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Reflections on Energy Sustainability in Latin America: Biomass and Circular Economy

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***Abstract**: The use of resources based on the circular economy and the adaptation to renewable forms of energy has now become a fundamental paradigm for developing a more sustainable and responsible world. The change of these energy practices in the contemporary world is posed as a complex challenge, since from the economic, political and social point of view, the change in industries poses a radical change in consumption and production habits. However, the use of new energy strategies, from the point of view of industries and States, has become a key point in the search for greater stability of the environment and society. This article is a theoretical overview of the different proposals, challenges and problems posed by the adaptation of new energy sources and the circular economy in Latin America.*

***Keywords:** Latin America, Biomass, Circular Economy, Sustainability.*

I. Introduction

Currently there are multiple methods, processes and ways of approaching the phenomenon of renewable energies at the national and international levels. Of which stand out approaches to bioenergy, life cycle analysis, pellets, briquettes, pelletizers, forest residues, biomass, among others (Romero 2010). Each of these energy perspectives result in the potential possibility of renewable and clean energy, which not only allow extensive care for the environment, but also enable and permeate the economic possibilities of nations. Countries such as Spain, Germany, Italy and the United Kingdom have invested in the first decades in sustainable economic models that allow a new energy development (Caraballo and García 2017, 573). In terms of the circular economy, various challenges have been raised that have hindered the use of this type of strategy to heal the environment and fundamentally have other commercial practices that allow greater use of the resources and materials used. Elements such as recycling, reuse and remanufacturing are also an essential part of bio-ecological proposals for a more sustainable development of energy and resources. This article is a theoretical review of the different forms of energy that have been used and wasted in the framework of sustainability in Mexico and in some other Latin American countries.

In the particular case of Mexico, from the beginning of the six-year term of the government of Andrés Manuel López Obrador, the conditions began to be created to stop, block and limit access to clean and cheaper energy, while the recovery of energy was promoted. dirty as coal, fossil fuels and the construction of a refinery in the oil port of Dos Bocas in the municipality of Paraíso Tabasco. In addition to this, also through certain legal changes sought by the president of the country, new ways have begun to be developed to nationalize the economy and the energy market through the control and monopoly of the State of the sources of service and energy production. in various sectors of the country. The electrical reform proposed in Mexico seeks to limit the participation of private agents in the country's energy development, establishing a monopoly of around 54% of energy sources to the main government energy company of the State, the CFE (Ocampo 2021). . Situation that positions Mexico as one of the nations that begin to separate itself from the rest of the leading countries in the creation and promotion of clean energy and care for the environment proposed in agreements and conferences such as the one in Glasgow Scotland at COP26. Competitiveness and the energy crisis that is being faced globally requires a constant adaptation of multiple public and private agents to enable the promotion of clean,

sustainable and lower-cost energy for citizens today. In nations like Argentina, the artificial pricing of energy costs, State control and the limitation of private industry participation have set an example in reducing national energy production, international dependence, rising prices and lack of energy initiative. clean. Where since the beginning of the second decade of the 21st century, Argentina still depends 87% on hydrocarbon-based energies (Recalde, Bouille and Girardin 2015). The regulations and projects that Mexico tries to introduce in the third decade of the 21st century, is actually a historical energy exercise that has been carried out in different sectors of Latin America for decades and even five years. The energy regulations promoted since 1960 in Argentina by Juan Domingo Perón.

II. Energy Practices in America Latina

Although during the 1990s a public restructuring began in some Latin American nations, in Mexico there was only 10% access to private capital within the government frameworks aimed at the energy sector (Lorio and Sanin 2019, p.15). Biomass energy, which also has its conceptual correlation as biofuel, is determined as a biological section product of the degradation of some materials of an agricultural, forestry nature and of some industries linked to the sector (EPEC 2015, 2). Authors who are experts in the field, such as Francisco Burgos, determine that Biomass is one of the main sources of sustainable energy that exist as a technological, environmental and social possibility in the contemporary world. Productions such as Bioethanol have had only in the last century from 1900 to 2006 or Biodiesel since 1991, a comprehensive technological development that enables its use in different energy media (Burgos 2010, 13). In addition to biodiesel and bioethanol, there are other possibilities such as Solid Biomass, Biogas, Biofuels or Organic Fractions of Urban Solid Waste FORSU (Quintero and Quintero 2015, 31). These types of biological resources require multiple processes and stages that must be exploited depending on their taxonomic, biological, chemical and physical characteristics. In the case of the FORSE, it is necessary, for example, to take into account a four-stage energy development system: from which the reduction of waste is recovered, recovery of material for recycling, energy transformation of the waste and finally the discharge of waste. leftover materials (Quintero and Quintero 2015, 31). Each of these stages must be strictly monitored for the correct use of this bioenergy, even though this type of energy is characterized by maintaining a low degree of CO2 and a high degree of volatile chemical derivatives and oxygen (EB 2008 ,7). The use of this type of material recycling and material recovery proposes a new way of thinking about used or surplus materials as a fundamental resource in the creation of energy based on an ethic and strategy of circular economies.

