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Evidence for a National (Eco)Innovation System for the Wind Energy Sector

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Abstract
The emergence of a clean and economically sustainable ecosystem has changed the context of innovations, and since the beginning of the 21st century, discussions about Ecoinnovationhave gained relevance. In this context, the present work aims to analyze the need for a National EcoinnovationSystem (SNECO) in the Wind Sector, based on the conception of national innovation systems. It starts from the theoretical development of heterodox economics, with a neo-Schumpeterian focus, which seeks to present answers to the problems encountered in the market through innovation. Methodologically, the study consists of a documental survey, analyzing theoretical and applied academic research on Ecoinnovationin an analysis of the wind sector, based on secondary data. The results show that although there is no evidence of a consolidated Brazilian energy SNECO with strong interaction in the scientific/technological, productive, and political subsystems, potentialities are perceptible. To this end, political and operational measures become necessary, expanding and reorganizing the government's strategic action, followed by cooperative actions among the organizations present in the Brazilian wind energy system.
Keywords: Ecoinnovation. Electrical Sector. Brazil.

Evidências Para um Sistema Nacional de (Eco)Inovação Para o Setor Eólico

Resumo
A emergência em torno de um ecossistema limpo e economicamente sustentável modificou o contexto das inovações, ganhando relevância, desde o início do século XXI, as discussões sobre ecoinovação. Neste contexto, o presente trabalho tem como objetivo analisar a necessidade de um Sistema Nacional de Ecoinovação (SNECO) no Setor Eólico, embasado na concepção de sistemas nacionais de inovação. Parte do desenvolvimento teórico da economia heterodoxa, com enfoque neoschumpeteriano, o qual busca apresentar respostas para os problemas encontrados no mercado através da inovação. Metodologicamente, o estudo constitui-se de um levantamento documental, analisando pesquisas acadêmicas teóricas e aplicadas sobre ecoinovação em uma análise diante do

Setor Eólico, com base em dados secundários. Os resultados demonstram que embora não se apresentem evidências de um SNECO brasileiro energético consolidado com forte interação nos subsistemas científico/tecnológico, produtivo e político, potencialidades são perceptíveis. Para tanto, tornam-se necessárias medidas políticas e operacionais, ampliando e reordenando a atuação estratégica governamental, seguidas de ações cooperativas entre as organizações presentes no sistema eólico brasileiro.
Palavras–chave: Ecoinovação. Setor Elétrico. Brasil.

Evidencias para un Sistema Nacional de (Eco) Innovación para el Sector Eólico

Resumen
La aparición de un ecosistema limpio y económicamente sostenible ha cambiado el contexto de las innovaciones, y las discusiones sobre la ecoinnovación han cobrado relevancia desde principios del siglo XXI. En este contexto, este documento tiene como objetivo discutir la aparición de un Sistema Nacional de Ecoinnovación (SNECO) en el Sector Eólico, basado en el diseño de sistemas nacionales de innovación. Comienza con el desarrollo teórico de la economía heterodoxa, con un enfoque Neoschumpeterian, que busca proporcionar respuestas a los problemas encontrados en el mercado a través de la innovación. Metodológicamente, el estudio consiste en una encuesta documental, que analiza la investigación académica teórica y aplicada sobre la ecoinnovación y una breve aplicación al sector eléctrico, basada en datos secundarios. Los resultados demuestran que aunque no hay evidencia de un SNECO energético brasileño consolidado con una fuerte interacción en los subsistemas científico / tecnológico, productivo y político, las potencialidades son notables. Para este fin, son necesarias medidas políticas y operativas, ampliando y reordenando la acción estratégica del gobierno, seguida de acciones cooperativas entre las organizaciones presentes en el sistema eólico brasileño.
Palabras clave: (Eco) Innovación. Sector eléctrico. Brasil.

1 Introduction

Since the second half of the 20th century, the debate about economic relations and their environmental impacts has become notorious. Such analysis includes several segments, including industry, whose polluting potential is remarkable throughout the production process, which causes, in some cases, the generation of negative externalities that may impact the future of society itself, such as the latest cases of environmental disasters that occurred in Brazil.

In this context, the emergence of a clean and economically sustainable ecosystem has changed the scenario of innovations, considering that modifications with less degrading content, or that generate positive impacts on the environment, have gained scope in developed (and developing) countries.

As of the 1970s, symbolized in The Silent Spring (Carson, 1962) and the report "the limits of growth" (Meadows et al., 1972). These and seminal works called attention to the problem of demoeconomic expansion in a world finite of resources and the negative consequences in terms of erosion of the quality of human life resulting from this process.

Meadows et al. (1972) brought catastrophic conclusions: the relationship between man and the environment would lead to environmental collapse within 100 years, since the pattern of consumption of natural resources would cause the

exhaustion of available reserves. The work guided the discussions at the first United Nations (UN) conference in 1972.

In subsequent decades, two strands have gained prominence: one that believes in the technological potential as a vector for environmentally friendly processes and products (VILHA and CARVALHO, 2005); and another, which highlights the limitations of combining economic growth and environmental preservation, the case of ecological economists (ROMEIRO, 2012; DALY, 2007). Those who believe in the possibility of greater responsibility of the productive system with the environment still suffer from a series of collective actions, that is, a greater integration between economic players, in face of the fragile business environment established in recent years in Brazil, stemming from political-institutional instability, weakening the collaborative environment with little integrated actions between companies.

Thus, it is necessary a greater intervention of public authorities, in order to conduct the maturation process of an innovative environment among organizations (LUSTOSA, 2011). It is also noteworthy that the intervention should not occur only in the sense of leading to a collaborative environment, but rather an environment that promotes the mitigation of environmental impacts from the beginning to the end of the production chain. Given this, the guiding question of this study is: "What is the need for a National (Eco) Innovation System for the Brazilian wind sector?".

The attention developed around the concept of Ecoinnovation is connected to the prevention of environmental damage and impacts, for this, it seeks to mitigate the amount of polluting waste to be used in the environment. Yurdakul and Kazan (2020) present the theme and highlight that the technologies that are currently developed, are significantly transforming the concepts of production, and why not highlight on the logistics and structure of markets. In consideration of such aspect, the activity developed in the Wind Sector in Brazil is a new activity, being incorporated into the Brazilian economic activity in the 1990s, according to a study developed by Gouvêa and Silva (2018), which enables a better incorporation into the National Innovation System, since its structuring consists of something relatively new in Brazil.

In order to understand these relationships, this study aims to analyze the need for a Brazilian ecoinnovation system focusing on the Wind Sector, resulting in a healthier and more efficient ecosystem for future generations, using the synergies between government, institutions, and the environment, considering, also, the participation of academia and research centers and institutes.

Some studies have advanced the discussion of the relevance of Ecoinnovation for the Brazilian economy. Paludo, Trujillo and Oliveira (2021), discuss the revelance of ecoinnovation for the pursuit of sustainable socioeconomic development presenting how the national literature has addressed this context. Koeller et al. (2020) rescue the relationship between innovation, environment and technology, via conceptual discussion and through a literature review, highlighting the interest by the academy in discussing the topic. The works of Ferreira et al. (2018) and Jesus; Polo and Rodrigues (2022) analyzed how ecoinnovation has been worked in the energy sector.

Silveira et al. (2015) prioritize the energy sector and the public policies directed to it, concluding that the Brazilian National Innovation System (NIS) is in a

consolidation phase. Still for the aforementioned authors, the Energy Sector has continuous Research and Development (R&D) policies, in addition to a more qualified human capital, which encourages innovation, even if by force of regulation, after all, companies must invest at least 1% of net operating revenue, according to Bin et. al. (2015).

