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Climate Change and Innovation in Brazil: Threats and Opportunities

Gabriel Wedy

Cacia Pimentel

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**CLIMATE CHANGE AND
INNOVATION IN BRAZIL:
THREATS AND OPPORTUNITIES**

By Gabriel Wedy and Cacia Pimentel

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Sabin Center for Climate Change Law
Columbia Law School
435 West 116th Street
New York, NY 10027
Tel: +1 (212) 854-3287
Email: columbiaclimate@gmail.com
Web: <https://climate.law.columbia.edu/>
Twitter: @ColumbiaClimate
Blog: <http://blogs.law.columbia.edu/climatechange>

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About the authors: Gabriel Wedy is a Federal Judge. Professor of the Ph.D., LL.M. and Undergraduate Law Programs of *Universidade do Vale do Rio dos Sinos* – Unisinos (Brazil). Professor of Environmental Law at the Superior School of Federal Judges (Brazil). Visiting Professor (Gastwissenschaftler) at Universität Heidelberg/Institut für deutsches und europäisches (Germany). Former Visiting Scholar at Columbia Law School/Sabin Center for Climate Change

Law. Former President of the Association of Federal Judges of Brazil (Ajufe). Author, among others, of the books *Sustainable Development in the Age of Climate Change: A Fundamental Right*; *Climate Litigation: According to Brazilian, U.S. and German Law*, and several articles in the area of environmental law published in Brazil and abroad.

Cacia Pimentel is a Law Professor, Practicing Attorney and Renewable Energy and Climate Change Consultant. Ph.D. Candidate at *Mackenzie University Law School* and Research Scholar at the *Sabin Center for Climate Change*, at *Columbia University*, New York (2020); LL.M. at *Cornell University Law School*. At Cornell, she studied the impact of subsidies on the ethanol market. MBA on Economic Law at *Fundação Getulio Vargas*, Brazil. She studied Clean Energy Law, Decarbonization Legal Processes and Public Policies, and provides support to companies to adapt their legal internal policies and contracts to decarbonization needs and to mitigate the effects of climate change. She also volunteers for Advanced Biofuels U.S.A. and other non-profit organizations that help to dispel misconceptions about biofuels and bioelectricity to deep decarbonize the world energy matrix.

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1. INTRODUCTION

In recent decades, Brazil has adopted a political approach focused on maintaining economic stability and consolidating inclusive social policies. However, despite repeated attempts, little progress has been made in overcoming difficulties within the country and making Brazil more competitive in the global market. Nevertheless, there seems to be an awakening and a certain consensus among scholars of Brazilian problems that the expected inclusive economic growth cycle may be achieved if Brazil invests in enhancing the bioeconomy business environment through bioenergy and innovation.

The actual crisis is fast-tracking two major transformations at the global level: the energy transition and the information revolution, both dependent on innovation. Brazil showcases a comparative advantage for renewable energy sources in comparison to the rest of the world. Even considering the controversial major use of hydroelectricity and sugarcane biofuels, these sources are undoubtedly less harmful than fossil sources, such as coal and diesel. This could be an unprecedented opportunity. Nevertheless, Brazil has faced considerable environmental disasters in recent years, despite its consistent legal framework protecting the environment.

This paper advocates a legal pathway to disseminate knowledge and to reach sustainable growth by adopting decarbonization processes and innovation. By decarbonization processes, the authors mean the transition to a decarbonized economy by adopting innovative technological transformations that provide bioeconomy growth and

lead traditional manufacturers into renewable and sustainable industries. In relation to these processes, it is essential that decision makers, especially public officials in the national environmental and innovation agencies, understand the existing legal paths, modernize the instruments used for cooperation and the generation of new products with a focus on growth and competitiveness, and enforce environmental protection law and mechanisms. Regarding innovation, the premise is that the new cooperation instruments allowed by the legal framework of innovation will strengthen relations between public and private agents.

This paper first presents the principles and main environmental and energy transition rules that comprise the current Brazilian legal framework. It then shows the contradictions that need to be overcome in the environmental system. Finally, the paper presents opportunities and proposals for change and improvement towards sustainable growth.

