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WOOD PLASTIC COMPOUNDS (WPC) PRODUCTS AND ITS CONTRIBUTION TO BIOECONOMY: A DESCRIPTION OF THE CURRENT SCENARIO IN BRAZIL

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Abstract

Also known as natural fiber polymer Composites, Wood Plastic Compounds (WPC), are a blend of wood, wood flour, thermoplastic resins and other additives that can be used in various ways, such as, walls, boxes for packaging different materials, fences, houses, among others. Bioeconomy is defined as a sustainable part of the economy associating with the utilization of the biological resources (wood, health, fibers, animal based – including fish -, food, industrial products and Bioenergy) in the production and conversation of it in biomass with a low environmental impact. The main purpose of this paper is to show the relevance of the WPC products in a sustainable world and how it can contributes to the introduction of Bioeconomy concepts in Brazil. This descriptive research was based on a survey applied to a Brazilian WPC industry aiming to raise important economic, social and environmental data about the current scenario. It was found that the company works on a sustainable way while manufactures WPC products, esteeming the Bioeconomy concept while they have the focus on the low environmental impact with a low carbon footprint and finding an alternative solution to the deforestation of the Amazon. WPC decks can be presented to the foreign market as soon as the company is able to take all the legal and simple first steps to become an authorized company, also operating in the international market.

Keywords: Bioeconomy, Brazil, Sustainability, Wood Plastic Compounds (WPC).

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1 INTRODUCTION

It sets the scene of natural resources are becoming scarce. Whole nations are struggling for seeking water, food, wood, energy and soil/land. This shows how the human being claims to a lifesaving solution to achieve and to take their society to a sustainable way (UN, 2015).

In accordance with FAO (Food and Agricultural Organization of the United Nations), the natural resources depend of a sustainable governance and management ways to make them possible to benefit all generations, from the present and for the future (FAO, 2015).

Regarding this, some countries in Europe, Asia, as well the United States of America (USA) and Canada, showed a considerable evolution in this matter through the introduction of Bioeconomy concepts in their societies.

Formally, Brazil is not a beginner in researching this subject, but still has a gap to fill the concept, especially regarding to policies and legal matters to apply Bioeconomy definition and actions in the sustainable Brazilian agendas.

Studies indicate that Brazil, even not knowing it, started working with a part of the this economy area in the beginning of the XX century, while introducing the Biofuel named ethanol, (a fuel produced with sugar cane raw material) with the aim of reducing the dependency of the petrol foreign market also reducing the successive crises of the sugar sector. This idea was supported, in 1975, by the Brazilian National Alcohol Program (Programa Nacional do Álcool) which overall objective was to reduce the Brazilian dependency of the imported petrol. In that time, there was no worries about the CO2 (Carbon Dioxide) emission while burning fossil fuel and its influence in the environment and in the human being wellness. Being guided for this information, it is logical that wasn't any evidence about Bioeconomy term in the Brazilian policies. The situation just started changing with the flexi-fuel cars in 2003, when the advance of the studies and searches in the Biofuel area in Brazil, makes it a renowned competitive player in the internal and in the foreign markets making bioethanol gaining autonomy as liquid fuel (LEITE; CORTEZ, 2008).

In 2010, a company from the south of Brazil, which produces WPC products, had it project funded by FINEP – Financiadora de Estudos e Projetos (Financier of Studies and Projects) –, a Brazilian public company fostering science, technology and innovation in companies, universities, technological institutes and other public or private institutions with the aim of repairing the Brazilian Navy ships and to build wharfs using WPC material (FINEP, 2010).

In 2012, Embrapa, also developed an important project including bioeconomy in Brazil establishing a laboratory at Forschungszentrum Jülich in Germany. The collaborative research is focused on the topics of bioeconomy and plant phenotyping. This cooperation is important for the sustainable development of this key issue for the future. (Julich Forschunsgszentrum, 2012).

In the same year in an Earth Summit in Rio de Janeiro, as part of the green economy approach negotiation, Brazil participates on a proposal to develop a post-fossil fuel Bioeconomy. This Bioeconomy approach was based on the use of biomass as a fuel and as a raw material focusing the manufacture products variety from plastics and chemical. Also, in that opportunity, the range of technologies including Biodiversity and Biotechnology were discussed. (Hall et al, 2012).

The connection with Wood Plastic Compounds may be linked with a diversity of world summits discussing the need of sustainable society, environmental issues, the conscientious use of natural resources, and ways to create clean and green options to find a

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better way to grow the economy and welfare. Due to that, WPC based products could be included as one option that may solve such endless and innocuous discussions.

