RPPI
Revista Brasileira de Políticas Públicas e Internacionais

RenovaBio: The Appropriate Expansion of Biofuels in the Energy Matrix

RenovaBio: A Adequada Expansão dos Biocombustíveis na Matriz Energética

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DOI: 10.22478/ufpb.2525-5584.2026v11n1.70167

Recebido em: 13/05/2024
Aprovado em: 03/11/2026

Abstract: RenovaBio is a Brazilian public policy that aims to promote the adequate expansion of biofuels in the country's energy matrix. This initiative is crucial not only to reduce greenhouse gas emissions, but also to strengthen energy security and boost the economy through sustainable development. RenovaBio seeks to encourage the production and consumption of biofuels through the implementation of emissions reduction targets, established based on the life cycle of biofuels. The general objective of the work is to analyze the impact of RenovaBio on the expansion of biofuels and its influence on the Brazilian energy matrix. Using the hypothetical deductive method, the work sought to investigate the challenges faced in the implementation and evaluation of this public policy, as well as highlighting the fundamental role of popular participation and the final consumer as key parts of this process. In summary, RenovaBio represents a holistic strategy for the promotion of biofuels in Brazil, based on emissions reduction targets, evaluation of public policies, popular participation and consumer empowerment. This integrated approach is essential for the transition to a more sustainable and resilient energy matrix.

Keywords: biofuels; energy matrix; Public Policy; RenovaBio.

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Resumo: A RenovaBio é uma política pública brasileira que visa promover a expansão adequada dos biocombustíveis na matriz energética do país. Essa iniciativa é crucial não apenas para reduzir as emissões de gases de efeito estufa, mas também para fortalecer a segurança energética e impulsionar a economia por meio do desenvolvimento sustentável. A RenovaBio busca incentivar a produção e o consumo de biocombustíveis por meio da implementação de metas de redução de emissões, estabelecidas com base no ciclo de vida dos biocombustíveis. O objetivo geral do trabalho é analisar o impacto do RenovaBio na expansão dos biocombustíveis e sua influência na matriz energética brasileira. Através do método hipotético dedutivo, o trabalho buscou investigar os desafios enfrentados na implementação e avaliação dessa política pública, bem como ressaltar o papel fundamental da participação popular e do consumidor final como peças chave desse processo. Em resumo, a RenovaBio representa uma estratégia holística para a promoção de biocombustíveis no Brasil, com base em metas de redução de emissões, avaliação de políticas públicas, participação popular e o empoderamento do consumidor. Essa abordagem integrada é essencial para a transição para uma matriz energética mais sustentável e resiliente.

Palavras-chave: biocombustíveis; matriz energética; Políticas Públicas; RenovaBio.

1. INTRODUCTION

Nos últimos anos, a busca por fontes de energia renovável e ambientalmente sustentáveis tem se tornado uma prioridade global. A crescente preocupação com as mudanças climáticas, a poluição do ar e a escassez de recursos fósseis tem levado governos e indústrias a explorar alternativas mais limpas e eficientes para abastecer nossas necessidades energéticas. Nesse contexto, a RenovaBio surge como uma iniciativa brasileira de destaque, promovendo a expansão dos biocombustíveis como uma solução viável e econômica.

In recent years, the search for renewable and environmentally sustainable energy sources has become a global priority. Growing concern about climate change, air pollution, and the scarcity of fossil resources has led governments and industries to explore cleaner and more efficient alternatives to meet our energy needs. In this context, RenovaBio has emerged as a prominent Brazilian initiative, promoting the expansion of biofuels as a viable and economical solution.

RenovaBio is a public policy implemented by the Brazilian government in 2017, whose main objective is to stimulate the production and consumption of biofuels in the

country. The initiative seeks to reduce greenhouse gas (GHG) emissions, promote energy efficiency and guarantee energy security by encouraging the production of ethanol, biodiesel and other biofuels.

In this sense, the general objective of this study is to analyze, based on the hypothetical-deductive method, the most appropriate way to expand biofuels in the Brazilian energy matrix and the impact of that expansion. More specifically, the article examines how public policy evaluation and popular participation can contribute to this process, as well as the role of the biofuel consumer in broadening market liquidity and improving risk management in the business.

Following this introduction, the article is organized into four sections: the first contextualizes RenovaBio; the second examines its axes of action; the third addresses public policy evaluation and social participation; and the fourth analyzes the role of the end consumer.

