



Bioeconomy in the Amazon

Conceptual, Regulatory and Institutional Analysis

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About Amazon 2030

The **Amazon 2030** project is a Brazilian research initiative with the purpose of developing an action plan for the Brazilian Amazon. Our objective is to achieve conditions for a higher standard of economical and human development in the region, and to achieve a sustainable use of natural resources by 2030.

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Bioeconomy; Biotechnology; Biomass; Bioecology; Biodiversity; Amazon

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List of Acronyms

ANP	National Agency for Petroleum, Natural Gas and Biofuels
ARPA	Amazon Protected Areas Program
CAR	Rural Environmental Registry
CBIOS	Decarbonization Credits
CDR	Regional Development Centers
CGEE	Center for Management of Strategic Studies
CGEN	Genetic Resources Management Council
CPI/PUC-Rio	Climate Policy/Pontifical Catholic University of Rio de Janeiro
CNI	Brazil's National Confederation of Industry
CNPq	National Council for Scientific and Technological Development
CTNBio	National Technical Commission on Biosafety
Embrapa	Brazilian Agricultural Research Corporation
Embrapii	Brazilian Industrial Research and Innovation Corporation
ENCTI	National Science, Technology and Innovation Strategy
FNRP	National Fund for Benefit Sharing
GMOs	Genetically Modified Organisms
ICMBio	Chico Mendes Institute of Biodiversity Conservation
INPA	National Institute for Research in the Amazon
INPI	National Institute of Intellectual Property
MAPA	Ministry of Agriculture, Livestock and Food Supply
MCTI	Ministry of Science, Technology and Innovation
MICITT	Ministry of Science, Technology and Telecommunication
ME	Ministry of Economy
MEC	Ministry of Education
MJSP	Ministry of Justice and Public Security
MMA	Ministry of the Environment
MME	Ministry of Mines and Energy
MMFDH	Ministry of Women, Family and Human Rights
OBio	Bioeconomy Observatory
ODBio	Opportunities and Challenges in Bioeconomy
OCDE	Organization for Economic Cooperation and Development
PACTI -	
Bioeconomy	Action Plan for Science, Technology and Innovation in Bioeconomy
PNRGAA	National Policy on Genetic Resources for Food and Agriculture
PPBio	Amazon Bioeconomy Priority Program

RD&I	Research, Development and Innovation
R&D	Research and Development
RegularizaAgro	National Plan for Environmental Compliance of Rural Properties
RenovaBio	National Biofuels Policy
SAF	Secretariat of Family Agriculture and Cooperatives
SAFs	Agroforestry Systems
SDI	Secretariat for Innovation, Sustainable Development and Irrigation
SDGs	Sustainable Development Goals
SETEC	Professional and Technological Education Secretariat
SFB	Brazilian Forest Service
SisGen	National System for the Management of Genetic Heritage Resource and Associated Traditional Knowledge
SNUC	National System of Protected Areas
ST&I	Science, Technology and Innovation
Suframa	Superintendence of the Manaus Free Zone
TCP	Traditional Peoples and Communities
ZFM	Manaus Free Zone

Introduction

Over the last decade, the bioeconomy sector has grown in prominence worldwide, offering solutions to the great challenges of this century, such as climate change, food security, and loss of biodiversity. It also comprises an important element for sustainable rural development strategies and provides a means to combine production and environmental protection. As such, bioeconomy represents a new economic and productive paradigm.

In Brazil, special attention is placed on bioeconomy in connection with proposals for the sustainable development of the Amazon region. Nonetheless, **bioeconomy is a broad, fluid and evolving concept**. It covers both **high-tech intensive sectors**, such as pharmaceuticals, cosmetics and green chemistry, and **extractive activities of non-timber forest products**, such as oils, fruits, seeds and resins. From this perspective, bioeconomy creates opportunities for adding value to Brazilian socio-biodiversity products produced by family farming and by traditional peoples and communities.

Bioeconomy has also been identified as the solution for the transition from a fossil-based economy to a biobased and renewable green economy, by means of **sustainable and innovative use of biomass** for the production of bioproducts, biochemicals, bioagro-inputs, biofuels, and bioenergy.

The Amazon has the greatest potential and the greatest risks associated to the promotion of bioeconomy. The activity is usually treated as a driver of sustainable economic development for the region. However, without concern for the impact of changes in land use and for the conservation of biodiversity, bioeconomy can also be a threat to the forest, due to deforestation of native vegetation to produce biomass.

The Amazon is vast, complex and full of peculiarities. It is not a homogeneous region for which a single development proposal can be chosen. The “various Amazons” comprise at least four distinct areas with enormous diversity in terms of conservation, landscape, and socioeconomic activity: the **conserved Amazon**, with native forests and inhabited by traditional peoples and communities, the **deforested Amazon**, with agricultural activities and degraded areas, the **Amazon under pressure**, an area of forest transition and a deforestation expansion frontier, and the **urban Amazon**, with cities (AMZ2030 2021; *Concertação pela Amazônia* 2021).

Therefore, **when we talk about bioeconomy for the Amazon, which bioeconomy are we talking about? Which Amazon are we talking about? What governance structure and regulatory frameworks are needed to promote bioeconomy in the region?**

To help answer these questions, researchers from the Climate Policy Initiative/Pontifical Catholic University of Rio de Janeiro (CPI/PUC-Rio), in partnership with AMZ2030, have studied the concept of bioeconomy, mapped national and international policies and strategies on the topic, and analyzed the main regulatory frameworks and governance institutions associated with this activity in Brazil. **This report presents the current stage of bioeconomy in Brazil, with emphasis on regulatory and institutional issues, using a common vocabulary.** Based on the structure that classifies bioeconomy into three visions - i.e., *biotechnology, bioresources, and bioecology* (Box 1) - the document aims to organize narratives, strategies, regulatory frameworks, plans and programs of different national players and institutions, and the identification of alignments and conflicts between the three visions.

This general view facilitates dialogue between the different visions and allows for the construction of a more collaborative and conciliatory strategy, in which different bioeconomy proposals can coexist. In addition, this work contributes to the design of a governance structure and a regulatory environment suitable for bioeconomy in the Amazon, with its different visions and purposes.

Box 1. Bioeconomy visions according to Bugge et al. (2016)

The **biotechnology vision** emphasizes the importance of biotechnology and its commercial application. This perspective prioritizes economic growth, assuming, without further investigation, the positive environmental effects of activities resulting from biotechnology. Economic growth would derive from the capitalization resulting from investments in research and development (R&D) and from biotechnology application. To this end, the key governance mechanisms are geared towards the promotion of research and innovation.

The **bioresources vision** promotes the development of new processing chains based on biological raw materials, with a view to replacing fossil raw materials. Although this vision draws more attention to sustainability than in the biotechnology vision, little consideration is given to environmental aspects; the central focus remains on technological and economic development. In contrast with the biotechnology vision, issues associated with different land uses are addressed under this perspective, which seeks to improve land productivity, including areas degraded by the production of biofuels. However, there is little discussion of the impact of land use changes on environmental issues (e.g., deforestation and climate change). Furthermore, the relationship between the use of bioresources and other resources or products (fertilizers, water, pesticides) is rarely discussed. R&D plays a prominent role, similarly to the biotechnology vision, but innovation and multidisciplinary research, involving several areas besides biotechnology, are emphasized.

Finally, the **bioecology vision** prioritizes sustainability and ecological processes that optimize the use of energy and natural resources, promote biodiversity conservation, and avoid monocultures and soil degradation. In this context, economic growth and job creation would be secondary to sustainability concerns. This vision places an emphasis on promoting biodiversity, conserving ecosystems and associated services, and preventing soil degradation, with emphasis on circular and self-sustainable modes of production. Transdisciplinary research related to sustainability is also prioritized, such as the study of the potential for sustainable biomass cultivation.

The study is divided into four sections. The **first section** presents the mapping of the concept of bioeconomy in the literature produced by academia, governments, and productive sectors, both nationally and internationally. The **second section** summarizes policies and strategies dedicated to bioeconomy that have been adopted by multilateral organizations (Organization

for Economic Cooperation and Development - OECD and the European Union), industrialized countries (United States and Germany) and developing countries with similar environmental characteristics as Brazil (Malaysia and Costa Rica). The **third section** addresses the main plans, projects and programs of the government, academia, civil society organizations, and the productive sector for the development of bioeconomy in Brazil and the Amazon region. Finally, the **fourth section** presents the survey and analysis of the main national regulatory frameworks and the respective governance structure in place for each bioeconomy vision. This is the main contribution of this paper, considering that national regulatory frameworks and governmental institutions have never been analyzed from the three bioeconomy visions, allowing for the identification of where the visions overlap and any existing conflicts (Figure 1).

