Modeling The Impacts of Brazil's Ecological Transformation Plan

EXECUTIVE SUMMARY

PAGE PARTNERSHIP FOR ACTION ON GREEN ECONOMY

UFRJ UNIVERSIDADE FEDERAL DO RIO DE JANEIRO

NOVO BRASIL PLANO DE TRANSFORMAÇÃO ECOLÓGICA

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MINISTRY OF FINANCE

BRAZILIAN GOVERNMENT BRASIL UNITING AND REBUILDING

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Brasilia, August 2025

TECHNICAL SHEET

This document was developed within the framework of the cooperation between the Ministry of Finance of Brazil, the United Nations Environment Programme (UNEP), and the Partnership for Action on Green Economy (PAGE), with technical implementation by the Institute of Economics of the Federal University of Rio de Janeiro (IE-UFRJ). The following authorities and technical teams from the Ministry of Finance contributed to its preparation: Minister Fernando Haddad, Executive Secretary Dario Durigan, Deputy Executive Secretary Rafael Ramalho Dubeux, Secretary of Economic Policy Guilherme Mello, Undersecretary for Sustainable Development Cristina Fróes de Borja Reis, Undersecretary for Macroeconomic Policy Raquel Nadal, General Coordinator for Economic Projections Rafael Leão, General Coordinator for Social and Environmental Impact Analysis Matias Cardomingo, General Coordinator for Sustainable Finance José Pedro Bastos Neves, and Coordinator for International Macroeconomics Cristiano Duarte. From UNEP and PAGE: Elisa Tonda, Steven Stone, Asad Naqvi, Alberto Pacheco Capella, Beatriz Carneiro, Luciana Fontes de Meira, Vera Weick, Josephine Musango, Kesia Braga, Alice Dauriach, Andrea Bassi (external reviewer), Klara Gunnarsson, Clóvis Zapata (UNIDO), Giuliano Montanari (UNITAR), Tahmina Mahmud, and Aguinaldo Maciente (ILO). From the Federal University of Rio de Janeiro (UFRJ): Project Coordinator Ítalo Pedrosa and researchers Fabio Freitas, Kaio Vital da Costa, Matheus Trotta Vianna, Felipe Moraes Cornelio, João Emboava Vaz, and Igor Faria de Araujo.

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EXECUTIVE SUMMARY

This Executive Summary presents the key findings and insights from the project *Modeling the Impacts of Brazil's Ecological Transformation Plan*, developed through a collaboration between the Undersecretariat for Sustainable Economic Development of the Secretariat of Economic Policy at the Ministry of Finance and the United Nations Environment Programme (UNEP), under the Partnership for Action on Green Economy (PAGE), with technical implementation by the Federal University of Rio de Janeiro (UFRJ).

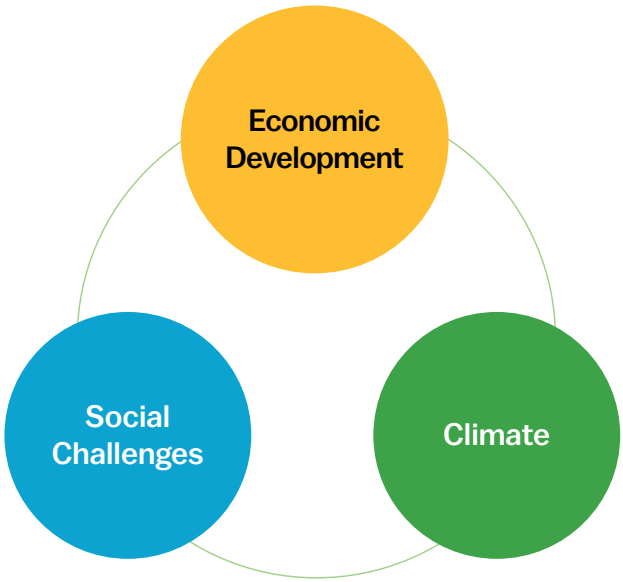
The project developed a dynamic, multisectoral macroeconomic model that integrates economic and environmental data from the Brazilian economy. Its primary objective is to assess, at the national level, the potential impacts of the policies proposed under the Ecological Transformation Plan (ETP) on greenhouse gas (GHG) emissions, macroeconomic indicators, and sectoral dynamics. The analysis explored nine scenarios that combine different macroeconomic conditions and levels of ETP policy implementation, allowing for an examination of the effects on economic growth, per capita income, employment, and GHG emissions.