2. THE BRAZILIAN ENVIRONMENTAL AND INNOVATION LEGAL FRAMEWORK

The right to an ecologically balanced environment is acknowledged by the doctrine¹ and jurisprudence of the Brazilian Supreme Court as a public asset and a fundamental

¹ *Direito fundamental ao desenvolvimento sustentável na era das mudanças climáticas: um direito fundamental* (Gabriel Wedy, 2018).

right that embodies a new dimension or third generation concept to be preserved for the best interest of present and future generations, following the pathways of a wide anthropocentrism. Cruelty towards animals and animal abuse, by the way, are forbidden by the Brazilian Constitution of 1988.² The Constitution is a modern charter that confirms an authentic *Social–Environmental Rule of Law* by devoting an entire chapter of its text to environmental protection.

The pinnacle of environmental protection in Brazil’s legal system, thus, is not inserted in a mere statute, but in the original writing of the Federal Constitution, which provides that:

“Art. 225. Everyone has the right to an ecologically balanced environment, a good of common use for the people and essential to a healthy quality of life, and the public authorities and the community have the duty of defending it and preserving it for present and future generations.”

Additionally, article 225 provides several mandates to public authorities, related to preserving and restoring ecosystems, fauna, flora and diversity, performing environmental impact studies before any work or activities that may potentially cause damage to the environment (including mineral resources, power plants and nuclear reactors), and promoting environmental education. Another legal provision is the

² Brazilian Federal Supreme Court (STF). Case, Recurso Extraordinário 22.164/SP. Justice: Celso de Mello.

protection of the Brazilian Amazon Forest, the Atlantic Forest, the Serra do Mar, the Pantanal Matogrossense and the Coastal Zone, all declared as national heritage. Their use shall be, as required by law, under conditions that ensure environmental preservation, including the use of natural resources.

Act No. 6,938/1981 established the National Environmental Policy (PNMA) and systematized the standards of the Brazilian Environmental Act. Article 2 states that “*the objective of PNMA is the preservation, improvement and recovery of environmental quality favorable to life, aiming to ensure conditions for socio-economic development, national security interests and the protection of the dignity of human life.*”³

Article 3 has proven to be ground-breaking by providing relevant concepts for Environmental Law, such as *environment, environmental resources and degradation of environmental quality*, as well as marking the difference between the concepts of *pollution and polluter*. Article 4 of the Act No. 6,938/81 provides the guiding objectives of PNMA:

³ Act 6.938/81, art. 2. The objective of the National Environmental Policy is the preservation, improvement and recovery of the environmental quality favorable to life, aimed at ensuring conditions to socio-economic development, national security interests and the protection of the dignity of human life, meeting the following principles: I - governmental action in the maintenance of ecological balance, considering the environment as a public asset to be mandatorily safeguarded and protected, bearing in mind the public usage; II - rationalization of the use of soil, subsoil, water and air; III - planning and supervision of the use of environmental resources; IV - protection of ecosystems, with preservation of representative areas; V - controlling and zoning activities that are potentially or effectively pollutant; VI - fostering the study and research of technologies aimed at the rational use and protection of environmental resources; VII - follow-up of environmental quality status; VIII - recovery of degraded areas; IX - protection of areas at risk of degradation; X - environmental education in levels of academic education, including educating the communities, aiming at enabling them to actively participate in the environmental defense.

I – compatibilization of socio-economic development with preservation of environmental quality and ecological balance; II – definition of priority areas for governmental action regarding ecological quality and balance, taking into account the interests of the Federal Union, the States, the Federal District, Territories and Municipalities; III – establishing criteria and standards for environmental quality and standards related to the use and handling of environmental resources; IV – development of domestic research and technologies aimed at the rational use of environmental resources; V – dissemination of environmental handling technologies, disclosure of environmental data and information and enhancement of public awareness regarding the need to preserve environmental quality and ecological balance; VI – preservation and restoration of environmental resources aiming at their rational use and permanent availability, contributing to the maintenance of an ecological balance suitable for life; VII – enforcing, upon the polluter and the predator, the obligation of recovering and/or indemnifying the damage caused and, upon the user, the compensation for the use of environmental resources with economic purposes.