In this context, it is possible to see how the Bioeconomy definition and WPC are closely related.

The WPC products are originated from biomass, using renewable materials as well as the Bioeconomy concept includes and aims a sustainable part of economy which is based in the biomass production and use of sustainable materials. Both aim a low environmental impact, making possible a sustainable way to achieve an ecofriendly, economic and social wellness.

The main objective of this paper is to show the relevance of WPC based products in the Brazilian scenario and how they can contribute to the adoption of Bioeconomy concepts in Brazil.

This work is justified by the need to raise awareness about the importance of using sustainable inputs in several stages of the supply chain and also because there is a need to discuss the current projects in development and to find possible recommendations to simplify policies and legal matters, as well as to increase the possibility of new projects in the WPC area, which would facilitate the entry of the Bioeconomy concepts and application in Brazil.

It is hoped that the findings and reflections at the end of this work may contribute to the advancement of knowledge on the subject.

2 LITERATURE REVIEW

The importance of the Bioeconomy

To start understanding the Bioeconomy concept, it is important to know about a Romanian economist who approached the subject for the first time in 1966. Nicholas Georgescu-Roegen's contribution to social economics was his development of a comprehensive theory of economy, society, and biophysical constraints. Georgeous named his new approach as bioeconomics and in 1977 he published an important paper arguing and opposing the economist's analyses views. This paper approached the economics are more than exchange market description and policies recommendations. To the author, these economics' analyses should consider the biophysical and social context regarding the comsuption and production framework (GOWDY; MESNER, 1998).

The Bioeconomy is defined as a sustainable part of the economy associating with the utilization of the biological resources (wood, health, fibers, animal based – including fish -, food, industrial products and Bioenergy) in the production and conversation of it in biomass with a low environmental impact (EPSO, 2011; FIESP, 2014).

The European Commission of Bioeconomy policies calls the attention to the importance of Bioeconomy describing and illustrating the matter in the Figure 1 as a maximum benefits which the various sectors of the Bioeconomy must be properly attached, since they are all correlated.

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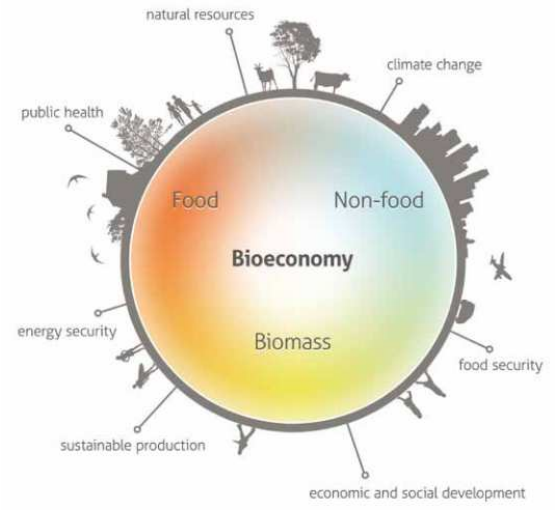


Figure 1: Bioeconomy benefits for several sectors.
Source: EPSO, 2011, p. 6.

Also, the primary production within industries of agriculture, forestry, fisheries, aquaculture, food, health, chemical, biotechnological and energy, which make use of biological resources and biomass, are linked within Bioeconomy concept (EU, 2015).

They bet Bioeconomy as a strategy applied by society to fight and eradicate urgent problems, such as climate change, also taking this opportunity to increase the competition for natural resources and the development in the rural and regional areas. They advise that Bioeconomy must be received and understand as a green and new concept of the economic and social order with a challenge in changing most of practices and structures already existed in the world (SITRA, 2015).

In accordance with Leal Filho, during speech on the event named "Workshop Brasil-Reino Unido de Biodiversidade e BioEconomia" (Brazil-United Kingdom Workshop of Biodiversity and Bioeconomy), the Bioeconomy matter also involves innovations in the field of applied life sciences covering the development of biological products and requiring new approaches to biotechnology (LEONEL, 2014).

Wood Plastic Compounds (WPC)

The WPC concept was created in 1970s in Italy, becoming popularized in North America in the early 1990s and spreading to India, Singapore, Malaysia, Japan and China in the 21st century (PRITCHARD, 2004).

