

BRICS CLIMATE POLICIES. PROSPECTS FOR COOPERATION IN THE CONTEXT OF GLOBAL CLIMATE GOVERNANCE FRAGMENTATION

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Key Low-Carbon Development Policies and Instruments in Brazil¹

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Abstract

Brazil has a strong potential to achieve national climate goals and can also be an important decarbonization partner for other countries, especially in the supply of green hydrogen and critical raw materials for the production of new climate-neutral technologies. This article highlights the main tools and policies for Brazil's decarbonization and identifies potential areas in which the country can not only achieve its nationally determined contributions (NDCs), but also ensure innovative green economic growth.

Low carbon intensity energy sources can ensure a low carbon footprint for industrial products, which can make goods more attractive in the face of increasing requirements and the introduction of measures such as the European Union's (EU) carbon border adjustment mechanism (CBAM). Extensive deployment of renewable energy creates opportunities for the country to produce sustainable hydrogen, which will be in demand both domestically and globally. The main challenge for Brazil's decarbonization is its extensive agriculture, as well as widespread deforestation, the rate of which increased under the Bolsonaro administration. For agricultural products, which make up a large share of exports, deforestation regulations like those adopted in the EU would be a real barrier and could close European and other markets. The mining and processing of critical raw materials could be a potential breakthrough for the country's economic growth due to the widespread decarbonization of the global economy. The low carbon intensity of the country's industry, including mining, due to renewable energy sources appears to be a significant advantage.

Lula's return has given the international community hope that, at least in forestry and agriculture, significant efforts can be expected from Brazil, including international support, financing, and auditing.

Keywords: low-carbon development in Brazil, green hydrogen, Amazon reforestation, carbon units, renewable energy, critical raw materials, methane reduction, climate finance

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Introduction

Brazil ranks ninth in terms of gross domestic product (GDP) (eighth for GDP at purchasing power parity) [World Bank, n.d.], seventh in population, and 12th in greenhouse gas emissions [Friedrich et al., 2023], so its contribution to achieving the Paris goals at the global level could be significant. The country has vast potential to achieve national climate goals and could also become an important partner in the decarbonization of other countries, especially in the supply of green hydrogen and critical raw materials used for the production of new climate-neutral technologies. The purpose of this study is to highlight the main instruments and priorities of Brazil's decarbonization policy and identify potential areas in which the country will not only be able to achieve its nationally determined contribution (NDC), but also ensure innovative green economic growth. This is carried out through an analysis of the main documents in areas related to economic decarbonization and identification of the key policy directions. The article sheds light on the most significant and interesting examples of low-carbon development policy measures, which illustrate the approach chosen in the country and give an idea of the prospects for its development.

From 2018 to 2022, the president of Brazil was Jair Bolsonaro, whose scepticism toward the problems of climate change and a complete ban on international control in the Amazon (which was previously envisaged as part of the functioning of the Amazon Fund), along with a simultaneous increase in deforestation, led to a stagnation of the climate agenda development, deteriorating indicators related to emissions in the field of land use and forestry, and a cautious attitude toward the country's policies on the part of the international community. The president and his team of ministers have publicly expressed their opposition to many of Brazil's existing climate policies and have passed legislation that weakens the institutional and legal framework for combating deforestation and other environmental crimes, as well as reforms that significantly weaken the participation of civil society, including advocates for environmental protection, in developing policies and overseeing their implementation [Climate Observatory, 2019]. His administration's attitude to climate issues also affected the country's participation in international initiatives. Brazil submitted an updated NDC under the United Nations Framework Convention on Climate Change (UNFCCC) in 2022, with strengthened targets on paper that were weaker in practice than those adopted in 2016 during the Temer administration thanks to the recalculation of the baseline, that is, the level of emissions in 2005 [Climate Action Tracker, n.d.]. The NDC itself is brief and uninformative. However, a number of important decisions were nevertheless made during his presidential term. They establish the foundations for the development of a carbon market in the country.

Lula da Silva (commonly referred to simply as Lula), who took office in January 2023, immediately demonstrated his readiness to take decisive action to limit deforestation in the Amazonia and cooperate with all international partners. His administration has yet to adopt a new multi-year plan or approve Brazil's priorities in other areas of decarbonization. At the United Nations (UN) general assembly in September 2023 and at the Climate Ambition Summit, Lula's administration announced a return to the goals submitted by Brazil to the UNFCCC in 2016, which means strengthening the country's climate goals [Spring, 2023].

Like all countries, Brazil will face rapid changes in climate conditions. By the end of the century, the average temperature in Brazil, depending on the trajectory of global greenhouse gas emissions (GHGs), is expected to rise by 1.7°C to 5.3°C compared to the 1986–2005 average. All biomes of Brazil are vulnerable to the effects of changes in temperature and precipitation, although with considerable regional differences. Climate change will have a significant impact on the agricultural sector. This impact will disproportionately hit the poorest regions of the country, such as the northeast, where people have lower incomes, education levels, and access to adequate housing [World Bank Group, 2023].

The vast Amazon forests, which are commonly referred to as the “lungs of the planet,” have

become net emitters of GHGs, which negatively affects emissions sequestration at the global level [Kimbrough, 2021]. Solving problems in land and forest management will significantly reduce emissions and increase their absorption in the future. Brazil has a unique energy matrix, in which renewable energy sources already make up a significant share: 42% of total energy consumption and more than 80% of electricity generation, thanks to huge reserves of hydro resources and a favourable climate for the development of solar and wind energy. The country's exports also have a relatively lower carbon intensity, which may change as oil exports increase. Brazil has enormous domestic resources to significantly reduce emissions and achieve climate goals with positive effects on global emissions, making an analysis of the transformation of its decarbonization policies important and relevant.

Climate Profile of Brazil

Greenhouse gas emissions in Brazil in 2021 reached their highest levels in 19 years. According to the System for the Estimation of Greenhouse Gases (SEEG), Brazil emitted 2.42 billion gross tonnes of CO₂e (a unit of measurement that includes all greenhouse gases) in 2021 [Brotero, 2022]. In 2019, Brazil accounted for 2.2% of global GHG emissions, significantly less than China, the United States and India, the leading emitters [Friedrich et al., 2023]. Its per capita emissions of 5 tons of CO₂ equivalent (tCO₂e) were below the global average [Morgado Simões, Delivorias, 2022].