Act No. 6,938/81 provides rules to establish the whole environmental system (SISNAMA, art. 6) and authorities of the National Council for the Environment (CONAMA, art 8); establishes requirements for environmental licenses to construct, deploy, expand and operate facilities and activities that use environmental resources, which are potentially or effectively pollutant or capable of causing environmental

degradation by any means (art 10); the responsibility of financing entities and bodies, which must condition the approval of projects authorized for these benefits to licensing and complying with the rules, criteria and standards issued by CONAMA (art 12); definition of administrative and criminal liabilities for environmental breaches (art 14, *kaput*, §§2 to 5; and art 15), notwithstanding civil liability remedies for restoring the damage caused, regardless of guilt (art 14, §1); creation of the Environmental Control and Inspection Fee (TCFA) to empower IBAMA (art 17-B to 17-H, and 17-P to 17-Q), among others. Law No. 6,938/1981 is a sort of Brazilian Environmental Code as it is the most important legislation within the legal framework of the country.

Brazil has also established a Civil Liability Act due to Nuclear Damage (Act No. 6,453/77); the Act to set up the Brazilian Environment Institute - Ibama (Act No. 7,735/1989); the Pesticides Act (Act No. 7,802/1989); the Water Resources Act (Act No. 9,433/1997); the Environmental Crimes Act (Act No. 9,605/1998); the Nature Conservation Unit System Act (Act No. 9,985/2000); the Biosafety Act (Act No. 11,105/2005); the Atlantic Forest Act (Act No. 11,428/2006); the National Basic Sanitation Policies Act (Act No. 11,445/2007); the Act to set up the Chico Mendes Institute for Biodiversity Preservation (Act No. 11,516/2007); the National Climate Change Policies Act (Act No. 12,187/2009); the National Solid Waste Policies Act (Act No. 12,305/2010); the Environmental Information Access Act (Act No. 12,527/2011); the Administrative Authority regarding Environmental Matters Act (Complementary Act No. 140/2011); the New Forest Code (Act No.

12,651/2012) and the National Civil Protection and Defense Policies Act (Act No. 12,608/2012).

Nevertheless, despite the existence of a consistent legal framework protecting the environment, Brazil has faced countless environmental disasters in recent years, as shown in the recent tragedies of the ruptures of the tailings dams in Mariana (2015)⁴ and Brumadinho (2019)⁵ in the State of Minas Gerais, which caused fatalities and irreversible damage to the environment, to the domestic economy and to the affected communities. We are also currently facing an unprecedented environmental disaster with the pollution stemming from a mysterious leak of an immense amount of oil on our coastline.⁶

Within a context of low economic growth in Brazil, it is important to analyze the government incentive tools and R&D policies that have been successful in leveraging private spending on green innovation. In particular, Act No. 13,243/2016 (Legal Framework for Science, Technology and Innovation) and the Federal Innovation Executive Order establish a legal framework for Science, Technology and Innovation as well as provide incentives for scientific development, research, technological training and innovation. These laws seek to overcome the obstacles encountered by previous legislation. The new regulation sets principles focused on both promoting cooperation and

⁴ The Wall Street Journal. “Deadly Brazil Mine Accident Puts Waste Dams in Spotlight.” Available at: <https://www.wsj.com/articles/deadly-brazil-mine-accident-puts-waste-dams-in-spotlight-11548874428>. Accessed on: 12/15/2020.

⁵ The New York Times. “7 People Killed and 200 Missing in Brazil After Dam Collapses, Officials Say.” Available at: <https://www.nytimes.com/2019/01/25/world/americas/brazil-dam-burst-brumadinho.html>. Accessed on: 1/11/2019.

⁶ The Guardian. “Brazil Oil Spill Beaches Bolsonaro Volunteers.” Available at: <https://www.theguardian.com/world/2019/oct/22/brazil-oil-spill-beaches-bolsonaro-volunteers>. Accessed on: 1/11/2019.

interaction between the public and private sectors and establishing strategic alliances, technology parks, incubators, asset sharing and corporate participation. The rule also makes clear the conditions for profit distribution among state researchers, an innovation in the Brazilian legal system.

The Federal Innovation Executive Order provides that the public Scientific and Technological Institution (ICT) agency may enter into a technology transfer and licensing contract for its innovations for exploitation on its own or in partnership (art. 11). In addition, an economic subsidy, financing or shareholding for the development of innovative products or processes may be granted and may also be earmarked for capital and current expenses, as long as they are specifically targeted to the financed activity (art. 20). These mechanisms could, in principle, facilitate the introduction of new technologies developed by ICT into the market, such as innovations related to renewable energy.

