BRAZIL'S NET-ZERO FUTURE AND CIRCULAR BIOECONOMY

Achieving Nationally Determined Contribution (NDC) while Saving Vital Ecosystems

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Structural shifts toward green growth (circular bioeconomy) require substantive investments to re-direct funding from unsustainable to sustainable (green) infrastructures, decarbonized modes of transport, as well as training and upskilling to transform the labor force for greener industries. Although limited in scope, this brief is meant to assist in (i) conceptualizing a long-term strategy aligned with the 2050 net zero target, (ii) identifying policies that complement sectoral targets, and (iii) ensuring that sectoral policies are synthesized across multiple sectors (e.g., forestry, agriculture, energy, transport, industry, waste).

Key Expert Insights[1]

- ***Novo Pac* – NDC alignment:** Review Novo Pac for compatibility with Nationally Determined Contribution (NDC), and redirect funding from unsustainable to green projects
- **Low-carbon agriculture ABC+ Plan:** Improve oversight, transparency and monitoring
- ***Amazonian Energies* program:** Ensure a rapid transition from diesel-based systems to distributed energy generation using renewable energy with storage, with participation of local communities
- **Capacity building:** Allocate budget for training and green-job upskilling across states, municipalities, and at local levels
- **Commit to fossil-fuel phase-out:** End fossil fuel subsidies, stop new oil and gas exploration, and decommission existing oil and coal-fired power plants

1 Key insights from expert elicitation (the list is not exhaustive), conducted in Brazil with 62 country experts.

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CPL Analytical Insights[2]

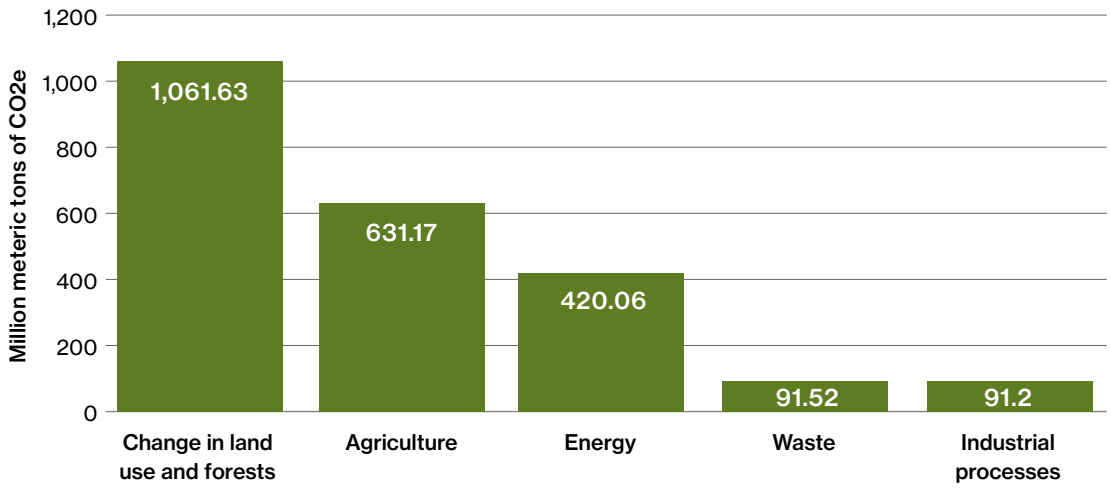
- **Economy-wide**: Ensure that all cross-sectoral programs and policies provide disincentives (rather than incentives) for deforestation and have investments aligned toward growth in the circular bioeconomy
- **Transportation and economy-wide:** Implement policy incentives to increase the uptake of feedstock from wastes or residual biomass, and promote the transformation of residual biomass into biofuels
- **Construction and waste:** Implement and enforce green building and construction codes at national and municipal levels to stimulate the uptake of new bio-based construction materials (bio-cement) and associated technologies
- **Green Industrial Strategy:** (i) Create policy incentives for immediate deployment of available decarbonization technologies for energy-intensive steel and cement sectors (i.e., *energy efficiency measures and recycling); and (ii)* strengthen industry standards and make reductions in industrial process emissions binding

2 CPL analytical insights are based on a comprehensive literature review (peer-reviewed published research), and overview of reports and policy inventories at the national level conducted by CPL. The insights feed into a broader, coherent policy framework, and can assist policymakers in coordinating cross-sectoral targets to reach NDC ambition in the short-, mid-, and long-term.