SEEG divides total emissions into five sectors: waste, industrial processes, energy, agriculture and forestry, and land-use change. The latter sector, which includes deforestation, liming (cultivation of soil for agricultural purposes), soil organic carbon, and burning of forest residues, accounts for 49% of the country's total emissions. In 2021, deforestation in the Amazon accounted for 77% of forestry and land use emissions.

In the total volume of emissions, changes in land and forest use amounted to 49%, agriculture—25%, energy—18%, industry and waste management—4% each [O Globo, 2022]. This distribution of emissions differs greatly from the global average: energy consumption (electricity, heating and cooling, transport, industry, and other uses) accounts for about 3/4 of total emissions, while agriculture, forestry, and land use combined account for only about 18% [World Bank Group, 2023]. Brazil's unusual emissions profile creates a different set of opportunities and cost structures for decarbonization compared to other countries.

Climate Goals

In its 2022 NDC, Brazil aimed to reduce greenhouse gas emissions by 37% by 2025, compared to 2005, and by 50% by 2030, compared to a 2005 baseline. The reduction target by 2030 is 962 MtCO₂e [UNFCCC, 2021]. Emissions targets for 2030 are 58% higher than 1990 levels and 4% lower than in 2010. The country also has a stated goal of achieving carbon neutrality by 2050, which is enshrined in the 2022 NDC and is constantly voiced by officials. The net zero emissions target could have been enshrined in national legislation even before the submission of the NDC, but the bill was never passed or entered into force [Ministry of the Environment of Brazil, 2019].

Climate Action Tracker shows that, compared to the original 2016 NDC, the change in base year emissions data increases the 2025 and 2030 emissions targets by more than 70 MtCO₂e. Rather than making Brazil's climate goals more ambitious, changes to the base year weakened the original goal. The absolute total emissions level from the NDC update in 2022 is higher than in the original NDC [Climate Action Tracker, n.d.]. As noted earlier, in 2023 Brazil announced its readiness to return to the 2016 goals.

The 2022 NDC also sets a separate target for the land and forestry sector to achieve zero illegal deforestation by 2028. Lula has pledged to achieve zero deforestation in the Brazilian Amazon by

2030 [Carbon Brief, 2023]. Lula appointed Marina Silva as minister of environment. During her tenure from 2003–10, she reduced deforestation by 70% by implementing new management of public forests, creating a forest service and a biodiversity institute, as well as several funds to support the Amazon. The record of reducing logging and deforestation in Lula's first two terms is impressive. Between 2000 and 2013, agricultural productivity grew by 105.6%, compared with 11.7% and -5.5% for services and manufacturing, respectively. Forest conservation policies helped reduce the rate of deforestation in the Amazon by 80% from 2004 to 2012. These results from Lula's policies have led to a positive reaction among climate experts and activists to his re-election.

Brazil has yet to submit its long-term low-carbon development strategy to the UNFCCC. The latest NDC provided is written as formally as possible, essentially being a single page on which Brazil outlines its reduction targets for 2025 and 2030. An additional 10 pages of the document include an appendix entitled “Information to Promote Clarity, Transparency and Understanding of Brazil's NDCs,” which presents responses to a questionnaire.

Main Documents

Analysis of some documents and laws adopted in 2021–22 shows that while the work on the strategy was actively underway and was almost completed by the authorities, the administration of Bolsonaro did not do so in the end. The topic of climate change is considered important by Brazilians and ranks as a high priority. According to a Pew poll, 85% of Brazilians consider climate change to be a serious problem [Wilson Center, 2022]. Probably, on the eve of the elections, Bolsonaro decided to quickly adopt regulations to develop decarbonization policy in response to the electorate's mood. In his first years in office, laws aimed at achieving low-carbon development were virtually non-existent—all activity occurred in 2021–22. Bolsonaro was known for his scepticism of the problem of climate change, and during his term deforestation of the Amazon reached its maximum [Roy, 2022] and grew at an alarming rate [Al Jazeera, 2023]. Many climate initiatives have been approved by presidential decrees, which do not need to be approved by both chambers of parliament. The only instrument to influence the adoption of decrees is a veto from parliament, but the positive nature of the proposed measures did not provide a reason to do so. The problem with presidential decrees is that they are easily repealed. Lula's administration may cancel all the decrees of the previous president, including in the climate sector, with one decision. We can expect new policies, decrees, and laws from his administration in the climate sector, as well as the reversal of measures already taken. But at the moment, the climate decrees are active.

The Green Growth Programme was approved in 2021 by presidential decree. Its goals are to:

- combine economic growth and development with sustainable initiatives;
- improve natural resource management to stimulate productivity, innovation, and competitiveness;
- create “green” jobs;
- promote forest conservation and biodiversity protection;
- reduce greenhouse gas emissions to facilitate the transition to a low-carbon economy;
- stimulate the attraction of public and private funds for the development of the green economy from national and international sources; and
- encourage the development of research and scientific developments that contribute to the sustainable use of natural resources, reducing greenhouse gas emissions, forest conservation, and protection of biodiversity [President of Brazil, 2021].

Brazil's Green Growth Programme describes the main directions that need to be implemented in the country's policies. It is very general and does not set any target indicators, but it can serve as a framework for building other industry strategies and plans around it.

Guiding Principles for the National Climate Neutrality Strategy

In 2022, the Ministry of the Environment of Brazil developed and published a document outlining actions needed to achieve climate neutrality. The nature of this document is very similar to the long-term development strategies that countries submit to the UNFCCC. It likely represents the department's contribution to writing the strategy, which was never sent as part of its Paris Agreement commitments.

In the land use and forestry sector, the main target is to reduce illegal deforestation starting in 2022 by 15% per year until 2024, by 40% in 2025 and 2026, and by 50% in 2027, reaching the target of zero illegal deforestation in 2028 [Government of Brazil, 2023].

The energy sector plans to achieve an estimated share of 45% to 50% renewable energy in the energy matrix in 2030 and continue to expand its share.

In agriculture and livestock, implementation of the Sector Plan for Adaptation and Low Carbon Agriculture and Livestock for Sustainable Development (ABC+ Plan) is the main strategy to address climate change in agriculture, together with other plans, programmes, and strategies for the sector.

