New Economy for the Brazilian AMAZON

EXECUTIVE SUMMARY

WRI BRASIL

THE NEW CLIMATE ECONOMY
The Global Commission on the Economy and Climate

Research Coordination

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Family farming fruit harvest in Apuí, Amazonas.
Photo: Dereck Mangabeira/Idesam.

Foreword

The coming decades will define whether the Amazon – home to more than 28 million inhabitants, 198 indigenous peoples, and harboring the most biodiverse forest, the largest freshwater reservoir and the largest tropical bloc for climate regulation on the planet – will become the great catalyst for Brazil's low-carbon economy. Or whether, in the opposite direction, the Amazon will reach an irreversible point of degradation, deepening current inequalities and jeopardizing the stability and competitiveness of the country's entire economy.

How to guide the Legal Amazon towards a decarbonization trajectory, transforming the region's economy so that it grows, generates opportunities, values local cultures and environmental assets, while fighting inequality and deforestation? This question motivated the 76 researchers who signed the New Economy for the Amazon report.

The study combines different techniques and knowledge to present a unique depiction of the Legal Amazon's current economy, bringing to light the region's economic and environmental relations with the rest of Brazil and the world. The study focuses on carbon-intensive sectors that must change course in order to become a relevant part of a standing forest economy, more suited to the challenges of this century.

The study further explores the role of the bioeconomy, revealing a vigorous activity hitherto invisible to conventional instruments used to measure economic activity. Although it is based on the secular form of production of the original peoples, constantly innovated by local technologies developed in Amazonian villages, rural areas and cities, the bioeconomy remains underestimated in terms of its current impact and future potential. The work provides visibility to these activities, demonstrating their relevance as a solution for the region's future economy.

The report also assesses the economic performance of the Legal Amazon under different scenarios, comparing the current trajectory, which has been driving degradation, with alternative decarbonization scenarios, especially in the agricultural, livestock and energy sectors.

More than comparing GDP and job creation results, as economic performance is traditionally assessed, the New Economy for the Amazon gives shape to a qualitative analysis of that which is wanted for the future – and there is no future for Brazil without the Amazon. The results show that it is impossible for the country to reach its Paris Agreement targets and contribute to curbing global warming without eliminating deforestation in the Amazon. Even assuming that deforestation is eliminated, it will still be necessary to restore large areas of the forest and adopt new ways of generating and consuming energy, whether in rural or urban areas.

This report proposes a transition that generates quality jobs and opportunities for the region's citizens, while driving important changes in the rest of the country. The New Economy for the Amazon can be the great catalyst for the decarbonization of the entire Brazilian economy and the greatest opportunity for economic and social development in the country's contemporary history.

Fernanda Boscaini
Executive Director of WRI Brasil


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EXECUTIVE SUMMARY

Highlights

The Amazon rainforest is on the cusp of a crucial tipping point following decades of extensive deforestation that would have widespread ramifications for Brazil's people and economy, and the global climate.

A new analysis of various scenarios for the Brazilian Amazon's economy through 2050 finds that a deforestation-free, low-carbon pathway delivers the largest and most equitable economic growth for the region and for the whole country. This scenario — called the New Economy for the Brazilian Amazon — includes several major yet achievable transformations: zero deforestation, expanding the Amazon's bioeconomy to sustainably produce goods, expanding forest restoration, adopting low-emissions agriculture and livestock practices, and decarbonizing Brazil's energy mix.

This scenario would produce significant economic, jobs, and climate benefits for Brazil. By 2050, the Brazilian Amazon economy's GDP would grow by BRL 40 billion above the reference scenario, while adding 312,000 additional jobs. Brazil would also have 81 million more hectares of standing forests compared to business as usual and reduce its emissions by 94%, meeting its Paris Agreement climate target.

The investments to finance this transition are 1.8% of Brazil's national GDP per year, just 0.8% more than the reference scenario, or an additional BRL 2.56 trillion by 2050.

The Amazon would be the great catalyst for the decarbonizing the entire Brazilian economy, as investments would flow throughout the country.

Context

The Brazilian Legal Amazon (LAM), an area covering almost 60% of the Brazilian territory, holds the most extensive and biodiverse forest in the world, the largest freshwater reservoir and the most important climate regulating forest block on the planet, embracing a significant part of the Cerrado biodiversity hotspot. It is home to 28 million Brazilians, 198 indigenous ethnic groups from almost 50 language families. Despite its unique cultural and biological richness, LAM has suffered a chronic process of degradation, with 83 million hectares of primary forests having been cleared, jeopardizing its capacity to absorb carbon and provide ecosystem services - such as climate regulation and rainfall irrigation - for which there are no economically viable substitutes on such a large scale, for the own Amazon and surrounds economy, especially agriculture and livestock.

Climate change negatively impacts the forest and the economy, disproportionately affecting the poorest and already vulnerable populations. In addition to forest degradation and erosion of biodiversity, reducing the conditions of subsistence of traditional populations, climate change has a direct impact on agriculture, which is highly dependent on rainfall, as 96% of planted areas and 99% of pastures in Brazil do not have any irrigation systems in place (IBGE, 2019). The poorest people are the biggest victims of food price fluctuations resulting from crop failures and shortages due to systemic weather events such as droughts and floods. Living in areas at risk, with poor sanitation and without adequate assistance, the poor are also primarily affected by increases in flash floods, landslides, and epidemics.

Stopping deforestation and curbing global warming are crucial for the people of Amazon and beyond. Achieving the Paris Agreement goals and reducing emissions to curb global warming to 1.5°C requires investments of around 2% of global GDP per year – until stability in greenhouse gas (GHG) concentrations in the atmosphere is achieved (Stern, 2015). Exceeding the 1.5°C threshold considerably increases the investments needed to adapt and replace carbon-intensive processes, as well as increases the costs of recovering from more severe climate impacts, which may require up to 9% of global GDP per year (Guo, Kubli, & Saner, 2021).

Late afternoon in the Ver-o-Peso market, in Belém, Pará. Photo: Nayara Jinknss/WRI Brasil.

Brazil's role in containing global warming is vital and will require shifting to an economy that is free of deforestation and forest degradation, with low-carbon agricultural, livestock and industrial production. Brazil emitted about 67 gigatons of carbon dioxide ($GtCO_2$) over the past 30 years (SEEG, 2022). To meet the Paris Agreement goals and curb global warming to 1.5°C, this study estimates that the balance of Brazil's emissions between 2020 and 2050 (carbon budget) cannot exceed 7.7 $GtCO_2$. In the Legal Amazon, net emissions cannot exceed 1.4 $GtCO_2$ by 2050, which corresponds to a 96% reduction compared to the 36 $GtCO_2$ emitted over the past 30 years.