The results demonstrate that, by harnessing the opportunities presented by the ecological transformation, Brazil can simultaneously promote economic growth, generate employment across multiple sectors, and reduce GHG emissions, without harming income distribution. The ETP, therefore, represents a unique opportunity for Brazil to align its development trajectory with climate and nature-positive goals.

CONTEXT

The Government of Brazil has adopted a range of policies to drive the transition to a low-carbon economy, aiming to achieve net-zero greenhouse gas (GHG) emissions by 2050, while also promoting economic development and addressing social challenges. The Ecological Transformation Plan (ETP) is a key strategy in this process, structured around six pillars that outline pathways to achieve these goals: Sustainable Finance, Technological Densification, Bioeconomy and Agri-food Systems, Energy Transition, Circular Economy, and New Green Infrastructure and Adaptation. Within this framework, the ETP aims to design and implement a coherent set of economic policies to achieve climate neutrality by 2050, in line with the commitments made under the Paris Agreement (2015) and Brazil's Nationally Determined Contributions (NDCs). Thus, the ETP represents a strategic opportunity to enhance competitiveness, attract investment, generate quality employment, and promote economic development with social inclusion and environmental sustainability.

The Partnership for Action on Green Economy (PAGE), which brings together five United Nations agencies (UNEP, UNDP, ILO, UNIDO, and UNITAR), recognizes the potential of the ETP to integrate environmental priorities into Brazil's economic planning and seeks to provide analytical and technical inputs to support its implementation. To this end, PAGE aimed to quantify the macroeconomic, social, and environmental impacts of the Plan, with a view to inform policy formulation and decision-making processes. This approach seeks to enhance the effectiveness of policies across environmental, social, and economic dimensions. This work was developed in partnership with the Undersecretariat for Sustainable Economic Development of the Secretariat of Economic Policy of the Ministry of Finance, and benefited from technical support provided by the Federal University of Rio de Janeiro (UFRJ). It presents an assessment of the potential impacts of the ETP, with a focus on overall economic activity, including trajectories of per capita income, employment and inequality; GHG emissions pathways; job creation potential; income generation; and the integration of the government's deforestation targets into emissions modelling.

