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REGULATORY CHALLENGES OF THE CARBON CREDIT MARKET IN BRAZIL

DESAFIOS REGULATÓRIOS DO MERCADO DE CRÉDITOS DE CARBONO NO BRASIL

DESAFÍOS REGULATORIOS DEL MERCADO DE CRÉDITOS DE CARBONO EN BRASIL

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ABSTRACT

The growing relevance of the carbon market in the international arena places Brazil before the challenge of structuring a regulated system capable of reconciling economic competitiveness with environmental protection. In this context, the enactment of Law No. 15,042/2024, which establishes the Brazilian Greenhouse Gas Emissions Trading System (SBCE), constitutes a regulatory milestone, while raising doubts about its sufficiency to consolidate a robust and effective market. This study aimed to assess the law's capacity to enable a regulated carbon market in Brazil, considering its historical and legal trajectory, the distinctions between voluntary and regulated markets, the main technical and institutional challenges, as well as its merits and limitations. Methodologically, the research is exploratory, with a qualitative approach, based on bibliographic and documentary review across scientific databases (Scielo, Scopus, Google Scholar) and legislative records. From an initial corpus of 303 documents, 90 were selected for in-depth analysis and organized into thematic categories (regulatory frameworks, market design, infrastructure, socio-environmental justice, and methodological gaps). The results indicate that, although the law advances by creating a mandatory system with phased implementation and benefit-sharing mechanisms, significant gaps persist. These include the exclusion of agribusiness from emission limits, the absence of clear sectoral reduction targets, weaknesses in monitoring, reporting, and verification (MRV), and the risk of speculative dynamics. In conclusion, Law No. 15,042/2024 constitutes an important step but remains insufficient. Regulatory and institutional refinements are required to ensure an environmentally effective, legally stable, and socially

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just carbon market. Ongoing research and careful monitoring of its implementation will be essential for aligning the system with Brazil's climate goals.

Keywords: Emissions Trading System. Climate Policies. Market Regulation. Sustainable Development. Environmental Governance.

RESUMO

A crescente relevância do mercado de carbono no cenário internacional coloca o Brasil diante do desafio de estruturar um sistema regulado capaz de alinhar competitividade econômica e proteção ambiental. Nesse contexto, a promulgação da Lei nº 15.042/2024, que institui o Sistema Brasileiro de Comércio de Emissões (SBCE), representa um marco normativo, mas levanta dúvidas quanto à sua suficiência para consolidar um mercado robusto e efetivo. Este estudo teve como objetivo avaliar a capacidade da lei em viabilizar o mercado regulado de carbono no Brasil, considerando sua trajetória histórica e jurídica, as distinções entre os mercados voluntário e regulado, os principais desafios técnicos e institucionais, além de seus méritos e limitações. Metodologicamente, a pesquisa caracteriza-se como exploratória, de abordagem qualitativa, baseada em revisão bibliográfica e documental em bases científicas (Scielo, Scopus, Google Scholar) e registros legislativos. Dos 303 documentos inicialmente identificados, 90 foram selecionados para análise integral, organizados em categorias temáticas (marcos regulatórios, desenho de mercado, infraestrutura, justiça socioambiental e lacunas metodológicas). Os resultados indicam que, embora a lei avance ao criar um sistema obrigatório, com fases de implementação progressiva e mecanismos de repartição de benefícios, persistem lacunas regulatórias e setoriais - como a exclusão do agronegócio, ausência de metas claras por setor, fragilidades em monitoramento, relato e verificação (MRV) e risco de especulação. Conclui-se que a Lei nº 15.042/2024 constitui um avanço importante, mas ainda insuficiente, demandando aperfeiçoamentos regulatórios e institucionais para garantir um mercado ambientalmente efetivo, juridicamente seguro e socialmente justo. Pesquisas contínuas e o monitoramento de sua implementação serão cruciais para adequação às metas climáticas brasileiras.

Palavras-chave: Sistemas de Comércio de Emissões. Políticas Climáticas. Regulação de Mercado. Desenvolvimento Sustentável. Governança Ambiental.

RESUMEN

La creciente relevancia del mercado de carbono en el escenario internacional presenta a Brasil el desafío de estructurar un sistema regulado capaz de alinear la competitividad económica y la protección ambiental. En este contexto, la promulgación de la Ley N.º 15.042/2024, que establece el Sistema Brasileño de Comercio de Emisiones (SBCE), representa un hito regulatorio, pero plantea interrogantes sobre su suficiencia para consolidar un mercado robusto y efectivo. Este estudio tuvo como objetivo evaluar la capacidad de la ley para habilitar un mercado regulado de carbono en Brasil, considerando su trayectoria histórica y legal, las distinciones entre los mercados voluntarios y regulados, los principales desafíos técnicos e institucionales, y sus méritos y limitaciones. Metodológicamente, la investigación es exploratoria, con un enfoque cualitativo, basada en una revisión bibliográfica y documental de bases de datos científicas (Scielo, Scopus, Google Scholar) y registros legislativos. De los 303 documentos identificados inicialmente, se seleccionaron 90 para un análisis completo, organizados en categorías temáticas (marcos regulatorios, diseño de mercado, infraestructura, justicia socioambiental y brechas

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metodológicas). Los resultados indican que, si bien la ley avanza al crear un sistema obligatorio con fases de implementación progresivas y mecanismos de distribución de beneficios, persisten brechas regulatorias y sectoriales, como la exclusión de la agroindustria, la falta de objetivos sectoriales claros, las deficiencias en el monitoreo, reporte y verificación (MRV) y el riesgo de especulación. La conclusión es que la Ley N.° 15.042/2024 representa un avance importante, pero sigue siendo insuficiente, requiriendo mejoras regulatorias e institucionales para garantizar un mercado ambientalmente eficaz, jurídicamente seguro y socialmente justo. La investigación y el monitoreo continuos de su implementación serán cruciales para el cumplimiento de los objetivos climáticos de Brasil.