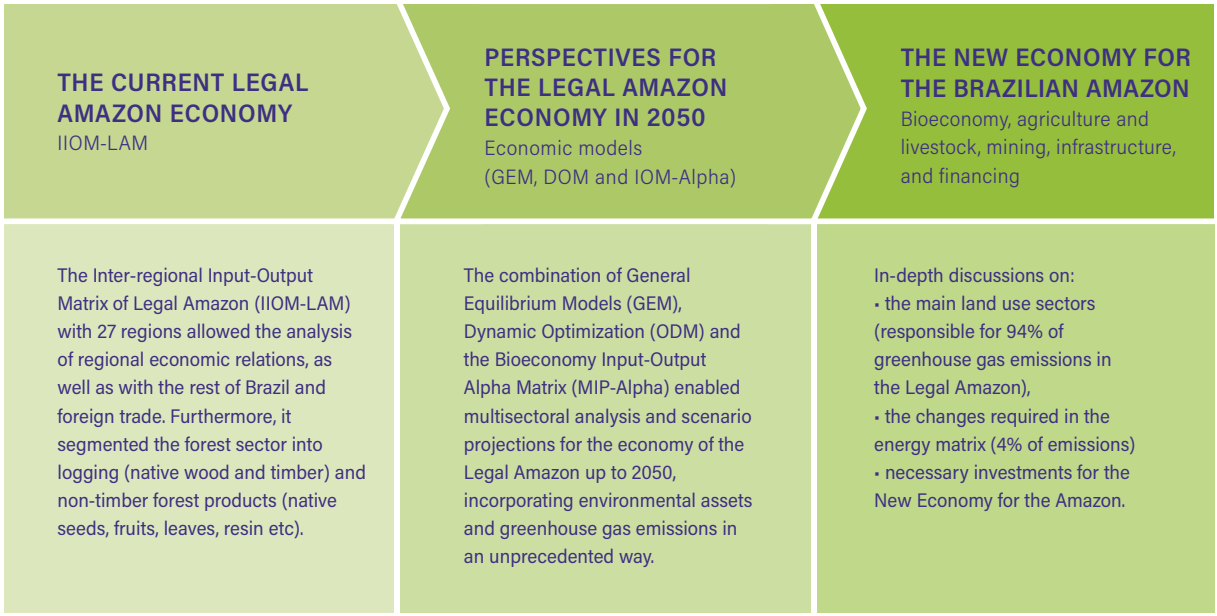
The New Economy for the Brazilian Amazon

The New Economy for the Brazilian Amazon (NEA-BR), an initiative by WRI Brasil in partnership with Brazilian research institutions and organizations from different regions, recognizes that advancing economic and social development combined with climate mitigation calls for profound changes in Brazil's economy. The initiative positions the Amazon as the great catalyst for these changes across Brazil. This report shows that investments in conserving and expanding natural assets, strengthening the bioeconomy, and shifting agriculture and livestock production and the energy matrix to low-carbon models in the Legal Amazon (LAM) would result in a stronger economy, with better performance than that based on the continued expansion of carbon-intensive activities. The structural changes of the transition to the NEA led by the Amazon would reach the entire Brazilian economy through the flows of investments, inputs and products exchanged between regions, leading the country towards the decarbonization of its entire economy.

The NEA study pioneered the integration of multiple economic models developed by different research groups in the country to build a comprehensive analysis of the LAM's current economy and outline different scenarios for its future economy. Different econometric techniques were combined, with the development of Inter-regional Input-Output Matrix (IIOM-LAM), General Equilibrium (GEM) and Dynamic Optimization (DOM) Models coupled to

Combu island, Belém, Pará.
Photo: Nayara Jinknss/WRI Brasil.

Figure SE 1 | **The New Economy for the Brazilian Amazon report**



Source: Elaborated by the authors.

computable modules of land use changes, and Input-Output Alpha Accounts Matrix (IOM-Alpha) for the bioeconomy. The work enables the analysis of the peculiarities of the LAM, the characteristics of its different regions, their trade flows, inputs, products, emissions and deforestation incorporated into them.

The methodological choices for the coupling and interaction of analytical models have some limitations. Although the NEA's originality offers a new perspective for the assessment and planning of the LAM's economy, there are limits and restrictions inherent to the models and interpretation of results, such as: (1) underestimation of potential positive effects generated by gains in human capital or technological progress on economic performance, (2) undervaluation of the degradation and depletion of natural resources, (3) undervaluation of ecosystem services, (4) underestimation of the current bioeconomy and, therefore, of the future bioeconomy, particularly in the secondary and tertiary sectors, and (5) non-spatially explicit economic results.

NEA's analytical approach

The NEA adopts the boundaries of the Brazilian Legal Amazon as its study area. The Amazon biome covers approximately 6.2 million square kilometers in eight countries in South America and in French territory, approximately 60% of which is in Brazil. The LAM, on the other hand, is a legal delimitation that includes the entirety of the Brazilian Amazon Basin, encompassing the tropical forest and adjacent Cerrado areas. Instituted by Law N. 1.806/1953, it amounts to 5 Mkm2 – 59% of the Brazilian territory. With about 28 million inhabitants (Ipeadata, 2022) and an average Human Development Index below 0.58 (Firjan, 2020), it fully covers the states of Acre, Amazonas, Amapá, Pará, Rondônia, Tocantins and Mato Grosso, in addition to Maranhão in its portion west of the 44th meridian.

The LAM is a mosaic of forest and savannah environments, with unique cultural and biological richness. With dozens of ecosystems managed by native peoples for more than 10 thousand years, the indigenous population of the LAM currently stands at nearly 600 thousand people from 198 ethnic groups and 49 language families (ISA, 2023) (Museu Emílio Goeldi, 2023). Forest management, agriculture and manufacturing techniques bring together a profusion of traditional knowledge about medicinal drugs, cosmetics, food, fibers, infrastructure materials and energy, still unknown to science, but commonplace in the original economy – or indigenous bioeconomy – characterized by its capacity to support the environment and respect for intangible assets that are inseparable from production.

The LAM houses the most extensive and biodiverse forest in the world, also encompassing a significant part of the Cerrado biodiversity hotspot. The largest tropical carbon stock in the world, the Amazon stores 120 GtC above ground (Gatti et al., 2021), equivalent to twelve times the annual emissions resulting from global economic activities (Valsecchi do Amaral et al., 2017). The LAM is responsible for recycling between 6.3 and 7.4 trillion cubic meters of water per year through the so-called "flying rivers", which irrigate the Brazilian center-south and is the region's most important service provided to the agribusiness, hydroelectric power generation, industry and sanitation sectors in the country and the Southern Cone (Baker et al., 2021). Over the past 30 years, the land use and energy sector has accounted for nearly 98% of all cumulative AML emissions. They are, therefore, the focus of this report.

Despite its relevance and role in the economy, the Amazon is approaching a point of no return due to its current trajectory of accelerated degradation. About 83 million hectares of primary forests have already been deforested in the Amazon (Prodes, 2022b). Considering the entire LAM, approximately 23% of the original cover has already been deforested, with 59 million hectares of primary forests and Cerrado areas deforested in the last 36 years (Mapbiomas, 2022c). The continuity of this process is leading to a point of no return (Nobre et al., 2016), with changes in the carbon cycles that cause the region to become a net carbon emitter, which happens when its capacity to absorb falls below its own emissions (Gatti et al., 2021).