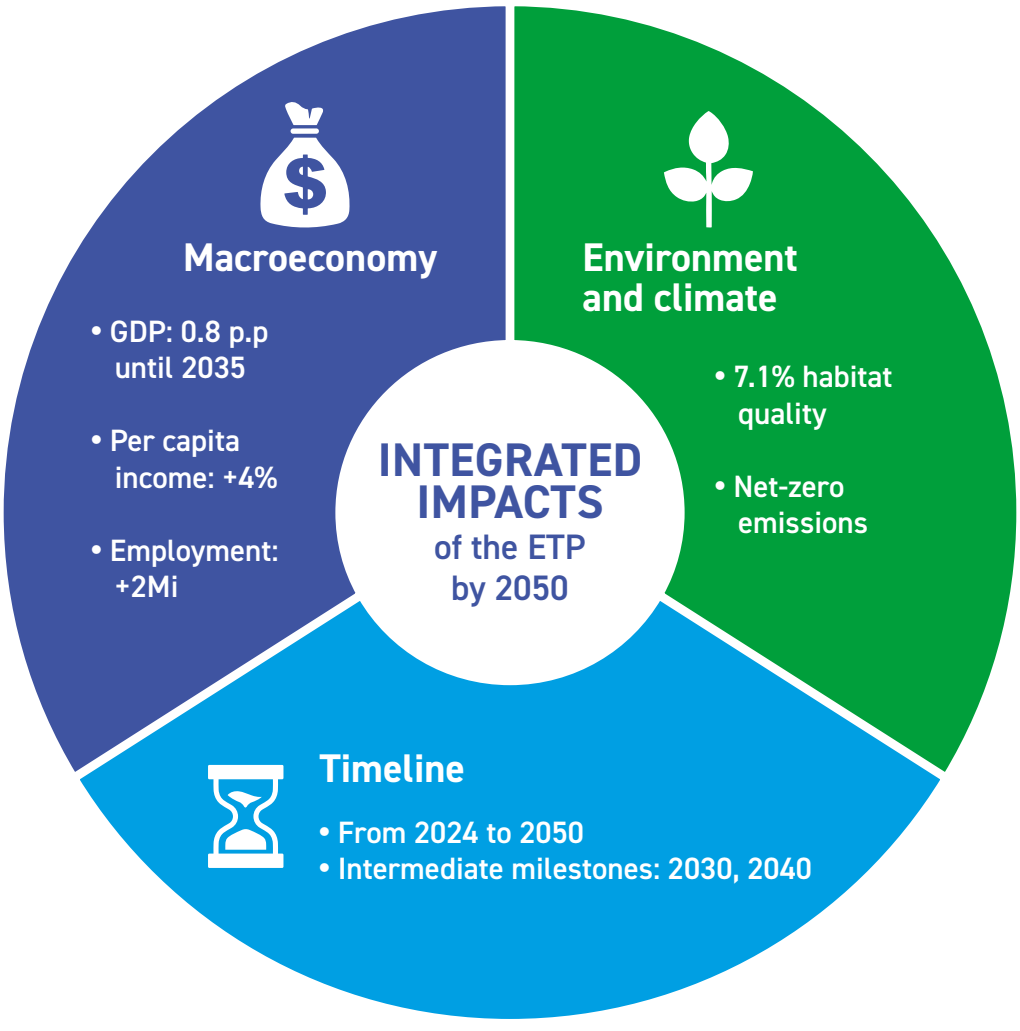


Guiding question:

What are the potential impacts of the policies planned under the ETP on the economy and GHG emissions?

Key findings:

- **Can increase GDP growth** by 0.8 p.p by 2035 and 0.15 p.p.
- **Can raise income per capita levels** in 2050 by more than 4 p.p.
- **Can create around 2 million jobs** until 2035 across all sectors.
- **Do not worsen income inequality** and can reduce it in some scenarios.
- **Can reduce GHG emissions** to near net-zero by 2050.
- **Can increase up to 7.1 p.p in the habitat quality index and biodiversity conservation** by 2050.



THE MODEL

The dynamic, multisectoral input-output model is based on input-output matrices (IOM) and data derived from the System of National Accounts published by IBGE, supplemented by additional databases. Its structure is built around a core economic module grounded in dynamic input-output principles, which generates the main macroeconomic and sectoral variables. The model includes four auxiliary modules—agriculture, transportation, electric energy, and habitat quality[1]—that provide in-depth sectoral analysis, particularly for estimating greenhouse gas (GHG) emissions. These auxiliary modules are fed by the results of the core economic module, operating in a coupled manner without direct feedback to the central module. Thus, the interaction occurs sequentially: the economic core generates inputs that feed the auxiliary modules, allowing for more precise capture of specific impacts on sectoral emissions without affecting the overall economic dynamics.

