	2.40	1.45	2.45
Disposable income_HH_2 (2015=1) (40% of households)	1.00	1.04	1.37	2.15	1.38	2.17
Disposable income_HH3 (2015=1) (30% of households)	1.00	1.01	1.29	1.92	1.30	1.93
Disposable income_HH4 (2015=1) (richest 10% of households)	1.00	0.98	1.23	1.80	1.23	1.80
Disposable income_HH1 (in relation to CPS)	-	-	-	-	0.7%	1.8%
Disposable income_HH_2 (in relation to CPS)	-	-	-	-	0.4%	0.9%
Disposable income_HH3 (in relation to CPS)	-	-	-	-	0.3%	0.4%
Disposable income_HH4 (in relation to CPS)	-	-	-	-	0.1%	0.1%

Source: the authors.

The carbon pricing scheme leads to higher domestic price levels, contributing to deteriorating terms of trade and affecting trade balance results. The ratio trade balance deficit / GDP is higher in DDS than in CPS, throughout the period up to 2050, although lower than in 2020 (but higher than in 2015).

A smart recycling of carbon pricing revenues can be socially friendly. Carbon revenues are distributed back to the economy, keeping the government net lending evolution identical in DDS and CPS, under the following rules: i) part of the carbon revenues are transferred back from the government to households to neutralize the effect of the carbon price on purchasing power; ii) the rest of the carbon revenues is used to reduce labor charges. The latter decreases distortions on the economy and is key to creating additional 150 thousand jobs in DDS compared to CPS. These jobs are created mainly in the services, transport, forest, and biofuels sectors. The carbon price penalizes in a higher proportion carbon-intensive sectors, and recycling carbon revenues favors more labor-intensive sectors and poorer household classes.

The higher employment and wage levels in DDS improve income distribution. The positive impact on households' income levels is particularly relevant in HH1 and HH2 groups (bottom 60%), which depend more on labor income. HH1 (the 20% poorest households, most of which were under the extreme poverty line in the base year) benefit even more from the DDS scenario due to the direct transfers of collected carbon revenues from the government.

DDS allows neutralizing GHG emissions in 2050 while mitigates the adverse effects of carbon taxation on poor households. Disposable income gains in DDS are significant compared to CPS, thanks to higher activity levels, lower labor charges, and increased transfers from the government, which are reflected in more jobs and higher income. DDS is also progressive in terms of income distribution throughout the period up to 2050, as lower income household classes show higher disposable income growth than richer ones, and faster increase than in CPS.

2.2.4 Sectoral deep dives

- *Agriculture, Forestry and Land Use (AFOLU)*

Agriculture is an essential driver of Brazilian economic growth. Production has grown rapidly over the past decades, driven by rising global demand and technological advances. Changes in crop management practices and expansion in the harvested area have enabled Brazil to become a leading exporter of soybeans, beef, and cellulose.

Both the CPS and the DDS assume a continuation of historical trends in food preferences. Environmental concerns in developed countries lead to less consumption of animal food, giving rise to food rich in micronutrients and vitamins, such as fruits and vegetables. On the other hand, staple food (such as carbohydrates) continues to play an essential role in food preferences in low and middle-income countries. Global meat consumption per capita would increase due to a combination of income and population growth, especially in Asian and Latin American countries. Consumption levels in developed regions are already high. The demand for meat increases as it becomes more accessible in developing countries.

Agriculture, Forestry and Land Use Change (AFOLU) is the primary source of greenhouse gas (GHG) emissions. Therefore, mitigation actions in this sector are critical for Brazil to achieve climate neutrality in 2050.

In the DDS, agriculture production increases significantly, but is GHG emissions are kept in 2050 slightly (1%) under 2019 level. There is an expressive growth in crop production, while the agricultural area increases moderately due to high productivity gains. In 2019-2030, total output rises 23%, and 47% between 2030-2050. The area occupied by crops increases 8% by 2030 and 6% in 2030-2050, reaching 75 Mha in 2050. Beef production grows 75%, reaching 18.3 million CWE in 2050, with a total herd of 200 million heads. Livestock size decreases 6% over time due to productivity gains, and it is raised on 105 Mha of pastureland (a 35% reduction).

Cattle ranching intensification is the action with the most significant mitigation potential. Additional recovery of 60 Mha from degraded pastures associated with increased productivity of the cattle herd reduces emissions from enteric fermentation by 6% in 2019-2050. In this scenario, the stocking rate goes from 1.31 head of cattle/ha to 1.96 by 2050. Adopting low-carbon agriculture technologies (for example, the no-till system and biological nitrogen fixation), recommended by the Low-Carbon Agriculture Plan (ABC Plan), increases along with soybean and other crops.

The reduction of deforestation is key for Brazil to reach climate neutrality. The annual area deforested in 2019 in the Amazon biome doubled compared to 2012 and was 34% larger than in 2018 (INPE, 2020). The area deforested in the country in 2023 is projected to be 15% greater than in 2019. Efforts to curb deforestation will resume in 2023, given the possibility of change in governmental policies and increasing international pressure over agricultural chains associated with deforestation. After 2023, deforestation control policies are resumed, reaching a reduction of 10% in 2023-2025. Zero illegal deforestation in the Amazon biome will be achieved in 2050. twenty years later than the NDC target. Emissions from deforestation will amount to 71 MtCO2eq in 2050, which corresponds to a 92% reduction compared to 2019. Protected Areas (Conservation Units and Indigenous Lands) will remove 487 MtCO2eq in 2050 (24% more than in 2019), thanks to the addition of 53 Mha of public non-destinated forests, registered in the Brazilian Forest Service, to the 276 Mha protected today.

Fostering reforestation and restoration of 30 Mha with native species in public and private areas is also relevant. It removes 417 MtCO2eq by 2050 and it is a measure in line with the NDC (2015), the Bonn Challenge (Bonn Challenge, 2011), and the national Native Vegetation Recovery Plan (Planaveg, 2017). This mitigation action is challenging and goes beyond the area considered in the NDC target (12 Mha by 2030). It can be made possible with government support, international funds, payment for environmental services programs, and forest offsets allowed through the cap-and-trade system imposed on Industry.

Fast-growing planted forests (eucalyptus and pine) are critical carbon removals. They include homogeneous forests and crop-livestock-forest integration systems. The surface of planted forests will reache 13 Mha in 2030 and 19.5 Mha in 2050. This area meets the demand from all sectors: energy (charcoal and firewood), industry (pulp and paper, sawn wood, plywood, panels, and others), and pellets production for exports.

In the DDS, net emissions of the AFOLU sector reach negative values (-439 Mt CO2eq), allowing the country to achieve carbon neutrality in 2050.

In the CPS, agricultural production grows more than in DDS (25% in 2019-2030 and 50% between 2030 and 2050). This results from a higher demand for biofuels in CPS due to more ICE and less electric vehicles than in DDS. Crop area increases 7% by 2030 and 7% in 2030-2050, reaching 76 Mha. Beef production grows 77%, reaching 18.5 million CWE in 2050, with a 23% larger herd reaching 263 million heads, and raised on 171 Mha of pastureland (5% increase).

Pastureland recovery in CPS is half of the DDS. 30 Mha are recovered up to 2050, increasing the stocking rate to 1.54 head of cattle/ha by 2050. Emissions from enteric fermentation grow 23% between 2019 and 2050. The penetration rate of low-carbon technologies, such as the no-till system and biological nitrogen fixation, is limited to the increase of the planted soy area. Emissions from the agricultural sector increase by 23% in 2050 compared to 2019.

As in the DDS, the annual deforested area increases until 2023 and decreases by 10% between 2023-2025. However, the annual area deforested in 2025 (1.97 Mha) is maintained in 2026-2050. Deforestation of this area emits approximately 1,024 Mt CO2eq per year. Considering the current government's lack of interest in expanding the areas of environmental protection, as well as allocating human and financial resources for their management, CPS does not foresee the creation or expansion of protected areas in 2020-2050, with the 2019 level remaining constant until 2050 (279 Mha). This area will remove 391 Mt CO2eq in 2050.

Although more modestly than in DDS, the reforestation and restoration of 3 Mha with native species in public and private areas remove 55 Mt CO2eq by 2050. It is equivalent to 25% of the area considered in the NDC target for 2030 (12 Mha). The area of forests planted with pine and eucalyptus species grows 53% in 2019-2050, totaling 13.5 Mha.

In the CPS, net emissions from AFOLU total 1,080 Mt CO2eq in 2050, a 21 % increase compared to 2019. Of this total, 60% comes from agriculture and 40% from land use change and forestry.

The Brazilian agricultural sector can become even more competitive globally if it increases productivity efficiently and sustainably. International pressures on the control of farming chains associated with degradation and deforestation contribute to making DDS viable. Countries that do not commit to reducing GHG emissions and controlling deforestation will face market barriers that will hamper exports. The soybean, beef, and forestry chains are examples of this context that apply to Brazil.

International and national financing programs focusing on climate change, sustainable agriculture, and the environment would help to make the DDS pathway feasible. Among them: Green Climate Fund, Global Environment Facility (GEF), Least Developed Countries Fund (LDCF – GEF), Special Climate Change Fund (SCCF – GEF), Adaptation Fund (AF), and the Amazon Fund.

- *Transport*

The scenarios embody different visions of the future of Brazilian passenger and freight mobility. The CPS represents the continuation of current incentives for biofuels and energy efficiency, but with no increase in ambition after 2030. The DDS expands and diversifies the biofuels market, besides requiring other measures such as accelerating the electrification of the vehicle fleet and expanding the transport infrastructure in key areas.

Globally, the DDS demands a continuous reduction in the relationship between price and energy density of batteries. Fully autonomous vehicles remain a niche market, restricted to developed economies or pilot tests in emerging countries. Hydro Vegetable Oil (HVO) becomes an important energy source in oil refineries, taking advantage of the liquid fossil fuels distribution chain. International funding programs focused on sustainable policies and infrastructure become commonplace among the main financial agents.

In both scenarios, society experiences new mobility configurations linked to population aging, teleactivities, new technologies, and structural changes. Cities are planned to increase integration and decentralize activities to reduce commuting times and congestion. The major metropolitan areas focus on high-efficiency modes and active transport, creating pedestrian-friendly environments. Teleactivities lead to changes in the pattern of passenger and freight transport. In non-metropolitan areas, transport systems maintain the historical pattern of growth and design.

In the DDS, consumers choose more efficient and eco-friendly technologies, stimulating the penetration of electromobility and biofuels. Brazil increasingly invests in charging infrastructure and basic conditions for electric vehicles, such as standards and regulations, financing, and new business models. Unlike the CPS, new local manufacturers of electric trucks and buses, and automobile components change the industry pattern, reducing the impact of the devaluation of the local currency on imports. The electrification of the bus fleet and prioritization measures induce the population to increase public transport use, reducing the need to own a private car. Financial incentives to develop a national advanced bioenergy industry expand the offer and variety of biofuels, for example, biokerosene, bio-oil, and HVO.

No new passenger cars with internal combustion engines (ICE) will be registered from 2045. At the same time, the market penetration of electric vehicles is further accelerated compared to the CPS. In 2050, almost half of the vehicle stock is composed of hybrids (HEV), plug-in hybrids (PHEV), and fully electric vehicles (BEV). Total car stock reaches 76 million, with a much lower motorization rate than in the CPS (326 against 456 cars per 1,000 inhabitants). Private mobility (pkm/cap) accounts for a 41% share in this scenario. Electricity reaches 11% of the total energy consumed in passenger transport, while liquid biofuels account for 52%. As a result, GHG emissions fall by 52%, reaching 49 MtCO2eq. Carbon (g CO2/MJ) and energy (MJ/pkm) intensities fall by 41% and 54%.

Freight diesel railways are gradually modernized and electrified via contractual additives in their respective concessions. Regulatory frameworks increase productivity in rail and water transport. Sustainable logistics and certification programs increase efficiency in road transport. The redesign of transport networks focusing on high-capacity modes balances the modal split of Brazilian freight transport reasonably. In 2050, road transport accounts for 42% of the transport activity (tkm), and rail and water account for 35% and 22%.

BEV, HEV, and PHEV constitute 33% of the stock of freight vehicles, concentrated on urban transport. Despite the advances made, electricity is responsible for only 2% of the energy consumed in freight transport. In turn, biofuels account for 37%. These shares stem from the strategic prioritization of electrification of passenger transport, leaving freight transport to absorb the liquid fuel supply surplus. GHG emissions fall by 32%, reaching 62 Mt CO2eq. Carbon (g CO2/MJ) and energy (MJ/pkm) intensities fall by 32% and 46%.

In the CPS, the biofuels industry is restricted to biodiesel and ethanol. Electromobility incentives are limited to experiments in metropolitan areas. The end of sales of ICE cars is expected to occur only in 2050 when the total stock of cars reaches 106 million. Private mobility (pkm/cap) accounts for a 50% share, much higher than in the DDS. This participation is due to a lower proportion of public and non-motorized transport, as fewer investments are expected.

Electricity is not representative in this scenario, accounting for only 4% of the total energy consumed in passenger transport by 2050. However, biofuels account for 38% in the same year. GHG emissions from passenger transport increase by 25%, reaching 126 Mt CO2eq. Even so, carbon (g CO2/MJ) and energy (MJ/pkm) intensities decrease by 8% and 21%, mainly due to the increased participation of biofuels and energy efficiency programs.

Freight railways continue to have only diesel-electric locomotives. Rail and water transport activities grow at levels below their potential. In 2050, road transport accounts for 48% of the transport activity (tkm). BEV, HEV, and PHEV reach 20% of the stock of freight vehicles. Electricity is less consumed than in DDS, accounting for only 0.2% of the total energy consumed in freight transport by 2050. Liquid biofuels account for 18%. Freight transport emissions increase 18%, reaching 112 Mt CO2eq. Carbon (g CO2/MJ) and energy (MJ/pkm) intensities fall by 10% and 23%.

- *Industry*

The Brazilian industry accounted for 26% of the national GDP, in 2019. This participation has decreased over the last 30 years due to successive crises. Industrial growth is assumed to restart in 2021. From 2020 until 2050, the value-added annual average growth rate of the cement, iron and steel, and chemical industries reaches 2.6%, 1.9%, and 1.7%, respectively.

The industry's sector emissions correspond to about 16% (162 Mt CO2eq) of the country total, with half of them coming from the three above-mentioned sectors. In CPS, assuming the same performance of current mitigation policies and measures, GHG emissions will reach 290 Mt CO2eq in 2050, 75% from energy consumption and 25% from IPPU.

In DDS, implementing well-known mitigation measures in the industry sector reduces 35% of its GHG emissions in 2050. No new industrial processes nor mitigation technologies are assumed. Mitigation actions include: substantial acceleration of energy efficiency improvement, allowing energy intensities to decrease from 21 to 25% in 2050, according to the industrial branch; fuel shift to renewables, including an increased use of charcoal for pig iron production and of wood and residues in cement kilns; and an increased use of ashes and slag to replace clinker in cement blending. The full replacement of HFCs by low GWP gases would be nearly completion (98% reduction of its emissions) by 2050. As a result, DDS emissions will reach 190 MtCO2eq in 2050, 35% less than in the CPS, with energy-intensive industries accounting for 87% of these emissions.

- *Energy Supply*

Offshore oil and gas production from the pre-salt layer increase steadily in both scenarios. After the sharp oil price reduction due to the COVID-19 crisis (from 66 USD/barrel in 2019 to 23 USD/barrel in 2020), it is assumed that oil price will grow linearly to 45 USD/barrel in 2025 and remain constant at this level until 2050. Under these assumptions, increasing shares of Brazilian oil production are directed towards exports, as production costs are kept low and remain competitive in the world market. In DDS, this share is higher as oil and gas domestic consumption are 30% lower than in CPS, which also allows to keep GHG emissions from refineries and fugitive emissions under control.

Total energy supply emissions in 2050 are 95 Mt CO2eq in CPS and 68 Mt CO2eq in DDS. Brazil`s energy supply-related emissions are expected to grow in the immediate future (mainly those from energy self-consumption and fugitive emissions, while emissions from power generation present little growth), peak around 2035, and then decline through 2050. Power generation expansion trend in Brazil is already based on renewable sources, and thus presents low GHG emissions than most other countries. In both scenarios, GHG emissions from power generation decrease further, from 24 Mt CO2eq in 2019 to 16 Mt CO2eq in CPS and only 1.7 Mt CO2eq in DDS, in 2050.

Electricity consumption grows faster than overall energy consumption, but end-use efficiency gains allow for a lower growth in DDS. In CPS, electricity consumption grows by almost 78% from 2019 to 2050, reaching 972 TWh (terawatt-hours), but in DDS, its growth is limited to 928 TWh (70% increase), despite an increase of 25 TWh of its use in transport, thanks to a consumption reduction of 63 TWh in the industrial sector, compared to CPS.

In DDS, the Brazilian power generation reaches nearly net zero emissions by 2050. In both scenarios, hydro, wind energy and photovoltaics are the main sources to expand their power generation. After 2040 when the Brazilian hydropower potential will be almost fully explored, biomass will replace its role and complement wind and solar contributions. In 2050, the required installed capacity of hydropower is 146 GW on both scenarios. Onshore wind capacity reaches 50 GW in CPS and 46 GW in DDS, while photovoltaic systems account for 51 GW in CPS and 53 GW in DDS. Biomass reaches 31 GW in CPS and 28 GW in DDS. Natural gas is restricted to CPS with 11 GW and offshore wind to the DDS with 3 GW. Moreover, old thermopower plants are decommissioned and replaced by renewable power plants (wind, solar photovoltaic, and biomass) due to their lower costs in both scenarios. However, in CPS, natural gas still plays an important role in dispatchable power generation. On the other hand, in DDS, the development of large intermittent renewable capacities is made possible by increasingly using hydropower generation and batteries to ensure grid operation flexibility.

Global carbon pricing and fast technological development in renewable energy technologies (mainly batteries, solar and wind), are the key international enablers of DDS. A domestic carbon tax can reduce the competitiveness of power generation from natural gas, while technology improvements and growing international experience of developers can enable the competitiveness of renewables.

- *Waste*

Both scenarios consider that national solid waste policy (PNRS) and national sanitation plan (PNSB) goals are met regarding the extension of service coverage.

Regarding solid waste, the percentage of collected waste increases from 90% today to 100% in 2030. Adequate final disposal goes from 40% to 95% in 2050. In DDS, landfilling is limited to around 70%, with biogas capture and methane destruction rate reaching 65%. As in developed countries, thermal and biological plants would be introduced, reaching 8% and 10% of total waste disposal, respectively. Recycling rate goes up to 10%. In CPS, only landfilling is the technical option considered, with biogas capture and methane destruction remaining at a constant rate of 15% throughout the period. The recycling rate remains at 3%.

Sewage collection rates go from 53% today to 84% in 2050, with anaerobic treatment plants treating 21% of the collected volume. Of the methane generated in these plants, in DDS the destruction rate goes from 40% to 80% in 2050, while in CPS it reaches only 55%.

GHG emissions in DDS are cut by 36% in 2050, while in CPS they grow by 82%. The substantial extension of sanitation services to bridge the current infrastructure deficit can lead to a huge increase of emissions unless biogas capture and burning technologies are massively introduced. The amount of cumulative avoided GHG emissions in this sector is high. These technologies will be cost-effective thanks to global pricing schemes leading to international trade of mitigation outcomes and the financial flows required to meet the funding requirements of these investments.

2.3 Synergies and trade-offs with country non-climate objectives

Living standards in Brazil will improve slowly, and the distance to developed countries will be reduced by 2050, following the global trend. Under DDS, a smart recycling of carbon pricing revenues delivers reductions of both GHG emissions and social inequalities. Compensating poor households for increased price levels through green checks and fostering employment through reduction of labor taxes are the key enablers to maximize the synergy between climate and fiscal policies. Several complex iterations exist with SDGs, but overall synergies with DDS are summarized in Table 6.

Table 6. Synergies with SDGs

Very high synergy with SDGs	
#13	Climate action (radical mitigation),
#7	Affordable and clean energy (power generation reaches nearly net zero emissions),
#11	Sustainable cities (cleaner cities due to higher use of biofuels, electric vehicles, and increased use of mass public transport systems),
#15	Life on land (radical reduction of deforestation and increase of protected forests).
High synergy with SDGs	
#9	Industry, innovation and infrastructure (more innovation and competitiveness in industry and higher investment in low-carbon infrastructure),
#17	Partnerships for the goals (higher levels of international cooperation),
#6	Clean water and sanitation (faster growth of public sanitation infrastructure thanks to higher investment targeted at GHG emissions reduction).
Moderate synergy with SDGs	
#1	No poverty,
#2	No hunger,
#3	Good health,
#4	Quality education,
#8	Decent work and economic growth,
#10	Reduced inequalities,
#12	Responsible consumption and production (slightly higher GDP/capita and disposable income to poorer households; lower unemployment rate and new jobs in the services, transport, forest, and biofuels sectors).
Neutral for SDGs	
#5	Gender equality,
#14	Life below water,
#16	Peace, justice and strong institutions.

AFOLU

Global food security and maintenance of high biodiversity can be complementary and synergistic goals by using sustainable agricultural practices that protect, restore, and promote rational use of ecosystems and at the same time reduce GHG emissions.

Increased use of sustainable agricultural practices such as mixed, rotational, and succession crops, with zero tillage and crop-livestock-forestry integration, deliver co-benefits such as optimization and intensification of soil nutrient cycling, greater soil water retention, conservation of biodiversity, and increased agricultural productivity.

Protecting, restoring, and promoting the sustainable use of forests, including forest diversification and management, prevents desertification, halts / reverses land degradation, and reduces biodiversity losses. In addition, the forest carbon stock also contributes to reducing emissions through the use of forest-based products to replace non-renewable resources.

Transport

Electric mobility provides considerable co-benefits for the urban population's health, energy security, and social security spending, besides reducing GHG emissions. There is a direct relationship between the health budget and air pollution in cities, mainly caused by vehicles equipped with internal combustion engines. The more urban planners perceive a reduction in hospital admissions for respiratory problems, the more they encourage the use of electric vehicles in metropolitan areas, especially buses and light trucks. The dissemination of electric mobility goes together with expanding the supply of electricity and telecommunications to remote areas. It allows the installation of larger commercial and industrial buildings such as hospitals and schools, which demand higher voltages. Finally, electric mobility in road and rail transport reduces dependence on diesel oil, which is currently a major problem in Brazil, especially in freight transport. In addition to being a more expensive and polluting source of energy, the high volatility of crude oil and diesel prices has caused social instability, including strikes and protests, as well as inflation.

Industry

Decarbonization through higher energy efficiency fosters industrial productivity and employment generation for skilled human resources in the industry and across its entire supply chain. The adoption of low-carbon industrial processes and other innovations increases competitiveness and resilience. Additionally, since these measures require investments in retrofit or construction of new facilities, they create direct and indirect jobs in the supply chain and induce new jobs due to workers' spending on goods and services. Furthermore, improving energy efficiency and increasing alternative fuels reduce external dependence and the risks associated with fluctuations in currency and energy commodity prices, as the steel and cement industries import a significant share of their fuels.

Energy Supply

Expanding affordable and renewable energy production (with power generation reaching nearly net zero emissions by 2050) fosters employment generation, reduces air and water pollution, and improves overall societal well-being and resilience. Decentralized wind and solar energy deployment allows for regional development, and it is an excellent opportunity for stimulating economic growth in distant communities. Bioenergy deployment in various forms, and for different purposes, has many synergies with industrial development and environmental protection in rural areas.

Waste

Cheap GHG emissions reduction available through capture and flaring of biogas encourage investment in sanitation and help to accelerate the building up of the infrastructure required to bridge the historical gap in the level of service coverage. Low-income households are the main beneficiaries of this service expansion that brings considerable social benefits. Power generation through controlled incineration of waste in big cities, the use of refuse-derived fuel (RDF), and biogas as a fuel in the industry increase energy supply.

2.4 Priority short-term policies and actions

The main priorities for the short-term derived from the scenario analysis are:

- Resuming policies successfully adopted in the recent past (2004-2012) to sharply reduce annual deforestation rates: both command-and-control and economic instruments.
- Developing smart financial mechanisms to foster the funding of investments in mitigation actions, and mainly in forest cover restoration and low-carbon infrastructure.

- Carbon Pricing: provide a long-term, stable signal to induce economic agents to choose low-carbon technologies through a well-structured cap-and-trade scheme for industry and a carbon tax on other sectors.
- Relying on the AFOLU sector to reduce and capture the largest share of emissions in the first half of the century to get close to the net-zero target by 2050 helps to reduce overall costs for Brazil and provides sufficient time for disruptive technologies to be economically viable.

For AFOLU, policies and actions focused on reducing deforestation and increasing carbon sinks are key in Brazil. The current government has discontinued several successful environmental policies, and therefore annual deforestation rates have increased in recent years. The resumption of command and control strategies – monitoring, inspection, collection of fines, and application of embargoes – that are already known and effective in reducing deforestation is considered a short-term priority. Other effective policies and actions are: promoting articulation and integration between the various government agencies; environmental and land tenure regularization; forest concession on public lands not assigned for any specific use; expansion of areas conservation units category, and demarcation of indigenous lands.

In the agricultural sector, effective policies and actions are associated with the conditioning of soft public loans to farmers and ranchers upon compliance with the forest code and environmental regulations (Environmental Rural Registry – CAR); monitoring the origin of agricultural products (traceability) and restriction of the market for products associated with deforestation; and enabling financial mechanisms to foster low-carbon agriculture practices, including technical assistance and rural extension.

In transport, the fastest GHG emission reductions in the short-term can be achieved by an acceleration of the RenovaBio program with higher targets for biofuel sales and regularly updating energy efficiency targets for internal combustion engines. This includes greater public encouragement of second-generation biofuels, particularly HVO, increasingly added to biodiesel-diesel blends. The introduction of carbon taxes on gasoline and diesel oil is also necessary. Furthermore, a complementary set of policy instruments regarding the prioritization of public transport needs to be deployed. This means increasing subsidies and tax exemptions to mass public transport systems to improve the sector’s capacity to deal with post-pandemic economic uncertainty and instability. The design and implementation of new business models associated with the penetration of electric buses can help the recovery and improvement of the urban buses transport service (highly damaged by the pandemics). Besides, the development and approval of missing standards and regulations, combined with education and awareness campaigns, are required to allow for the growth of the electric vehicle market (mainly in metropolitan areas).

Financial support for investment in low-carbon technologies through credit mechanisms and fiscal exemptions are short-term priorities for industry. The transition to a less carbon intensive industry is to be supported by significant investments and a change in the current financial structure that does not favour low-carbon technologies. Providing access to financial products and fiscal exemptions for those types of investment are required to make them more profitable. In addition, a cap-and-trade system for GHG emissions reduction in industry, allowing for offsets from AFOLU up to a limit, is key to help decarbonize the sector. Carbon pricing improves the competitiveness and benefits of those companies that take the lead.

Regarding the energy supply, is pivotal to keep the national energy policy oriented to tapping the potential for renewable energy deployment. A carbon pricing scheme will encourage biofuels use and production and avoid additional fossil fuel-fired thermopower generation capacity. Natural gas is a transitional fuel for a sustainable energy system transformation, while incentives are to be applied to accelerate the decommissioning of coal-fired power generation. The gradual elimination of fossil fuel subsidies, which do not help the poor and hamper renewable energy and energy efficiency efforts, is also a key measure. Reform of fossil fuel subsidies should be accompanied by targeted and time-limited transitional support for vulnerable industries, communities, regions, and consumers. Incentives for distributed solar PV generation have to be kept for a while (subsidies and tax exemptions to be fully withdrawn only in 2045).

In the waste sector, is key to design and implement incentives and adequate regulations to promote the capture and flaring of biogas and its use as a fuel. It is also fundamental to promote municipalities' capacity building and encourage partnerships to develop a portfolio of investment opportunities. Increased recycling rates can be achieved through stricter regulation and correct market signals to encourage the reinsertion of scrap materials and post-consumer wastes into the economic cycle.

2.5 Investments patterns

The highlights of the study with regards to investment can be summarized as follows:

A significant share of avoided emissions can be obtained at negative or very low costs. Costs for a given mitigation option may vary throughout the three decades due to increasing economies of scale and variations in cost assumptions (e.g., decreasing costs for electric vehicles and renewable electricity). Additional investment in mitigation would sum about USD 83 billion in a pathway leading to net-zero GHG emissions in 2050.

This would represent a 0.5% increase in the investment rate (Total Investments/GDP) in DDS over CPS. Most of the investments would be needed in industry, agriculture and forestry, and transportation sectors. For AFOLU: Adequate investment patterns can be made possible by sales of forest offsets through a cap-and-trade system applied to industry, and by expanding credit for a number of sustainable forest uses and agriculture practices.

Mechanisms introducing payments for environmental services can attract private investments to restore native forests and compensate forest producers for maintaining forest stocks. Law 14,119/2021 makes provision for these payments and considers modalities such as compensation for reduced emissions from deforestation and degradation (REED +), green bonds, and Quotas for Environmental Reserve (CRA). In addition, changes proposed in the Forest Concessions Law (Law 11,284 / 2006) can streamline contracts and make the concession process viable.

In the agricultural sector, the leading financial players are banks, cooperatives, capital equity, industry, suppliers, traders, and distributors. Green bonds have the potential to support agriculture towards sustainable production. Law 13,986 / 2020 that creates a solidarity guarantee fund helps the country's agricultural sector to access international markets. One of the significant innovations facilitating access to capital markets is the possibility of directly issuing Agribusiness Credit Receivables Certificates (CRAs) in the offshore market.

For Transport: Strengthened national industry to support electric mobility and smart grids, reducing the negative effects of exchange rate volatility and inflation. Government can provide financial incentives and basic infrastructure to attract electric vehicle industries and suppliers. Also, credit lines can be supplied to finance intensively used electric vehicles (mainly buses and light trucks) at lower rates compared to conventional internal combustion vehicles. Access to financial instruments for green investments such as green bonds and structured green funds can also be increased. Modern standards and regulations can enhance legal security and guarantees for public/private partnerships to invest in railways and waterways. Also related to these transport modes, public and private partnerships can be fostered to improve intermodality, increasing the number of terminals, expanding road access to ports, and interconnecting regional railways and waterways.

For Industry: Specific credit lines for decarbonization – energy efficiency, fuel shifts, and new processes – of heavy industry (mainly cement and steel) are to be supplied. Creating specific and diversified credit lines through federal bank regulation is vital to promote massive investment in less carbon-intensive technologies and processes. Uniform guidelines for credit analysis and appropriate rates for the specificities of the industrial sector can be highlighted as important features for new credit lines. Access to green bonds can also help spur investments in low-carbon technologies.

Energy Supply: Higher investments required in hydro, wind, and solar power, as well as in bioenergy, benefit from smart financial mechanisms allowing to de-risk low-carbon projects and to attract larger financial flows at lower capital costs. Expanding or reinforcing the transmission system (national grid) is a pre-requisite to accommodate a considerable growth of renewable power generation, mostly located in remote sites. Similarly, it is necessary to expand the Brazilian gas pipeline network, which might be used in the long run for the transport of “green hydrogen”. In addition, financial support is needed in the form of grants, loans, and tax cuts aimed at green transport, circular economy, energy efficiency improvements, and clean energy research, development, and deployment.

For Waste: An appropriate regulatory framework is required to enable funding mechanisms of investments for biogas capture and flaring in new and existing landfills and sewage treatment plants. This would also simultaneously foster waste recycling and re-use.

At economy-wide level, additional mitigation investments in DDS (compared with CPS) amount to USD 24.12 billion in 2021-2030, USD 90.62 billion in 2031-2040, and USD 148.75 billion in 2041-2050, in Transport (41.7%), Waste (25.7%), AFOLU (21.0%), Industry (9.4%) and Energy Supply (2.2%) sectors (considering the whole 2021-2050 period). Table 7–Additional mitigation investment in DDS compared to CPS, per economic sector, per decade details the additional investment (CAPEX) in DDS compared to CPS.

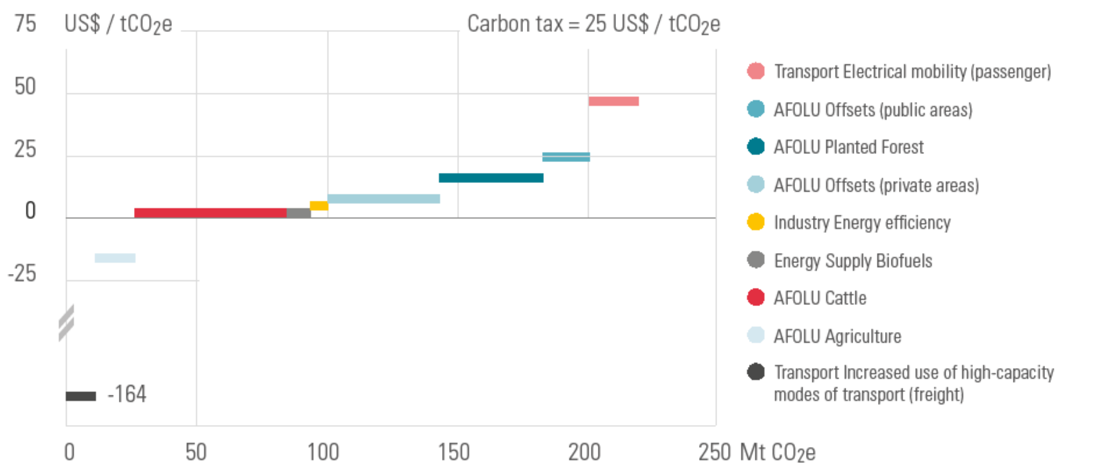
Table 7. Additional mitigation investment in DDS compared to CPS, per economic sector, per decade

Sectoral investment (USD billion)	2021-2030	2031-2040	2041-2050
AFOLU	4.26	14.59	36.38
Transport	17.02	38.32	54.55
Industry	2.39	7.88	14.63
Energy Supply	0.45	1.74	3.49
Waste	-	28.09	39.70
TOTAL	24.12	90.62	148.75

Notes: 1. Additional investment in energy supply considers power and biofuels. 2. Exchange rate 3.15 R$/USD (values of 2015). 3. Values not discounted.

Figure 1 presents the marginal abatement cost curve (MACC) for the first period (2021-2030). Figure 2 and Figure 3 present the MACC for the following decades (2031-2040 and 2041-2050, respectively). Over the whole period, DDS includes the adoption of 32 mitigation actions. However, to better illustrate the relationship between mitigation costs and abatement potential, we highlighted separately in the three figures below the main mitigation actions (including only those avoiding at least 5 $MtCO_2eq$) contributing to the total abatement in each decade.