Palabras clave: Sistemas de Comercio de Emisiones. Políticas Climáticas. Regulación del Mercado. Desarrollo Sostenible. Gobernanza Ambiental.

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1 INTRODUCTION

The Earth's atmosphere consists of various gases and particles, with nitrogen and oxygen in greater quantities, as well as other gases that form what is known as the greenhouse effect. Among these gases, carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) stand out as the main ones. CO_2 is the most significant of these gases (IPCC AR6 WG3, 2022) and contributes substantially to climate change, such as the rise in global average temperatures (Hansen *et al.* 2006). This is due to its long residence time in the atmosphere and its gradual yet significant increase year after year.

Humanity is convinced that reducing CO_2 emissions is essential, particularly to curb the rose in global temperatures. Several alternatives have been proposed, including the preservation of carbon stocks in soils, forests, and other types of vegetation (Smith *et al.*, 2016).

Among the alternatives studied for mitigating climate change, the knowledge of carbon dynamics is of great relevance. The process carried out by plants, which capture CO_2 through photosynthesis and store it in their biomass, is widely recognized (Dias-Filho, 2006; Viana *et al.*, 2023), as well as the process carried out by the soil (Lal and Cerri, 2006; Pinheiro-Junior *et al.*, 2024), which stores it in the form of carbon. It is also known that carbon is stored in areas with large amounts of dense forests (Soepadmo, 1993; Pan *et al.*, 2011). In this context, Brazil stands out as a powerhouse in forest carbon stocks, particularly in dense forests, due to its vast forested areas and the diversity of biomes with varying capacities for carbon sequestration and storage, especially in the Amazon (Heinrichi *et al.*, 2021).

In addition to environmental preservation, carbon stockpile can generate credits, especially through the reduction of emissions due to deforestation and forestry manipulation (REDD+). Carbon credits correspond to a type of financial tool used to mitigate greenhouse gas emissions into the atmosphere, thus contributing to reducing the impact of climate change. The fundamental idea is to assign a financial value to verified reductions in carbon emissions, in order to encourage the reduction of greenhouse gas emissions in a more efficient and economical way (Ribeiro, 2007; Souza, Alvarez and Andrade, 2014; Souza *et al.*, 2023).

The regulation of Brazil's carbon credit market faces complex and multifaceted challenges. This emerging market, which plays a crucial role in combating climate change, involves the trading of credits, with each credit representing one ton of CO_2 either avoided or removed from the atmosphere (Fisher, 2010; Mendes, 2013).

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The establishment of a robust regulatory framework is considered decisive to ensure the integrity and transparency of the carbon credit market. This regulation must set clear guidelines for the quantification, reporting, and verification of emissions, as well as define strict standards for emission reduction projects (Vilar, 2022). Studies suggest that such regulation is requirement to guarantee that carbon credits genuinely represent effective, measurable, and permanent reductions in greenhouse gas emissions (Cames *et al.,* 2016). However, if it is widely acknowledged that the implementation of a carbon credit market brings both economic and environmental benefits, the question arises: is Law No. 15,042/2024 sufficient to enable a robust carbon market in Brazil, or do its regulatory and sectoral gaps undermine the environmental effectiveness and legal stability of the proposed system?

Projects on carbon credits often occur in areas with a significant presence of traditional communities, whose ways of life may be impacted (Alvarez, Elfying and Andrade, 2016; Schroeder 2010). Therefore, it is essential that these communities are effectively involved in the decision-making process and that part of the benefits generated by carbon projects are reverted towards the sustainable development of these communities (Alkmin, 2023; Souza *et al.,* 2023).

The overarching purpose of this study is to examine the capacity of Law No. 15,042/2024 to structure a regulated carbon market in Brazil, assessed in light of its normative advances, regulatory and sectoral shortcomings, as well as the multifaceted challenges posed to environmental effectiveness, legal certainty, and socio-environmental inclusion.

In pursuing this goal, the research further intends to scrutinize the historical and legal trajectory of the principal international conferences, agreements, and legislative initiatives that have shaped the carbon market within the Brazilian context; to delineate the distinctions between voluntary and regulated carbon markets by emphasizing their legal, economic, and operational underpinnings; to identify and categorize the principal technical, institutional, and regulatory barriers to the effective implementation of the Brazilian Emissions Trading System (SBCE); and to critically assess the merits and limitations of Law No. 15,042/2024 through reference to the scientific literature and antecedent legislative proposals that informed its enactment. Finally, the study seeks to formulate complementary guidelines and policy recommendations designed to strengthen the effectiveness and resilience of the Brazilian carbon market, informed by comparative international experiences.