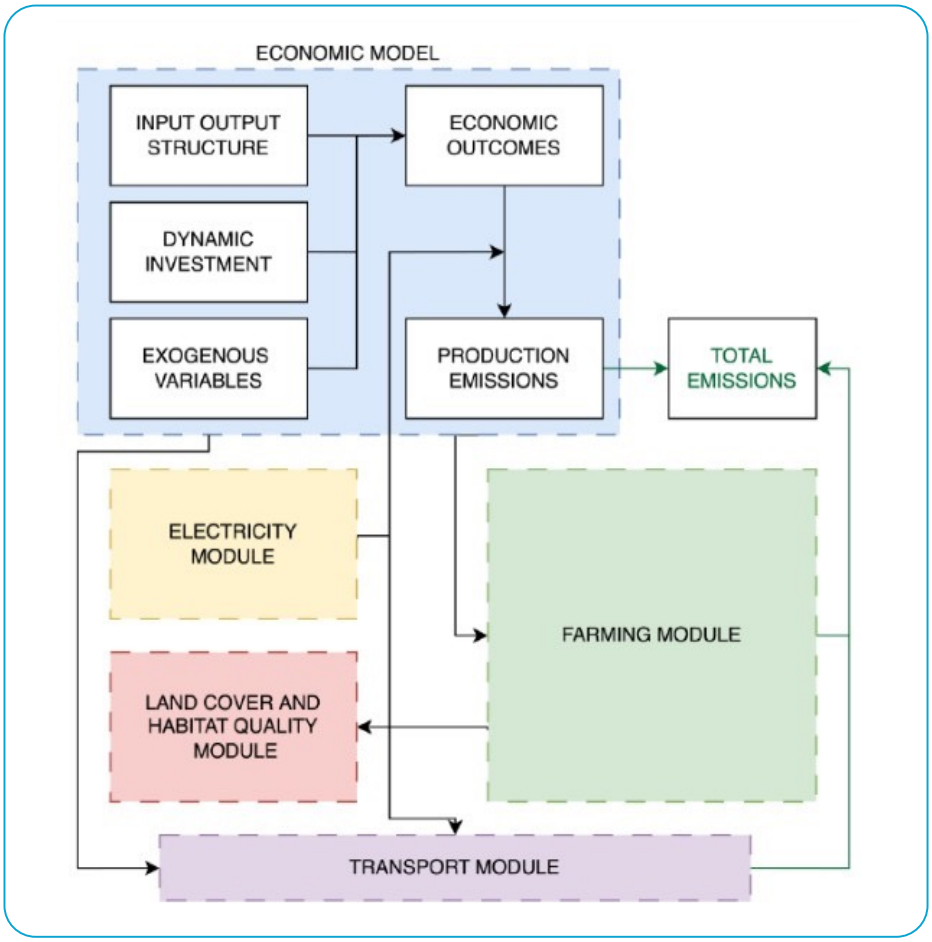
Economic outcomes are generated through relationships between intermediate consumption, household consumption, investment dynamics, and a set of external variables. These outcomes drive GHG emissions linked to the production of goods and services and feed into the agricultural module, where agricultural and livestock production determine both the quantity and type of land use. The economic outcomes also inform the transportation module, particularly through the relationship between the durable goods sector and vehicle production, while the electricity module is used to calculate emission coefficients. Using results from the agricultural module, the model estimates changes in land use and the habitat quality index.

The model aims to analyse GDP growth, per capita income, employment levels, inequality, and GHG emissions over the period 2024 to 2050, using 2019 as the base year for calibration. It considers 40 economic sectors, 10 income classes, 5 main Brazilian trade partners (United States, Argentina, China, European Union, and Rest of the World), 8 energy sources, 12 land types, and 25 transportation fleets.

“The model suggests that the ETP contributes to both emissions reduction and economic development, demonstrating that environmental and economic goals can be aligned.”

1. The Habitat Quality Index (HQI) is used in ecology, environmental conservation, and land-use planning to assess an environment's capacity to sustain native species. In this work, the HQI module is based on the Natural Capital Project's Habitat Quality model, which uses land cover maps as input data to calculate an index that serves as an indicator of biodiversity conditions. See: https://naturalcapitalproject.stanford.edu/software/invest

Figure 1: Overview of the input-output model



SCENARIOS

The model considers nine scenario combinations, deriving from two dimensions:

1. **Macroeconomic dimension:** Assesses growth scenarios based on macroeconomic variables such as fiscal policy, external conditions, and monetary policy. The scenarios can be optimistic, intermediate, or pessimistic.[2, 3]

2. **Policy dimension:** For evaluating different scenarios of implementation of the Ecological Transformation Plan (ETP).[4] The scenarios can involve no implementation, partial implementation, or full implementation of the ETP.

2. The intermediate scenario is considered the representative baseline for the Brazilian economy, as it reflects recent economic fluctuations and policy cycles. Thus, it provides a robust reference for analysing macroeconomic and sectoral impacts.

3. In the pessimistic scenario, it is important to note that the level of activity is not entirely zero (see Annex A), as per capita autonomous expenditures remain constant and vary according to population dynamics.

4. See examples in Annex B.

For macroeconomic variables

Intermediate scenario (historical trend)

The growth of exogenous macroeconomic variables follows the historical trajectory of the Brazilian economy since 2000. This results in a baseline for macroeconomic variables.

Optimistic scenario

This scenario assumes a growth rate of 2.5 per cent for key macroeconomic variables and alignment with the upper limit of public spending defined by the Brazilian fiscal framework.

Pessimistic scenario

This scenario assumes near-zero growth in per capita spending, thereby maintaining it at the initial level of the simulation.

For ETP policies

No ETP implementation

The macroeconomic structure varies according to the historical average demand pattern, without influence from ETP policies.

Partial ETP implementation

Assumes the achievement of 50 per cent of the targets outlined in the ETP.