Figure 1. Marginal Abatement Cost Curve 2021-2030 (mitigation actions avoiding at least 5 $MtCO_2eq$)



** Increased use of high-capacity modes of transport - in this measure, the following actions are taken: (i) expansion of the railway network, restricted to projects under implementation; (ii) investments in waterway and land access, such as port areas, as well as expansion of port capacity; (iii) increasing energy efficiency and expanding the capacity of profitable railroads; (iv) recovery of underused railways in strategic locations; (v) logistical optimization; and (vi) increased activity by reducing bureaucracy in cabotage and rail transport.*

Figure 2. Marginal Abatement Cost Curve 2031-2040 (mitigation actions avoiding at least 5 $MtCO_2eq$)

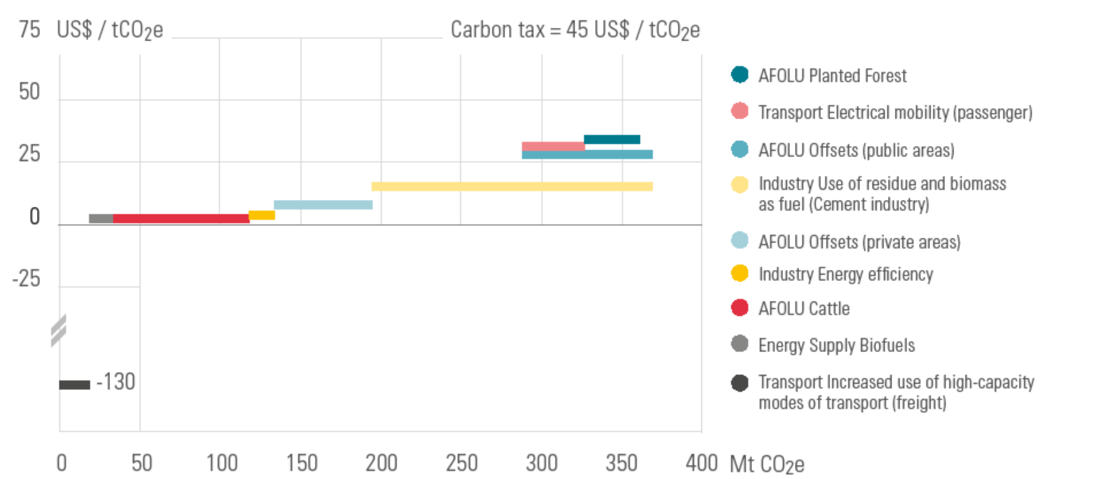
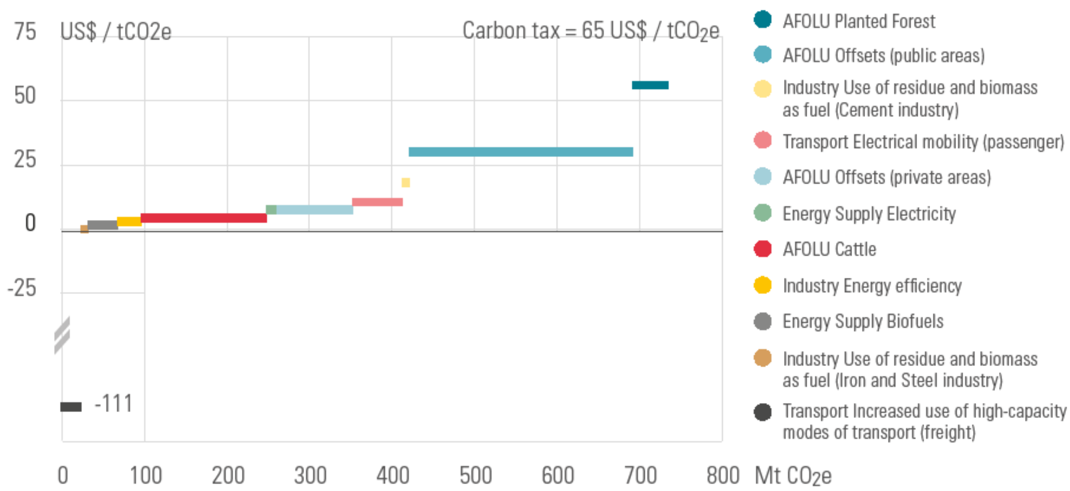


Figure 3. Marginal Abatement Cost Curve 2041-2050 (mitigation actions avoiding at least 5 MtCO2eq)



2.6 Key international enablers and accelerators of domestic transitions

The key international conditions that make DDS plausible in Brazil are:

- Strong international effort to meet the Paris Agreement, with most countries adopting carbon pricing.
- Substantial support of Annex I countries to foster financial flows targeted at mitigation actions in non-Annex I countries, including both the climate finance tools within UNFCCC (GCF, SDM) and international financial initiatives to channel private capital to low-carbon investments.
- International oil price allowing the domestic offshore pre-salt oil production to be competitive
- Preferential commercial mechanisms to require traceability and proof of origin of agricultural and forestry product exports can contribute to the control of deforestation in Brazil.

AFOLU: Border taxes adjustments according to carbon footprints and market incentives for agricultural and forestry products with traceability and proof of origin can help control deforestation in Brazil. A growing international demand for wood pellets can help Brazil to massively plant forests for export. Global per capita meat consumption will increase, and Brazil will continue to be a major global player in beef supply. Demand will keep increasing as meat becomes more affordable in developing and least developed countries. Global economic growth, especially in Asian and Latin American countries with large middle classes, will support the growth in demand for meat, even with a decline in demand from developed countries.

Transport: Global awareness and local interests (policymakers and potential investors) will converge, making electric mobility the main technological change in the transport sector (to the detriment, for example, of hydrogen fuel cell vehicles, non-plugin hybrid vehicles, and internal combustion engine vehicles). The end of large-scale production of internal combustion engine passenger vehicles will take place first in the main manufacturing countries. At the same time, the relationship between price and energy density of batteries will continue to decline, reaching purchase price parity in Brazil between 2035 and 2040. The slow pace compared to major global players is due to the absence of local electric vehicle manufacturers and suppliers and an unstable local currency. The main routes connecting regional and national metropolitan areas between countries will provide charging stations for trucks, buses, and cars. Problems related to interoperability between stations managed by different operators, as well as the second life of electric vehicle batteries, will not be representative. Drop-in biofuels will be a key element when considering non-electric solutions across countries, mainly applied to long-distance freight transport.

Industry: Global carbon pricing and deployment of low-carbon technologies help the national industry embark on a decarbonization pathway. Global carbon prices will make less carbon-intensive products more competitive, rewarding early runners investing in low-carbon technologies. New cost-effective industrial processes will reduce the carbon footprint of cement and steel. Investment costs are one of the major obstacles for the sector. Technologies like Direct Reduction Iron using hydrogen are expensive for the Brazilian industry. The consolidation of new technologies and decreasing its costs will be fundamental to help the decarbonization of the industry sector.

Energy Supply: More effective technology research, development and transfer, and international long-term investment funding are key enablers for decarbonization in the sector. Availability of natural gas cost-effective technologies to replace coal and oil products in the industry (e.g., direct reduction of iron ore for steel manufacturing), as well as for power generation at low load factor (for complementing intermittent power sources, like wind and solar generation) will help avoiding carbon lock-in (if natural gas was channeled to baseload power generation). International oil prices will allow domestic offshore pre-salt oil production to be competitive. This will supply the opportunity of scaling up the use of oil rent for the improvement of education and health in the country. Recycling carbon pricing revenues to lower taxes on labor and reduce capital costs will encourage job creation and investment in low-carbon infrastructure, improving overall economic productivity.

Waste: International financial flows, both through Article 6 of the Paris agreement and voluntary carbon markets, can significantly increase investments in biogas capture and flaring. Promoting the use of biogas as an energy source, (e.g., as biomethane) and technology transfer of other environmentally friendly solutions can help mitigation in this sector.

2.7 Summary of key findings

- DDS is just one among many pathways for Brazil to reach climate neutrality by 2050.
- Underlying assumption: use of available technologies only; huge mitigation potential at low costs in Brazil even before the deployment of technological “breakthroughs”.
- Sharp reduction of annual deforestation rate and native vegetation restoration in public and private areas have a significant abatement potential and lower costs than mitigation actions in other sectors.
- A pathway towards net-zero GHG emissions in 2050 can be reached with a carbon price of 25, 45 and 65 USD/t CO_2eq, respectively, in each decade.

- DDS allows to reach carbon neutrality while keeping slightly better economic and social development results than in CPS (smart recycling of carbon pricing revenues).

Visualization of country results

Figure 4. GHG Emissions under Current Policies & Deep Decarbonization Scenarios (Mt CO2eq)

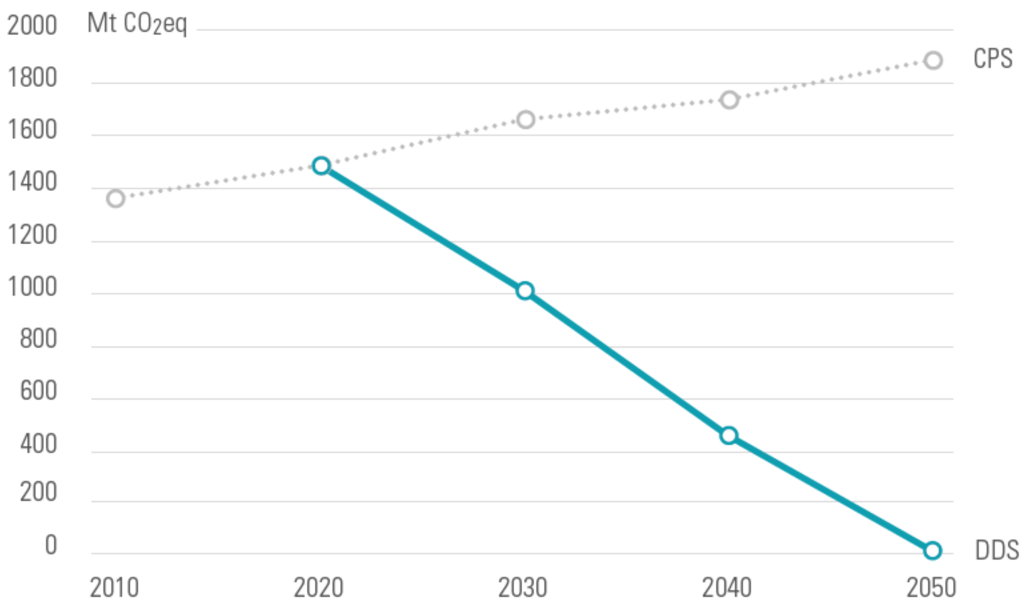


Figure 5. GHG Emissions, CO2 and non-CO2 (Mt CO2eq)

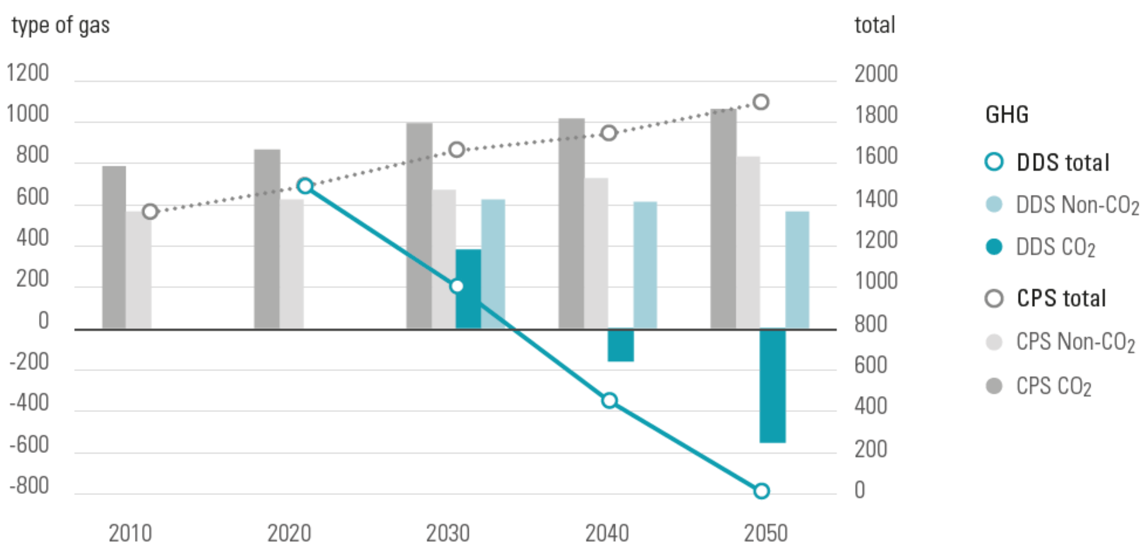


Figure 6. GHG Emissions x Population x GDP (2010 =1)

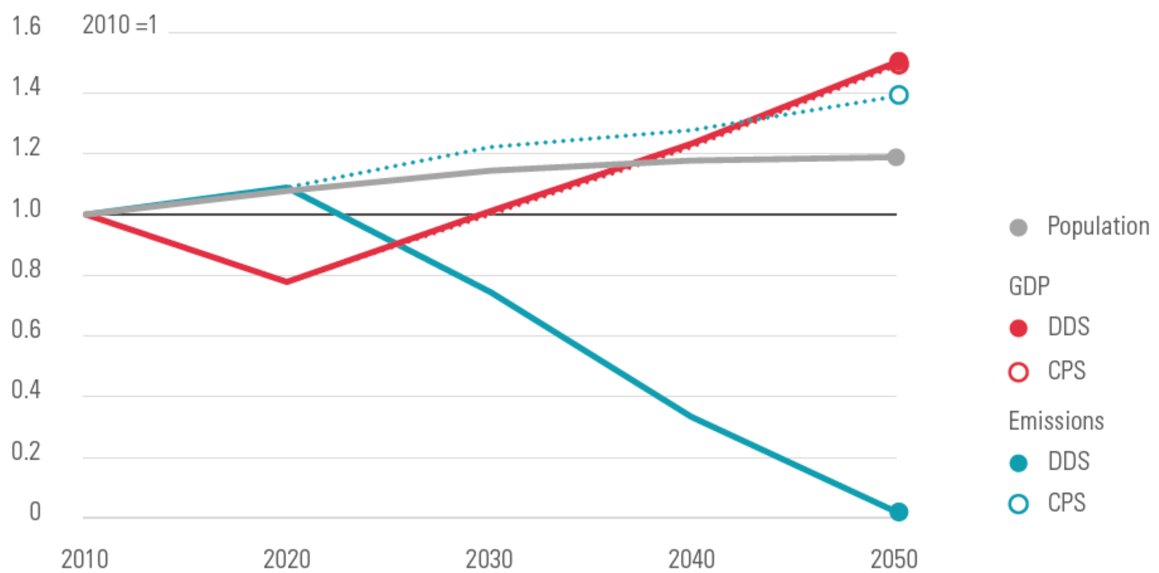
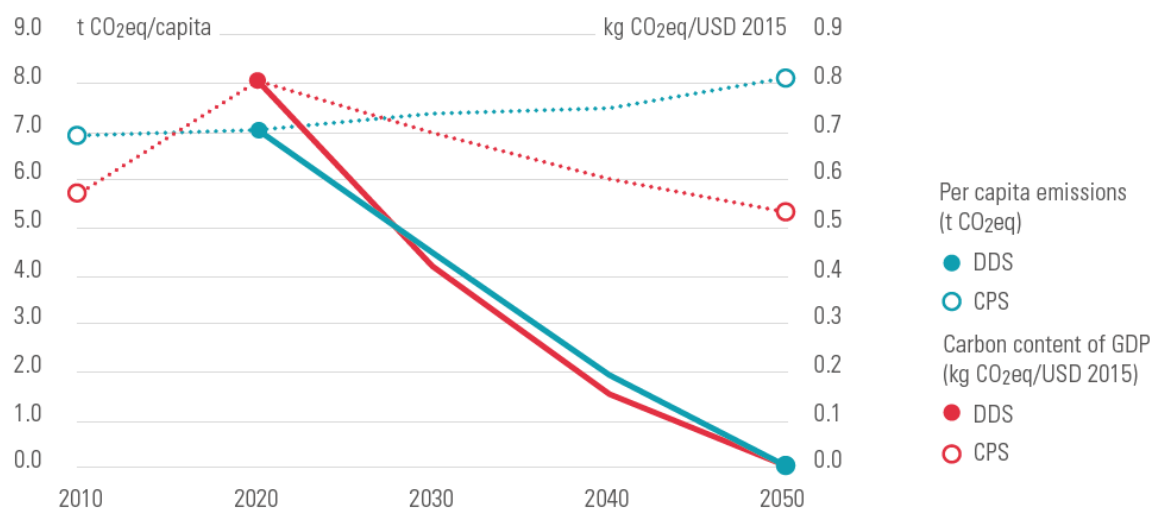


Figure 7. Emissions Intensity per capita and per GDP



3) Analysis of the sectoral tabs of the CTI Imports spreadsheet

This section presents a summary of the input data of the CTI model that were revised by Centro Clima.

Subsections 3.1 to 3.6 summarize the data provided and assess the compatibility of the bottom-up models used by Centro Clima and the CTI model. The data are classified into: Centro Clima Data (provided by Centro Clima), Original data (already in the original CTI spreadsheet), Unidentified data (not found in any database consulted) and Non-pertinent data (not applicable or from unknown origin).

Table 8. Data classification according to the Centro Clima revision

(green)	Centro Clima data
(yellow)	Original data
(orange)	Unidentified data
(red)	Non-pertinent data

There is a set of complete tables in the appendix that mirror the sectoral tabs of the Import worksheet of the CTI model. The colors used according to the table above indicate the classification of the data.

The CTI Import excel file with the revisions provided by Centro Clima accompanies this report. The Input Global Assumption tab displays population and GDP growth estimates used in the DDPBIICS study up to 2050.

3.1 Transport – passenger and freight

3.1.1 Input data summary

The sector is represented by the passenger and freight tabs, with a total of 1,587 variables. Considering both tabs, 90% (1,430) of the input variables were fully provided by Centro Clima (see table 9). The other 10% represents original data that we kept, including some blank values (marked in orange). It is worth mentioning that the blank values represent variables that do not affect the quality of the model results, such as CH_4 and N_2O emissions or last-mile information (incorporated into the 'short-haul' category due to the lack of consistent data at this level of disaggregation in Brazil). Considering only the passenger tab, 94% of the data were fully provided by Centro Clima. This share reaches 86% in the case of the freight input tab. There are no cases of non-relevant variables or not covered by our model (TEMA).

Table 9. Percentage of passenger and freight data provided.

Passenger and Freight Input Tabs

	Centro Clima data	1,430	90%
	Original Data	24	2%
	Unidentified data	133	8%
	Non-pertinent data	0	0%

Passenger Input Tab

	Centro Clima data	719	94%
	Original Data	6	1%
	Unidentified data	37	5%
	Non-pertinent data	0	0%

Freight Input Tab

	Centro Clima data	711	86%
	Original Data	18	2%
	Unidentified data	96	12%
	Non-pertinent data	0	0%

The Transport-Energy-Emissions Multi-Tier Analysis (TEMA) model is used to articulate historical and future transport activity data with the resulting energy use and GHG emissions (Gonçalves et al., 2019; 2020). Fundamentally, the TEMA model considers three fundamental approaches: bottom-up, top-down and Activity-Structure-Intensity-Fuel (ASIF), covering up to 109 technology variations. The joint application of the approaches depends on the availability of local data. In the Brazilian case, a tier 3 bottom-up approach is employed to calculate road transport emissions, since technology-level data is available. Other modes of transport such as air, rail, water (inland navigation and cabotage) and pipelines are estimated using the ASIF approach. A top-down approach is then employed to verify and adjust the results of the other two approaches. Assumptions and hypotheses are defined after intensive literature reviews, interviews, and workshops with stakeholders.

To reduce uncertainty, we provided consistent data from government sources and reference studies, avoiding a large number of different sources. This procedure reduces inconsistencies when comparing, for example, the resulting energy intensity, carbon intensity and transport activity (load factors, p-km, t-km, etc.). Table 10 presents the sources considered to provide the required passenger and freight input data.

Table 10. Summary of data sources

Sheet	Bloc	Comment	Source
Passenger	Activity	For road, rail and active transport (LDV, twow, threew, bus, minibus and rail)	TEMA model (Gonçalves et al., 2019; 2020)
		For and aviation	ANAC (2022)
	Stock	For road transport	TEMA model, MCTI (2020)
	Energy	For road transport	MCTI (2020), EPE (2021)
		For non-road modes	TEMA model, EPE (2021)
	GHG	For CO_2	MCTI (2020)
		For HFC	TEMA model
	Historical outputs	All requested data	ANFAVEA (2022), Embraer (2018)
Freight	Activity	For road transport	TEMA model
		For air, rail, IWW and marine	TEMA model, ANAC (2022), ANTT (2022), ANTAQ (2022)
	Stock	All requested data	MCTI (2020)
	Energy	All requested data	TEMA model, MCTI (2020), EPE (2021)
	GHG	For CO_2	MCTI (2020)
		For HFC	TEMA model

3.1.2 Main points of divergence between models and/or data

The main divergence between both models is the method for estimating prospective scenarios. While the TEMA model estimates the activity, energy and emissions for each year, the CTI model adopts extrapolations, considering a set of curve types, a 'start' year, and an 'end' year. This structural difference between the models is critical, as the CTI model does not allow the introduction and discontinuation of technologies, behavioural changes, and other transformations, when they occur at specific periods in the time horizon.

This is very apparent in the case of the increase or introduction of new blends of biofuels, which in Brazil follows a specific schedule, or the discontinuation of a certain technology at a specific moment in time (for example, vehicles powered by CNG and other fossil fuels). In the CTI model, technological and behavioural changes are distributed over the time horizon based on curves that are not as precise as they would be in a real situation.

Furthermore, the CTI model quantifies and propagates to future estimates the average error identified in the historical period, when comparing input variables from top-down and bottom-up approaches. As the CTI model is structured differently from the TEMA model, it is difficult to set all adjustment factors to 1. For example, in the TEMA model, energy use by technology is very sensitive to the utilization rate (VKT), which is not the case for the CTI model, prioritizing aggregate indicators such as p-km/cap or t-km/GDP. Obtaining equal results from structurally distinct models is a complex task, due to the need to maintain the integrity of the input data. Despite this, we were able to set most variables to 1, leaving others with an error of less than 10%. The propagated error/adjustment factor was then handled by adjusting specific lever variables over successive rounds. As not all sectors were able to reproduce future estimates in the CTI model, the results of the transport scenarios will not be presented. Other specific differences/problems faced are listed in table 11.

Table 11. Specific issues faced when converting data from the TEMA model to the CTI model

	Problem	Solution adopted
1	The CTI model does not consider flexible fuel technologies (FFV) and flexible fuel hybrid vehicles. In Brazil, FFVs represent most of the fleet of automobiles, light commercial vehicles and motorcycles. Such vehicles consume hydrous ethanol and gasoline (the latter, blended with 27% anhydrous ethanol), with different energy efficiencies, significantly impacting the sector's carbon emissions	Allocation of FFVs to the categories "ICE gasoline" and "HV gasoline", considering both historical and future data. To reduce the inaccuracies caused by this problem, adjustments were made to the energy efficiency of "ICE gasoline" and "HV gasoline" vehicles and the share of renewables in gasoline
2	Other technologies are also absent in the CTI, such as: electric freight and passenger locomotives (for non-urban transport); diesel-powered vessels in inland navigation; ships powered by heavy fuel oil in cabotage (marine); and kerosene-powered planes (for passengers and freight transport)	As in the previous solution, adjustments were made to the energy efficiency of each technology; to the share of renewable energy in each fuel and to the emission factors, considering both historical and future data
3	In the CTI model, non-plug-in hybrid vehicles (HEV), in both freight and passenger transport, are considered as zero-emission vehicles, which is not correct, as they consume liquid fuels	Allocation of these vehicles to the "PHEV gasoline" category. Adjustments were also made to the future energy efficiency of PHEV vehicles (as hybrid technology is not relevant in the historical period), as well as the share of gasoline and electricity consumed by these vehicles
4	Only one option to indicate the share of renewables in each fuel is available. In other words, all transport modes will have vehicles/technologies consuming fossil fuels with the same blend ratio (ethanol, biodiesel etc). In Brazil, the percentage of blended biofuels varies significantly between modes of transport. For example, the biodiesel content is historically higher in road and rail modes when compared to inland navigation	Adoption of a common content, equivalent to the real proportion of each biofuel in the transport sector, considering both historical and future data

3.1.3 Suggestions for model improvements

Although we were successful in reproducing our results in the CTI model, the suggestions above would improve compatibility in general, especially when considering models from countries with a strong biofuel market. Our suggestions do not involve changes to the CTI model's logical structure, such as accounting biofuel emissions from end-use sectors or using extrapolations or past-to-future adjustment factors, as they are intrinsic attributes. Therefore, the following suggestions involve specific changes, aiming to expand the possibilities of the CTI model, such as:

- Insertion of the category of "flexible fuel vehicle" (FFV), as well as a variable indicating the share of fuel consumed by these vehicles (for example, share of hydrous ethanol or gasoline).
- Insertion of passenger (for non-urban transport) and freight electric locomotives.
- Insertion of kerosene powered aircraft. The CTI model assumes that all aircraft are gasoline powered (as only smaller aircraft are powered by this fuel).
- Insertion of diesel-powered vessels in inland navigation. The CTI model assumes that all inland navigation vessels are gasoline powered.
- Insertion of heavy fuel oil-powered ships in cabotage/marine. The CTI model assumes that all ships are diesel powered.
- Insertion of other advanced biofuels such as Hydrotreated Vegetable Oil (HVO), Bio-oil and Biokerosene, as they are considered in Brazilian and other countries scenarios.

- Non-plug-in hybrid vehicles (HEV) should emit carbon in the CTI model. Furthermore, the category "flexible fuel hybrid vehicle" should be inserted, powered, for example, by ethanol and gasoline (this technology was implemented in Brazil in 2019 and already represents the largest share). As in the case of FFVs (mentioned above), a variable that indicates the share of fuel consumed by these vehicles should be added.
- The variables that indicate the proportion of renewable energy in each fuel should also indicate the mode of transport (so different modes can have different biofuel contents).

3.1.4 References

ANAC – National Civil Aviation Agency (2022). Data and statistics. Available at: https://www.gov.br/anac/pt-br/assuntos/dados-e-estatisticas. Accessed on 28 April 2022.

ANFAVEA – National Association of Motor Vehicle Manufacturers. (2022). Yearbook of the Brazilian Automobile Industry. Available at: https://anfavea.com.br/site/. Accessed on 28 April 2022.

ANTAQ – National Agency for Waterway Transport (2022). Waterway Statistician. Available at: http://ea.antaq.gov.br/. Accessed on 28 April 2022.

ANTT – National Land Transport Agency (2022). Railway Sector Yearbook. Available at: https://portal.antt.gov.br/anuario-do-setor-ferroviario. Accessed on 28 April 2022.

Embraer (2018). Annual Reports. Available at: https://ri.embraer.com.br/. Accessed on 28 April 2022.

EPE – Energy Research Company (2021). National Energy Balance – 2021. Base Year 2020, Ministry of Mines and Energy, DF, Brazil. Available at: https://www.epe.gov.br. Accessed on 28 April 2022.

Gonçalves, D. N. S., Goes, G. V., Márcio de Almeida, D. A., & de Mello Bandeira, R. A. (2019). Energy use and emissions scenarios for transport to gauge progress toward national commitments. Energy Policy, 135, 110997.

Gonçalves, D. N. S., Goes, G. V., Márcio de Almeida, D. A (2020). Energy transition in Brazil: Paris Agreement compatible scenario for the transport sector up to 2050. Climate Transparency. Available at: https://www.climate-transparency.org/. Accessed on 28 April 2022.

MCTI – Ministry of Science, Technology and Innovations (2020). Brazil's Fourth National Communication to the United Nations Framework Convention on Climate Change (UNFCCC). Available at: https://issuu.com/mctic/docs/quarta_comunicacao_nacional_brasil_unfccc. Accessed on 28 April 2022.

3.2 Industry

3.2.1 Input data summary

The industry worksheet brings together 17 datasets with 797 rows divided into input and calibration data. The tab has been populated with data when available or with estimates where possible. Overall, the industry sheet has a high level of description and breakdown. Data referring to the production of steel and cement are available with greater granularity because they are homogeneous products and a reduced number of production processes. In Brazil, there is only steel production with oxygen and electric furnaces. Thus, no data referring to Hisarna, Hydrogen or DRI was filled in. For cement production, only the dry process is used.

Our data regarding the industry production come from two main sources. The Brazilian Institute of Geography and Statistic (IBGE), a governmental institute that produces the Annual Survey of Industry, and the national associations (Steel and Cement) that also provide data. Energy consumption can be found in the Brazilian National Balance (EPE, 2020). Emissions and some emission factors in the 4th Inventory of Greenhouse gas are published by the Ministry of Science, Technology and Innovation.

Table 12. Percentage of the industry data provided.

	Centro Clima data	142	21.7%
	Original Data	655	78.3%
	Unidentified data	0	0%
	Non-pertinent data	0	0%

Table 13. Summary of data sources

Bloc	Comment	Source
Activity	Only data regarding production of steel, chemical and cement.	Steel production: (IABr, 2021) Cement production: (SNIC, 2019) Chemical production:(IBGE, 2022)
Lifetime	No changes	
Share of regional production	No changes	
Matrix of product composition	No data available for product composition	
Share of recycled historical input	Only steel was changed	(IABr, 2021)
Matrix of technology used per material	Steel: primary is only by Oxygen; Secondary by EAF. Cement: only dry process	IABr, 2021; SNIC, 2019
Matrix of specific consumption per technology and vector	Filled with values for steel, cement, chemical and other industries considering the energy consumption (Brazilian Energy Balance) and the production.	(EPE, 2021; Grottera et al., 2022; IABr, 2021; SNIC, 2019)
Historical share of solid biomass in solid vector	All values are given by the Brazilian Energy Balance	(EPE, 2021)
Emission factors for process	Steel and cement emission factors were calculated considering emissions and production;	(Grottera et al., 2022; MCTIC, 2020)
Electricity consumption of CCS	No changes	
Feedstock per process	Steel, chemical and cement. Considered energy consumption and production.	(EPE, 2021; Grottera et al., 2022; IABr, 2021; SNIC, 2019)

Bloc	Comment	Source
Total amount of material produced	All values filled. Production in Other Industries in Value Added[5]	Steel production: (IABr, 2021) Cement production: (SNIC, 2019) Chemical production:(IBGE, 2022)
Energy per process	All values filled considering the Brazilian Energy Balance	(EPE, 2021)
Emissions per material produced (CO2e)	All values filled considering the National Inventory of greenhouse gas emissions.	(MCTIC, 2020)

3.3.2 Main points of divergence between models and/or data

The Centro Clima model for energy consumption and emissions estimates uses considerably more aggregated data than the CTI model because of the lack of information regarding the Brazilian industry. As in the Brazilian Energy Balance, our model has even industrial segments[6] . For steel and cement emissions and energy consumption, we desegregate production by process step (e.g., raw material preparation) and route (blast furnace and electric arc furnace). However, chemical, and other industries have aggregated estimations based on value added of the sector's level of heterogeneity and the lack of data.

Another difference is the demand in the industry sector. Centro Clima model uses IMACLIM, a CGE model. Industry production is driven by macroeconomic vectors rather than a demand for specific products (houses, roads, cars). Considering the increase in population and the GDP, IMACLIM provides the level of activity of the different economic sectors.

3.3.3 Suggestions for model improvements

To improve the model to better represent Brazil’s industry sector, we suggest considering a simplification in data requirements. First, the high-level detail of the industry sector makes it hard to match and fill values, especially regarding the activity and product composition. The possibility of adapting the level of the model granularity to the available data can improve the model outcomes.

[5] Since there are no available values for Other Industries as requested in the spreadsheet, we used Value Added ($) instead. We adjusted all Other Industries' variables (production, specific consumption, emission factor, etc.) to reflect value-added rather than mass, consistently.

[6] (i) steel, (ii) cement, (iii) chemical, (iv) pulp and paper, (v) food and beverage, (vi) iron alloy, (vii) nonferrous metal, (viii) ceramic, (ix), (x) mining and pelleting (oil production not included), (xi) other industries.

3.3.4 References

EPE. (2021). Balanço Energético Nacional.

Grottera, C., Naspolini, G. F., la Rovere, E. L., Schmitz Gonçalves, D. N., Nogueira, T. de F., Hebeda, O., Dubeux, C. B. S., Goes, G. V., Moreira, M. M. R., Mota da Cruz, G., Gesteira, C. J. M., Wills, W., Castro, G. M., D'Agosto, M. de A., le Treut, G., da Cunha, S. H. F., & Lefèvre, J. (2022). Energy policy implications of carbon pricing scenarios for the Brazilian NDC implementation. Energy Policy, 160(December 2020). https://doi.org/10.1016/j.enpol.2021.112664

IABr. (2021). Brazil Steel Databook 2021.

IBGE. (2022). PIA – Pesquisa Industrial Anual – Produto. https://www.ibge.gov.br/estatisticas/economicas/industria/9044-pesquisa-industrial-anual-produto.html?=&t=o-que-e

MCTIC. (2020). QUARTO INVENTÁRIO NACIONAL DE EMISSÕES E REMOÇÕES ANTRÓPICAS DE GASES DE EFEITO ESTUFA – RELATÓRIO DE REFERÊNCIA SETOR – SETOR DE PROCESSOS INDUSTRIAIS E USO DE PRODUTOS.

SNIC. (2019). Números – Números da indústria. http://snic.org.br/numeros-industria.php

3.4 Residential and Nonresidential

Close to 2/3 of buildings' energy and GHG emissions data required by the spreadsheet is not available in Brazil. This is due to at least two reasons. First, several of the listed technologies, such as district cooling and heat pumps are rarely or never utilized in Brazil. Second, almost no space heating is used in the country and space cooling has been employed in a very irregular way, so that most households and a great proportion of commercial installations lack any air conditioning facility or restrict it to a minor area. Thus, as opposed to non-tropical countries, in Brazil the energy demand of buildings is not clearly correlated to their area, as implied, and data collection on energy use has to be based on other criteria.

Only a small proportion of the required data is promptly available in Brazil, altogether about 4% of what was requested, highlighted in green in the tables below. Additionally, roughly 31% of the data, in orange, might eventually be found in specialized sources or using proxies, and we will have to further research how to get them at the required level of detail. The remaining 65% cannot be obtained, either because the activity/technology is not used in Brazil or because there is no reliable data about it.

Due to the lack of data, our simulations in this sector use an econometric approach correlating some few variables.

Table 14. Percentage of Residential input provided

	Centro Clima data	20	12%
	Original Data	0	
	Unidentified data	0	
	Non-pertinent data	152	88%

Table 15. Percentage of Non- Residential input provided

	Centro Clima data	3	3%
	Original Data	0	
	Unidentified data	0	
	Non-pertinent data	116	97%

3.5 Energy – power and oil & gas

3.5.1 Input data summary

In this section, we present an assessment of historical Energy sectoral data in Brazil (for Input OilGas and Input Power tabs). This assessment is based on information provided by The Energy Research Office (EPE in its Portuguese acronym) that aims to support the Brazilian Ministry of Mines and Energy (MME) energy policies with studies and research on energy planning covering electricity, oil, natural gas and its derivatives and biofuels, and others Brazilian entities such as the ANP (Brazilian National Agency for Petroleum, Natural Gas and Biofuels), MCTIC (Ministry of Science, Technology, Innovation and Communications) and ABEÉolica (Brazilian Association of Wind Energy).

We provided in total 169 rows of variables, considering both tabs: Oil&Gas and Power. In this regard, we were able to fully provide 78% of the inputs (131 variables marked in green). Regarding those marked in red, they are neither covered in our inventories nor available locally (9%, 16 variables marked in red).

Power and Oil & gas Input Tabs:

	Centro Clima data	131	78%
	Original Data	15	9%
	Unidentified data	7	4%
	Non-pertinent data	16	9%

More specifically, 75% of the requested Oil&Gas data (marked in green) was provided (45 out of 60). In the case of Power, we provided 79% (86 out of 109) of the requested data. For 12% of the Oil&Gas (7 out of 60), marked in orange, the original spreadsheed came with blank lines information and remained blank. While 14% of the Power input data (15 out of 109), marked in yellow, remained with the original data from IPCC. Finally, 13% of the requested Oil&Gas inputs and 7% of requested Power inputs were not provided as no local data is available.