These legal instruments should also allow for identifying obstacles and adopting creative solutions, modernizing internal rules and avoiding conflicting rules. They can also encourage public agents to adopt measures that provide more robust results, such as partnerships with social organizations, which can accelerate the market's access to innovations.

3. RISKS AND OPPORTUNITIES TO THE BRAZILIAN ENVIRONMENT

Political polarization is evident in Brazil. A great number of parties from extreme left and extreme right wings are represented in the National Congress. This hampers a dialogue-based development of a mature and rational environmental policy, committed to the sustainable development of Brazil. The country lacks moderation and balance in its domestic politics, i.e., the middle road, identified as a key feature by Aristotle in Ancient Greece.⁷

Moreover, political polarization between the left and right wings jeopardizes the decision-making process and is an obstacle to reaching consensus and a balanced dialogue. The lessons of Cass Sunstein on the phenomenon⁸ and, especially, of Daniel Kahneman, are noteworthy.⁹ The protection of the environment and a stable climate should not be dealt with as an ideological matter, but rather, as a matter of common sense capable of uniting the society as we the People are entitled to our own future.

The implementation of the constitutional principles of precaution and prevention is necessary. Brazil has several unique ecosystems to protect, other than the Amazon, such as *Caatinga*, *Cerrado*, *Atlantic Forest*, *Cocais Forest*, *Pantanal*, *Araucárias Forest*, the mangroves

⁷ See, *Nicomachean Ethics* (Aristotle, ed. 1980).

⁸ See, *The Ethics of Influence: Government in the Age of Behavioral Science* (Cass Sunstein, ed. 2016); *Going to Extremes: How Like Minds Unite and Divide* (Cass Sunstein, ed. 2009); *Wiser: Getting Beyond Groupthink to Make Groups Smarter* (Cass Sunstein & Reid Hastie), ed. 2015); *Why Societies Need Dissent* (Cass Sunstein, ed. 2005).

⁹ See, *Thinking, Fast And Slow* (Daniel Kahneman, ed. 2011).

and the Pampa. There is an immense biodiversity throughout that needs protection, as shown recently in a U.N. report that points out that one million species are endangered.¹⁰ There is a noticeable increase in fire outbreaks in the Amazon Forest and in deforestation as a result of the illegal practice of agriculture and cattle breeding, which accounts for 74% of greenhouse gas emissions in the country.¹¹

By August 2020, 3,070 square kilometers of deforestation in the Legal Amazon area were detected, according to the Deforestation Alert System (SAD). This figure represents an increase compared to previous years. In 2018, 545 square kilometers of deforestation were recorded.

The data are even more alarming when forest fires and logging are taken into account. In 2019, the Imazon index of “degradation” computed 922 square kilometers of degraded forest, a 675% increase compared to August of the previous year, which registered 19 square kilometers. The State of Mato Grosso accounts for 45% of this total and Pará accounts for 42%.¹²

According to the [Amazon Institute of Man and Environment \(Imazon\)](#), there are technical differences between both indexes. Deforestation is characterized as the process of total and permanent destruction of a green area. It is important to note that most of the

¹⁰ United Nations. *Relatório da Onu mostra que 1 milhão de espécies de animais e plantas enfrentam riscos de extinção*. Available at: <https://nacoesunidas.org/relatorio-da-onu-mostra-que-1-milhao-de-especies-de-animais-e-plantas-enfrentam-risco-de-extincao/>. Accessed on 7/23/2019

¹¹ See, *Litígios climáticos: de acordo com o direito brasileiro, norte-americano e alemão* (Gabriel Wedy, Ed. 2019).

¹² <https://imazon.org.br/publicacoes/boletim-do-desmatamento-da-amazonia-agosto-2019/>

time the forest is converted into pasture lands. Degradation is characterized by partial and selective logging, usually for the purposes of selling the wood. Examples of degradation are forest fires, often used to open clearings.¹³

In July 2019, the world-famous federal agency National Institute of Special Research (INPE), reported an increase of 278% in deforestation alerts in the Amazon compared to the previous year.¹⁴ It is an extremely serious matter that the government disavowed these and other data about deforestation in the Amazon raised by INPE, based on accurate satellite images, and the head of the agency was terminated. These events have prompted criticism from the director of the Biospheric Sciences Laboratory at the Space Flight Center of NASA, Douglas Morton. He stated that *“the termination of Ricardo Galvão from the command of INPE is significantly alarming, as it reflects how the current Brazilian government looks at science.”*¹⁵ As a matter of fact, in certain aspects our governmental policy is characterized by obscurantism and driven by harmful biases.