The industrial sector will promote new industrial process standards, including the development, production, and commercialization of new, less GHG-intensive technologies to strengthen low-carbon industrial production.

The waste sector plans to continue efforts to help achieve the country's landfill closure target by 2024 through the zero landfill programme, which has already contributed to the closure of 645 of 3,257 landfills since 2019, and also to meet the targets set by the National Solid Waste Plan, in line with objectives of the National Solid Waste Policy. In addition, the Ministry of Environment and Climate Change is calling for increased use of materials that reduce environmental impact and reduce emissions from production processes. This goal will be accompanied by achieving a waste recycling rate of 27% in 2031.

Strengthening market mechanisms to reduce emissions through actions and projects to reduce or remove greenhouse gases, both at the national level and through international cooperation, is an important part of the strategy to increase available resources beyond direct climate change finance. Such mechanisms will serve to scale up investments in emissions reductions and promote sustainable development, as well as provide additional incentives for action beyond government climate change policies and measures. The package of measures will be aimed at stimulating different types of markets, be it a regulated domestic mechanism, a voluntary market, or international mechanisms to reduce emissions.

Although Brazil has the status of a developing country, the climate neutrality actions also include cooperation programmes with less developed countries through the Brazilian Cooperation Agency (ABC). Interaction will be carried out through the following initiatives:

- a sectoral plan for adaptation to climate change and low-carbon emissions in agriculture and livestock;
- Plan ABC+ (low-carbon agriculture);
- the national programme for payment for environmental services (Floresta +);
- the zero landfill programme (Zero Lixo);
- the national solid waste policy;
- a legal framework in the field of sanitation;
- the concession of national parks and other areas of cooperation.

In this way, the Climate Neutrality Action Directions could serve as the basis for the long-term, low-carbon development strategy that parties to the Paris Agreement committed to submit to the UNFCCC. The document can also be used by the new administration because it is politically neutral, while structuring the directions of government policy and systematizing measures in key sectors. It sets ambitious goals in the field of land and forest management and the share of renewable

energy sources in addition to hydropower, which already dominates the energy matrix. Achieving these goals can ensure the maximum reduction in emissions, taking into account the sectors' shares in total emissions. Brazil does not specify what each sector's contribution to overall emissions reduction should be, so it is difficult to assess how significant a role will be given to increasing carbon sink. The document not only lays out actions and principles for national policies, but also contains a section on assistance to less developed countries, reflecting Brazil's desire to strengthen South-South cooperation.

Policy Directions and Instruments

Agriculture

The main focus for achieving emissions reductions in the sector is the implementation of the Sector Plan for Adaptation and Low Carbon Agriculture and Livestock for Sustainable Development 2020–2030 (Plan ABC+) as the core strategy.

Initiatives up to 2030 will build on the results demonstrated in the first phase of the ABC+ Plan, which concluded in 2020, achieving 155% of its targets. In general, the entire plan is aimed at increasing the efficiency and intensity of agriculture and preventing soil degradation. Such a set of measures will reduce the need to log forests to create additional agricultural land for crops or pastures, making a significant contribution to stopping deforestation. Innovative feeding practices for cattle and other industrially important animals, as well as proper management of their waste, should lead to more sustainable use of pastures and reductions in methane emissions. The 2003–10 agricultural policies of Lula's administration helped increase its efficiency by more than 100%, so the new team, including previous members, can develop real experience in practical implementation.

Combating Deforestation and Reforestation

On his first day of a new presidential term, Lula signed a package of seven decrees aimed at protecting the environment. As part of the package, Lula reinstated the Amazon Fund, a \$1.2 billion initiative designed to protect the world's largest rainforest, which had been put on hold for three years. Donors Germany and Norway suspended contributions to the fund in 2019 during the Bolsonaro administration, after the former president unilaterally removed the fund's board of directors and technical committee.

The fund, created during Lula's second term in 2008, supports 102 conservation projects in the Amazon, including forests managed by indigenous people and small-scale farmers.

Among his first executive mandates, Brazil's new president also moved the Rural Environmental Registry—which tracks all rural land holdings—from the agriculture ministry to the environment ministry, eliminated the option to formalize conciliation rather than pay environmental fines, and revived a plan to prevent and control deforestation in the Amazon.

The country also has an anti-deforestation plan. Plans to prevent and combat deforestation in biomes include the development of sustainable productive activities with renewed policies for the sustainable use of public forests, promoting reforestation, the bioeconomy, low-carbon agriculture, and green infrastructure [Government of Brazil, 2020]. As of August 2023, deforestation in the Brazilian Amazon fell by 66.11% and reached the lowest monthly level since 2018 [Watts, 2023].

On 1 January 2023, Decree No 11.367 created the Permanent Interdepartmental Commission for the Prevention and Combating of Deforestation, a collegial body under the civil chamber under the president of the republic, responsible for determining and coordinating interdepartmental actions to reduce the rate of deforestation in the country, in which the Ministry of Environment and Climate

Change plays the role of executive secretary. The decree also created an Executive Sub-Commission responsible for the Action Plan to Prevent and Combat Deforestation in the Legal Amazon, consisting of 13 ministries [Government of Brazil, 2023].

While Brazil has not provided sectoral emission reduction targets and it is unclear what share it allocates to sequestration, it can be assumed that cuts in the land, forestry, and agriculture sectors will play a critical role in achieving its NDCs, as the share of emissions in these sectors is significant, and preventing deforestation and illegal logging will already contribute to reducing emissions. Sound reforestation policies will help increase absorption rates in the future. The decisions to protect the Amazon were the first taken by Lula's administration since taking office, underscoring the priority of this policy area for the new president. At the Conference of the Parties (COP) to the UNFCCC in Egypt at the end of 2022, Lula already represented Brazil as president-elect and declared that “Brazil is back,” proclaiming more a serious attitude toward climate change and the environment. Regarding the protection of the Amazon, Lula immediately called on international partners to resume cooperation and restored the work of the Amazon Fund, which also involved an external audit of activities—to which Bolsonaro had been harshly opposed. Policies in the areas of low-carbon agriculture and land and forest management can be expected to be central in achieving climate goals in Brazil given that the country demonstrates its greatest willingness to act in these areas. Climate experts and activists routinely criticize decarbonization strategies that focus mostly on raising carbon sink. But the absorptive capacity of the Amazon Rainforest is so large and important on a global scale, and the sector's share of emissions so significant, that such criticism loses its usual justification. In addition, Brazil has not specified what share of CO₂ absorption it includes in its long-term plans to achieve climate neutrality. In the field of renewable energy development, the country is also taking incentive measures and setting ambitious plans.