Main results

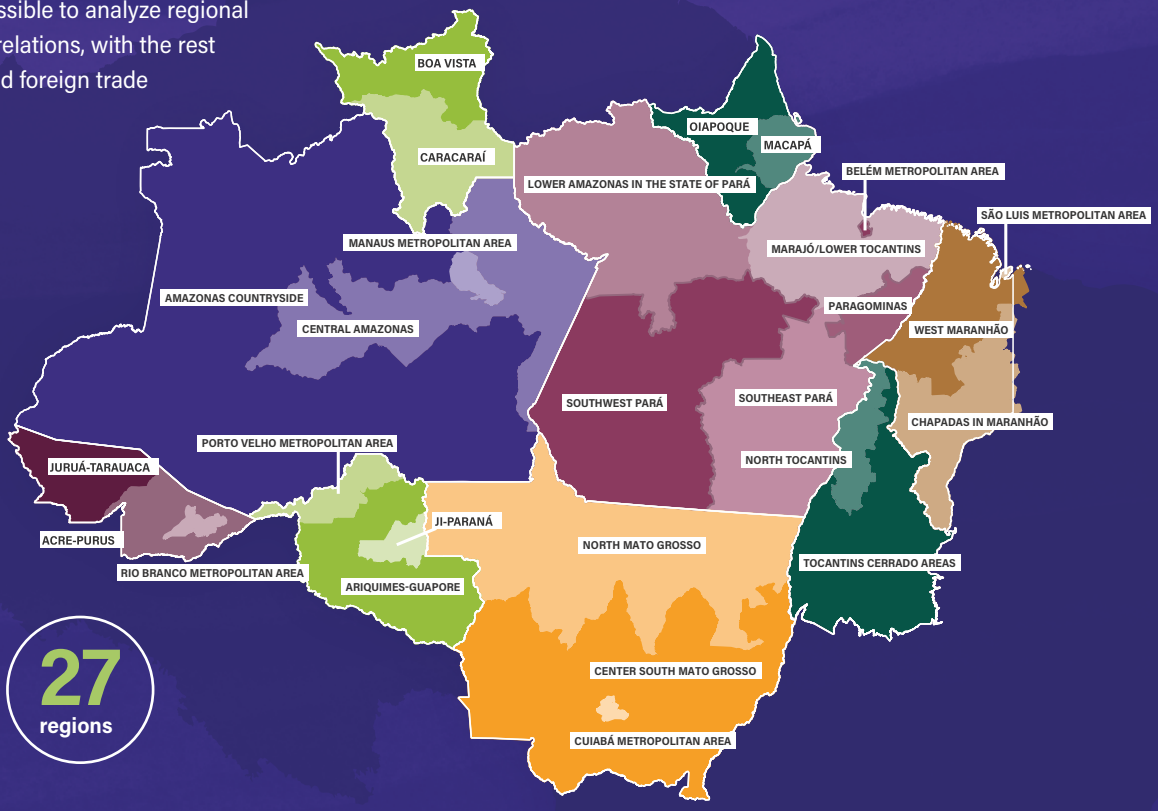
The Legal Amazon's current economy

The LAM's current economy runs a deficit in commercial transactions and a surplus in emissions, with highly carbon-intensive transactions. Under the current economic arrangement, the region is a large depositary of land that supplies low added value inputs to the national and international economy, exporting primary products and purchasing qualified goods and services with higher added value. The use of IIOM-LAM shows that, in 2015 – the most recent data available – the LAM's trade flows with the rest of Brazil resulted in exports of BRL 355 billion and imports of BRL 469 billion, with a BRL 114 billion deficit. On the other hand, emissions of 863 $MtCO_2$ were generated in the LAM to meet internal and external demands, with deforestation of around 1.5 million hectares. The complete IIOM-LAM is available at www.wribrasil.org.br/publicacoes/nova-economia-amazonia-nea.

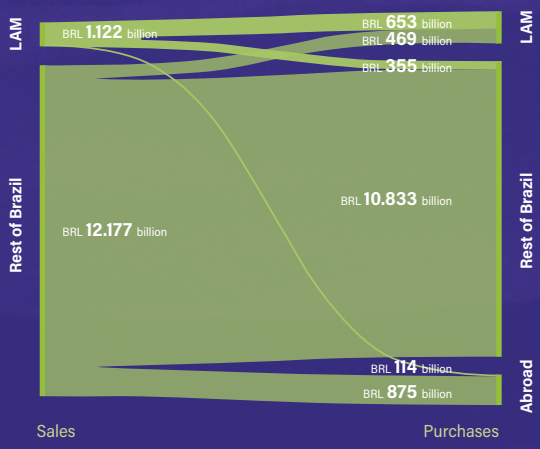
River transport in Combu island, in Belém, Pará. Photo: Nayara Jinknss/WRI Brasil.

Figure SE2 | The current Legal Amazon economy revealed by IIOM-LAM

The development of an Input-Output Matrix for 27 regions of the Legal Amazon, defined by their technological trajectories, made it possible to analyze regional economic relations, with the rest of Brazil and foreign trade



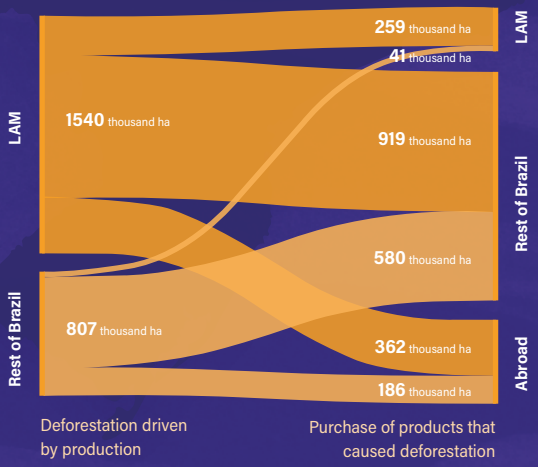
The Legal Amazon imports more than it exports, generating a COMMERCIAL DEFICIT...



By selling basic products and purchasing goods and services with higher added value, the Legal Amazon economy has a BRL 114 billion deficit in commercial transactions.