In view of this, this work is justified given the relevance of discussing the adoption of clean and sustainable practices in the electricity sector, especially when compared to traditional systems. De Freitas et al. (2021), identified that the international literature has advanced in recent years around the theme of ecoinnovation, taking on new concepts and approaches. Thus, this work seeks to broaden the discussion around this theme by bringing contributions in the theoretical field by analyzing the recent literature available and its advances. On the practical side, it aims to discuss and propose the development of a National (Eco)Innovation System, i.e., focused on the inclusion of new technologies and the mitigation of environmental impacts caused by 'outdated technologies'.

The work is a bibliographical study, using secondary sources, in consideration of the studies developed, analyzed, and already published in relation to the theme. The methodology based on a bibliographical study appears as the necessary basis to direct the discussion, criticism, and the proposition of new means. In contribution to the use of this methodology, the studies of Rennings (2000), Andersen (2008), Carrillo-Hermosilla and Könnölä (2010) and Koeller, Miranda, Lustosa and Podcameni (2020) can be cited.

It is noteworthy that the use of bibliographic study is based on materials already published, focusing data collection on articles that, after structured and selected from criteria (relevance to the theme, number of citations and time of publication) and filtering, formed a portfolio, leading to the verification of trends and currents focused on the central theme. According to Souza *et al.* (2015), from the perspective of scientific knowledge, studies are currently developed to evaluate scientific productions, thus examining the quality of these publications.

The paper is divided into four more items, in addition to this introduction. In item 2 the conceptual framework about national innovation system and the Brazilian case is discussed; item 3 presents the sui generis taxonomy of the Brazilian case; item 4 characterizes the Brazilian national ecoinnovation system for the Wind Sector; sequentially, the conclusions of the study will be listed in item 5.

2 The National Innovation System (NIS): Theoretical and applied aspects.

Unlike the reductionist model of neoclassical theory, the real world cannot be represented in a situation of equilibrium, or even represented from a set of choices known ex-ante. Freeman and Soete (2008) expose that the process of Research and Development occurring 'inside' the industry presents the possibility of generating a large amount of innovations, allowing the participation of small and large companies, therefore, there is no ideal company model.

Unlike the orthodox analysis of economics, Freeman and Soete (2008) follows a neo-Schumpeterian line of analysis, in which agents that operate in the market, regardless of size, can act in the same common space.

In support of the analysis presented by the authors, the work of Dosi (1988) collaborates with the above argument, since it highlights the importance of investments in Research and Development being related to the process of search (R&D) and selection (choice of technology by the market), which comes to occur before the technological paradigm in force.[1]

In light of this brief discussion, Sbicca and Palaez (2006) define Innovation System as "a set of public and private institutions that contribute in the macro and microeconomic spheres to the development and diffusion of new technologies. The development of the National Innovation System starts from microeconomic aspects, from an endogenous perspective, as the actions and relations of the agents participating in the system are shared. This aspect is evident in the work of Hodgson (1997) and Hodgson (2006), when starting from microeconomic analysis until reaching the macroeconomic level via a reconstitutive downward causation model. With this, it involves understanding policies and aspects that affect local and regional policies, coming to the National level.

Conceptually, the National Innovation System can be characterized as a network of organizations (and/or institutions) that act as drivers, diffusers or authors of innovations in a given region, sector, place or country (LUNDVALL, 1994; FREEMAN AND SOETE, 2008; CASSIOLATO AND LASTRES, 2005; FILIPPETTI AND ARCHIBUG, 2011; RIBEIRO, 2019; NIEMEYER AND BIGGI, 2019).

Moreover, the discussion from this concept arises directly from the innovative process, an aspect derived from Joseph Alois Schumpeter's (1982) work, Theory of Economic Development, which was originally published in 1911, in its German edition. Schumpeter's work, as a pioneer in the subject, indicates that economic gains come from a process of transformation in the market, which is called creative destruction, the result of substituting society's habits, and allied to this substitution of habits, new products emerge, and this way, the process of economic development is characterized. As a result, Schumpeter shows that there is a break in the circular flow of economic activity, the changes occur discontinuously and disturb the existing balance.

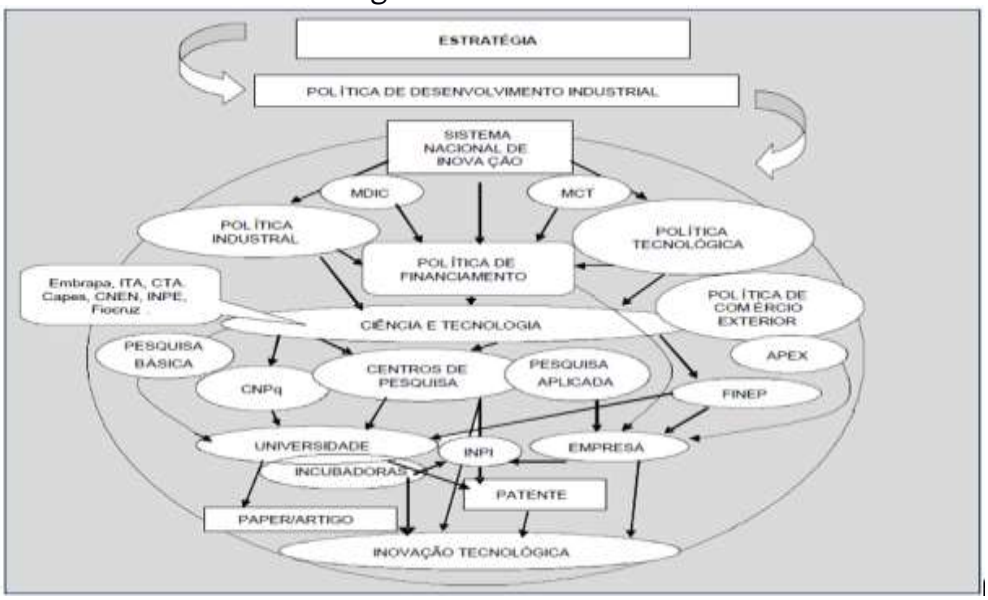
However, the focus for this author was centered on individual entrepreneurs and large corporations, a landmark that was only expanded after the work of Nelson and Winter (1982), who began to understand innovation as a systemic process, in which the market is in an intense movement of search and selection, and the key for companies is in the act of routineization, derived from the companies' adaptation to the market. The authors use arguments that allude to evolutionary biology applied to economics. Because of this, the process of adaptation of companies to the environment emerges. In this way, it becomes possible to

1 The concept of technological paradigm is presented by Dosi (1982) and Dosi (1988), the author is based on the work 'The Structure of Scientific Revolutions' by Thomas Kuhn (1962), in which the concept of scientific paradigm is cited. In Dosi (1988, p. 7), technological paradigm consists of the model answer or "standard solution to techno-economic problems."
Both works follow the neo-Schumpeterian evolutionary line linked to the SPRU - Science Policy Research Unit, different from the line followed by Nelson and Winter (1982; 2005). The SPRU is a leading research center in science, innovation, policy and technology management. Available at: < https://www.sussex.ac.uk/business-school/people-and-departments/spru/about/history>. Accessed on: 11 Aug. 2022.

evaluate multiple dimensions emphasizing regional and national perspectives, in addition to the technological one, as can be seen in the works of Dosi (1982; 1988), for example.

The analysis applied to the NIS presents multiple results and approaches. Albuquerque (1996) compiled three segments: (1) countries that were ahead, possessing a mature and consolidated system; (2) countries whose NIS focuses on innovative diffusion and; (3) countries with non-consolidated NIS, although they have built science and technology systems, as is the case of Brazil. This statement is corroborated in the quantitative analysis, where data indicate an immature and inefficient Brazilian NIS, when compared to other more consolidated economies. Furthermore, the Brazilian NIS and its multiple actors are summarized in Figure 1.