Key Messages

- **The “various Amazons” require different visions of bioeconomy.** In the conserved Amazon, bioecology and biotechnology visions add value to the standing forest and to the knowledge and ways of life of traditional peoples and communities. In the deforested Amazon, biomass production can be an alternative for restoring degraded areas, based on the bioresource vision. In the Amazon under pressure, bioecology vision and sustainable biomass production through agroforestry systems (AFS) can provide economic alternatives to contain the advance of deforestation. Finally, research, development and innovation (RD&I) hubs and industrial hubs in high-technology intensive sectors - such as pharmaceuticals, cosmetics, and green chemistry - can flourish in the urban Amazon.
- **Brazil has a broad set of regulations for different elements in the three bioeconomy visions:** (i) legal frameworks that address science, research, technology, and innovation (biotechnology vision); (ii) policies and regulations to encourage biomass for production of biofuels, biorefineries, and bioenergy generation and land use laws (bioresource vision); and (iii) policies and regulations to promote Brazilian socio-biodiversity, agro-extractive production, protection, and sustainable use of forests and other forms of native vegetation (bioecology vision) (Figure 1). However, some legal frameworks need to be improved and any changes must consider their impacts on different sectors, given that regulation can be important for more than one vision.
- **Bioeconomy governance in Brazil is currently shared by multiple players and institutions, with little coordination and dialogue between them.** An effective and innovative governance arrangement for the Amazon bioeconomy must consider strategies and mechanisms that promote commitment, cooperation and coordination. It must also consider the sociocultural diversity of the Amazon and the peoples that inhabit it. Poor governance of bioeconomy in the Amazon can hinder the region's sustainability.

What is bioeconomy after all?

- Bioeconomy is a broad, fluid, and evolving concept. The adoption of the bioeconomy classification in three “visions” – **biotechnology, bioresources and bioecology** (Bugge et al. 2016) - helps to organize narratives, strategies, governance structures, and regulatory frameworks on the subject.
- In common, the three visions address the **use of biological raw materials to produce goods and services**, but each of these visions adopts different paths and has different objectives. In the biotechnology vision, the main objective is the commercial application of products derived from biotechnology; the bioresources vision promotes the production and processing of biomass with a view to replacing fossil raw materials; and, finally, the bioecology vision focuses on conservation and sustainable use of biodiversity and natural resources.

Bioeconomy lacks a uniform and widely agreed definition. It is an amorphous and developing term.

According to literature, bioeconomy was conceptualized in the late 1960s as “an economic order that appropriately acknowledges the biological bases of almost all economic activities” (Birner 2018 p.18). The term was then used by the Georgescu-Roegen, “father” of ecological economy, to develop the idea that unlimited growth is incompatible with the laws of nature (Vivien et al. 2019). Currently, the term is used quite differently to designate, in general terms, “the use of biological knowledge for commercial and industrial purposes” (Birner 2018 p.19).

The concept of bioeconomy has been defined more clearly in the last decade in dedicated policies and strategies by multilateral organizations, such as the OECD, the European Union and its member countries, the United States, and Asian, Latin-American, and African countries (IACGB 2020 p.164). Even in these institutions and countries, the definition of bioeconomy continues to be updated in more recent documents.

In Brazil, several players, especially in industry, academia, and government agencies, have been producing a wide range of reports, articles, and seminars on the subject, in which bioeconomy takes on different forms. They frequently point out which sectors are affected, the relevant legislation and the institutions involved. There are few efforts to define a national concept of bioeconomy; often it is just about understanding “what is covered and what is not” (MCTI/CGEE *Perspectivas* 2020).

Bugge et al (2016), in an article devoted to understanding the concept of bioeconomy, found that the term lends itself to different definitions and is characterized by being a master narrative open to various interpretations. Based on a literature review, the authors identified three bioeconomy visions: (i) biotechnology; (ii) bioresources; (iii) bioecology. The authors make it clear that the three visions are interrelated in different ways, but they manage to make a distinction based on the most prominent characteristics of each one (Box 1).

Some researchers and institutions also seek to conceptualize bioeconomy based on ethics, justice, and sustainability criteria, such as the Finnish Center for Future Studies, by means of the BioEcoJust project (Taylor et al. 2019), and academic articles that classify bioeconomy narratives based on sustainability criteria (Vivian et al., 2019) and the relationship between bioeconomy, biodiversity, and people (Bastos Lima and Palme 2022).

This classification of bioeconomy into three “visions” by Bugge et al. (2016) helps to organize the narratives, strategies, plans and programs that have been proposed in Brazil. This study adopts this approach for the purpose of analyzing the main regulatory frameworks and the governance structure. This theoretical framework has also been adopted by other national studies on bioeconomy (WRI 2022).

Main strategies and public policies devoted to bioeconomy in the international context

- In the strategies and public policies of multilateral organizations and industrialized countries in the northern hemisphere, bioeconomy is addressed from a biotechnology and bioresources visions, with a strong emphasis for **food security** and **climate change** mitigation and adaptation.
- Countries with a high rate of **biological diversity** (megadiverse) consider the value of biodiversity in their bioeconomy strategies, as is the case of Malaysia and Costa Rica, although there are conceptual differences and different strategic objectives between these two countries.

Overview of public policies and strategies adopted by the OECD, European Union, Germany, and the United States

Bioeconomy gained momentum and became the object of public strategies and policies dedicated to its development thanks to strong action by the European Union and the OECD. The document *The Bioeconomy to 2030: Designing a Policy Agenda*, published by the OECD in 2009, guided the international debate and influenced the development of the theme in Brazil. In the European Union, although bioeconomy has been the subject of studies and discussions since the 2000s, it was from 2012 onwards, with the publication of the document *Innovating for Growth: A Bioeconomy Strategy for Europe*, that the topic became the object of public policies implemented by its member states, except for Germany, which was the first European country to enact a specific strategy in 2010 (IACGB, 2020). The United States also released the document *National Bioeconomy Blueprint*, in 2012, with a purpose to develop a bioeconomy policy in the country.

Bioeconomy concept

The first bioeconomy strategies and policies published in industrialized countries of the northern hemisphere contained a much narrower definition, i.e., “a world where biotechnology contributes to a significant share of economic output” (OECD 2009 p. 22), or “the production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, biobased products and bioenergy” (European Union 2012 p.9). These concepts have been revised and are currently more comprehensive, but still define bioeconomy from a biotechnology and/or bioresources visions.

In some countries, the concept of bioeconomy has been modernized, encompassing a more holistic understanding of production and consumption that considers the systemic relationship between biological processes and the environment. In Germany, for example, bioeconomy has been defined as the “production, utilization and conservation of biological resources, including related knowledge, science, technology, and innovation, to provide information, products, processes, and services in all economic sectors aiming toward a sustainable economy” (Global Bioeconomy Summit 2018 p.2).

Objectives of bioeconomy strategies

In general, these strategies and public policies reinforce the central role of research, development, and innovation (RD&I), with great emphasis on biotechnology. Sustainable production and the use of biomass is a central objective in the transition from an economy based on fossil raw materials to a biobased economy, with emphasis on biofuels, bioproducts

and bioenergy. In this context, there is a great concern with food security and climate change mitigation and adaptation through the reduction of greenhouse gas emissions.

Importance of biodiversity, sustainability criteria and traditional knowledge in bioeconomy strategies

The first generation of bioeconomy policies did not expressly address environmental problems, and sustainability was taken as a premise of the concept. Years later, there is now a greater awareness that replacing fossil raw materials with biological resources is not necessarily sustainable, and can lead to over-exploitation of resources, such as the unsustainable use of forests for production of bioenergy and bioproducts, or even the replacement of native vegetation for biomass cultivation. In various strategies and policies, sustainability and circular economy concepts have become part of objectives and concerns.

Despite some efforts to align bioeconomy strategies and policies with the UN Sustainable Development Goals (SDGs) (OECD 2019), discussions lack considerations on the impact of land use changes, such as deforestation (especially in southern hemisphere countries) for biomass production. Furthermore, biodiversity conservation concerns are almost non-existent in the policies of industrialized countries in the northern hemisphere.

Governance of bioeconomy strategies

Regarding governance, there is a prevalence of government agencies and institutions related to science, RD&I, economy, agriculture, and energy, with very little participation of environment ministries and agencies.

Overview of strategies and public policies adopted by Malaysia and Costa Rica

The bioeconomy strategies and public policies of industrialized northern hemisphere countries should not be adopted by southern hemisphere countries with completely different environmental characteristics and a high degree of biodiversity without prior analysis and assessment of what may be appropriate and what should be developed, and considerations for the peculiarities of the country. Therefore, it is crucial to investigate public policies adopted by countries with tropical forests and similar characteristics to those of Brazil when it comes to developing a bioeconomy for the Amazon region.