The research adopts a qualitative, exploratory-analytical approach guided by the hypothetical-deductive method. The procedures are a bibliographic review on public policy evaluation, social participation and sustainable consumption, and a documentary analysis of Law No. 13,576/2017, Decree No. 9,888/2019 and the relevant regulatory acts. The time frame covers the establishment of the policy in 2017 and official data for the 2025 fiscal year.

The analysis was developed by interpreting the legal objectives of the policy and its implementation mechanisms, relating them to the dimensions of public policy evaluation, social participation and consumer protection. Official data were used as indicators of implementation and of compliance with regulatory obligations, without being taken, in isolation, as proof of effective emissions reductions or of effects on fuel prices. Because this is bibliographic and documentary research, the study does not seek to establish causal relationships, but to identify institutional and regulatory aspects that may contribute to improving the policy.

Given this scenario, this study seeks to demonstrate that the proper expansion of biofuels in the Brazilian energy matrix depends not only on the economic and regulatory mechanisms established by RenovaBio, but also on the continuous evaluation of its results, the effectiveness of social participation and the protection of consumer rights.

2. RENOVABIO AND THE EXPANSION OF BIOFUELS

From November 30 to December 11, 2015, 196 countries met to discuss and establish guidelines on climate change and the most appropriate means of global climate adaptation. These discussions resulted in the Paris Agreement, adopted on December 12, 2015. Brazil ratified the Agreement through Decree No. 9,073/2017, thereby giving it normative force within Brazilian territory.

The Paris Agreement establishes three pillars of action under its Article 2, namely: (a) holding the increase in the global average temperature below 2°C and pursuing efforts to limit the temperature increase to 1.5°C (above pre-industrial levels); (b) increasing the ability to adapt to the impacts of climate change and fostering development with low GHG emissions; and (c) making financial flows consistent with a pathway toward low GHG emissions (United Nations [UN], 2015a).

Article 4 of the Agreement provides that each signatory country must establish nationally determined contributions (NDCs) to achieve the objectives set out in the document and periodically report on the measures implemented. In Brazil's case, one of the contributions the country undertook to promote was the creation of the National Biofuels Policy, RenovaBio.

RenovaBio was developed by the Ministry of Mines and Energy (MME) and resulted in the enactment of Law No. 13,576/2017. Its objectives include meeting Brazil's commitments under the Paris Agreement; using biofuels as an energy alternative capable of reducing greenhouse gas (GHG) emissions; stimulating biofuel production and distribution; and supporting the sector so that it can compete in the market, among other measures set out in Article 1 of the law.

However, seven years after the Paris Agreement was adopted, Brazil was found to be moving away from meeting its targets and had become the fifth-largest emitter of greenhouse gases into the atmosphere. (Machado, 2022) Data from the Greenhouse Gas Emissions and Removals Estimates System show that the increase in Brazil's GHG emissions is related to rising deforestation rates and the burning of fossil fuels in the energy sector. (Institute of Energy and Environment [IEMA], 2022)

It is therefore important to stress that Brazil's poor performance in meeting its targets cannot be attributed solely to the performance of RenovaBio; rather, it raises the hypothesis that the system is being implemented ineffectively.

In addition to the Paris Agreement, the United Nations General Assembly also defined 17 Sustainable Development Goals (SDGs) and 169 targets to achieve this development in a cohesive and integrated manner, in the so-called 2030 Agenda (UN, 2015b). Among the guidelines laid down, SDG 7 provides that by 2030 it should be possible to ensure universal access to energy services; to increase the share of renewable energy; to double the global rate of improvement in energy efficiency; and to strengthen the development of renewable energy technologies and the modernization of energy infrastructure in less developed countries (UN, 2015b, p. 26).

In addition, SDG 13 addresses action against climate change and its impacts on the planet, proposing strategies and educational measures to raise awareness of climate change. This shows that RenovaBio presents itself as a policy that seeks to combat climate change through an energy transition toward a mechanism of carbon capture by biofuels.