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2 MATERIAL AND METHOD

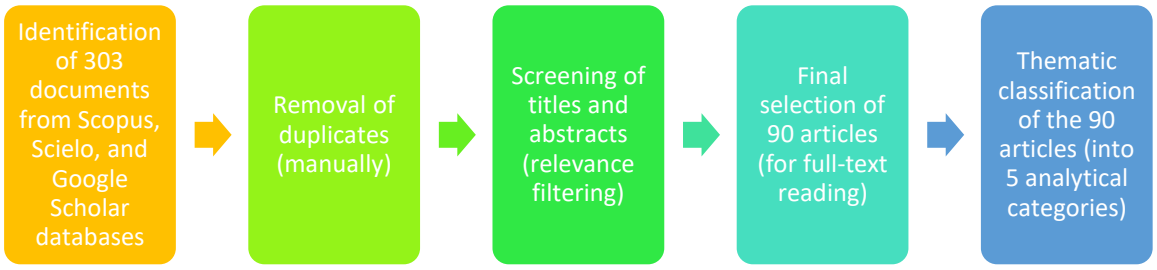
In this work, a narrative literature review was used, which involved a detailed study of publications related to the topic under discussion. The research is characterized as exploratory, with a qualitative approach, and bibliographic procedures. Data collection was carried out through consultation of the Scielo, Scopus, and Google Scholar databases, selecting journals classified as Qualis "A" or "B" or with an H-index greater than two, as well as undergraduate and postgraduate works (dissertations or theses). Documents such as Bills and Opinions were also gathered from federal legislative bodies (Federal Senate and Chamber of Deputies). According to Dourado and Ribeiro (2023), this type of literature review is a solid and reliable source of information, as it compiles knowledge from various selected publications, facilitating the identification of gaps in existing research.

The search strategy used the descriptors: "CARBON CREDIT" OR "CARBON CREDITS" AND BRAZIL OR BRASIL AND REGULAÇÃO OR REGULATION OR "PROJETO DE LEI" OR "PROJECT OF LAW", in All Fields. The timeframe considered was the last six years (2019–2024), with the inclusion of classic or pioneering works beyond this period based on relevance and citation volume.

Initially, 303 documents were retrieved. After removing duplicates and applying relevance filters based on title and abstract screening, 90 documents were selected for full-text analysis. Figure 1 illustrates the methodological flow used for selection, based on adapted PRISMA guidelines.

Figure 1

Methodological flow used for selection of documents



Source: elaborated by the authors.

Subsequently, the selected publications were classified into thematic categories, following an inductive coding process derived from content analysis. The categories reflect the dominant axes of discussion present in the carbon credit regulatory debate in Brazil:

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Regulatory Frameworks and Legal Instruments (e.g., PLs, decrees, SBCE, SINARE);

Market Design and Economic Mechanisms (e.g., cap-and-trade, voluntary vs. regulated systems);

Infrastructure and Implementation Challenges (e.g., MRV systems, institutional gaps);

Social and Environmental Justice (e.g., REDD+, indigenous participation, benefit sharing);

Technical Proposals and Methodological Gaps (e.g., additionality, leakage, double counting).

These categories are detailed in Table 1, which also lists representative references for each cluster. This analytical classification supported a more structured discussion of results, allowing comparisons between international experiences and the Brazilian context, with emphasis on gaps in current legislation (Law 15.042/2024) and potential areas for improvement.

Table 1

List of quantities by thematic categories and relevant works

Thematic Category	Nº of Articles	Representative Works
Regulatory Frameworks	24	Lima (2023); Souza *et al.* (2020); BRASIL (2024)
Market Design and Economic Mechanisms	18	Cames et al. (2016); Reisch (2022)
Infrastructure and Implementation	12	Vilar (2022); Rocha (2019); Rocha, Álvarez and Silveira (2014)
Social/Environmental Justice	20	Alkmin (2023); Alvarez; Elfving and Andrade (2016); Brito and Pozzetti (2021)
Methodological Gaps and Proposals	16	Poyer, Silveira and Oliveira (2020); Montovanelli (2023)

Source: elaborated by the authors.

Given the established objectives, the study was developed along the following topics: Historical Context of Carbon Market Regulations; Carbon Market: Voluntary vs Regulated; Challenges, Brazilian Potentials in the Regulated Market and Conclusions, presented below. The data was analyzed descriptively and demonstrated in boxes to better demonstrate the results obtained.

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3 RESULTS AND DISCUSSIONS

3.1 HISTORICAL CONTEXT OF CARBON MARKET REGULATIONS

The inception and evolution of the carbon credit concept is situated in the broader context of global concerns about climate change and the role of greenhouse gas emissions. This idea originated from the growing awareness of the need to establish for efficient and scalable mechanisms to reduce global carbon emissions and mitigate global warming. In the initial phase, the notion of crediting emerged as an innovative tool to incentivize the reduction of emissions in a cost-effective manner (Guimarães, 2023).

The initial discussions started indirectly at the Stockholm Conference (1972), when the interdependence of human beings and the environment was recognized. At the Vienna Convention (1985) there was an international agreement to protect the stratospheric ozone layer. Its aim was to prevent the production and consumption of ozone-depleting substances such as chlorofluorocarbons (CFCs).

The Montreal Protocol (1987) was a complement to the Vienna Convention and established specific targets for the progressive elimination of the use of substances that cause the depletion of the ozone layer. At ECO-92 (1992) there was a significant milestone in promoting global awareness of environmental issues and establishing commitments in the search for more sustainable development.

These events did not directly debate the creation of the carbon credit market, but their ideals contributed to highlighting the problems the modern world was experiencing. Table 2 summarizes the historical evolution of the carbon credit market.

Table 2

Summary of the historical evolution of the regulation of the Carbon Credit Market

Year	Event	Action
1972	Stockholm Conference	Declaration on the Human Environment “To inspire and guide the peoples of the world to preserve and improve the human environment”. Emergence of the concept of Sustainability.
1985 / 1987	Vienna Convention and Montreal Protocol	Protecting the ozone layer and restricting CFC emissions for the sake of protecting the ozone layer.
1992	ECO-92	Agenda 21 for sustainable development. Creation of the Convention on Diversity and the Framework Convention on Climate Change.
1997	Kyoto Protocol - COP III of the United Nations Framework Convention on Climate Change	Establishment of targets and market mechanisms for the reduction of greenhouse gases. The reduction of greenhouse gases could be financially compensated through CERs - Certified Emission Reductions.