Malaysia and Costa Rica were chosen in this study because they were the first developing countries with tropical forests and high levels of biodiversity (megadiverse) to adopt specific bioeconomy strategies.

Bioeconomy concept

Conceptually, the policies of the two countries differ greatly. In Malaysia, bioeconomy is defined as all economic activities derived from the commercial application of biotechnology (Bioeconomy Corporation). On the other hand, Costa Rica has a more holistic and comprehensive understanding of bioeconomy, which is defined as “the production, utilization, conservation and restoration of biological resources, including related knowledge, science, technology, and innovation, to provide information, products, processes and services in all economic sectors aiming toward a sustainable economy” (Costa Rica 2020a p.3). This difference arises from the historical context in which the policies were developed.

Objectives of the bioeconomy strategies

In Malaysia, the National Bioeconomy Program was created in 2010 as one of the pillars of the National Biotechnology Policy enacted in 2005. One of Malaysia's goals is to strengthen the biotechnology sector by capitalizing on natural resources and biodiversity. The strategic sectors for the development and use of biotechnology are health, agriculture, and industry (Arujanan and Singaram 2018). The country aims to become a global biotechnology hub. To this end, the government created an agency, the Malaysian Corporation for the Development of Bioeconomy, with the goal of implementing the biotechnology and bioeconomy policy and promoting commercial opportunities for both the domestic and foreign private sectors in the area of biotechnology and bioindustries. The government launched two specific programs: the Bioeconomy Transformation Program, to develop biobased industries; and the Bioeconomy Community Development Program, to ensure the supply of raw materials and extracts derived from biological resources for bioindustries. Farmers are encouraged and trained to become bioagro-entrepreneurs. The program aims to increase the social mobility of farmers through technology-based entrepreneurship. Finally, the Malaysian government created a kind of seal for biotechnology companies called Bionexus Status. Companies that receive this classification receive tax incentives, financing, and support programs (Bioeconomy Corporation n.d.).

On the other hand, Costa Rica's National Bioeconomy Strategy, launched in 2020, aims to combine production with environmental protection and has three strategic objectives. The first is to make Costa Rica a model country in sustainable development using biology resources to promote social inclusion and equity, balanced territorial development, conservation, knowledge, and sustainable use of biodiversity. The second objective is to turn bioeconomy into one of the pillars of the country's productive transformation through innovation, value-adding, diversification of the economy, application of the principles of circular bioeconomy, and the decarbonizing of production and consumption processes. The third objective is to promote convergence between the country's wealth in biological resources and the use of national capacities in the field of biological sciences to enhance this wealth (Costa Rica 2020a).

Importance of biodiversity, sustainability criteria and traditional knowledge in bioeconomy strategies

Despite Malaysia's significant biological diversity, biodiversity is only mentioned in one of the nine pillars of the national biotechnology policy, related only to the health sector for the development of new drugs (Arujanan and Singaram 2018). There is a lack of discussions on sustainability, biodiversity conservation and application of rules for access and sharing of benefits from genetic resources and associated traditional knowledge. The Nagoya Protocol was only regulated by Malaysia in 2017 and yet the regulation has not been incorporated into the programs of the national bioeconomy agency.

In Costa Rica, sustainable use of biodiversity and strengthening of sustainable economic, social, and environmental development are pillars of the national bioeconomy strategy. The document also highlights the importance of three international conventions: the Convention on Biological Diversity, the Paris Agreement on Climate Change, and the Convention to Combat Desertification. The Costa Rican strategy does not specifically refer to the sharing of benefits from access to traditional knowledge, but social inclusion of Indigenous peoples is one of its principles (Costa Rica 2020a).

Governance of bioeconomy strategies

Regarding governance, the bioeconomy agenda in Malaysia is led by the Ministry of Science, Technology and Innovation and several agencies and research institutes linked to it. Other research institutes and universities also conduct research activities related to biotechnology, especially in the areas of agriculture and forestry. As mentioned, the Malaysian Bioeconomy Development Corporation is the main government agency for the promotion and implementation of the country's national bioeconomy policy (Arujanan and Singaram 2018).

In Costa Rica, the Ministry of Science, Technology and Telecommunications - MICITT is the leader of the bioeconomy agenda and responsible for implementing the national strategy. But the strategy is the result of a joint effort also involving the Ministries of Environment and Energy; Agriculture and Livestock and Economy, Industry and Commerce (Presidency of Costa Rica 2020). These ministries are responsible for the governance in association with the MICITT. The national strategy provides for the creation of a National Advisory Council for Bioeconomy, which will have a technical secretariat and thematic working groups (Costa Rica 2020a).

Bioeconomy in Brazil and in the Amazon: main national players and projects under discussion

- Brazil does not have a national strategy devoted to bioeconomy, but many proposals under development in the country share the objective of structuring and adding value to productive chains of biodiversity goods and services, considering elements of the three bioeconomy visions.
- In Brazil, there is little dialogue between the players that support the different visions, especially when it comes to bioeconomy for the Amazon.
- The lack of a national strategy dedicated to the theme, or even a regional bioeconomy strategy for the Amazon, built collaboratively by all stakeholders and relevant sectors, can make one bioeconomy vision prevail over the others.

In Brazil, bioeconomy has also been the object of studies, plans, and programs by governmental, academic, civil society, and productive sector institutions. In the governmental area, the Ministry of Science, Technology and Innovation (*Ministério da Ciência, Tecnologia e Inovações* - MCTI) leads the agenda, but the Ministry of Agriculture, Livestock and Food Supply (*Ministério da Agricultura, Pecuária e Abastecimento* - MAPA) and the Brazilian Agricultural Research Corporation (*Empresa Brasileira de Pesquisa Agropecuária* - EMBRAPA) also have programs dedicated to the theme. In the productive sector, Brazil's National Confederation of Industry (*Confederação Nacional da Indústria* - CNI) has been pushing the sector towards this theme, having prepared two specific reports on bioeconomy. Academia and civil society are also very much engaged in discussions on bioeconomy, publishing technical notes, and reports, as well as in promoting seminars and spaces for exchange, with a special focus on the Amazon.

Bioeconomy concept

The concept of bioeconomy varies greatly among these players and is often determined more by the sectors involved than by the activity itself. MCTI, EMBRAPA, and CNI have a bioeconomy perspective that combines the biotechnology and bioresources visions, and understand that bioeconomy is “like a model that employs new technologies in order to originate a wide diversity of products” (CNI 2020); “all economic activity derived from bioprocesses and bioproducts that contributes to efficient solutions in the use of biological resources that promote the transition to a new model of sustainable development and the well-being of society” (MCTI/CGEE 2021) or “is based on the intensive use of scientific and technological knowledge, such as knowledge produced by biotechnology and by new technological routes, and the use of biomass” (EMBRAPA 2022).

MAPA has several definitions of bioeconomy, varying between the three visions, since the theme is addressed by different secretariats. In 2020, the ministry created a Technical Working Group to standardize the understanding of the concept, scope of action, and internal governance structure of MAPA on bioeconomy topics, and presented a draft normative act with a proposal to organize MAPA's activities in the field of bioeconomy. So far, the theme does not seem to have been unified within the ministry.

In academia, civil society organizations, and companies that fall into the category of “innovative entrepreneurship”, bioeconomy has been treated as a combination of the biotechnology and bioecology visions, the latter prevailing in projects in the Amazon. The Amazon 4.0 proposal (Nobre & Nobre 2018) places a lot of emphasis on RD&I, but also considers the conservation of biodiversity, maintenance of environmental services and traditional communities and populations as central elements.

Some stakeholders conceptualize bioeconomy more restrictively, as “the set of economic activities related to production chains based on the management and cultivation of Amazon biodiversity, with added value and positive impact on local sustainable development” (Viana 2019). Others refer to it more broadly as “any value chain guided by advanced scientific knowledge and the search for technological innovation in the application of biological and renewable resources in industrial processes to generate a circular economic activity and collective social and environmental benefits” (*Instituto Escolhas* and IRICE 2019).

The *Uma Concertação pela Amazônia* (2021) initiative understands that there are several definitions of bioeconomy and proposes a taxonomy for bioeconomy that considers the characteristics of the “various Amazons”. In this context, bioeconomy would be classified as socio-bioeconomy, forest-based bioeconomy or agro-bioeconomy, thus underscoring the role of science, technology, and innovation as a way to integrate different production arrangements. Similarly, the New Economy of the Amazon (NEA-BR) initiative also highlights the possibility of implementing different bioeconomy approaches but emphasizes that the bioecological bioeconomy should be the predominant approach in forest areas (WRI 2022).