Renewable Energy

The situation in Brazil's electricity generation and overall energy matrix is unique. Clean and renewable energy sources account for 48% of total primary energy in Brazil, while the global average is 14%. Wind, solar, hydro, and biomass sources account for 83% of electricity—a level unparalleled in the world. Analysis of scenarios for the World Bank Group's Country Climate and Development Report [2023] shows that Brazil can achieve net zero gross energy emissions by 2050 at little additional cost to the energy system compared to the baseline scenario. The modelled zero-emission power system would use 99% renewables and 1% nuclear, and would cost BRL 375 billion, compared to BRL 374 billion for the baseline case.

Renewable energy projects may reap the benefits of the special infrastructure incentives regime, which suspends the application of certain taxes on goods and services used in the development of these projects. Many components used in solar energy projects also benefit from zero import tax rates.

BNDES offers financing for renewable energy projects that achieve a certain minimum content of locally produced components and has previously provided the majority of financing for renewable generation projects in Brazil. However, in recent years, BNDES interest rates, which were previously heavily subsidized, are moving closer to market commercial lending rates and maximum BNDES loan levels are being lowered, so the benefits of this funding source have diminished. Instead, there has been an increase in the use of tax-advantaged infrastructure bonds [Rhodes, n.d.].

With more than a million job openings in the renewable energy sector, Brazil is one of the largest creators of jobs in the renewable energy sector, and opportunities in this segment are growing.

Solar energy is growing rapidly in Brazil. With more than 26 gigawatts (GW) of total installed

capacity, the sector created 781,000 new jobs and prevented the emission of 34 million tons of CO₂. In the next five years, 134 solar energy projects will be implemented in the country with a total value of \$42 billion. Over the next 10 years, the largest spending on solar energy in Brazil will be in the regions of Ceará, Minas Gerais, and Bahia. The Brazilian government has published a law on distributed generation of solar photovoltaic energy and other renewable sources. The law introduced clear rules creating a stable and balanced legal framework for the use of clean and sustainable sources such as solar photovoltaics for self-generation of electricity in homes, small businesses, land, rural areas, and public buildings. The new rules provide legal certainty for the sector and should accelerate investment in new solar photovoltaic projects in Brazil [Global Solar Council, 2022].

Brazil ranks sixth in the 2023 Global Wind Energy Report with 24 GW of installed onshore wind capacity. According to the report, the country ranked third in the number of new wind farms in 2022, behind only China and the United States [Airswift, 2023]. Offshore wind power is on the radar of multinationals such as Equinor, Neoenergia, EDP, Engie, and Petrobras. In the next five years, 28 onshore wind energy projects will be implemented in the country with a total cost of \$10 billion.

Another strategic direction for the development of renewable energy sources in the country is the production of biofuel. The Brazilian national biofuel policy (RenovaBio), launched in 2017, recognizes the strategic role of biofuels (ethanol, biodiesel, biomethane, aviation biokerosene and others) in Brazil's energy matrix, given their contribution to energy security, market predictability, and the reduction of greenhouse gas emissions in fuel sector. Its goal is to reduce the carbon intensity of Brazil's transport matrix by increasing the use of biofuels and creating a market for carbon credits to offset greenhouse gas emissions from fossil fuels.

RenovaBio consists of three strategic directions. Under the first, the government annually sets national decarbonization targets for 10 years, which translate into binding individual targets for fuel distributors, proportional to their shares of the fossil fuel market. In the second direction, biofuel producers voluntarily certify their products and, as a result, receive energy and environmental sufficiency points. These estimates are multiplied by the volume of biofuels sold, resulting in a decarbonization credit that the producer can commercialize. The possibility of commercializing carbon credits is the third direction of the programme [Ministry of Mines and Energy of Brazil, 2021a].

Brazil has significant hydrocarbon reserves, especially offshore oil and gas. State-owned Petrobras plays a significant role in the country's economy. Projects related to the development of hydrocarbon production will be carried out in the country, which worries climate experts and activists. Concerns about the reliability of hydropower in the face of growing water scarcity have led the government to seek expansion of gas-fuelled power generation, potentially increasing the carbon intensity of the Brazilian economy. In June 2021, as part of a new law to privatize Eletrobras, Brazil's largest electricity generation and transmission utility, the National Congress demanded that 8 GW of new thermal capacity be installed by 2030. By law, these power plants must be at least 70% inflexible, which will lead to a significant increase in the share of thermal energy in Brazil's base energy supply.

In parallel, Brazil plans to increase oil production from its large offshore oil and associated gas reserves, which are among the largest in the world, by about 80% over 2021 levels. Currently, they are competitive in the world market and are an important source of national income. Projections of future declines in global oil and gas demand as a result of the global trend toward net zero emissions by mid-century could pose a risk to these revenues. Brazil's reserves are estimated to have a breakeven oil price of around \$40 a barrel, and the International Energy Agency (IEA) in its net zero scenario suggests a price of \$36 in 2030 and \$24 by 2050.

The Inter-American Development Bank has estimated that Brazil's future oil production could

either fall by 50% or double its 2016 level, depending on the pace of global decarbonization, underscoring the great uncertainty surrounding the future competitiveness of Brazilian oil. Fuel production accounted for 5% of total national emissions in 2019, the third largest share in the energy sector (after transportation and industry). Petrobras, the main state-owned national oil company, reduced the carbon intensity of oil production to 15.9 kgCO_{2e} per barrel of oil in 2021, below the global average, and is aiming to eliminate gas flaring [World Bank Group, 2023].

Brazil has achieved success in terms of the share of renewable energy sources in energy generation and total consumption. Possessing vast water resources, the country is realizing its potential in hydropower. But dry seasons and a general decline in river levels pose risks to stable power generation. Therefore, in its long-term energy plan, Brazil envisages a reduction in the share of hydropower in the matrix, while compensating for it with the growth of other renewable sources, primarily wind, solar energy, and bioethanol. The country also has significant oil and gas reserves, which it plans to actively develop. Exports of crude oil, its processing into petroleum products within the country, and further sales abroad will increase. This could increase the carbon intensity of the economy, which is currently at relatively low levels. Brazil expects to reduce the carbon intensity of oil and gas production and refining and to develop capture technologies.