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Year	Event	Action
2012	RIO+20	Creation of the SDGs and institutional commitment by States Parties to structure a green economy and eradicate poverty.
2015	Paris Agreement COP 21 of the United Nations Framework Convention on Climate Change	Establishment of iNDCs (Intended Nationally Determined Contribution) to reduce GHG.
2024	Law 15,042 approved	Establishes the Brazilian Greenhouse Gas Emissions Trading System (SBCE)

Source: elaborated by the authors.

An analysis of the main international conferences, such as Kyoto and Paris, reveals the progressive evolution of global understanding and response to climate change, particularly in the context of the carbon credit market. These conferences, milestones in the history of climate negotiations, have outlined paths and established fundamental commitments for the global management of greenhouse gas emissions (Lima, 2023).

In order to look for options to promote sustainable development, the 3rd Conference of the Parties (COP-3) generated documents of intents. These documents were signed by the countries that, at the time, were responsible for 55% of global emissions. The agreement set targets for the developed countries, which were members of the Organization for Economic Cooperation and Development (OECD), included in Annex I of the agreement. In addition, Russia signed the agreement in 2004, and Eastern European countries also became signatories (Seiffert, 2009; Delpupo, 2009).

The Kyoto Protocol established emission reduction targets of around 5.2% in relation to 1990 levels for developed countries, which at the time were considered to be the main contributors to emissions. These targets were projected for the first period of the agreement, between 2008 and 2012 (Souza *et al.,* 2012).

This agreement established both conditions and targets to reduce the continuous increase in greenhouse gas emissions resulting from the growing volume of global production (Lombardi, 2008). A significant contribution of the Kyoto Protocol was the incorporation of three forms of flexibility mechanisms to achieve the stipulated targets. Through these mechanisms, emission reduction efforts from different countries, projects and initiatives can be considered to meet local targets. These mechanisms include:

a) Emissions Trading System (ETS),

b) Joint Implementation Mechanism (JI) and

c) Clean Development Mechanism (CDM).

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The CDM is the only mechanism that allows developing countries (like Brazil) to carry out emission reduction and removal projects in order to generate carbon credits, by allowing carbon credits to be traded with Annex I countries that need to reduce their excess emissions. This mechanism is considered an economic instrument that gave rise to the regulated carbon market worldwide. The regulated carbon market consists of an institutional environment where participants are subject to national or global legislation and standards, which establish criteria and rules for designing projects and trading Certified Emission Reductions (CERs) from CDM projects (Souza *et al.*, 2012).

With the replacement of the Kyoto Protocol by the Paris Agreement, there was a new look at the world, letting countries express how much they could contribute to reducing their emissions through NDCs, which must pass through the congresses and parliaments of each country (Hamilton *et al.,* 2021). In its NDC, presented in 2015, Brazil set out its goals for mitigating climate change. Officially, Brazil has committed to reducing its emissions by 37% by 2025 and 50% by 2030, based on its 2005 emissions, through mitigation and adaptation measures (UNFCCC, 2023). At COP29 in November 2024, Brazil set a new target by proposing to reduce net greenhouse gas emissions by 59% to 67% by 2035, relative to 2005 levels. Table 3 shows a summary of the main commitments ratified in the Paris Agreement by the five countries with the highest CO_2 emissions, which accounted for 61% of emissions in 2022.

Through these conferences, there has also been a progressive increase in the global ambition to reduce emissions. While the Kyoto Protocol focused on short-term targets and a more quantitative approach, the Paris Agreement introduced a long-term vision aimed at limiting the increase in global temperature to values below 2°C above pre-industrial levels (Brito and Pozzetti, 2021).

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Table 3

Summary of the main commitments ratified in the Paris Agreement by the top 5 CO_2 emitting countries

Country	Treaties signed	Global CO_2 emissions (2022)	
		%	$MtCO_2$
1º China	• peak CO_2 emissions by 2030; • reduce energy intensity by 2030; • increase the share of non-fossil sources by 20% by 2030; • expand areas of afforestation and reforestation;	32%	11.900
2º USA	• reduce greenhouse gas emissions by 26% to 28% below 2005 levels by 2025; • increase renewable energy sources; • improve energy efficiency in various economic sectors; • Implement policies and initiatives to promote sustainability and resilience to climate change, including the preservation of forests and natural ecosystems; • contribute to the financing of climate initiatives in developing countries;	13,7%	5.080
3º India	• reduce the greenhouse gas emissions intensity of its GDP by 33% to 35% by 2030, compared to 2005 levels; • increase the installed capacity of non-fossil energy to 40% of the total by 2030; • create an additional carbon sink of 2.5 to 3 billion tons of carbon dioxide equivalent by increasing forest cover and improving the quality of forests by 2030; • invest in clean technologies and promote technology transfer to support their sustainable growth; • implement measures to increase the country's resilience to the impacts of climate change, including the protection of vulnerable communities and the development of resilient infrastructure;	7,4%	2.760
4º Russia	• reduce their greenhouse gas emissions by 25% to 30% below 1990 levels by 2030; • maintain current forests as a carbon sink; • promote energy efficiency in sectors such as transportation, industry and construction, with the aim of reducing total energy consumption and associated emissions; • increase the use of renewable energy sources;	4,3%	1.600
5º Japan	• reduce its greenhouse gas emissions by 26% by 2030, compared to 2013 levels; • significantly improve energy efficiency in sectors such as transportation, industry and buildings to reduce energy consumption and associated emissions; • increase the share of renewable energy sources; • implement adaptation measures to increase the country's resilience to the impacts of climate change;	2,9%	1.060
TOTAL		60,3%	22.400

Source: Elaborated by the author based on data from Climate Watch - PIK (2024) – CO_2 Emissions excluding Land Use Change and Forests.