Input OilGasTab:

	Centro Clima data	45	75%
	Original Data	0	0%
	Unidentified data	7	12%
	Non-pertinent data**	8	13%

Input PowerTab:

	Centro Clima data	86	79%
	Original Data	15	14%
	Unidentified data	0	0%
	Non-pertinent data	8	7%

3.5.2 Main points of divergence between models and /or data

In our scenarios, to meet the energy demand, energy supply is estimated using the Energy Matrix Model (MATRIZ), an energy flow optimization model developed by CEPEL (Research Center in Electricity), that is conceived as a tool to support long-term energy system expansion planning studies. MATRIZ is a large computational model, based on linear programming, which receives as exogenous input data the evolution during the study period of all different final energy demands, the primary resources availability, as well as the main characteristics and technical data of all energy transformation technologies, obtaining, as a result, the optimal values of annual energy flows corresponding to electricity and fuel production, imports, exports and energy transfers between regions.

The MATRIZ model finds, among the numerous "feasible solutions" to the expansion optimization problem, which solution minimizes the present value of the total cost of investment and operation of the energy system, also known as the "optimal solution". A feasible solution is any supply alternative among different energy sources, capable of attending an energy demand scenario. This solution must satisfy all constraints provided, such as capacity limits of electric power generation sources, minimum and maximum capacity factors by source, transport boundaries between regions, processing capacity and refining profiles of existing and new refineries, limits of processing capacity, import and/or regasification of natural gas, availability of sugarcane bagasse for thermoelectric generation.

However, despite the differences in models, we were able to provide

3.5.3 Suggestions for model improvements

We suggest using different historical period for each metric, because different sectors/metrics have different updated values for more recent years. For example, for power it is possible to have up to date data until 2020, however for other sectors the last year with available information is 2016.

3.5.4 References

All sources are detailed in the annex table.

3.6 AFOLU

3.6.1 Input data summary

This section presents the data assessment provided in the Input AFOLU tab in the Import spreadsheet. The Input AFOLU tab is populated in 337 rows, split into six groups: 1-Food; 2-Land-use; 3-Forestry; 4-Bioenergy; 5-GHG Emission (Lulucf and Agriculture), and 6-Outputs.

Of the total rows, we provided 72 variables data (21% of the total variables), and 265 (79%) remained as in the original version of the CTI spreadsheet (Table 16).

Table 16. Spreadsheet Input AFOLU

	Centro Clima data	72	21%
	Original Data	265	79%
	Unidentified data	0	0%
	Non-pertinent data	0	0%

The AFOLU CTI model has a higher level of data disaggregation compared to the Centro Clima model due to differences in the model's structure. Therefore, most of them has not been altered.

Data source are the Food and Agriculture Statistics (Faostat); Brazilian Institute of Geography and Statistics (IBGE); Centro Clima (2020) – Assumptions based on DDPBIICS Project; Fourth National Communication of Brazil to the United Nations Framework Convention on Climate Change (Brazil, 2021); Brazilian Beef Exporters Association (ABIEC, 2020); Centro Clima (2020) – Estimates from DDPBIICS Project using data from INPE, SEEG, SOS Mata Atlântica; MapBiomas Collection 6 (Mapbiomas, 2020); Centro Clima (2020) – Estimate from DDPBIICS using data from IBGE/PEVS; Brazilian Energy Balance (BEN, EPE); Brazilian Tree Industry (IBÁ); Third National Communication of Brazil to the United Nations Framework Convention on Climate Change (Brazil, 2016)

3.6.2 Main points of divergence between models and/or data

Our production values and area for agriculture and livestock activities are projected until 2050 according to the evolution of the Gross Domestic Product – GDP (macroeconomic modeling), demands from the energy, industry, and transport sectors (sugar, ethanol, biodiesel, firewood, charcoal, and cellulose). We disaggregate crops into sugarcane, maize, soybean, and a group of 14 other crops (cotton, peanuts, rice, oats, rye, barley, peas, broad beans, beans, sunflowers, castor beans, sorghum, wheat and triticale). To estimate the demand for arable land, we use the evolution of crop productivity gains as in the literature. Emissions estimates follow the methodology of the Third National Inventory (Brazil, 2016) in a simplified way. They account for emissions from agricultural soils (nitrogen fertilizers, agricultural residues, animal manure in pastures and organic soils), enteric fermentation, burning of agricultural residues, rice cultivation, manure management and liming (Brazil, 2016).

The CTI model details emissions in greater granularity considering the following sources:

- Emissions from arable land: human crops land, wetland rice for human food, non-food crops, energy crops, rice crops.
- Emissions from Livestock: emissions of land dedicated to livestock (animal grassland, animal crops land, wetland rice for animal food); Emissions of animal food (young beef cattle, old beef cattle, dairy cattle, sheep and goats, pigs, poultry, other animals); Emissions of animal-based food (dairy cattle, laying hens).

Regarding LULUCF, the main important issue is the estimate of deforestation. In the CTI model, the deforested area is estimated from land demand (row 468 AFOLU /CTI Spreadsheet) obtained when accounting for all productive activities carried out on arable land (Human food crops, Animals grassland, animal feeding crops, Forest, Energy crops, Permanent grassland, Non-food crops, Degraded, Delta) (from row 460 to 468 AFOLU /CTI Spreadsheet). However, there is no arable land deficit in the country that justifies deforestation in aggregate terms since land grabbing of public land is the most relevant driver of deforestation in the Amazon region. Therefore, Centro Clima uses exogenously estimated deforestation rates by a backcasting exercise from the future deforestation rate required to achieve net-zero and intermediate targets at some point in time. We consider the success of previous policies in reducing deforestation rates and expert judgment.

Another point to pay attention to is using the concepts of managed and unmanaged[7] surface (lines 198 and 199, Input AFOLU spreadsheet). In the case of Brazil, in addition to emissions and removals associated with land conversion to agriculture, carbon removals by forests and grassland vegetation that occur in protected areas are also accounted in the national inventory. It is the case of Conservation Units (UC) and Indigenous Lands (TI) (MCTI, 2020), where economic activities are restricted by law. So, a share of managed land is assumed to be sequestering carbon without being used for agricultural purposes.

3.6.3 Suggestions for model improvements

- Review the model regarding emissions from deforestation due to the importance of this source in the country.

3.6.4 References

BRASIL (2020). Brazil's Fourth National Communication to the United Nations Framework Convention on Climate Change (UNFCCC). Available at: https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/sirene/publicacoes/comunicacoes-nacionais-do-brasil-a-unfccc

BRASIL (2016). Brazil's Thirty National Communication to the United Nations Framework Convention on Climate Change (UNFCCC). Available at: https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/sirene/publicacoes/comunicacoes-nacionais-do-brasil-a-unfccc

Brazilian Beef Exporters Association (ABIEC, 2021). Available at: http://abiec.com.br/publicacoes/beef-report-2021/

[7] Land where human interventions and practices have been applied to perform production, ecological or social functions (IPCC, 2006, 2019)

Brazilian Energy Balance (BEN, 2021), Available at: https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/balanco-energetico-nacional-2021

Brazilian Institute of Geography and Statistics (IBGE). Sistema IBGE de recuperação Automática – Sidra. Produção Agrícola Municipal. Available at: https://sidra.ibge.gov.br/pesquisa/pam/tabelas

Brazilian Institute of Geography and Statistics (IBGE). Sistema IBGE de recuperação Automática – Sidra. Produção Pecuária Municipal. Available at: https://sidra.ibge.gov.br/pesquisa/ppm/quadros/brasil/2020

Brazilian tree industry (IBÁ). Annual Report (2021). Available at: https://www.iba.org/publicacoes

Map Biomas (2020). Collection 6. Available at: https://mapbiomas.org/

Centro Clima (2020) – Estimates from DDPBIICS Project: AFOLU Sector.

Food and Agriculture Statistics (Faostat). Food and agriculture data. Available at: https://www.fao.org/faostat/en/#data

SEEG – Sistema de Estimativas de Emissões e Remoções de Gases de Efeito Estufa – http://seeg9-brasil-site.herokuapp.com/

3.7 Waste

3.6.1 Input data synthesis

For the waste sector, Centro Clima provided 20 of the 24 variables of the CTI spreadsheet (12 variables for solid waste and 12 for wastewater). Therefore, we could fully provide 83% of the inputs from databases or by simplifying and adapting the existing data. However, three variables were neither covered in our inventories nor available locally (12,5%).

Table 17. Statistics for input waste data of the Import Brazil file.

	Centro Clima data	20	83,3
	Original data	1	4,2
	Unidentified data	3	12,5
	Non-pertinent data	0	0,0

Whenever possible, we provided data from publications. We also provided information from the Centro Clima Model for Waste Management and Emission Estimations. Data regarding solid waste treatment are more abundant than those for wastewater since and can be obtained at the "National Sanitation Information System" – SNIS (MDR, 2021) and the annual "National Basic Sanitation Survey" (PNSB – IBGE, 2020). Emission factors are also available from the 4th Inventory of Greenhouse gas published by the Ministry of Science, Technology and Innovation (MCTI, 2021).

In Brazil, the most used treatment is still landfilling. However, many municipalities (especially small to medium-sized ones) make use of inadequate landfills. Since the approval of the “National Solid Waste Policy” (Brasil, 2010), this situation began to improve, and now, with the “National Solid Waste Plan” – PLANARES (MMA, 2022) and the “National Basic Sanitation Plan” – PLANSAB (MDR, 2021), there are targets for closing inappropriate landfills and expanding the wastewater collection and treatment by 2040. In addition, the plan includes the gradual displacement of the waste mass from landfills to several other forms of biological and thermal treatment and the recovery of biogas from anaerobic processes for energetic purposes in the same horizon.

3.6.2 Main points of divergence in the model and/or data

The “Centro Clima Model for Waste Management and Emission Estimations” follows the 2019 Refinement of the 2006 International Panel on Climate Change Guidelines for National Greenhouse Gas Inventories (IPCC, 2019), using aggregated data due to the lack of information regarding the Brazilian waste management sector.

In the model, solid waste and wastewater are desegregated into landfill, biological and thermal treatments (solid waste) and domestic and industrial wastewater processes (wastewater).

Regarding the data, there is no information on the amount of solid waste that leaves landfills and goes to other treatments, such as recycling, thermal and composting. In practice, landfilling is the last step of the treatment process, so the waste from other treatments is sent to landfills and not the opposite way. Therefore, this information is non-existent (data lines 19, 20, 21).

In respect to the data in lines 24 and 27, the emissions from the organic part of the waste and the total emission from incineration were estimated so that it was possible to calculate the respective emission intensities since there is no information available. Practically 50% of Brazilian waste is organic and dumped directly without pre-treatment in landfills, most of them in inadequate conditions.

Similarly, to data lines 35, 36 and 37, the emission intensities from domestic sewage treatment as a function of the respective BOD loads had to be calculated by dismembering the BOD loads for each volume, therefore: collected and treated, collected and untreated and uncollected. This calculation was direct because our methodology already separates all BOD load into these three groups and then the “collected and treated” group is subdivided into all other forms of domestic treatment, among aerobic and anaerobic plants and septic and rudimentary tanks.

3.6.3 Suggestions for improvements to the model

To improve the model, we suggest adding more treatment options by subsector, for example, co-processing, biological treatment, thermal treatment for solid waste, and biogas use replacing natural gas, either for electricity generation or for energy use.

3.6.4 References

[1] IPCC, 2019. 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Calvo Buendia, E., Tanabe, K., Kranjc, A., Baasansuren, J., Fukuda, M., Ngarize, S., Osako, A., Pyrozhenko, Y., Shermanau, P. and Federici, S. (eds). Published: IPCC, Switzerland.

[2] BRAZIL, 2010. Law No. 12.305, of August 2nd, 2010, establishing the “National Solid Waste Policy”; amends Law No. 9,605, of February 12, 1998; and takes other measures. Official Gazette of the Union, Executive Power, Brasília, DF, August 3rd, 2010.

[3] BRAZILIAN INSTITUTE OF GEOGRAPHY AND STATISTICS. National Basic Sanitation Survey 2017: water supply and sanitary sewage / IBGE, Coordination of Population and Social Indicators. – Rio de Janeiro: IBGE, 2020. 124 p.: il.Includes bibliography and glossary.ISBN 978-65-87201-11-5

[4] CENTRO CLIMA, 2021. Economic and Social Implications of a Development Strategy Based on a More Ambitious NDCfor Brazil by 2030, La Rovere, E.L., Wills, W., Dubeux, C.B.S., D'Agosto, M., Schmitz, D., Goes, G.V., Naspolini, G., Walter, M.C.L., Hebeda, O., Guimarães, B.S., Nogueira, E.C., Gesteira, C., Westin, F., Cunha, S.H.F., Loureiro, S.M. and Lima, I.M. In: Climate and Development. Visions for Brazil 2030. Climate Policy and Scenarios Document. Rio de Janeiro: Center for Integrated Studies on Climate Change and the Environment, COPPE, UFRJ, 2021.

[5] MINISTRY OF REGIONAL DEVELOPMENT. National Secretary of Sanitation. National Basic Sanitation Plan – PLANSAB. Annual Assessment Report. Brasilia DF:MDR, 2021. Apr. 141 pp.

[6] MINISTRY OF REGIONAL DEVELOPMENT. National Sanitation Information System – SNIS 2021 Diagnoses. Brasília, DF: MDR, 2022. National Sanitation Department.Access Mode: www.snis.gov.br (online).

[7] MINISTRY OF SCIENCE, TECHNOLOGY AND INNOVATIONS. Secretary of Research and Scientific Training. Fourth National Communication from Brazil to the United Nations Framework Convention on Climate Change / Secretariat for Research and Scientific Training. – Brasília: MCTI, 2021. 620 p.: iL. ISBN: 978-65-87432-18-2.

[8] MINISTRY OF THE ENVIRONMENT. Department of Environmental Quality. National Solid Waste Plan – PLANARES [electronic resource] /coordination of André Luiz Felisberto França... [et. al.]. – Brasilia DF: MMA, 2022. 209 p. : il. ; color. Access Mode: World Wide WebISBN 978-65-88265-15-4 (online).

Appendix

Transport

Passenger Input Tab

Row	Bloc	Sector/Technology	Unit	Source
2	**0. Required inputs & assumptions**			
3	**1. Activity**			
4		Demand per capita	K pkm/capita	TEMA model
5				
6		Uban share of total demand	%	TEMA model
7				
8	**1.A. Urban**			
9	**Modal share**	LDV	%	TEMA model
10		TwoW	%	TEMA model
11		ThreeW	%	TEMA model
12		Bike	%	TEMA model
13		Walk	%	TEMA model
14		Bus	%	TEMA model
15		Minibus	%	TEMA model
16		Rail	%	TEMA model
17				
18	**Occupation rates**	Bus	pkm/vkm	TEMA model
19		Minibus	pkm/vkm	TEMA model
20		TwoW	pkm/vkm	TEMA model
21		ThreeW	pkm/vkm	TEMA model
22		LDV	pkm/vkm	TEMA model
23				
24	Vkm demand per mode	Bus	G vkm	4th National Communication
25		Minibus	G vkm	4th National Communication
26		TwoW	G vkm	4th National Communication
27		ThreeW	G vkm	4th National Communication
28		LDV	G vkm	4th National Communication
29				
30	Passenger demand per mode	Bike	G pkm	TEMA model
31		Walk	G pkm	TEMA model
32		Rail	G pkm	TEMA model
33				
34	**1.B. Non-urban**			
35	**Aviation share**	Short haul	%	ANAC
36				

Row	Bloc	Sector/Technology	Unit	Source
37	**Modal share**	LDV	%	TEMA model
38		TwoW	%	TEMA model
39		ThreeW	%	TEMA model
40		Bike	%	TEMA model
41		Walk	%	TEMA model
42		Bus	%	TEMA model
43		Minibus	%	TEMA model
44		Rail	%	TEMA model
45		Aviation	%	TEMA model
46				
47	**Occupation rates**	Bus	pkm/vkm	TEMA model
48		Minibus	pkm/vkm	TEMA model
49		TwoW	pkm/vkm	TEMA model
50		ThreeW	pkm/vkm	TEMA model
51		LDV	pkm/vkm	TEMA model
52				
53	**Long-haul aviation**	Demand per capita	K km/capita	ANAC
54				
55	Vkm demand per mode	Bus	G vkm	4th National Communication
56		Minibus	G vkm	4th National Communication
57		TwoW	G vkm	4th National Communication
58		ThreeW	G vkm	4th National Communication
59		LDV	G vkm	4th National Communication
60				
61	Passenger demand per mode	Bike	G pkm	TEMA model
62		Walk	G pkm	TEMA model
63		Rail	G pkm	TEMA model
64		ShortHaul AND LongHaul	G pkm	TEMA model
65				
66	**2. Stock**			
67	**2.A. Urban**			
68	**Amount of vehicles**	Bus	K veh	TEMA model
69		Minibus	K veh	TEMA model
70		TwoW	K veh	TEMA model
71		ThreeW	K veh	TEMA model
72		LDV	K veh	TEMA model
73				
74	**Train**	Constant utilization rate (of base year)	M pkm/veh	user choice
75		Constant renewal rate (of base year)	%	user choice
76				

Row	Bloc	Sector/Technology	Unit	Source
77	**Bike**	Constant utilization rate (of base year)	M pkm/veh	user choice
78		Constant renewal rate (of base year)	%	user choice
79				
80	**Utilization Rate**	Bus	vkm/veh	4th National Communication
81		Minibus	vkm/veh	4th National Communication
82		TwoW	vkm/veh	4th National Communication
83		ThreeW	vkm/veh	4th National Communication
84		LDV	vkm/veh	4th National Communication
85	**Life distance**			
86	**Lifedistance of the fleet**	Bus – ICE diesel	K km	4th National Communication
87		Bus – ICE gas	K km	4th National Communication
88		Bus – ICE gasoline	K km	
89		Bus – BEV	K km	4th National Communication
90		Bus – FCEV	K km	4th National Communication
91		Bus – PHEV diesel	K km	4th National Communication
92		Bus – PHEV gasoline	K km	4th National Communication
93		Bus – HV diesel	K km	4th National Communication
94		Bus – HV gasoline	K km	4th National Communication
95				
96		Minibus – ICE diesel	K km	4th National Communication
97		Minibus – ICE gas	K km	4th National Communication
98		Minibus – ICE gasoline	K km	
99		Minibus – BEV	K km	4th National Communication
100		Minibus – FCEV	K km	4th National Communication
101		Minibus – PHEV diesel	K km	4th National Communication
102		Minibus – PHEV gasoline	K km	4th National Communication
103		Minibus – HV diesel	K km	4th National Communication
104		Minibus – HV gasoline	K km	4th National Communication
105				
106		TwoW – ICE diesel	K km	4th National Communication
107		TwoW – ICE gas	K km	4th National Communication
108		TwoW – ICE gasoline	K km	4th National Communication
109		TwoW – BEV	K km	4th National Communication
110		TwoW – FCEV	K km	4th National Communication
111		TwoW – HV diesel	K km	4th National Communication
112		TwoW – HV gasoline	K km	4th National Communication
113				
114		ThreeW – ICE diesel	K km	
115		ThreeW – ICE gas	K km	
116		ThreeW – ICE gasoline	K km	Assumption
117		ThreeW – BEV	K km	Assumption

Row	Bloc	Sector/Technology	Unit	Source
118		ThreeW – FCEV	K km	Assumption
119		ThreeW – HV diesel	K km	Assumption
120		ThreeW – HV gasoline	K km	Assumption
121				
122		LDV – ICE diesel	K km	4th National Communication
123		LDV – ICE gas	K km	4th National Communication
124		LDV – ICE gasoline	K km	4th National Communication
125		LDV – BEV	K km	4th National Communication
126		LDV – FCEV	K km	4th National Communication
127		LDV – PHEV diesel	K km	4th National Communication
128		LDV – PHEV gasoline	K km	4th National Communication
129		LDV – HV diesel	K km	4th National Communication
130		LDV – HV gasoline	K km	4th National Communication
131				
132	**Lifedistance of new vehicles**	Bus – ICE diesel	K km	4th National Communication
133		Bus – ICE gas	K km	4th National Communication
134		Bus – ICE gasoline	K km	
135		Bus – BEV	K km	4th National Communication
136		Bus – FCEV	K km	4th National Communication
137		Bus – PHEV diesel	K km	4th National Communication
138		Bus – PHEV gasoline	K km	4th National Communication
139		Bus – HV diesel	K km	4th National Communication
140		Bus – HV gasoline	K km	4th National Communication
141				
142		Minibus – ICE diesel	K km	4th National Communication
143		Minibus – ICE gas	K km	4th National Communication
144		Minibus – ICE gasoline	K km	
145		Minibus – BEV	K km	4th National Communication
146		Minibus – FCEV	K km	4th National Communication
147		Minibus – PHEV diesel	K km	4th National Communication
148		Minibus – PHEV gasoline	K km	4th National Communication
149		Minibus – HV diesel	K km	4th National Communication
150		Minibus – HV gasoline	K km	4th National Communication
151				
152		TwoW – ICE diesel	K km	
153		TwoW – ICE gas	K km	
154		TwoW – ICE gasoline	K km	4th National Communication
155		TwoW – BEV	K km	4th National Communication
156		TwoW – FCEV	K km	4th National Communication
157		TwoW – HV diesel	K km	4th National Communication
158		TwoW – HV gasoline	K km	4th National Communication
159				

Row	Bloc	Sector/Technology	Unit	Source
160		ThreeW – ICE diesel	K km	
161		ThreeW – ICE gas	K km	
162		ThreeW – ICE gasoline	K km	Assumption
163		ThreeW – BEV	K km	Assumption
164		ThreeW – FCEV	K km	Assumption
165		ThreeW – HV diesel	K km	Assumption
166		ThreeW – HV gasoline	K km	Assumption
167				
168		LDV – ICE diesel	K km	4th National Communication
169		LDV – ICE gas	K km	4th National Communication
170		LDV – ICE gasoline	K km	4th National Communication
171		LDV – BEV	K km	4th National Communication
172		LDV – FCEV	K km	4th National Communication
173		LDV – PHEV diesel	K km	4th National Communication
174		LDV – PHEV gasoline	K km	4th National Communication
175		LDV – HV diesel	K km	4th National Communication
176		LDV – HV gasoline	K km	4th National Communication
177	**Technology shares**			
178	**Technology of the fleet**	Bus – ICE diesel	%	TEMA model
179		Bus – ICE gas	%	TEMA model
180		Bus – ICE gasoline	%	TEMA model
181		Bus – BEV	%	TEMA model
182		Bus – FCEV	%	TEMA model
183		Bus – PHEV diesel	%	TEMA model
184		Bus – PHEV gasoline	%	TEMA model
185		Bus – HV diesel	%	TEMA model
186		Bus – HV gasoline	%	TEMA model
187				
188		Minibus – ICE diesel	%	TEMA model
189		Minibus – ICE gas	%	TEMA model
190		Minibus – ICE gasoline	%	TEMA model
191		Minibus – BEV	%	TEMA model
192		Minibus – FCEV	%	TEMA model
193		Minibus – PHEV diesel	%	TEMA model
194		Minibus – PHEV gasoline	%	TEMA model
195		Minibus – HV diesel	%	TEMA model
196		Minibus – HV gasoline	%	TEMA model
197				
198		TwoW – ICE diesel	%	TEMA model
199		TwoW – ICE gas	%	TEMA model
200		TwoW – ICE gasoline	%	TEMA model
201		TwoW – BEV	%	TEMA model

Row	Bloc	Sector/Technology	Unit	Source
202		TwoW – FCEV	%	TEMA model
203		TwoW – HV diesel	%	TEMA model
204		TwoW – HV gasoline	%	TEMA model
205				
206		ThreeW – ICE diesel	%	TEMA model
207		ThreeW – ICE gas	%	TEMA model
208		ThreeW – ICE gasoline	%	TEMA model
209		ThreeW – BEV	%	TEMA model
210		ThreeW – FCEV	%	TEMA model
211		ThreeW – HV diesel	%	TEMA model
212		ThreeW – HV gasoline	%	TEMA model
213				
214		LDV – ICE diesel	%	TEMA model
215		LDV – ICE gas	%	TEMA model
216		LDV – ICE gasoline	%	TEMA model
217		LDV – BEV	%	TEMA model
218		LDV – FCEV	%	TEMA model
219		LDV – PHEV diesel	%	TEMA model
220		LDV – PHEV gasoline	%	TEMA model
221		LDV – HV diesel	%	TEMA model
222		LDV – HV gasoline	%	TEMA model
223				
224		Train – ICE diesel	%	TEMA model
225		Train – ICE gas	%	TEMA model
226		Train – ICE gasoline	%	TEMA model
227		Train – BEV	%	TEMA model
228		Train – FCEV	%	TEMA model
229				
230		Bike – Electric	%	TEMA model
231		Bike – Non-electric	%	TEMA model
232				
233	**Technology of new vehicles**	Bus – ICE diesel	%	TEMA model
234		Bus – ICE gas	%	TEMA model
235		Bus – ICE gasoline	%	TEMA model
236		Bus – BEV	%	TEMA model
237		Bus – FCEV	%	TEMA model
238		Bus – PHEV diesel	%	TEMA model
239		Bus – PHEV gasoline	%	TEMA model
240		Bus – HV diesel	%	TEMA model
241		Bus – HV gasoline	%	TEMA model
242				
243		Minibus – ICE diesel	%	TEMA model

Row	Bloc	Sector/Technology	Unit	Source
244		Minibus – ICE gas	%	TEMA model
245		Minibus – ICE gasoline	%	TEMA model
246		Minibus – BEV	%	TEMA model
247		Minibus – FCEV	%	TEMA model
248		Minibus – PHEV diesel	%	TEMA model
249		Minibus – PHEV gasoline	%	TEMA model
250		Minibus – HV diesel	%	TEMA model
251		Minibus – HV gasoline	%	TEMA model
252				
253		TwoW – ICE diesel	%	TEMA model
254		TwoW – ICE gas	%	TEMA model
255		TwoW – ICE gasoline	%	TEMA model
256		TwoW – BEV	%	TEMA model
257		TwoW – FCEV	%	TEMA model
258		TwoW – HV diesel	%	TEMA model
259		TwoW – HV gasoline	%	TEMA model
260				
261		ThreeW – ICE diesel	%	TEMA model
262		ThreeW – ICE gas	%	TEMA model
263		ThreeW – ICE gasoline	%	TEMA model
264		ThreeW – BEV	%	TEMA model
265		ThreeW – FCEV	%	TEMA model
266		ThreeW – HV diesel	%	TEMA model
267		ThreeW – HV gasoline	%	TEMA model
268				
269		LDV – ICE diesel	%	TEMA model
270		LDV – ICE gas	%	TEMA model
271		LDV – ICE gasoline	%	TEMA model
272		LDV – BEV	%	TEMA model
273		LDV – FCEV	%	TEMA model
274		LDV – PHEV diesel	%	TEMA model
275		LDV – PHEV gasoline	%	TEMA model
276		LDV – HV diesel	%	TEMA model
277		LDV – HV gasoline	%	TEMA model
278				
279		Train – ICE diesel	%	TEMA model
280		Train – ICE gas	%	TEMA model
281		Train – ICE gasoline	%	TEMA model
282		Train – BEV	%	TEMA model
283		Train – FCEV	%	TEMA model
284				
285		Bike – Electric	%	TEMA model

Row	Bloc	Sector/Technology	Unit	Source
286		Bike – Non-electric	%	TEMA model
287	**Efficiency**			
288	**Efficiency of the fleet**	Bus – ICE diesel	kWh/vkm	4th National Communication
289		Bus – ICE gas	kWh/vkm	
290		Bus – ICE gasoline	kWh/vkm	
291		Bus – BEV	kWh/vkm	
292		Bus – FCEV	kWh/vkm	
293		Bus – PHEV diesel	kWh/vkm	
294		Bus – PHEV gasoline	kWh/vkm	
295		Bus – HV diesel	kWh/vkm	
296		Bus – HV gasoline	kWh/vkm	
297				
298		Minibus – ICE diesel	kWh/vkm	4th National Communication
299		Minibus – ICE gas	kWh/vkm	
300		Minibus – ICE gasoline	kWh/vkm	
301		Minibus – BEV	kWh/vkm	TEMA model
302		Minibus – FCEV	kWh/vkm	
303		Minibus – PHEV diesel	kWh/vkm	
304		Minibus – PHEV gasoline	kWh/vkm	
305		Minibus – HV diesel	kWh/vkm	
306		Minibus – HV gasoline	kWh/vkm	
307				
308		LDV – ICE diesel	kWh/vkm	4th National Communication
309		LDV – ICE gas	kWh/vkm	4th National Communication
310		LDV – ICE gasoline	kWh/vkm	4th National Communication
311		LDV – BEV	kWh/vkm	TEMA model
312		LDV – FCEV	kWh/vkm	
313		LDV – PHEV diesel	kWh/vkm	
314		LDV – PHEV gasoline	kWh/vkm	
315		LDV – HV diesel	kWh/vkm	
316		LDV – HV gasoline	kWh/vkm	
317				
318		TwoW – ICE diesel	kWh/vkm	
319		TwoW – ICE gas	kWh/vkm	
320		TwoW – ICE gasoline	kWh/vkm	4th National Communication
321		TwoW – BEV	kWh/vkm	TEMA model
322		TwoW – FCEV	kWh/vkm	
323		TwoW – HV diesel	kWh/vkm	
324		TwoW – HV gasoline	kWh/vkm	
325				
326		ThreeW – ICE diesel	kWh/vkm	
327		ThreeW – ICE gas	kWh/vkm	

Row	Bloc	Sector/Technology	Unit	Source
328		ThreeW – ICE gasoline	kWh/vkm	4th National Communication
329		ThreeW – BEV	kWh/vkm	TEMA model
330		ThreeW – FCEV	kWh/vkm	
331		ThreeW – HV diesel	kWh/vkm	
332		ThreeW – HV gasoline	kWh/vkm	
333				
334		Train – ICE diesel	kWh/pkm	
335		Train – ICE gas	kWh/pkm	
336		Train – ICE gasoline	kWh/pkm	
337		Train – BEV	kWh/pkm	TEMA model
338		Train – FCEV	kWh/pkm	
339				
340		Bike – Electric	kWh/pkm	TEMA model
341		Bike – Non-electric	kWh/pkm	
342				
343		Bus – ICE diesel	kWh/vkm	4th National Communication
344		Bus – ICE gas	kWh/vkm	
345		Bus – ICE gasoline	kWh/vkm	
346		Bus – BEV	kWh/vkm	
347		Bus – FCEV	kWh/vkm	
348		Bus – PHEV diesel	kWh/vkm	
349		Bus – PHEV gasoline	kWh/vkm	
350		Bus – HV diesel	kWh/vkm	
351		Bus – HV gasoline	kWh/vkm	
352				
353		Minibus – ICE diesel	kWh/vkm	4th National Communication
354		Minibus – ICE gas	kWh/vkm	
355		Minibus – ICE gasoline	kWh/vkm	
356		Minibus – BEV	kWh/vkm	
357		Minibus – FCEV	kWh/vkm	
358		Minibus – PHEV diesel	kWh/vkm	
359		Minibus – PHEV gasoline	kWh/vkm	
360		Minibus – HV diesel	kWh/vkm	
361		Minibus – HV gasoline	kWh/vkm	
362				
363		LDV – ICE diesel	kWh/vkm	4th National Communication
364		LDV – ICE gas	kWh/vkm	4th National Communication
365		LDV – ICE gasoline	kWh/vkm	4th National Communication
366		LDV – BEV	kWh/vkm	TEMA model
367		LDV – FCEV	kWh/vkm	
368		LDV – PHEV diesel	kWh/vkm	
369		LDV – PHEV gasoline	kWh/vkm	

Row	Bloc	Sector/Technology	Unit	Source
370		LDV – HV diesel	kWh/vkm	
371		LDV – HV gasoline	kWh/vkm	TEMA model
372				
373		TwoW – ICE diesel	kWh/vkm	
374		TwoW – ICE gas	kWh/vkm	
375		TwoW – ICE gasoline	kWh/vkm	4th National Communication
376		TwoW – BEV	kWh/vkm	TEMA model
377		TwoW – FCEV	kWh/vkm	
378		TwoW – HV diesel	kWh/vkm	
379		TwoW – HV gasoline	kWh/vkm	
380				
381		ThreeW – ICE diesel	kWh/vkm	
382		ThreeW – ICE gas	kWh/vkm	
383		ThreeW – ICE gasoline	kWh/vkm	4th National Communication
384		ThreeW – BEV	kWh/vkm	TEMA model
385		ThreeW – FCEV	kWh/vkm	
386		ThreeW – HV diesel	kWh/vkm	
387		ThreeW – HV gasoline	kWh/vkm	
388				
389		Train – ICE diesel	kWh/pkm	
390		Train – ICE gas	kWh/pkm	
391		Train – ICE gasoline	kWh/pkm	
392		Train – BEV	kWh/pkm	TEMA model
393		Train – FCEV	kWh/pkm	
394				
395		Bike – Electric	kWh/pkm	TEMA model
396		Bike – Non-electric	kWh/pkm	
397	**2.B. Non-urban**			
398	**Amount of vehicles**	Bus	K veh	TEMA model
399		Minibus	K veh	TEMA model
400		TwoW	K veh	TEMA model
401		ThreeW	K veh	TEMA model
402		LDV	K veh	TEMA model
403				
404	**Train**	Constant utilization rate (of base year)	M pkm/veh	user choice
405		Constant renewal rate (of base year)	%	user choice
406				
407	**ShortHaul**	Constant utilization rate (of base year)	M pkm/veh	user choice
408		Constant renewal rate (of base year)	%	user choice
409				

Row	Bloc	Sector/Technology	Unit	Source
410	**Aviation**	Constant utilization rate (of base year)	M pkm/veh	user choice
411		Constant renewal rate (of base year)	%	user choice
412				
413	**Bike**	Constant utilization rate (of base year)	M pkm/veh	user choice
414		Constant renewal rate (of base year)	%	user choice
415				
416	**Utilization Rate**	Bus	vkm/veh	TEMA model
417		Minibus	vkm/veh	TEMA model
418		TwoW	vkm/veh	TEMA model
419		ThreeW	vkm/veh	TEMA model
420		LDV	vkm/veh	TEMA model
421	**Life-distance**			
422	**Lifedistance of the fleet**	Bus – ICE diesel	K km	4th National Communication
423		Bus – ICE gas	K km	4th National Communication
424		Bus – ICE gasoline	K km	
425		Bus – BEV	K km	4th National Communication
426		Bus – FCEV	K km	4th National Communication
427		Bus – PHEV diesel	K km	4th National Communication
428		Bus – PHEV gasoline	K km	4th National Communication
429		Bus – HV diesel	K km	4th National Communication
430		Bus – HV gasoline	K km	4th National Communication
431				
432		Minibus – ICE diesel	K km	4th National Communication
433		Minibus – ICE gas	K km	4th National Communication
434		Minibus – ICE gasoline	K km	
435		Minibus – BEV	K km	4th National Communication
436		Minibus – FCEV	K km	4th National Communication
437		Minibus – PHEV diesel	K km	4th National Communication
438		Minibus – PHEV gasoline	K km	4th National Communication
439		Minibus – HV diesel	K km	4th National Communication
440		Minibus – HV gasoline	K km	4th National Communication
441				
442		LDV – ICE diesel	K km	4th National Communication
443		LDV – ICE gas	K km	4th National Communication
444		LDV – ICE gasoline	K km	4th National Communication
445		LDV – BEV	K km	4th National Communication
446		LDV – FCEV	K km	4th National Communication
447		LDV – PHEV diesel	K km	4th National Communication
448		LDV – PHEV gasoline	K km	4th National Communication
449		LDV – HV diesel	K km	4th National Communication