Objectives of bioeconomy proposals

The bioeconomy proposals currently under discussion and implementation by agencies and institutions have several objectives in common. Structuring and adding value to productive chains of biodiversity goods and services is a strategic objective of several proposals. Some institutions prefer to use the concept of socio-biodiversity or agro-biodiversity so as to also consider the knowledge of Indigenous peoples, traditional populations and family farmers. The productive sector recognizes the comparative advantage of Brazil's enormous biological wealth and wants to add value to the “biodiversity brand” (CNI 2020).

Government, the productive sector, and academia also see bioeconomy as an opportunity for developing a biobased economy by using biotechnology and innovation to create new products, processes, and services in the chemical, pharmaceutical, cosmetic, vaccine, enzyme (chemistry with high added value), and forest-based industries, among others.

The replacement of industrial and agro inputs and fossil fuels with raw material of biological origin (biomass) in the production of bioproducts, bioinputs, biofuels and bioenergy is one of the pillars of the strategies championed by the MCTI, CNI, EMBRAPA, and MAPA.

Civil society and MAPA also make the case that bioeconomy should promote income generation and the productive inclusion of family farmers and traditional peoples and communities, prompting the movement of economic activities towards the interior of the country. Civil society groups emphasize the importance of valuing traditional knowledge and drawing closer to local ways of life and production.

Finally, a few proposals also encompass the maintenance of ecosystem services and the promotion of tourism/ecotourism as bioeconomy objectives.

The importance of biodiversity, sustainability criteria and traditional knowledge in bioeconomy proposals

Unlike most countries that have already adopted bioeconomy strategies and policies, current proposals in Brazil consider (with varying degrees of importance) environmental criteria, such as: conservation and sustainable use of biodiversity and natural resources, maintenance of environmental services, sustainable development, and a circular and low-carbon economy. However, only a few proposals — focused on the Amazon — consider the importance of traditional knowledge as a key element in the bioeconomy agenda.

Bioeconomy proposals that take on a bioresources vision do not address the risk that growing biomass for the purpose of biofuel production might cause environmental effects. The conversion of native forest for biomass production could cause loss of biodiversity and the emission of greenhouse gases, thus further aggravating climate change.

Governance of bioeconomy proposals

The MCTI is the only ministry to have put together a governance proposal for a national bioeconomy strategy, having prepared a technical note — Governance Analysis and Models (MCTI/CGEE 2020) — and a report — Governance Model Proposal for the Brazilian Bioeconomy (MCTI/CGEE 2020). According to the MCTI, the governance arrangement should have a threefold structure: a National Bioeconomy Panel of an advisory nature; an Interministerial Council, in charge of implementing a national bioeconomy strategy, with a Technical Steering Committee; and coordinating bodies, such as Technical and Sector-based Boards and Working Groups.

Key legal frameworks and governance structure for the Amazon bioeconomy

Regulatory frameworks

- Though Brazil does not have a specific regulatory framework for bioeconomy, the country has a broad legal framework that regulates activities encompassed by the different visions.
- Regulatory frameworks must have sufficient flexibility to accommodate more than one vision.
- The Biodiversity Law is central to any bioeconomy strategy for the Amazon, but local communities, public and private institutions and academia have divergent positions on the matter.

Brazil does not have any specific regulatory frameworks for bioeconomy. This document starts from the taxonomy of the three “visions” of bioeconomy (Box 1) and assesses the legislative framework and governance institutions applicable to bioeconomy in Brazil, and specifically in the Amazon.

At the foundation of the three different visions lies the objective of promoting innovation (from a broad perspective) to enable the development of the bioeconomy. The understanding of how this “innovation” occurs varies with each perspective. In that regard, **the regulations and public policies that are most relevant will vary from one bioeconomy vision to another.**

The **biotechnology vision** emphasizes the use of research and the commercial application of biotechnology in different sectors of the economy. Essential to this vision, therefore, are legal frameworks that address science, research, technology and innovation. The **bioresources vision**, on the other hand, promotes the development of new processing chains for biology-based raw materials with a view to replacing fossil raw materials. This vision highlights policies and regulations that promote the production and processing of biomass for the production of biofuels, biorefineries and bioenergy generation, as well as regulatory frameworks for land use. Finally, the **bioecology vision** highlights the importance of conservation and sustainable use of biodiversity and environmental services. Family, organic, and low-carbon farming, as well as knowledge and production methods of traditional peoples and communities, have a greater relevance under this vision. As such, policies and regulations that value Brazil's socio-biodiversity, agro-extractive production, protection and sustainable use of forests and other forms of native vegetation are central to this vision (Figure 1).

The existence of a legislative framework to address matters related to the three visions of bioeconomy does not, in itself, guarantee a favorable regulatory environment for developing these visions in the Amazon. Matters must be adequately regulated, there must be legal certainty, and these regulations must be effectively enforced.

Figure 1. Main Regulatory Frameworks in the Three Bioeconomy Visions



Source: CPI/PUC-RIO, 2022

* Sugarcane Agroecological Zoning (ZAE) was revoked in 2019, but a preliminary injunction in 2020 forces Brazilian government to comply the ZAE.

These visions are not isolated, but rather interrelated, which means that regulatory frameworks can be important to more than one vision and, in such cases, the challenge is precisely to have regulations in place that are suitable to different purposes and perspectives.

Such is the case, for example, of the **Legal Framework for Biodiversity**, composed of the Law on Access and Benefits Sharing of Genetic Resources and Associated Traditional Knowledge (Law no. 13,123/2015) and its regulatory decree (Decree no. 8,772/2016), which **play a central role in both in the biotechnology and bioecology visions.**

Stakeholders, institutions, and productive sectors working with RD&I under the biotechnology vision consider the Legal Framework for Biodiversity to be excessively complex and bureaucratic, as it does not encourage activities pertaining to research, technological development, and innovation (Bockmann et al. 2018; Fiocruz 2018; MCTI/CGEE *Perspectivas* 2020; CNI 2020). Several researchers have criticized the need to register with the National System for the Management of Genetic Resource and Associated Traditional Knowledge (SisGen) for all research activities, while commercial activities, which are potentially harmful to biodiversity, such as the export of ornamental fish, remain exempt from this requirement (Bockmann et al. 2018; Fiocruz 2018). Finally, research institutions claim that there is no legal certainty for access to Brazilian biodiversity and criticize the fines imposed by the legislation, “which are incompatible with the advancement of scientific research and technological innovation” (*Academia Brasileira de Ciência* 2018).

The Legal Framework for Biodiversity is also essential to promoting the rational and sustainable use of natural resources and adding value to the Amazon's socio-biodiversity, products, and services, all of which entail a wide range of traditional knowledge and an enormous wealth of species of flora, fauna, fungi and microorganisms. However, actors and organizations that defend the bioeconomy from a bioecology perspective argue that the Legal Framework for Biodiversity does not adequately regulate the right of traditional peoples and communities to Free, Prior, and Informed Consultation (FPIC) (Dourado 2017; Mares De Souza Filho 2017; Moreira 2017; Monteiro 2017) and the sharing of benefits arising from access to traditional knowledge (Santilli 2015; Golden 2017; Moreira 2017). According to Bensusan (2018), the law places traditional knowledge users (industries and researchers) and providers (Indigenous peoples, traditional communities and family farmers) on opposing sides, but fails to establish mechanisms to strike a balance of forces between them.

Legal frameworks for land use and for protection and sustainable use of native vegetation, such as the Forest Code, are also central to bioeconomy from both the bioresources and the bioecology visions.

The Brazilian Forest Code is an instrument for land use and forest zoning in rural properties. The Forest Code imposes a limit on the expansion of agriculture activities through two legally binding protection instruments: the Permanent Preservation Areas (PPAs) and Legal Forest Reserves (LFR). PPAs are riparian buffer zones and other ecological buffers that must be conserved due to their critical role for the protection of the ecosystem functions, such as ensuring a clean and steady water supply, regulating hydrological and weather cycles, protecting geological and soil stability, or conserving biodiversity. The second protection rule of the Forest Code requires all private properties to set-aside land for biodiversity protection, as Legal Forest Reserves. Properties located within the Legal Amazon must conserve a much higher percentage of land as LFR than properties outside that region.¹ In this sense, the Forest Code serves as a constraint on the expansion of agricultural activity for the purpose of biomass production and induces an increase in productivity and innovation. On the other hand, policies that encourage the production of biomass can ultimately encourage illegal deforestation and push for a new amendment of the law, either to grant new amnesties or to weaken protection rules. As such, the agroecological zoning of certain crops, such as sugarcane and palm, is essential to preventing the expansion of agriculture into forested areas in the Amazon.