The expansion of biofuels plays a fundamental role in the transition to a more sustainable energy matrix. Unlike fossil fuels, biofuels are produced from renewable raw materials such as sugarcane, corn, soybeans and even organic waste. This reduces dependence on non-renewable fuels and contributes to lower CO_2 emissions, since the carbon released during combustion is offset by the carbon absorbed by the crops used in production. In addition, biofuels are cleaner in terms of local pollutant emissions, such as particulate matter and nitrogen oxides, which improves air quality and reduces negative impacts on human health (Ministério de Minas e Energia [MME] & Empresa de Pesquisa Energética [EPE], 2017).

It should be stressed that being considered a renewable source does not simply mean that such energy sources do not pollute the environment, not least because, to some extent, any activity can generate a greater or lesser environmental impact. Nevertheless, sources considered renewable have lower impacts than non-renewable ones (Mitchell & Woodman, 2010).

The major challenge in implementing RenovaBio is that Brazil’s transport sector relies predominantly on fossil fuels, which are major GHG emitters. The country would

therefore have to invest heavily in the use of biofuels to enable an appropriate and satisfactory energy transition. In this regard, the private sector is investing in a sector that has been part of the energy matrix since the 1930s, when Decree No. 19,717/1931 made it mandatory to blend 5% ethanol into gasoline imported from abroad(Empresa de Pesquisa Energética [EPE], 2019).

For RenovaBio to achieve the objectives laid out on the basis of the Paris Agreement and the SDGs through the energy transition, the regulations adopted must be reassessed; although regulation is not solely responsible for achieving the goals of changing the energy matrix, it plays a vital role in steering these transformations properly (Mitchell & Woodman, 2010).

RenovaBio plays a crucial role in fostering the expansion of biofuels in Brazil. It sets carbon emission reduction targets for fuel distributors, creating a market for Decarbonization Credits (CBIOs, from the Portuguese *Créditos de Descarbonização*), which distributors can purchase to meet their targets. This market-based approach creates a financial incentive to increase biofuel production and consumption. The initiative also stimulates investment in research and development of more efficient biofuel production technologies, making the production chain more sustainable and competitive (MME, 2021).

The expansion of biofuels not only reduces greenhouse gas emissions but also promotes energy security, creates jobs and stimulates technological innovation. With the continued efforts of all sectors of society, it is reasonable to anticipate progress toward a cleaner and more sustainable future, in which biofuels play a central role in the global energy matrix.

3. RENOVABIO'S OPERATIONAL PILLARS AND ITS IMPACT ON BRAZIL'S ENERGY MATRIX

Article 4 of Law No. 13,576/2017, which establishes the National Biofuels Policy, sets out three operational pillars to achieve the objectives in Article 1: GHG-emissions-reduction targets, certification of biofuel production, and decarbonization credits (CBIOs).

The first strategic pillar, set out in Article 4(I) of the aforementioned legislation, consists of decarbonization targets. These targets are unilaterally established by the regulatory authority to ensure a lower carbon intensity in Brazil's energy matrix, as defined in Article 5(XII) of Law No. 13,576/2017. The body responsible for setting the targets is the National Energy Policy Council (CNPE), pursuant to Decree No. 9,888 of June 27, 2019. Fuel distributors are required to comply with them. (MME)

Under Article 6 of Law No. 13,576/2017 and Article 2(III) of Decree No. 9,888/2019, these targets must take into account the commitments made under the Paris Agreement to reduce GHG emissions, the supply and availability of biofuels, the value of energy resources, the protection of consumer rights and interests, increases in fuel consumption, and the impact on fuel prices.

Meeting the target represents compensation by the fossil-fuel distributor for the carbon dioxide emitted into the atmosphere as a result of its activities. To meet the targets, fuel distributors must acquire CBIOs, which are issued in connection with biofuel production and traded on a market similar to a stock exchange, pursuant to Article 3(2) of Decree No. 9,888/2019. (Moura Nunes Jr., 2022, p. 39)

Each distributor must demonstrate compliance with its individual target to the National Agency of Petroleum, Natural Gas and Biofuels (ANP). RenovaBio legislation provides for fines in cases of total or partial noncompliance (Article 9 of Law No. 13,576/2017).

The second strategic pillar is the decarbonization credit (CBIO), defined in Article 5(V) of the RenovaBio Law as an "instrument recorded in book-entry form for the purpose of demonstrating compliance with the individual target of a fuel distributor." It is therefore an environmental asset equivalent to one tonne of carbon that has not been emitted into the atmosphere. This volume is verified through an Electronic Invoice or through the Energy-Environmental Efficiency Rating (NEEA) contained in the biofuel certification (Article 5(XIII) of Law No. 13,576/2017).