Background

In October 2023, Brazil reconfirmed to the United Nations Framework Convention on Climate Change (UNFCCC) its commitment to the country's First Nationally Determined Contribution (NDC), namely (i) the absolute net greenhouse gas emission target for 2025 (limiting emissions to 1.32 $GtCO_2e$), (ii) limiting emissions to 1.20 GtCO2e by 2030, and (iii) reaching climate neutrality by 2050. This step has signaled strong climate ambition by the resumed presidency of Inácio Lula da Silva, who has articulated Brazil's priorities: low-carbon socioeconomic development, as well as reconstruction of the environmental policy that included strengthened monitoring, law enforcement and/or other measures to halt deforestation by 2030. When juxtaposed against Brazil's NDC, these priorities should be translated into policies in the highest emitting sectors (Figure 1).

Figure 1. Greenhouse gas emissions by sector (in million metric tons of CO_2e, 2023)



After experiencing catastrophic effects of climate change in 2024 (drought in the Amazon associated with wildfires that burned 5 million hectares in August alone, and flash floods in the south of the country), President Lula stated in the run-up to COP29 that Brazil is fully engaged in the "1.5° C Mission." In his statements, he also referred to an *economy less dependent on fossil fuels, t*he need to *accelerate decarbonization,* and the *importance of multilateral efforts* in the current climate emergency. Within the national context, Lula's vision of sustainable development is linked to *bioeconomy,* particularly in tropical forests, from which currently excluded indigenous and traditional communities could also benefit.

Results

Preliminary results of the Climate Policy Lab study suggest that the realization of Brazil's NDC ambition will greatly depend on specific actions and policies in the largest emitting sectors – forestry and agriculture – and their synergies with policies in the energy, transport, industry, and waste sectors. Halting agriculture-driven deforestation could be achieved if crop production becomes more intensified and confined to specific regions, while primary forests and native vegetation in all biomes remain protected and/or restored. In a related way, resource efficiency – one of the core components of bioeconomy – can be improved if agricultural and forestry residues start to be reused and recycled rather than burned without being reused.

Bio-waste derived bioLPG and biogas can greatly reduce the demand for petroleum-derived natural gas and LPG.

OPPORTUNITIES

Circular bioeconomies. Natural gas used for process heating, power generation, and as feedstock in petrochemicals, fertilizers, steel, ceramics, and food processing can be replaced by plant (or bio-based) residues that are generated, but not reused in the agriculture and forestry sectors (often burned in open air). **Policies** to regulate circular bioeconomy would be needed to make this shift, specifically, policy incentives that promote the transformation of residual biomass into biofuels (bioethanol, biomethane, biobutanol). If produced from agricultural byproducts, bioethanol achieves optimal emissions savings.

Agriculture. The updated National Plan for Adaptation and Low Carbon Emissions in Agriculture (ABC+ 2020–2023) promotes new technologies and sustainable practices in agriculture systems to reduce emissions in the sector. In addition to adaptation strategies, the stated objectives include emission reductions in the sector by 1.1 Gt CO_2 – by expanding forested areas, improving animal waste treatment, recovering degraded pastures, and implementing integrated crop-livestock-forestry systems and no-till farming. Combined with the 2020 National Bioinputs Program, the use of bio-based products in agriculture is clearly promoted. However, the program could be strengthened by improved methodologies, and extension to all agriculture and livestock farming.

Waste-to-energy. Capture and use of biogas for energy from waste streams and the treatment of domestic wastewater can contribute to emission reductions in densely populated urban areas. In agriculture, anaerobic digestion and livestock residual waste can substantially contribute to national electricity generation. Biogas and bio-waste-derived bioLPG could replace a majority of the demand for petroleum-derived natural gas and LPG.

Steel and cement sectors. Environmental impacts of the two sectors refer to trade-embodied resources utilization, and trade-embodied impacts most commonly captured in five dimensions (i.e., air emissions, embodied land use, water consumption, material consumption and damage to the ecosystem). Basic metals manufacturing can be a driver of ecosystem damage, which is a key consideration for high-biodiversity areas of Brazil. To address these issues, (i) *sectoral policies* can incentivize immediate deployment of existing low-carbon technologies to refocus on *efficiency measures and recycling* (e.g., innovative technologies used in scrap steel recycling); and (ii) the use of *life*

cycle assessment (LCA) will provide a full-flow material analysis to reveal the ecotoxicity effect of rare earth and basic-metal processing, and the associated biodiversity loss.