Row	Bloc	Sector/Technology	Unit	Source
450		LDV – HV gasoline	K km	4th National Communication
451				
452		TwoW – ICE diesel	K km	
453		TwoW – ICE gas	K km	
454		TwoW – ICE gasoline	K km	4th National Communication
455		TwoW – BEV	K km	4th National Communication
456		TwoW – FCEV	K km	4th National Communication
457		TwoW – HV diesel	K km	4th National Communication
458		TwoW – HV gasoline	K km	4th National Communication
459				
460		ThreeW – ICE diesel	K km	
461		ThreeW – ICE gas	K km	
462		ThreeW – ICE gasoline	K km	Assumption
463		ThreeW – BEV	K km	Assumption
464		ThreeW – FCEV	K km	Assumption
465		ThreeW – HV diesel	K km	Assumption
466		ThreeW – HV gasoline	K km	Assumption
467				
468	**Lifedistance of new vehicles**	Bus – ICE diesel	K km	4th National Communication
469		Bus – ICE gas	K km	4th National Communication
470		Bus – ICE gasoline	K km	
471		Bus – BEV	K km	4th National Communication
472		Bus – FCEV	K km	4th National Communication
473		Bus – PHEV diesel	K km	4th National Communication
474		Bus – PHEV gasoline	K km	4th National Communication
475		Bus – HV diesel	K km	4th National Communication
476		Bus – HV gasoline	K km	4th National Communication
477				
478		Minibus – ICE diesel	K km	4th National Communication
479		Minibus – ICE gas	K km	4th National Communication
480		Minibus – ICE gasoline	K km	
481		Minibus – BEV	K km	4th National Communication
482		Minibus – FCEV	K km	4th National Communication
483		Minibus – PHEV diesel	K km	4th National Communication
484		Minibus – PHEV gasoline	K km	4th National Communication
485		Minibus – HV diesel	K km	4th National Communication
486		Minibus – HV gasoline	K km	4th National Communication
487				
488		LDV – ICE diesel	K km	4th National Communication
489		LDV – ICE gas	K km	4th National Communication
490		LDV – ICE gasoline	K km	4th National Communication
491		LDV – BEV	K km	4th National Communication

Row	Bloc	Sector/Technology	Unit	Source
492		LDV – FCEV	K km	4th National Communication
493		LDV – PHEV diesel	K km	4th National Communication
494		LDV – PHEV gasoline	K km	4th National Communication
495		LDV – HV diesel	K km	4th National Communication
496		LDV – HV gasoline	K km	4th National Communication
497				
498		TwoW – ICE diesel	K km	
499		TwoW – ICE gas	K km	
500		TwoW – ICE gasoline	K km	4th National Communication
501		TwoW – BEV	K km	4th National Communication
502		TwoW – FCEV	K km	4th National Communication
503		TwoW – HV diesel	K km	4th National Communication
504		TwoW – HV gasoline	K km	4th National Communication
505				
506		ThreeW – ICE diesel	K km	
507		ThreeW – ICE gas	K km	
508		ThreeW – ICE gasoline	K km	Assumption
509		ThreeW – BEV	K km	Assumption
510		ThreeW – FCEV	K km	Assumption
511		ThreeW – HV diesel	K km	Assumption
512		ThreeW – HV gasoline	K km	Assumption
513	**Technology share**			
514	**Technology of the fleet**	Bus – ICE diesel	%	TEMA model
515		Bus – ICE gas	%	TEMA model
516		Bus – ICE gasoline	%	TEMA model
517		Bus – BEV	%	TEMA model
518		Bus – FCEV	%	TEMA model
519		Bus – PHEV diesel	%	TEMA model
520		Bus – PHEV gasoline	%	TEMA model
521		Bus – HV diesel	%	TEMA model
522		Bus – HV gasoline	%	TEMA model
523				
524		Minibus – ICE diesel	%	TEMA model
525		Minibus – ICE gas	%	TEMA model
526		Minibus – ICE gasoline	%	TEMA model
527		Minibus – BEV	%	TEMA model
528		Minibus – FCEV	%	TEMA model
529		Minibus – PHEV diesel	%	TEMA model
530		Minibus – PHEV gasoline	%	TEMA model
531		Minibus – HV diesel	%	TEMA model
532		Minibus – HV gasoline	%	TEMA model
533				

Row	Bloc	Sector/Technology	Unit	Source
534		LDV – ICE diesel	%	TEMA model
535		LDV – ICE gas	%	TEMA model
536		LDV – ICE gasoline	%	TEMA model
537		LDV – BEV	%	TEMA model
538		LDV – FCEV	%	TEMA model
539		LDV – PHEV diesel	%	TEMA model
540		LDV – PHEV gasoline	%	TEMA model
541		LDV – HV diesel	%	TEMA model
542		LDV – HV gasoline	%	TEMA model
543				
544		TwoW – ICE diesel	%	TEMA model
545		TwoW – ICE gas	%	TEMA model
546		TwoW – ICE gasoline	%	TEMA model
547		TwoW – BEV	%	TEMA model
548		TwoW – FCEV	%	TEMA model
549		TwoW – HV diesel	%	TEMA model
550		TwoW – HV gasoline	%	TEMA model
551				
552		ThreeW – ICE diesel	%	TEMA model
553		ThreeW – ICE gas	%	TEMA model
554		ThreeW – ICE gasoline	%	TEMA model
555		ThreeW – BEV	%	TEMA model
556		ThreeW – FCEV	%	TEMA model
557		ThreeW – HV diesel	%	TEMA model
558		ThreeW – HV gasoline	%	TEMA model
559				
560		Train – ICE diesel	%	TEMA model
561		Train – ICE gas	%	TEMA model
562		Train – ICE gasoline	%	TEMA model
563		Train – CE	%	TEMA model
564		Train – FCEV	%	TEMA model
565				
566		Short haul – ICE	%	TEMA model
567		Short haul – BEV	%	TEMA model
568				
569		Bike – Electric	%	TEMA model
570		Bike – Non-electric	%	TEMA model
571				
572		Long haul – ICE	%	TEMA model
573		Long haul – BEV	%	TEMA model
574				
575	**Technology of new vehicles**	Bus – ICE diesel	%	TEMA model

Row	Bloc	Sector/Technology	Unit	Source
576		Bus – ICE gas	%	TEMA model
577		Bus – ICE gasoline	%	TEMA model
578		Bus – BEV	%	TEMA model
579		Bus – FCEV	%	TEMA model
580		Bus – PHEV diesel	%	TEMA model
581		Bus – PHEV gasoline	%	TEMA model
582		Bus – HV diesel	%	TEMA model
583		Bus – HV gasoline	%	TEMA model
584				
585		Minibus – ICE diesel	%	TEMA model
586		Minibus – ICE gas	%	TEMA model
587		Minibus – ICE gasoline	%	TEMA model
588		Minibus – BEV	%	TEMA model
589		Minibus – FCEV	%	TEMA model
590		Minibus – PHEV diesel	%	TEMA model
591		Minibus – PHEV gasoline	%	TEMA model
592		Minibus – HV diesel	%	TEMA model
593		Minibus – HV gasoline	%	TEMA model
594				
595		LDV – ICE diesel	%	TEMA model
596		LDV – ICE gas	%	TEMA model
597		LDV – ICE gasoline	%	TEMA model
598		LDV – BEV	%	TEMA model
599		LDV – FCEV	%	TEMA model
600		LDV – PHEV diesel	%	TEMA model
601		LDV – PHEV gasoline	%	TEMA model
602		LDV – HV diesel	%	TEMA model
603		LDV – HV gasoline	%	TEMA model
604				
605		TwoW – ICE diesel	%	TEMA model
606		TwoW – ICE gas	%	TEMA model
607		TwoW – ICE gasoline	%	TEMA model
608		TwoW – BEV	%	TEMA model
609		TwoW – FCEV	%	TEMA model
610		TwoW – HV diesel	%	TEMA model
611		TwoW – HV gasoline	%	TEMA model
612				
613		ThreeW – ICE diesel	%	TEMA model
614		ThreeW – ICE gas	%	TEMA model
615		ThreeW – ICE gasoline	%	TEMA model
616		ThreeW – BEV	%	TEMA model
617		ThreeW – FCEV	%	TEMA model

Row	Bloc	Sector/Technology	Unit	Source
618		ThreeW – HV diesel	%	TEMA model
619		ThreeW – HV gasoline	%	TEMA model
620				
621		Train – ICE diesel	%	TEMA model
622		Train – ICE gas	%	TEMA model
623		Train – ICE gasoline	%	TEMA model
624		Train – CE	%	TEMA model
625		Train – FCEV	%	TEMA model
626				
627		Short haul – ICE	%	TEMA model
628		Short haul – BEV	%	TEMA model
629				
630		Bike – Electric	%	TEMA model
631		Bike – Non-electric	%	TEMA model
632				
633		Long haul – ICE	%	TEMA model
634		Long haul – BEV	%	TEMA model
635	**Efficiency**			
636	**Efficiency of the fleet**	Bus – ICE diesel	kWh/vkm	4th National Communication
637		Bus – ICE gas	kWh/vkm	
638		Bus – ICE gasoline	kWh/vkm	
639		Bus – BEV	kWh/vkm	
640		Bus – FCEV	kWh/vkm	
641		Bus – PHEV diesel	kWh/vkm	
642		Bus – PHEV gasoline	kWh/vkm	
643		Bus – HV diesel	kWh/vkm	
644		Bus – HV gasoline	kWh/vkm	
645				
646		Minibus – ICE diesel	kWh/vkm	4th National Communication
647		Minibus – ICE gas	kWh/vkm	
648		Minibus – ICE gasoline	kWh/vkm	
649		Minibus – BEV	kWh/vkm	
650		Minibus – FCEV	kWh/vkm	
651		Minibus – PHEV diesel	kWh/vkm	
652		Minibus – PHEV gasoline	kWh/vkm	
653		Minibus – HV diesel	kWh/vkm	
654		Minibus – HV gasoline	kWh/vkm	
655				
656		LDV – ICE diesel	kWh/vkm	4th National Communication
657		LDV – ICE gas	kWh/vkm	4th National Communication
658		LDV – ICE gasoline	kWh/vkm	4th National Communication
659		LDV – BEV	kWh/vkm	TEMA model

Row	Bloc	Sector/Technology	Unit	Source
660		LDV – FCEV	kWh/vkm	
661		LDV – PHEV diesel	kWh/vkm	
662		LDV – PHEV gasoline	kWh/vkm	
663		LDV – HV diesel	kWh/vkm	
664		LDV – HV gasoline	kWh/vkm	TEMA model
665				
666		TwoW – ICE diesel	kWh/vkm	
667		TwoW – ICE gas	kWh/vkm	
668		TwoW – ICE gasoline	kWh/vkm	4th National Communication
669		TwoW – BEV	kWh/vkm	TEMA model
670		TwoW – FCEV	kWh/vkm	
671		TwoW – HV diesel	kWh/vkm	
672		TwoW – HV gasoline	kWh/vkm	
673				
674		ThreeW – ICE diesel	kWh/vkm	
675		ThreeW – ICE gas	kWh/vkm	
676		ThreeW – ICE gasoline	kWh/vkm	4th National Communication
677		ThreeW – BEV	kWh/vkm	TEMA model
678		ThreeW – FCEV	kWh/vkm	
679		ThreeW – HV diesel	kWh/vkm	
680		ThreeW – HV gasoline	kWh/vkm	
681				
682		Train – ICE diesel	kWh/pkm	
683		Train – ICE gas	kWh/pkm	
684		Train – ICE gasoline	kWh/pkm	
685		Train – CE	kWh/pkm	TEMA model
686		Train – FCEV	kWh/pkm	
687				
688		Short haul – ICE	kWh/pkm	TEMA model
689		Short haul – BEV	kWh/pkm	TEMA model
690				
691		Long haul – ICE	kWh/pkm	TEMA model
692		Long haul – BEV	kWh/pkm	TEMA model
693				
694		Bike – Electric	kWh/pkm	TEMA model
695		Bike – Non-electric	kWh/pkm	
696				
697	**Efficiency of new vehicles**	Bus – ICE diesel	kWh/vkm	4th National Communication
698		Bus – ICE gas	kWh/vkm	
699		Bus – ICE gasoline	kWh/vkm	
700		Bus – BEV	kWh/vkm	
701		Bus – FCEV	kWh/vkm	

Row	Bloc	Sector/Technology	Unit	Source
702		Bus – PHEV diesel	kWh/vkm	
703		Bus – PHEV gasoline	kWh/vkm	
704		Bus – HV diesel	kWh/vkm	
705		Bus – HV gasoline	kWh/vkm	
706				
707		Minibus – ICE diesel	kWh/vkm	4th National Communication
708		Minibus – ICE gas	kWh/vkm	
709		Minibus – ICE gasoline	kWh/vkm	
710		Minibus – BEV	kWh/vkm	
711		Minibus – FCEV	kWh/vkm	
712		Minibus – PHEV diesel	kWh/vkm	
713		Minibus – PHEV gasoline	kWh/vkm	
714		Minibus – HV diesel	kWh/vkm	
715		Minibus – HV gasoline	kWh/vkm	
716				
717		LDV – ICE diesel	kWh/vkm	4th National Communication
718		LDV – ICE gas	kWh/vkm	4th National Communication
719		LDV – ICE gasoline	kWh/vkm	4th National Communication
720		LDV – BEV	kWh/vkm	TEMA model
721		LDV – FCEV	kWh/vkm	
722		LDV – PHEV diesel	kWh/vkm	
723		LDV – PHEV gasoline	kWh/vkm	
724		LDV – HV diesel	kWh/vkm	
725		LDV – HV gasoline	kWh/vkm	TEMA model
726				
727		TwoW – ICE diesel	kWh/vkm	
728		TwoW – ICE gas	kWh/vkm	
729		TwoW – ICE gasoline	kWh/vkm	4th National Communication
730		TwoW – BEV	kWh/vkm	TEMA model
731		TwoW – FCEV	kWh/vkm	
732		TwoW – HV diesel	kWh/vkm	
733		TwoW – HV gasoline	kWh/vkm	
734				
735		ThreeW – ICE diesel	kWh/vkm	
736		ThreeW – ICE gas	kWh/vkm	
737		ThreeW – ICE gasoline	kWh/vkm	4th National Communication
738		ThreeW – BEV	kWh/vkm	TEMA model
739		ThreeW – FCEV	kWh/vkm	
740		ThreeW – HV diesel	kWh/vkm	
741		ThreeW – HV gasoline	kWh/vkm	
742				
743		Train – ICE diesel	kWh/pkm	

Row	Bloc	Sector/Technology	Unit	Source
744		Train – ICE gas	kWh/pkm	
745		Train – ICE gasoline	kWh/pkm	
746		Train – CE	kWh/pkm	TEMA model
747		Train – FCEV	kWh/pkm	
748				
749		Short haul – ICE	kWh/pkm	TEMA model
750		Short haul – BEV	kWh/pkm	TEMA model
751				
752		Long haul – ICE	kWh/pkm	TEMA model
753		Long haul – BEV	kWh/pkm	TEMA model
754				
755		Bike – Electric	kWh/pkm	TEMA model
756		Bike – Non-electric	kWh/pkm	
757	**3. Energy**			
758	**3.A. Urban**			
759	**Bus**	Bus – PHEV – elec	%	
760		Bus – PHEV – Fuel	%	
761	**Minibus**	Minibus – PHEV – elec	%	
762		Minibus – PHEV – Fuel	%	
763	**LDV**	LDV – PHEV – elec	%	
764		LDV – PHEV – Fuel	%	
765				
766	Diesel	Efuel	%	4th National Communication
767	Diesel	BioFuel	%	4th National Communication
768	Diesel	FossilFuel	%	4th National Communication
769	Gasoline	Efuel	%	4th National Communication
770	Gasoline	BioFuel	%	4th National Communication
771	Gasoline	FossilFuel	%	4th National Communication
772	Gas	Efuel	%	4th National Communication
773	Gas	BioFuel	%	4th National Communication
774	Gas	FossilFuel	%	4th National Communication
775				
776	**Energy consumption of**	Bus	TWh	4th National Communication
777		Minibus	TWh	4th National Communication
778		TwoW	TWh	4th National Communication
779		ThreeW	TWh	4th National Communication
780		LDV	TWh	4th National Communication
781		Train	TWh	4th National Communication
782		Bike	TWh	4th National Communication
783				
784	**3.B. Non-urban**			
785	**Bus**	Bus – PHEV – elec	%	

Row	Bloc	Sector/Technology	Unit	Source
786		Bus – PHEV – Fuel	%	
787	**Minibus**	Minibus – PHEV – elec	%	
788		Minibus – PHEV – Fuel	%	
789	**LDV**	LDV – PHEV – elec	%	
790		LDV – PHEV – Fuel	%	
791				
792	Diesel	Efuel	%	4th National Communication
793	Diesel	BioFuel	%	4th National Communication
794	Diesel	FossilFuel	%	4th National Communication
795	Gasoline	Efuel	%	4th National Communication
796	Gasoline	BioFuel	%	4th National Communication
797	Gasoline	FossilFuel	%	4th National Communication
798	Gas	Efuel	%	4th National Communication
799	Gas	BioFuel	%	4th National Communication
800	Gas	FossilFuel	%	4th National Communication
801	Aviation gasoline	Efuel	%	4th National Communication
802	Aviation gasoline	BioFuel	%	4th National Communication
803	Aviation gasoline	FossilFuel	%	4th National Communication
804				
805	**Energy consumption of**	Bus	TWh	4th National Communication
806		Minibus	TWh	4th National Communication
807		TwoW	TWh	4th National Communication
808		ThreeW	TWh	4th National Communication
809		LDV	TWh	4th National Communication
810		Train	TWh	4th National Communication
811		Bike	TWh	4th National Communication
812		ShortHaul AND LongHaul	TWh	4th National Communication
813				
814	**4. GHG**			
815	**4.A. CO2**			
816	**Urban emissions**	Bus	MtCO2	4th National Communication
817		Minibus	MtCO2	4th National Communication
818		TwoW	MtCO2	4th National Communication
819		ThreeW	MtCO2	4th National Communication
820		LDV	MtCO2	4th National Communication
821		Train	MtCO2	
822		Bike	MtCO2	
823				
824	**Non-urban emissions**	Bus	MtCO2	4th National Communication
825		Minibus	MtCO2	
826		TwoW	MtCO2	
827		ThreeW	MtCO2	

Row	Bloc	Sector/Technology	Unit	Source
828		LDV	MtCO2	4th National Communication
829		Train	MtCO2	
830		Bike	MtCO2	
831		ShortHaul AND LongHaul	MtCO2	4th National Communication
832				
833	**4.B. CH4**			
834	**Urban emissions**	Bus	MtCH4	*not used for now*
835		Minibus	MtCH4	*not used for now*
836		TwoW	MtCH4	*not used for now*
837		ThreeW	MtCH4	*not used for now*
838		LDV	MtCH4	*not used for now*
839		Train	MtCH4	*not used for now*
840		Bike	MtCH4	*not used for now*
841				
842	**Non-urban emissions**	Bus	MtCH4	*not used for now*
843		Minibus	MtCH4	*not used for now*
844		TwoW	MtCH4	*not used for now*
845		ThreeW	MtCH4	*not used for now*
846		LDV	MtCH4	*not used for now*
847		Train	MtCH4	*not used for now*
848		Bike	MtCH4	*not used for now*
849		ShortHaul	MtCH4	*not used for now*
850		LongHaul	MtCH4	*not used for now*
851				
852	**4.C. N2O**			
853	**Urban emissions**	Bus	MtN2O	*not used for now*
854		Minibus	MtN2O	*not used for now*
855		TwoW	MtN2O	*not used for now*
856		ThreeW	MtN2O	*not used for now*
857		LDV	MtN2O	*not used for now*
858		Train	MtN2O	*not used for now*
859		Bike	MtN2O	*not used for now*
860				
861	**Non-urban emissions**	Bus	MtN2O	*not used for now*
862		Minibus	MtN2O	*not used for now*
863		TwoW	MtN2O	*not used for now*
864		ThreeW	MtN2O	*not used for now*
865		LDV	MtN2O	*not used for now*
866		Train	MtN2O	*not used for now*
867		Bike	MtN2O	*not used for now*
868		ShortHaul	MtN2O	*not used for now*
869		LongHaul	MtN2O	*not used for now*

Row	Bloc	Sector/Technology	Unit	Source
870				
871	**4.D. HFC**			
872		Average HFC charge/ Bus	kg HFC/Bus	TEMA model
873		Average HFC charge/ Minibus	kg HFC/Minibus	TEMA model
874		Average HFC charge/ LDV	kg HFC/LDV	TEMA model
875	HFC – alternative HFC shares	HFC share – LDV	%	TEMA model
876		HFC share – Bus	%	TEMA model
877		HFC share – Minibus	%	TEMA model
878				
879	**5. Historical outputs**			
880	**5.A. Industry**			
881		Cars & light trucks (non EV)	M veh	ANFAVEA
882		Cars & light trucks (EV)	M veh	
883		Trucks (non EV)	M veh	ANFAVEA
884		Trucks (EV)	M veh	
885		Ships Passengers (non EV)	K veh	
886		Ships Passengers (EV)	K veh	
887		Ships Freight (non EV)	K veh	
888		Ships Freight (EV)	K veh	
889		Rail Passenger	K veh	
890		Rail Freight	K veh	
891		Airplanes (non EV)	K veh	EMBRAER
892		Airplanes (EV)	K veh	
893				
894	**5.B. Power**			
895		Transport electricity	TWh	EPE
896				
897	**5.D. Oil&Gas**			
898		Natural gas	TWh	4th National Communication
899		Oil	TWh	4th National Communication
900		Coal	TWh	4th National Communication
901				
902	**5.F. Transport energy**			
903		Renewables	TWh	4th National Communication

Freight Input Tab

Row	Bloc	Sector/Technology	Unit	Source
2	0. Required inputs & assumptions			
3	1. Activity			
4		Demand per GDP	tkm/$ of GDP	TEMA model
5				
6	**(travelling short distances)**	Short-haul	%	TEMA model
7	**(travelling long-distances)**	Long-haul	%	TEMA model
8	**(Last-mile to consumer)**	Last-mile	%	not used for now
9	**1.A. Short-haul**			
10	**Modal share**	LCV	%	TEMA model
11		MFT	%	TEMA model
12		HFT	%	TEMA model
13		IWW	%	TEMA model
14		Train	%	TEMA model
15		Marine	%	TEMA model
16		Aviation	%	TEMA model
17				
18	**Load factor**	LCV	tkm/vkm	TEMA model
19		MFT	tkm/vkm	TEMA model
20		HFT	tkm/vkm	TEMA model
21				
22	Vkm demand per mode	LCV	G vkm	4th National Communication
23		MFT	G vkm	4th National Communication
24		HFT	G vkm	4th National Communication
25				
26	Tons demand per mode	IWW	G tkm	TEMA model
27		Train	G tkm	TEMA model
28		Marine	G tkm	TEMA model
29		Aviation	G tkm	TEMA model
30	**1.B. Long-haul**			
31	**Modal share**	LCV	%	TEMA model
32		MFT	%	TEMA model
33		HFT	%	TEMA model
34		IWW	%	TEMA model
35		Train	%	TEMA model
36		Marine	%	TEMA model
37		Aviation	%	TEMA model
38				
39	**Load factor**	LCV	tkm/vkm	TEMA model
40		MFT	tkm/vkm	TEMA model

Row	Bloc	Sector/Technology	Unit	Source
41		HFT	tkm/vkm	TEMA model
42				
43	Vkm demand per mode	LCV	G vkm	4th National Communication
44		MFT	G vkm	4th National Communication
45		HFT	G vkm	4th National Communication
46				
47	Tons demand per mode	IWW	G tkm	TEMA model
48		Train	G tkm	TEMA model
49		Marine	G tkm	TEMA model
50		Aviation	G tkm	TEMA model
51	**1.C. Last-mile**			
52	**Modal share**	LDV	%	TEMA model
53		TwoW	%	TEMA model
54		Bike	%	TEMA model
55		Drones/robots	%	TEMA model
56				
57	**Load factors**	LDV	tkm/vkm	TEMA model
58		2W	tkm/vkm	TEMA model
59				
60	**2. Stock**			
61	**2.A. Short-haul**			
62	**Amount of vehicles**	LCV	K veh	TEMA model
63		MFT	K veh	TEMA model
64		HFT	K veh	TEMA model
65	Utilization Rate	LCV	vkm/veh	4th National Communication
66		MFT	vkm/veh	4th National Communication
67		HFT	vkm/veh	4th National Communication
68				
69	**Train**	Constant utilization rate (of base year)	M tkm/veh	user choice
70		Constant renewal rate (of base year)	%	user choice
71				
72	**Airplane**	Constant utilization rate (of base year)	M tkm/veh	user choice
73		Constant renewal rate (of base year)	%	user choice
74				
75	**Marine**	Constant utilization rate (of base year)	M tkm/veh	user choice
76		Constant renewal rate (of base year)	%	user choice
77				
78	**IWW**	Constant utilization rate (of base	M tkm/veh	user choice

Row	Bloc	Sector/Technology	Unit	Source
		year)		
79		Constant renewal rate (of base year)	%	user choice
80				
81	**Life distance**			
82	**Lifedistance of the fleet**	LCV – ICE diesel	K km	4th National Communication
83		LCV – ICE gas	K km	4th National Communication
84		LCV – ICE gasoline	K km	4th National Communication
85		LCV – BEV	K km	4th National Communication
86		LCV – FCEV	K km	4th National Communication
87		LCV – PHEV diesel	K km	4th National Communication
88		LCV – PHEV gasoline	K km	4th National Communication
89		LCV – HV diesel	K km	4th National Communication
90		LCV – HV gasoline	K km	4th National Communication
91		LCV – CEV diesel	K km	
92		LCV – CEV gasoline	K km	
93				
94		MFT – ICE diesel	K km	4th National Communication
95		MFT – ICE gas	K km	4th National Communication
96		MFT – ICE gasoline	K km	
97		MFT – BEV	K km	4th National Communication
98		MFT – FCEV	K km	4th National Communication
99		MFT – PHEV diesel	K km	4th National Communication
100		MFT – PHEV gasoline	K km	4th National Communication
101		MFT – HV diesel	K km	4th National Communication
102		MFT – HV gasoline	K km	4th National Communication
103		MFT – CEV diesel	K km	
104		MFT – CEV gasoline	K km	
105				
106		HFT – ICE diesel	K km	4th National Communication
107		HFT – ICE gas	K km	4th National Communication
108		HFT – ICE gasoline	K km	
109		HFT – BEV	K km	4th National Communication
110		HFT – FCEV	K km	4th National Communication
111		HFT – PHEV diesel	K km	4th National Communication
112		HFT – PHEV gasoline	K km	4th National Communication
113		HFT – HV diesel	K km	4th National Communication
114		HFT – HV gasoline	K km	4th National Communication
115		HFT – CEV diesel	K km	
116		HFT – CEV gasoline	K km	
117				
118	**Lifedistance of new vehicles**	LCV – ICE diesel	K km	4th National Communication
119		LCV – ICE gas	K km	4th National Communication

Row	Bloc	Sector/Technology	Unit	Source
120		LCV – ICE gasoline	K km	4th National Communication
121		LCV – BEV	K km	4th National Communication
122		LCV – FCEV	K km	4th National Communication
123		LCV – PHEV diesel	K km	4th National Communication
124		LCV – PHEV gasoline	K km	4th National Communication
125		LCV – HV diesel	K km	4th National Communication
126		LCV – HV gasoline	K km	4th National Communication
127		LCV – CEV diesel	K km	
128		LCV – CEV gasoline	K km	
129				
130		MFT – ICE diesel	K km	4th National Communication
131		MFT – ICE gas	K km	4th National Communication
132		MFT – ICE gasoline	K km	
133		MFT – BEV	K km	4th National Communication
134		MFT – FCEV	K km	4th National Communication
135		MFT – PHEV diesel	K km	4th National Communication
136		MFT – PHEV gasoline	K km	4th National Communication
137		MFT – HV diesel	K km	4th National Communication
138		MFT – HV gasoline	K km	4th National Communication
139		MFT – CEV diesel	K km	
140		MFT – CEV gasoline	K km	
141				
142		HFT – ICE diesel	K km	4th National Communication
143		HFT – ICE gas	K km	4th National Communication
144		HFT – ICE gasoline	K km	
145		HFT – BEV	K km	4th National Communication
146		HFT – FCEV	K km	4th National Communication
147		HFT – PHEV diesel	K km	4th National Communication
148		HFT – PHEV gasoline	K km	4th National Communication
149		HFT – HV diesel	K km	4th National Communication
150		HFT – HV gasoline	K km	4th National Communication
151		HFT – CEV diesel	K km	
152		HFT – CEV gasoline	K km	
153	**Technology share**			
154	**Technology of the fleet**	LCV – ICE diesel	%	TEMA model
155		LCV – ICE gas	%	TEMA model
156		LCV – ICE gasoline	%	TEMA model
157		LCV – BEV	%	TEMA model
158		LCV – FCEV	%	TEMA model
159		LCV – PHEV diesel	%	TEMA model
160		LCV – PHEV gasoline	%	TEMA model
161		LCV – HV diesel	%	TEMA model

Row	Bloc	Sector/Technology	Unit	Source
162		LCV – HV gasoline	%	TEMA model
163		LCV – CEV diesel	%	TEMA model
164		LCV – CEV gasoline	%	TEMA model
165				
166		HFT – ICE diesel	%	TEMA model
167		HFT – ICE gas	%	TEMA model
168		HFT – ICE gasoline	%	TEMA model
169		HFT – BEV	%	TEMA model
170		HFT – FCEV	%	TEMA model
171		HFT – PHEV diesel	%	TEMA model
172		HFT – PHEV gasoline	%	TEMA model
173		HFT – HV diesel	%	TEMA model
174		HFT – HV gasoline	%	TEMA model
175		HFT – CEV diesel	%	TEMA model
176		HFT – CEV gasoline	%	TEMA model
177				
178		MFT – ICE diesel	%	TEMA model
179		MFT – ICE gas	%	TEMA model
180		MFT – ICE gasoline	%	TEMA model
181		MFT – BEV	%	TEMA model
182		MFT – FCEV	%	TEMA model
183		MFT – PHEV diesel	%	TEMA model
184		MFT – PHEV gasoline	%	TEMA model
185		MFT – HV diesel	%	TEMA model
186		MFT – HV gasoline	%	TEMA model
187		MFT – CEV diesel	%	TEMA model
188		MFT – CEV gasoline	%	TEMA model
189				
190		Marine – ICE	%	TEMA model
191		Marine – BEV	%	TEMA model
192		Marine – FCEV	%	TEMA model
193				
194		IWW – ICE	%	TEMA model
195		IWW – BEV	%	TEMA model
196		IWW – FCEV	%	TEMA model
197				
198		Train – ICE diesel	%	TEMA model
199		Train – ICE gas	%	TEMA model
200		Train – ICE gasoline	%	TEMA model
201		Train – CE	%	TEMA model
202		Train – FCEV	%	TEMA model
203				

Row	Bloc	Sector/Technology	Unit	Source
204		Airplane – ICE	%	TEMA model
205		Airplane – BEV	%	TEMA model
206		Airplane – FCEV	%	TEMA model
207				
208	**Technology of new vehicles**	LCV – ICE diesel	%	TEMA model
209		LCV – ICE gas	%	TEMA model
210		LCV – ICE gasoline	%	TEMA model
211		LCV – BEV	%	TEMA model
212		LCV – FCEV	%	TEMA model
213		LCV – PHEV diesel	%	TEMA model
214		LCV – PHEV gasoline	%	TEMA model
215		LCV – HV diesel	%	TEMA model
216		LCV – HV gasoline	%	TEMA model
217		LCV – CEV diesel	%	TEMA model
218		LCV – CEV gasoline	%	TEMA model
219				
220		MFT – ICE diesel	%	TEMA model
221		MFT – ICE gas	%	TEMA model
222		MFT – ICE gasoline	%	TEMA model
223		MFT – BEV	%	TEMA model
224		MFT – FCEV	%	TEMA model
225		MFT – PHEV diesel	%	TEMA model
226		MFT – PHEV gasoline	%	TEMA model
227		MFT – HV diesel	%	TEMA model
228		MFT – HV gasoline	%	TEMA model
229		MFT – CEV diesel	%	TEMA model
230		MFT – CEV gasoline	%	TEMA model
231				
232		HFT – ICE diesel	%	TEMA model
233		HFT – ICE gas	%	TEMA model
234		HFT – ICE gasoline	%	TEMA model
235		HFT – BEV	%	TEMA model
236		HFT – FCEV	%	TEMA model
237		HFT – PHEV diesel	%	TEMA model
238		HFT – PHEV gasoline	%	TEMA model
239		HFT – HV diesel	%	TEMA model
240		HFT – HV gasoline	%	TEMA model
241		HFT – CEV diesel	%	TEMA model
242		HFT – CEV gasoline	%	TEMA model
243				
244		Train – ICE diesel	%	TEMA model
245		Train – ICE gas	%	TEMA model

Row	Bloc	Sector/Technology	Unit	Source
246		Train – ICE gasoline	%	TEMA model
247		Train – CE	%	TEMA model
248		Train – FCEV	%	TEMA model
249				
250		Airplane – ICE	%	TEMA model
251		Airplane – BEV	%	TEMA model
252		Airplane – FCEV	%	TEMA model
253				
254		Marine – ICE	%	TEMA model
255		Marine – BEV	%	TEMA model
256		Marine – FCEV	%	TEMA model
257				
258		IWW – ICE	%	TEMA model
259		IWW – BEV	%	TEMA model
260		IWW – FCEV	%	TEMA model
261	**Efficiency**			
262	**Efficiency of the fleet**	LCV – ICE diesel	kWh/vkm	4th National Communication
263		LCV – ICE gas	kWh/vkm	4th National Communication
264		LCV – ICE gasoline	kWh/vkm	4th National Communication
265		LCV – BEV	kWh/vkm	TEMA model
266		LCV – FCEV	kWh/vkm	
267		LCV – PHEV diesel	kWh/vkm	
268		LCV – PHEV gasoline	kWh/vkm	
269		LCV – HV diesel	kWh/vkm	
270		LCV – HV gasoline	kWh/vkm	TEMA model
271		LCV – CEV diesel	kWh/vkm	
272		LCV – CEV gasoline	kWh/vkm	
273				
274		MFT – ICE diesel	kWh/vkm	4th National Communication
275		MFT – ICE gas	kWh/vkm	
276		MFT – ICE gasoline	kWh/vkm	
277		MFT – BEV	kWh/vkm	
278		MFT – FCEV	kWh/vkm	
279		MFT – PHEV diesel	kWh/vkm	
280		MFT – PHEV gasoline	kWh/vkm	
281		MFT – HV diesel	kWh/vkm	
282		MFT – HV gasoline	kWh/vkm	
283		MFT – CEV diesel	kWh/vkm	
284		MFT – CEV gasoline	kWh/vkm	
285				
286		HFT – ICE diesel	kWh/vkm	4th National Communication
287		HFT – ICE gas	kWh/vkm	

Row	Bloc	Sector/Technology	Unit	Source
288		HFT – ICE gasoline	kWh/vkm	
289		HFT – BEV	kWh/vkm	
290		HFT – FCEV	kWh/vkm	
291		HFT – PHEV diesel	kWh/vkm	
292		HFT – PHEV gasoline	kWh/vkm	
293		HFT – HV diesel	kWh/vkm	
294		HFT – HV gasoline	kWh/vkm	
295		HFT – CEV diesel	kWh/vkm	
296		HFT – CEV gasoline	kWh/vkm	
297				
298		Marine – ICE	kWh/tkm	TEMA model
299		Marine – BEV	kWh/tkm	
300		Marine – FCEV	kWh/tkm	
301				
302		IWW – ICE	kWh/tkm	TEMA model
303		IWW – BEV	kWh/tkm	
304		IWW – FCEV	kWh/tkm	
305				
306		Train – ICE diesel	kWh/tkm	TEMA model
307		Train – ICE gas	kWh/tkm	
308		Train – ICE gasoline	kWh/tkm	
309		Train – CE	kWh/tkm	
310		Train – FCEV	kWh/tkm	
311				
312		Airplane – ICE	kWh/tkm	TEMA model
313		Airplane – BEV	kWh/tkm	
314		Airplane – FCEV	kWh/tkm	
315				
316	**Efficiency of new vehicles**	LCV – ICE diesel	kWh/vkm	4th National Communication
317		LCV – ICE gas	kWh/vkm	4th National Communication
318		LCV – ICE gasoline	kWh/vkm	4th National Communication
319		LCV – BEV	kWh/vkm	TEMA model
320		LCV – FCEV	kWh/vkm	
321		LCV – PHEV diesel	kWh/vkm	
322		LCV – PHEV gasoline	kWh/vkm	
323		LCV – HV diesel	kWh/vkm	
324		LCV – HV gasoline	kWh/vkm	TEMA model
325		LCV – CEV diesel	kWh/vkm	
326		LCV – CEV gasoline	kWh/vkm	
327				
328		MFT – ICE diesel	kWh/vkm	4th National Communication
329		MFT – ICE gas	kWh/vkm	