Hydrogen

According to experts, Brazil has the potential to become a key player in the global hydrogen market. It benefits from abundant wind and solar energy potential, an integrated low-carbon energy grid, and geographic advantages for exports to Europe and the east coast of North America, as well as significant domestic market capacity [Gurlit et al., 2021]. McKinsey estimates that developing global demand for sustainable hydrogen will create \$200 billion worth of investment opportunities in Brazil over the next 20 years [Ibid.].

In August 2022, Brazil published a resolution establishing the National Hydrogen Program (PNH2). Its goals include decarbonizing the economy, stimulating national technological development, and developing a competitive hydrogen market [Presidency of the Republic of Brazil, 2022a].

The hydrogen strategy covers six priority areas: strengthening R&D and technological base, capacity building and human capital formation, energy planning, improving the legal framework, market development and competitiveness, and international partnership and cooperation.

The Brazilian government's efforts to create a low-carbon hydrogen economy also include: 20 years of R&D support for low-carbon hydrogen; the National Energy Policy Council's 2021 resolution, which identifies hydrogen as a priority area for government and public interest in energy, R&D investments and strengthening R&D support; and the Brazilian Energy Treaty on Hydrogen, concluded as part of the UN High Level Dialogue on Energy in 2021.

Brazil participates in international cooperation on low-carbon hydrogen through the German-Brazilian Energy Partnership ("H₂ Brazil" in the German-Brazil Power-to-X Partnership Programme), the U.S.-Brazil Energy Forum, the UK-funded Brazil Energy Programme, India-Brazil bioenergy cooperation, the BRICS Energy Research Cooperation Platform, the Brazilian Hydrogen Energy Treaty concluded as part of the UN High-Level Energy Dialogue, and other initiatives.

Brazil has significant resources for hydrogen production, both from renewable sources and from natural gas and biofuels. All three types are in demand in the domestic market and abroad. Green hydrogen can be used to produce exportable products to reduce their carbon footprint and can be sold directly to the global market. The European Union (EU) may be interested in buying large quantities of green hydrogen based on its hydrogen strategy and REPowerEU plan. Blue hydrogen (derived from natural gas) can be used industries focused on domestic consumption and sales to international partners with less stringent origin requirements. Hydrogen produced from biofuels can

be used for the country's transport system. Brazil's advantages make it an attractive market for investment, but implementation requires further improvement of the legal framework, regulation, and standards. Increasing energy production from renewable energy sources is necessary to increase green hydrogen production levels.

Carbon Pricing

Brazil does not currently have an explicit carbon pricing system. The possibility of its introduction is envisaged in the main climate law adopted in 2009. Since then, there has been discussion about which pricing methods are preferable in Brazil. To date, there have only been attempts to consider the possibility of introducing an emissions trading system. To achieve this, the country began to participate in the Market Readiness Partnership, which assessed the opportunities and risks of introducing an emissions trading system (ETS) and proposed its own configurations. The carbon tax is seen as an undesirable measure for socio-political reasons. In recent documents and policies, Brazil favours a voluntary carbon market, another pricing tool. This approach incentivizes decarbonization actions without setting emissions caps. Carbon markets are still emerging at the global level, as not all rules and principles have yet been developed under Article 6 of the Paris Agreement. But the size of voluntary markets is constantly growing, and the demand for the opportunity to obtain carbon units to meet the goals by other states only stimulates the process.

In May 2022, the government published Decree 11.075, which created the Sinare National Greenhouse Gas Reduction System. The decree requires the ministries of environment and economy to develop sectoral plans to mitigate the effects of climate change, including setting specific emissions targets. It also calls for the creation of “mechanisms for integration with the international regulated market” [Presidency of the Republic of Brazil, 2022b].

The law, adopted on 13 January 2021, defines the concepts, goals, guidelines, actions, and criteria for the implementation of the National Policy on Payment for Environmental Services, creates the National Registry of Payments for Environmental Services and the federal Payment for Environmental Services programme, and provides for agreements on payments for environmental services. According to the law, the methods of payment for environmental services are direct payments, monetary or non-monetary; provision of social improvements to rural and urban communities; compensation associated with a certificate for reducing emissions from deforestation and degradation; green bonds; lending; and ecological reserve quotas. This legislation creates an environment for carbon credits to circulate in the economy, as decarbonization actions can be rewarded in a variety of ways, including reduction certificates.

Ordinance No 518 of 29 September 2020 launched the Floresta + Carbono (Forests + Carbon) programme in Brazil [Ministry of the Environment of Brazil/Office of the Minister of Brazil, 2020]. This programme primarily aims to stimulate the voluntary carbon market and provide a more favourable business environment for investment in forest conservation. Through the development of a voluntary carbon market, Brazil hopes to complement its efforts to reduce emissions in the forestry sector. The ordinance establishing it prevents double counting of the results of forest projects in government reporting on emission reductions. That is, the efforts undertaken by actors will have to be attributed exclusively to them and not to the state of Brazil.

The programme provides legal security for the forest carbon market, where purchasers of carbon credits have a legal guarantee that the purchased carbon credit will cover and effectively offset GHG emissions in the voluntary carbon market. Carbon credits certified and verified by organizations such as Verra, which offers strict standards and mechanisms to ensure the legality and technical accuracy of emissions reductions, now receive a guarantee from the Brazilian federal government that "double counting" will be prevented and that the credits will not be claimed by the

Brazilian government to fulfill its NDC—a challenge that has historically prevented increased investment in forest conservation and restoration in Brazil [Biofolica, 2020].

Experts note that Brazil has decided to follow the principle of "more markets and less taxes" as a pricing strategy [Ribeiro, 2022]. The country is ready to implement projects under Article 6 of the Paris Agreement when the details on it are finally clarified. According to forecasts, international carbon credit markets of states will not be able to fully operate anytime soon. Efforts are currently being made to develop a voluntary market, and measures in this direction will help attract additional funding to forestry projects. Traditional pricing instruments, tax and ETS, are not yet planned, although the country has been interacting with various institutions for several years to develop a possible ETS. Therefore, if a choice is made, it will be in favour of a market instrument.