Figure 1. Brazilian NIS



Source: Leis *et al.* (2013); Maldaner (2004).

Villaschi (2005) argues that the Brazilian NIS presented unsatisfactory results in the 1990s, motivated, among other factors, by the non-inclusion of technological policy as an inducer of development, coupled with the lack of domains (technological, economic and institutional), a factor that only happened in the following decade. By analyzing the contributions of Simões et. al. (2002), it is noticeable that scientific and technological activities in Brazil present differences in their regional aspects, where from a municipal analysis it was verified the protagonism of the Center-South regions, with respect to patents and academic production (scientific articles).

It can be highlighted that, compared to other regions, the Center-South is one step ahead. On the other hand, in the work of Maldaner (2004) a comparison between the nations Brazil and South Korea is verified, indicating the need for interlocution among three very important actors (Universities, Governments and companies), aspects based on the analysis developed by Henry Etkowitz and Loet Leydesdorf about the Triple Helix (2000), besides the construction of strategic, operational and regulatory plans, aiming at the strengthening of the Brazilian NIS. As Etzkowitz and Chunyan Zhou (2017) point out, "university-industry-government

interactions, which form a 'triple helix' of innovation and entrepreneurship, are the key to knowledge-based economic growth and social development. Also according to the authors, in their study, they point out that:

> We define the Triple Helix as a model of innovation in which university/academia, industry, and government, as primary institutional spheres, interact to promote development through innovation and entrepreneurship. In the interaction process, new secondary institutions are formed on demand, i.e. "hybrid organizations". The dynamics of institutional spheres for development in a triple helix synthesizes the internal power and external power of their interactions (ETZKOWITZ AND ZHOU, 2017).

Nevertheless, other authors analyze the NIS in specific economic segments. Cunha et al. (2009) focus on the innovative potential of nascent and new companies in Brazil, justifying that their low performance is explained by three factors: the motivation by necessity, typical of emerging economies (companies that generate employment and income); the process of competition between firms (discouraging cooperation); and the Brazilian NIS itself, which does not create an environment of dialogue between the actors (such as universities and companies).

Corroborating in this sense, Gadelha et al. (2013) describe the relationships in the Brazilian health economic/industrial complex, a sector that presents favorable results regarding innovation. However, Brazil stands out as a consumer market, although it has been increasing the volume of sales and exports, requiring more aggressive innovation strategies. In this sense, an articulation between the segments of the complex and other actors strengthen the sector's NIS.

Pereira and Dathein (2015) conclude that innovations in the manufacturing industry carried out by foreign companies in Brazil are more significant, although they contribute little to the Brazilian NIS, since the relationships with the other authors (spillover effect) are weak or nonexistent. Still for the authors, domestic companies innovate on a smaller scale, acting as "followers" of the external groups.

In a comparison between the Brazilian and South Korean NIS, Andrade (2019) emphasizes the importance of local small and medium enterprises for systematic strengthening. Moreover, joining Asian value chains has proven to be an effective strategy for strengthening the Korean system.

An attempt to analyze the incorporation of themes related to the environment and sustainability in the Brazilian NIS is proposed by Guerra et al. (2014), who point out advances in governmental actions (specific legislation for innovation, project and investment subsidies, among others), but there are gaps to be filled, such as a greater recognition of private research institutions and a decrease in the cyclical nature of the policy. Thus, they conclude that the search for technological tools for a more sustainable society has in the articulation among actors one of the necessary levers, that is, a greater connection between innovation, environmental issues and sustainability.

> In the approach to Brazil's SNCT&I, attention should also be paid to the emergence of studies on the theme of social technology, with a view to expanding analyses that contribute to understanding popular initiatives for income generation and the development of technologies aimed at

> enterprises of their solidarity nature, as well as the connection with environmental and sustainability issues (GUERRA et al. 2014: 137).

In relation to the National Innovation System in Brazil, it is possible to consider that it is still recent in relation to the System of other countries. As an independent country, Brazil is close to its 200th anniversary, however, the first Industrial Revolution occurred between 1760 and 1850 transforming handicraft production into manufacturing production. The English system was already operating, the revolution can be understood as the change in the habits of the market agents. New labor relations and inventions emerged that impacted society and the markets. During this period, Brazil was in the process of moving away from Portugal, still during the second revolution, the country faced a process of intense social and economic transformations, which affected not only the Proclamation of the Republic, but affects the country to this day.

With the international crisis of 1929, Brazil was affected due to its agro-export business model, since the United States was one of the largest buyers of coffee. As the crisis hit the American economy, the demand for the Brazilian product was affected, and the government's solution was to buy and burn sacks of coffee to try to minimize the impact of the devaluation. From 30, the business model is modified, the country was affected socially, politically and economically, Brazil began to adopt a model of import substitution, in which sought to develop domestic industry and create the necessary conditions for scientific, technological and cultural support institutions. In Dias (2009), the author argues that from 1950 the scientific and technological policy began to be institutionalized, implementing projects, regulatory frameworks and training of technical force capable of meeting the existing challenges.

Bresser-Pereira (1974) points out that Brazil sought to achieve the substitution of products that were once imported, on the other hand, exports remained stagnant. In contribution to the discussion, Mattei and Santos Junior (2009, p. 107) present that:

> [...] The end of the accumulation pattern based on import substitution industrialization guided by the State was directly related to the growing foreign indebtedness verified since the end of the 1960s, passing through the years of the economic "miracle" until the rise in international interest rates in 1979, when the Brazilian foreign debt reached high levels.

With the emergence of the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Capes) and Conselho Nacional de Desenvolvimento Científico e Tecnológico (Cnpq) as of the 1950s, the elements of the SNI began to be implemented; however, it was as of the 1990s that the Brazilian SNI began to gain the necessary elements for all agents to be able to act, unlike what occurred via the import substitution model.

However, the documental analysis demonstrates the insufficiency of studies that are dedicated to the Brazilian environmental NIS, or that approach Ecoinnovation or green economy, themes that gained relevance in the second half of the 20th century, mainly due to the impacts to be mitigated. After all, the agents and the institutional environment are always changing, corroborating the Veblenian analysis, in which the habits and instincts of individuals affect the entire system.

Finally, Conceição points out that (2002, p. 123) "institutions change and, even through gradual changes, can put pressure on the system through explosions, conflicts, and crises, leading to changes in attitudes and actions." Thus, the present paper is closer to the heterodox field of analysis than the orthodox mainstream.

3 Ecoinnovation: Taxonomy and the Brazilian Case

The process of ecoinnovation presents numerous strands and approaches, being a consensus for many authors and institutions, that it includes any invention (or transformation) that expands economic gains but mitigates environmental degradation (James 1997; Kemp et al. 1998; Andersen 2008; Horbach 2008).

Contributing to the approach, Maçaneiro (2012) highlights that ecoinnovation does not seek only the reduction of carbon emissions through new technologies, but a rupture of the prevailing paradigms, using new processes, forms and learning, replacing traditional practices. As can be seen, aspects of Nelson and Winter's (1982) approach were adapted, presenting the importance of evolutionary economics in this process.

Although it is a relatively recent concept, dating back to 1996 with Driving Ecoinnovation (FUSSLER, 1996), there has been an increase in contemporary academic research and production.

In a bibliographic survey for the term, Vaz et al. (2017) maps 305 mentions throughout the texts, in addition to 24 appearances of the word "Ecoinnovation/ecoinnovation" in national and international journal titles: Scientific Periodicals Electronic Library (SPELL), Scientific Electronic Library Online (SCIELO), Portal de Periódicos CAPES/MEC (CAPES) and Google Scholar.