International conferences have increasingly become critical forums for discussions on integrity and effectiveness. Consequently, issues such as transparency, accounting, and the prevention of “double counting” of emissions have become central topics, reflecting the

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ongoing effort to enhance and strengthen market mechanisms in the context of climate change (Oliveira, 2022).

In the early stages, carbon market policies focused mainly on creating cap-and-trade systems, in which limits or caps were set on total allowable emissions, and companies or countries could trade emission permits. These systems sought to incorporate the environmental cost of carbon emissions into economic decisions, encouraging investments in cleaner and more efficient technologies (Chagas, Ferreira and Feitosa, 2022).

With the growing understanding of the impacts of climate change, there has also been a greater emphasis on the need for inclusive and fair approaches. Public policies have begun to recognize and integrate sustainable development considerations, including the protection of biodiversity, the promotion of social equity and the involvement of local and indigenous communities in carbon credit projects (Montovanelli, 2023; Alkmin, 2023).

A comparison of global regulations surrounding carbon credit markets highlights the diversity of approaches adopted by different nations and economic blocks, reflecting the varied economic, environmental and political contexts. This comparison reveals the differences in regulatory frameworks and the similarities in fundamental objectives and challenges faced (Stevanato, 2022).

In the European Union, for example, the Emissions Trading System (EU ETS) represents one of the oldest and most sophisticated carbon markets in the world. It is characterized by a strict cap-and-trade regime, where a ceiling for emissions is set and emission rights are traded. This system has been instrumental in reducing greenhouse gas emissions in the region, demonstrating the effectiveness of a well-structured and coherent regulatory approach (Oliveira, 2021).

In contrast to the European model, the carbon credit regime in the United States is marked by a decentralized approach based on state initiatives, such as the California Cap-and-Trade Program. This program, specific to the state of California, illustrates how sub-national regulations can be effective in managing emissions, offering flexibility and adaptability to local contexts (Maldaner, 2022).

On the Asian continent, particularly in China, the approach has been to gradually implement emissions trading systems. Initially launched as pilot projects in various cities and provinces, these systems are evolving into a national scheme, reflecting China's growing importance on the climate change scene and its pragmatic, phased approach to implementing environmental policies (Fonseca, 2022).

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In regions with established emissions trading systems, such as the European Union, there has been a clear boost in the adoption of low-carbon technologies, demonstrating the potential of these markets to stimulate changes in industrial and energy practices (Delgado, 2022). However, challenges have also been identified, such as the need to set emission ceilings that are both ambitious and achievable. Experience has shown that caps that are too high can fail to promote significant emission reductions, while caps that are too low can impose excessive economic challenges, especially for industries in transition (Nicoleti, 2022).

The integrity of carbon credit markets depends heavily on confidence in the accuracy of emissions data and the effectiveness of reported reductions. Challenges related to double counting and quality have driven efforts to improve monitoring systems and international regulation (Souza, 2020).

An emerging understanding is the importance of climate justice and social inclusion in markets. Initiatives must consider the environmental and economic aspects and the social impact and involvement of local communities. International experience has shown that the most successful projects are those that combine emission reductions with local social and environmental benefits (Oliveira, 2021).

3.2 CARBON MARKET: VOLUNTARY VS REGULATED

The structure and operation of the voluntary carbon credit market has distinct characteristics that differentiate it from regulated markets. The former is characterized by the trading of carbon credits outside of a mandatory regulatory framework, where the buying and selling of credits is driven by the will of interested parties to contribute to the reduction of greenhouse gas emissions, in addition to achieving corporate or personal sustainability goals. In the voluntary market, companies, governments or individuals can buy credits to offset their own emissions, with the aim of becoming neutral or achieving other environmental goals. They are generated by projects that reduce, avoid or capture greenhouse gas emissions. Common examples include reforestation projects, renewable energy, carbon capture and storage, and energy efficiency improvements (Montovanelli, 2023).

Unlike regulated ones, where they are often traded within parameters set by government policies, voluntary ones offer greater freedom in terms of how and where credits can be generated and sold. This provides a breeding ground for innovation and experimentation in reduction projects (Silveira and Oliveira 2021).

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Although it is not regulated by a specific legal framework, the market relies heavily on credibility and transparency. Therefore, carbon credits are often validated and verified by independent third parties, according to internationally recognized standards and protocols. This ensures that the emission reductions are real, measurable and permanent (Delgado, 2022).

The regulated market is structured under guidelines and standards established by governmental or intergovernmental authorities, differing substantially from the voluntary market in terms of regulation and supervision. This form of market is often based on international agreements, such as the Kyoto Protocol, or on national legislation that sets emission reduction targets for entire sectors or countries (Souza, 2020).

In this system, they are used as a tool to meet regulatory obligations to reduce emissions. Generally, a cap is set on the total emissions allowed within a jurisdiction or sector. Companies or entities that emit greenhouse gases are then obliged to hold an amount of carbon credits equivalent to their emissions, encouraging them to reduce their emissions or buy additional credits on the market if they exceed their allocated limits (Anis, Carducci and Ruviaro, 2022).