The scenario is most worrisome. It is far from the perspective of the current Brazilian government to comply with the *Paris Agreement* and the *2030 Agenda for Sustainable Development*. It is worth recalling that sustainable development is a

¹³ WWF alert at <https://www.wwf.org.br/informacoes/english/?76634/Legal-Amazon-loses-more-than-3000-km2-of-forest-in-the-first-half-of-2020> Accessed on 12/15/2020.

¹⁴ O Globo. “Alertas do Inpe sobre desmatamento na Amazônia aumentam 278%.” Available at: <https://oglobo.globo.com/sociedade/alertas-do-inpe-sobre-desmatamento-na-amazonia-crescem-278-em-julho-23857095>. Accessed on 12/15/2020.

¹⁵ BBC Brasil. “Demissão do Chefe do Inpe é alarmante segundo diretor da Nasa.” Available at: <https://www.bbc.com/portuguese/brasil-49256294>. Accessed on 12/15/2020.

constitutional principle according to a leading case of the Supreme Federal Court.¹⁶ There is no political convergence on the part of the government and segments of the extreme right wing, who hold radical views and, above all, are uninformed as to the scientific postulates of *Laudato Si*, questioning the noble and ecological purposes of the *Vatican Synod* for the Amazon, instituted by Pope Francis in 2020.¹⁷

The government is mistaken when it believes these policies will achieve economic progress. In fact these policies do not generate profit; rather, they cause losses and are harmful for the future of capitalism itself.

In the worst-case scenario, environmental degradation and deforestation may have a dramatic and negative financial impact amounting to US\$ 5 trillion for Brazil until 2050. This is a situation where governance is weakened, deforestation explodes and Brazil would have to buy carbon credits abroad to do its part in the global efforts of reducing greenhouse gas emissions. This is the exact conclusion reached by 10 prominent Brazilian researchers in a paper published in *Nature Climate Change*, one of the most renowned scientific publications on climate change.¹⁸

4. OPPORTUNITIES THROUGH CRISES

¹⁶ Supreme Federal Court (STF). Case, ADI-MC 3540/2009. 5.5.2009. Justice Celso de Mello.

¹⁷ The New York Times. Pope Synod Amazon. Available at: <https://www.nytimes.com/reuters/2019/10/27/world/americas/27reuters-pope-synod-amazon.html>. Accessed on: 12/15/2020.

¹⁸ Valor Econômico. “Retrocesso Ambiental pode custar 5 trilhões ao Brasil até 2050.” Available at: <https://www.valor.com.br/brasil/5647915/retrocesso-ambiental-pode-custar-us-5-tri-ao-brasil-ate-2050-diz-estudo?fbclid=IwAR1Cx9jSMxzW0hyaEEMvW7IEablu70IX3vmKOGJUOST2XqaPDIyy9USKXjA>. Accessed on: 12/15/2020.

The current global crisis has brought opportunities to accelerate some of the decarbonization processes, especially those related to environmental protection and energy transition. When considering the direct impact that the legal framework for innovation may have on new decarbonization processes, it is essential to highlight the main programs, rules and initiatives that could lead Brazil in the right direction.

There are few public entities that, despite budget constraints, have started relevant programs and courses of action for direct and indirect support of green innovation. The most relevant example is the Brazilian Agricultural Research Corporation (EMBRAPA), the federal public company that develops sustainable practices for agriculture and livestock to overcome technological barriers and increase production through sustainable methods.

Created by Act No. 5,851, since 1972 EMBRAPA has been the main supplier of new technologies for Brazilian agribusiness. Its researchers work in 43 Decentralized Units nationwide. In addition, it also has several international collaboration projects, emphasizing the performance of the virtual laboratory model operating abroad: Labex North America and Labex Europe (EMBRAPA, 2019).