Industry accounts for only 4% of total emissions. Extending the ETS to it could contribute to reducing emissions, but it would not be decisive, and enterprises would face additional costs. Electricity generation in Brazil has one of the lowest carbon intensity in the world, there is no point in introducing ETS in this sector, as China and Indonesia did. Transport and buildings contribute to energy emissions. One could consider introducing an ETS following the example of the EU for buildings and transport, but this is too advanced a measure that directly affects citizens and will certainly not be received with enthusiasm in an environment where even businesses are not faced with the need to buy emission allowances.

Reducing Methane Emissions

Brazil is the fifth largest methane emitter in the world. On 21 March 2022, the Brazilian government launched a new stimulus package aimed at developing programmes and actions to reduce methane emissions, in particular, through the development of biogas and biomethane initiatives. The Federal Strategy to Promote the Sustainable Use of Biogas and Biomethane is a package of measures that includes the National Zero Methane Programme and is in line with the commitments made by Brazil in the context of COP26, the Global Methane Pledge and other domestic regulatory measures such as the National Methane Policy [Official Diary of Uniao, 2022].

One of the main goals of the incentive package, in addition to promoting research and development of new technologies to reduce methane emissions and the use of biogas and biomethane as sources of sustainable energy and fuel, is to promote the development of carbon markets, in particular, the introduction of methane credits. While the package does not provide details on how methane credits can be used, they are assumed to represent a ton of methane that has not been released into the atmosphere and are expected to be consistent with existing carbon credit markets, meaning they will be monetizable in some form.

Decarbonization of Oil Production and Carbon Capture Technologies

The Brazilian state-owned oil company, Petrobras, has traditionally focused its decarbonization efforts on reducing the carbon intensity of pre-salt oil and gas production, rather than combating emissions produced by industry [Battersby, 2022]. Currently, Brazil does not have a developed technology market or extensive research on carbon capture. But Petrobras has recently begun exploring the prospects of introducing them at its facilities. Petrobras is considering offering carbon capture and storage solutions to third party industrial emitters in Brazil as part of a potential diversification strategy from the company's core oil and gas operations.

In May 2023, it was announced that Petrobras is preparing a pilot project for carbon capture and storage (CCS) from industrial emissions and is seeking partnerships to establish a full-scale CCS centre in the country. When fully implemented, the project will involve the construction of CO₂ flow infrastructure from industrial site capture sites to permanent storage in a 25 million ton

per year saline aquifer reservoir.

Petrobras, like many other major oil companies, recognizes that widespread decarbonization and the transition away from fossil fuels could lead to significant reductions in profitability and threaten its operating model. As a state-owned company, it did not have strong incentives to diversify its activities as did private companies. But with Brazil itself setting a goal of achieving carbon neutrality by 2050, there are reasons to think about the future of the company. Active development and implementation of technologies has begun that could reduce emissions during oil production and transportation. As part of its efforts to diversify its operations while reducing its carbon intensity, Petrobras is also developing and implementing wind power and biofuels projects.

Climate Finance

The infrastructure investment needed for climate action in Brazil is estimated by the World Bank at about 1.2% of GDP per year in 2022–50 and just 0.8% in 2022–30 [World Bank Group, 2023].

Although Brazil accounts for only 1% of the global green bond market, Brazilian companies are increasingly interested in issuing them. The first green bond issuance by a Brazilian company occurred in 2015, when food manufacturer BRF S/A raised €500 million on the European market through a green bond issue with a maturity of seven years. In its market releases, the company said the bond proceeds would be used to finance energy efficiency, greenhouse gas emission reductions, and other climate-friendly projects.

In 2020, Brazilian companies raised \$5.3 billion through 37 sustainability-related equity issues, more than double the amount raised in 2019. As of February 2021, a total of \$9 billion in green securities had been issued, with the agribusiness sector accounting for more than 27% of the total.

Financial institutions are also participating in the green bond market and issuing their own green securities to raise funds to finance sustainable projects. For example, at the end of 2020, Bradesco, one of the largest Brazilian banks, issued BRL 1.2 billion in environmental, social, or governance (ESG)-related bonds and, in early 2021, Banco BTG Pactual, a large investment bank, raised \$500 million on the international market through the issuance of green bonds [de Castro Stievani, Bürgel, 2022].

In 2021, BNDES took an important step toward developing the sustainable lending market and launched the Sustainable Development Bond Framework. This framework facilitates the issuance of green, social, and sustainable BNDES bonds in Brazil and abroad. The Inter-American Development Bank participated in the process through technical cooperation. This initiative expands the financing opportunities provided by the Green Bond Framework launched in 2017, which allowed BNDES to become the first Brazilian bank to issue this type of security on the international capital market and the first financial institution to issue green financial instruments in the local market in 2020. After the innovative issue by BNDES, other market participants have already begun issuing similar securities.

Funds raised through future concept-based operations will be used to finance and refinance new or existing projects in the BNDES portfolio. The project models eligible for funding cover six green and three social categories. Green categories include: renewable energy; energy efficiency; sustainable management of water, wastewater, and sanitation; pollution prevention and control; clean transport; and environmentally sustainable management of living natural resources and land use [BNDES, 2021].

Financial market climate aspects as well as instruments are not yet as well developed in Brazil. This is hampered by an unformed regulatory environment and by the lack of uniform sustainability standards or a green taxonomy. Addressing these issues will be key to securing private funding. Brazil is undergoing the process of joining the Organisation for Economic Co-operation and

Development (OECD); the implementation of its standards could make the financial market much more transparent and attractive for developed countries. Lula's attitude toward the OECD is much more sceptical than that of the country's two previous presidents. He does not classify Brazil as a developed country, but rather emphasizes its belonging to the Global South and the importance of cooperation between developing countries. It is not yet clear what the fate of the country's accession to the OECD will be.

International Funding

Brazil attracts funding for climate projects from international funds.

The Amazon Fund is a REDD+ mechanism created to collect contributions for grant investments to prevent, monitor, and combat deforestation and to promote the conservation and sustainable use of the Brazilian Amazon [Amazon Fund, n.d.]. The Amazon Fund has received donations from foreign governments and companies and has a combined size of \$1.2 billion. Donors include Norway, Germany, and Petrobras (Brazil). Contributions from donor countries are included as official development assistance (ODA) [Climate Funds Update, n. d.].