Full ETP implementation

Assumes full (100 per cent) achievement of the targets outlined in the ETP.

Matrix of scenarios:

Policy / Macro	No ETP Implementation	ETP policies partially implemented	ETP policies fully implemented
Intermediate/ historical trend	Scenario 0 (Business As Usual)	Scenario 1	Scenario 2
Optimistic	Scenario 3	Scenario 4	Scenario 5
Pessimistic	Scenario 6	Scenario 7	Scenario 8

RESULTS

What are the potential impacts of the policies planned under the ETP on the economy and GHG emissions?

1. GDP GROWTH AND PER CAPITA VALUE ADDED

The ETP demonstrates effectiveness as a policy for promoting sustainable economic growth. The model points to positive impacts on GDP growth rates across all time periods (short, medium and long term). Notably, the effects of the ETP on economic activity are even more significant in adverse macroeconomic contexts, highlighting the plan's role in the resilience of the economy.

Main results of the modelling:

- **Short term (2025-2030):** average GDP growth increases from 2.38 per cent (intermediate baseline scenario) to up to 3.02 per cent with the ETP (+27 per cent). In a pessimistic scenario, it rises from 1.19 per cent to up to 1.83 per cent (+53 per cent).
- **Medium term (2025-2040):** average growth goes from 2.10 per cent (base) to up to 2.38 per cent (+13 per cent). In a pessimistic scenario, the increase is from 0.95 per cent to up to 1.21 per cent (+27 per cent).
- **Long term (2025-2050):** average growth rises from 2.05 per cent to up to 2.21 per cent (+8 per cent). In a pessimistic scenario, it goes from 0.86 per cent to up to 1.01 per cent (+17 per cent).

The results indicate that the ETP has its most significative effects in the first 10 to 15 years following implementation, a period in which there is a peak in productivity gains, investment and emissions reduction. After this period, the impacts decrease in intensity but remain positive, indicating a sustainable and consistent economic trajectory.

Analysis of the isolated effects of the ETP in different macroeconomic scenarios shows that the impacts on per capita value added stem from five structural changes promoted by the plan, among which the expansion of investment stands out, made possible especially by the sustainable finance axis.

The modelling shows that the ecological transition also translates into positive impacts on the average income of the population, in both the short and long term. In addition, the magnitude of the effects depends mainly on the degree of implementation of the ETP, varying little between the different macroeconomic scenarios. In the most optimistic scenario, the plan could raise per capita income by approximately 4 p.p. by 2050, peaking at up to 6 p.p. in 2035.

2. EMPLOYMENT

In all scenarios, employment levels increase with the implementation of ETP policies. The magnitude of this increase varies significantly across macroeconomic scenarios, reaching its highest level in the optimistic scenario with full ETP implementation (Scenario 5), in line with the level of economic activity. According to the model, most jobs generated by the ETP are created in the first few years after policy implementation.

- On average, by 2035, full ETP implementation results in an additional 2 million jobs across all macroeconomic scenarios.
- Employment increases in all sectors, except in pessimistic macroeconomic scenarios (6, 7, and 8). Thus, the model shows that making the Brazilian economy greener does not imply job losses in sectors that are important to the economy.

3. EMISSIONS

According to the model, full implementation of the PTE significantly accelerates the decarbonisation trajectory, resulting in a significant reduction in emissions. Notably, in scenarios 2 and 8, which contemplate full adoption of the plan, emissions align with Brazil's NDC target of net zero by 2050. Furthermore, in these scenarios, deforestation is eliminated, and the agricultural sector becomes a net CO2 remover, offsetting emissions from manufacturing, electricity generation and other sectors. Improved land productivity and command-and-control policies are crucial to achieving this outcome.[5]