Biofuel producers (primary issuers) may qualify and request the issuance of CBIOs in an amount proportional to the volume of biofuel produced and marketed (Article 2(III) of ANP Resolution No. 802/2019). Producer participation in certification is voluntary, unlike distributors, which are required to meet their targets. The number of

CBIOs acquired enables the ANP to assess whether decarbonization targets have been fully met.

The third and final pillar is biofuel certification, as provided for in Article 4(III) of Law No. 13,576/2017. It consists of calculations performed by an inspection firm to assess energy efficiency and GHG emissions associated with the biofuel produced by the accredited company. These calculations determine the Energy-Environmental Efficiency Rating (NEEA) assigned to the volume of fuel produced, which in turn determines how many CBIOs may be issued based on the volume produced and marketed.

As currently regulated, RenovaBio therefore affects the different participants in the biofuel production chain in different ways. For producers or primary importers, it provides an incentive to increase the production and sale of biofuels with lower GHG emissions, since CBIOs can be traded on the stock exchange. In addition to encouraging production, the policy incentivizes producers to improve fuel efficiency and thereby increase their Energy-Environmental Efficiency Rating, which is used to calculate the value of CBIOs.

For distributors, on the other hand, even though the system does not prevent them from selling fossil fuels, it creates an additional obligation to meet decarbonization targets through the acquisition of CBIOs. If a distributor chooses not to replace fossil fuels with biofuels that have lower GHG emissions, it must bear a form of compensation cost by acquiring CBIOs, which may even lead to higher prices for the fossil fuels it distributes.

Although final consumers are not part of the fuel-trading chain covered by RenovaBio's three operational pillars and do not directly benefit from the purchase and sale of CBIOs, they may benefit indirectly when fossil fuels are replaced by biofuels. In addition, even if fossil-fuel prices rise, increased biofuel supply at fairer prices could potentially lead to a change in the biofuel business model.

Furthermore, society in general benefits from the policy, albeit indirectly, given the environmental preservation effects that the replacement of fossil fuels can ensure for present and future generations.

It follows that RenovaBio's three operational pillars form an incentive system intended to increase the share of fuels with lower carbon intensity in Brazil's energy matrix, in accordance with the objectives established by Law No. 13,576/2017.

The implementation of this mechanism can be examined through the data released by the National Agency of Petroleum, Natural Gas and Biofuels (ANP, 2026), according to which 40.06 million CBIOs were retired in 2025, equivalent to approximately 99% of the national target of 40.39 million. However, retirements corresponded to 88.2% of the individual targets calculated for distributors, which totaled 45.28 million CBIOs after adjustments and the incorporation of prior obligations.

The data highlight the importance of monitoring the policy's results, but do not, in isolation, allow the conclusion that emissions or fuel prices fell proportionally, which requires the analysis of specific indicators. The evaluation of RenovaBio should therefore consider not only the execution of its regulatory mechanisms but also its effectiveness in relation to the environmental and economic objectives established.

4. THE APPROPRIATE EXPANSION OF BRAZIL'S ENERGY MATRIX

The foregoing discussion sought to show that RenovaBio's objective is to promote the appropriate expansion of Brazil's energy matrix through an innovative policy involving limited state intervention in the economy. Nevertheless, despite the sophistication of its three operational pillars, the expansion of Brazil's energy matrix also depends on factors external to the program's framework.

This is because, to speak of a proper policy, there are essential elements that must be considered, such as cost-effectiveness, civic engagement and respect for citizens' fundamental rights, for example. Accordingly, in order to analyze whether the policy is indeed adequate, RenovaBio is examined from three distinct perspectives: public policy evaluation, social participation and the impacts on the end consumer.

4.1. Public policy evaluation

As discussed above, RenovaBio is a public policy that seeks to stimulate the increased use of biofuels in Brazil through mechanisms such as Decarbonization Credits.

Eloisa de Matos Hofling (2001, p. 31) summarizes public policy as "the State in action," since it is the means through which elected representatives seek to implement the government agenda.

Ana Paula Barcellos (2010, p. 102), in turn, understands public policy as the coordination of the means available to the State to achieve certain socially relevant objectives previously defined in the political arena. In the context of this study, the socially relevant objective is expanding biofuels in Brazil's energy matrix in order to mitigate the environmental impacts caused by conventional fuels.