WPC can be considered most dynamic sectors of today's plastic industry with an average annual growth rate of approximately 18% in Northern America and 14% in Europe (GUPTA et al., 2007).

WPC consists of a mixture of wood, thermoplastic resins and other additives.

According with Crookston, et al, (2011), the wood can be used in various forms, but it is more likely used in wood flour (fine particles) also being possible the use of recycled or even virgin plastic materials to produce the WPC products. The authors, also explain the importance of polyethylene in the production of WPC products due to its thermally stability in the extrusion procedure and its durability in nature.

In accordance with Klyosov (2007), decks made of WPC have been the most attractive product in the market. The author details the decks from WPC with a pretty good looking and

assure the safety of this type of decks illustrating “the walk on them barefoot without any precautions to get a splinter in the foot”. There are no splinters in WPC decks.

The main interested aspects pointed from the author are the minimum required maintenance in the WPC decks. It means, less money spending in chemical products to maintaining the regular staining and painting, considering this type of biobased product is colored for life. Their resistance to biological degradation like microbial and termite, indicating another advantage in saving money and saving the environment of antimicrobial and antitermite harmful agents (KLYOSOV, 2007).

The deck installation difficulty’s degree is in the easy range, due to their safety of lack splinters, easiness to cut, to screw, to saw and to nail. This ease way of installation has attracted many professionals to work on it and thereby it has contributed to increase their incomes and consequently had improved economic and social well-being of the society (KLYOSOV, 2007).

Yadama and Shook (2004) explains the advantages of products which contain WPC, highlighting their ideal utility for external uses. The evaluated items are explained in Figure 2.

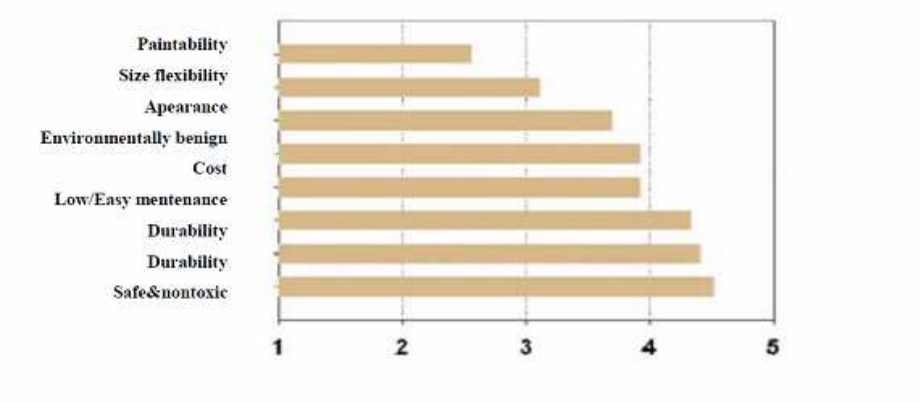
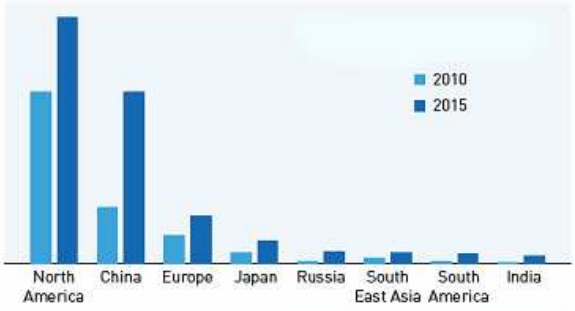


Figure 2: Degree of Importance.
Source: Yadama et al 2004 (wpcinfo.org)

The WPC scenario around the world

Nowadays, the major production of WPC can be found in China with (25% p.a) with a considerable growing of the Chinese domestic WPC demand.
In accordance with Bioplastics Magazine, the Chinese WPC industry is the second largest in the world after United States.

According to the forecast (Figure 3) China and USA will reach the highlighted positions of the global WPC production in 2015 whereas South America countries still rank the worst WPC global market share and it includes Brazil. (BIOPLASTIC MAGAZINE, 2013).



	2010	2015	growth % p.a	global share in 2015
North America	900000	1300000	8	48%
China	300000	900000	25	33%
Europe	150000	250000	11	9%
Japan	60000	120000	15	4%
Russia	10000	70000	48	3%
South East Asia	30000	55000	13	2%
South America	10000	50000	38	2%
India	5000	40000	52	1%
Total	1450000	2695000	13	103%

Figure 3: WPC market development.
Source: BIOPLASTIC MAGAZINE, 2013, p. 17.