Already in using the informational base web of Science, 862 journals were surveyed that used the theme ecoinnovation (or related terms), between 1978/2017 (SILVA et al. 2018).

Also using the web of science, Kneipp et al. (2011) used bibliometric analysis and investigated the expansion of the term Sustainable Innovation between 2000 and 2011. The mapping of 1022 publications confirms the prominence of texts in English language, in addition to the adherence of the theme to the areas of management, environmental sciences and business, confirming an expansion in academic production linked to the aforementioned term.

Another highlight is the mapping performed by Schiederig et al. (2012), emphasizing the management of green innovation linked to technology. The authors point out an increase in academic production between 1990-2010, with strong influence of research headed by the Netherlands, Italy and Germany in the 8516 documented publications.

Spezamiglio *et al.* (2016) merges bibliographic and bibliometric references to understand the developments and intercessions between competitiveness, sustainability and innovation. The result of the 379,971 papers selected between 1970 and 2015 (with significant increase in the last five years of the survey) highlight, among other factors, an increase in themes linked to eco-efficiency and cleaner organizational processes.

It is worth noting that ecoinnovation presents similar classifications, with different objectives, as highlighted by Pinsky et al. (2015): sustainable innovation,

which considers economic and social changes; environmental innovation, focusing on cost reduction; ecoinnovation, which prioritizes environmental performance and green innovation, which focuses on company performance and its environmentally friendly image.

Regarding the taxonomy of ecoinnovation, several authors report classifications for Ecoinnovations, as shown in Chart 1:

Table 1. Categories of Ecoinnovation

Author(s)	Types of observed eco-innovations	Examples
Rennings (1998)	Technological	Repairing contaminated soils, reducing emissions, etc.
	Organizational	Service innovations.
	Social	Programs for the sustainable use of Environmental Protection Areas (EPAs).
	Institutional	A3P sustainability program in the Brazilian public administration.
Andersen(2006; 2008)	Involved by the Environmental Sector	Reuse of waste.
	Integrated	Clean technology improvement programs.
	Alternative product creation	Use of ethanol as vehicle fuel.
	Organizational Macros	Organizational and institutional change programs.
	That affect the process in general	Government vehicle depollution programs.
Kemp e Foxon (2007)	Environmental Technologies	Environmental monitoring
	Organizational	Environmental management.
	Environmentally legal	Water management.
	Ecological	Organic farming.
	That affect the process in general	Biotechnology.
Carrillo-Hermosilla *et al.* (2009)	Adding Components	Chimneys, anti-pollution filters.
	Subsystem changes	Energy efficient products.
	System changes	Alternative renewable energy systems.

Source: Research results and adaptation of Marceneiro e Cunha (2010).

Regarding mechanisms for gauging ecoinnovation, Andersen (2006) cites three sources: Patents, R&D investments for environmental protection, and surveys. The Organization for Economic Cooperation and Development (OECD, 2009) indicates generic sources of data collection, besides those already mentioned: large or small scale surveys (through questionnaires) and panel surveys (of the same company over time).

But why eco-innovate? Although the answer is implicit in the previous paragraphs, it is worth considering the elements listed by Fernandes (2012, p. 51):

> Economic and financial factors, such as the pursuit of cost reduction; 2. Environmental factors related to resource sustainability and access to raw materials; 3. Technological factors related to technical capabilities such as basic science, infrastructure and human capital; 4. Regulatory and legislative factors related to standards imposed by legislation, regulation and standardization; 5. Socio-cultural factors related to the community's own pressure towards environmental issues, reinforcement of the company's image, or even cultural pre-dispositions towards partnerships.

Having highlighted the concepts, categories, and the relevance about ecoinnovation, it is now time to address the theme involving the Brazilian case. As an illustration, some works discuss the themes in multiple aspects, such as Maçaneiro (2012), Brasil et al. (2015), Jacomossi et al. (2016), Queiroz (2017), Vendler and Maçaneiro (2018), Ferreira et al. (2018), among others. These works were chosen, due to the diversity of ecoinnovation typologies that are addressed, as well as the segments evaluated. In such a way, the perception of ecoinnovation is also multidisciplinary, which allows particular and more efficient analyses.

In addition to the analysis of specific segments, some researchers use the Industrial Survey of Technological Innovation (PINTEC) as a source of data and information, thus allowing for a broader assessment. Hoff et. al. (2016) state that 33.5% of the companies surveyed in PINTEC 2008 are ecoinnovators, with more expressive implementations in the area of environmental management, reduction of impacts on the environment, and reduction in the consumption of raw materials. Moura (2016), using an econometric model with data from PINTEC 2011, concludes that Brazilian ecoinnovative companies are generally not domestically owned and find as a main bottleneck the high costs with ecoinnovation (although probabilistically, such expenditures do not contribute to significant results).

Other empirical studies already indicate relevance for Brazilian firms to ecoinnovate, reaching the following conclusions: technical innovation increases the performance of Brazilian industries; cooperation with external partners influences the adoption of ecoinnovative techniques and, there is a significant relationship between firms' socioeconomic performance and ecoinnovation (RABÊLO et al., 2016; TUMELERO, 2017; RABÊLO AND MELO, 2018).

From the cited biographical survey, it is possible to affirm that Brazil presents significant results about ecoinnovation in multiple areas, as well as expressive results throughout the innovative chain.

4 Towards a National Wind (Eco)Innovation System: Perspectives and Evidence

The international literature indicates the relevance of the National Ecoinnovation System (SNECO), as in Cocke (2011), who selects some regions of the world, regarding climate change and governmental action. For the author, market relations will bring different solutions to environmental problems, where the option for free enterprise tends to generate more satisfactory results, since more coordinated economies tend to respond later to climate change. Still: "[...] national regimes are crucial, providing general frameworks that allow ecoinnovators to access subsidies and incentives to enable exploration" (Cocke 2011, p. 143).

Brazil is cited by the author as an important segment in energy innovation, with prominence in the areas of biofuels and wind power, although most of the ecoinnovations of the former are located in Central America and Europe. When analyzing countries in Europe, it can be seen that in Portugal, the country has been presenting extremely important factors, as we can see in the work of Fernandes (2012) about the country, where he describes the National (ECO) Innovation System (SNECO), where he analyzes theoretical and empirical aspects.

Still on the study by Fernandes (2012), the author highlights that there is a core of institutions, actors and dynamics of Ecoinnovation in the process of consolidation, that is, still in embryonic form, with little business adhesion and low internal cooperation. However, the most expressive results are centered on recycling and renewable energy. It is perceived that recycling in Portugal has been moving away from minimizing the negative environmental effects of waste. On the other hand, it focuses on waste reduction along the production chain and reintroduces the result of recycling into the chain, thus originating new products. Due to this, as pointed out by Fernandes (2012, p. 39), the focus sector of Ecoinnovation analysis comes to be Renewable Energy, given the increasing performance of agents in this sector, with the country having the 5th most ambitious target in the European union.

In order to focus the analysis for Brazil, the need arises to analyze the Brazilian Energy Sector, since considering its sub-areas, biomass and wind energy present themselves as the most favorable to act towards developing a National Ecoinnovation System. In Aloise, Nodari and Dorin (2016), the authors discuss about characteristics and driving factors of eco-innovations, these discuss that innovations begin to incorporate the premises of sustainability, because, link several performance measures when considering environmental degradation, use and better allocation of raw materials and environmental resources, since the generation of waste from activities that generate pollution can open space for the generation of innovation, to the extent that allow mitigate environmental problems, making new forms of innovation as ecological and sustainable.