Although public policies can exist without financial expenditure, it is important to note that this is not the case in most instances, since the pursuit of socially relevant objectives is directly linked to state action, which in turn requires the allocation of resources.

For this reason, given that public funds are finite, public policies are commonly associated with the principle of efficiency. In this context, the following observation by Vanice Regina Lírio do Valle (Valle, 2018, p. 185, our translation) is particularly relevant:

> "Its association with the principle of efficiency seems almost instinctive; this objective could only be achieved with the support of this strategic component, which connects current demands with available resources, channels state action through one of its organizational arms, and projects expectations of future results."

It can be inferred from the passage above that the expenditure of financial resources must be linked to the expected result. In the case of RenovaBio, which is the largest decarbonization program on the planet, with planned investment of BRL 1 trillion through 2030 (EPE, 2019a), an expected result commensurate with the high level of investment arises.

Thus, the need to verify whether allocated resources are commensurate with the results achieved gives public policy evaluation considerable importance, a topic that has gained prominence in Brazilian legal scholarship. This is reflected in the fact that two constitutional amendments adopted in recent years addressed public policy evaluation (Constitutional Amendments Nos. 108/2020 and 109/2021).

Public policy evaluation is the final stage of the public policy cycle, which comprises problem definition, agenda setting, project formulation, implementation, and, finally, monitoring and evaluation (Raeder, 2018, p. 128).

In summary, once a social problem has been identified, it becomes part of the public agenda. Actions and objectives are then developed to address it, followed by implementation. Finally, monitoring and evaluation take place in order to "provide credible and useful information to enable the experience gained to be incorporated into the decision-making process" (Bellen & Trevisan, 2008, p. 536).

In light of the foregoing, an appropriate expansion of Brazil's energy matrix requires a balance between the investment made and the results sought and achieved. Public policy evaluation is essential to carrying out this analysis.

This scenario can be illustrated by Brazil's commitments under the Paris Agreement. Each signatory established targets for reducing greenhouse gas (GHG) emissions, and Brazil undertook to reduce its emissions by 48% by 2025 and 53% by 2030, using 2005 as the baseline year (Bellen & Trevisan, 2008, p. 536). Monitoring and evaluating RenovaBio makes it possible to assess whether, and to what extent, the policy contributes to achieving these objectives.

The finding that a policy is insufficient in relation to its objectives does not, however, mean that the policy as a whole is deficient. Monitoring a public policy serves the purpose of identifying the source of such deficiency and, consequently, making changes to remedy any shortcomings identified in the evaluation work.

Moreover, the contribution of public policy evaluation to accountability should not be overlooked. This term, on the rise in academic circles, refers to the idea of transparency and responsibility on the part of public managers. Wagner Bandeira Andriola and José Liberato Barrozo Filho (Andriola and Barrozo, 2020, p. 602, our translation) summarize the relationship between accountability, transparency and public policy evaluation in an unparalleled way in the following excerpt:

> "Accountability is a perspective of transparency and oversight of public affairs through evaluation systems designed to generate relevant information about the appropriateness of public resources used to implement programs and activities that form part of public policies. Society now expects public policies and the programs that comprise them to account for their performance through systematic evaluation."

Finally, it is worth noting the significant growth of public policy evaluation in Brazilian scientific and legislative contexts (Tavares & Bittencourt, 2020, p. 173). Constitutional Amendments Nos. 108/2020 and 109/2021 provide examples, as they amended the Federal Constitution to include provisions concerning evaluation activities.

Specifically, Constitutional Amendment No. 108/2020 added a sole paragraph to Article 193 of the Constitution, establishing the State's duty to ensure social participation in the formulation, monitoring, and evaluation of public policies, a topic examined in the following section.

In RenovaBio's case, public policy evaluation must distinguish compliance with regulatory obligations from the environmental and economic outcomes actually achieved. For example, CBIO retirement data make it possible to monitor the implementation of decarbonization targets, but they are not sufficient on their own to demonstrate actual emissions reductions or effects on fuel prices (ANP, 2026).