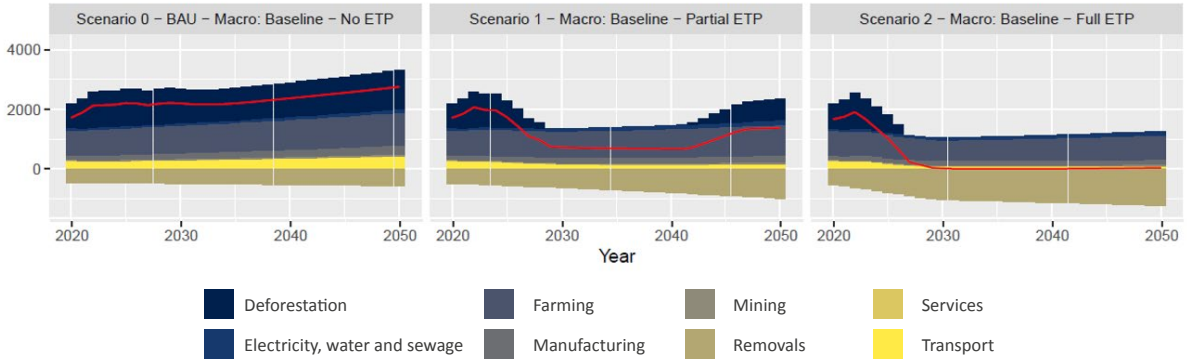
In the optimistic scenario, land availability emerges as a critical factor in reconciling the plan's environmental goals with economic development. In a high-growth context, increasing demand in Sector 1 (agriculture, forestry, logging, livestock, and fishing) may heighten the pressure on land availability and pose a risk of increased deforestation. To mitigate these risks, it will be essential to align the plan's policies with efforts to promote land productivity gains to meet demand without exceeding environmental limits.[6]

5. It should be noted that the results obtained indicate a faster pace of decarbonisation than that observed in other climate models. This difference stems mainly from the fact that the model used in this study highlights agriculture as a significant source of increased greenhouse gas removals. This dynamic is not considered in the Omega model (available at: https://www.gov.br/fazenda/pt-br/central-de-conteudo/publicacoes/conjuntura-economica/estudos-economicos/2024/nota-informativa-os-impactos-do-plano-de-transformacao-ecologica-de-acordo-com-as-estimativas-do-modelo-omega-do-banco-mundial). In the case of the model adopted in the Climate Plan, removals are mainly concentrated in reforestation activities, which have a longer maturation period before generating meaningful impacts.

6. In this scenario, it is important to highlight that deforestation in Brazil is largely regulated by command-and-control policies, but regulatory limits were not considered in the analysis. Potential improvements to the model could include the introduction of external constraints on deforestation to reflect these limits, which may reduce the level of deforestation observed in high-growth scenarios.

The figures below show net emissions and sectoral composition in the historical trend macro scenario. The red line represents total net emissions.

Figure 2: Decomposition of simulated net GHG emissions (in MtCO2eq)



4. INEQUALITY

Based on the inequality measure adopted for the model—the Palma Index, which compares the income share of the richest 10 per cent of the population with that of the poorest 40 per cent, where lower values indicate better income distribution—the results show a downward trend in income inequality across all ETP implementation scenarios.[7] This decline is slightly faster when ETP policies are in place, reinforcing this structural change and reducing the index by one point in 2050 in the intermediate and pessimistic scenarios. According to the model, the ETP does not increase income inequality in any scenario.

5. HABITAT QUALITY

The ETP is expected not only to support the decarbonisation of Brazil's productive structure but also to contribute significantly to the preservation of the country's rich biodiversity. The effects of land use changes on biodiversity are represented by variations in the Habitat Quality Index. In the business-as-usual BAU scenario (Scenario 0—Intermediate and no ETP implementation), the index decreased by 2.7 per cent. In Scenario 2 (Intermediate with full ETP implementation), it increased by 4.2 per cent. Compared to the BAU scenario, full ETP implementation represents a 7.1 p.p. improvement in habitat quality, underscoring the plan's substantial contribution to biodiversity conservation.

7. It should be noted that the model's analysis focused on changes based on the sectoral composition of output, as the ETP does not include any direct income redistribution policies. The model assumes that the distribution of value added among the 10 income classes remains fixed in each sector, meaning reductions in income inequalities result from structural changes. Consequently, sectors with lower inequality increase their share of income, while those with higher inequality see their share decrease.

6. HIGHLIGHTS BY ETP PILLAR

Sustainable Finance

The success of the ecological transformation depends on stable long-term financing conditions. Such stability is essential to ensure the continuity and effectiveness of the modernisation process, including the transition to more sustainable and efficient machinery and equipment, the financing of agricultural activities, and the promotion of incentives for electric mobility.

Technological Densification

Policies aimed at accelerating investment in new machinery and equipment can promote the adoption of low-carbon technologies. Specific local content policies that influence the sectoral composition of production also generate impacts on employment and income distribution.