BRL 114 million

...And its exports are linked to MUCH HIGHER DEFORESTATION RATES



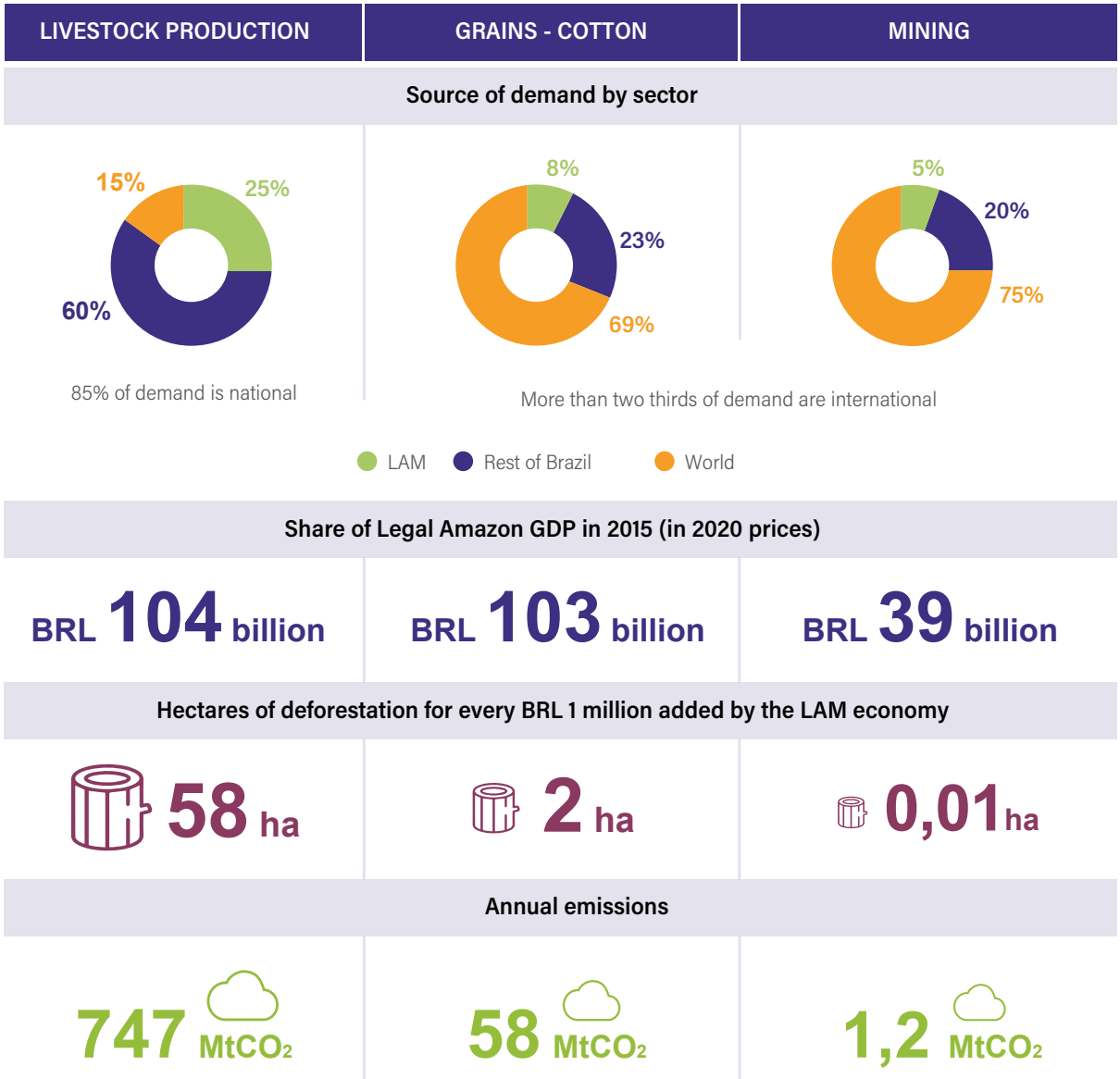
83% by external demand

More than 83% of deforestation in the LAM is stimulated directly or indirectly by existing demand from the rest of Brazil and abroad.

Note 1: trade flows at basic prices in the year 2015, according to the IIOM-LAM (at 2020 prices).
Note 2: Deforestation incorporated into commercial transactions per one thousand hectares.
Note 3: Results of this study.
Source: Elaborated by the authors.

More than 83% of deforestation in the LAM originates from demand arising from the rest of Brazil and from foreign trade. Deforestation is often assessed from the perspective of supply, that is, which productive sectors are promoting the replacement of forests by other land uses. The IIOM-LAM makes it possible to see the deforestation phenomenon from the perspective of demand as well, identifying the sources of incentives for the productive sectors to engage in deforestation. In the IIOM-LAM, the breakdown by origin of demand indicates that, while 46% of the LAM's VA is stimulated by existing demand from outside the region, 83% of deforestation is triggered by this external demand, as the region's exports are characterized by low VA and intensive deforestation. Only 12% of deforestation observed today in the LAM results from direct, indirect and induced stimuli from the region's internal demand. In absolute terms, of total deforestation in the LAM in 2015, 919 thousand hectares were induced by demand from the rest of Brazil, 362 thousand hectares by international demand and 259 thousand hectares by demand from the LAM region.

Figure SE 3 | **Analysis of deforestation and emissions by LAM sector and source of demand**



Note: Results of this study.
Source: Elaborated by the authors.

The Legal Amazon's economy in 2050

Using General Equilibrium (GEM) and Dynamic Optimization (DOM) models, four different scenarios were outlined for the LAM's economy in 2050, combining two restrictions to the allocation of production factors and technological choices: control of total GHG emissions and control of deforestation. In the **Reference (REF)** scenario, no restrictions were applied. In the **Technological Support (STE)** scenario, deforestation was not restricted, but the condition was imposed that total emissions by 2050 could not exceed the estimated limit of 7.7 $GtCO_2$ for compliance with the Paris Agreement's 1.5°C scenario, forcing the optimization of energy technologies in support of the decarbonization of the economy. The opposite was done in the **Forest Support (SFL)** scenario, with deforestation restricted to zero, but no limits imposed on any other emission sources in the economy, forcing the optimization of land use. Finally, in the scenario for the **New Economy for the Amazon (NEA)**, the two restrictions were applied, combining optimization of land use and the energy matrix to achieve the goal of maintaining net accumulated emissions in Brazil at 7.7 $GtCO_2$ between 2020 and 2050.

Figure SE 4 | Window to the future: economic scenarios

The study projects scenarios for the economy of the Legal Amazon until 2050 combining restrictions on emissions and deforestation

Note 1 : In order to meet the emission targets established in the Paris Agreement and curb global warming to 1.5°C, this study estimated that the balance of emissions in Brazil between 2020 and 2050 (carbon budget) cannot exceed 7.7 $GtCO_2$.
Note 2: Results of this study.
Source: Elaborated by the authors

Without restrictions on deforestation, Brazil will not be able to meet its climate targets. Eliminating deforestation is also insufficient – it is necessary to combine it with the decarbonization of agriculture, livestock production and the energy matrix. The persistence of the carbon-intensive economy represented by the REF scenario would result in accumulated emissions of 43.6 $GtCO_2$ by 2050. The STE scenario, on the other hand, failed to produce a viable mathematical solution, which illustrates the impossibility of meeting the Paris Agreement targets without restricting deforestation. No combination of technological and energy packages from other sectors of the economy would be able to neutralize the emissions resulting from changes in land use. The SFL scenario shows that, even with zero deforestation in Amazon, the other regions and sectors would emit 21.1 $GtCO_2$ by 2050, a figure almost three times higher than the target. In the NEA scenario, emissions were restricted to the target of 7.7 $GtCO_2$, which would lead to the optimization of land use, increase in agricultural and livestock productivity through the intensive use of capital and labor, decreased pressure on native vegetation and restoration of 24 Mha in favor of carbon sequestration and the bioeconomy. In this scenario, LAM emissions were estimated at 1.4 $GtCO_2$ by 2050.

Qualified GDP and a larger number of inclusive jobs, especially in bioeconomy, are major advantages of the transition to the New Economy for the Amazon. The national GDP in 2050 in the REF scenario was estimated at BRL 14.432 trillion (at 2020 values), while in the NEA scenario, this indicator is slightly higher, BRL 14.658 trillion. In the LAM, the GDP in the REF scenario was estimated at BRL 1.301 trillion against BRL 1.340 trillion in the NEA scenario. **Under the NEA scenario, around 312 thousand additional jobs would be created in the LAM alone**, with 365 thousand additional jobs in the bioeconomy, and another 468 thousand additional jobs in restoration, replacing jobs in carbon-intensive chains. In these chains, more than 91% of current positions are held by minority groups such as black and indigenous people. In the NEA scenario, the jobs held by these groups fill about 18.7 million positions (81% of the total), with 345 thousand additional jobs compared to the REF. By the end of 2050, the NEA's GDP would produce less than one fifth of the total emissions in the REF scenario and an additional 81 Mha of native vegetation, with a 19% larger forest carbon stock, generating savings that contribute to climate negotiations, attract financing and generate essential ecosystem services for production.

The investments required to finance the transition to the NEA amount to BRL 2.56 trillion by 2050 (additional to the REF scenario). Investments in LAM were estimated at BRL 3.36 trillion in the REF scenario (1.0% per year of national GDP) and BRL 5.92 trillion in the NEA scenario (1.8% per year of national GDP) by 2050. Of the additional BRL 2.56 trillion in the NEA scenario, BRL 659 billion would be applied to strategic land use, through technical changes to intensify production of the agricultural, livestock, bioeconomy and restoration sectors; BRL 410 billion to changes in the energy matrix and another BRL 1.49 trillion to induced infrastructure. Investments would not be restricted to the LAM, given the intricate input-output relationship between the region and the rest of the country, implying harmonization of standards, products and processes. **The Amazon would be the great catalyst for the decarbonization of the Brazilian economy**.