The evaluation should therefore consider complementary indicators, such as the evolution of the share of biofuels in the energy matrix and emissions-reduction results, relating them to the objectives established by Law No. 13,576/2017. This analysis makes it possible to identify any shortcomings and guide corrections in the implementation of the policy, in line with the principles of efficiency and transparency. In addition, disclosing evaluation results strengthens accountability by allowing society to follow the execution of the program and to question the adequacy of the measures adopted.

4.2. Social participation

The importance of measuring social participation in the development of RenovaBio stems from several factors. These include aspects structurally related to policy design, democratic legitimacy, and the fundamental values underlying environmental protection.

The first systematic formulation of public policy analysis is attributed to David Easton, who developed a concept based on a systems approach in which interaction between the state and civil society is mediated by inputs (demands) that enter the political system and generate responses (Schmidt, 2018, p. 123). For Easton, social participation in public policy makes it possible to assess the degree of social influence on the operations of the political system (1970, p. 194). Analyzing social participation in RenovaBio therefore means examining the degree of social influence on the public agenda for environmental protection.

Social participation is also associated with democratic legitimacy. According to Specie (2015, p. 164), social participation emerges as a procedural response to the legitimacy deficit of the welfare state and traditional political institutions. Drawing on Robert Dahl, Milani (2008, p. 554) emphasizes the critical nature of contemporary polyarchies, in which the capacity to manage and implement public policies is linked to the State's pursuit of legitimacy as the coordinator of the social and political arena. This legitimacy deficit may hinder voluntary acceptance of RenovaBio if the policy is implemented vertically, that is, imposed unilaterally by the elected representatives heading the Executive Branch.

According to Pierre Rosanvallon (2018, p. 161), elections have lost some of their strength as a source of democratic legitimacy because of the complexities of postmodern society. This legitimacy deficit gives rise to a demand for post-electoral legitimacy, including social participation as a form of "democracy of exercise." Social participation in RenovaBio can therefore be understood as a means of legitimizing environmental protection policy and overcoming the ideological conflicts intensified during elections through the collective and ongoing development of the policy.

There are also analyses that attribute to social participation a role in improving the delivery of public services. According to Malena, Foster, and Singh (2004, p. 7),

social accountability drives development because it enables qualitative gains in the delivery of the services that are the object of the policy. Applying this finding to RenovaBio, social participation improves the energy renewal policy, making the measures adopted satisfactory and adequate for environmental preservation.

Beyond legitimizing the policy itself, improving social participation mechanisms in RenovaBio means strengthening Brazilian democracy. According to Alicia Ziccardi (2004, p. 247), citizen participation generates positive institutional commitments that support community work, create a democratic culture, and strengthen democracy. Enrique Peruzzotti and Catalina Smulovitz (2006, p. 5) discuss analyses questioning elections as an effective mechanism of oversight. In their view, effective accountability of public officials requires social participation in public management oversight, which can also be applied to RenovaBio.

Social participation in the development of RenovaBio is also related to the policy's very purpose: promoting an environmentally sound energy transition. The literature refers to "ecological participatory democracy" to argue that constitutional protection of the environment "presupposes a politicized, creative civil society that plays a leading role in the state's political arena, calling for an autonomous and participatory citizen who is not subordinate to the state apparatus or economic power" (Sarlet&Fensterseifer, 2021, p. 588). At the international level, social participation is guaranteed by Principle 10 of the Rio Declaration on Environment and Development, according to which everyone "shall have appropriate access to information concerning the environment held by public authorities." States should "facilitate and encourage public awareness and participation by making information widely available," and provide effective access to judicial and administrative proceedings, including redress and remedies.

Law No. 13,576/2017 institutionalized social participation at two significant stages of the policy. It requires public consultation for the issuance or renewal of the Efficient Biofuel Production Certificate (Article 24) and for the establishment of decarbonization targets (Article 12). These provisions make social participation relevant both to oversight of private actors (in the issuance of certificates) and to oversight of the Administration (in setting targets).

Institutionalization is identified by Malena et al. (2004, p. 18) as a central element for achieving social accountability. For the authors, institutionalization allows civil society participation to be systematically incorporated into the policy, ensuring permanent oversight. In RenovaBio's case, there appear to be efficient mechanisms for perpetuating social participation, at least with regard to oversight of private entities. This is because the law expressly requires the certifying institution to consider the proposals put forward in public consultation (Article 24, §2). There is no obligation to accept them, but there is a duty to consider each suggestion and to reject it with a reasoned justification.