In contribution to the theme, Yurdakul and Kazan (2020) point out that the concept of Ecoinnovation began to be used as of the 1990s, with the purpose of mitigating the environmental impacts suffered as a result of the negative effects caused by pollution and other negative externalities that may arise.

4.1 Brazilian Energy Sector Overview

In order to initially demonstrate that the need to think about renewable energy has begun to emerge, the question arises as to how the current Brazilian energy context is. Because of this, the current potential was verified, based on information made available by the Information Bank of the National Electric Energy Agency (ANEEL).

Based on the data researched, Brazil still has a strong secular dependence on the hydraulic matrix, as shown in Table 2.

Table 2. Electric Energy Matrix

Origin	Source	%
biomass	Agro-industrial	6,6536
	Liquid biofuels	0,0027
	Forest	1,8541
	Urban solid waste	0,0026
	Animal waste	0,0831
Wind	**Wind kinetics**	**8,646**
Fossil	Mineral coal	1,8904
	Natural gas	7,7721
	Other fossils	0,0918
	Petroleum	5,1578
Hydro	**Hydraulic Potential**	**60,7337**
Nuclear	Uranium	1,1569
Solar	Solar radiation	1,2057
Undi-Eletric	Water kinetics	0
Importation	Paraguay Argentina Venezuela Uruguay	4,7494

Source: Generation Information Bank, ANEEL (2019).

As shown in Chart 2, sources such as Biomass - agro-industrial -, and Wind-Kinetic - present relevance. Still in the case of biomass, the co-generation of energy, through the burning of straw and bagasse, corresponds to a significant productive source, becoming a potential element of the third main product of the agro-industrial sector, along with sugar and ethanol. Furthermore, wind energy is beginning to show relevance, given the Brazilian energy potential, since Brazil is a continental country with several characteristics that change from region to region.

Therefore, the last decade of the 20th century is marked by the establishment of wind energy production in Brazil, initially with the installation of the first wind turbine, in 1992, in the Fernando de Noronha archipelago.

In 1999 the first wind power plant was inaugurated in the state of Ceará. As Gouveia and Silva (2018) expose, the sector of the segment only came to show expansion in the following years, after strong government intervention .

Already in 2001, during the energy crisis, the Emergency Wind Energy Program - PROEÓLICA aimed to expand the Brazilian energy supply in the following biennium. Subsequently, the sector expansion occurred through Law No. 10.438, April 2002, which culminated in the Program of Incentive to Alternative Sources of Electric Energy (PROINFA), which aims to produce electricity through alternative sources: wind, small hydroelectric plants and biomass.

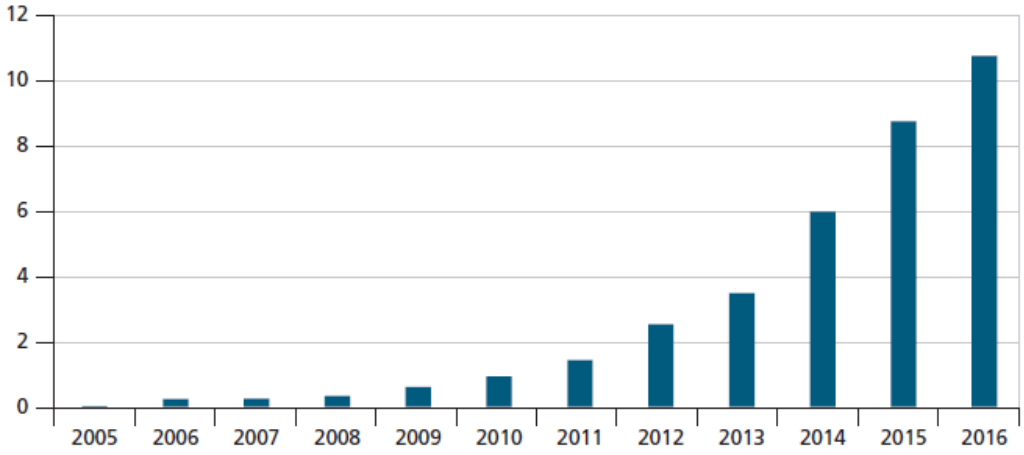
Since then, the wind power segment has been expanding in the country: in 2016, the installed capacity reached new heights with 10.7 GW, standing out with 7% of Brazilian electricity generation. As it highlights:

> [...] Proinfa was responsible for contracting 1,422.9 MW,

> through subsidized prices. This policy, with its maturity, raised the country to a unique level, in which non-conventional renewable energies are currently contracted without the need for subsidies, such as feed-in tariffs, used by other countries that invest in this source (MELO 2013, p. 125).

The impact promoted by the expansion can be visualized in Figure 2. As pointed out by Abeeólica (2017) and Losekann (2018) studies, Brazil reached the 9th position in installed capacity and the 5th country that has added the most to its wind power generation capacity, demonstrating that the investment and proposed actions, still in 2002, are having the desired effect. The vertical axis from 0 to 12 represents the amount of gigawatts generated; the columns referring to the years 2005 to 2016 represent the amount of gigawatts generated per year. According to a study developed by Losekann (2018), while in 2005 the gigawatt generation was below 2 (GW), in 2016 the generation reached 10.7 gigawatts, approaching the 12 (GW) scale.

Figure 2. Evolution of Wind Power Generation Capacity (2005-2016) in GW

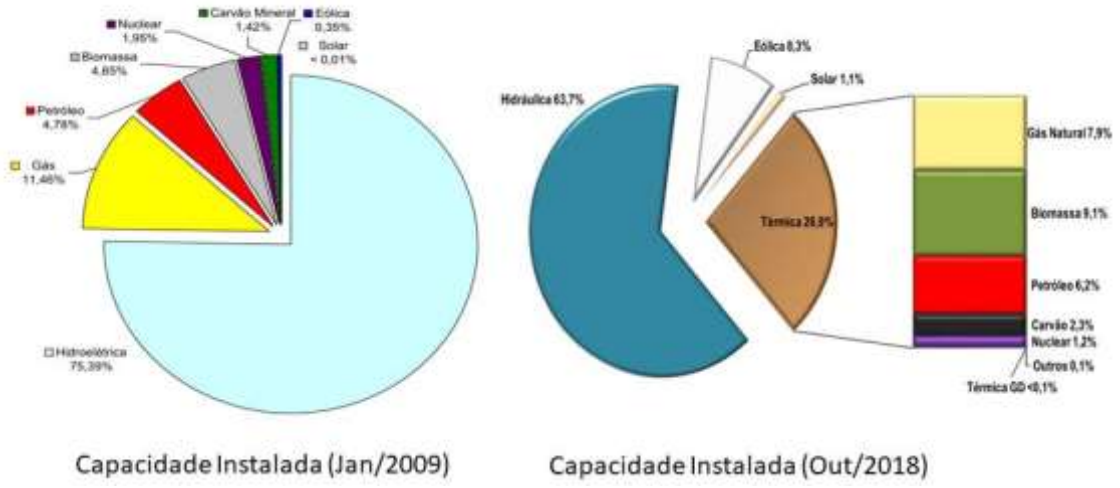


Source: Abeeólica (2017) and Losekann (2018).

The actions taken, as of 2004, not only allowed the development of a new model for the generation and commercialization of electricity in Brazil, but also opened space for renewable energy sources (biomass, solar and wind), enabling the emergence of two new environments for the commercialization of energy, such as: i) Regulated Contracting Environment and ii) Free Contracting Environment (ANEEL 2009; Brazil 2004a; Brazil 2004b). The new configuration, post-2004, has enabled new aspirations for the National Innovation System in the Energy Sector, for besides enabling the expansion of the production potential, it has consolidated the articulation of a complex network of actors between public and private agents, seeking joint action and in a strategic way, not only focusing on the expansion, but in developing a solid relationship and enriching the Brazilian energy matrix. From the discussion pointed out above, one can perceive here a strong process of adaptation of the agents in the face of market changes, as pointed out in the studies of Winter (1964), Nelson and Winter (1982), Vromen (1995, 2006) and Witt (2006).