Oil production from andiroba seeds in the riverside community of Bauana, in Carauari, Amazonas. Photo: Ricardo Oliveira.

Figure SE 5 | **Benefits of the New Economy for the Amazon**

Maintaining the standing forest and reducing emissions represent an opportunity to strengthen the Amazon's economy.

An unprecedented combination of data and models enabled the assessment of economic, social and environmental results that demonstrate the benefits of the New Economy for the Amazon compared to the current trajectory by 2050.

BENEFITS

ENVIRONMENTAL AND CLIMATE-RELATED

+22 Mha*
of restored forests

+81 Mha
OF STANDING FOREST

59 Mha
of avoided deforestation

WATER

13% reduction
in water loss due to surface runoff

Higher penetration of water into the soil increases the resilience of agricultural and livestock production to water stress and reduces the risk of flooding

SOIL FERTILITY

16% nitrogen **18% phosphorus**
lower soil nutrient loss

Savings in fertilizer replacement costs from BRL 46 to 8.7 billion over 30 years

EMISSIONS

94% less
net carbon emissions

Emissions reduction of
35,9 GTC ⟩⟩ Brazil
24,2 GTC ⟩⟩ LAM

CARBON

19% more
carbon stock

Environmental asset to back carbon credits, climate negotiations and attract financing

*In the NEA scenario, 24 Mha are of forests are restored, and in the Reference scenario the estimate restoration is 2 Mha, so the total difference between the scenarios is 22 Mha.
Note: Results of this study.
Source: Elaborated by the authors.

ADVANTAGES OF THE NEA

BENEFITS

ECONOMIC AND SOCIAL

+BRL 40 billion
IN THE LEGAL AMAZON'S GDP

+312 thousand
additional jobs in the region

BIOECONOMY

higher GDP, reaching
BRL 38.5 billion

JOBS

More sustainable jobs replacing occupations linked to deforestation. 833 thousand additional jobs in the bioeconomy and restoration sectors

MULTISECTOR

Growth in all sectors, including agriculture, livestock production, mining and bioeconomy, with less land and more labor and capital

CITIES

Cities assume a vital role in the development and innovation of the bioeconomy, as they are the platform for the circular and proximity economy for standing forest products

ADDITIONAL INVESTMENTS FOR THE TRANSITION

Low carbon agricultural and livestock production	BRL 442 billion
Bioeconomy and restoration	BRL 217 billion
Energy matrix	BRL 410 billion
Infrastructure	BRL 1,49 trillion

The Amazon would be the catalyst for Brazil's low-carbon economy.

Bioeconomy

The bioeconomy proposed by the NEA is one that evolves with the forest standing and the rivers flowing. The Amazon bioeconomy must be able to adjust to the biome's biocapacity, building upon economic activities that do not disrupt the complex ecological balances that guarantee the health of the forest and rivers on which the population depends, combining tradition and innovation, as a bioecological bioeconomy (Costa and Fernandes, 2016) (Costa et al., 2022). This bioeconomy already exists, but it is partially invisible in national accounts due to the high level of informality and the inadequacy of official methods for capturing indicators.

The bioeconomy revealed by the new indicators is thriving in the LAM. Even with limitations inherent to the collection of primary data and traceability of informal activities, the bioeconomy already generates an annual Gross Value of Production (GVP) of BRL 15 billion in the LAM. The application of the IOM-Alpha method reveals that the bioeconomy is a vector of strong dynamism in the proximity economy, with great capacity to generate local production and employment. Assessments based on the IOM-Alpha show that the region's bioeconomy, encompassing only 13 primary products (for which there are reliable data), currently generates BRL 9.5 billion in VA, a GDP of approximately BRL 12.1 billion and a wage bill of BRL 1.89 billion across the chain (primary, secondary and tertiary sectors). Pará emerges as the leader of the bioeconomy, accounting for 73% of the LAM's wage bill. The LAM's IOM-Alpha is available at at www.wribrasil.org.br/publicacoes/nova-economia-amazonia-nea.

In the scenario of transition to the NEA, the bioeconomy emerges as an important GDP component. Despite data and projection limitations – this study was limited to only 13 primary products and their derivatives from the secondary and tertiary sectors –, in the NEA scenario, the bioeconomy's GDP in the LAM will reach BRL 38.5 billion in 2050, or 2.8% of the regional GDP, employing 947 thousand people, around 4% of the total number of jobs in the entire region. In the REF scenario, the GDP of the bioeconomy would be close to BRL 22.3 billion, generating around 592 thousand jobs.

Figure SE 6 | The bioeconomy is larger than current instruments can measure

Conventional Input-Output matrices do not allow any differentiation between the standing forest economy from the deforestation economy.

The separation of these sectors through the IIOM-LAM, added to the innovations of the IOM-Alpha, allow us to see the thriving economy of the forest and its peoples, invisible to current instruments.

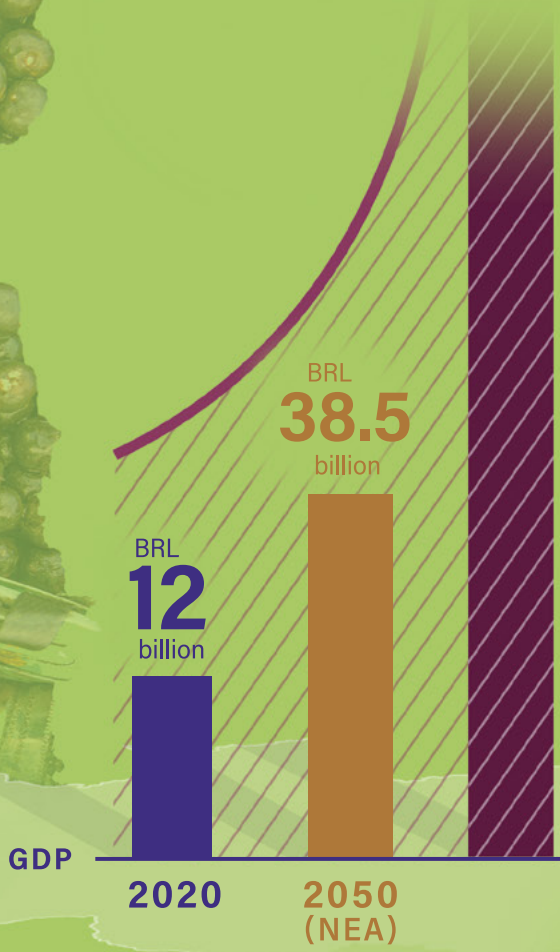
THE METHODOLOGIES USED IN THIS STUDY ENABLE:

The segmentation of the forest extraction sector into **destructive** (which implies felling that irreversibly damages the mother plant) and **non-destructive** (which assumes the maintenance of the plant and, on a large scale, the forest), in addition to **silviculture.**

The inclusion of the **secondary** and **tertiary** sectors, especially **individual entrepreneurs** with a description of activities related to the bioeconomy

The differentiation of **monocultures** of Amazonian products from small production systems, such as **agroforests.**

LAM'S BIOECONOMY GDP



The bioeconomy will likely be much larger

Just for food consumption, the forest peoples use more than 270 native products.