This obligation is less explicit for public consultations on target-setting, which concern oversight of the Administration. Although it may be argued that suggestions made during public consultation must be rejected on reasoned grounds because they derive from the constitutional right to petition (Article 5(XXXIV)(a) of the 1988 Constitution) and the response must comply with Article 50 of Law No. 9,784, practical experience has shown that public officials do not take such contributions into account. This underscores the importance of expressly establishing a duty to provide reasons, as is already contemplated for oversight of private entities.

Accordingly, improving social participation in RenovaBio does not require the Administration to accept every contribution submitted; rather, it requires transparency about whether those contributions were considered and the reasons supporting the final decision. Expressly establishing a duty to give reasons in consultations concerning decarbonization targets would help reduce the asymmetry between target-setting and certification procedures, strengthen social oversight, and make it possible to verify whether submissions were genuinely considered. This measure would also enhance the legitimacy of regulatory decisions without undermining the technical and decision-making authority of the bodies responsible for implementing the policy.

5. THE ROLE OF THE FINAL CONSUMER IN THE CONTEXT OF RENOVABIO

For the energy transition and the resulting transformation of the energy matrix to take place, countries must seek to reduce the share of fossil fuels and energy sources in

their matrices, increase energy efficiency, and encourage sources that do not emit GHGs. The trend is therefore for countries to reduce their use of non-renewable energy and increase the use of renewable sources, such as wind, solar, and bioenergy.

The energy transition rests on four main pillars, the so-called four “D's”: decentralization, design, decarbonization and digitalization. Decarbonization is characterized by its focus on carbon emissions, that is, on generating energy by means that emit less carbon into the atmosphere. Design is aimed at improving the infrastructure of buildings, vehicles and technologies in order to increase energy efficiency. Decentralization is characterized by generating energy close to the consumer, that is, it seeks to avoid energy losses and higher service costs. And digitalization refers to the use of technologies in the production process (EPE, 2019b).

With this in mind, this section examines the role of the final consumer. As with any measure directed at the market for goods and services, the consumer is the final recipient of RenovaBio’s policies; consumer law therefore plays an important role in promoting fair and transparent practices in the biofuel market.

Consumer law is the protection of the final recipient of goods or services placed on the market, as a distinct and vulnerable agent (Marques, 2004, p. 51). Since the emergence of international concern with sustainable development, concern for the defense and protection of consumer rights in the consumer market has also come to include ecological values, drawing closer to environmentalist movements (Garcia, 2016, p. 67).

If, on the one hand, products have become more technological and innovative, on the other, suppliers have become concerned about the safety of their products, which may heighten future risks to the environment and, consequently, to consumers' health. Accordingly, legal scholarship holds that vulnerability in consumer relations is also environmental vulnerability (Moraes, 2009, p. 180).

It should be noted that, among the objectives of the 2030 Agenda for Sustainable Development, SDG 12 is concerned with ensuring sustainable consumption patterns for present and future generations (UN, 2024). Thus, it is important to address the consumer's role in contributing to the objectives set out in the RenovaBio regulations.

In the context of sustainable development, the figure of the “green consumer” emerges. The green consumer is an agent with potential economic power who is able to

create demand for more sustainable products, attentive to environmental issues both in the marketing and in the production of goods. These are individuals who are more aware of environmental issues and concerned about preserving the environment. Therefore, the more sustainable the products, the better the company's reputation. According to Gunningham and Grabosky (1998, pp. 107–109), consumer demands may even be more stringent than government standards.

A study conducted with students at the Federal University of Uberlândia in 2016 showed that consumers care about the financial gain of buying an environmentally friendly product and, faced with environmental marketing, are more likely to buy it. Beyond that, however, it is not enough for the product to be environmentally friendly; it must also offer better performance, even at a higher price. For example, a more expensive light bulb that saves more energy and lasts longer is more attractive to consumers because it demonstrates financial and environmental gain (Cavalcanti, 2023).

Another important study, carried out by the Credit Protection Service (SPC Brasil) in collaboration with the National Confederation of Shopkeepers, confirmed that the Brazilian consumer is at a transitional stage, that is, moving toward a more sustainable consumption pattern and showing greater environmental awareness (Souza, Oliveira, & Melillo, 2021).