Biotechnology and biomanufacturing. This sector has the potential to create new products in more efficient ways, while shifting from a fossil-based economy to a bioeconomy. Improved resource efficiency, achieved by the application of novel microorganisms, metabolic engineering or biomass-transformative processes, can contribute to decarbonization in multiple sectors, from food and pharma to agriculture and energy**.**

Transportation sector. In existence since the 1970s, the Ethanol Biofuel program has been deemed successful on the one hand, yet on the other, it has been accompanied by negative externalities in the land use sector – a reality that Brazil is struggling with today, along with the "food versus energy crop" controversy. The transportation sector and biofuels industry could potentially benefit by switching to bio-based residual feedstocks to produce biofuels, with new value chains forming within the circular bioeconomy. **Policies** in the biofuel and transportation sector can be implemented to incentivize the uptake of feedstock (e.g., *waste or residual biomass).*

Construction sector. Bio-based (often wood) waste, 63% of which is burned without energy recovery, can go towards the production of bio-cement as well as used for other purposes in the construction sector. **Policies** at both national and municipal levels, including green building and construction codes, could help stimulate the uptake of new construction materials and technologies.

RISKS

Cross-sectoral risks. The large domestic demand for biofuels and upstream products that source sugarcane to produce biofuel (soy to produce biodiesel) constitute specific risks for the land-use, land-use change and forestry (LULUCF) sector. When not synergized with public policy instruments (i.e., *PPCDAm, PPCerrado, ENREDD+, Planaveg),* the industry and transportation programs and policies (e.g., *Fuel of the Future, PROCEL, Hydrogen National Plan-PNH2, National biofuels policy-RenovaBio, Green Mobility and Innovation Program-MOVER,* and *Amazon Energies*) run the risk of undermining NDC ambition, could potentially contribute to the increase in land-use emissions from deforestation, which are associated with increasing demand in these sectors. Importantly, this is a key issue if Brazil continues to rely on vast forested regions (the Amazon biome) or restored areas (Cerrado) as carbon sinks.

Energy sector. Brazil's electricity mix is overwhelmingly dominated by renewables (89% in 2023), and the energy matrix likewise has a high share of renewables (49%). However, the country is the world's ninth largest producer of petroleum (the largest in South America), and recently expanded its natural gas production and consumption, including in the transportation sector (natural gas as transportation fuel reached a 26% share in 2020). Brazil is a net importer of coal and natural gas, and a net crude oil exporter (9% of Brazil's total export volume). Importantly, it is the world's largest exporter of sugarcane-derived biofuel (24% of the world's ethanol). Biofuels are also consumed domestically (accounting for 25% of transportation fuel).

The "dash for gas and oil" locks in higher emissions and potentially stranded assets. Current offshore oil and gas reserves imply a much larger exploration and extraction carbon footprint. While profitable, the committed investments lock the country into a carbon intensive trajectory that is neither compatible with the stated NDC nor with core principles of circular bioeconomy. Based on our survey results, an overwhelming majority of respondents

> Government procurement could be coordinated with short-, mid- and long-term industrial strategies that include training and upskilling for industrial transformation.

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stressed the need to avoid future fossil-fuel dependence by implementing policies to phase-out fossil-fuels, end fossil-fuel subsidies, and increase carbon tax.

Conclusions

This brief has outlined approaches that can be considered to align Brazil's NDC ambition with specific policy actions across multiple sectors (e.g., forestry, agriculture, energy, transport, steel and cement industry, and waste). Structural shifts toward green growth (circular bioeconomy), however, require substantive investments to redirect funding from unsustainable to sustainable (green) infrastructures, decarbonization of energy-intensive industries such as steel and cement, and decarbonized modes of transport – in addition to investments in human resources for greener industries. Government procurement could be leveraged as a strategic tool to support the take-off of rapidly maturing technologies, and should be coordinated with short-, mid- and long-term industrial strategies that include training and upskilling for industrial transformation.

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