EMBRAPA is taking advantage of the innovation framework and legal mechanisms to encourage innovation and scientific and technological research for zero-carbon production. Under the ABC Plan, EMBRAPA is helping farmers to adopt low-carbon farming practices under seven programs: 1) Recovery of Degraded Pastures; 2)

Integrated Crop–Livestock–Forestry Systems (ICLF) and Agroforestry Systems (AFS); 3) No-till Farming Systems; 4) Biological Nitrogen Fixation (BNF); 5) Planted Forests; 6) Animal Waste Treatment; and (7) Climate Change Adaptation.

In September 2020, EMBRAPA launched a new program called Carbon Neutral Meat. It is a certification for cattle raised in silvopastoral (livestock–forest) or agro-silvopastoral (crop–livestock–forest, ILPF) integration systems. The main objective of this new technology is to guarantee that the animals that originated the product had their emissions of enteric methane offset during the production process by the growth of trees in the system. The system also provides shade so that the animals were in a thermally comfortable environment, with a high degree of wellbeing. These precepts strengthen the brand and are closely linked to the ILPF benchmark. This innovation can contribute to the ABC Plan and sustainable development while also mitigating methane emissions and other GHGs into the atmosphere, especially carbon dioxide (CO₂) and and nitrogen (N₂O).

Other public initiatives in 2020 are related to the drafting of a new regulatory sanitation framework, including waste–to–energy and a new natural gas regulatory framework to promote a more competitive market. Additionally, the Energy Agency opened for public discussion a proposal for overhauling the Brazilian electricity sector. These initiatives are yet to be launched.

In August 2020, the Nagoia Protocol was finally ratified by the Brazilian Congress. This multilateral treaty allows equitable access to genetic resources and benefit sharing resulting from their use (ABS System–Access and Benefit–Sharing). This initiative is expected to allow more efficient protection of Brazilian biodiversity and promote bioeconomy, helping the transition towards decarbonization.

Previously, in June 2020, the federal government launched a program called More Forest, that establishes payment for environmental monitoring, surveillance, firefighting, research, tree planting, environmental inventory, and agroforestry systems services. However, the Environmental Ministry is yet to develop guidance rules to let companies and society at large obtain such funds.

Also, in June 2020, Executive Order 10,387 allows ethanol and other biofuel industries to issue green debentures to encourage and fortify the biofuel sector. And the Renovabio Program (RENOVABIO), the country’s national biofuel policy, has finally obtained its guidance rules (Order No. 263/2020) to boost the biofuel sector and to help attain energy transition, allowing farmers in particular to issue carbon credit certifications (CBIOs) for sugarcane ethanol, biodiesel and biomethane. Therefore, under this policy, there are compulsory individual targets, to be met by fuel distributors, to reduce greenhouse gas emissions. By November 2020, over 10 million CBIOs had been issued by the renewable energy sector.

Finally, the BIOFUTURE Platform Policy Blueprint is an agreement signed by 20 countries regarding bioeconomy and clean energy initiatives. This Platform sets forth five principles in fighting the current crisis:

1) Do not backtrack: Ensure the long-term continuity and predictability of the goals for bioenergy, biofuels and bio-based materials and the existing policy mechanisms that have proved successful;

2) Consider short-term COVID support for producers: When appropriate, address short-term challenges for the bioenergy and bio-based materials industries in the context of relief packages related to economic losses caused by COVID;

3) Reassess fossil fuel subsidies: Take advantage of a low oil price environment to reassess fossil fuel subsidies for a fairer playing field;

4) Rebuild better with Bio: Where appropriate, integrate the bioeconomy sector as part of broader recovery programs, for example, requiring investments / targets in bioeconomics as part of aid and recovery packages for specific sectors, such as transport and chemicals; and

5) Rewarding sustainability: Integrating sustainability reward mechanisms into political structures, promoting positive externalities in the production and use of biofuels, chemicals and materials.

Brazil certainly needs stronger measures against deforestation as well as public policies that stimulate the green economy (mandates, certifications, exemptions, and the carbon market). Brazil also needs the energy transition of landfills (incentives and use of biomethane, as Brazil still has over 2,000 landfills in major cities, although they are forbidden by law). Furthermore, Brazil is yet to see the development of carbon sequestration technologies to counterbalance oil and diesel production.

Renewable energy producers complain of the low level of private funding, especially solar, wind, biomethane, ethanol, biodiesel and fuel cell technologies for electric cars. But tax reform experts say that a green tax reform is needed to boost this sector and improve the business environment.