The bioeconomy 4.0, which includes **industrialization, innovation, research** and **technology**, can raise GDP to levels that are still difficult to calculate.

The bioeconomy projection was carried out based on only **13 native products** for which reliable data is available:

- açaí fruit
- açaí palm heart
- cocoa
- nuts
- babassu coconut
- babassu oil
- cupuaçu
- honey
- rubber
- buriti
- urucum
- copaíba
- andiroba

BIOECONOMY SECTORS ANALYZED

PRIMARY

BRL **1.92** billion

Extraction and agro-extraction

may take place through non-destructive extraction or production via sustainable systems, such as agroforestry

SECONDARY

BRL **3.98** billion

Artisanal and industrial

processing includes everything from the açaí beater to large pulp factories

TERTIARY

BRL **9.15** billion

Trade, services and final consumption

From the Ver-o-peso market, in Belém, to the beaches in California

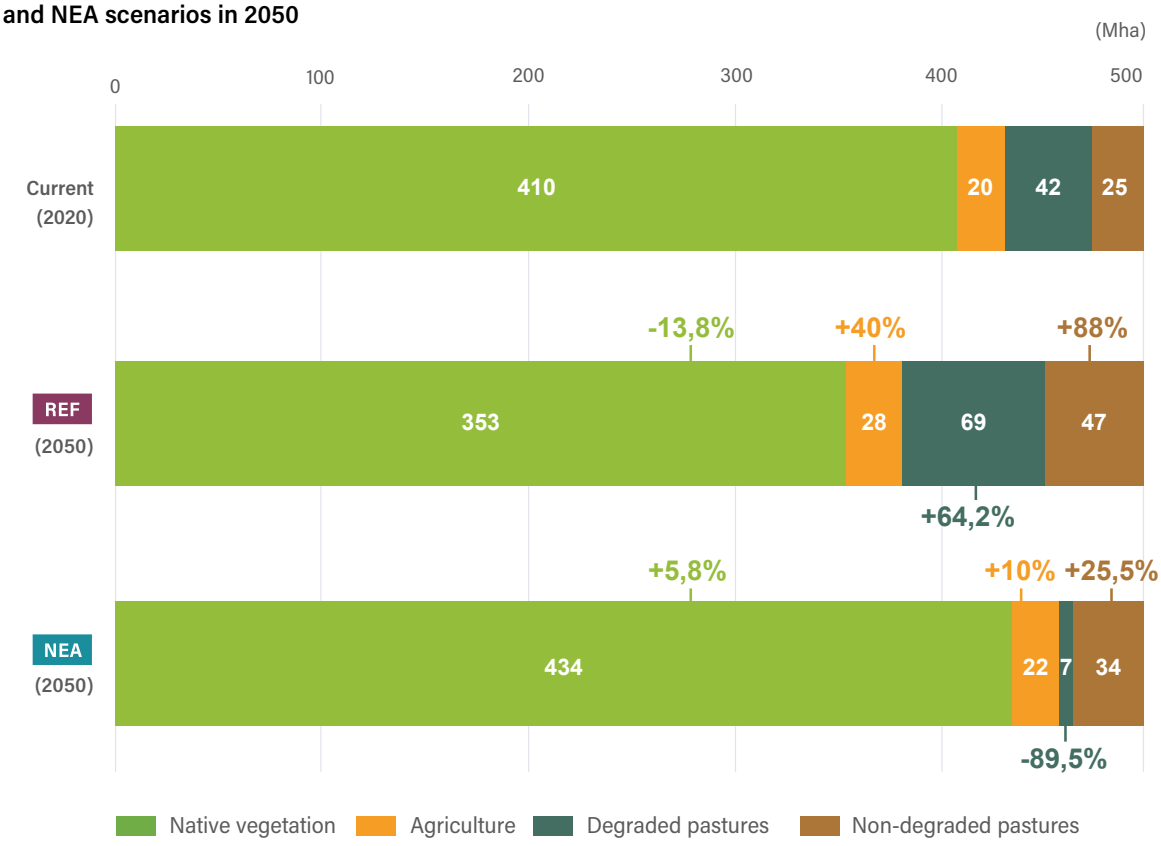
The bioeconomy will likely be much larger than indicated above. Research shows that the indigenous peoples of the Amazon have an extremely diverse diet, with up to 270 items used daily in cooking, compared to less than 30 items used by non-indigenous groups in the same region (Mesquita, Barreto, 2015; Skeltis, 2019). On a daily basis, they use up to 85 species of trees and more than two hundred herbs for food or medicine supplementation (Levis et al., 2018), and ingest about 30 species of insects – the food of the future – as a source of vitamins and iron (Roche et al., 2008). Because each ethnic group has its own food preferences and taboos, the resources available in the forest are spatially heterogeneous and as numerous as biodiversity (Freitas, Moreira, Freitas, 2005), which reinforces the hypothesis that the Amazon Forest itself, in good measure, is the result of persistent and millenary autochthonous forest management (Levis et al., 2017).

The bioeconomy scaling strategy that generates the best social, environmental and economic results for the NEA is based on the replication and expansion of productive arrangements already existing in the territory: inclusive, diverse and based on local ability and intelligence. The bioeconomy growth should take place through the multiplication of production arrangements that are typical or under development in the territory, which are labor intensive, based on forest products or the restoration of native vegetation, and which combine local solutions with the adaptation of efficient technological innovations. The transformation of primary products and their insertion in markets depend more on the ability to add local value and their capillarity in the territory than on a technological revolution. The bioeconomy is also vital for the generation of ecosystem services for which there are no substitutes that are economically viable or sufficiently available to meet productive demands, especially from the agricultural and livestock production sector.

The indigenous economy is based on community elements and benefit sharing, which are essential to the bioeconomy. The productive processes of the indigenous economy are generally structured around individual initiatives, organization into associations, cooperatives, collectives and groups of producers or family initiatives – often led by women. They combine food cultivars, medicinal herbs, dyes and textile products, as well as handicrafts and other cultural manifestations. Benefit sharing is a hallmark of the indigenous economy, following concepts of justice that encompass not only distribution based on work or knowledge of productive processes, but also recognition of different social roles and solidarity with excluded people. Decisions are always based on the gathering of collective resources and dialogue with ancestral heritage.

Women breaking native cacao in the Madeira river region, in Novo Aripuanã, Amazonas. Photo: Ricardo Oliveira.

Figure SE 7 | **Land use and land cover classes in the base year 2020, in the Reference and NEA scenarios in 2050**



Note: Results of this study.
Source: Elaborated by the authors.

Agriculture and livestock production

The agriculture and livestock production sector accounts for a large portion of the LAM's economy and must become free of deforestation and forest degradation to ensure its relevance by 2050. In the NEA scenario, higher land productivity, less susceptibility to water stress, and less soil fertility loss would boost agricultural and livestock production, allowing the sector to grow by substituting land for capital and labor. A productive reorganization would result in a more productive, resilient, deforestation-free and low-carbon agricultural and livestock production sector. With a more efficient land use and no deforestation and degradation, water loss from runoff would recede by 13%, protecting these activities from water stress, and nitrogen and phosphorus losses would decrease by 16% and 18%, respectively, reducing costs with fertilizers and generating savings in the range of BRL 4.6 - 8.7 billion over 30 years.