The Forest Code also plays an important role in promoting a bioecological bioeconomy. The law allows for sustainable economic use in Legal Forest Reserve areas, including sustainable timber management and the extraction of non-timber forest products. Additionally, the recovery of degraded areas to comply with Forest Code's PPA and LFR requirements can also be performed by means of agroforestry systems (SAFs). The Forest Code also created an innovative land database to integrate environmental information of rural properties, named the Rural Environmental Registry (CAR).² The Forest Code requires that every rural property be enrolled in the CAR system by each property owner (or lessee), declaring the current state of the environmental conditions of the area. However, family farmers, Indigenous peoples, and traditional communities still face challenges in registering their respective lands in the CAR and these areas are often subject to irregular registration in the CAR by third parties (Chiavari, Lopes and Araújo 2021; Lopes and Chiavari 2022). In this sense, the effective implementation of the Forest Code is crucial to the development of the bioecology vision in the Amazon.

Finally, **the legal frameworks of land tenure regularization are key to the three visions of bioeconomy.** Well-established property rights, whether individual or collective, are key to ensuring legal security, reducing violence in the countryside, enabling access to credit and the purchase of agricultural products by the government, promoting efficient land use, and

¹ Legal Amazon is a political concept, created in 1953, for territorial and socio-economic planning purposes. It corresponds to the geographic area that covers the states of Acre, Amapá, Amazonas, Mato Grosso, Pará, Rondônia, Roraima, Tocantins and western Maranhão. The Legal Amazon not only contains the Brazilian Amazon Forest, but also parts of the Cerrado and Pantanal (wetlands) biomes.

² CAR is the Brazilian acronym for *Cadastro Ambiental Rural*.

enabling environmental accountability. In this sense, land regularization actions should be a priority when designing and executing public policies geared towards the Amazon, including bioeconomy (Chiavari, Lopes and Araújo 2021).

The access to biodiversity genetic resources and associated traditional knowledge, as well as the sharing of benefits arising from such access, depend on legal certainty as to who holds these rights. Therefore, land tenure regularization of Indigenous lands and traditional territories, small farmers, protected areas and agrarian reform settlements is an essential condition to boosting both research and the business environment for Amazon socio-biodiversity. As applied to the Amazon, the bioresources vision also depends on well-defined land rights to promote agriculture activities. This definition would impact both the production of forest and agricultural biomass, be it by traditional communities, farmers (small, medium or large), or in public areas (by means of forest concession projects).

In this sense, it is imperative that the legal framework for land tenure regularization on public lands (Law no. 11,952/2009) not be changed. Land grabbing in the Amazon is conducive to deforestation, legal insecurity and violence, thus creating an unsuitable environment for investment in the region's bioeconomy. Every time the federal government changes the legal framework to benefit recent occupations conducted illegally, it conveys the message that rewards the invasion and grabbing of public lands because the legislation may change later to give amnesty for the crimes committed (Lopes and Chiavari 2021).

Governance

- In Brazil, governance over different bioeconomy activities is shared by several government ministries, bodies and institutions, organizations in the productive sector, and civil society, with multiple stakeholders operating without any kind of cooperation or coordination among them.
- Among the government institutions that are devoted to bioeconomy, the Ministry of Science, Technology and Innovation (*Ministério de Ciência, Tecnologia e Inovação* - MCTI) stands out in terms of leadership for putting together a national bioeconomy agenda with an emphasis on bioeconomy under the biotechnological vision.
- So far, the Ministry of the Environment (*Ministério do Meio Ambiente* - MMA) has been absent from discussions on bioeconomy and has yet to prepare a specific and comprehensive document on the topic.

By its very nature, bioeconomy is a cross-cutting activity involving different areas of knowledge, various sectors of the economy and multiple governmental and non-governmental institutions. An effective and innovative governance arrangement for the bioeconomy in the Amazon, which serves the “various Amazons”, must consider strategies and mechanisms to promote commitment, cooperation, and coordination (IPEA 2021). However, collegiate bodies that serve as arenas for dialogue involving different stakeholders - government, academia, productive sector and civil society - in the design and implementation of public policies were extinguished or completely re-purposed by the Bolsonaro’s government administration.

Poor bioeconomy governance in the Amazon puts the region's sustainability at risk. For example, biomass production only makes sense as an activity to restore degraded areas or within sustainable production arrangements, such as agroforestry systems (AFS). The unrestricted promotion of the bioeconomy, under the bioresources vision, could encourage the deforestation and conversion of forest lands into agriculture lands for growing oil palm, sugarcane and other crops for biofuel production. This would cause negative impacts on biodiversity and on ecosystem services for the regulation of rainfall and weather cycles.

Governance must also consider the socio-cultural diversity of the Amazon and Indigenous, riverine and other traditional communities as agents of knowledge, innovation and production. The forest must not be viewed solely as a source of raw material for RD&I of biotechnology products; it should be seen, above all, as a socio-biodiverse space where Amazon populations play a central role.

At this time, **Brazil does not have a national strategy devoted to bioeconomy and there is no agency responsible for coordinating this area.** Governance of public policies, plans, programs and projects directed at different bioeconomy activities is shared by several government ministries, bodies and institutions, organizations in the productive sector and civil society, with multiple stakeholders operating without necessarily any kind of cooperation or coordination among them. This document maps the main government agencies of the Federal Government. It should be noted, however, that state and municipal agencies are also important in the governance of bioeconomy activities.

Ministry of Science, Technology and Innovation (MCTI)

Under the current scenario, the Ministry of Science, Technology and Innovation (*Ministério da Ciência, Tecnologia e Inovações* - MCTI) stands out from the others in terms of leadership for having put together a national bioeconomy agenda **with an emphasis on bioeconomy from a biotechnology vision.** The MCTI has two organizations that feature bioeconomy as a central theme in their organizational structures. The first is the General Coordination of Science for Bioeconomy (*Coordenação Geral de Ciência para Bioeconomia* - CGBE), which is part of one of

the departments under the Ministry's Scientific Research and Training Secretariat. The second is the Center for Management of Strategic Studies (*Centro de Gestão de Estudos Estratégicos - CGEE*), a social organization linked to the MCTI. The CGEE has two projects devoted to bioeconomy: the Bioeconomy Observatory (OBio) and the Opportunities and Challenges in Bioeconomy (ODBio). In 2018, CGBE and CGEE jointly launched the Action Plan for Science, Technology and Innovation in Bioeconomy (PACTI Bioeconomy) as a result of the National Science, Technology and Innovation Strategy for 2016-2022 (*Estratégia Nacional de Ciência, Tecnologia e Inovação - ENCTI*), which established the creation of a bioeconomy plan as a strategic theme.

In addition to these bodies, the MCTI coordinates the National Technical Commission on Biosafety (CTNBio), which is responsible for providing technical support in the implementation of the National Biosafety Policy, including the issuance of norms and technical opinions for activities related to genetically modified organisms (GMOs), from research all the way to trade. Finally, other bodies linked to the MCTI also play a relevant role in RD&I for bioeconomy and related topics, such as the National Institute for Research in the Amazon (INPA), the National Council for Scientific and Technological Development (CNPq) and the Brazilian Industrial Research and Innovation Corporation (EMBRAPPI) (Figure 2).

Ministry of Education (MEC)

The Ministry of Education (*Ministério da Educação - MEC*) also plays a central role in RD&I through public universities, research institutions linked to the Ministry and strategic partnerships with other ministries. The MEC and CGEE/MCTI created Regional Development Centers (CDR) to liaise between higher education and ST&I institutions with a view to developing their respective regions. CDR/Pará focuses on promoting bioeconomy and biobusiness. The MEC also entered into partnerships with the MCTI and EMBRAPPI to promote research on the topics of circular economy, bioeconomy and advanced biomaterials with a focus on the Amazon biome. In 2022, the Professional and Technological Education Secretariat (*Secretaria de Educação Profissional e Tecnológica - SETEC*) of the MEC instituted the Professionals of the Future Project - Green Economy Skills, in partnership with Germany, to develop vocational education in sustainable sectors of the Brazilian economy, including bioeconomy.