In light of this new reality, research shows that “green consumers” are gaining ground as an influential tool in environmental policies, as is the case with RenovaBio. First, the rights of consumers vis-à-vis the biofuels policy deserve emphasis:

a) Information and transparency: as in any consumer relationship, Article 6 of the Consumer Protection Code establishes the basic right to information. Only when provided with accurate information about the fuel offered can consumers choose the more sustainable alternative.

b) Quality and safety: consumer law requires biofuels to meet established quality and safety standards. Biofuel regulations must therefore ensure that these products do not pose risks to the environment or consumers’ health.

c) Fair prices: even if consumers are willing to pay more for alternatives that demonstrate greater energy efficiency, prices must remain fair so as

not to undermine the supply and demand for biofuels and to ensure access for everyone.

d) Consumer education: offering more efficient biofuels with lower GHG emissions is of little use if consumers are not made aware of the behavioral practices they should adopt to help preserve the environment.

The end consumer can influence demand for sustainable biofuels and, consequently, encourage production practices aligned with RenovaBio's objectives. This influence, however, depends on concrete conditions of choice. In the fuel market, price, availability, fuel efficiency and vehicle compatibility are relevant factors in the purchase decision, whereas the carbon intensity and environmental performance of the product over its life cycle are not necessarily presented clearly at the time of refueling. Producer certification and the issuance of Decarbonization Credits (CBIOs), in turn, form part of the policy's regulatory structure, but do not by themselves ensure that consumers have access to comparable environmental information at the fuel pump.

Sustainable choice is also conditioned by price differences, distribution infrastructure and the technical characteristics of vehicles. Although the cost of CBIOs may be passed through the fuel chain, a proportional and automatic relationship with the final price paid by consumers cannot be presumed.

Thus, consumer participation should be understood as a potential stimulus to the energy transition, and not as an isolated responsibility for the policy's success. To increase RenovaBio's effectiveness, public authorities should evaluate measures to disseminate accessible and comparable environmental information and to promote transparency about the economic effects of the program and about the alternatives available to consumers.

Accordingly, although decarbonization targets, certification and CBIOs are complementary mechanisms for encouraging reductions in carbon intensity, their effectiveness from the consumer's perspective also depends on translating regulatory results into accessible information for purchasing decisions.

6. FINAL CONSIDERATIONS

The analysis of RenovaBio shows that the appropriate expansion of biofuels in Brazil's energy matrix depends not only on the regulatory framework established by Law No. 13,576/2017, but also on continuous evaluation of results, effective social participation mechanisms, and the availability of information that enables consumers to make informed choices.

Data from the National Agency of Petroleum, Natural Gas and Biofuels for 2025 demonstrate the importance of monitoring compliance with decarbonization targets. However, the retirement of CBIOs is an indicator of policy implementation and does not, on its own, prove actual emissions reductions or economic effects on fuel prices. Evaluation must therefore combine data on compliance with regulatory obligations with complementary environmental and economic indicators, in order to identify shortcomings and guide possible improvements to the measures adopted.

From a public management perspective, the ANP should increase transparency regarding RenovaBio's implementation indicators and environmental outcomes, and assess ways to make accessible and comparable environmental information available to consumers. The Ministry of Mines and Energy, in turn, should improve social participation procedures, particularly by explaining why contributions submitted in public consultations on decarbonization targets are accepted or rejected. These measures can strengthen social oversight, the legitimacy of regulatory decisions, and the accountability of public officials.

In the sphere of consumer relations, it was found that the consumer's role as a driver of the energy transition has concrete limits. Although certification and CBIOs are part of the mechanisms for encouraging biofuel production, they do not by themselves ensure that consumers have access, at the time of refueling, to clear and comparable environmental information. Thus, the promotion of sustainable consumption cannot be attributed exclusively to individual choices; it also depends on market transparency, supply conditions and the information measures adopted by public authorities.

Finally, this study is limited by its use of bibliographic and documentary research, without direct empirical research involving consumers or causal measurement of RenovaBio's effects on emissions and fuel prices. Future research could examine

these issues in greater depth by analyzing changes in the program's environmental and economic indicators, investigating consumer perceptions, and assessing the availability of environmental information at fuel stations. Consolidating RenovaBio as an instrument of the energy transition therefore requires not only compliance with its formal targets, but also evaluation of its outcomes and continuous improvement of transparency, participation, and consumer-protection mechanisms.

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