Row	Bloc	Sector/Technology	Unit	Source
330		MFT – ICE gasoline	kWh/vkm	
331		MFT – BEV	kWh/vkm	
332		MFT – FCEV	kWh/vkm	
333		MFT – PHEV diesel	kWh/vkm	
334		MFT – PHEV gasoline	kWh/vkm	
335		MFT – HV diesel	kWh/vkm	
336		MFT – HV gasoline	kWh/vkm	
337		MFT – CEV diesel	kWh/vkm	
338		MFT – CEV gasoline	kWh/vkm	
339				
340	**Efficiency of new vehicles**	HFT – ICE diesel	kWh/vkm	4th National Communication
341		HFT – ICE gas	kWh/vkm	
342		HFT – ICE gasoline	kWh/vkm	
343		HFT – BEV	kWh/vkm	
344		HFT – FCEV	kWh/vkm	
345		HFT – PHEV diesel	kWh/vkm	
346		HFT – PHEV gasoline	kWh/vkm	
347		HFT – HV diesel	kWh/vkm	
348		HFT – HV gasoline	kWh/vkm	
349		HFT – CEV diesel	kWh/vkm	
350		HFT – CEV gasoline	kWh/vkm	
351				
352		Train – ICE diesel	kWh/tkm	TEMA model
353		Train – ICE gas	kWh/tkm	
354		Train – ICE gasoline	kWh/tkm	
355		Train – CE	kWh/tkm	
356		Train – FCEV	kWh/tkm	
357				
358		Airplane – ICE	kWh/tkm	TEMA model
359		Airplane – BEV	kWh/tkm	
360		Airplane – FCEV	kWh/tkm	
361				
362		Marine – ICE	kWh/tkm	TEMA model
363		Marine – BEV	kWh/tkm	
364		Marine – FCEV	kWh/tkm	
365				
366		IWW – ICE	kWh/tkm	TEMA model
367		IWW – BEV	kWh/tkm	
368		IWW – FCEV	kWh/tkm	
369	**2.B. Long-haul**			
370	**Amount of vehicles**	LCV	K veh	4th National Communication
371		MFT	K veh	4th National Communication

Row	Bloc	Sector/Technology	Unit	Source
372		HFT	K veh	4th National Communication
373	**Utilization Rate**	LCV	vkm/veh	4th National Communication
374		MFT	vkm/veh	4th National Communication
375		HFT	vkm/veh	4th National Communication
376				
377	**Train**	Constant utilization rate (of base year)	M tkm/veh	user choice
378		Constant renewal rate (of base year)	%	user choice
379				
380	**Airplane**	Constant utilization rate (of base year)	M tkm/veh	user choice
381		Constant renewal rate (of base year)	%	user choice
382				
383	**Marine**	Constant utilization rate (of base year)	M tkm/veh	user choice
384		Constant renewal rate (of base year)	%	user choice
385				
386	**IWW**	Constant utilization rate (of base year)	M tkm/veh	user choice
387		Constant renewal rate (of base year)	%	user choice
388				
389	**Life distance**			
390	**Lifedistance of the fleet**	LCV – ICE diesel	K km	4th National Communication
391		LCV – ICE gas	K km	4th National Communication
392		LCV – ICE gasoline	K km	4th National Communication
393		LCV – BEV	K km	4th National Communication
394		LCV – FCEV	K km	4th National Communication
395		LCV – PHEV diesel	K km	4th National Communication
396		LCV – PHEV gasoline	K km	4th National Communication
397		LCV – HV diesel	K km	4th National Communication
398		LCV – HV gasoline	K km	4th National Communication
399		LCV – CEV diesel	K km	
400		LCV – CEV gasoline	K km	
401				
402		MFT – ICE diesel	K km	4th National Communication
403		MFT – ICE gas	K km	4th National Communication
404		MFT – ICE gasoline	K km	
405		MFT – BEV	K km	4th National Communication
406		MFT – FCEV	K km	4th National Communication
407		MFT – PHEV diesel	K km	4th National Communication
408		MFT – PHEV gasoline	K km	4th National Communication

Row	Bloc	Sector/Technology	Unit	Source
409		MFT – HV diesel	K km	4th National Communication
410		MFT – HV gasoline	K km	4th National Communication
411		MFT – CEV diesel	K km	
412		MFT – CEV gasoline	K km	
413				
414		HFT – ICE diesel	K km	4th National Communication
415		HFT – ICE gas	K km	4th National Communication
416		HFT – ICE gasoline	K km	
417		HFT – BEV	K km	4th National Communication
418		HFT – FCEV	K km	4th National Communication
419		HFT – PHEV diesel	K km	4th National Communication
420		HFT – PHEV gasoline	K km	4th National Communication
421		HFT – HV diesel	K km	4th National Communication
422		HFT – HV gasoline	K km	4th National Communication
423		HFT – CEV diesel	K km	
424		HFT – CEV gasoline	K km	
425				
426	**Lifedistance of new vehicles**	LCV – ICE diesel	K km	4th National Communication
427		LCV – ICE gas	K km	4th National Communication
428		LCV – ICE gasoline	K km	4th National Communication
429		LCV – BEV	K km	4th National Communication
430		LCV – FCEV	K km	4th National Communication
431		LCV – PHEV diesel	K km	4th National Communication
432		LCV – PHEV gasoline	K km	4th National Communication
433		LCV – HV diesel	K km	4th National Communication
434		LCV – HV gasoline	K km	4th National Communication
435		LCV – CEV diesel	K km	
436		LCV – CEV gasoline	K km	
437				
438		MFT – ICE diesel	K km	4th National Communication
439		MFT – ICE gas	K km	4th National Communication
440		MFT – ICE gasoline	K km	
441		MFT – BEV	K km	4th National Communication
442		MFT – FCEV	K km	4th National Communication
443		MFT – PHEV diesel	K km	4th National Communication
444		MFT – PHEV gasoline	K km	4th National Communication
445		MFT – HV diesel	K km	4th National Communication
446		MFT – HV gasoline	K km	4th National Communication
447		MFT – CEV diesel	K km	
448		MFT – CEV gasoline	K km	
449				
450		HFT – ICE diesel	K km	4th National Communication

Row	Bloc	Sector/Technology	Unit	Source
451		HFT – ICE gas	K km	4th National Communication
452		HFT – ICE gasoline	K km	
453		HFT – BEV	K km	4th National Communication
454		HFT – FCEV	K km	4th National Communication
455		HFT – PHEV diesel	K km	4th National Communication
456		HFT – PHEV gasoline	K km	4th National Communication
457		HFT – HV diesel	K km	4th National Communication
458		HFT – HV gasoline	K km	4th National Communication
459		HFT – CEV diesel	K km	
460		HFT – CEV gasoline	K km	
461	**Technology share**			
462	**Technology of the fleet**	LCV – ICE diesel	%	TEMA model
463		LCV – ICE gas	%	TEMA model
464		LCV – ICE gasoline	%	TEMA model
465		LCV – BEV	%	TEMA model
466		LCV – FCEV	%	TEMA model
467		LCV – PHEV diesel	%	TEMA model
468		LCV – PHEV gasoline	%	TEMA model
469		LCV – HV diesel	%	TEMA model
470		LCV – HV gasoline	%	TEMA model
471		LCV – CEV diesel	%	TEMA model
472		LCV – CEV gasoline	%	TEMA model
473				
474		MFT – ICE diesel	%	TEMA model
475		MFT – ICE gas	%	TEMA model
476		MFT – ICE gasoline	%	TEMA model
477		MFT – BEV	%	TEMA model
478		MFT – FCEV	%	TEMA model
479		MFT – PHEV diesel	%	TEMA model
480		MFT – PHEV gasoline	%	TEMA model
481		MFT – HV diesel	%	TEMA model
482		MFT – HV gasoline	%	TEMA model
483		MFT – CEV diesel	%	TEMA model
484		MFT – CEV gasoline	%	TEMA model
485				
486		HFT – ICE diesel	%	TEMA model
487		HFT – ICE gas	%	TEMA model
488		HFT – ICE gasoline	%	TEMA model
489		HFT – BEV	%	TEMA model
490		HFT – FCEV	%	TEMA model
491		HFT – PHEV diesel	%	TEMA model
492		HFT – PHEV gasoline	%	TEMA model

Row	Bloc	Sector/Technology	Unit	Source
493		HFT – HV diesel	%	TEMA model
494		HFT – HV gasoline	%	TEMA model
495		HFT – CEV diesel	%	TEMA model
496		HFT – CEV gasoline	%	TEMA model
497				
498		Train – ICE diesel	%	TEMA model
499		Train – ICE gas	%	TEMA model
500		Train – ICE gasoline	%	TEMA model
501		Train – CE	%	TEMA model
502		Train – FCEV	%	TEMA model
503				
504		Airplane – ICE	%	TEMA model
505		Airplane – BEV	%	TEMA model
506		Airplane – FCEV	%	TEMA model
507				
508		Marine – ICE	%	TEMA model
509		Marine – BEV	%	TEMA model
510		Marine – FCEV	%	TEMA model
511				
512		IWW – ICE	%	TEMA model
513		IWW – BEV	%	TEMA model
514		IWW – FCEV	%	TEMA model
515				
516	**Technology of new vehicles**	LCV – ICE diesel	%	TEMA model
517		LCV – ICE gas	%	TEMA model
518		LCV – ICE gasoline	%	TEMA model
519		LCV – BEV	%	TEMA model
520		LCV – FCEV	%	TEMA model
521		LCV – PHEV diesel	%	TEMA model
522		LCV – PHEV gasoline	%	TEMA model
523		LCV – HV diesel	%	TEMA model
524		LCV – HV gasoline	%	TEMA model
525		LCV – CEV diesel	%	TEMA model
526		LCV – CEV gasoline	%	TEMA model
527				
528		MFT – ICE diesel	%	TEMA model
529		MFT – ICE gas	%	TEMA model
530		MFT – ICE gasoline	%	TEMA model
531		MFT – BEV	%	TEMA model
532		MFT – FCEV	%	TEMA model
533		MFT – PHEV diesel	%	TEMA model
534		MFT – PHEV gasoline	%	TEMA model

Row	Bloc	Sector/Technology	Unit	Source
535		MFT – HV diesel	%	TEMA model
536		MFT – HV gasoline	%	TEMA model
537		MFT – CEV diesel	%	TEMA model
538		MFT – CEV gasoline	%	TEMA model
539				
540		HFT – ICE diesel	%	TEMA model
541		HFT – ICE gas	%	TEMA model
542		HFT – ICE gasoline	%	TEMA model
543		HFT – BEV	%	TEMA model
544		HFT – FCEV	%	TEMA model
545		HFT – PHEV diesel	%	TEMA model
546		HFT – PHEV gasoline	%	TEMA model
547		HFT – HV diesel	%	TEMA model
548		HFT – HV gasoline	%	TEMA model
549		HFT – CEV diesel	%	TEMA model
550		HFT – CEV gasoline	%	TEMA model
551				
552		Train – ICE diesel	%	TEMA model
553		Train – ICE gas	%	TEMA model
554		Train – ICE gasoline	%	TEMA model
555		Train – CE	%	TEMA model
556		Train – FCEV	%	TEMA model
557				
558		Airplane – ICE	%	TEMA model
559		Airplane – BEV	%	TEMA model
560		Airplane – FCEV	%	TEMA model
561				
562		Marine – ICE	%	TEMA model
563		Marine – BEV	%	TEMA model
564		Marine – FCEV	%	TEMA model
565				
566		IWW – ICE	%	TEMA model
567		IWW – BEV	%	TEMA model
568		IWW – FCEV	%	TEMA model
569	**Efficiency**			
570	**Efficiency of the fleet**	LCV – ICE diesel	kWh/vkm	4th National Communication
571		LCV – ICE gas	kWh/vkm	4th National Communication
572		LCV – ICE gasoline	kWh/vkm	4th National Communication
573		LCV – BEV	kWh/vkm	TEMA model
574		LCV – FCEV	kWh/vkm	
575		LCV – PHEV diesel	kWh/vkm	
576		LCV – PHEV gasoline	kWh/vkm	

Row	Bloc	Sector/Technology	Unit	Source
577		LCV – HV diesel	kWh/vkm	
578		LCV – HV gasoline	kWh/vkm	TEMA model
579		LCV – CEV diesel	kWh/vkm	
580		LCV – CEV gasoline	kWh/vkm	
581				
582		MFT – ICE diesel	kWh/vkm	4th National Communication
583		MFT – ICE gas	kWh/vkm	
584		MFT – ICE gasoline	kWh/vkm	
585		MFT – BEV	kWh/vkm	
586		MFT – FCEV	kWh/vkm	
587		MFT – PHEV diesel	kWh/vkm	
588		MFT – PHEV gasoline	kWh/vkm	
589		MFT – HV diesel	kWh/vkm	
590		MFT – HV gasoline	kWh/vkm	
591		MFT – CEV diesel	kWh/vkm	
592		MFT – CEV gasoline	kWh/vkm	
593				
594		HFT – ICE diesel	kWh/vkm	4th National Communication
595		HFT – ICE gas	kWh/vkm	
596		HFT – ICE gasoline	kWh/vkm	
597		HFT – BEV	kWh/vkm	
598		HFT – FCEV	kWh/vkm	
599		HFT – PHEV diesel	kWh/vkm	
600		HFT – PHEV gasoline	kWh/vkm	
601		HFT – HV diesel	kWh/vkm	
602		HFT – HV gasoline	kWh/vkm	
603		HFT – CEV diesel	kWh/vkm	
604		HFT – CEV gasoline	kWh/vkm	
605				
606		Train – ICE diesel	kWh/tkm	TEMA model
607		Train – ICE gas	kWh/tkm	
608		Train – ICE gasoline	kWh/tkm	
609		Train – CE	kWh/tkm	
610		Train – FCEV	kWh/tkm	
611				
612		Airplane – ICE	kWh/tkm	TEMA model
613		Airplane – BEV	kWh/tkm	
614		Airplane – FCEV	kWh/tkm	
615				
616		Marine – ICE	kWh/tkm	TEMA model
617		Marine – BEV	kWh/tkm	
618		Marine – FCEV	kWh/tkm	

Row	Bloc	Sector/Technology	Unit	Source
619				
620		IWW – ICE	kWh/tkm	TEMA model
621		IWW – BEV	kWh/tkm	
622		IWW – FCEV	kWh/tkm	
623				
624	**Efficiency of new vehicles**	LCV – ICE diesel	kWh/vkm	4th National Communication
625		LCV – ICE gas	kWh/vkm	4th National Communication
626		LCV – ICE gasoline	kWh/vkm	4th National Communication
627		LCV – BEV	kWh/vkm	TEMA model
628		LCV – FCEV	kWh/vkm	
629		LCV – PHEV diesel	kWh/vkm	
630		LCV – PHEV gasoline	kWh/vkm	
631		LCV – HV diesel	kWh/vkm	
632		LCV – HV gasoline	kWh/vkm	TEMA model
633		LCV – CEV diesel	kWh/vkm	
634		LCV – CEV gasoline	kWh/vkm	
635				
636		MFT – ICE diesel	kWh/vkm	4th National Communication
637		MFT – ICE gas	kWh/vkm	
638		MFT – ICE gasoline	kWh/vkm	
639		MFT – BEV	kWh/vkm	
640		MFT – FCEV	kWh/vkm	
641		MFT – PHEV diesel	kWh/vkm	
642		MFT – PHEV gasoline	kWh/vkm	
643		MFT – HV diesel	kWh/vkm	
644		MFT – HV gasoline	kWh/vkm	
645		MFT – CEV diesel	kWh/vkm	
646		MFT – CEV gasoline	kWh/vkm	
647				
648		HFT – ICE diesel	kWh/vkm	4th National Communication
649		HFT – ICE gas	kWh/vkm	
650		HFT – ICE gasoline	kWh/vkm	
651		HFT – BEV	kWh/vkm	
652		HFT – FCEV	kWh/vkm	
653		HFT – PHEV diesel	kWh/vkm	
654		HFT – PHEV gasoline	kWh/vkm	
655		HFT – HV diesel	kWh/vkm	
656		HFT – HV gasoline	kWh/vkm	
657		HFT – CEV diesel	kWh/vkm	
658		HFT – CEV gasoline	kWh/vkm	
659				
660		Train – ICE diesel	kWh/tkm	TEMA model

Row	Bloc	Sector/Technology	Unit	Source
661		Train – ICE gas	kWh/tkm	
662		Train – ICE gasoline	kWh/tkm	
663		Train – CE	kWh/tkm	
664		Train – FCEV	kWh/tkm	
665				
666		Airplane – ICE	kWh/tkm	TEMA model
667		Airplane – BEV	kWh/tkm	
668		Airplane – FCEV	kWh/tkm	
669				
670		Marine – ICE	kWh/tkm	TEMA model
671		Marine – BEV	kWh/tkm	
672		Marine – FCEV	kWh/tkm	
673				
674		IWW – ICE	kWh/tkm	TEMA model
675		IWW – BEV	kWh/tkm	
676		IWW – FCEV	kWh/tkm	
677	**2.C. Last-mile**			
678	**Amount of vehicles**	TwoW	K veh	not used for now
679		LDV	K veh	not used for now
680				
681	**Utilization Rate**	TwoW	vkm/veh	not used for now
682		LDV	vkm/veh	not used for now
683				
684	**Bike**	Constant utilization rate (of base year)	M tkm/veh	user choice
685		Constant renewal rate (of base year)	%	user choice
686				
687	**Drone**	Constant utilization rate (of base year)	M tkm/veh	user choice
688		Constant renewal rate (of base year)	%	user choice
689	**Life distance**			
690	**Lifedistance of the fleet**	LDV – ICE diesel	K km	4th National Communication
691		LDV – ICE gas	K km	4th National Communication
692		LDV – ICE gasoline	K km	4th National Communication
693		LDV – BEV	K km	4th National Communication
694		LDV – FCEV	K km	4th National Communication
695		LDV – PHEV diesel	K km	4th National Communication
696		LDV – PHEV gasoline	K km	4th National Communication
697		LDV – HV diesel	K km	4th National Communication
698		LDV – HV gasoline	K km	4th National Communication
699				
700		TwoW – ICE diesel	K km	

Row	Bloc	Sector/Technology	Unit	Source
701		TwoW – ICE gas	K km	
702		TwoW – ICE gasoline	K km	4th National Communication
703		TwoW – BEV	K km	4th National Communication
704		TwoW – FCEV	K km	4th National Communication
705		TwoW – HV diesel	K km	4th National Communication
706		TwoW – HV gasoline	K km	4th National Communication
707				
708	**Lifedistance of new vehicles**	LDV – ICE diesel	K km	4th National Communication
709		LDV – ICE gas	K km	4th National Communication
710		LDV – ICE gasoline	K km	4th National Communication
711		LDV – BEV	K km	4th National Communication
712		LDV – FCEV	K km	4th National Communication
713		LDV – PHEV diesel	K km	4th National Communication
714		LDV – PHEV gasoline	K km	4th National Communication
715		LDV – HV diesel	K km	4th National Communication
716		LDV – HV gasoline	K km	4th National Communication
717				
718		TwoW – ICE diesel	K km	
719		TwoW – ICE gas	K km	
720		TwoW – ICE gasoline	K km	4th National Communication
721		TwoW – BEV	K km	4th National Communication
722		TwoW – FCEV	K km	4th National Communication
723		TwoW – HV diesel	K km	4th National Communication
724		TwoW – HV gasoline	K km	4th National Communication
725	**Technology share**			
726	**Technology of the fleet**	LDV – ICE diesel	%	TEMA model
727		LDV – ICE gas	%	TEMA model
728		LDV – ICE gasoline	%	TEMA model
729		LDV – BEV	%	TEMA model
730		LDV – FCEV	%	TEMA model
731		LDV – PHEV diesel	%	TEMA model
732		LDV – PHEV gasoline	%	TEMA model
733		LDV – HV diesel	%	TEMA model
734		LDV – HV gasoline	%	TEMA model
735				
736		TwoW – ICE diesel	%	TEMA model
737		TwoW – ICE gas	%	TEMA model
738		TwoW – ICE gasoline	%	TEMA model
739		TwoW – BEV	%	TEMA model
740		TwoW – FCEV	%	TEMA model
741		TwoW – HV diesel	%	TEMA model
742		TwoW – HV gasoline	%	TEMA model

Row	Bloc	Sector/Technology	Unit	Source
743				
744		Bike – Electric	%	TEMA model
745		Bike – Non-electric	%	TEMA model
746				
747	**Technology of new vehicles**	LDV – ICE diesel	%	TEMA model
748		LDV – ICE gas	%	TEMA model
749		LDV – ICE gasoline	%	TEMA model
750		LDV – BEV	%	TEMA model
751		LDV – FCEV	%	TEMA model
752		LDV – PHEV diesel	%	TEMA model
753		LDV – PHEV gasoline	%	TEMA model
754		LDV – HV diesel	%	TEMA model
755		LDV – HV gasoline	%	TEMA model
756				
757		TwoW – ICE diesel	%	TEMA model
758		TwoW – ICE gas	%	TEMA model
759		TwoW – ICE gasoline	%	TEMA model
760		TwoW – BEV	%	TEMA model
761		TwoW – FCEV	%	TEMA model
762		TwoW – HV diesel	%	TEMA model
763		TwoW – HV gasoline	%	TEMA model
764				
765		Bike – Electric	%	TEMA model
766		Bike – Non-electric	%	TEMA model
767	**Efficiency**			
768	**Efficiency of the fleet**	LDV – ICE diesel	kWh/vkm	4th National Communication
769		LDV – ICE gas	kWh/vkm	4th National Communication
770		LDV – ICE gasoline	kWh/vkm	4th National Communication
771		LDV – BEV	kWh/vkm	TEMA model
772		LDV – FCEV	kWh/vkm	
773		LDV – PHEV diesel	kWh/vkm	
774		LDV – PHEV gasoline	kWh/vkm	
775		LDV – HV diesel	kWh/vkm	
776		LDV – HV gasoline	kWh/vkm	TEMA model
777				
778		TwoW – ICE diesel	kWh/vkm	
779		TwoW – ICE gas	kWh/vkm	
780		TwoW – ICE gasoline	kWh/vkm	4th National Communication
781		TwoW – BEV	kWh/vkm	TEMA model
782		TwoW – FCEV	kWh/vkm	
783		TwoW – HV diesel	kWh/vkm	
784		TwoW – HV gasoline	kWh/vkm	

Row	Bloc	Sector/Technology	Unit	Source
785				
786		Bike – Electric	kWh/tkm	TEMA model
787		Bike – Non-electric	kWh/tkm	
788				
789		Drone – Electric	kWh/tkm	
790				
791	**Efficiency of new vehicles**	LDV – ICE diesel	kWh/vkm	4th National Communication
792		LDV – ICE gas	kWh/vkm	4th National Communication
793		LDV – ICE gasoline	kWh/vkm	4th National Communication
794		LDV – BEV	kWh/vkm	TEMA model
795		LDV – FCEV	kWh/vkm	
796		LDV – PHEV diesel	kWh/vkm	
797		LDV – PHEV gasoline	kWh/vkm	
798		LDV – HV diesel	kWh/vkm	
799		LDV – HV gasoline	kWh/vkm	TEMA model
800				
801		TwoW – ICE diesel	kWh/vkm	
802		TwoW – ICE gas	kWh/vkm	
803		TwoW – ICE gasoline	kWh/vkm	4th National Communication
804		TwoW – BEV	kWh/vkm	TEMA model
805		TwoW – FCEV	kWh/vkm	
806		TwoW – HV diesel	kWh/vkm	
807		TwoW – HV gasoline	kWh/vkm	
808				
809		Bike – Electric	kWh/pkm	TEMA model
810		Bike – Non-electric	kWh/pkm	
811				
812		Drones/robots – Electric	kWh/pkm	
813	**3. Energy**			
814	**3.A. Short-haul**			
815	**Share of PHEV vehicles**	LCV – PHEV – elec	%	
816		LCV – PHEV – Fuel	%	
817				
818		MFT – PHEV – elec	%	
819		MFT – PHEV – Fuel	%	
820				
821		HFT – PHEV – elec	%	
822		HFT – PHEV – Fuel	%	
823				
824	**Share of CEV vehicles**	LCV – CEV – elec	%	
825		LCV – CEV – Fuel	%	
826				

Row	Bloc	Sector/Technology	Unit	Source
827		MFT – CEV – elec	%	
828		MFT – CEV – Fuel	%	
829				
830		HFT – CEV – elec	%	
831		HFT – CEV – Fuel	%	
832				
833	**Diesel**	Efuel	%	TEMA model
834		BioFuel	%	TEMA model
835		FossilFuel	%	TEMA model
836				
837	**Gasoline**	Efuel	%	TEMA model
838		BioFuel	%	TEMA model
839		FossilFuel	%	TEMA model
840				
841	**Gas**	Efuel	%	TEMA model
842		BioFuel	%	TEMA model
843		FossilFuel	%	TEMA model
844				
845	**Aviation gasoline**	Efuel	%	TEMA model
846		BioFuel	%	TEMA model
847		FossilFuel	%	TEMA model
848				
849	**Ship gasoline**	Efuel	%	TEMA model
850		BioFuel	%	TEMA model
851		FossilFuel	%	TEMA model
852				
853	**Energy consumption of**	LCV	TWh	4th National Communication
854		MFT	TWh	4th National Communication
855		HFT	TWh	
856		IWW	TWh	TEMA model
857		Train	TWh	
858		Marine	TWh	
859		Aviation	TWh	
860				
861	**3.B. Long-haul**			
862	**Share of PHEV vehicles**	LCV – PHEV – elec	%	
863		LCV – PHEV – Fuel	%	
864				
865		MFT – PHEV – elec	%	
866		MFT – PHEV – Fuel	%	
867				
868		HFT – PHEV – elec	%	

Row	Bloc	Sector/Technology	Unit	Source
869		HFT – PHEV – Fuel	%	
870				
871	**Share of CEV vehicles**	LCV – CEV – elec	%	
872		LCV – CEV – Fuel	%	
873				
874		MFT – CEV – elec	%	
875		MFT – CEV – Fuel	%	
876				
877		HFT – CEV – elec	%	
878		HFT – CEV – Fuel	%	
879				
880	**Diesel**	Efuel	%	TEMA model
881		BioFuel	%	TEMA model
882		FossilFuel	%	TEMA model
883				
884	**Gasoline**	Efuel	%	TEMA model
885		BioFuel	%	TEMA model
886		FossilFuel	%	TEMA model
887				
888	**Gas**	Efuel	%	TEMA model
889		BioFuel	%	TEMA model
890		FossilFuel	%	TEMA model
891				
892	**Aviation gasoline**	Efuel	%	TEMA model
893		BioFuel	%	TEMA model
894		FossilFuel	%	TEMA model
895				
896	**Ship gasoline**	Efuel	%	TEMA model
897		BioFuel	%	TEMA model
898		FossilFuel	%	TEMA model
899				
900	**Energy consumption of**	LCV	TWh	
901		MFT	TWh	4th National Communication
902		HFT	TWh	4th National Communication
903		IWW	TWh	
904		Train	TWh	TEMA model
905		Marine	TWh	TEMA model
906		Aviation	TWh	TEMA model
907				
908	**3.C. Last-mile**			
909	**Share of PHEV vehicles**	LDV – PHEV – elec	%	
910		LDV – PHEV – Fuel	%	

Row	Bloc	Sector/Technology	Unit	Source
911		TwoW – PHEV – elec	%	
912		TwoW – PHEV – Fuel	%	
913				
914	**Diesel**	Efuel	%	TEMA model
915		BioFuel	%	TEMA model
916		FossilFuel	%	TEMA model
917				
918	**Gasoline**	Efuel	%	TEMA model
919		BioFuel	%	TEMA model
920		FossilFuel	%	TEMA model
921				
922	**Gas**	Efuel	%	TEMA model
923		BioFuel	%	TEMA model
924		FossilFuel	%	TEMA model
925				
926	**4. GHG**			
927	**4.A. CO2**			
928	**Short-haul emissions**	LCV	MtCO2	4th National Communication
929		MFT	MtCO2	4th National Communication
930		HFT	MtCO2	
931		IWW	MtCO2	4th National Communication
932		Train	MtCO2	
933		Marine	MtCO2	
934		Aviation	MtCO2	
935				
936	**Long-haul emissions**	LCV	MtCO2	
937		MFT	MtCO2	4th National Communication
938		HFT	MtCO2	4th National Communication
939		IWW	MtCO2	
940		Train	MtCO2	TEMA model
941		Marine	MtCO2	TEMA model
942		Aviation	MtCO2	TEMA model
943				
944	**4.B. CH4**			
945	**Short-haul emissions**	LCV	MtCH4	
946		MFT	MtCH4	
947		HFT	MtCH4	
948		IWW	MtCH4	
949		Train	MtCH4	
950		Marine	MtCH4	
951		Aviation	MtCH4	
952				

Row	Bloc	Sector/Technology	Unit	Source
953	**Long-haul emissions**	LCV	MtCH4	
954		MFT	MtCH4	
955		HFT	MtCH4	
956		IWW	MtCH4	
957		Train	MtCH4	
958		Marine	MtCH4	
959		Aviation	MtCH4	
960				
961	**4.C. N2O**			
962	**Short-haul emissions**	LCV	MtN2O	
963		MFT	MtN2O	
964		HFT	MtN2O	
965		IWW	MtN2O	
966		Train	MtN2O	
967		Marine	MtN2O	
968		Aviation	MtN2O	
969				
970	**Long-haul emissions**	LCV	MtN2O	
971		MFT	MtN2O	
972		HFT	MtN2O	
973		IWW	MtN2O	
974		Train	MtN2O	
975		Marine	MtN2O	
976		Aviation	MtN2O	
977				
978	**4.D. HFC**			
979		Average HFC charge/ LDV	kg HFC/LDV	TEMA model
980		Average HFC charge/ LCV	kg HFC/LCV	TEMA model
981		Average HFC charge/ MFT	kg HFC/MFT	TEMA model
982		Average HFC charge/ HFT	kg HFC/HFT	TEMA model
983				
984	**HFC – alternative HFC shares**	HFC share – LDV	%	TEMA model
985		HFC share – LCV	%	TEMA model
986		HFC share – MFT	%	TEMA model
987		HFC share – HFT	%	TEMA model

Industry

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
Row				
3	Activity			
4		Infrastructure – road	[km² or km of 1 lane]	MoMo
5		Infrastructure – rail	km of 1 lane]	MoMo
6		Mechanical equipments	# tons mecanical equipments	Buildings
7		Consumer packaging	# tons packaging	US EPA and World Bank and ECF CTI [Climact]
8		Electrical equipment	# tons electrical equipments	Energy
9		Electrical cables	# cables (1km long)	Energy
10		Pipes	# pipes (1m diameter, 1km long)	Energy
11		Other steel	# tons of steel	Instituto Aço Brail
12		Other ChemicalHVC	# tons of chemical	Pesquisa Industrial Anual
13		Other ChemicalAmmonia	# tons of chemical	Pesquisa Industrial Anual
14		Other ChemicalOther	# tons of chemical	Pesquisa Industrial Anual
15		Other cement	# tons of cement	Sindicato Nacional da Industria de Cimento
16		Other material to be added in future development	# tons of other materials	N/A
17		Other material to be added in future development	# tons of other materials	N/A
18		Other material to be added in future development	# tons of other materials	N/A
19		Other	# tons of other materials	N/A
20				
21	Lifetime			
22	Note: lifetime has to be understood relatively- it's the relative value compared with the targets of the scenario that will affect the demand.			
23	Road	Infra		CEA
24	Rail	Infra		CEA
25	Mechanical equipments			
26	Consumer packaging	Consumer goods	Year	Global calc
27	Electrical equipment	Energy	Year	Global calc – to review
28	Electrical cables	Energy	Year	Change LEVER
29	Pipes	Energy	Year	Change LEVER

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
30	Other steel	Other	Year	N/A : plug
31	Other ChemicalHVC	Other	Year	N/A : plug
32	Other ChemicalAmmonia	Other	Year	N/A : plug
33	Other ChemicalOther	Other	Year	N/A : plug
34	Other cement	Other	Year	N/A : plug
35	Other material to be added in future development			N/A : plug
36	Other material to be added in future development			N/A : plug
37	Other material to be added in future development			N/A : plug
38	Other	Other	Year	N/A : plug
39				
40				
41	**Share of regional production (from EU here)**			
42	% of product demand that is made in the region. (>100% if net exporter <100% if net importer)			
43		Cars & light truck	%	OICA and BTS
44		Cars & light truck EV	%	OICA and BTS
45		Trucks	%	OICA
46		Trucks EV	%	OICA
47		Batteries	%	Assumed 100%
48		Residential buildings new	%	Assumed 100%
49		Residential buildings renovated	%	Assumed 100%
50		Other buildings new	%	Assumed 100%
51		Other buildings renovated	%	Assumed 100%
52		Fertilizer	%	International Fertilizer Industry Association
53		Wind turbines	%	Multiple
54		PV panels	%	Multiple
55		Ships Passengers	%	Climact assumptions
56		Ships Freight	%	Climact assumptions
57		Rail Passenger	%	Climact assumptions
58		Rail Freight	%	Climact assumptions
59		Airplanes	%	Boeing and Airbus orders

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
60		Appliance Black	%	Climact assumptions
61		Appliance White	%	Climact assumptions
62		Other product to be added in future development	%	
63		Other product to be added in future development	%	
64		Other product to be added in future development	%	
65				
66		Infrastructure	%	Assumed 100%
67				Assumed 100%
68		Mechanical equipments	%	Climact assumptions
69		Consumer packaging	%	Climact assumptions
70		Other power plants	%	Assumed 100%
71		Electrical cables	%	Assumed 100%
72		Pipes	%	Assumed 100%
73		Other steel	%	Must be 100%, else leads to inconsistent figures
74		Other ChemicalHVC	%	Must be 100%, else leads to inconsistent figures
75		Other ChemicalAmmonia	%	Must be 100%, else leads to inconsistent figures
76		Other ChemicalOther	%	Must be 100%, else leads to inconsistent figures
77		Other cement	%	Must be 100%, else leads to inconsistent figures
78		Other material to be added in future development	%	
79		Other material to be added in future development	%	
80		Other material to be added in future development	%	
81		Other	%	Must be 100%, else leads to inconsistent figures
82				
83	Matrix of product composition			
84	Note: currently communicated as a matrix with a single entry (no multiptle year). If only 1 year is provided, it is still manageable. The levers will apply on the last year of data available.			
85				

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
86		Cement		
87				
88				
89				
90				
91				
92				
93				
94				
95				
96				
97				
98				
99				
100				
101				
102				
103				
104				
105				
106				
107				
108				
109				
110				
111				
112				
113				
114				
115				
116				
117				
118				
119				
120				
121				
122				
123				
124				
125				
126				