To date, the problems that have not been overcome are related to competitiveness, cooperation and accountability. The study developed by Mazzucato and Penna for the Center for Management and Strategic Studies (CGEE-MCTIC) presents a series of recommendations, such as establishing and promoting mechanisms for competition, cooperation and accountability in results-oriented programs and policies to help balance the participation of the State, the business sector and academia (MAZZUCATO; PENNA, 2016). In addition, public investment in research should be encouraged, since it not only corrects market failures, but can also take part in the risk of creating products and markets, helping in sustainable economic growth (MAZZUCATO, 2014).

This understanding is in line with the 17 SDGs of the 2030 Agenda for Sustainable Development, a landmark framework for multilateralism in the formulation of international policies signed in 2015. Agenda 2030 provided sustainable growth planning for the present and future of nations. Together, it recognizes that the end of poverty and other deprivations must accompany strategies that improve health and education, reduce inequality and stimulate economic growth, while combating climate change and the destruction of oceans and forests.

The Division of Sustainable Development Goals (DSDG) of the United Nations Department of Economic and Social Affairs (UNDESA) is responsible for evaluating the implementation of Agenda 2030 at the U.N., including the Global Report on Sustainable Development (GSDR) and related thematic issues on water, energy, climate, oceans, urbanization, transport, science and technology. The innovation system runs through several of the sustainability objectives, while stressing objective 9, called Industry, Innovation and Infrastructure.

Most countries have shown interest in the topic of energy transition, with some enhanced awareness of the obstacles presented by fossil sources and traditional renewables, as well as the advantages offered by the most advanced technological options already available. And, certainly, the role of the State has been expanding in capitalist countries. A recent IPEA study has pointed out the need to reformulate national

development programs in order to adapt them to the UN SDGs, the central axis of Agenda 2030.

5. CONCLUSION

The Brazilian government, society and economic groups should adhere to the fundamental constitutional duty of guaranteeing a balanced environment as well as promoting sustainable development based on its four modern pillars: environmental protection, economic development, good governance and social inclusion. Likewise, there is a need for suitable environmental regulations to deal with challenges that are increasingly complex, difficult and global amid our contemporary society marked by risk¹⁹ and an absence of scientific certainties.²⁰

This does not seem to be enough. Brazil should enforce, among other things, the principles of environmental education (Act no 9,795/1999), precaution (Legislative Decree No. 1, of 02/03/1994), prevention (Art. 225,1, item IV, FC), sustainable development (Preamble, Art. 170, item VI and 225, FC) and polluter–payer (Art. 4, item VII, of the Act 6,938/1981). All of these are provided for in our legal framework. Brazilian society should be united in this commitment for developing minimal political consensus in the defense of the environment. These principles arising from the Constitution and our laws bind

¹⁹ See *Risk Society: Towards a New Modernity* (Ulrich Beck, ed. 1997).

²⁰ See *The End of Certainty* (Ilya Prigogine, ed. 1977).

governments in federal, state, municipal and district spheres and must be adhered to by companies and economic groups.

It is very important to recall that not only individuals, but also corporations may be liable for the same harmful action to the environment in the civil, administrative and also criminal fields (Art. 225, p. 3, FC and Art. 3, Act 9,605/1998). Public research institutions may also play a central role in raising the market's awareness of decarbonization processes and knowledge and generating an even greater social return. An example of this is the innovative way found by EMBRAPA to help beef rangers reduce greenhouse gas emissions. For instance, EMBRAPA researchers developed a protocol that mitigates the impact of livestock methane gas emission by planting trees and integrating pasture management²¹. This behavior deserves to be emulated by other public research institutions.

The reasonable way for western democracies to reach economic development is by transitioning to renewable energy sources, with the purpose of protecting the environment and promoting social inclusion with good governance. These are the basic tenets that underpin the *2030 Agenda for Sustainable Development*²² that should guide the world and

²¹ the Carbon Neutral Brazilian Beef (CNBB) protocol - <https://www.embrapa.br/en/busca-de-noticias/-/noticia/55384885/research-develops-protocol-to-produce-beef-by-neutralizing-greenhouse-gas-emissions>

²² See *The Age of Sustainable Development* (Jeffrey Sachs, ed. 2015).

Brazil. The modern rule of law must be applied wisely and responsibly in this era of climate change to achieve the goals agreed upon in Paris until the year 2100