North America countries also have their contribution to Bioeconomy and WPC products. In Toronto, CRIBE - Centre for Research and Innovation in the Bio-Economy - is partnering with GreenCore Composites to develop a new green technology process that will allow wood fiber applied in use to a number of new products as packaging and building applications, as pallets and various other containers types. (CRIBE, 2012).

In February 2014 the USGBC (U.S Green Building Council) from the United States of America informed about Company which is an US manufacturer of advanced wood polymer composites, which is responsible in made from reclaimed wood fibers combined with HDPE, PP or PVC, using potential waste stream materials to the WPC green final product as decking, window parts and much more. (USGBC, 2014).

In Germany, there is a company in Baden-Württemberg State which manufactures WPC products, using a renewable resource for industrially manufactured products instead of plastics. This company products bricks, walls, pet houses among others. (BIOPLASTIC MAGAZINE, 2014)

In Brazil, the economic data to WPC products are full of gaps with urgent needs to be filled. There are some companies which are still producing WPC products in South and Southeast of the country but their production has still no Bioeconomic relevance in the global market share. (REVISTA TECNOLOGIA DEL PLÁSTICO, 2011).

Challenges faced by Bioeconomy

In accordance with The Copenhagen Declaration for a Bioeconomy in Action from March 2012, there are 22,000,000 employs in the Europe's bioeconomy area. It means 9% of workforce (DCSR, 2012).

The Finish government is investing in the Ecotourism as part of a Sustainable Strategy aiming the growth from Bioeconomy. According to them, the Bioeconomy is the backbone of Finland's economy now and in the future. The national Bioeconomy strategy for Finland was published in early 2014. (BIOTALUS, 2014).

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OECD and non-OECD countries face a range of environmental, social, and economic challenges over the next two decades. They expected an increase by 28% in the global population until 2030. This raise will call to an increase world demand in health services to provide a better life's length and quality also a demand for the essential natural resources which includes energy, water, food, house and fiber for clothing. At the same time, the world's ecosystems that support human societies will be almost over exploited and unsustainable becoming almost impossible to reverse the damage caused by such changes in the global ecosystem, implying considerable damages in a most basic means of survival for the human being as agricultural productivity and water supplies. (OECD, 2009).

However, the situation in Brazil is very different in terms of applying the bioeconomy concept beyond Biofuel and innocuous discussions on Agendas and bills. In 2014, the National Industry Confederation - CNI (Confederação Nacional das Indústrias), created an Agenda to the competitiveness, focusing in opportunities and obstacles in Bioeconomy area. This agenda is based on OCDE (2009) document which divides the Bioeconomy matter in three parts: biotechnology, human health, industrial and primary production. The aim of the Brazilian Agenda includes generating a critical mass of qualified researchers for new talent in scientific and technological leadership which can emerge in Brazil. In this sense, it may be necessary create or strengthen on competitive and meritocratic basis a more restricted set highly qualified research groups, facilitating their cooperation with high renown international institutions, so that these groups also make reference in the bioeconomy border (CNI, 2014).

In February 2015, during a Brazilian conference to discuss an Agenda based on Bioeconomy matters, the coordinator of intellectual property and the Bioeconomy of the CNI, Diana Jungmann, approached the term and its related subjects, making public the first research on the perception of the issue among people who are already familiar to the Bioeconomy issues as business representatives, the executive and legislative powers, academia and experts in the field. To the coordinator of this program, stays the perception of barriers exist within both sides, in government, in academia environment and for business players. Also this means clear urgent methods to advance in the area. It was clear that Brazil needs to work hard to qualify the necessary manpower and, above all, improve the set of laws that will enable the development of the Bioeconomy in the country. The promise to 2015, is based on a hard work to see if, within a new cycle of government, the advances in both sides, such as the regulatory framework of intellectual property as the bioeconomy, will advance. The CNI proposal, once more, is based on more discussion and more Agendas. They will discuss with the government the issues that are really obstacles, and which will be the measures to resolve it (JUNGMAN, 2015).

One of the most important and recent step toward Bioeconomy made from Brazilian government, is the bill number 7.735/2014 concerning about Biodiversity, approved by Brazilian president in April 2015. The bill sets clear rules for the allocation of benefits which will become essential to researches and to Brazilian Bioeconomy's development. For the Business Secretary of the Brazilian Agricultural Research Corporation (Embrapa), Rosa Miriam de Vasconcelos, the Embrapa believes that this legal framework can, in addition to eliminating obstacles to research, also create conditions for Brazil to enter efficiently in Bioeconomy. Legally based on the current legislation, the company is obliged to negotiate a benefits concession contract before the assessment tests (CNI, 2015).