The results of these actions can be seen in Figure 3. It can be seen that the changes provided the necessary advance to the sector and to the Innovation System. As the figure shows, in 2009, wind power generation comes close to 0.35% of the installed capacity and, in 2018, the results point to 8.3%, very close to the values presented in Table 1 of 8.6%, according to ANEEL's Generation Information Bank (2019).

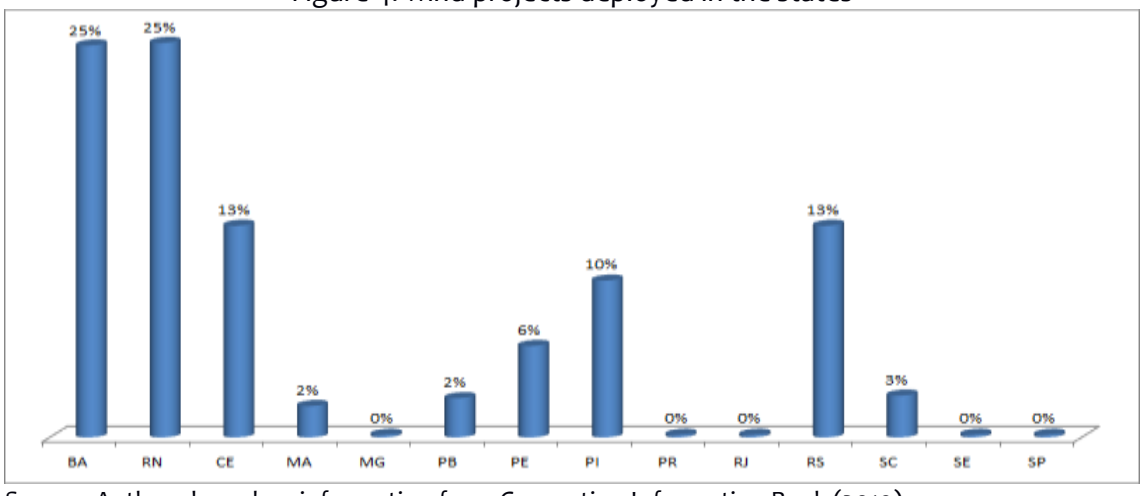
Figure 3. installed capacity matrix of electric energy generation 2009-2018



Source: Boletim de Monitoramento do Sistema Elétrico Brasileiro (2009-2018); Ministry of Mines and Energy

In continuity with the policy of supporting new sources of renewable energy, Figure 4 shows a map of participation of wind power projects by state. The states that present a percentage of 0% have only one project implemented, and again the Northeast region presenting a strong potential for renewable energy generation, as in the case of photovoltaic energy.

Figure 4. wind projects deployed in the states



Source: Authors based on information from Generation Information Bank (2019).

The progress of wind energy occurred, basically, from the new configuration of the Brazilian Electric Power Sector, from PROINFA, as already evidenced its planning and action, from the Free Contracting Environment (ACL), which allowed a strong advance in the installed capacity. The data presented by Abeeólica (2017) point to an advance of approximately 39,531% in just 11 years, jumping from 27.1 MW in 2005 to 10,740 MW in 2016. This growth factor should be expanded further in the coming years, possibly reaching 24,000 MW still in 2024, representing 11.6% of the Brazilian energy matrix (DINIZ, 2018).

Global Wind Energy Council (GWEC) data, meanwhile, point out that Brazil has configured itself as the largest wind energy producer in Latin America (and eighth worldwide), with 14.33 GW of installed capacity in 2018 (up from 10.74 GW in 2016), and with potential expansion capacity (especially in the Northeast region), given the country's climatic conditions.

Having demonstrated the potentiality of the Brazilian Wind Sector and its recent expansion, it is worth identifying whether there is a consolidated SNECO for the aforementioned segment.

4.2 Characterization and bottlenecks of the Brazilian Wind SNECO

The Brazilian ecoinnovation macro segment is the subject of research for authors, such as Hupffer and Ashton (2016), who argue that the Brazilian legal system (National Environmental Policy and the 1988 Federal Constitution) provides a legal basis for the occurrence of Brazilian ecoinnovations, although specific economic-legal mechanisms are lacking. Thus, economic incentives are needed for the development of ecoinnovations and ecodesign.

Boff and Boff (2017) call for the need to implement frameworks that encourage Ecoinnovationin the renewable energy sector. By analyzing the public policies and the Brazilian legal system (Laws 10973/2004 and 11196/2005), they conclude that the effort is still timid, and an expansion of government disbursement is necessary[2].

Among the vast array of Ecoinnovationin productive sectors, it is worth noting the national leadership in initiatives linked to the production of wind energy, given its sustainable character and lower power of ecosystemic degradation. Terciote (2002) presents the advantages in the production of wind energy (decrease in CO2 emissions, small occupied area, among others) and disadvantages (impact on fauna, noise pollution, electromagnetic interference and visual impact). However, the technological development itself in the last decade has considerably mitigated the problems cited by the author. Nascimento et. al. (2012: 648) point out that:

> [...] the pillars of sustainability (economic, social and environmental) can be seen throughout virtually all issues involving the deployment of new wind power plants. However, it is important to note that economic issues are at the core of the discussions and it is through the economic viability

[2] We highlight the already mentioned PROINFA, besides the initiative entitled Transformation of the energy efficiency market in Brazil (3E Project), developed by the Ministry of Environment, with emphasis on government buildings. Furthermore, Law 11.196/2005 instituted the Special Regime for the Acquisition of Capital Goods for Exporting Companies (RECAP).

> of these plants that environmental and social issues are also benefited [...]. This highlights the need for government incentives to strengthen the sector, especially in countries like Brazil, which, over the years, has used a number of public sources for partial financing of energy projects in the country and, strengthening the dynamics of this sector, could give the country a prominent position in the possible "new wave" of paradigms and technological trajectories.

Analyzing research with emphasis on the Brazilian Wind Sector, it is possible to verify the trajectory of the scientific/technological, productive and political subsystems, according to Podcameni (2014), who develops a conceptual framework using the theoretical bases of the NIS.

The author emphasizes the need for synergy between the three segments, which is not noticeable in the Brazilian Wind Sector. From the arguments of the work, it is possible to conclude a classification from the three aforementioned frameworks, establishing the following evaluative criteria for synergies: Strong, Insufficient and Weak. Table 3 presents the definition of the categories.

Table 3. Brazilian Wind SNECO: Classification of interactions based on the indicators: strong, insufficient and weak

Indicator	Requirement
Strong	Meets the established criteria very well
Insufficient	Partially meets the established criteria
Weak	Does not meet the established criteria

Source: Prepared by the authors from Podcameni, (2014).

Regarding the scientific/technological subsystem, we consider as indicators of synergy: reports of interaction between universities/research centers in the production of equipment related to the wind power segment.

The productive subsystem, on its turn, starts from the reflection about some of the following aspects: (1) association between players as a priority for the sector's expansion; (2) absorption of external technology; (3) interaction between clients and suppliers; (4) incentives from the National Bank for Economic and Social Development (BNDES) in the productive expansion (or nationalization of components). The analysis of this subsystem can be carried out based on the supply chain analysis, or even sector analysis, enabling the knowledge of the interactions present here.