Bioeconomy and Agri-food Systems

Policies promoting sustainable agriculture and livestock farming can turn the sector into a net remover of GHG emissions, provided that deforestation is effectively addressed.

Energy Transition

Biofuels play a strategic role in the energy transition, contributing significantly to both emissions reduction and in the restructuring of production chains associated with the replacement of fossil fuels.

Circular Economy

The treatment of animal waste represents an important source of decarbonisation, helping to reduce soil contamination while providing sustainable inputs for agriculture. The adoption of new technologies and machinery to convert waste into productive inputs, as well as the use of more efficient equipment, can also contribute to increased labour productivity.

New Green Infrastructure and Adaptation

The construction sector, being labour intensive, is the most directly impacted by investments in adaptation infrastructure. This generates employment and contributes to reducing inequality.

POLICY HIGHLIGHTS

- Without the ecological transformation, it will not be possible to achieve Brazil's NDCs. This underscores the ETP's importance as a strategic government initiative and a necessary pathway to fulfil the country's climate commitments.
- The model indicates that the ETP contributes to both emissions reduction and to economic development, demonstrating that environmental and economic objectives can be aligned.
- The ETP has the potential to lead to the achievement of net-zero GHG emissions by 2050.
- Brazil ranks among the least polluting countries in certain sectors. However, urgent attention is required in hard-to-abate sectors where the country currently lags.
- Agricultural growth increases land demand. To prevent long-term deforestation, even with pasture restoration policies, land productivity must increase faster than production.
- To prevent long-term deforestation, even with pasture restoration policies, land productivity must grow at a faster rate than production.
- Sustainable finance drives low-carbon investment and accelerates technological upgrading. Policies should prioritise the decarbonization of highly polluting sectors.
- No trade-off is observed between environmental progress and social improvements. Moreover, the ETP can be combined with targeted social policies to further reduce inequality.
- Achieving NDC targets poses significant challenges in Brazil, given the complexity of the country's economy. To sustain emissions reductions while promoting growth, complementary policies focused on sustainable land use and investments in productivity and biotechnology are necessary.

CONCLUSION

The results of this study demonstrate that the ETP is a key strategy for aligning economic growth, job creation, and the reduction of greenhouse gas emissions. The model shows that it is possible to promote economic growth while reducing emissions, an especially relevant outcome for developing countries pursuing sustainable development pathways.

Nevertheless, challenges remain, particularly with respect to controlling deforestation and accelerating decarbonisation. Without an ecological transition, Brazil will be unable to meet its climate targets, including its NDC. This underscores the ETP as an essential pathway for the country's economic and climate ambitions.

This study represents the first phase of a broader effort. A second phase is planned to expand the model, incorporate new variables, and introduce methodological improvements to address current limitations. The findings reinforce that ecological transformation is not only an environmental imperative, but also a concrete opportunity to enhance the competitiveness of the Brazilian economy, attract investment, stimulate innovation, and promote a just and inclusive transition.

By advancing this work, Brazil is taking an important step towards building a robust analytical foundation to inform public policies that integrate economic development, social justice, and climate action.

ANNEXES

ANNEX A – Macroeconomic dimension

Dimension	Variable	Intermediate	Optimistic	Pessimistic
Fiscal Policy	Growth rate of government consumption	1.4%	2.5%	0.15%
Fiscal Policy	Growth rate of government investment	1.6%	2.5%	0.15%
Monetary Policy	Growth rate of durables consumption	2.2%	2.5%	0.15%
Monetary Policy	Growth rate of residential investment	2.3%	2.5%	0.15%
External Sector	Income elasticity of exports	0.86	1.1	0.62

ANNEX B – Representation of the ETP's political dimension (non-exhaustive)

Policy	ETP Axis	Variables
Technological change	Technological Densification	Speed of technological convergence
Industrial policy	Technological Densification	Increase in national content
Financial policy	Sustainable Finance	Increase in depreciation
Energy efficiency policy	Sustainable Finance	Increase in energy efficiency
Electricity production	Energy Transition	Share of renewable sources by 2050
Electrification	Energy Transition	Share of electric vehicles by 2050
Biofuels	Energy Transition	Share of biofuel-powered vehicles
Agriculture	Bioeconomy and Agrifood Systems	Area of sustainable agriculture
Intensive livestock farming	Bioeconomy and Agri-food Systems	Share of livestock under intensive production
Land restoration	Bioeconomy and Agri-food Systems	Area of recovered pasture
Planted forests	Bioeconomy and Agri-food Systems	Area of planted forest
Animal waste treatment	Circular Economy	Treated animal waste
Infrastructure	New Green Infrastructure and Adaptation	Increase in government investment