Globally, the Bioeconomy concept will face up more than linked matters as social, environment and economic impacts, but also, it will face the culture and education subjects that besides being attached in social matters, they may be stronger and harder to be face than other challenges which will be on the way. The way a nation treats the education field to their

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society can be the main key to decide about whole process, including a final decision to adopt or not a concept which is responsible to change and affect all their lives.

Bioeconomy, WPC and the economics innovation

The process of interpreting an idea or invention into a good or service that creates value or for which customers will pay, reaches the innovation concept. For the real existence of innovation it is essential that the concept of it and the product created on the idea, reflect in a feasible economically way, analyzing the costs which this product will present and also it this product can achieve a specific market and or the final consumer need (ATHAVALE, 2014).

Innovation involves deliberate application of information, imagination and initiative in deriving greater or different values from resources, and includes all processes by which new ideas are generated and converted into useful products. In business, innovation often results when ideas are applied by the company in order to further satisfy the needs and expectations of the customers. In a social context, innovation helps create new methods for alliance creation, joint venturing, flexible work hours, and creation of buyers' purchasing power (PATIL, 2014).

Innovation involves concise application of information, imagination and initiative in constitute larger or different resource values. The same concept includes all the processes generated by new ideas and consequently transformed into useful products and added value. Within the business sector, innovation most often begins to take shape from the moment that companies apply their ideas aiming to satisfy the expectations of their customers. In a social context, innovation is helpful in creating new methods for attaching customer’s loyalty to the company, to its products, even to buyers' purchasing power creation (BHAKKAD, 2014).

The innovation is often considered as an important element of policies towards sustainable development. The focus on an innovation is not enough to achieving the high demand on environmental sustainability studies (NILL et al, 2009).

The Innovation includes three innovation stages: a product, a process and a behavioral innovation (PIANA, 2003).

For several political and economic reasons, the most of policymakers are not fond of innovation economics and innovation policies. (ATKINSON et al, 2012)

Innovations are important guide for the Bioeconomy dissemination. Since Bioeconomy concept encompasses all the sectors linked with services and technologies and which produce, process or use biological resources, the innovation potential and concept are indispensable (PATHAN et al, 2014).

The Bioeconomy idea and concept bring opportunities for the application of systematic operations, social innovations as well as on a branch of products. These biobased products as Biofuel, WPC and other chemical ones are still developed and have a market value added (RÖNNL et al, 2014).

In 2013, at Fifth German WPC Conference, the winner of the WPC Innovation Award 2013 was elected from six nominated candidates. The prize was sponsored by a noted German company. According with Director of the hosting organization nova-Institute, Michael Carus, the quality and the number of the submitted WPC products were very high if compared with years ago (NOVA INSTITUTE, 2013).

3 MATERIAL AND METHODS

Considering that the main objective of this paper as to show the relevance of the WPC products in a sustainable world and how it can contributes to the introduction of Bioeconomy concepts in Brazil, it was chosen to adopt a descriptive approach. Descriptive researches aims to describe the characteristics of a given population or phenomenon or establishing relationships between variables (GIL, 2002). It enables the development of an analytical level that allows to identify the different forms of phenomena, ordering and classification The facts are observed, recorded, analyzed, classified without the researcher interfere in them, that is, phenomena are studied, but not manipulated (ANDRADE, 2005). It is the most appropriate type of study when it needs to get better understanding of the behavior of various factors and elements that influence certain phenomenon.

One of the most significant features of a descriptive study is the use of standardized data collection techniques, highlighting the questionnaire. A questionnaire consists of an ordered series of questions that must be answered in writing and without the presence of the researcher (GIL, 2002).

To achieve the necessary data about the current scenario for WPC in Brazil, a questionnaire were applied to a WPC industry named Nanoway Composites, in the Southeast of the country. The questionnaire was sent to be answered by one of the managers and included economic, environmental and social aspects, among others. It consisted of the following seven questions:

1. Why the company chose to produce WPC (Wood Plastic Compounds) based products?
2. Which WPC products do the company works? Please, summarize the production process, including the necessary machinery and raw material.
3. Is the commerce of WPC products economic feasible?
4. What is the contribution of WPC products to Bioeconomy?
5. Does the company import raw materials? If yes, which ones? If not, why?
6. Does the company export WPC products? If so, to which countries? If not, do you have plans to export it?
7. What are the main difficulties to commercialize WPC products? Any legislation, economic or technical issues?