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
127		ChemicalAmmonia		
128				
129				
130				
131				
132				
133				
134				
135				
136				
137				
138				
139				
140				
141				
142				
143				
144				
145				
146				
147				
148				
149				
150				
151				
152				
153				
154				
155				
156				
157				
158				
159				
160				
161				
162				
163				
164				
165				
166				
167				

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
168		ChemicalHVC		
169				
170				
171				
172				
173				
174				
175				
176				
177				
178				
179				
180				
181				
182				
183				
184				
185				
186				
187				
188				
189				
190				
191				
192				
193				
194				
195				
196				
197				
198				
199				
200				
201				
202				
203				
204				
205				
206				
207				
208				

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
209		ChemicalOther		
210				
211				
212				
213				
214				
215				
216				
217				
218				
219				
220				
221				
222				
223				
224				
225				
226				
227				
228				
229				
230				
231				
232				
233				
234				
235				
236				
237				
238				
239				
240				
241				
242				
243				
244				
245				
246				
247				
248				
249				

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
250		Steel		
251				
252				
253				
254				
255				
256				
257				
258				
259				
260				
261				
262				
263				
264				
265				
266				
267				
268				
269				
270				
271				
272				
273				
274				
275				
276				
277				
278				
279				
280				
281				
282				
283				
284				
285				
286				
287				
288				
289				
290				

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
291		Other material 1		
292				
293				
294				
295				
296				
297				
298				
299				
300				
301				
302				
303				
304				
305				
306				
307				
308				
309				
310				
311				
312				
313				
314				
315				
316				
317				
318				
319				
320				
321				
322				
323				
324				
325				
326				
327				
328				
329				
330				
331				

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
332		Other material 2		
333				
334				
335				
336				
337				
338				
339				
340				
341				
342				
343				
344				
345				
346				
347				
348				
349				
350				
351				
352				
353				
354				
355				
356				
357				
358				
359				
360				
361				
362				
363				
364				
365				
366				
367				
368				
369				
370				
371				
372				

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
373		Other material 3		
374				
375				
376				
377				
378				
379				
380				
381				
382				
383				
384				
385				
386				
387				
388				
389				
390				
391				
392				
393				
394				
395				
396				
397				
398				
399				
400				
401				
402				
403				
404				
405				
406				
407				
408				
409				
410				
411				
412				
413				

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
414		Other Industries		
415				
416				
417				
418				
419				
420				
421				
422				
423				
424				
425				
426				
427				
428				
429				
430				
431				
432				
433				
434				
435				
436				
437				
438				
439				
440				
441				
442				
443				
444				
445				
446				
447				
448				
449				
450				
451				
452				
453				
454				

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
455				
456	Share of recycled historical input			
457	Steel		% recycled	Instituto Aço Brail
458	Chemical HVC		% recycled	
459	Chemical Ammonia		% recycled	
460	Chemical Nitrogen		% recycled	
461	Chemical Other		% recycled	
462	Cement		% recycled	
463	Other industries		% recycled	Climact assumption
464				
465	Share of material made within the region			
466	Steel		% made in region	World Steel
467	Chemical HVC		% made in region	IHS, Argus, Technon
468	Chemical Ammonia		% made in region	IHS, Argus, Technon
469	Chemical Other		% made in region	IHS, Argus, Technon
470	Cement		% made in region	World Cement
471	Other industries		% made in region	Unknown, Used manufacturing balance of tarde
472				
473	Matrix of technology used per material			
474				
475	SteelPrimarySteel.Oxygen		% of material made with the technology	Instituto Aço Brasil
476	SteelPrimarySteel.OxygenHisarna		% of material made with the technology	Instituto Aço Brasil
477	SteelSecondarySteel.Electric		% of material made with the technology	Instituto Aço Brasil
478	SteelSecondarySteel.ElectricDRI		% of material made with the technology	Instituto Aço Brasil
479	Chemical HVCPrimaryChemical HVC		% of material made with the technology	
480	Chemical HVCSecondaryChemical HVC		% of material made with the technology	

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
481	Chemical AmmoniaPrimaryChemical Ammonia		% of material made with the technology	
482	Chemical AmmoniaSecondaryChemical Ammonia		% of material made with the technology	
483	Chemical NitrogenPrimaryChemical Nitrogen		% of material made with the technology	
484	Chemical NitrogenSecondaryChemical Nitrogen		% of material made with the technology	
485	Chemical OtherPrimaryChemical Other		% of material made with the technology	
486	Chemical OtherSecondary Chemical Other		% of material made with the technology	
487	CementPrimary Cement.Klinker Dry		% of material made with the technology	Sindicato Nacional da Industria de Cimento
488	CementPrimary Cement.Klinker Wet		% of material made with the technology	Sindicato Nacional da Industria de Cimento
489	CementPrimary Cement.Polymers		% of material made with the technology	Sindicato Nacional da Industria de Cimento
490	CementSecondaryCement.ZeroEmissionByProducts		% of material made with the technology	Sindicato Nacional da Industria de Cimento
491	Other industriesPrimaryOther industriesPrimary		% of material made with the technology	
492	Other industriesSecondaryOther industriesSecondary		% of material made with the technology	
493				
494	**Matrix of specific consumption per technology and vector**			
495				
496				
497	Electricity.Steel.Oxygen.Primary			Instituto Aço Brasil; Balanço Energético Nacional
498	Electricity.Steel.OxygenHisarna.Primary			
499	Electricity.Steel.Electric.Secondary			Instituto Aço Brasil; Balanço Energético Nacional
500	Electricity.Steel.ElectricDRI.Secondary			
501	Electricity.ChemicalHVC.Primary			Sindicato Nacional da Industria de Cimento, Balanço energético

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
				nacional
502	Electricity.ChemicalAmmonia.Primary			Sindicato Nacional da Industria de Cimento, Balanço energético nacional
503	Electricity.ChemicalOther.Primary			Sindicato Nacional da Industria de Cimento, Balanço energético nacional
504	Electricity.Cement.KlinkerDry.Primary			Sindicato Nacional da Industria de Cimento, Balanço energético nacional
505	Electricity.Cement.KLinkerWet.Primary			Pesquisa Industrial Anual, Balanço energético nacional
506	Electricity.Cement.Polymers.Primary			
507	Electricity.Cement.ZeroEmissionByProducts.Secondary			
508	Electricity.OtherIndustries.Primary			Balanço energético Nacional
509	Electricity.OtherIndustries.Secondary			Balanço energético Nacional
510	Electricity.ChemicalAmmonia.Secondary			Balanço energético Nacional
511	Electricity.ChemicalHVC.Secondary			Balanço energético Nacional
512	Electricity.ChemicalOther.Secondary			Balanço energético Nacional
513				
514	Solid.Steel.Oxygen.Primary			Instituto Aço Brasil; Balanço Energético Nacional
515	Solid.Steel.OxygenHisarna.Primary			
516	Solid.Steel.Electric.Secondary			Instituto Aço Brasil; Balanço Energético Nacional
517	Solid.Steel.ElectricDRI.Secondary			
518	Solid.ChemicalHVC.Primary			Sindicato Nacional da Industria de Cimento, Balanço energético nacional
519	Solid.ChemicalA			Sindicato Nacional da

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
	mmonia.Primary			Industria de Cimento, Balanço energético nacional
520	Solid.ChemicalOther.Primary			Sindicato Nacional da Industria de Cimento, Balanço energético nacional
521	Solid.Cement.KlinkerDry.Primary			Sindicato Nacional da Industria de Cimento, Balanço energético nacional
522	Solid.Cement.KLinkerWet.Primary			Pesquisa Industrial Anual, Balanço energético nacional
523	Solid.Cement.Polymers.Primary			
524	Solid.Cement.ZeroEmissionByProducts.Secondary			
525	Solid.OtherIndustries.Primary			Balanço energético Nacional
526	Solid.OtherIndustries.Secondary			Balanço energético Nacional
527	Solid.ChemicalAmmonia.Secondary			Balanço energético Nacional
528	Solid.ChemicalHVC.Secondary			Balanço energético Nacional
529	Solid.ChemicalOther.Secondary			Balanço energético Nacional
530				
531	Liquid.Steel.Oxygen.Primary			Instituto Aço Brasil; Balanço Energético Nacional
532	Liquid.Steel.OxygenHisarna.Primary			
533	Liquid.Steel.Electric.Secondary			Instituto Aço Brasil; Balanço Energético Nacional
534	Liquid.Steel.ElectricDRI.Secondary			
535	Liquid.ChemicalHVC.Primary			Sindicato Nacional da Industria de Cimento, Balanço energético nacional
536	Liquid.ChemicalAmmonia.Primary			Sindicato Nacional da Industria de Cimento, Balanço energético nacional
537	Liquid.ChemicalOther.Primary			Sindicato Nacional da Industria de Cimento,

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
				Balanço energético nacional
538	Liquid.Cement.KlinkerDry.Primary			Sindicato Nacional da Industria de Cimento, Balanço energético nacional
539	Liquid.Cement.KLinkerWet.Primary			Pesquisa Industrial Anual, Balanço energético nacional
540	Liquid.Cement.Polymers.Primary			
541	Liquid.Cement.ZeroEmissionByProducts.Secondary			
542	Liquid.OtherIndustries.Primary			Balanço energético Nacional
543	Liquid.OtherIndustries.Secondary			Balanço energético Nacional
544	Liquid.ChemicalAmmonia.Secondary			Balanço energético Nacional
545	Liquid.ChemicalHVC.Secondary			Balanço energético Nacional
546	Liquid.ChemicalOther.Secondary			Balanço energético Nacional
547				
548	Gas.Steel.Oxygen.Primary			Instituto Aço Brasil; Balanço Energético Nacional
549	Gas.Steel.OxygenHisarna.Primary			
550	Gas.Steel.Electric.Secondary			Instituto Aço Brasil; Balanço Energético Nacional
551	Gas.Steel.ElectricDRI.Secondary			
552	Gas.ChemicalHVC.Primary			Sindicato Nacional da Industria de Cimento, Balanço energético nacional
553	Gas.ChemicalAmmonia.Primary			Sindicato Nacional da Industria de Cimento, Balanço energético nacional
554	Gas.ChemicalOther.Primary			Sindicato Nacional da Industria de Cimento, Balanço energético nacional
555	Gas.Cement.KlinkerDry.Primary			Sindicato Nacional da Industria de Cimento, Balanço energético

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
				nacional
556	Gas.Cement.KLinkerWet.Primary			Pesquisa Industrial Anual, Balanço energético nacional
557	Gas.Cement.Polymers.Primary			
558	Gas.Cement.ZeroEmissionByProducts.Secondary			
559	Gas.OtherIndustries.Primary			National Energy Balance
560	Gas.OtherIndustries.Secondary			National Energy Balance
561	Gas.ChemicalAmmonia.Secondary			National Energy Balance
562	Gas.ChemicalHVC.Secondary			National Energy Balance
563	Gas.ChemicalOther.Secondary			National Energy Balance
564				
565	Hydrogen.Steel.Oxygen.Primary			
566	Hydrogen.Steel.OxygenHisarna.Primary			
567	Hydrogen.Steel.Electric.Secondary			
568	Hydrogen.Steel.ElectricDRI.Secondary			
569	Hydrogen.ChemicalHVC.Primary			
570	Hydrogen.ChemicalAmmonia.Primary			
571	Hydrogen.ChemicalOther.Primary			
572	Hydrogen.Cement.KlinkerDry.Primary			
573	Hydrogen.Cement.KLinkerWet.Primary			
574	Hydrogen.Cement.Polymers.Primary			
575	Hydrogen.Cement.ZeroEmissionByProducts.Secondary			

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
576	Hydrogen.OtherIndustries.Primary			
577	Hydrogen.OtherIndustries.Secondary			
578	Hydrogen.ChemicalAmmonia.Secondary			
579	Hydrogen.ChemicalHVC.Secondary			
580	Hydrogen.ChemicalOther.Secondary			
581				
582				
583	Heat.Steel.Oxygen.Primary			
584	Heat.Steel.OxygenHisarna.Primary			
585	Heat.Steel.Electric.Secondary			
586	Heat.Steel.ElectricDRI.Secondary			
587	Heat.ChemicalHVC.Primary			
588	Heat.ChemicalAmmonia.Primary			
589	Heat.ChemicalOther.Primary			
590	Heat.Cement.KlinkerDry.Primary			
591	Heat.Cement.KLinkerWet.Primary			
592	Heat.Cement.Polymers.Primary			
593	Heat.Cement.ZeroEmissionByProducts.Secondary			
594	Heat.OtherIndustries.Primary			
595	Heat.OtherIndustries.Secondary			
596	Heat.ChemicalAmmonia.Secondary			

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
597	Heat.ChemicalHVC.Secondary			
598	Heat.ChemicalOther.Secondary			
599				
600				
601				
602				
603				
604				
605				
606				
607				
608	**Historical share of solid biomass in solid vector**			
609	CementKlinkerDryPrimary		%	National Energy Balance
610	CementKLinkerWetPrimary		%	National Energy Balance
611	CementPolymersPrimary		%	National Energy Balance
612	CementZeroEmissionByProductsSecondary		%	National Energy Balance
613	ChemicalAmmoniaSecondary		%	National Energy Balance
614	ChemicalAmmoniaPrimary		%	National Energy Balance
615	ChemicalHVCSecondary		%	National Energy Balance
616	ChemicalHVCPrimary		%	National Energy Balance
617	ChemicalOtherSecondary		%	National Energy Balance
618	ChemicalOtherPrimary		%	National Energy Balance
619	OtherIndustries Primary		%	National Energy Balance
620	OtherIndustries Secondary		%	National Energy Balance
621	SteelOxygenPrimary		%	National Energy Balance
622	SteelOxygenHisarnaPrimary		%	National Energy Balance
623	SteelElectricSecondary		%	National Energy Balance
624	SteelElectricDRI Secondary		%	National Energy Balance

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
625				
626				
627				
628	**Emission factors for combustion**			
629	See "Global Assumption" sheet			
630				
631	**Emission factors for process**			
632				
633	**CO_2 Emissions Factors**			
634	SteelOxygenPrimary		MtCO2/Mt	EmissionFactors.Process.CO2.SteelOxygenPrimary
635	SteelOxygenHisarnaPrimary		MtCO2/Mt	EmissionFactors.Process.CO2.SteelOxygenHisarnaPrimary
636	SteelElectricSecondary		MtCO2/Mt	EmissionFactors.Process.CO2.SteelElectricSecondary
637	SteelElectricDRISecondary		MtCO2/Mt	EmissionFactors.Process.CO2.SteelElectricDRISecondary
638	ChemicalHVCPrimary		MtCO2/Mt	EmissionFactors.Process.CO2.ChemicalHVCPrimary
639	ChemicalAmmoniaPrimary		MtCO2/Mt	EmissionFactors.Process.CO2.ChemicalAmmoniaPrimary
640	ChemicalOtherPrimary		MtCO2/Mt	EmissionFactors.Process.CO2.ChemicalOtherPrimary
641	CementKlinkerDryPrimary		MtCO2/Mt	EmissionFactors.Process.CO2.CementKlinkerDryPrimary
642	CementKlinkerWetPrimary		MtCO2/Mt	EmissionFactors.Process.CO2.CementKlinkerWetPrimary
643	CementZeroEmissionByProductsSecondary		MtCO2/Mt	EmissionFactors.Process.CO2.CementZeroEmissionByProductsSecondary
644	CementPolymersPrimary		MtCO2/Mt	EmissionFactors.Process.CO2.CementPolymersPrimary
645	OtherindustriesPrimary		MtCO2/Mt	EmissionFactors.Process.CO2.OtherindustriesPrimary
646	OtherindustriesSecondary		MtCO2/Mt	EmissionFactors.Process.CO2.OtherindustriesSecondary
647	ChemicalAmmoniaSecondary		MtCO2/Mt	EmissionFactors.Process.CO2.ChemicalAmmoniaSecond

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
				ary
648	ChemicalHVCSecondary		MtCO2/Mt	EmissionFactors.Process.CO2.ChemicalHVCSecondary
649	ChemicalOtherSecondary		MtCO2/Mt	EmissionFactors.Process.CO2.ChemicalOtherSecondary
650			MtCO2/Mt	N/A
651			MtCO2/Mt	N/A
652				
653	**CH_4 Emissions Factor**			
654	SteelOxygenPrimary		MtCH4/Mt	Global Calc
655	SteelOxygenHisarnaPrimary		MtCH4/Mt	Global Calc
656	SteelElectricSecondary		MtCH4/Mt	Global Calc
657	SteelElectricDRISecondary		MtCH4/Mt	Global Calc
658	ChemicalHVCPrimary		MtCH4/Mt	Global Calc
659	ChemicalAmmoniaPrimary		MtCH4/Mt	Global Calc
660	ChemicalOtherPrimary		MtCH4/Mt	Global Calc
661	CementKlinkerDryPrimary		MtCH4/Mt	Global Calc
662	CementKlinker WetPrimary		MtCH4/Mt	Global Calc
663	CementZeroEmissionByProducts Secondary		MtCH4/Mt	Global Calc
664	CementPolymersPrimary		MtCH4/Mt	Global Calc
665	Otherindustries Primary		MtCH4/Mt	Global Calc
666	Otherindustries Secondary		MtCH4/Mt	Global Calc
667	ChemicalAmmoniaSecondary		MtCH4/Mt	N/A
668	ChemicalHVCSecondary		MtCH4/Mt	N/A
669	ChemicalOtherSecondary		MtCH4/Mt	N/A
670				
671				
672	**N_2O Emissions Factors**			

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
673	SteelOxygenPrimary		MtN2O/Mt	Global Calc
674	SteelOxygenHisarnaPrimary		MtN2O/Mt	Global Calc
675	SteelElectricSecondary		MtN2O/Mt	Global Calc
676	SteelElectricDRISecondary		MtN2O/Mt	Global Calc
677	ChemicalHVCPrimary		MtN2O/Mt	Global Calc
678	ChemicalAmmoniaPrimary		MtN2O/Mt	Global Calc
679	ChemicalOtherPrimary		MtN2O/Mt	Global Calc
680	CementKlinkerDryPrimary		MtN2O/Mt	Global Calc
681	CementKlinker WetPrimary		MtN2O/Mt	Global Calc
682	CementZeroEmissionByProducts Secondary		MtN2O/Mt	Global Calc
683	CementPolymersPrimary		MtN2O/Mt	Global Calc
684	Otherindustries Primary		MtN2O/Mt	Global Calc
685	Otherindustries Secondary		MtN2O/Mt	Global Calc
686	ChemicalAmmoniaSecondary		MtN2O/Mt	N/A
687	ChemicalHVCSecondary		MtN2O/Mt	N/A
688	ChemicalOtherSecondary		MtN2O/Mt	N/A
689				
690	**Electricity consumption of CCS**			
691				
692	Mwh per ton of GHG captured		TWh/Mt	
693				
694	**Feedstock per process**			
695				
696	SteelOxygen.Electricity	Feedstock	TWh/Mt	Instituto Aço Brasil; National Energy Balance
697	SteelOxygen.FossilFuelCoal	Feedstock	TWh/Mt	Instituto Aço Brasil; National Energy Balance

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
698	SteelOxygen.FossilFuelOil	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
699	SteelOxygen.FossilFuelGas	Feedstock	TWh/Mt	Instituto Aço Brasil; National Energy Balance
700	SteelOxygen.Hydrogen	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
701	SteelOxygen.BioFuelSolidWaste	Feedstock	TWh/Mt	Instituto Aço Brasil; National Energy Balance
702	SteelOxygenHisarna.Electricity	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
703	SteelOxygenHisarna.FossilFuelCoal	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
704	SteelOxygenHisarna.FossilFuel Oil	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
705	SteelOxygenHisarna.FossilFuelGas	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
706	SteelOxygenHisarna.Hydrogen	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
707	SteelOxygenHisarna.BioFuelSolidWaste	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
708	SteelElectric.Electricity	Feedstock	TWh/Mt	Instituto Aço Brasil; National Energy Balance
709	SteelElectric.FossilFuelCoal	Feedstock	TWh/Mt	Instituto Aço Brasil; National Energy Balance
710	SteelElectric.FossilFuelOil	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
711	SteelElectric.FossilFuelGas	Feedstock	TWh/Mt	Instituto Aço Brasil; National Energy Balance
712	SteelElectric.Hydrogen	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
713	SteelElectric.BioFuelSolidWaste	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
714	SteelElectricDRI.Electricity	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
715	SteelElectricDRI.FossilFuelCoal	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
716	SteelElectricDRI.FossilFuelOil	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
717	SteelElectricDRI.FossilFuelGas	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
718	SteelElectricDRI.Hydrogen	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
719	SteelElectricDRI.BioFuelSolidWaste	Feedstock	TWh/Mt	Global Calculator – Michel Cornet

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
720	ChemicalHVC.Electricity	Feedstock	TWh/Mt	pesquisa industrial anual, National Energy Balance
721	ChemicalHVC.FossilFuelCoal	Feedstock	TWh/Mt	pesquisa industrial anual, National Energy Balance
722	ChemicalHVC.FossilFuelOil	Feedstock	TWh/Mt	pesquisa industrial anual, National Energy Balance
723	ChemicalHVC.FossilFuelGas	Feedstock	TWh/Mt	pesquisa industrial anual, National Energy Balance
724	ChemicalHVC.Hydrogen	Feedstock	TWh/Mt	pesquisa industrial anual, National Energy Balance
725	ChemicalHVC.BioFuelSolidWaste	Feedstock	TWh/Mt	pesquisa industrial anual, National Energy Balance
726	ChemicalAmmonia.Electricity	Feedstock	TWh/Mt	pesquisa industrial anual, National Energy Balance
727	ChemicalAmmonia.FossilFuelCoal	Feedstock	TWh/Mt	pesquisa industrial anual, National Energy Balance
728	ChemicalAmmonia.FossilFuelOil	Feedstock	TWh/Mt	pesquisa industrial anual, National Energy Balance
729	ChemicalAmmonia.FossilFuelGas	Feedstock	TWh/Mt	pesquisa industrial anual, National Energy Balance
730	ChemicalAmmonia.Hydrogen	Feedstock	TWh/Mt	pesquisa industrial anual, National Energy Balance
731	ChemicalAmmonia.BioFuelSolidWaste	Feedstock	TWh/Mt	pesquisa industrial anual, National Energy Balance
732	ChemicalOther.Electricity	Feedstock	TWh/Mt	pesquisa industrial anual, National Energy Balance
733	ChemicalOther.FossilFuelCoal	Feedstock	TWh/Mt	pesquisa industrial anual, National Energy Balance
734	ChemicalOther.FossilFuelOil	Feedstock	TWh/Mt	pesquisa industrial anual, National Energy Balance
735	ChemicalOther.FossilFuelGas	Feedstock	TWh/Mt	pesquisa industrial anual, National Energy Balance
736	ChemicalOther.Hydrogen	Feedstock	TWh/Mt	pesquisa industrial anual, National Energy Balance
737	ChemicalOther.BioFuelSolidWaste	Feedstock	TWh/Mt	pesquisa industrial anual, National Energy Balance
738	CementKlinkerDry.Electricity	Feedstock	TWh/Mt	Sindicato Nacional da Industria de Cimento, National Energy Balance
739	CementKlinkerDry.FossilFuelCoal	Feedstock	TWh/Mt	Sindicato Nacional da Industria de Cimento, National Energy Balance
740	CementKlinkerDry.FossilFuelOil	Feedstock	TWh/Mt	Sindicato Nacional da Industria de Cimento, National Energy Balance
741	CementKlinkerDry.FossilFuelGas	Feedstock	TWh/Mt	Sindicato Nacional da Industria de Cimento, National Energy Balance

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
742	CementKlinkerDry.Hydrogen	Feedstock	TWh/Mt	Sindicato Nacional da Industria de Cimento, National Energy Balance
743	CementKlinkerDry.BioFuelSolidWaste	Feedstock	TWh/Mt	Sindicato Nacional da Industria de Cimento, National Energy Balance
744	CementKlinker Wet.Electricity	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
745	CementKlinkerWet.FossilFuelCoal	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
746	CementKlinkerWet.FossilFuelOil	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
747	CementKlinkerWet.FossilFuelGas	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
748	CementKlinker Wet.Hydrogen	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
749	CementKlinker Wet.BioFuelSolidWaste	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
750	CementPolymers.Electricity	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
751	CementPolymers.FossilFuelCoal	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
752	CementPolymers.FossilFuelOil	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
753	CementPolymers.FossilFuelGas	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
754	CementPolymers.Hydrogen	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
755	CementPolymers.BioFuelSolidWaste	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
756	CementZeroEmissionByProducts.Electricity	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
757	CementZeroEmissionByProducts.FossilFuelCoal	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
758	CementZeroEmissionByProducts.FossilFuelOil	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
759	CementZeroEmissionByProducts.FossilFuelGas	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
760	CementZeroEmissionByProducts.Hydrogen	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
761	CementZeroEmissionByProducts.BioFuelSolidWa	Feedstock	TWh/Mt	Global Calculator – Michel Cornet

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
	ste			
762	Otherindustries Primary.Electricity	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
763	Otherindustries Primary.FossilFuelCoal	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
764	Otherindustries Primary.FossilFuelOil	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
765	Otherindustries Primary.FossilFuelGas	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
766	Otherindustries Primary.Hydrogen	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
767	Otherindustries Primary.BioFuelSolidWaste	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
768	Otherindustries Secondary.Electricity	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
769	Otherindustries Secondary.FossilFuelCoal	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
770	Otherindustries Secondary.FossilFuelOil	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
771	Otherindustries Secondary.FossilFuelGas	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
772	Otherindustries Secondary.Hydrogen	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
773	Otherindustries Secondary.BioFuelSolidWaste	Feedstock	TWh/Mt	Global Calculator – Michel Cornet
774				
775	**Young Modulus**			
776	From Steel to HVC			
777	From Cement to HVC			
778				
779				
780				
781	**Total amount of material produced**			
782				

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
783	Cement		Mt	Sindicato Nacional da Industria de Cimento
784	ChemicalAmmonia		Mt	Pesquisa Industrial Anual
785	ChemicalHVC		Mt	Pesquisa Industrial Anual
786	ChemicalOther		Mt	Pesquisa Industrial Anual
787	OtherIndustries		Mt	Pesquisa Industrial Anual
788	Steel		Mt	Instituto Aço Brasil
789				
790	**Energy per process**			
791				National Energy Balance
792				National Energy Balance
793				National Energy Balance
794				National Energy Balance
795				National Energy Balance
796				National Energy Balance
797				
798	**To change to get the right total**			
799			TWh/Mt	
800			TWh/Mt	
801			TWh/Mt	
802			TWh/Mt	
803			TWh/Mt	
804			TWh/Mt	
805			TWh/Mt	
806			TWh/Mt	
807			TWh/Mt	
808			TWh/Mt	
809			TWh/Mt	
810			TWh/Mt	
811			TWh/Mt	
812			TWh/Mt	
813			TWh/Mt	
814			TWh/Mt	
815			TWh/Mt	
816			TWh/Mt	
817			TWh/Mt	
818			TWh/Mt	
819			TWh/Mt	

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
820			TWh/Mt	
821			TWh/Mt	
822			TWh/Mt	
823			TWh/Mt	
824			TWh/Mt	
825			TWh/Mt	
826			TWh/Mt	
827			TWh/Mt	
828			TWh/Mt	
829			TWh/Mt	
830			TWh/Mt	
831			TWh/Mt	
832			TWh/Mt	
833			TWh/Mt	
834			TWh/Mt	
835			TWh/Mt	
836			TWh/Mt	
837			TWh/Mt	
838			TWh/Mt	
839			TWh/Mt	
840			TWh/Mt	
841			TWh/Mt	
842			TWh/Mt	
843			TWh/Mt	
844			TWh/Mt	
845			TWh/Mt	
846			TWh/Mt	
847			TWh/Mt	
848			TWh/Mt	
849			TWh/Mt	
850			TWh/Mt	
851			TWh/Mt	
852			TWh/Mt	
853			TWh/Mt	
854			TWh/Mt	
855			TWh/Mt	
856			TWh/Mt	
857			TWh/Mt	
858			TWh/Mt	
859			TWh/Mt	
860			TWh/Mt	

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
861			TWh/Mt	
862			TWh/Mt	
863			TWh/Mt	
864			TWh/Mt	
865			TWh/Mt	
866			TWh/Mt	
867			TWh/Mt	
868			TWh/Mt	
869			TWh/Mt	
870			TWh/Mt	
871			TWh/Mt	
872			TWh/Mt	
873			TWh/Mt	
874			TWh/Mt	
875			TWh/Mt	
876			TWh/Mt	
877			TWh/Mt	
878			TWh/Mt	
879			TWh/Mt	
880			TWh/Mt	
881			TWh/Mt	
882			TWh/Mt	
883			TWh/Mt	
884			TWh/Mt	
885			TWh/Mt	
886			TWh/Mt	
887			TWh/Mt	
888			TWh/Mt	
889				
890				
891				
892				
893				
894				
895				
896				
897				
898				
899				
900				
901	Emissions per			

GHG Model – Industry	Bloc	Sector/Technology	Unit	Source
	material produced (CO2e)			
902	Blend process and combustion in one			
903	Total CO2e			
904	Cement (Combustion + process)			Fourth national GHG inventory
905	Chemicals			Fourth national GHG inventory
906	OtherIndustries			Fourth national GHG inventory
907	Steel			Fourth national GHG inventory

CENTRO CLIMA
CENTRO DE ESTUDOS INTEGRADOS SOBRE MEIO AMBIENTE E MUDANÇAS CLIMÁTICAS - COPPE / UFRJ

UFRJ COPPE

Buildings

Residential				
	Bloc	**Sector/Technology**	**Unit**	**Source**
	0. Required inputs & assumptions			
3	**1. ACTIVITY**			
4		Floor area demand per capita	m^2/capita	BuMo, EU28, A3;A8
5				
6	*This two factors have been revised so that new surface area produced this year are aligned with historical data*	Demolition activity	%	Extended BuMo
7		Renovation activity	%	Extended BuMo
8				
9	**2. STOCK**			
10	**Buildings lifetime**	New area (must be a multiple of 5)	yr	user choice
11		Renovated area (must be a multiple of 5)	yr	user choice
12				
13	**2.B. Heating**			
14	**Specific Energy Demand**	New area	kWh/m^2/yr	user choice
15		Renovated area	kWh/m^2/yr	user choice
16		Old area	kWh/m^2/yr	BuMo
17		Best in Old area (must be lower than the input time series)	kWh/m^2/yr	Used EE indicators dataset. Took energy intensity of first quartile as a percentage of the average, then applying this % to min value in data series above.
18				
19	**2.C. Space cooling**			
20	**Specific Energy Demand**	New area	kWh/m^2/yr	user choice
21		Renovated area	kWh/m^2/yr	user choice
22		Old area	kWh/m^2/yr	BuMo
23		Best in Old area (must be lower than the input time series)	kWh/m^2/yr	Used EE indicators dataset. Took energy intensity of first quartile as a percentage of the average, then applying this % to min value in data series above.
24	**Penetration**	Penetration of space cooling in old area	%	Extended BuMo
25		Penetration of space cooling in others areas	%	Extended BuMo
26				

Residential				
	Bloc	**Sector/Technology**	**Unit**	**Source**
27	**2.D. Water heating**			
28	**Water heating**	Total energy consumption	kWh/capita/yr	BuMo, EU28, A3;A65
29				
30	**2.E. Lighting**			
31	**Specific Energy Demand**	New area	kWh/m²/yr	user choice
32		Renovated area	kWh/m²/yr	user choice
33		Old area	kWh/m²/yr	BuMo
34		Best in Old area (must be lower than the input time series)	kWh/m²/yr	Used EE indicators dataset. Took energy intensity of first quartile as a percentage of the average, then applying this % to min value in data series above.
35	**Penetration**	Penetration of space lighting	%	IBGE. https://seriesestatisticas.ibge.gov.br/series.aspx?vcodigo=PD213&t=iluminacao-eletrica-existencia-domicilio e https://seriesestatisticas.ibge.gov.br/series.aspx?vcodigo=PD387&t=iluminacao-eletrica-existencia-domicilio
36				
37	**2.F. Appliances**			
38	**Appliance penetration (%)**	Fridges	Units/ capita	IBGE
39		Freezers	Units/ capita	IBGE
40		Dishwashers	Units/ capita	IBGE
41		Washers	Units/ capita	IBGE
42		Dryers	Units/ capita	IBGE
43		Televisions	Units/ capita	IBGE
44	**Appliance specific energy use**	Fridges	kWh/unit	Extended BuMo
45		Freezers	kWh/unit	Extended BuMo
46		Dishwashers	kWh/unit	Extended BuMo
47		Washers	kWh/unit	Extended BuMo
48		Dryers	kWh/unit	Extended BuMo
49		Televisions	kWh/unit	Extended BuMo
50	**Other plug load**	Other plug load per capita	kWh/ capita	Extended BuMo
51				
52	**2.G. Cooking**			
53		Total energy consumption	kWh/capita/yr	BuMo, EU28, A3;A38
54				
55	**2.H. Ventilation**			
56	**Penetration**	Penetration of ventilation in old area	%	Extended BuMo
57		Penetration of ventilation in	%	Extended BuMo

Residential				
	Bloc	**Sector/Technology**	**Unit**	**Source**
		other areas		
58	**Specific energy demand**	Old area	kWh/m²/yr	Extended BuMo
59		Other areas	kWh/m²/yr	user choice
60	**3. ENERGY**			
61	**3.B. Space heating**			
62	**Technology**	Boiler solid	%	BuMo, EU28, A73 + 84
63		Boiler liquid	%	BuMo, EU28, A74
64		Boiler gas	%	BuMo, EU28, A80
65		Electrical	%	BuMo
66		CHP solid	%	BuMo, IEA, Werner 2017
67		CHP liquid	%	BuMo, IEA, Werner 2018
68		CHP gas	%	BuMo, IEA, Werner 2019
69		Heat pump hybrid	%	Assumed zero because hybrid heat pumps are zero in historical BuMo data
70		Heat Pump full electric	%	BuMo, EU28, A82
71		Solar thermal	%	BuMo, EU28, A87
72		District heating	%	BuMo, EU28, A83
73				
74		COP Heat Pumps	%	Literature review
75		HP Hybrid Ratio Elec/Gas	%	Element Energy 2017
76				
77	**Efficiency**	Boiler	%	Extended BuMo
78		Electrical	%	Assumption
79		CHP	%	Extended BuMo
80		Heat pumps	%	Extended BuMo
81		Solar thermal	%	Extended BuMo
82		District heating	%	Extended BuMo
83				
84	**Calibration**	District Heat	TWh	BuMo
85		Electricity	TWh	BuMo
86		BioGas	TWh	BuMo
87		Synthetized Gas	TWh	BuMo
88		Natural Gas	TWh	BuMo
89		BioLiquid	TWh	BuMo
90		Oil	TWh	BuMo
91		Biomass	TWh	BuMo
92		Coal	TWh	BuMo
93				
94	**3.C. Space cooling**			
95	**Technology**	District cooling	%	Extended BuMo
96		Heat pump full electric	%	Extended BuMo