ANNEX C –Model results for growth and employment[8]

Scenario	Average growth rate			Employment (in millions)		
	2025-2030	2025-2040	2025-2050	2025	2035	2050
(0) BAU—Historical trend, no ETP Key macroeconomic variables grow in line with historical trends, with no ETP policies implemented.	2.43%	2.11%	2.07%	102.6	110.9	123.3
(1) Historical trend, partial ETP Key macroeconomic variables grow in line with historical trends, with full ETP implementation of ETP policies, achieving half of the established targets.	2.77%	2.26%	2.17%	102.7	112.0	124.4
(2) Historical trend, full ETP Key macroeconomic variables grow in line with historical trends, with full implementation of all ETP policies, achieving all targets.	3.11%	2.39%	2.23%	102.8	113.0	125.1
(3) Optimistic, no ETP Key macroeconomic variables grow faster than historical averages, with no ETP policies implemented.	3.35%	2.98%	2.93%	103.8	115.4	133.7
(4) Optimistic, partial ETP Key macroeconomic variables grow faster than historical averages, with full implementation of ETP policies, achieving half of the established targets.	3.70%	3.14%	3.04%	103.9	116.6	135.0
(5) Optimistic, full ETP Key macroeconomic variables grow faster than historical averages, with full implementation of ETP policies, achieving all targets.	4.04%	3.27%	3.09%	104.0	117.7	135.7
(6) Pessimistic, no ETP Key macroeconomic variables grow more slowly than historical trends, keeping pace with population growth, with no ETP policies implemented.	1.21%	0.92%	0.84%	101.9	105.6	110.1
(7) Pessimistic, partial ETP Key macroeconomic variables grow more slowly than historical trends, keeping pace with population growth, with partial ETP implementation achieving half of the established targets.	1.53%	1.05%	0.93%	101.9	106.6	111.0
(8) Pessimistic, full ETP Key macroeconomic variables grow more slowly than historical trends, in line with population growth, with full ETP implementation achieving all targets.	1.86%	1.17%	0.99%	102.0	107.6	111.5

8. The 'zero' scenario, which combines the macroeconomic historical trend scenario with the no ETP scenario, serves as the Business-as-Usual (BAU) baseline. It reflects current trajectories without political intervention and is used as the reference for comparison in the model.

ANNEX D – Sector description

Sector	Description
1	Agriculture, forestry, logging, livestock, and fishing
2	Extraction of oil and gas, including support activities
3	Iron ore extraction, including processing and agglomeration
4	Other extractive industries
5	Food and beverages
6	Manufacture of tobacco products
7	Manufacture of textile products
8	Manufacture of clothing and accessories
9	Manufacture of footwear and leather goods
10	Manufacture of wood products
11	Manufacture of pulp, paper, and paper products
12	Printing and reproduction of recordings
13	Oil refining and coking
14	Manufacture of biofuels
15	Manufacture of organic and inorganic chemicals, resins, and elastomers
16	Pharmaceutical products
17	Perfumery, hygiene, and cleaning products
18	Manufacture of pesticides, disinfectants, paints, and various chemicals
19	Rubber and plastic products
20	Cement and other non-metallic mineral products
21	Manufacture of steel and derivatives
22	Metallurgy of non-ferrous metals
23	Metal products, excluding machinery and equipment
24	Machinery, equipment, furniture, and various other industrial products
25	Household appliances and electronic equipment
26	Automobiles, vans, trucks, and buses
27	Parts and accessories for motor vehicles
28	Other transportation equipment
29	Production and distribution of electricity, gas, water, sewage, and urban sanitation
30	Construction
31	Commerce
32	Transportation, storage, and postal services
33	Accommodation and food services
34	Information services
35	Financial intermediation, insurance, supplementary pension plans, and related services
36	Real estate activities and rentals
37	Services provided to businesses and households, and maintenance services
38	Private education
39	Private healthcare
40	Public education, healthcare, administration, defence, and social security

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