One of the essential elements for the correct technological development of Biomass is through its classification and its correct taxonomic division of the chemical components, geographical variants and physical components of the waste (Ramírez et al, 2004, 212). Some authors such as Peña approach said design through what they determine as natural Biomass, residual Biomass and energy crops (Peña 9). Each of these sectors is decisive: for example, the division of residual biomass is determined by its chemical and physical characteristics into dry and wet, forestry, agricultural, natural wastewater, livestock or even industrial waste. (Rock 10). These divisions are comprehensive, in order to determine the basic characteristics required for its application in different environments and sectors, whether Industrial or rural. Despite this, this taxonomy shows an energy advantage, since in all areas of human social development, there is always an opportunity for energy application in some form of bioenergy.

At the international, national and global level, energy is taking a radical and gradual turn on the technological and energy paradigm shift. At present, at the transnational level, biomass energy represents a total of 10% of total energy and 77% of renewable energies, while in Mexico it only covers around 5% in 2011 (Masera et al. All. 2011, p.5). This being a profound energy disadvantage today not only for the country, but also for the areas related to the ecological damage produced by other types of fossil energy, since to a large extent the economic relationship of the countries is also related in different indicators such as this is the case of GDP and energy consumption (Posso 2000, 201).

One of the countries with the best development of a paradigm shift and of taking advantage of these energy opportunities in Latin America is precisely Brazil. Since it is one of the main producers of bioethanol based on agricultural products such as sugar cane, contributing only in the 1990s and the first decade of the 21st century a supply of 14% of the total energy supply through biomass (Huacuz 2015, 58). This type of energy resources can not only be produced with environments and resources linked to sugar cane, but also with beets, corn and some other agricultural materials through fermentation in anhydrous ethyl alcohol or bioethanol (Huacuz 2015, 58). Each of these resources can generate an opportunity for economic, social and even cultural growth in agricultural regions where this type of crop is an energy opportunity for the creation of new forms of energy in Latin America.

Each of the elements, resources and materials that are provided by the possible sources of biomass, can be used in different active spaces within the economic framework of nations. In other words, as presented in the FOCER table (Strengthening of Renewable Energy Capacity for Central America), they not only make possible an intense reduction of the polluting and economic dependence on fossil energies. But a new way of interacting with the dynamics of energy entropy in cities, fields and natural spaces. From the energy, caloric potential, composition and moisture content (FOCER 2002, 10), it is possible to interact with multiple strategies for the creation and use of energy in a sustainable paradigm that is both economic and morally civic with the environment. This being an essential element in the economic and cultural development of many communities in Latin America and Mexico, where it is important, in addition to adapting to the new technological challenges of energy, also to the perspectives of multiple community assemblies to promote the economic survival of localities in Mexico (Restrepo 2021, 622).

The respective table mentioned above by FOCER (2002, 11), mentions the different physical and chemical characteristics of industrial, urban, forestry and even agricultural waste, from which it is possible to create new conditions for the use of entropy. technological and residual. In each of these sectors, the iterative capacity of the natural and industrial constant of waste creation enables the creation of new sequential chains of development of new forms of renewable energy such as biomass, tidal, geothermal, solar, wind energy, among others. another (Fonct 2014,16).

Only in the field of residual biomass is it possible to create an annual energy yield rate of exponential growth that replaces many energies of a more expensive and harmful nature for the environment, such as all those derived from oil (González 10, 2014). Some of the most used species in the field of forest residues and wood in Mexico are detected by the National Forest Directorate, such as Eucalyptus, Laurel and Pine, at commercial levels greater than 76,069 cubic meters annually (Arroyo y Reina 2016). Despite this, there are also some technological disadvantages of some ecological waste in automotive mechanical systems or some fossil fuels, depending on their moisture levels or production. However, there are many opportunities for the adaptability of the multiple biomasses in different items, areas and methods of use, in order to generate greater energy competitiveness. In the case of biofuels based on forest residues, the density and humidity level of the Eucalyptus or the Colorada (Eucalyptus Globulus and Guarea Kunthiana), create the conditions to be able to have a greater increase in the categories of energy density and caloric power (Arroyo and Queen 2016). All this must be taken into account through the chemical use of wood in its elements of Carbon, Oxygen, Hydrogen H, Nitrogen N and some other minerals (Arroyo and Reina 2016), of which it is possible to synthesize in these elements some forms of heat energy.

The energy sources provided by their chemical and physical values, as well as the entropy processes in caloric elements such as steam, require a series of comprehensive systems and methods for the correct use of all residual resources. From the case of forestry to agriculture and industry, the notion of processes must be an element to be taken into account in an integral and fundamental way in the creation of energies with renewable characteristics.