Residential				
	Bloc	**Sector/Technology**	**Unit**	**Source**
97		Heat pump hybrid	%	Extended BuMo
98		Night cooling	%	Extended BuMo
99		Evaporative cooler	%	Extended BuMo
100		Room air conditioner	%	Extended BuMo
101		Split AC	%	Extended BuMo
102		Central HVAC	%	Extended BuMo
103				
104		COP Heat Pumps	%	Literature review
105				
106	**Efficiency**	District Cooling	%	Extended BuMo
107		Night Cooling	%	Assumption
108		Evaporative cooler	%	Extended BuMo
109		Room air conditioner	%	Extended BuMo
110		Split AC	%	Extended BuMo
111		Central HVAC	%	Extended BuMo
112				
113	**Calibration**	District cold	TWh	BuMo
114		Electricity	TWh	BuMo
115		BioGas	TWh	BuMo
116		Synthetized Gas	TWh	BuMo
117		Natural Gas	TWh	BuMo
118				
119	**3.D. Water heating**			
120	**Technology**	Boiler solid	%	BuMo, EU28, A99 + 109
121		Boiler liquid	%	BuMo, EU28, A100
122		Boiler gas	%	BuMo, EU28, A104 – 105
123		Electrical	%	BuMo
124		CHP solid	%	BuMo, IEA, Werner 2017
125		CHP liquid	%	BuMo, IEA, Werner 2018
126		CHP gas	%	BuMo, IEA, Werner 2019
127		Heat pump hybrid	%	Assumed zero because hybrid heat pumps are zero in historical BuMo data
128		Heat Pump full electric	%	BuMo, EU28, A107
129		Solar thermal	%	BuMo, EU28, A112
130		District heating	%	BuMo, EU28, A108
131				
132	**Calibration**	District Heat	TWh	BuMo
133		Electricity	TWh	BuMo
134		BioGas	TWh	BuMo
135		Synthetized Gas	TWh	BuMo
136		Natural Gas	TWh	BuMo

Residential				
	Bloc	**Sector/Technology**	**Unit**	**Source**
137		BioLiquid	TWh	BuMo
138		Oil	TWh	BuMo
139		Biomass	TWh	BuMo
140		Coal	TWh	BuMo
141				
142	**3.E. Lighting**			
143	**Efficiency**	Lighting	%	CLIMACT Assumption
144				
145	**Calibration**	Lighting	TWh	BuMo
146	**3.F. Appliances**			
147	**Efficiency**	White Appliances	%	CLIMACT Assumption
148		Black Appliances	%	CLIMACT Assumption
149				
150	**Calibration**	Elec	TWh	BuMo
151	**3.G. Cooking**			
152	**Technology**	Electric technology	%	A124
153		Gas technology	%	A123
154		Liquid technology	%	A121
155		Solid technology	%	A120+125
156				
157	**Efficiency**	Electric cooking	%	BuMo intermediate
158		Gas cooking	%	BuMo intermediate
159		Liquid cooking	%	BuMo intermediate
160		Solid cooking	%	BuMo intermediate
161				
162	**Calibration**	Electricity	TWh	BuMo
163		Biogas	TWh	BuMo
164		Synth Gas	TWh	BuMo
165		Natural Gas	TWh	BuMo
166		Bioliquid	TWh	BuMo
167		Oil	TWh	BuMo
168		Biomass	TWh	Assumption
169		Coal	TWh	Assumption
170	**3.H. Ventilation**			
171	**Calibration**	Elec	TWh	BuMo
172	**3.I. Fuel switch**			
173		BioGas share in Gas	%	IEA World Energy Balances (note that the IEA residential category doesn't precisely align with the BuMo boundaries, but it is quite close)
174		Synthetized Gas share in Gas	%	Assumed zero

Residential				
	Bloc	Sector/Technology	Unit	Source
175		BioLiquid share in Liquid	%	
176		Biomass share in Solid	%	Solid fuel is Wood and charcoal. Residential sector in Brazil does not use coal
177	**4. GHG**			
178	**4.A. CO_2**			
179	**4.A.i. Space Heating**			
180	**Calibration**	CO_2 emissions	$MtCO_2$	Total Residential emissions value in line 242
181	**4.A.ii. Space Cooling**			
182	**Calibration**	CO_2 emissions	$MtCO_2$	Total Residential emissions value in line 242
183	**4.A.iii. Water Heating**			
184	**Calibration**	CO_2 emissions	$MtCO_2$	Total Residential emissions value in line 242
185	**4.A.ii. Cooking**			
186	**Calibration**	CO_2 emissions	$MtCO_2$	Total Residential emissions value in line 242
187	**4.B. CH_4**			
188	**4.B.i. Space Heating**			
189	**Calibration**	CH_4 emissions	$MtCH_4$	Total Residential emissions value in line 242
190	**4.B.ii. Space Cooling**			
191	**Calibration**	CH_4 emissions	$MtCH_4$	Total Residential emissions value in line 242
192	**4.B.iii. Water Heating**			
193	**Calibration**	CH_4 emissions	$MtCH_4$	Total Residential emissions value in line 242
194	**4.B.ii. Cooking**			
195	**Calibration**	CH_4 emissions	$MtCH_4$	Total Residential emissions value in line 242
196	**4.C. N_2O**			
197	**4.C.i. Space Heating**			
198	**Calibration**	N_2O emissions	MtN_2O	Total Residential emissions value in line 242
199	**4.C.ii. Space Cooling**			
200	**Calibration**	N_2O emissions	MtN_2O	Total Residential emissions value in line 242
201	**4.C.iii. Water Heating**			
202	**Calibration**	N_2O emissions	MtN_2O	Total Residential emissions value in line 242
203	**4.C.ii. Cooking**			
204	**Calibration**	N_2O emissions	MtN_2O	Total Residential emissions value in line 242
205	**4.D. HFC**			

Residential				
	Bloc	**Sector/Technology**	**Unit**	**Source**
206	**AC**	Refregirant use rate	kg HFC/kW	Accounted in Input Industry
207		Leakage rate	%	Accounted in Input Industry
208				
209	**Refregirators**	Number of Refrigerators	millions	IBGE. https://seriesestatisticas.ibge.gov.br/series.aspx?vcodigo=PD237&t=domicilios-particulares-permanentes-posse-geladeira
210		Refrigerator HFC Charge Amount	kg HFC/refrigerator	Accounted in Input Industry
211		Annual leakage rate	%	Accounted in Input Industry
212		Share of Refrigerators Retired	%	Accounted in Input Industry
213		Retired refrigerator HFC Charge Amount	kg HFC/refrigerator	Accounted in Input Industry
214		End of Life Emissions Rate	%	Accounted in Input Industry
215				
216	**Share of alternative HFC**		%	Accounted in Input Industry
217	**5. Outputs**			
218	**5.A. Industry**			
219	**Area built this year**	Residential buildings new	Mm^2	Extended BuMo
220		Residential buildings renovated	Mm^2	Extended BuMo
221		NonResidential buildings new	Mm^2	Extended BuMo
222		NonResidential buildings renovated	Mm^2	Extended BuMo
223				
224	**Appliance stock**	Fridges	1000 units	IBGE. https://seriesestatisticas.ibge.gov.br/series.aspx?vcodigo=PD237&t=domicilios-particulares-permanentes-posse-geladeira
225		Freezers	1000 units	IBGE. https://biblioteca.ibge.gov.br/visualizacao/livros/liv98887.pdf
226		Dishwashers	1000 units	
227		Washers	1000 units	IBGE. https://seriesestatisticas.ibge.gov.br/series.aspx?vcodigo=PD280&t=domicilios-particulares-permanentes-posse-maquina-lavar
228		Dryers	1000 units	
229		Televisions	1000 units	IBGE. https://seriesestatisticas.ibg

Residential				
	Bloc	**Sector/Technology**	**Unit**	**Source**
				e.gov.br/series.aspx?vcodigo =PD282&t=domicilios-particulares-permanentes-posse-televisao
230	**5.B. Power**			
231		Residential electricity	TWh	BEN
232		Non-residential electricity	TWh	BEN
233	**5.C. Oil&Gas**			
234		Natural gas	TWh	Natural Gas e LPG
235		Oil	TWh	no
236		Coal	TWh	no
237	**5.F. Energy**			
238		Renewables	TWh	Wood and charcoal
239		Heat	TWh	
240		Coal	TWh	
241	Extra data			
242	**6. GHG**			
243	**CO2**			
244	**Total**			
245	Residencial	CO2 emissions	MtCO2	Fourth National GHG Inventory
246				
247	**CH4**			
248	**Total**			
249	Residencial	CH4 emissions	MtCH4	Fourth National GHG Inventory
250				
251	**N2O**			
252	**Total**			
253	Residencial	N2O emissions	MtN2O	Fourth National GHG Inventory

Non-residental				
	Bloc	**Unit**	**Sector/Technology**	**Source**
2	**0. Required inputs & assumptions**			
3	**1. ACTIVITY**			
4		m^2/capita	Floor area demand per person	
5				
6		%	Demolition activity	
7		%	Renovation activity	
8				
9	**2. STOCK**			
10	**Buildings lifetime**	yr	New area (must be a multiple of 5)	user choice
11		yr	Renovated area (must be a multiple of 5)	user choice
12				
13	**2.B. Space heating**			
14	**Specific Energy Demand**	kWh/m^2/yr	New area	user choice
15		kWh/m^2/yr	Renovated area	user choice
16		kWh/m^2/yr	Old area	
17		kWh/m^2/yr	Best in Old area (must be lower than the input time series)	
18				
19	**2.C. Space cooling**			
20	**Penetration**	%	Penetration of space cooling in old area	
21		%	Penetration of space cooling in others areas	
22	**Specific Energy Demand**	kWh/m^2/yr	New area	user choice
23		kWh/m^2/yr	Renovated area	user choice
24		kWh/m^2/yr	Old area	
25		kWh/m^2/yr	Best in Old area (must be lower than the input time series)	
26				
27	**2.D. Water heating**			
28		kWh/capita/yr	Total energy consumption	
29				
30	**2.E. Lighting**			
31	**Penetration**	%	Penetration of space lighting	IBGE. https://seriesestatisticas.ibge.gov.br/series.aspx?vcodigo=PD213&t=iluminacao-eletrica-existencia-domicilio e

Non-residental				
	Bloc	**Unit**	**Sector/Technology**	**Source**
				https://seriesestatisticas.ibge.gov.br/series.aspx?vcodigo=PD387&t=iluminacao-eletrica-existencia-domicilio
32	**Specific Energy Demand**	kWh/m²/yr	New area	user choice
33		kWh/m²/yr	Renovated area	user choice
34		kWh/m²/yr	Old area	
35		kWh/m²/yr	Best in Old area (must be lower than the input time series)	
36				
37	**2.F. Appliances**			
38	**Penetration**	%, w.r.t. baseyear	Penetration of white appliances	to check with calibration
39		%, w.r.t. baseyear	Penetration of black appliances	
40	**Specific energy demand**	kWh/capita/yr	White appliances	
41		kWh/capita/yr	Black appliances	
42				
43	**2.G. Ventilation**			
44	**Penetration**	%	Penetration of ventilation in old area	to check with calibration
45		%	Penetration of ventilation in other areas	
46	**Specific energy demand**	kWh/m²/yr	Old area	
47		kWh/m²/yr	Other areas	user choice
48				
49	**3. ENERGY**			
50	**3.B. Space heating**			
51	**Technology**	%	Boiler solid	
52		%	Boiler liquid	
53		%	Boiler gas	
54		%	Electrical	
55		%	CHP solid	
56		%	CHP liquid	
57		%	CHP gas	
58		%	Heat pump hybrid	
59		%	Heat Pump full electric	
60		%	Solar thermal	
61		%	District heating	
62				
63		%	COP Heat Pumps	Literature

Non-residental				
	Bloc	**Unit**	**Sector/Technology**	**Source**
64		%	HP Hybrid Ratio Elec/Gas	
65				
66	**Efficiency**	%	Boiler	
67		%	Electrical	Assumption
68		%	CHP	Assumption
69		%	Heat pumps	
70		%	Solar thermal	
71		%	District heating	
72				
73	**Calibration**	TWh	District Heat	BuMo
74		TWh	Electricity	BuMo
75		TWh	BioGas	BuMo
76		TWh	Synthetized Gas	BuMo
77		TWh	Natural Gas	BuMo
78		TWh	BioLiquid	BuMo
79		TWh	Oil	BuMo
80		TWh	Biomass	BuMo
81		TWh	Coal	BuMo
82	**3.C. Space cooling**			
83	**Technology**	%	District cooling	
84		%	Heat pump full electric	
85		%	Heat pump hybrid	
86		%	Night cooling	
87		%	Evaporative cooler	
88		%	Room air conditioner	
89		%	Split AC	
90		%	Central HVAC	
91				
92		%	COP Heat Pumps	Literature
93				
94	**Efficiency**	%	District Cooling	
95		%	Night Cooling	Assumption
96		%	Evaporative cooler	Assumption
97		%	Room air conditioner	
98		%	Split AC	
99		%	Central HVAC	
100				
101	**Calibration**	TWh	District cold	BuMo
102		TWh	Electricity	BuMo
103		TWh	BioGas	BuMo

Non-residental				
	Bloc	Unit	Sector/Technology	Source
104		TWh	Synthetized Gas	BuMo
105		TWh	Natural Gas	BuMo
106	**3.D. Water heating**			
107	**Technology**	%	Boiler solid	
108		%	Boiler liquid	
109		%	Boiler gas	
110		%	Electrical	
111		%	CHP solid	
112		%	CHP liquid	
113		%	CHP gas	
114		%	Heat pump hybrid	
115		%	Heat Pump full electric	
116		%	Solar thermal	
117		%	District heating	
118				
119	**Calibration**	TWh	District Heat	BuMo
120		TWh	Electricity	BuMo
121		TWh	BioGas	BuMo
122		TWh	Synthetized Gas	BuMo
123		TWh	Natural Gas	BuMo
124		TWh	BioLiquid	BuMo
125		TWh	Oil	BuMo
126		TWh	Biomass	BuMo
127		TWh	Coal	BuMo
128	**3.E. Lighting**			
129	**Efficiency**	%	Lighting	Assumption
130				
131	**Calibration**	TWh	Lighting	BuMo
132	**3.F. Appliances**			
133	**Efficiency**	%	White Appliances	Assumption
134		%	Black Appliances	Assumption
135				
136	**Calibration**	TWh	Elec	To replace – model values inserted here
137	**3.G. Ventilation**			
138	**Calibration**	TWh	Elec	To replace – model values inserted here
139	**3.I. Fuel switch**			
140		%	BioGas share in Gas	
141		%	Synthetized Gas share in Gas	Assumption
142		%	BioLiquid share in Liquid	

Non-residental				
	Bloc	**Unit**	**Sector/Technology**	**Source**
143		%	Biomass share in Solid	Solid fuel is Wood and charcoal. NonResidential sector in Brazil does not use coal
144	**4. GHG**			
145	**4.A. CO2**			
146	**4.A.i. Space Heating**			
147	**Calibration**	MtCO2	CO2 emissions	Total Residential emissions value in line 172
148	**4.A.ii. Space Cooling**			
149	**Calibration**	MtCO2	CO2 emissions	Total Residential emissions value in line 172
150	**4.A.iii. Water Heating**			
151	**Calibration**	MtCO2	CO2 emissions	Total Residential emissions value in line 172
152	**4.B. CH4**			
153	**4.B.i. Space Heating**			
154	**Calibration**	MtCH4	CH4 emissions	Total Residential emissions value in line 172
155	**4.B.ii. Space Cooling**			
156	**Calibration**	MtCH4	CH4 emissions	Total Residential emissions value in line 172
157	**4.B.iii. Water Heating**			
158	**Calibration**	MtCH4	CH4 emissions	Total Residential emissions value in line 172
159	**4.C. N2O**			
160	**4.C.i. Space Heating**			
161	**Calibration**	MtN2O	N2O emissions	Total Residential emissions value in line 172
162	**4.C.ii. Space Cooling**			
163	**Calibration**	MtN2O	N2O emissions	Total Residential emissions value in line 172
164	**4.C.iii. Water Heating**			
165	**Calibration**	MtN2O	N2O emissions	Total Residential emissions value in line 172
166	**4.D. HFC**			
167		billions of $	Services Sector Value Added	Accounted in Input Industry

Non-residental				
	Bloc	**Unit**	**Sector/Technology**	**Source**
168		t HFC/$ billion commercial sector value added	Commercial refrigeration HFC emissions factor	Accounted in Input Industry
169				
170	**Share of alternative HFC**	%		Accounted in Input Industry
171				
172	**5. GHG**			
173	**CO2**			
174	**Total**			
175	NonResidential	MtCO2	CO2 emissions	Fourth National GHG Inventory
176				
177	**CH4**			
178	**Total**			
179	NonResidential	MtCH4	CH4 emissions	Fourth
180				
181	**N2O**			
182	**Total**			
183	NonResidential	MtN2O	N2O emissions	Fourth

Oil & gas

Row	Activity	Bloc	Unit	Source
3	Projected Production and Consumption from External Sources			
4	Projected Crude Oil Production			
5		Conventional	Million boe	EPE, 2021 (BEN – Séries Históricas e Matrizes) - https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
6		Unconventional	Million boe	Brazil does not have Unconventional Crude Oil Production
7				
8	Projected Natural Gas Production			
9		Conventional	Million boe	EPE, 2021 (BEN – Séries Históricas e Matrizes) - https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
10		Unconventional	Million boe	Brazil does not have Unconventional Natural Gas Production
11				
12				
13	Projected Crude Oil Consumption		Million boe	EPE, 2021 (BEN – Séries Históricas e Matrizes)- Oferta Interna Petróleo -Matrizes Abertas 2000 2020- https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
14				
15	Projected Natural Gas Consumption		Million boe	EPE, 2021 (BEN – Séries Históricas e Matrizes) - https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
16				
17	Total Coal Production		ktons	EPE, 2021 (BEN – Séries Históricas e Matrizes) - https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
18				
19	Total Oil to be refined		Million boe	EPE, 2021 (BEN – Séries Históricas e Matrizes) - https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
20				

Row	Activity	Bloc	Unit	Source
21	Coal mining: surface vs underground			
22		% Surface Mining	%	(Brasil, 2020) Quarta comunicação nacional e relatórios de atualização bienal do brasil à convenção-quadro das nações unidas sobre mudança do clima quarto inventário nacional de emissões e remoções antrópicas de gases de efeito estufa. Relatório de referência setor energia subsetor emissões fugitivas mineração e manejo do carvão mineral. https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/sirene/publicacoes/relatorios-de-referencia-setorial
23		% Underground Mining	%	(Brasil, 2020) Quarta comunicação nacional e relatórios de atualização bienal do brasil à convenção-quadro das nações unidas sobre mudança do clima quarto inventário nacional de emissões e remoções antrópicas de gases de efeito estufa. Relatório de referência setor energia subsetor emissões fugitivas mineração e manejo do carvão mineral. https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/sirene/publicacoes/relatorios-de-referencia-setorial
24				
25	Upstream indirect (heat + elec) and direct emissions (combustion)			
26	Oil & Gas			
27	Total energy		TJ	EPE, 2021 (BEN – Séries Históricas e Matrizes) – Consumo do setor energético (Exploração Line 243)- Matrizes Abertas 2000 2020- https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
28				
29	% Mix – Coal		%	Zero
30	% Mix – Natural Gas		%	EPE, 2021 (BEN – Séries Históricas e Matrizes) -% no Consumo do setor energético (Exploração Line 243)Matrizes Abertas 2000 2020- https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
31	% Mix – Oil		%	EPE, 2021 (BEN – Séries Históricas e Matrizes) – % no Consumo do setor energético (Exploração Linha 243))Matrizes Abertas 2000 2020- https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
32	% Mix – Other (Renewables)		%	Zero

Row	Activity	Bloc	Unit	Source
33	% Mix Heat		%	
34	% Mix – Electricity		%	EPE, 2021 (BEN – Séries Históricas e Matrizes) -% no Consumo do setor energético (Exploração Line 243)Matrizes Abertas 2000 2020- https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
35				
36	Coal			
37	Direct Energy		TJ	EPE, 2021 (BEN – Séries Históricas e Matrizes) – % Consumo do setor energético (Linha 248- CARVÃO MINERAL & OUTROS))Matrizes Abertas 2000 2020- https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
38				
39	% Mix – Coal		%	EPE, 2021 (BEN – Séries Históricas e Matrizes)- Coke oven gas-Consumo do setor energético (Linha 248- CARVÃO MINERAL & OUTROS))Matrizes Abertas 2000 2020- https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
40	% Mix – Natural Gas		%	zero
41	% Mix – Oil		%	zero
42	% Mix – Other (Renewables)		%	zero
43	% Mix Heat		%	zero
44	% Mix – Electricity		%	EPE, 2021 (BEN – Séries Históricas e Matrizes) -Electricity- Consumo do setor energético (Linha 248- CARVÃO MINERAL & OUTROS))Matrizes Abertas 2000 2020- https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
45				
46	Emissions Factor			
47	Fugitive emissions from crude oil production			
48		Conventional	tCO2e/boe	Energy model (MATRIZ)
49		Unconventional	tCO2e/boe	Brazil does not have Unconventional Natural Gas an Oil Production
50				
51	Projected Natural Gas Production			
52		Conventional	tCO2e/boe	Fugitive emissions from crude oil and Natural Gas Production are calculated together
53		Unconventional	tCO2e/boe	Brazil does not have Unconventional Natural Gas an Oil Production
54	Coal			

Row	Activity	Bloc	Unit	Source
55		Surface	tCH4/ktons	Energy model (MATRIZ) data
56		Underground	tCH4/ktons	Energy model (MATRIZ) data
57				
58	MidStream			
59		Crude Oil transport	tCH4/boe	Hargreaves, 2019. Data from ANP, 2018; MCTIC, 2015. Refining Emission Factor. http://www.ppe.ufrj.br/images/publica%C3%A7%C3%B5es/mestrado/dissertacao_Fernanda_Hargreaves_revfinal.pdf
60		Natural Gas transport	tCH4/toe	Hargreaves, 2019. Data from ANP, 2018; MCTIC, 2015. Transport Emission Factor. http://www.ppe.ufrj.br/images/publica%C3%A7%C3%B5es/mestrado/dissertacao_Fernanda_Hargreaves_revfinal.pdf
61			tCO2/toe	Hargreaves, 2019. Data from ANP, 2018; MCTIC, 2015. Transport Emission Factor. http://www.ppe.ufrj.br/images/publica%C3%A7%C3%B5es/mestrado/dissertacao_Fernanda_Hargreaves_revfinal.pdf
62				
63				
64	Specific consumption factor (MWh of electricity per boe Oil refined)			
65		Specific consumption factor	MWh/boe	EPE, 2021 (BEN – Séries Históricas e Matrizes) -Consumo de Eletricidade Refino/ petróleo para Refino – BEN – Matrizes Abertas 2000 2020- https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
66				
67	Midstream indirect (heat + elec) and direct emissions (combustion)			
68	Oil & Gas			
69	Total energy		TJ	EPE, 2021 (BEN – Séries Históricas e Matrizes) -Consumo do setor energético (Line 244- Refino) Matrizes Abertas 2000 2020- https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
70				
71	% Mix – Coal		%	Zero
72	% Mix – Natural Gas		%	EPE, 2021 (BEN – Séries Históricas e Matrizes) – Consumo do setor energético (Line 244- Refino) Matrizes Abertas 2000 2020- https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas

Row	Activity	Bloc	Unit	Source
73	% Mix – Oil		%	EPE, 2021 (BEN – Séries Históricas e Matrizes) – Consumo do setor energético (Line 244- Refino) Matrizes Abertas 2000 2020- https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
74	% Mix – Other (Renewables)		%	Zero
75	% Mix Heat		%	EPE, 2021 (BEN – Séries Históricas e Matrizes) – Modified for Refinery Gas-Consumo do setor energético (Line 244-Refino))Matrizes Abertas 2000 2020- https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
76	% Mix – Electricity		%	EPE, 2021 (BEN – Séries Históricas e Matrizes) – Consumo do setor energético (Line 244- Refino))Matrizes Abertas 2000 2020- https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
77				
78	Coal			
79	Total energy		TJ	Upstream + Midstream – Line 25
80				
81	% Mix – Coal		%	Upstream + Midstream – Line 25
82	% Mix – Natural Gas		%	Upstream + Midstream – Line 25
83	% Mix – Oil		%	Upstream + Midstream – Line 25
84	% Mix – Other (Renewables)		%	Upstream + Midstream – Line 25
85	% Mix Heat		%	
86	% Mix – Electricity		%	Upstream + Midstream – Line 25
87				
88	Downstream emissions from refining			
89				
90	Total energy necessary for downstream processes		TJ	EPE, 2021 (BEN – Séries Históricas e Matrizes)- Consumo do setor energético (Line 245- Gasoduto) Matrizes Abertas 2000 2020- https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
91				
92	% Mix – Coal		%	EPE, 2021 (BEN – Séries Históricas e Matrizes)- Consumo do setor energético (Line 245- Gasoduto) Matrizes Abertas 2000 2020- https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-

Row	Activity	Bloc	Unit	Source
				Historicas-Completas
93	% Mix – Natural Gas		%	EPE, 2021 (BEN – Séries Históricas e Matrizes)- Consumo do setor energético (Line 245- Gasoduto) Matrizes Abertas 2000 2020- https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
94	% Mix – Oil		%	EPE, 2021 (BEN – Séries Históricas e Matrizes)- Consumo do setor energético (Line 245- Gasoduto) Matrizes Abertas 2000 2020- https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
95	% Mix – Other (Renewables)		%	EPE, 2021 (BEN – Séries Históricas e Matrizes)- Consumo do setor energético (Line 245- Gasoduto) Matrizes Abertas 2000 2020- https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
96	% Mix – Heat		%	EPE, 2021 (BEN – Séries Históricas e Matrizes)- Consumo do setor energético (Line 245- Gasoduto) Matrizes Abertas 2000 2020- https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
97	% Mix Electricity		%	EPE, 2021 (BEN – Séries Históricas e Matrizes)- Consumo do setor energético (Line 245- Gasoduto) Matrizes Abertas 2000 2020- https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
98				
99				
100	% of process emissions from total emissions		%	
101				
102	Downstream emissions from natural gas distribution			
103	Distribution and dispensing emissions	downstream transport carbon intensity / emission factor	tCH4/toe	
104				
105	Calibration Data (emissions)			
106	Upstream total			Calculated- Data from (EPE, 2021) (https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas) and our Energy model

Row	Activity	Bloc	Unit	Source
				(MATRIZ) – BEN e nossas estimativas; Emissões setor energético (Exploração e carvão) Fugitiva (E&P e Carvão)
107	Midstream total			Calculated- Data from (EPE, 2021) (https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas) and our Energy model (MATRIZ) – BEN e nossas estimativas;; Emissões setor energético energ Refino e Fugitiva Refino
108	Downstream total			Calculated- Data from (EPE, 2021) (https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas) and our Energy model (MATRIZ) – BEN e nossas estimativas; Emissão Gasoduto

Power

Row	Activity	Sector/Technology	Unit	Source
4	Power Demand			
5				Note: this is a section about historical data for electricity demand across different sectors. The more granular, the better, although aggregation within those categories is necessary.
6	Power demand	Power – Own Consumption	TWh	Line 247 in ktep – EPE, 2021 (BEN – Séries Históricas e Matrizes) Matrizes Abertas 2000 2020 - https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
7	Power demand	Energy Losses – T&D	TWh	Line 25 in Gwh- EPE, 2021 (BEN – Séries Históricas e Matrizes) Matrizes Abertas 2000 2020 - https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
8	Power demand	Agriculture	TWh	Line 33 in Gwh- EPE, 2021 (BEN – Séries Históricas e Matrizes) Matrizes Abertas 2000 2020 - https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
9	Power demand	Forestry	TWh	-
10	Power demand	Industry – cement/steel/chemicals/'all others'	TWh	Line 39 in Gwh- EPE, 2021 (BEN – Séries Históricas e Matrizes) Matrizes Abertas 2000 2020 - https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
11	Power demand	Transport	TWh	Line 34 in Gwh- EPE, 2021 (BEN – Séries Históricas e Matrizes) Matrizes Abertas 2000 2020 - https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
12	Power demand	Buildings	TWh	Line 30,31,32 – Residencial Comercial e Público in Gwh – EPE, 2021 (BEN – Séries Históricas e Matrizes) Matrizes Abertas 2000 2020 - https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
13	Power demand	Fuel- O&G +Alcohol +Mineral Coal and others	TWh	Line 242, 246 e 248 – EPE, 2021 (BEN – Séries Históricas e Matrizes) Matrizes Abertas 2000 2020 - https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
14				
15	Power demand	Total demand	TWh	Sum of lines above; Total Demand includes consumption by the energy sector of O&G, Alcohol, coal and others (Line 13)
16				
17	Own consumption and energy losses during Transport & Distribution of electricity			
18	Note for CEA: Historical data can be derived from previous section. If projection are available they can be useful.			
19	Consumption	Power – Own Consumption	% of other demand	% : Line 6/Line 15

Row	Activity	Sector/Technology	Unit	Source
			(excl energy losses)	
20	Consumption	Energy Losses – T&D by 2030	% of other demand (excl own consumption)	% : Line 7/(Line 15-(Line 6))
21				
22	Variable RES share in production mix			
23	Variable RES share	Onshore wind	%	EPE, 2021 (BEN – Séries Históricas e Matrizes)- BEN-Capítulo 5 (Balanço dos Centros de Transformação) 1970 – 2020 https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
24	Variable RES share	Offshore wind	%	EPE, 2021 (BEN – Séries Históricas e Matrizes)-BEN-Capítulo 5 (Balanço dos Centros de Transformação) 1970 – 2020 https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
25	Variable RES share	Utility-scale PV	%	EPE, 2021 (BEN – Séries Históricas e Matrizes)- BEN-Capítulo 5 (Balanço dos Centros de Transformação) 1970 – 2020 https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
26	Variable RES share	Small-scale PV	%	EPE, 2021 (BEN – Séries Históricas e Matrizes)- BEN-Capítulo 5 (Balanço dos Centros de Transformação) 1970 – 2020 https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
27	Variable RES share	Solar thermal	%	EPE, 2021 (BEN – Séries Históricas e Matrizes)- BEN-Capítulo 5 (Balanço dos Centros de Transformação) 1970 – 2020 https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
28				
29	Power Historic Production			
30		Coal	TWh	EPE, 2021 (BEN – Séries Históricas e Matrizes)- BEN-Capítulo 5 (Balanço dos Centros de Transformação) 1970 – 2020 https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
31		Gas	TWh	EPE, 2021 (BEN – Séries Históricas e Matrizes)- BEN-Capítulo 5 (Balanço dos Centros de Transformação) 1970 – 2020 https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
32		Oil	TWh	EPE, 2021 (BEN – Séries Históricas e Matrizes)- BEN-Capítulo 5 (Balanço dos Centros de Transformação) 1970 – 2020 https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
33		Nuclear	TWh	EPE, 2021 (BEN – Séries Históricas e Matrizes)- BEN-Capítulo 5 (Balanço dos Centros de Transformação)

Row	Activity	Sector/Technology	Unit	Source
				1970 – 2020 https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
34		Hydro	TWh	EPE, 2021 (BEN – Séries Históricas e Matrizes)- BEN-Capítulo 5 (Balanço dos Centros de Transformação) 1970 – 2020 https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
35		Geothermal	TWh	Brazil does not have Geothermal Power Production
36		Biomass	TWh	EPE, 2021 (BEN – Séries Históricas e Matrizes)- BEN-Capítulo 5 (Balanço dos Centros de Transformação) 1970 – 2020 https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
37		Onshore wind	TWh	EPE, 2021 (BEN – Séries Históricas e Matrizes)- BEN-Capítulo 5 (Balanço dos Centros de Transformação) 1970 – 2020 https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
38		Offshore wind	TWh	Brazil does not have Offshore wind Power Production
39		Utility-scale PV	TWh	EPE, 2021 (BEN – Séries Históricas e Matrizes)- BEN-Capítulo 5 (Balanço dos Centros de Transformação) 1970 – 2020 https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
40		Small-scale PV	TWh	EPE, 2021 (BEN – Séries Históricas e Matrizes)- BEN-Capítulo 5 (Balanço dos Centros de Transformação) 1970 – 2020 https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
41		Solar thermal	TWh	Brazil does not have Solar thermal Power Production
42		Others	TWh	BEN-Capítulo 5 (Balanço dos Centros de Transformação) 1970 – 2020 https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
43	Power Capacity (Historic)			
44	Capacity	Coal	GW	EPE, 2021 (BEN – Séries Históricas e Matrizes)-BEN Anexo I – Capacidade instaladaBEN - https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
45	Capacity	Gas	GW	EPE, 2021 (BEN – Séries Históricas e Matrizes)-BEN Anexo I – Capacidade instaladaBEN - https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
46	Capacity	Oil	GW	EPE, 2021 (BEN – Séries Históricas e Matrizes)-BEN Anexo I – Capacidade instaladaBEN - https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
47	Capacity	Nuclear	GW	EPE, 2021 (BEN – Séries Históricas e Matrizes)-BEN Anexo I – Capacidade instaladaBEN - https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
48	Capacity	Hydro	GW	EPE, 2021 (BEN – Séries Históricas e Matrizes)-BEN Anexo I – Capacidade instaladaBEN -

Row	Activity	Sector/Technology	Unit	Source
				https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
49	Capacity	Geothermal	GW	Brazil does not have Geothermal Power Capacity
50	Capacity	Biomass	GW	EPE, 2021 (BEN – Séries Históricas e Matrizes)- BEN Anexo I – Capacidade instaladaBEN - https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
51	Capacity	Onshore wind	GW	EPE, 2021 (BEN – Séries Históricas e Matrizes)- BEN Anexo I – Capacidade instaladaBEN - https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
52	Capacity	Offshore wind	GW	Brazil does not have Offshore wind Power Capacity
53	Capacity	Utility-scale PV	GW	EPE, 2021 (BEN – Séries Históricas e Matrizes)- BEN Anexo I – Capacidade instaladaBEN - https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
54	Capacity	Small-scale PV	GW	EPE, 2021 (BEN – Séries Históricas e Matrizes)- BEN Anexo I – Capacidade instaladaBEN - https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
55	Capacity	Solar thermal	GW	Brazil does not have Solar thermal Power Capacity
56		Others	GW	BEN Anexo I – Capacidade instaladaBEN - https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas
57	Capacity Factor			
58	Derived from previous section if capacity > 0. If not sources and geography used detailed			
59	Capacity Factor	Coal	%	Conta feita na planilha com os dados do BEN – EPE
60	Capacity Factor	Gas	%	Conta feita na planilha com os dados do BEN – EPE
61	Capacity Factor	Oil	%	Conta feita na planilha com os dados do BEN – EPE
62	Capacity Factor	Nuclear	%	Conta feita na planilha com os dados do BEN – EPE
63	Capacity Factor	Hydro	%	Conta feita na planilha com os dados do BEN – EPE
64	Capacity Factor	Geothermal	%	Brazil does not have Geothermal Power Production. Value From US – https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_6_07_b
65	Capacity Factor	Biomass	%	Conta feita na planilha com os dados do BEN – EPE
66	Capacity Factor	Onshore wind	%	Conta feita na planilha com os dados do BEN – EPE
67	Capacity Factor	Offshore wind	%	Brazil does not have Offshore wind Power Production. Value From US – https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_6_07_b
68	Capacity Factor	Utility-scale PV	%	Conta feita na planilha com os dados do BEN – EPE
69	Capacity Factor	Small-scale PV	%	Conta feita na planilha com os dados do BEN – EPE
70	Capacity Factor	Solar thermal	%	Brazil does not have Solar thermal Power Production. Value From US – https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_6_07_b