The Climate Investment Fund (CIF) in Brazil is financed through the Forestry Investment Programme. The \$70 million investment plan for this programme aims to promote the sustainable management and use of formerly artificial savanna forest areas, maintain carbon stocks and reduce GHG emissions, and improve the collection and management of information about the Cerrado biome. More than \$300,000 was awarded for technical assistance activities in 2020. Activities aim to improve the financial regulatory framework to stimulate investment in energy efficiency and distributed generation through green finance innovation labs [Climate Investment Funds, n.d.]. The Green Climate Fund is implementing nine projects worth \$394.8 million in Brazil [Green Climate Fund, n.d.].

World Bank Financing

In December 2022, the World Bank Board of Directors approved a \$500 million project to expand sustainability-related financing and strengthen private sector capacity to access carbon credit markets. In collaboration with the Bank of Brazil, the project will, for the first time, take a sustainable development approach to lending.

Emission reductions are expected to be up to 90 million tonnes of CO₂e by 2030, equivalent to about 4.5% of what Brazil needs to meet its net zero emissions commitments. The project is also expected to attract up to \$1.4 billion in private capital through increased funding from the central bank and private investors [World Bank, 2022].

The Brazil Climate Finance Project uses an “innovative financing approach that incentivizes companies to adopt and implement greenhouse gas reduction plans to reduce their carbon footprint company-wide” [World Bank, 2022]. The initiative also connects these companies to high-quality carbon markets

Thanks to the new initiative, the Bank of Brazil will be able to offer its clients service packages that combine financing and support to access carbon markets through a single window. This will allow Brazilian companies, in particular, small and medium-sized ones, to “receive an affordable end-to-end service, from measuring their carbon footprint to benefiting from highly integrated carbon credits” [World Bank, 2022].

The project will provide a \$400 million line of credit, and the Bank of Brazil will use these resources to provide sustainability-linked loans to companies seeking to reduce their carbon footprint. The initiative also includes a pilot \$98 million Climate Debt Fund that is expected to attract private capital to expand sustainability-related finance to the broader economy [World Bank,

2022].

These financial instruments are complemented by \$2 million in resources to enhance the Central Bank's capacity to support companies in adopting plans to reduce their environmental impact and access high-quality carbon markets through technical assistance [World Bank, 2022].

Brazil is trying to attract international funding to implement decarbonization policies. Most of the incoming funds go to the land and forestry sectors, primarily to efforts to restore the Amazon forests. Brazil participates in international initiatives such as REDD + and cooperates with the World Bank and other international development banks. At the same time, in its documents, both submitted within the framework of the Paris Agreement process and internal ones, Brazil does not provide estimates of the needs for international and external financing. The 2016 NDC divided emissions reduction targets into conditional (with support) and unconditional (through its own efforts), but the latest two updates make no reference to external funding.

Critical Raw Materials

Brazil has the third largest reserves of rare earth metals in the world. Brazil was not a major producer of rare earths in 2022, with production down to 80 million tonnes, even lower than 2021's 500 million tonnes. In 2012, a rare earth metal deposit worth \$8.4 billion was discovered in the country, but little came of it [Kelly, 2023]. Brazil's potential for mining and processing critical minerals and rare earth metals is enormous and currently largely untapped.

In 2021, the Brazilian Ministry of Mines and Energy, through the Interministerial Committee for the Review of Strategic Minerals Projects, adopted Resolution No 2, declaring certain minerals strategically important to the country's interests. In particular, the resolution declares the following three groups of minerals to be strategic:

- minerals that a country imports and that are needed to supply vital sectors of the economy: sulfur, phosphates, potassium, and molybdenum;
- minerals that are important for use in high-tech products and processes: cobalt, copper, tin, graphite, platinum group minerals; lithium, niobium, nickel, silicon, thallium, tantalum, titanium, tungsten, uranium, vanadium. Brazil has reserves of almost all these metals;
- minerals that have comparative advantage and are important to the economy because they generate a country's trade surplus: aluminum, copper, iron, graphite, gold, manganese, niobium, uranium. These metals and minerals are also mined in the country and are often exported.

The designation of these minerals as strategic indicates that they may be subject to policy action to encourage licensing and investment in mining projects under the National Strategic Minerals Policy [Ministry of Mines and Energy of Brazil, 2021b].

Brazil has begun bilateral cooperation with the United States, which has the world's sixth-largest reserves of rare earths, on critical minerals. In 2020, the U.S. and Brazil announced the creation of a U.S.-Brazil Critical Minerals Working Group to "advance bilateral cooperation on critical minerals essential to mutual security, sustainable development and future prosperity" [U.S. Embassy and Consulates in Brazil, 2020]. The working group intends to support bilateral diplomatic engagement and technical cooperation on critical minerals, including: enhancing the security of critical minerals in the U.S. and Brazil, promoting economically viable mining and production flows, stimulating investment, promoting technological innovation, and increasing the interconnectedness of the U.S.-Brazil critical minerals supply chain.

The importance of certain minerals and metals for the production of climate-neutral technologies provides Brazil with opportunities both to independently develop and further process and sell them, and to attract foreign investment in the sector. Currently, Brazil has established cooperation on critical raw materials only with the United States, but it is possible to expand the network of connections with countries that need it, primarily with the EU. Cooperation with its BRICS partners (Russia, India, China, and South Africa) is also possible. All members of the

association have certain reserves of critical minerals and raw materials. Interaction could develop to share best practices and possibly coordinate positions in global markets, especially if the EU implements its critical raw materials club and attempts to aggregate demand to lower global prices.

Conclusions

Brazil has significant potential to decarbonize its economy. The energy sector, which is responsible for a significant share of emissions in most countries around the world, does not contribute as significantly to Brazil's total emissions. More than 80% of electricity generation comes from renewable sources, and their share will only grow according to government plans until 2029. The government is taking measures to stimulate solar and wind energy and is implementing a comprehensive and multi-component policy for the development of biofuels. According to some calculations, Brazil could achieve zero emissions in the energy sector with a fairly small increase in funding compared to the baseline scenario. Such low-carbon energy will ensure a low carbon footprint for industrial products, which could make products more attractive in the face of increasing demands and the introduction of measures such as the EU Carbon Border Adjustment Mechanism (CBAM). The extensive introduction of renewable energy sources creates opportunities for the production of sustainable hydrogen in the country, which will be in demand both in the domestic and global markets. Brazil also has the resources to produce blue hydrogen from natural gas and hydrogen from biomass. They can also integrate into the country's energy system.