Considering that was decided to limit this study and focus it on one organization that produces and commercializes WPC products, the method can also be considered a case study. The case study is characterized by deep and thorough study of one or a few objects, a way that allows its broad and detailed knowledge (GIL, 2002).

4 RESULTS AND DISCUSSIONS

The survey was sent by email to Nanoway Composites manager on May 22nd 2015. A reply was received on May 31st 2015.

Firstly, it was asked the reasons to produce items based on WPC. According to the Nanoway Composites corporation manager, the most important reason is to replace the traditional solid wood decks, most of them hardwoods, which are contributing for the degradation of the Amazon Rain Forest.

About the items produced by the company, it was mentioned that it produces two types of WPC decks, hollow, with the composition of *Polyvinyl chloride* (PVC) and additives 50% and lignocellulosics fibers 50% (eucalyptus bark).

The production procedures consists of one extrusion line of a conical twin screw extruder, 86 mm, including the compounder, extrusion line, dyes, caterpillar and saw.

Next, it was asked about the economic feasibility of working with WPC based products. It was quoted by the manager that the line is still in the process of assembling and will be operational in three months.

Regarding the contribution of the products to Bioeconomy, it was mentioned that they have a low carbon footprint, since 50% of the PVC is salt and the other 50% of the product is a waste renewable material (the basic raw materials for PVC are derived from salt and oil).

In sequence, it was asked about the need for importing raw material. Nanoway Composites manager claimed to import only special additives not manufactured in Brazil. In summary, the raw material cost itself has local production.

About the exporting of these products, it was mentioned that it does not happen yet. The main obstacles to this matter are the cost of the raw materials, labor and taxes, that seems to be higher in Brazil in comparison with other countries.

Finally, regarding the difficulties to commercialize the WPC products, it was mentioned that there aren't technical issues or any fact related to legislation, only the non-legal suppliers competing against a product that has to pay all the taxes and the processing costs of cleaning and homogenizing waste material.

5 FINAL CONSIDERATIONS

Based on the collected and searched data, it's possible to conclude the evolution in Biobased market such as Bioeconomy concept praxis applied by countries as China, United States of America and European ones.

For the other side, also became clear the urgent investments with several efforts based on Bioeconomy concepts and WPC products within Brazil. Even the country still producing some WPC products, they are not enough to face the foreign market or even being part of a Bioeconomy society within the country.

Although Brazilian WPC products are good quality and with remarkable innovation goods, even so, it is not enough to achieve the Bioeconomy concept.

Furthermore, the Brazilian government takes part of the responsibility to campaign for biobased products besides the Biofuel of sugar cane. For assorted political reasons, Brazil has stimulated the Biofuel in the home and in the foreign markets. The Brazilian people must know that the variety of biobased products is beyond the Biofuel concept.

To integrate the Brazilian society in the concept of Bioeconomy and liked matters, the government with all Organizations involved and responsible to broadcast policies, agendas and bills, may start creating incentives to the companies which produce biobased products also a biobased labor relationship.

Another important and maybe the indispensable way to start a Bieoconomy nation is including the subject in the education of their citizens. Schools, Universities also people responsible for education, must work with Bioeconomy concept to educate their pupils in a sustainable and biobased society.

The Brazilian market WPC needs high attention to invest in research, innovation and clear information not just about Bieconomy procedures and policies but also to start a positive work within the export concepts and procedures. These may show to WPC industries how they can obtain several benefits of releasing their biobased products in the international market and in this opportunity, besides making part of the WPC global market share, they also may contribute to the society welfare, positively increasing social, economic and environmental aspects of the country.

Brazil has a huge potential to be a leading country in the Bioeconomy area. Considering its variety of natural resources and the implementation of its environmental policies, it remains only leave the paper to put into practice and become a sustainable nation with an internationally recognized Bioeconomic power.

This research was based in only one WPC Brazilian company. It does not mean the results shall be generalized reflecting the reality of other companies in the same industry.

Taking the gap of this matter, the study opens opportunities for proposals for future studies and conducting the same research in other companies that produce items based on WPC, comparing the Brazilian Bioeconomy reality with other countries, targeting them in stages as concepts Bioeconomy already established or in consolidation.

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