Row	Activity	Sector/Technology	Unit	Source
71				
72	Maximum Increase of variable RES Capacity per year			
73	CEA: Unless easy – not necessary to fill in – to be discussed during introduction			
74	Increase of Capacity for RES	All vRES	%	not necessary to fill in
75				
76	Lifetime of non-RES based capacity			
77	Capacity	Coal	Years	EPE, 2021. Plano decenal de energia. PDE 2030. Caderno de Preços de Geração 2021. https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-622/CadernodePre%C3%A7osdeGera%C3%A7%C3%A3o_r0.pdf
78	Capacity	Oil	Years	EPE, 2021. Plano decenal de energia. PDE 2030. Caderno de Preços de Geração 2021. https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-622/CadernodePre%C3%A7osdeGera%C3%A7%C3%A3o_r0.pdf
79	Capacity	Gas	Years	EPE, 2021. Plano decenal de energia. PDE 2030. Caderno de Preços de Geração 2021. https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-622/CadernodePre%C3%A7osdeGera%C3%A7%C3%A3o_r0.pdf
80	Capacity	Nuclear	Years	EPE, 2021. Plano decenal de energia. PDE 2030. Caderno de Preços de Geração 2021. https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-622/CadernodePre%C3%A7osdeGera%C3%A7%C3%A3o_r0.pdf
81				
82	Maximum Capacity factor increase			
83	Note: maximum capacity factor that a power plant can reach			
84	Capacity Factor	Coal	%	Capacity Factor max- weighted average CFmax for each electricity source per year (PDE 2030).
85	Capacity Factor	Oil	%	Capacity Factor max- weighted average CFmax for each electricity source per year (PDE 2030).
86	Capacity Factor	Nuclear	%	Capacity Factor max- weighted average CFmax for each electricity source per year (PDE 2030).
87	Capacity Factor	Gas	%	Capacity Factor max- weighted average CFmax for each electricity source per year (PDE 2030).
88				

Row	Activity	Sector/Technology	Unit	Source
89	Production Mix and Capacity for non-RES Trajectory			
90	this is a technical element and does not need to be changed when collecting data			
91	Carbon : Gas & Coal first			This is a technical element t and does not need to be changed when collecting data. Merit order (operation entry).
92	Carbon : Coal and Gas first			This is a technical element t and does not need to be changed when collecting data. Merit order (operation entry).
93	Carbon – Nuke : Gas and Nuke first			This is a technical element t and does not need to be changed when collecting data. Merit order (operation entry).
94	Nuke – Carbon : Nuke and Gas first			This is a technical element t and does not need to be changed when collecting data. Merit order (operation entry).
95				
96	Efficiency factor for Electricity – Hydrogen & eFuel			
97	Efficiency factor – amount of electricity needed to produce the hydrogen that will replace Gas. Currenlty only modelling hydrogen.			
98	200%		%	
99	250%			
100				
101	Electricity needed per tCO2e extracted			
102	Already given for industry – will become a global assumption			
103	to become a global assumption (used in industry as well)	TWh per Million tons of GHG captured	TWh/Mt	
104				
105	Emissions factor CO2			
106				Note for CEA: a priori something already discussed? Otherwise might be necessary to update (for projection as well)
107	Emissions intensity	Coal	MtCO2e/ TWh	IPCC and our estimates
108	Emissions intensity	Gas	MtCO2e/ TWh	IPCC and our estimates
109	Emissions intensity	Oil	MtCO2e/ TWh	IPCC and our estimates
110	Emissions intensity	Nuclear	MtCO2e/	Non Renewable – was considered zero emission

Row	Activity	Sector/Technology	Unit	Source
			TWh	
111	Emissions intensity	Hydro	MtCO2e/ TWh	Renewable – was considered zero emission
112	Emissions intensity	Geothermal	MtCO2e/ TWh	Zero
113	Emissions intensity	Biomass	MtCO2e/ TWh	IPCC and our estimates
114	Emissions intensity	Onshore wind	MtCO2e/ TWh	Renewable – was considered zero emission
115	Emissions intensity	Offshore wind	MtCO2e/ TWh	Renewable – was considered zero emission
116	Emissions intensity	Utility-scale PV	MtCO2e/ TWh	Renewable – was considered zero emission
117	Emissions intensity	Small-scale PV	MtCO2e/ TWh	Renewable – was considered zero emission
118	Emissions intensity	Solar thermal	MtCO2e/ TWh	Renewable – was considered zero emission
119	Emissions intensity	Biomass CCS	MtCO2e/ TWh	Negative
120				
121	Emissions factor N2O			
122	Same comment as above			
123	N2O Emission factor	Coal	kg/TJ	IPCC, 2006 – Chapter 2 TABLE 2.2 DEFAULT EMISSION FACTORS FOR STATIONARY COMBUSTION IN THE ENERGY INDUSTRIES. https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf
124	N2O Emission factor	Gas	kg/TJ	IPCC, 2006- Chapter 2 TABLE 2.6 UTILITY SOURCE EMISSION FACTORS- Natural Gas Combined Cycle. https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf
125	N2O Emission factor	Oil	kg/TJ	IPCC, 2006- Chapter 2. TABLE 2.2 DEFAULT EMISSION FACTORS FOR STATIONARY COMBUSTION IN THE ENERGY INDUSTRIES. https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf
126	N2O Emission factor	Biomass	kg/TJ	IPCC, 2006- Chapter 2. TABLE 2.2 DEFAULT EMISSION FACTORS FOR STATIONARY COMBUSTION IN THE ENERGY INDUSTRIES. https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf
127				
128	Emissions factor CH4			
129	Same comment as above			
130	CH4 Emission factor	Coal	kg/TJ	IPCC, 2006 – Chapter 2 TABLE 2.2 DEFAULT EMISSION FACTORS FOR STATIONARY COMBUSTION IN THE ENERGY INDUSTRIES. https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf
131	CH4 Emission factor	Gas	kg/TJ	IPCC, 2006- Chapter 2 TABLE 2.6 UTILITY SOURCE

Row	Activity	Sector/Technology	Unit	Source
				EMISSION FACTORS- Natural Gas Combined Cycle. https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf
132	CH4 Emission factor	Oil	kg/TJ	IPCC, 2006- Chapter 2. TABLE 2.2 DEFAULT EMISSION FACTORS FOR STATIONARY COMBUSTION IN THE ENERGY INDUSTRIES. https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf
133	CH4 Emission factor	Biomass	kg/TJ	IPCC, 2006- Chapter 2. TABLE 2.2 DEFAULT EMISSION FACTORS FOR STATIONARY COMBUSTION IN THE ENERGY INDUSTRIES. https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf
134				
135	Primary Energy efficiency factor			
136				Ratio of primary energy needed (in TWh) to produce one TWh of electricity
137			Twh/Twhe	EPE, 2021. Table 5.3 of BEN- Capítulo 5 (Balanço dos Centros de Transformação) 1970 – 2020- Consumo de Combustíveis (Near Line 40)/Geração Eletricidade total (Near Line 64)
138			Twh/Twhe	EPE, 2021. Table 5.3 of BEN- Capítulo 5 (Balanço dos Centros de Transformação) 1970 – 2020- Consumo de Combustíveis (Near Line 40)/Geração Eletricidade total (Near Line 64)
139			Twh/Twhe	EPE, 2021. Table 5.3 of BEN- Capítulo 5 (Balanço dos Centros de Transformação) 1970 – 2020- Consumo de Combustíveis (Near Line 40)/Geração Eletricidade total (Near Line 64)
140			Twh/Twhe	EPE, 2021. Table 5.3 of BEN- Capítulo 5 (Balanço dos Centros de Transformação) 1970 – 2020- Consumo de Combustíveis (Near Line 40)/Geração Eletricidade total (Near Line 64)
141				
142			Twh/Twhe	Same as PowerProduction.GetConversionFactorPrimaryEnergyNewCapacity equal Old
143			Twh/Twhe	Same as PowerProduction.GetConversionFactorPrimaryEnergyNewCapacity equal Old
144			Twh/Twhe	Same as PowerProduction.GetConversionFactorPrimaryEnergyNewCapacity equal Old
145			Twh/Twhe	Same as PowerProduction.GetConversionFactorPrimaryEnergyNewCapacity equal Old
146				
147	Conversion to CO2e			
148	GWP	CH4 to CO2		IPCC, 2015. AR5 – GWP-100. https://ar5-syr.ipcc.ch/ipcc/ipcc/resources/pdf/IPCC_SynthesisReport.pdf

Row	Activity	Sector/Technology	Unit	Source
149	GWP	N2O to CO2		IPCC, 2015. AR5 – GWP-100. https://ar5-syr.ipcc.ch/ipcc/ipcc/resources/pdf/IPCC_SynthesisReport.pdf
150				
151	Emissions: historical data for each vectors & power plant			
152		Coal	Mt CO2e	EPE, 2021. BEN_Our Models (CENTRAIS. ELET. SERV. PÚBLICO e CENTRAIS ELET. AUTOPRODUTORAS)
153		Gas	Mt CO2e	EPE, 2021. BEN_Our Models (CENTRAIS. ELET. SERV. PÚBLICO e CENTRAIS ELET. AUTOPRODUTORAS)
154		Oil	Mt CO2e	EPE, 2021. BEN_Our Models (CENTRAIS. ELET. SERV. PÚBLICO e CENTRAIS ELET. AUTOPRODUTORAS)
155		Biomass	Mt CO2e	EPE, 2021. BEN_Our Models (CENTRAIS. ELET. SERV. PÚBLICO e CENTRAIS ELET. AUTOPRODUTORAS)
156				
157	Conversion for industrial needs			
158	Number of GW per windmills		GW/unit	ABEEólica, 2022. http://abeeolica.org.br/dados-abeeolica/
159	Number of GW per m^2 of PV installed		GW/m2	
160				
161				
162	Lifetime of PV and Windturbines			
163	PV		year	EPE, 2021. Plano decenal de energia. PDE 2030. Caderno de Preços de Geração 2021. https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-622/CadernodePre%C3%A7osdeGera%C3%A7%C3%A3o_r0.pdf
164	Windturbines		year	EPE, 2021. Plano decenal de energia. PDE 2030. Caderno de Preços de Geração 2021. https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-622/CadernodePre%C3%A7osdeGera%C3%A7%C3%A3o_r0.pdf
165				
166				
167	Calibration data			
168				
169				

AFOLU

Row	Bloc	Sector/Technology	Unit	Source
2	**0. Required inputs & assumptions**			
3	**1. FOOD**			
4	**Food activity**	Food calories per capita	kcal/person/day	World Bank
5		Food self-sufficiency	%	FAOStat
6				
7	**1.A. Meat**			
8	**Meat activity**	Meat calories per capita	kcal/person/day	FAOStat
9		Meat self-sufficiency	%	FAOStat
10				
11	**Type of meat produced**	Young beef cattle	%	FAOStat
12		Old beef cattle	%	FAOStat
13		Dairy cattle	%	FAOStat
14		Sheep and goats	%	FAOStat
15		Pigs	%	FAOStat
16		Poultry	%	FAOStat
17		Other animals	%	FAOStat
18				
19	**Animal-to-food conversion yields**	Young beef cattle	kcal/animal	Brazil CEA data
20		Old beef cattle	kcal/animal	Brazil CEA data
21		Dairy cattle	kcal/animal	Brazil CEA data
22		Sheep and goats	kcal/animal	Brazil CEA data
23		Pigs	kcal/animal	Brazil CEA data
24		Poultry	kcal/animal	Brazil CEA data
25		Other animals	kcal/animal	Assumption
26				
27	Livestock for meat (national stock)	Young and old beef cattle	animals	IBGE
28		Sheep and goats	animals	IBGE
29		Pigs	animals	IBGE
30		Poultry	animals	IBGE
31				
32	**1.B. Animal-based food**			
33	**Animal-based activity**	Animal-based calories per capita	kcal/person/day	FAOStat
34		Animal-based self-sufficiency	%	FAOStat
35				
36	**Type of animal-based food produced**	Milk product	%	FAOStat
37		Eggs	%	FAOStat
38		Seafood	%	FAOStat

Row	Bloc	Sector/Technology	Unit	Source
39				
40	**Animal-to-food conversion yields**	Dairy cattle	kcal/animal	FAOStat
41		Laying hens	kcal/animal	FAOStat
42				
43	Livestock for milk and eggs (national stock)	Dairy cattle	animals	IBGE
44		Laying hens	animals	IBGE
45				
46	**1.C. Crops**			
47	**Crops activity**	Crops self-sufficiency	%	FAOStat
48				
49	**Type of crops produced**	Rice	%	FAOStat
50		Soybean	%	FAOStat
51		Other crops	%	FAOStat
52	**1.E. Farming and Waste**			
53	**Amount of food wasted post-farm**	Young beef cattle	%	FAO
54		Old beef cattle	%	FAO
55		Dairy cattle	%	FAO
56		Sheep and goats	%	FAO
57		Pigs	%	FAO
58		Poultry	%	FAO
59		Other animals	%	FAO
60		Milk product	%	FAO
61		Eggs	%	FAO
62		Seafood	%	FAO
63		Rice	%	FAO
64		Soybean	%	FAO
65		Other crops	%	FAO
66				
67	**Share of animal intensively fed**	Young beef cattle	%	Literature
68		Old beef cattle	%	Literature
69		Dairy cattle	%	Literature
70		Sheep and goats	%	Literature
71				
72	**Conversion efficiency of feedlots**	Young beef cattle	%	Mekonnen & Hoekstra, 2012, "A global assessment of the water footprint of farm animals"
73		Old beef cattle	%	Mekonnen & Hoekstra, 2012, "A global assessment of the water footprint of farm animals"
74		Dairy cattle	%	Mekonnen & Hoekstra, 2012, "A global assessment of the water

Row	Bloc	Sector/Technology	Unit	Source
				footprint of farm animals"
75		Sheep and goats	%	Mekonnen & Hoekstra, 2012, "A global assessment of the water footprint of farm animals"
76		Pigs	%	Mekonnen & Hoekstra, 2012, "A global assessment of the water footprint of farm animals"
77		Poultry	%	Mekonnen & Hoekstra, 2012, "A global assessment of the water footprint of farm animals"
78		Other animals	%	Mekonnen & Hoekstra, 2012, "A global assessment of the water footprint of farm animals"
79		Milk product	%	Mekonnen & Hoekstra, 2012, "A global assessment of the water footprint of farm animals"
80		Eggs	%	Mekonnen & Hoekstra, 2012, "A global assessment of the water footprint of farm animals"
81				
82	**Conversion efficiency of pasture animals**	Young beef cattle	%	
83		Old beef cattle	%	
84		Dairy cattle	%	
85		Sheep and goats	%	
86				
87	**Proportion of diet from on-farm waste**	Young beef cattle	%	Mottet et al. 2017 "Livestock: On our plates or eating at our table?"
88	**(in terms of calories)**	Old beef cattle	%	Mottet et al. 2017 "Livestock: On our plates or eating at our table?"
89		Dairy cattle	%	Mottet et al. 2017 "Livestock: On our plates or eating at our table?"
90		Sheep and goats	%	Mottet et al. 2017 "Livestock: On our plates or eating at our table?"
91		Pigs	%	Mottet et al. 2017 "Livestock: On our plates or eating at our table?"
92		Poultry	%	Mottet et al. 2017 "Livestock: On our plates or eating at our table?"
93		Other animals	%	Mottet et al. 2017 "Livestock: On our plates or eating at our table?"
94		Milk product	%	Mottet et al. 2017 "Livestock: On our plates or eating at our table?"
95		Eggs	%	Mottet et al. 2017 "Livestock:

Row	Bloc	Sector/Technology	Unit	Source
				On our plates or eating at our table?"
96				
97	**Self-sufficiency level for animal feeding**	Self-sufficiency	%	CEA analysis based on FAOSTAT
98				
99	**Share of crops production for animals feeding**	Rice	%	FAOStat
100		Soybean	%	FAOStat
101		Other crops	%	FAOStat
102				
103	**Amount of non-edible waste from food on farm**	All crops	%	Assumption based on Ronzon & Piotrowski 2017, "Are primary agricultural residues promising for the European bioeconomy."
104				
105	**Share of on-farm waste collected as energy**	Rice	%	EU CTI
106		Soybean	%	EU CTI
107		Other crops	%	EU CTI
108				
109	**Share of post-farm waste collected as energy**	Young beef cattle	%	EU CTI
110		Old beef cattle	%	EU CTI
111		Dairy cattle	%	EU CTI
112		Sheep and goats	%	EU CTI
113		Pigs	%	EU CTI
114		Poultry	%	EU CTI
115		Other animals	%	EU CTI
116		Milk product	%	EU CTI
117		Eggs	%	EU CTI
118		Seafood	%	EU CTI
119		Rice	%	EU CTI
120		Soybean	%	EU CTI
121		Other crops	%	EU CTI
122	**1.F. Fertiliser**			
123	**Proportion of yield increase explained by fertiliser**	Rice	%	Literature
124		Soybean	%	Literature
125		Energy crops yields	%	Literature
126		Other crops	%	Literature
127				
128	**Initial utilisation rate of**	Rice	tons/Mha	Assumption based on IBGE data

Row	Bloc	Sector/Technology	Unit	Source
	fertiliser			and DDPBIICS Project
129		Soybean	tons/Mha	Assumption based on IBGE data and DDPBIICS Project
130		Energy crops yields	tons/Mha	Assumption based on IBGE data and DDPBIICS Project
131		Other crops	tons/Mha	Assumption based on IBGE data and DDPBIICS Project
132				
133	**Proportion of biological agriculture production**	Rice	%	Assumption based on DDPBIICS Project
134		Soybean	%	Assumption based on DDPBIICS Project
135		Energy crops yields	%	Assumption based on DDPBIICS Project
136		Other crops	%	Assumption based on DDPBIICS Project
137				
138	Total amount of fertilisers	Total	Mtons	IV NC (Brazil, 2021)
139				
140	**2. LAND-USE**			
141	**2.A. Available land**			
142	**In base year, surface of…**	country	Mha	OECD
143		wetland	Mha	FAOStat
144		unproductive land	Mha	FAOStat
145		initial settelment and infrastructures	Mha	FAOStat
146				
147	**Annual growth of settelement and infrastructures**		%	FAOStat
148				
149	**For the arable land**	Land multiuse	%	FAOStat
150		Land degradation	%	FAOStat
151				
152	**2.B. Food**			
153	**Pasture stocking density (formerly pasture feed conversion ratio)**	Young beef cattle	animals/ha	ABIEC (2020)
154		Old beef cattle	animals/ha	ABIEC (2020)
155		Dairy cattle	animals/ha	ABIEC (2020)
156		Sheep and goats	animals/ha	Assumption
157				
158	**Crops yields**	Rice	kcal/ha	FAOStat
159		Soybean	kcal/ha	FAOStat
160		Other crops	kcal/ha	FAOStat

Row	Bloc	Sector/Technology	Unit	Source
161				
162	Animal crops yields	Rice	kcal/ha	Assumption
163		Soybean	kcal/ha	Assumption
164		Other crops	kcal/ha	Assumption
165				
166	Human crops yields	Rice	kcal/ha	Assumption
167		Soybean	kcal/ha	Assumption
168		Other crops	kcal/ha	Assumption
169				
170	**Historical arable surface of**	Forest	Mha	MapBiomas
171		Energy crops	Mha	Estimate from DDPBIICS project
172		Animal grassland	Mha	ABIEC (2020)
173		Permanent grassland	Mha	Assumption
174		Non-food and animal crops	Mha	Assumption
175		Animal crops	Mha	Assumption
176		Non-food crops	Mha	Assumption
177		Food crops	Mha	Assumption
178		Net forest conversion	Mha	Estimate using data from INPE,SEEG,SOS Mata Atlantica and Brazil(2016); DDPBIICS Project
179				
180	**2.D. Soil organic carbon**			
181	Soil organic carbon stock (reference) in terms of tons of carbon (not of CO_2) in 1 ha of soil	Human food crops	tC/ha	CLIMACT Assumption
182		Animals grassland	tC/ha	CLIMACT Assumption
183		Animal feeding crops	tC/ha	CLIMACT Assumption
184		Forest	tC/ha	CLIMACT Assumption
185		Energy crops	tC/ha	CLIMACT Assumption
186		Permanent grassland	tC/ha	CLIMACT Assumption
187		Non-food crops	tC/ha	CLIMACT Assumption
188		Degraded	tC/ha	CLIMACT Assumption
189				
190	Levers and parameters	Time dependence of stock change factors	years	CLIMACT Assumption
191		Management regime (tillage)	%	CLIMACT Assumption
192		Input of organic matter	%	CLIMACT Assumption
193				
194	Soil organic carbon stock evolution	CO_2 sequestration/emissions	$MtCO_2$	http://seeg9-brasil-site.herokuapp.com/en?cama_set_language=en
195				

Row	Bloc	Sector/Technology	Unit	Source
196	**3. FORESTRY**			
197	**3.A. Biomass Sequestration**			
198	**Surface of…**	Tropical managed	Mha	MapBiomas
199		Tropical unmanaged	Mha	MapBiomas
200		Temperate managed	Mha	FAOSTAT data with assumptions
201		Temperate unmanaged	Mha	FAOSTAT data with assumptions
202		Boreal managed	Mha	FAOSTAT data with assumptions
203		Boreal unmanaged	Mha	FAOSTAT data with assumptions
204				
205	**Share of new forest**	Tropical managed	%	User choice
206		Tropical unmanaged	%	User choice
207		Temperate managed	%	User choice
208		Temperate unmanaged	%	User choice
209		Boreal managed	%	User choice
210		Boreal unmanaged	%	User choice
211				
212	**Share of deforestation**	Tropical managed	%	Assumption
213		Tropical unmanaged	%	Assumption
214		Temperate managed	%	CLIMACT Assumption
215		Temperate unmanaged	%	CLIMACT Assumption
216		Boreal managed	%	CLIMACT Assumption
217		Boreal unmanaged	%	CLIMACT Assumption
218				
219	**Carbon sequestration rate of…**	Tropical managed	MtCO2eq/Mha	IPCC Good Practice for LULUCF
220			MtCO2eq/Mha	
221			MtCO2eq/Mha	
222			MtCO2eq/Mha	
223			MtCO2eq/Mha	
224		Tropical unmanaged a	MtCO2eq/Mha	
225			MtCO2eq/Mha	
226			MtCO2eq/Mha	
227			MtCO2eq/Mha	
228			MtCO2eq/Mha	
229				
230		Temperate managed	MtCO2eq/Mha	IPCC Good Practice for LULUCF
231			MtCO2eq/Mha	3.163 https://www.ipcc.ch/site/assets/uploads/2018/03/GPG_LULUCF_FULLEN.pdf
232			MtCO2eq/Mha	
233			MtCO2eq/Mha	
234			MtCO2eq/Mha	

Row	Bloc	Sector/Technology	Unit	Source
235		Temperate unmanaged	MtCO2eq/Mha	
236			MtCO2eq/Mha	
237			MtCO2eq/Mha	
238			MtCO2eq/Mha	
239			MtCO2eq/Mha	
240				
241		Boreal managed	MtCO2eq/Mha	IPCC Good Practice for LULUCF
242			MtCO2eq/Mha	
243			MtCO2eq/Mha	
244			MtCO2eq/Mha	
245			MtCO2eq/Mha	
246		Boreal unmanaged	MtCO2eq/Mha	
247			MtCO2eq/Mha	
248			MtCO2eq/Mha	
249			MtCO2eq/Mha	
250			MtCO2eq/Mha	
251				
252	Forest sequestration of...	Total	MtCO2e	Estimate from DDPBIICS Project
253				
254	**3.B. Deforestation emissions**			
255	**Emissions factors CO2**	Tropical managed	MtCO2/Mha	Assumption
256		Tropical unmanaged	MtCO2/Mha	Assumption
257		Temperate managed	MtCO2/Mha	Assumption
258		Temperate unmanaged	MtCO2/Mha	Assumption
259		Boreal managed	MtCO2/Mha	Assumption
260		Boreal unmanaged	MtCO2/Mha	Assumption
261				
262	**Emissions factors CH4**	Tropical managed	MtCH4/Mha	Assumption
263		Tropical unmanaged	MtCH4/Mha	Assumption
264		Temperate managed	MtCH4/Mha	Assumption
265		Temperate unmanaged	MtCH4/Mha	Assumption
266		Boreal managed	MtCH4/Mha	Assumption
267		Boreal unmanaged	MtCH4/Mha	Assumption
268				
269	**Emissions factors N2O**	Tropical managed	MtN2O/Mha	Assumption
270		Tropical unmanaged	MtN2O/Mha	Assumption
271		Temperate managed	MtN2O/Mha	Assumption
272		Temperate unmanaged	MtN2O/Mha	Assumption
273		Boreal managed	MtN2O/Mha	Assumption
274		Boreal unmanaged	MtN2O/Mha	Assumption
275				
276	Deforestation emissions	Total	MtCO2e	Estimate using data from

Row	Bloc	Sector/Technology	Unit	Source
	of…			INPE,SEEG and Brazil (2016). Data from DDPBIICS Project
277				
278	**3.C. Wood Bioenergy**			
279				
280	Wood fuel [1864]	Production	m^3	DDPBIICS Project. Estimate using data from IBGE/PEVS
281		Importation	m^3	FAOSTAT
282		Exportation	m^3	FAOSTAT
283				
284	Wood pellets and other agglomerates [1696]	Production	tonnes	FAOSTAT
285		Importation	tonnes	FAOSTAT
286		Exportation	tonnes	FAOSTAT
287				
288	Energy conversion	Wood fuel	MWh/m^3	BEN (2021)
289		Wood pellets and other agglomerates	MWh/tons	BEN (2021)
290				
291	**3.D. Harvested Wood Products**			
292				
293	Wood-based panels [1873]	Production	m^3	FAOSTAT
294	Sawnwood [1872]	Production	m^3	FAOSTAT
295	Other industrial roundwood [1871]	Production	m^3	FAOSTAT
296				
297	Industrial roundwood [1865]	Production/harvest	m^3	FAOSTAT
298		Importation	m^3	FAOSTAT
299		Exportation	m^3	FAOSTAT
300				
301	Wood chips and particles [1619]	Importation	m^3	FAOSTAT
302		Exportation	m^3	FAOSTAT
303				
304	paper and paperboard [1876]	Production	tonnes	IBA; FAOSTAT
305				
306	Pulp from fibres other than wood [1668]	Production	tonnes	FAOSTAT
307		Importation	tonnes	FAOSTAT
308		Exportation	tonnes	FAOSTAT
309				
310	Wood pulp [1875]	Exportation	tonnes	FAOSTAT

Row	Bloc	Sector/Technology	Unit	Source
311				
312	Carbon sequestration factor of…	Roundwood, industrial roundwood, sawnwood, other industrial roundwood, pulpwood, chips, particles, wood fuel, wood residues	tonne C/m³	IPCC Table 12.4
313		Roundwood, industrial roundwood, sawnwood, other industrial roundwood, pulpwood, chips, particles, wood fuel, wood residues	tonne C/m³	IPCC Table 12.4
314		Paper and paperboard, pulp, recovered fibre pulp, recovered paper	tonne C/tonne	IPCC Table 12.4
315				
316	Average lifetime of…	Solidwood products	yrs	IPCC Table 12.4 (half-life divided by ln(2))
317		Paper and paperboard	yrs	IPCC Table 12.4 (half-life divided by ln(2))
318				
319	Share used as bioenergy	Solidwood products	%	user choice
320		Paper and paperboard	%	user choice
321				
322	Energy conversion	Solidwood products	MWh/m³	
323		Paper and paperboard	MWh/tons	
324				
325	**4. BIOENERGY**			
326	**4.A. MSW**			
327	**Municipal Solid Waste**	MSW collected per capita	kWh/person	IEA EEB
328				
329	**MSW fuel share**	solid	%	Assumption based on IEA EEB, based on data for agriculture/ forestry and food/ tobacco sectors
330		liquid	%	Assumption based on IEA EEB, based on data for agriculture/ forestry and food/ tobacco sectors
331		gas	%	Assumption based on IEA EEB, based on data for agriculture/ forestry and food/ tobacco sectors
332	**4.B. Farming Waste**			
333	**Farming waste**	Conversion efficiency	kWh/kcal	Assumption
334			kWh/kcal	Assumption
335				
336	**Farming waste fuel share**	solid	%	Assumption
337		liquid	%	Assumption

Row	Bloc	Sector/Technology	Unit	Source
338		gas	%	Assumption
339	**4.C. Energy crops**			
340	**Energy crops yields**		TWh/Mha	Appoximated from literature
341				
342	**Energy crops fuel share**	solid	%	Assumption based on IEA EEB, based on all biofuels excepting those from agriculture/ food
343		liquid	%	Assumption based on IEA EEB, based on all biofuels excepting those from agriculture/ food
344		gas	%	Assumption based on IEA EEB, based on all biofuels excepting those from agriculture/ food
345				
346	**4.G. Bioenergy emission factor**			
347	**EF MSW**	solid	MtCO2/TWh	Assumption
348		liquid	MtCO2/TWh	Assumption
349		gas	MtCO2/TWh	Assumption
350				
351	**EF Farming waste**	solid	MtCO2/TWh	Assumption
352		liquid	MtCO2/TWh	Assumption
353		gas	MtCO2/TWh	Assumption
354				
355	**EF energy crops**	solid	MtCO2/TWh	Assumption
356		liquid	MtCO2/TWh	Assumption
357		gas	MtCO2/TWh	Assumption
358				
359	**Wood bioenergy**	Wood fuel	MtCO2/TWh	Estimate from DDPBIICS Project
360		Wood pellets and other agglomerates	MtCO2/TWh	Assumption
361				
362	**HWP**	Solidwood products	MtCO2/TWh	Assumption
363		Paper and paperboard	MtCO2/TWh	Assumption
364				
365	**Imported bioenergy**	solid	MtCO2/TWh	Estimate from DDPBIICS Project
366		liquid	MtCO2/TWh	Assumption
367		gas	MtCO2/TWh	Assumption
368				
369	**5. GHG Emissions**			
370	**5.A. LULUCF**			
371	**CO2 Emissions factors**	Permanent grassland	MtCO2/Mha	Estimate from DDPBIICS Project
372		Settlements	MtCO2/Mha	Assumption
373		Wetlands	MtCO2/Mha	Assumption
374				

Row	Bloc	Sector/Technology	Unit	Source
375	**CH4 Emissions factors**	Wetland	MtCH4/Mha	IPCC wetlands supplement (5.26)
376				
377	Emissions of	Permanent grassland	MtCO2e	à faire
378		Settlement	MtCO2e	à faire
379		Wetland	MtCO2e	à faire
380		Soil organic carbon	MtCO2e	à faire
381		Forestry	MtCO2e	à faire
382		HWP	MtCO2e	à faire
383				
384	**5.B. Agriculture**			
385	**5.B.i. Land**			
386	**CH4 Emissions factors**	Wetland rice for human food	MtCH4/Mha	III NC (Brazil, 2016)
387				
388	**Fertilizers**	Emission factor	kgCO2e/kg	Estimated from DDPBIICS Project
389		Fertilizer	MtCO2e	III NC (Brazil, 2016)
390	**5.B.ii. Livestock**			
391	**CO2 Emissions factors**	Animal grassland	MtCO2/Mha	CTI 2017
392		AnimalCrops land	MtCO2/Mha	CTI 2017
393		Wetland rice for Animal food	MtCO2/Mha	CTI 2017
394		HumanCrops land	MtCO2/Mha	CTI 2017
395		Wetland rice for human food	MtCO2/Mha	CTI 2017
396		NonFood crops	MtCO2/Mha	CTI 2017
397		Energy crops	MtCO2/Mha	CTI 2017
398				
399		Young beef cattle	tCO2/animal	CTI 2017
400		Old beef cattle	tCO2/animal	CTI 2017
401		Dairy cattle	tCO2/animal	CTI 2017
402		Sheep and goats	tCO2/animal	CTI 2017
403		Pigs	tCO2/animal	CTI 2017
404		Poultry	tCO2/animal	CTI 2017
405		Other animals	tCO2/animal	CTI 2017
406				
407		Dairy cattle	tCO2/animal	CTI 2017
408		Laying hens	tCO2/animal	CTI 2017
409				
410	**CH4 Emissions factors**	Animal grassland	MtCH4/Mha	CTI 2017
411		AnimalCrops land	MtCH4/Mha	CTI 2017
412		Wetland rice for animal food	MtCH4/Mha	III NC (Brazil, 2016)
413				
414		Young beef cattle	tCH4/animal	III NC (Brazil, 2016)
415		Old beef cattle	tCH4/animal	III NC (Brazil, 2016)

Row	Bloc	Sector/Technology	Unit	Source
416		Dairy cattle (meat)	tCH4/animal	III NC (Brazil, 2016)
417		Sheep and goats	tCH4/animal	CTI 2017
418		Pigs	tCH4/animal	CTI 2017
419		Poultry	tCH4/animal	CTI 2017
420		Other animals	tCH4/animal	CTI 2017
421				
422		Dairy cattle (animal-based food)	tCH4/animal	CTI 2017
423		Laying hens	tCH4/animal	CTI 2017
424				
425	**N2O Emissions factors**	Animal grassland	MtN2O/Mha	CTI 2017
426		AnimalCrops land	MtN2O/Mha	CTI 2017
427		Wetland rice for Animal food	MtN2O/Mha	CTI 2017 (modified for calibration)
428				
429		Young beef cattle	tN2O/animal	CTI 2017
430		Old beef cattle	tN2O/animal	CTI 2017
431		Dairy cattle	tN2O/animal	CTI 2017
432		Sheep and goats	tN2O/animal	CTI 2017
433		Pigs	tN2O/animal	CTI 2017
434		Poultry	tN2O/animal	CTI 2017
435		Other animals	tN2O/animal	CTI 2017
436				
437		Dairy cattle	tN2O/animal	CTI 2017
438		Laying hens	tN2O/animal	CTI 2017
439				
440	Emissions of animal food	Young and Old beef cattle	MtCO2e	CTI 2018
441		Other animals	MtCO2e	CTI 2019
442	Emissions of animal-based food	Dairy cattle	MtCO2e	CTI 2018
443				
444		Rice	MtCO2e	III NC (Brazil, 2016)
445				
446	**6. Outputs**			
447	**6.B. Power outputs**			
448		electricity	TWh	IEA
449				
450	**6.C. Oil&Gas outputs**			
451		Natural gas	TWh	IEA
452		Oil	TWh	IEA
453		Coal	TWh	IEA

Waste

GHG Model – Waste		Activity	Unit	Source
Solid Waste Treatment				
5		Collection Rate MSW	%	[6],[8]
6		Recycle Rate MSW	%	[6],[8]
7		Composting Rate MSW	%	[6],[8]
8		Incineration Rate MSW	%	[6],[8]
Wastewater Treatment				
11		Recovery Rate (domestic)	%	[3],[6]
12		Treated Collection Rate (domestic)	%	[3],[6]
13		Untreated Collection Rate (domestic)	%	[3],[6]
Solid Waste Treatment – Landfills				
16		Total MSW Generated	million tonnes	[4],[6],[7]
17		% Organic	%	[6],[7]
18		% Collected	%	[6],[7]
19		% Recycled	%	Assumption based on OECD
20		% Composted	%	NA
21		% Incinerated	%	NA
Emissions Intensity of Organic MSW				
24		CH4 emission intensity from organic waste	tCH4/T organic waste	[1],[4]
Solid Waste Treatment – Incineration				
27		% Emission Intensity from Incineration/Open Burning (Intensity)	tCO2e/t waste	[1],[4]
Domestic Wastewater Treatment				
30		Domestic BOD per capita	tons/person	[7]
31		% Collected and treated	%	[3],[6],[7]
32		% Collected but not treated	%	[3],[6],[7]
33		% Uncollected	%	[3],[6],[7]
35		Emissions Intensity – Domestic Wastewater (Collected and Treated)	tCO2e/t of BOD	[1],[4]
36		Emissions Intensity – Domestic Wastewater (Collected and Untreated)	tCO2e/t of BOD	[1],[4]
37		Emissions Intensity – Domestic Wastewater (Uncollected)	tCO2e/t of BOD	[1],[4]
39		% Recovered (Flared and Recovered for Energy)	UNFCCC	NA
Industrial Wastewater Treatment				
43		% of total emissions from Wasterwater treatment that are industrial	%	[1],[4]