Ministry of Economy (ME)

Intellectual property rights are strongly linked to RD&I activities. This means that coordination between the MCTI and the Ministry of Economy (ME) is a necessity, because the National Institute of Intellectual Property (*Instituto Nacional da Propriedade Intelectual - INPI*) — the organization that registers patents — is linked to the ME. The Ministry is also responsible for

coordinating the National Intellectual Property Strategy and the National Biotechnology Committee. Additionally, the Superintendence of the Manaus Free Zone (*Zona Franca de Manaus - ZFM*), an entity linked to the ME, instituted the Amazon Bioeconomy Priority Program (PPBio) to diversify Amazon production activities and to preserve the Manaus Industrial Park's leading role in the region's economy (Figure 3).

Ministry of Agriculture, Livestock and Food Supply (MAPA)

The Ministry of Agriculture, Livestock and Food Supply (*Ministério da Agricultura, Pecuária e Abastecimento - MAPA*) is central to various bioeconomy activities under the **bioecology, biotechnology and bioresource visions**. The MAPA has two organizations that feature bioeconomy as a central theme in their organizational structures. The first is the Secretariat of Family Agriculture and Cooperatives (*Secretaria de Agricultura Familiar e Cooperativismo - SAF*), which identifies opportunities to add value to family farming products, small producers, peoples and traditional communities in socio-biodiversity activities. To this end, in 2019, the MAPA created the Brazil Socio-biodiversity Bioeconomy Program –, in which the Amazon stands out as one of the priority regions, with the objective of promoting sustainable development, productive inclusion and income generation.

The second organization within the MAPA structure to which bioeconomy is a central theme is the Secretariat for Innovation, Sustainable Development and Irrigation (*Secretaria de Inovação, Desenvolvimento Sustentável e Irrigação - SDI*), which has conducted a set of actions to promote the valuing, conservation and sustainable use of genetic resources for food and agriculture. Since 2019, the SDI has been discussing the development of a National Policy on Genetic Resources for Food and Agriculture (*Política Nacional de Recursos Genéticos para a Alimentação e Agricultura - PNRGAA*),³ and the Coordination in charge of Mechanization, New Technologies and Genetic Resources has been actively participating in national and international meetings and forums that touch on genetic resources and biological diversity. The SDI also coordinates the implementation of the National Program for Biobased Agricultural Inputs and presides its Strategic Board.

The Brazilian Agricultural Research Corporation (*Empresa Brasileira de Pesquisa Agropecuária - EMBRAPA*), an institution linked to the MAPA, holds a strategic position with regard to bioeconomy. The theme is one of the strategic objectives of Embrapa's VII Master Plan for 2020-2030 (EMBRAPA, 2020). In 2022, the institution published the document entitled Sustainable Development Goals of the 2030 agenda and bioeconomy: opportunities and potential for EMBRAPA's operations. EMBRAPA Agroenergia is a research unit devoted to the research and development of solutions for converting biomass into biofuels and bioproducts. The institution has other units that operate directly in the Amazon region, with projects on

³ The PNRGAA has undergone public consultation and a 2019 draft can be found here: bit.ly/3E03uf1.

ethnoknowledge, agro-biodiversity, forest management and production chains for non-timber forest products, such as *açaí* and Brazilian nuts. Finally, another very relevant bioeconomy action is the agreement between the MAPA and EMBRAPA for the expansion and maintenance of a Germplasm Bank to conserve genetic resources.

The Brazilian Forest Service (SFB), a specific agency under the MAPA, is tasked with managing public forests and forest concessions. The body maintains the National Forestry Information System (*Sistema Nacional de Informações Florestais - SNIF*), which aims to produce, organize, store, process and disseminate data, information and knowledge about Brazilian forests and the forest sector. The SFB is also the managing body of the National Rural Environmental Registry System (*Sistema Nacional de Cadastro Ambiental Rural - SICAR*), one of the pillars of the Forest Code, and presides over the Management Committee of the National Plan for Environmental Compliance of Rural Properties (*RegularizaAgro*), which aims to promote the environmental regularization of rural properties and implement the Forest Code (Figure 4).

Ministry of the Environment (MMA)

So far, the Ministry of the Environment (*Ministério do Meio Ambiente* - MMA) has been absent from discussions rounds on bioeconomy and has yet to prepare a specific and comprehensive document on the topic. Bioeconomy appears, superficially, as one of the axes of the National Plan for the Control of Illegal Deforestation and Recovery of Native Vegetation (2020-2023) prepared by the MMA in 2020. Despite this, the MMA remains a centerpiece of any governance arrangement involving bioeconomy in the Amazon. The MMA presides over the Genetic Resources Management Council (*Conselho de Gestão do Patrimônio Genético* - CGEN) — the body responsible for coordinating the implementation of the Legal Framework for Biodiversity — and is the Executive Secretary of the Steering Committee of the National Fund for Benefit Sharing (*Fundo Nacional para a Repartição de Benefícios* - FNRP). Furthermore, MMA operates the National System for the Management of Genetic Resources and Associated Traditional Knowledge (SisGen), an electronic system used to register and access genetic resources or associated traditional knowledge. In other words, the MMA is essential to all activities related to research, development and trade of products or processes derived from biodiversity and traditional knowledge.

The MMA also coordinates the National System of Protected Areas (*Sistema Nacional de Unidades de Conservação* - SNUC), the Amazon Protected Areas Program (*Áreas Protegidas da Amazônia* - ARPA) and also has a secretariat devoted to the region. Finally, IBAMA — which is responsible for monitoring environmental infractions on federal public lands — and ICMBio — the managing body in charge of federal protected areas - are linked to the MMA (Figure 5).

Ministry of Mines and Energy (MME)

The Ministry of Mines and Energy (MME) plays a strategic role in bioeconomy in the bioresource vision. The ministry has a department devoted to biofuels and coordinates the implementation of the National Biofuels Policy (RenovaBio) by means of the RenovaBio Committee and the National Agency for Petroleum, Natural Gas and Biofuels (*Agência Nacional do Petróleo, Gás Natural e Biocombustíveis* - ANP), an agency linked to the MME. RenovaBio was established as an integral part of the national energy policy and aims to outline a joint strategy that recognizes the importance and role of all types of biofuels (ethanol, biodiesel, biomethane, aviation biokerosene, and second generation biofuels, among others) into Brazil's power grid. The ANP is the agency tasked with authorizing biofuel production, with accrediting inspection firms that issue Efficient Biofuel Production Certificates, and with operating the platform that manages the backing for the issuance of decarbonization credits (CBIOs). As such, the MME operates as a driver and regulator for the production and processing of biomass for the purpose of generating biofuels (Figure 6).

Other Ministries

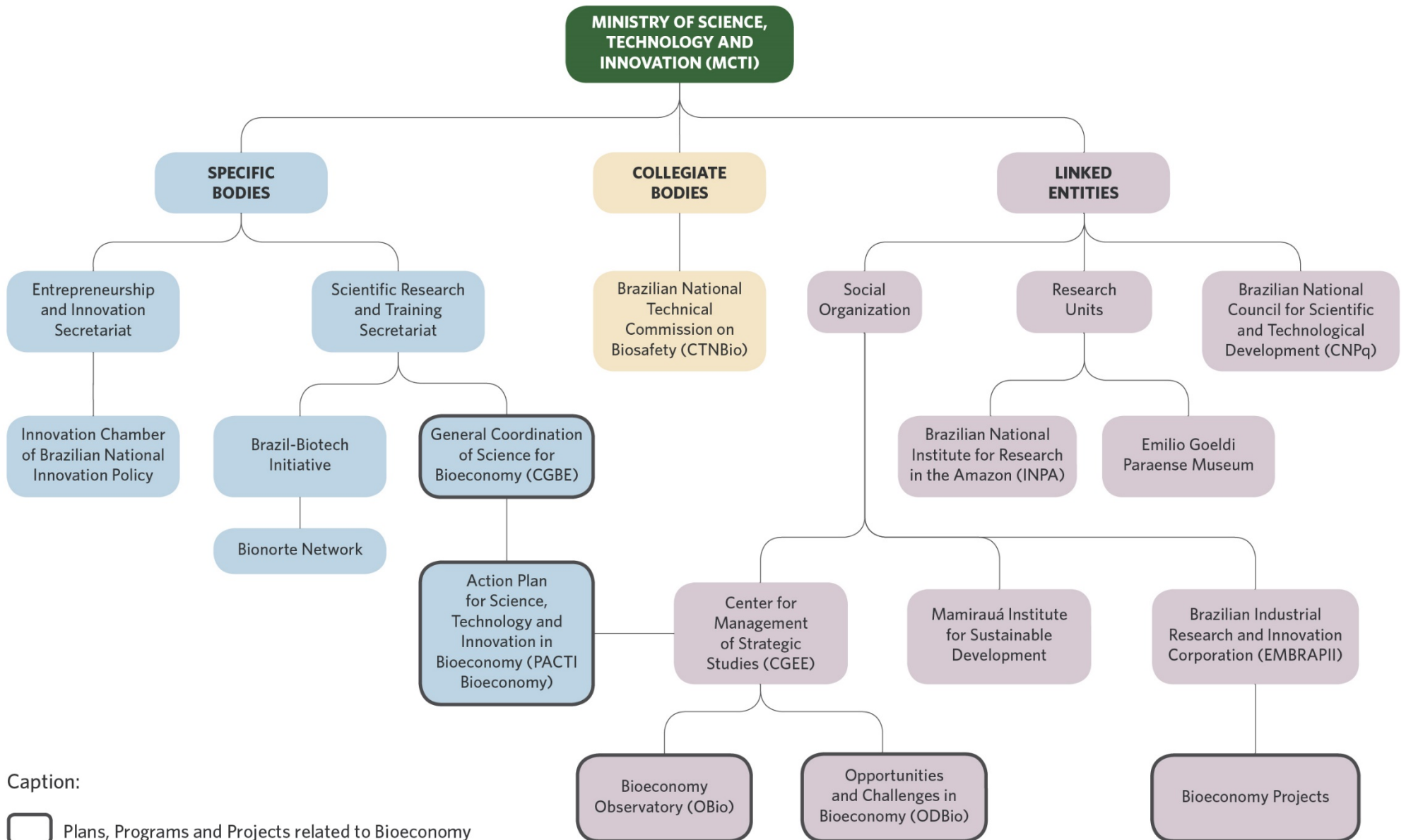
To effectively implement the bioecology vision, the **Ministry of Justice and Public Security** (*Ministério da Justiça e Segurança Pública - MJSP*) — to which FUNAI⁴ is linked — and the **Ministry of Women, Family and Human Rights** (*Ministério da Mulher, Família e dos Direitos Humanos - MMFDH*) — whose mandate is tied to traditional peoples and communities (TPC) — must be involved. Despite the importance of these ministries, no reference to bioeconomy was found in their organizational structure (Figure 7).