A distinctive feature of the regulated market is the existence of a cap-and-trade mechanism. This system allows companies that reduce their emissions below the established limits to sell surplus credits to others that are struggling to meet their targets. This creates an economic incentive to reduce emissions and promotes efficiency in the allocation of resources to where emissions reductions can be achieved at the lowest cost (Inácio Filho, 2022).

Integrity and effectiveness depend heavily on a rigorous emissions Monitoring, Reporting, and Verification (MRV) system. Such systems are key to ensuring that emissions reductions are real, measurable and verifiable, sustaining trust in the market and ensuring that emissions reduction targets are effectively achieved (Vercillo, 2023).

The economic and procedural differences are striking and significantly influence the dynamics and effectiveness of each system. In the economic sphere, the main distinction lies in the way carbon credit prices are set and the nature of the incentives for reducing emissions (Maldaner, 2022).

In the markets, carbon credit prices are generally influenced by factors such as emission targets set by the government, supply and demand within the cap-and-trade system, and penalties for non-compliance with quotas. This system tends to create a more stable and

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predictable price for carbon, reflecting environmental policies and objectives defined in a regulatory manner. It provides a direct incentive to reduce emissions, as companies look for ways to cut their costs by buying credits (Reisch, 2022).

On the other hand, in the voluntary market, prices are more influenced by market supply and demand, without the imposition of government limits or penalties. In many cases, companies acquire carbon credits voluntarily to meet corporate sustainability, social responsibility or marketing objectives. In this context, the price of credits can be more variable (and generally lower than in the regulated market), reflecting a diverse range of projects and their perceived environmental and social quality (Fonseca, 2022).

In terms of procedures, regulated markets require a robust system to ensure that emissions and reductions are accurately quantified and verified. This process often involves regulatory or certification bodies that ensure compliance with established standards. In addition, participation in a regulated market usually implies stricter legal and compliance requirements for companies (Souza, 2020).

Another challenge is the issue of “carbon leakage”, where companies can transfer production to countries with less stringent regulations, resulting in emissions not being reduced globally. To combat this, some jurisdictions have implemented measures such as free allocation of permits to sectors at risk of carbon leakage, seeking a balance between environmental protection and economic competitiveness (Moreira and Silva 2022).

3.3 BRAZIL'S CHALLENGES AND POTENTIAL IN THE REGULATED MARKET

In the context of the Brazilian carbon credit market, several current barriers can be identified, reflecting challenges at both structural and operational levels. One of the main barriers is the absence of a specific and comprehensive regulatory framework. This legal gap creates uncertainty about the rules of operation, discouraging potential investors and participants due to the lack of clarity about the rights and duties involved, and can even lead to fraud, as reported by CNN Brasil in the article entitled “PF carries out mega operation against fraud in granting carbon credits to multinationals” (Maia, 2024).

There are currently four rules in force in Brazil that legitimize the trading of carbon credits: the National Policy for Payment for Environmental Services (Law Nº. 14.119/21), the Cédula de Produto Rural - CPR-Verde (Decree Nº. 10.828/21); the National System for Reducing Greenhouse Gas Emissions - SINARE (Decree Nº. 11.075/22 amended by Decree

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Nº. 11.550/2023) and the Law 15.042/2024 which establishes the Brazilian Greenhouse Gas Emissions Trading System (SBCE).

However, it is important to note that these legal frameworks do not establish guidelines or regulations for this market. The approval of Law 15,042/2024 alone is not sufficient to ensure the operationalization of the market, as the law itself sets a timeline for the implementation of the SBCE, which will be gradual and divided into five main phases, as shown in table 4. This aims to ensure predictability and legal certainty for regulated companies, in addition to attracting international investments and positioning Brazil as a global leader in the carbon market.

Table 4

Phases for implementing the Brazilian Greenhouse Gas Emissions Trading System

Phase	Time – Months	Action - Objectives
1	12 to 24	Initial regulation, creation of the governing body, and definition of the sectors to be regulated. At this stage, the operational details of the system and the legal framework for market functioning will be established.
2	12	Operationalization of the monitoring, reporting, and verification (MRV) system for emissions. Companies will be required to report their emissions in a standardized manner, creating a database that will enable market oversight.
3	24	Start of the obligation to submit emissions reports and monitoring plans, providing the necessary data for the first National Allocation Plan (PNA).
4	Approximately 12 to 24	Start of the first allocation cycle of Carbon-Based Emission Allowances (CBEs) and the operationalization of the first auctions. The PNA will be published, defining the rules for quota distribution and the initial volume available to the market. During this phase, the first CBEs will begin to be issued and traded, involving regulated companies.
5	Approximately 12	Full implementation of the market, with the first CBE auction and the launch of the secondary market, allowing transactions between companies.

Source: prepared by the authors based on Law No. 15,042/2024.

Law No. 15,042/2024 establishes the Brazilian Greenhouse Gas Emissions Trading System (SBCE), defining emission caps, setting rules for the commercialization of offset credits, and creating standards for the functioning of the trading system. Its purpose is to reconcile economic competitiveness with environmental protection. By instituting the legal

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framework for the carbon credit market in Brazil, the law aligns national regulation with international standards and the commitments assumed under the United Nations Framework Convention on Climate Change and the Paris Agreement. In practice, this means the establishment of a mandatory system that imposes progressive emission reduction targets on regulated sectors and integrates Brazil's national reduction commitments under UN monitoring mechanisms.