The three biggest challenges for agriculture and livestock production in the transition to the NEA are: (1) the strategic use of land; (2) the productive intensification and mainstreaming of low carbon emission practices, and (3) the fight against rural inequality. The strategic use of land reflects a focus on recovering degraded pastures, both for livestock production and agriculture and forest restoration activities, in addition to increasing the areas with integrated and agroforestry systems. The productive intensification and mainstreaming of low carbon emission practices are guidelines for the sector's adaptation to climate change, specifically outlined by the country's low carbon emission plan for the sector ("Plano ABC+"), while the fight against rural inequality must be tackled mainly through family farmers' unobstructed and privileged access to credit, risk mitigation instruments, customized technical and managerial assistance, including for bioeconomy products, and differentiated, institutional markets with denomination of origin.

Investments to finance the transition of agricultural and livestock production would exceed those estimated for the REF scenario by about BRL 442 billion. The mainstreaming of low carbon emission practices and the intensification of agriculture and livestock activities should occur exclusively in consolidated degraded and anthropized areas, with a focus on the adoption of bio-inputs and integrated production systems (integrated crop-livestock-forestry and agroforestry systems, especially with native species). Agricultural and livestock production activities in the NEA scenario would maintain their share in the LAM's GDP compared to the base year 2020, receiving substantially higher investments to promote the transition, but simultaneously generating savings in fertilization replacement costs resulting from the erosion of ecosystem services observed in the REF scenario. Investments in the agriculture chains in the NEA scenario are 25% above the figures in the REF scenario, while investments in livestock production would be 84% higher in the NEA, reflecting the effort to generate productivity gains that offset the significant loss of pasture area.

Mining

Mineral assets are indispensable for the global energy transition and for building a low-carbon economy infrastructure. However, mining costs and benefits must be internalized and better distributed. Industrial mining in the LAM already generates approximately BRL 39 billion in GVP and 113 thousand jobs. The region has reserves of global significance that are already measured, such as 18% of tantalum, 11% of niobium, 9% of manganese and tin, in addition to other significant reserves, such as 8% of aluminum ore (metallurgical bauxite) and 4% of iron ore. The industry has advanced in precautionary practices and has been making progress in the adoption of environmental, social and corporate governance (ESG) criteria. However, current social and environmental impacts, such as exposure of the population to substances harmful to health, risks of disasters with tailings, territorial disorder following the end of the mining extraction cycle, pollution of groundwater and watercourses are negative externalities that need to be addressed. The exploitation of essential minerals for the transition must go beyond ESG practices and prioritize the well-being and safety of local populations and their natural resources, essential for their ways of life, translated into direct investments to promote environmental quality, the bioeconomy and regenerative productive systems that are compatible with local aspirations.

Infrastructure

The main energy solution for the NEA scenario is the implementation of photovoltaic systems, whether in floating systems on existing hydroelectric dams or on degraded pastures close to transmission structures, optimizing the installed capacity of the National Interconnected System (SIN). Together, these systems would generate 55% of the 131 TWh that will be demanded by the LAM in 2050 under the NEA scenario. Hydroelectric power plants, currently responsible for 85% of the installed capacity in the LAM, do not expand in the NEA scenario. Belo Monte would have been the last major hydroelectric power project in the region. The burning of agricultural, urban and bioeconomy waste, such as açaí pods, would be able to generate another 14TWh. This ideal approach to isolated systems would replace, in 2050 alone, the equivalent of 359 million liters of diesel, reducing emissions by almost 1.5 $MtCO_2$ and boosting the local economy.

As for the transportation sector, the required energy in the NEA scenario would reach 133 TWh in 2050, while in the REF scenario it would stand at 188 TWh. In the NEA, the energy demands of passenger and cargo transportation by road, hybrid waterway and air fluvial systems would be met as follows: 54% by second and third generation biofuels, 40% by renewable electric energy and only 6% by fossil fuels. Differently, in the REF scenario, 82% would come from fossil sources, 16% from biofuels and only 2% from electricity. Additionally, no new high-speed roads would be built, but replaced by hybrid waterway transportation systems. While emissions in 2050 would amount to 38 $MtCO_2$ in the REF, in the NEA scenario they would only reach 17 $MtCO_2$.

Heavy traffic in Av. Torquato Tapajós in Manaus, Amazonas. Photo: Bruno Kelly/WRI Brasil.

Financing

A significant expansion in the supply of financing will be necessary to reach the investment volumes required to decarbonize the global economy, and in Brazil this will be no different. Studies on the dimensioning of investments required to decarbonize the global economy have converged to rates close to 2% of GDP per year (Stern, 2015), while the values effectively applied have been around 0.1% in the most optimistic estimates (Guo, Kubli and Saner, 2021). Filling the gap in order to reach levels close to 2% of GDP requires a disruption in trends and a shift in the supply curve, given the steep 590% increase that needs to take place by 2030 to reach the required level (Naran et al., 2022). There are no references on the gap between investment and financing needs for Brazil.

Investments of BRL 2.56 trillion will be needed to finance the NEA transition. Brazil needs to invest around 4.5% of GDP per year over the next 25 years to guarantee a stock of infrastructure and minimize risks of economic strangulation (Frischtak, Mourão, 2017). In the present study, investment needs corresponding to 1.8% of GDP were estimated to finance the transition to the NEA. Although those investments would not necessarily be additional to the formation of a stock of infrastructure – which could be expanded under a decarbonized energy and agricultural/livestock production matrix –, the highly competitive environment to access financial resources adds to the challenge.

On the other hand, the costs of not promoting the transition to the NEA could be much higher. In the GEM models used in this study, the reference scenario for the LAM's economic growth does not include opportunity costs of the technologies employed in the NEA scenario, nor do-nothing costs, which reduce GDP in the reference scenario due to chronic and acute effects of climate change. Worldwide, projections indicate that the cost of not curbing warming below 2°C should range between 4% and 18% of global GDP by 2048 (Guo, Kubli and Saner, 2021). If the do-nothing penalties suggested for Brazil's GDP by the Swiss Re Institute are applied, the additional investments of BRL 2.56 trillion for the transition would, in the most conservative economic estimates, be less than half of the costs of not promoting the transition.

Table SE 1 | **Investments accumulated over 30 years, from 2020 to 2050 (BRL billion)**

		REF	NEA
STRATEGIC LAND USE		**992,7**	**1.651,4**
Agriculture		613,0	765,0
Livestock Production		345,0	635,0
Bioeconomy		13,0	40,2
Restoration		21,7	211,2
ENERGY AND INFRASTRUCTURE		**2.366,6**	**4.266,4**
Electricity		**942,8**	**1.337,4**
National Interconnected System	Wing Generation	195,7	199,1
	Solar Generation	73,8	75,1
	Biomass	77,1	359,9
	Other Sources	433,2	432,9
Local Systems	Solar Generation	163,1	268,9
	Waste	0,0	1,5
Biofuels		**17,2**	**33,0**
Passenger Road Transport		4,0	11,7
Cargo Road Transport		6,9	15,4
Hybrid Water Transport		4,9	1,7
Air-fluvial Transport		1,3	4,1
Induced Infrastructure		**1.406,6**	**2.896,0**
TOTAL		3.359,3	5.917,8

Note: Results of this study.
Source: Elaborated by the authors.

Recommendations

The public sector must assert its allocative and distributive roles to signal the directions to be taken by the economy going forward. Although renewable energies, such as solar, are already competitive, they are still penalized and distorted by the maintenance of subsidies to fossil fuels, whose extinction should be the main guideline for public sector actions. Brazilian subsidies to fossil fuels over the past decade amounted to almost USD 222 billion (Inesc, 2022), corresponding to 60% of the investments needed to change the energy matrix under the NEA scenario. In agriculture and livestock production, if the total volume of funds managed by Plano Safra (the government's agriculture and livestock production financing program) were earmarked to investment projects aligned with Plano ABC+, the annual average volumes of rural credit available for investment in the LAM would be enough to cover (if replicated over the 30-year period) almost 40% of the investment needs under the NEA scenario.