Regarding policy interaction, the following guidelines were used: (1) industrial and science, technology and innovation policies for the wind source and; (2) cross-cutting policies that benefit the sector (PODCAMENI, 2014).

Given the categories described above it is concluded that the level of interaction remains weak or insufficient, although some initiatives and potentialities are highlighted in the subsystems studied, as visualized in table 4.

Table 4. Brazilian Wind SNECO: Scientific/Technological and Productive Interaction

Author(s)	Scientific and Technological Interaction [1]	Productive Interaction [1]	Justification
Camillo (2013)	Insufficient	Weak	It highlights the participation of Universities/research centers in the construction and absorption of technology. However, the lack of interaction between the actors makes it difficult to advance in the sector, combined with the lack of absorption of imported technologies.
Melo (2013)	-	Insufficient	Considering the installation of factories in the national territory, it highlights the need to bring Brazil closer to the technological frontiers.
Lage e Procesi (2013)	-	Weak	They emphasize that the national wind turbine industry in Brazil imports the machinery (therefore, it does not absorb the imported technology), restricting itself to adapting them to its geographical particularities.
Podcameni (2014)	Weak	Insufficient	Difficulty in reconciling academic research and demands from the productive segments. In addition, transnational companies concentrate innovative processes in their countries of origin.
Deus e Issberner (2017)	Weak	Insufficient	Based on the mapping of research groups and directories registered with the NCSTD, with an emphasis on the Wind Sector, the potential for interaction between the actors (University, Government, private sector) is highlighted.
Araújo e Willcox (2018)	-	Insufficient	The development of the sector is linked to the ability to absorb foreign technology, nationalizing the components.
Gouvêa e Silva (2018)	-	Weak	They highlight the interaction between public and private actors as fundamental for expanding the production process and consolidating the national wind farm. However, the lack of local productive capacity is a strong obstacle.

Source: Search results.

Regarding political interaction, the textual interpretation implies divergence among the authors, as shown in table 5.

Table 5. Brazilian Wind SNECO: Policy Interaction

Author(s)	Political Interaction [1]	Justification
Camillo (2003)	Insufficient	It highlights the advances made by PROINFA, but its disarticulation combined with the lack of a specific industrial policy are gaps that Brazil needs to remedy.
Melo (2013)	Insufficient	Despite the progress of the Wind Sector, given the use of attractive financing and contracting of auctions, it also considered the obstacles: cancellation of auctions and discontinuation of NBESD policies.
Lage e Procesi (2013)	Strong	The public policy of auctioning alternative energy sources proved to be promising. Another outstanding factor refers to the federal and state tax exemptions, which contributed to the expansion of the sector.
Podcameni (2014)	Weak	Misguided, disjointed and inefficient policy. It highlights the lack of articulation between policies, as well as the difficulty in achieving their objectives.
Deus e Issberner (2017)	Insufficient	They highlight the discontinuity of public notices to promote the sector, policies to encourage the production of national goods and capital, and the formation of specialized labor.
Araújo e Willcox (2018)	Strong	The energy auctions, tax credits and tax incentives stand out (especially the NBESD). Thus, they emphasize that Brazil has achieved success in the sector, given the combination of industrial and energy policies.
Gouvêa e Silva (2018)	Insufficient	Public policies that encouraged the consolidation of the national wind farm. However, there is a lack of integrated planning between public agencies and entrepreneurs, as well as the maintenance of incentive policies.

Source: Search results.

From its taxonomy and subsector analysis, the low articulation between the three aforementioned segments is highlighted, which are fundamental for a good synergy of the wind energy SNECO. Although there is no formalized SNECO in the segment, there are interactions between innovative players, which once expanded (or improved), would further consolidate the eco-innovative segment.

In view of the facts mentioned, it is verified that Brazil presents potentialities that aim at the consolidation of a SNECO, where the spheres of public power should have an aggregating role, heading the systematic organization of the networks (companies-Fomentation Institutions, Universities, other research intuitions, etc.), and simultaneously, promote promotion and development policies with emphasis on the production of clean and renewable energy.

4.3 Propositions

Given the previous scenario, it can be seen that the government tends to be the major interlocutor in these modifications, promoting support and promotion policies and, above all, accepting the relevance of eco-innovation, both in the generation of wealth, and as an inducer of social and ecological transformations.

In contribution to the debate, Ansanelli et. al. (2021) the ecoinnovation emerges as a transition process which involves the Circular Economy, Green Economy and the presence of Industrial Innovation Ecosystems. The theme has aroused strong attention, in the sense that the debate directed towards the concern with the environment and global warming continues in high gear, in the face of several environmental disasters and negative impacts on the economy, these have ended up promoting negative externalities that can hardly be mitigated.

In relation to the Brazilian academic environment, some studies have been developed as Rabêlo (2015) and Ansanelli et. al. (2021), these seek to identify factors that convey the performance of firms amid industries in Brazil. In both works, the market is presented as the main determining factor, while environmental regulation does not represent as much significant effect, therefore, cooperation between agents emerges as the main factor inducing actions aimed at ecoinnovation. However, it is necessary to highlight that the firms used in these studies used data from PINTEC, although the agents that participate in the Ecoinnovation System consist of a public beyond the firms. Thus, it is important to highlight the work of Penrose (2006), in which the author emphasizes that firms are more than a simple administrative unit, since they correspond to a set of tangible and intangible productive resources, and this relationship allows the development of relationships that may lead to the emergence of incremental innovations and the construction of partnership and cooperation relationships.

Also, in contribution to the present work, the work of Penrose (2006) is extremely important, because it was the first one that had the real interest in understanding what happens inside the black box different from the neoclassical model. The innovation actions, besides allowing the growth of firms, allow the development of industries and the emergence of others. In contribution to such factor, Penrose (2006, p. 31):

> *The enterprising firm, if it is a large one, will permanently commit part of its resources to the task of investigating the possible avenues for profitable expansion, acting on the general presumption, supported perhaps by past experience, that there are always likely to be opportunities for profitable growth, or that expansion is necessary in a competitive world*.

On the other hand, entrepreneurial and innovative small businesses take advantage of opportunities that may arise and of the cooperative relationship, Tigre (2006) on Penrose's contribution emphasizes that experience enhances the ability of firms to acquire new knowledge and to improve it, thus their productive capacity is expanded due to improved knowledge that allows them to take advantage of opportunities that may arise. Thus, the results presented by Rabêlo (2015) and Ansanelli et. al. (2021) corroborates Penrose's work.

Still on the participation of agents in the market, Porter (1990) emphasizes that the unit of analysis becomes the industry, which is formed by a group of agents that compete with each other in the provision of goods and services; the author presents his idea through 5 (five) competitive forces that model the structure of each industry: (1) the threat of new entrants, (2) the threat of substitute products or services, (3) the bargaining power of suppliers, (4) the bargaining power of buyers, and (5) rivalry among existing competitors.

The contributions of Porter (2005) and Penrose (2006) corroborate the development of Innovation Ecosystems, since Porter presents the idea that the establishment of profitable and favorable positions determines the pattern of behavior and action within the industry, and its relationship with other agents outside the industry. As well as Penrose, when addressing that the firm's expansion process occurs via the use of the opportunities present in the market. In this sense, both authors corroborate the development of the logic of Innovation Ecosystems, given the cumulativeness of knowledge and the relationship that begins to exist between industries and their relationship with other agents.

In contribution to Spinosa, Schlemm and Reis (2015) the Innovation Ecosystems should be able to promote actions that can: (i) promote urban and environmental development; (ii) establish network relationship between knowledge and urban development poles; (iii) stimulate socio-cultural capital; (iv) stimulate institutional development ; (v) promote public policies, environmental sustainability social and technical, in order to facilitate intensive and knowledge activities; (vi) stimulate knowledge from inside and outside the innovation ecosystem, adoption of positive actions from inside and outside the innovation ecosystem.