The main challenge to Brazil's decarbonization for many years has been extensive agriculture, as well as widespread deforestation, the rate of which increased under the Bolsonaro administration. Amazon forests have been net emitters for several years now, and their absorptive capacity is rapidly declining. Emissions from agriculture and land use account for the lion's share of total emissions. Actions to increase agricultural intensity, intelligent livestock farming, reforestation, and prevention of deforestation and illegal logging could significantly reduce the country's main source of emissions. The EU's package of measures to combat deforestation linked to European consumption also applies to all imported goods. And while Brazil's industrial products could see new opportunities through increased relative competitiveness due to their low carbon footprint, agricultural products, which account for a large share of exports, would pose a real barrier and could close the European market. Preventing deforestation and reforestation will not only help reduce emissions and increase future absorptive capacity, but also ensure that agricultural products meet standards in important markets.

Brazil's hydrocarbon reserves are significant, and the country is making development plans taking into account revenues from their sale on international markets and use in the national economy. With rising global energy prices, offshore oil production in Brazil has become more profitable, increasing government revenues and creating incentives to make the economy more carbon intensive. The increased demand for natural gas, primarily liquefied gas, also contributes to the growing production and processing of hydrocarbons. During a serious drought in the country, when the volume of electricity generation at hydroelectric power stations decreased, it was decided to build reserve capacities running on gas. Climate experts feared that the market situation following the coronavirus pandemic and the geopolitical crisis of 2022 would lead to increased investment in fossil fuels, which would then be unable to be redirected to the development of renewable energy sources. But analysis by various advocacy groups shows that much of the economic recovery support has not been directed toward fossil fuel projects. On the contrary, support was provided for many green initiatives, most notably for biofuels and ethanol [Energy Policy Tracker, 2021]. Overall, the country's fossil fuel subsidies are low and cover a small share of the country's emissions according to OECD calculations.

Petrobras, as a state-owned company, plays a leading role in implementing the country's oil

and gas policies. Rising energy prices certainly have a positive effect on its resources and budget. With less incentive than that of private companies to think through a long-term strategy in a world where decarbonization potentially dominates the process, Petrobras has begun to diversify its activities. The company has assets in the fields of biofuels and wind energy. Carbon capture and storage projects are now being actively developed, which will help not only the company itself, but also all enterprises that wish to use the Petrobras infrastructure to implement these processes. In addition, the company is trying to implement technologies to reduce emissions during production.

The extraction and processing of critical minerals and raw materials could be a potential breakthrough for ensuring the growth of the country's economy thanks to the widespread decarbonization of the world economy. Brazil has significant reserves that have not yet been developed. The extraction of such metals and minerals may be associated with serious risks and threats to the environment, so the policy must be balanced and justified. Brazil can create the conditions to attract sustainable investment in development. A significant advantage is ensured by the low carbon intensity of the country's industry, including mining, thanks to renewable energy sources. Currently, Brazil has established partnerships in the field of industrial design only with the United States. The EU appears to be another potential partner and is most interested in reliable supplies and promises to promote suppliers in supply chains, that is, to leave them a significant share of added value.

Brazil's international funding needs for its decarbonization have not been clearly articulated for several years, and the estimates presented in the 2016 NDC have not been updated or included in the 2020 and 2022 versions. The country, in its documents, notes the need to attract international investment and sets the goal of making Brazil an attractive market. So far, Brazil's financial sector has not been reformed to green it. One of the main financing instruments is green bonds, both from private companies and those issued by BNDES. Brazil attracts funding from international funds and initiatives, but it is not that significant. Restoring the Amazon Fund will help leverage international resources to achieve zero deforestation and zero illegal logging goals.

Another way to attract financing for forestry projects could be the development of a voluntary carbon market in the country. A series of decrees passed by Bolsonaro in 2021 and 2022 laid the groundwork for the development of carbon markets. The special project "Forests + Carbon" will help those wishing to buy carbon credits from Brazilian businesses, ensuring that there is no double counting. Traditional carbon pricing instruments have not been introduced in the country, a tax has not even been considered, and the process of developing an ETS model was not finished. But given the small share of emissions from industry and energy generation, the introduction of cap-and-trade will not lead to such significant contributions to NDCs as forestry and agricultural policies. Brazil is awaiting the completion of the approval processes on Article 6 of the Paris Agreement, which will allow it to even more actively implement climate projects, primarily forestry ones.

A country's emissions profile also affects Brazil's potential cooperation with other countries on decarbonization issues. Lower carbon intensity of energy than in leading developed countries makes the just energy transition partnership, which the Group of 7 (G7) countries signed with South Africa, Indonesia, and Vietnam and plan to sign with India, virtually meaningless for the country. For Brazil, reducing emissions from forest management is more urgent, so funding will be more likely to be attracted for these projects, which is already being done through the Amazon Fund. Brazil could be a potentially important and attractive partner in the supply of green hydrogen and critical raw materials, so cooperation would be more likely to focus on this area.

Bolsonaro's attitude to the climate agenda affected the development of policy in this area in Brazil. He did not hide his negative attitude toward restrictive measures and negated the ability of activists and researchers to influence climate and environmental policy. The easing of many of the restrictions that ensured the enormous reduction in deforestation between 2000 and 2013 has led to unprecedented rates of deforestation and rising emissions. Under the UNFCCC, Brazil's

participation has also become less systematic, and the base year 2005 emissions update, which effectively increased the amount of emissions the country expects to produce, has made international organizations, climate experts and some countries sceptical of Brazil's climate policies. This attitude, coupled with his administration's reluctance to address climate issues, slowed down decarbonization in the country and made it less attractive to investors. Lula's rise to power gave hope that, at least in the areas of forestry and agriculture, significant efforts could be expected from Brazil, including international support, funding, and auditing. The administration's position on other areas is not yet clear; it will probably be more clearly formulated at the Constitutional Court at the end of 2023.

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