Before being enacted as Law 15,042/2024, the text was processed under Bill 182/2024, which consolidated the following bills addressing various issues related to emissions and carbon credit trading:

- Bill 10.073/2018: Establishes an IPI reduction for products suitable for the low-carbon green economy;
- Bill 290/2020: Provides for environmental compensation for electricity generation and the certification of carbon credits for generation projects using alternative sources;
- Bill 3.606/2021: Proposes the establishment of a regulatory framework for MBRE;
- Bill 2.122/2021: Proposes the definition of rules for financial assets related to the mitigation of greenhouse gas emissions;
- Bill 4.028/2021: Proposes the creation of general guidelines for the regulation of the carbon market in Brazil;
- Bill 412/2022: Regulates the Brazilian Emissions Reduction Market (MBRE), provided for by Law 12.187, of December 29, 2009, and amends Laws 11.284, of March 2, 2006; 12,187, of December 29, 2009; and 13,493, of October 17, 2017;
- Bills No. 7.578/2017, 5.710/2019, 528/2021, 4.290/2023, 4.088/2021, 5.157/2023 and 155/2023, which deal with similar matters and were therefore joined as substitutes to Bill 182/2024;

It is important to mention these bills, as each emerged within a specific political and social context, reflecting distinct economic, political, environmental, and social interests. Law No. 15,042/2024 ultimately consolidated nearly all of them, except for the exclusion of obligations requiring the agribusiness sector to comply with emission limits.

Although Brazil has great potential for generating carbon credits, especially due to its vast forest cover and renewable energy opportunities, it still lacks a mature market infrastructure that can effectively manage the supply and demand for credits, as well as ensure the integrity and transparency of transactions (Maldaner, 2022). In both the public and private sectors, there is a lack of specialized knowledge, its potential and its operational

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mechanisms. This lack of knowledge and experience can result in mistrust or the adoption of inefficient practices (Poyer, Silveira and Oliveira, 2020).

The law 15,042/2024 lists a series of actions that can generate carbon credits, including restoration, maintenance and conservation of permanent preservation areas (APPs), legal reserves or restricted use areas, and conservation units; integral or sustainable use conservation units with a management plan; land reform settlement projects; indigenous peoples and traditional communities are allowed to participate in the market through associations. A preliminary analysis of the draft laws was carried out in December 2024, where the following positive and negative points can be seen in table 05.

Table 5

Analysis of the Positive and Negative Points of the Bills Regulating Carbon Credits in Brazil

 **Pros**	 **Cons**
• It will provide competitive advantages for the Brazilian economy. • It will encourage changes in production and consumption patterns, promoting greater demand for clean technologies. • Regulating the carbon market could become an effective way of reducing greenhouse gas (GHG) emissions, aligning the sustainability tripod: economically viable, socially fair and ecologically correct. • Implementing carbon pricing will help mitigate climate change by creating economic incentives for companies to adopt sustainable practices, as well as stimulating investment in research and innovation. • It increases the mix of compensation possibilities, creating rules and methodologies for certifications, through CBEs (Brazilian Emission Quotas) and CRVEs (Certificates of Verified Emission Reduction or Removal).	• Carbon pricing alone will not be enough to mitigate the environmental impacts needed to reduce the effects of climate change. • Many carbon offset projects do not result in significant emission reductions, serving merely as a way for companies to offset their pollution without modifying their production processes. • There are concerns about climate justice, as local communities in developing countries, where many offsets occur, may suffer socio-environmental impacts without receiving direct benefits. • They do not explicitly address methane credits, which were included in Decree 11.003/2022 by Decree 11.075/2022. It would be pertinent to include such a reference in the legislation, especially considering the global commitment made by Brazil at COP 26 to reduce methane gas emissions by 30%. • They do not directly address the issue of reducing deforestation.

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Pros	Cons
• Establishes control of activities that emit more than 10,000 tons of CO2 per year. Companies with emissions of between 10,000 and 25,000 tons per year will have to submit an emissions monitoring plan to the SBCE management body, including the submission of an annual emissions and removals report. For activities with emissions of more than 25,000 tons per year, it will be compulsory to submit an annual report on the periodic reconciliation of obligations, which is not currently done. • The issuance of carbon bonds will be validated and regulated by the Brazilian state, which could be important in providing more technical and legal security for both generators and purchasers of decarburization bonds. • This is a significant step forward in terms of legal certainty, considering that, currently, with the deregulated and voluntary market, negotiations can lead to various risks and legal consequences for those who acquire carbon credits and use them as proof of reductions and compensations at a global level. • It guarantees traditional and indigenous communities the right to receive and participate in the management of financial resources generated by carbon credit projects carried out in their territories. They will be entitled to 50% of the credits in the case of conventional greenhouse gas removal initiatives, and 70% of the credits in the case of avoided deforestation and forest degradation projects, conservation, and forest management (REDD+).	Even after the signing of the Glasgow declaration on forests and land use at COP 26, this action does not entail formal obligations. • Although the main focus is on regulating financial transactions in the context of a market structure, it would be beneficial to highlight the importance of meeting the targets set in the Paris Agreement, especially by reducing deforestation. • The creation of an Emissions Trading System (ETS) could result in carbon emissions becoming yet another commodity for the international market, without generating significant impacts for Brazil's economic growth. There is concern that the ETS could be concentrated in the hands of large corporations or volatile on the speculative market. • Agriculture, forestry and alternative land use were excluded in the vote by the Senate (Bill 412/2022) and the House (PL 2.148/2015) under the pretext that Brazilian agriculture is low-impact, with a vast area of the country still preserved and increasingly, environmental barriers are being established globally for agricultural products and commodities, which is already causing the Agribusiness sector to organize itself to reduce emissions. • Emission levels can be increased (made more flexible), taking into account the cost-benefit ratio of regulation and compliance with Brazil's commitments to the United Nations Framework Convention on Climate Change.