Also, in relation to the study of Spinosa, Schlemm and Reis (2015) and different from the analysis performed by Rabêlo (2015) and Ansanelli et. al. (2021) and other international studies, the authors point out that Innovation Ecosystems involve firms and places for knowledge-based innovations, spaces for collective learning and knowledge exchange, in addition to organizations that can promote the culture of innovation, research and R&D centers.

Regarding the composition of agents within Innovation Ecosystems, the studies by Kortelainen and Järvi (2014), Spinosa, Schlemm and Reis (2015), Ikenami, Garnica and Ringer (2016) and Teixeira et al. (2015), of these are presented as agents that comprise: (i) educational, knowledge, research and development institutions; (ii) organizations and private; (iii) banks, investors, funding mechanisms; (iv) environments that can promote the interaction of innovation agents, R&D developers and that can disseminate the culture of innovation; (v) other institutional stakeholders that can favor the advancement of Ecoinnovation actions, thus, the synergy that occurs between the agents comes to be the reason that allows the cooperation and success of Ecoinnovation.

Contributing to the discussion, Sampaio (2018) highlights that ecoinnovation emerges as a subtype of innovation, with the purpose of developing innovations that can promote environmental advantages, favorably mitigating the

environmental damage promoted by other similar products in the market. The author also highlights that the presence of environmental regulation emerges as a strong driver of its use, favoring the minimization of negative externalities present in the market.

The study developed by Ervilha, Vieira and Fernandes (2019), as well as Rabêlo (2015) and Ansanelli et. al. (2021) develop analysis via PINTEC, however, the authors present contribution in the participation or incentive of government actions, where these come to occur via combination of two approaches: either through the demand-pull model - pulled by demand; or technology-push - through the R&D process. The relationship of government action occurred through tax incentives, indicating that government support "increases by approximately 23% the chances that firms are in more relevant ecoinnovation categories compared to firms that do not receive such government support." (SAMPAIO, 2018). Thus, government participation becomes necessary as it regulates actions and promotes ways that can contribute to advancement.

According to the study developed by Rennings (2000), the author highlights that since the Rio 92 the world has committed itself to guiding its actions on sustainable principles, and that the search for sustainability corresponds to the development of long-range and long-term changes. In the study developed by Rennings (2000, p. 320), the author presents the importance of understanding the innovation process, citing possible actions of which are cited:

(i) Strategies for regulating the effectuation of technological forces or changes in the technological regime, and not the simple change of environmental loads (reduction of greenhouse gases);

(ii) The benefits of environmental policy should be favorable to develop innovations to create new means and not simple regulation or even cost increase in reducing production;

(iii) Changes in the regime and actions in a realistic way, and not simple options to be proposed, for example, for the development of new vehicles and renewable systems a whole chain must emerge, so it takes time for adaptation and improvement. There is a need for transition via a learning process (Nelson and Winter, 2005).

(iv) Changing scenarios with goals of sustainability, progress and technological complement;

(v) The invention and adaptation of processes and products that are environmentally desirable to society must be part of everyday life, so the agents present in the market need time for the adaptation process;

(vi) Finally, the author emphasizes that many sustainability programs are needed, in addition to initiatives that can promote scientific and innovative policies capable of improving the economic and social systems.

Based on the discussion and the aspects presented and proposed by Rennings (2000), from the operational point of view, the following action points are described that can be adopted aiming at an expansion of management:

1. Development of specific technical studies for ecoinnovation, focused on small, medium and large companies and the industrial segments, as in Aloise (2018).
2. Promotion of policies to foster eco-innovation, especially in areas of pollution control and wind energy production.
3. Closer ties between companies, research institutions and universities.
4. Training of government agents focused on sustainability and inserting them in debates about innovation.
5. Establish efficient relationships with external partners, with emphasis on technology transfer and local production of the capital inputs of the wind power segment.
6. Stimulating the development and registration of ecoinnovative patents, especially in environmentally strategic and potential areas, as pointed out by Hille et al. (2020).
7. Revision of wind power purchase and sale auctions, establishing more efficient contracts that are immune to macroeconomic fluctuations.
8. Policies of credit incentives consistent with other RD&I policies.
9. Development of a local industry, with the possibility of supplying the demand for equipment.
10. Training plans to train local labor generating employment and income in communities affected by wind farms.

Given the reach in the objectives outlined above, the consolidation of a SNECO is an important strategic tool, aiming at the existence of a technological and innovative environment, but environmentally balanced for present and future generations.

5 Final Considerations

This study develops a reflection and qualitative analysis of the global Ecoinnovation process and the actions necessary for the development and maintenance of the Brazilian National Ecoinnovation System, more precisely starting with the Electric Power System. In relation to this sector, it will be considered in function of its specificities, due to the possibilities it presents in mitigating the impacts of negative externalities.

One must consider that the consolidation of the Brazilian National Innovation System happened late, bringing intense reflexes in the segments that innovate, besides, of course, the changes with a sustainable and ecological focus. Even though the Brazilian NIS was developed late, it makes room for the incorporation of Ecoinnovation actions, since the concept has been used since the 1990s.

Based on this aspect, the National Wind Energy Innovation System is presented with a considerable advance in the last few years, since the sector went

through intense modifications, whether of an operational nature or of an institutional and legal nature, through the reconfiguration of the sector by means of the new regulatory framework developed in 2004, arising a combination of public intervention with a certain level of competition and private opening.

These factors have enabled a new positioning, arising from the adaptations caused by the strong impact brought about by the neoliberal model planned and implemented in the 1990s, causing direct impacts on the segment in question. The main one was the supply crisis, which generated a wave of "blackouts" throughout the year 2001. Due to such actions, a new model emerged, and the sector started to count on at least 1% of the Net Operating Revenue of the agents, necessary for the advancement of R&D, however, well below other countries, as evidenced by Bin et al. (2015). The actions arising from R&D, articulations and policies developed were able to promote the advancement of renewable energy in the Brazilian energy matrix, such as biomass, solar energy, and wind energy (the result of our analysis).

However, even in the face of the advances presented in this study, there is still the need to make some notes necessary for the advancement of the National Ecoinnovation System for wind energy.

One outstanding point is the inexpressive interrelation between the market units (industries or companies) and the executive and scientific public power. The breaking down of these barriers is totally necessary, both for the expansion of ecoinnovations already existing in the production units, and for the development (and improvement) of new ecoinnovative technologies.

As limiting factors to the present study are analyses that could enhance the degree of interaction between Academia, Government and Market, based on the Triple Helix analysis, as well as analyses and studies that show the degree of R&D, configuring aspects that point to the search and selection process. This shows that such factors are still not so explored. And, data that identify the intense search and selection process, even in the face of the information already present. Another point refers to the criteria used by the authors in the selection of articles for analysis, even in the search for reducing selection bias, the researchers may not have considered some relevant works in the area.

As new research to be highlighted, besides the points already mentioned in relation to operational aspects, it is evident the need to analyze the impact promoted by the wind power segment before the energy is obtained. In this case, the externalities generated in the production of turbines and rotation blades that transform kinetic energy into mechanical energy, in addition to transport and maintenance, as well as the collection of data from some sectors that make up the system to verify the assumptions raised here. In addition to these aspects, the NIS of Ecoinnovation enables the development of environmental policies and incentives for environmental innovations, which may be aligned with policies that encourage improvements in the activities developed in the market, which have support in the scientific community and which are promoted for the benefit of society as a whole, promoting improvements for sustainability and for the environment.

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