The private sector needs to increase its capacity for innovation and become a driver of the new economy. Between 2013 and 2020, approximately BRL 61 billion in green bonds were issued in Brazil, of which 50% financed energy projects, while 25% went to land use projects, 10% to transportation projects, 4% to construction projects, 4% to projects involving water resources, 4% to projects involving waste and 3% to the industrial sector (CBI, 2021). Many corporations have been investing in decarbonization, largely following criteria relating to actions with positive impacts on the ESG spheres, which are difficult to account for. The volume of associated shares traded on the stock exchange reached around BRL 2 billion. It is true that public sector signaling is essential to ensure safety, but there is already enough information for the private sector to take the lead in the race for innovation and adaptation of the economy to the needs of decarbonization.

Employ instruments and methods that enable the adequate assessment of the LAM's social and economic development. Adoption of Input-Output Matrices capable of segmenting activities typical of the Amazonian economy and its different regions offer a technically robust and replicable alternative. Accounting techniques for generally undersized monetary flows, as revealed by the IOM-Alpha for the bioeconomy chain, are essential to break with the undersizing bias connected with these activities, which prevent their relevance from being recognized and, therefore, adopted as part of the solution through the circular and proximity economy.

"Beira" market in downtown Manaus, Amazonas.
Photo: Bruno Kelly/WRI Brasil.

Establish clear milestones in the conceptualization of bioeconomy plans and programs that are compatible with products, processes and productive structures that protect the standing forest, biodiversity and knowledge of indigenous peoples and traditional populations. The bioeconomy is not to be confused with low-carbon agriculture and livestock production, although they are complementary in the transition to the NEA. The entire structuring of systems for promotion, innovation, research and development of products and processes must be based on the concept of standing forests and flowing rivers as bioeconomy pillars, safeguarding and promoting the fair distribution of benefits to people and communities that hold traditional knowledge. **Sustainable economy should be prioritized in indigenous territories with their peoples as protagonists**, with actions that promote the exchange of knowledge, technical and financial support, valuing traditional knowledge and involving political representations of indigenous peoples. Indigenous professionals must lead the planning and operation of production chains, from production to commercialization.

Eliminating subsidies or promoting cross-subsidies from fossil fuels to energy from renewable sources with an emphasis on solar generation and second-generation biofuels is essential to the decarbonization of the economy. As shown in this study, the volume of subsidies to fossil fuels in Brazil, in the last decade alone, amounted to a value equivalent to half of what is needed to structure the energy matrix under the NEA scenario. Differentiated taxation in favor of electric vehicles, public transport concession policies aimed at fleet electrification, regulation that leads to the progressive growth of the volumetric content of biodiesel produced in deforestation-free areas that are compliant with the Soy Moratorium and reduction of docking fees for vessels with batteries and biofuels are other points to be addressed by fiscal policies in order to promote the decarbonization of transportation in the region.

Redirect the availability of rural credit, gradually transforming the Plano Safra into a Low Carbon Emission Agricultural Plan (ABC). Currently, only 3% of all credit for investment in agriculture and livestock production in the LAM coming from Plano Safra is earmarked to low carbon emission practices. As demonstrated in this study, if the current volume of loans granted in the LAM were annually applied only to low-carbon agriculture and livestock production, it would be enough to finance 40% of the investments necessary for the transition of this sector to the NEA. We endorse the recommendations of the Brazilian Coalition on Climate, Forests and Agriculture (2022), in particular its recommendation to increase funds that authorize the payment of interest rate equalization on rural financing granted under the Plano Safra for low-carbon agriculture and livestock activities, in addition to including private investment funds that finance credit lines aligned with the ABC+ and Pronaf ABC+ programs.

Re-establish the role of the public sector in territorial management and governance. Reestablish the Plan for the Prevention and Control of Deforestation in the Amazon and support the updating of State Plans for the Prevention and Control of Deforestation; resume the allocation of

public forests for conservation, Indigenous Lands and sustainable forest management; reestablish the territorial security of protected areas (Indigenous Lands and Conservation Units) and support the forest-based economy in these areas; implement the National Plan for the Recovery of Native Vegetation (Planaveg) and support state programs for the restoration of landscapes and native vegetation; and structure the jurisdictional Reduction of Emissions from Deforestation and Degradation (REDD+) systems of the Amazon states.

Restore governance and guarantee the investments of the Amazon Fund. The Amazon Fund, in addition to providing support for command-and-control actions, indigenous communities and the implementation and analysis of the Rural Environmental Registry (CAR), must play a vital role in the development of the bioeconomy. Fund resources can both initiate the structuring of new chains and generate scale gains for existing chains and businesses. Among the possible actions are priority investments in enterprise management, technical and management assistance, access to markets, working capital, logistics, technology and provision of specialized services.

Create a methodological framework and taxonomies for the financial and capital markets on the requirements for green investments in the Amazon that promote the reduction of emissions and the preservation of biodiversity. A legal framework for the carbon market in Brazil is thus necessary, based on a broad discussion with society about the earmarking of subsidies, leading to their progressive shift from carbon-intensive activities to the development of new technologies and the implementation of low emission productive practices throughout the economy. There are many potential sources of funds, both domestic and international. These sources must be accessed and give rise to a new mainstream financing model.

Ka'apor people of the Indigenous Land Alto Turiacu, in northern Maranhão, install cameras for autonomous monitoring of their territory in areas threatened by illegal loggers. Photo: Lunae Parracho/Greenpeace.

About the New Economy for the Brazilian Amazon

The New Economy for the Brazilian Amazon (NEA-BR) is an initiative led by WRI Brasil and The New Climate Economy, in partnership with more than 75 researchers from various Brazilian regions, and organizations, including the Federal University of Pará (UFPA), University of São Paulo (USP), Federal University of Rio de Janeiro (UFRJ), Federal University of Minas Gerais (UFMG), Institute for Environmental Research in the Amazon (IPAM), Instituto de Conservação e Desenvolvimento Sustentável do Amazonas (IDESAM), Center for Climate Crime Analysis (CCCA), Concertation for the Amazon and Associação Contas Abertas.

The initiative has the financial support of Instituto Clima e Sociedade (iCS), the Danish Ministry of Foreign Affairs, the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection of Germany, Instituto Arapyaú, Good Energies Foundation, and the Climate and Land Use Alliance (CLUA).

Cocoa produced on Combu Island, Belém, Pará. Photo: Dado Photos/Shutterstock.

About WRI Brasil

WRI Brasil is a research institute that transforms great ideas into actions to promote environmental protection, economic opportunity and human well-being. It works in the development of studies and implementation of sustainable solutions in climate, forests and cities. It combines technical excellence with political articulation and works in partnership with governments, companies, academia and civil society.

WRI Brasil is part of the World Resources Institute (WRI), a global research institution operating in more than 60 countries. WRI relies on the expertise of approximately 1,400 professionals in offices in Brazil, China, the United States, Europe, Mexico, India, Indonesia and Africa.

About The New Climate Economy

The Global Commission on Economics and Climate and its flagship project The New Climate Economy were created to help governments, businesses and society make more informed decisions about how to achieve prosperity and economic development while addressing climate change.

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