Finally, the **National Council of the Amazon**, a collegiate body under the **Vice President's Office** that is tasked with coordinating and integrating policies for the Amazon at the federal level, does not have any proposal on the topic of bioeconomy and is absent from any discussions on the subject.

Below are the organizational charts of the key ministries whose policies are devoted/tied to the topic of bioeconomy.

⁴ FUNAI is the Brazil's federal agency for Indigenous affairs.

Figure 2. Organizational Chart of the Ministry of Science, Technology and Innovation

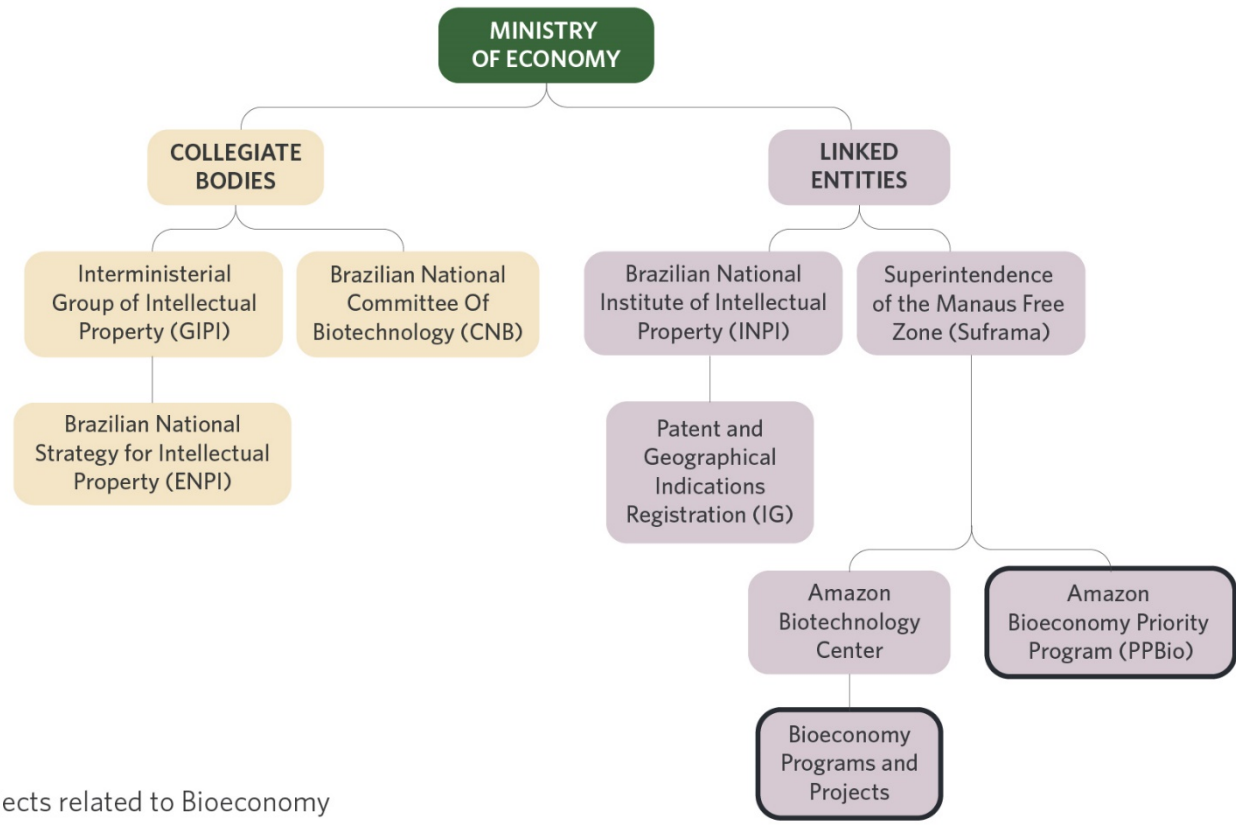


Caption:

 Plans, Programs and Projects related to Bioeconomy

Source: CPI/PUC-Rio, 2022

Figure 3. Organizational Chart of the Ministry of Economy



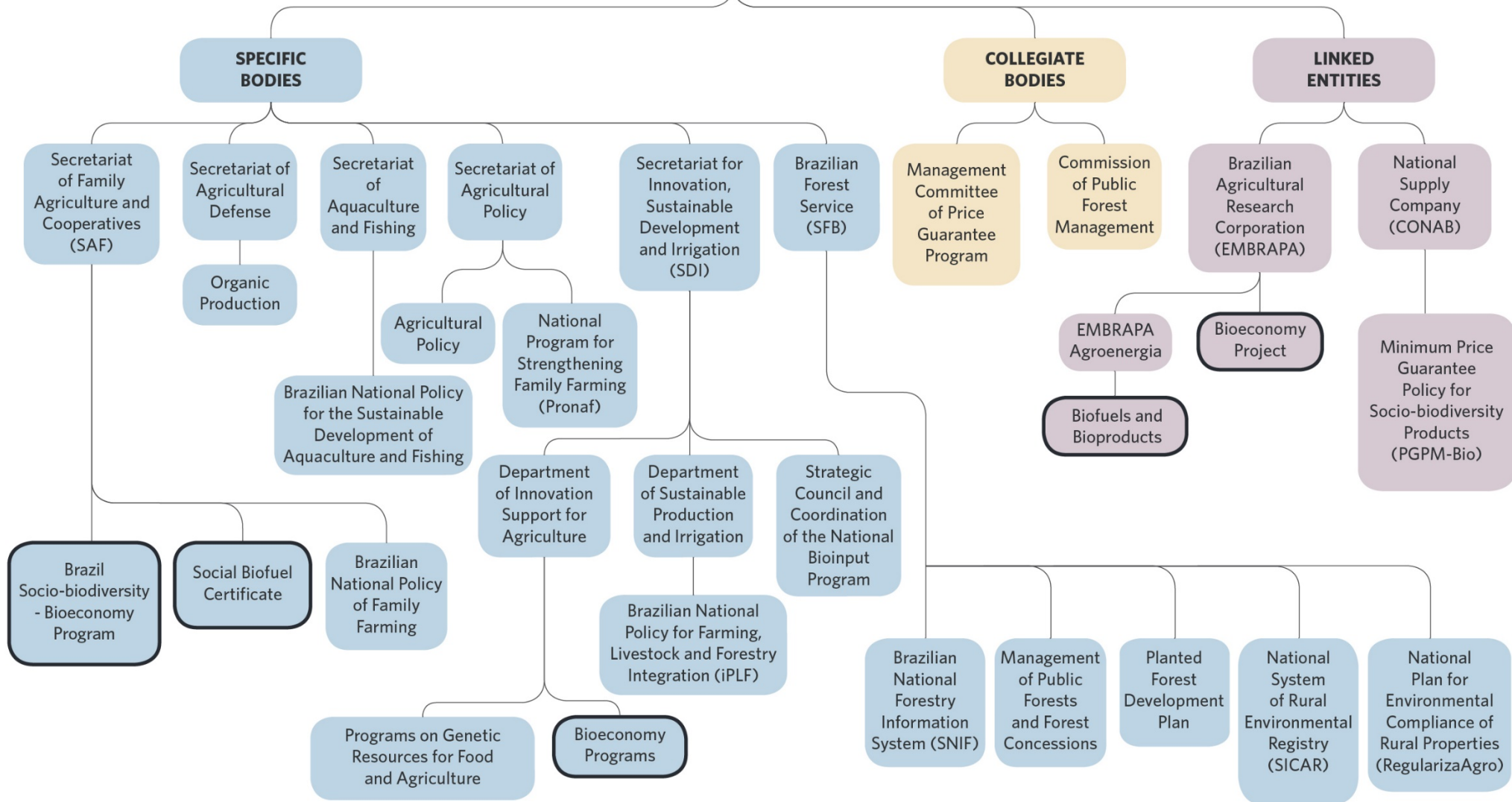
Caption:

 Plans, Programs and Projects related to Bioeconomy

Source: CPI/PUC-Rio, 2022

Figure 4. Organizational Chart of Ministry of Agriculture, Livestock and Food Supply

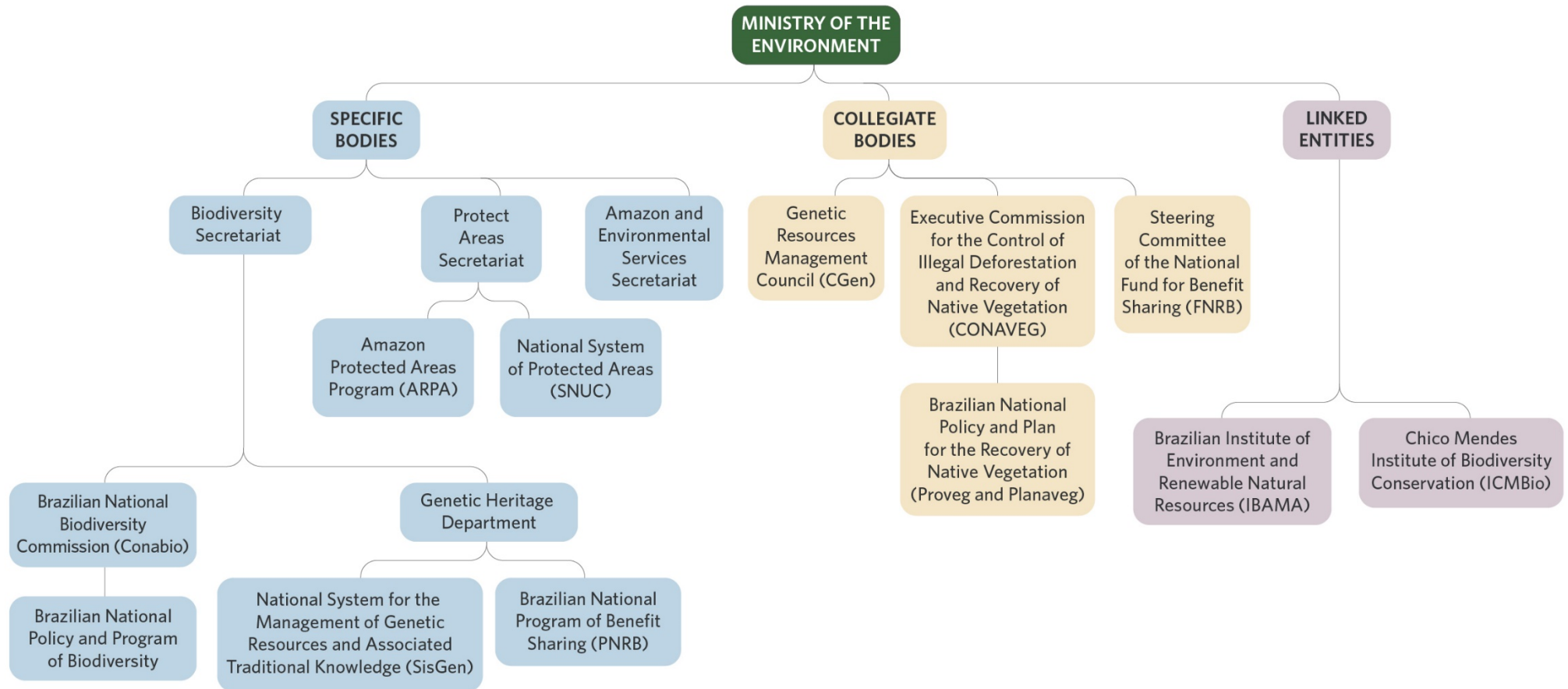
MINISTRY OF AGRICULTURE, LIVESTOCK AND FOOD SUPPLY (MAPA)



Caption:

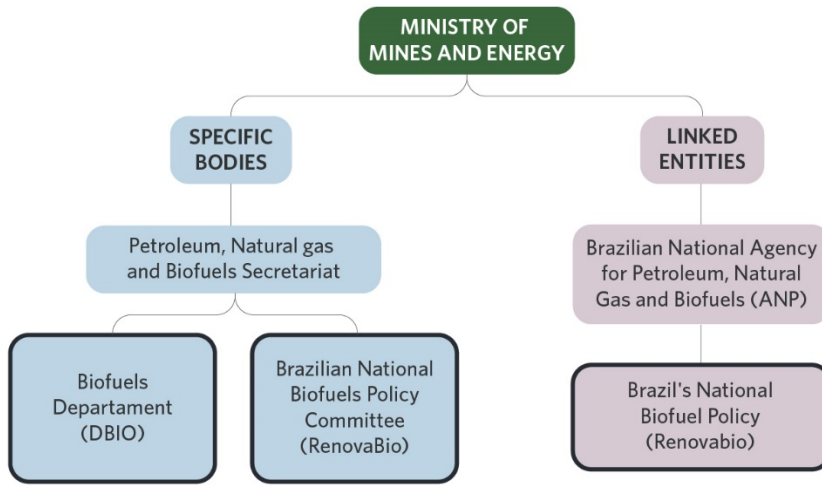
Plans, Programs and Projects related to Bioeconomy

Figure 5. Organizational Chart of the Ministry of the Environment



Source: CPI/PUC-RIO, 2022

Figure 6. Organizational Chart of the Ministry of Mines and Energy

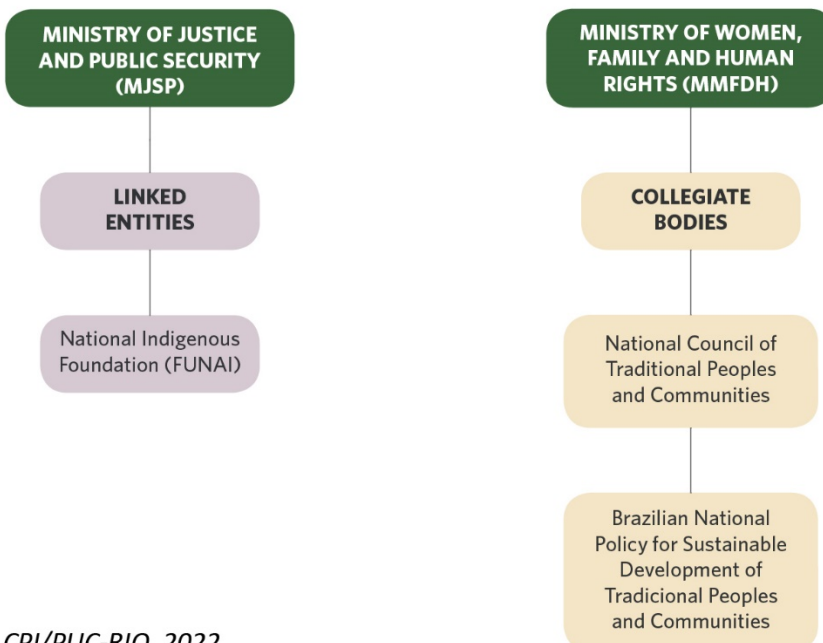


Caption:

Plans, Programs and Projects related to Bioeconomy

Source: CPI/PUC-RIO, 2022

Figure 7. Organizational Charts of the Ministry of Justice and Public Security and the Ministry of Women, Family and Human Rights



Source: CPI/PUC-RIO, 2022

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