Source: elaborated by the authors based on Law No. 15,042/2024.

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The complexity and diversity of the Brazilian environmental scenario also pose challenges. The country has a wide range of biomes and great socio-environmental diversity, which makes the implementation of carbon credit projects and the measurement of their emission reductions particularly challenging (Vercillo, 2023). This complexity requires customized and well-founded approaches that take into account the peculiarities of each region and community (Munhoz, 2023).

From a social point of view, the carbon credit market has the potential to generate tangible benefits for local communities, especially those located in rural areas or in regions of great ecological importance, although the viability of this depends on areas of at least 20,000 hectares, due to the high fixed costs of auditing and certifying projects (Credcarbo, 2024; Carbonext, 2024); through consortium contracts or partnerships, it is possible to unite areas of 4,000 hectares or more in order to reach the break-even point of economic viability.

Well-structured projects can create jobs, foster sustainable local development and improve people's quality of life, in line with the United Nations Sustainable Development Goals. However, it is essential that these projects are developed in a participatory and inclusive manner, ensuring that the benefits are shared with local communities and that their rights and ways of life are respected (Brito and Pozzetti, 2021).

An important strategy is also investment in infrastructure and technical capacity. This involves, for example, developing systems that minimize carbon emissions, as well as training qualified professionals to manage and operate these systems (Rocha, 2019).

The awareness and involvement of all stakeholders must be promoted, including the private sector, the government, local communities and civil society. This can be achieved through educational campaigns, participatory dialogues and collaboration with non-governmental organizations and academic institutions. The inclusion of diverse perspectives and the dissemination of information about the benefits and functioning of the carbon credit market can foster broader and more effective uptake (Vargas, Delazeri and Ferreira, 2022).

Another fundamental aspect is the integration of credit policies with other environmental and economic initiatives. This includes aligning credit policies with national strategies for sustainable development, forest conservation, renewable energy and poverty reduction. An integrated approach can maximize environmental and social benefits while contributing to the low-carbon economy (Brito and Pozzetti, 2021).

This framework must establish clear guidelines on the issuing, marketing and monitoring of carbon credits, guaranteeing transparency, reliability and compliance with

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international standards. This regulation in phases should also include inspection mechanisms and penalties for non-compliance with the established standards (Baeta, 2020).

4 CLOSING REMARKS

Law No. 15,042/2024 represents a relevant advancement by establishing the Brazilian Greenhouse Gas Emissions Trading System (SBCE) and aligning the country with international climate mitigation commitments. However, the findings of this study indicate that the law is not yet sufficient to enable a robust carbon market, as it contains regulatory, operational, and sectoral gaps that compromise both environmental effectiveness and legal certainty.

The analysis of the historical and legal trajectory of the carbon market shows that the law is the result of a long process of legislative maturation, influenced by international agreements (such as the Kyoto Protocol and the Paris Agreement) and the consolidation of several previous legislative proposals. While the text incorporates important regulatory elements, it failed to fully include crucial sectors such as agribusiness, based on fragile justifications. This omission weakens the scope of national climate policy.

The comparison between voluntary and regulated carbon markets reinforces the importance of transitioning to a state-managed system with binding targets, emissions control, and environmental integrity. While the voluntary market operated with variable credibility and lacked legal obligations, the regulated market imposes emission caps and trading rules grounded in monitoring, reporting, and verification (MRV) methodologies. Law 15,042/2024 advances in this direction, but its effective implementation will depend on complementary regulations and the creation of robust institutional structures.

Among the main technical and institutional challenges identified are: the absence of a fully operational governing body; the need for a reliable MRV system; the technical unpreparedness of many public and private actors; and the complexity of implementing projects in diverse socio-environmental contexts. Additionally, the economic viability of carbon projects, according to international standards, is still limited to large areas (>20,000 hectares), potentially excluding small rural producers and traditional communities unless consortia are formed.

The critical analysis of the law also reveals strategic limitations. There are no clearly defined emission reduction targets by sector; methane credits and effective deforestation control mechanisms are omitted; and the compensation system may allow companies to

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merely “buy the right to pollute” without being encouraged to change their production processes. Furthermore, there is a risk that the market could become a speculative commodity with no real climate benefit.

Despite these issues, Law 15,042/2024 contains important merits: it guarantees benefit-sharing with Indigenous and traditional communities; proposes the issuance of regulated carbon quotas (CBEs and CRVEs); and promotes predictability through a five-phase implementation model. Its existence already constitutes a legal milestone that can be improved and expanded.

Based on successful international experiences, the following recommendations are made for subsequent regulatory phases and possible revisions to the law: (a) include all economic sectors, especially agriculture and land use; (b) impose limitations on the use of offset mechanisms to prevent misuse; (c) improve MRV methodologies to avoid double counting; (d) set ambitious and progressive emission reduction targets; (e) integrate SBCE with other environmental and climate public policies; and (f) ensure participatory governance with transparency, oversight, and social inclusion in all technical working groups and regulatory bodies involved in the law’s implementation.

In conclusion, although it is an important step, Law No. 15,042/2024 still requires regulatory and operational refinements to guarantee the establishment of an environmentally effective, legally stable, and socially just carbon market in Brazil. Ongoing research and rigorous monitoring of the law’s implementation will be crucial to ensure its success and alignment with the country’s climate goals.

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