> Biomass in our environment represents a viable alternative for energy use in steam boilers, this assertion is made considering that there are entities that carry out research on this resource, such is the case of the Corporation for Energy Research (CIE) and the National Institute of Energy Efficiency and Renewable Energies (INER). (Stream and Queen 2016, 21)

The mention of energy through biomass using the opportunities of heat and steam, of chemical elements and any other form of usable entropy through the multiple natural residues. Corporations such as the CIE or the INER, which the authors mention, show the deep link between state, governmental and private apparatuses for the creation of energy research adaptability systems, energy efficiency programs and industries that support this type of program. Research such as that of Cruz carried out in 2017 on the creation of bioreactor designs that take advantage of the potential of energy from organic animal waste in Peru based on Indian and Chinese biodigesters (26), show the need to take advantage of all kinds of resources through new scientific energy methods and where Latin America can be an energy power in the future through these new paradigms.

Part of this type of research and projects focuses on the creation of new ways of using resources, but also on a key term in the development of nations, which is energy independence. The different energy sources in developed countries like the United States focus on oil, natural gas, coal, nuclear power and hydroelectric power. However, despite the fact that the use of oil since 1974 continues to be the most widely used energy resource in North America, biomass has still managed to grow in different industrial sectors in the country (US Energy 2011).

Despite this slow rise in the use of clean energy, international groups and associations such as the European Union mention that around the middle of the 21st century, energy from biomass will produce a fifth of all global energy (Dallemand et all.2015). This projection allows visualizing the deep need that exists in the national and international market to adapt new technologies. All this, in order to create better ecological, economic, social and cultural conditions through the construction of new energy paradigms in Mexico and Latin America. Since around the entire continent there are multiple chemical, physical and thermal variants of possible biomass energy sources.

> The value of a particular type of a biomass depends on the chemical and physical properties of the large molecules from which it is made, Man for millennia has exploited the energy stored in these chemical bonds, by burning biomass as a fuel and by eating plants for the nutritional content of their sugar and starch. More recently, fossilized biomass has been exploited as coal and oil… One important factor which is often overlooked when considering the use of biomass to assist alleviate global warming. (McKendry 2002,38)

McKendry's perspective explains the profound need for change in the technological processes of energy creation for the future of the 21st century. The chemical and physical variants of each component and residue make it possible to generate new forms of energy from the characteristics of the residual products. Enzymatic, fermentation, gasification, biochemical processes, among others (Cheng 2017), must be taken into account under the taxonomic variants of the residues of the future biomass. Each of the technological and logistical challenges proposed by the use of these technologies are established within the framework of the creation of sustainable strategies for the establishment of said clean and renewable energies (Zhang et al. 2017, 10). The production of synthetic gasoline based on elements such as Diesel through the biomass of forest wood in the United States exemplifies the search for the pragmatic and efficient use of all the resources of said biomass (Sakanishi 2004, 4). In these processes, it is possible to extract under certain conditions gasoline, oils, gases and other derivative products that allow the best application of forest biomass. For this reason, it is also fundamental to create logistical and methodological conditions for the responsible use of energy sources, since even in cases where efficient processes are not created, it is possible to create deforestation, as in the particular case of Indonesia, where around 20,000 palm trees were deforested. for biodiesel production (Faba et al. 2014).

It is important to emphasize that the use of these processes can be generated in the creation of energy sources of heat, electricity or fuels through thermodynamic conversions or biochemical conversions (Heat, Electricity and Fuels) in each of the residual processes (Faaij 2006). In countries with advanced economic development, such as the case of the People's Republic of China in 2020, various projects linked to the creation of economic, industrial strategies and practices for the creation of biomass energy in rural areas of the eastern country were created. The agricultural areas of China from 2004 to 2020 have had an almost minimal reduction from 752 million people to 681 million, a situation that allows us to think about the energy demand of these populations and their possible energy resources through biomass sources (Zhang et al. al, 2020, 5). In these populations, there has also been an enormous growth in the consumption of sources such as gas, oil and gasoline, a situation that projects a deep need for these resources by 2030 in the Chinese population, evidenced in the following table (Zhang et al, 2020 , 7):

The economic scenarios of countries such as China, the United States, Japan, and the United Kingdom also emerge as a possible general simulation of the future energy needs of Latin American, Asian, and the rest of the world for the last few decades. In cases such as the European Union in particular, biomass energy is used in a percentage of 43.9% in residential areas, 22.7% in Industry, of which bioheat, biomass gasoline and bioelectricity are its main energy resources (ETIP 2020). In other places, such as in the case of China, the increase in biomass sources present in the graph for the 2030s shows, if not a growth greater than that of other energy sources. If they exhibit a constant growth in the use of said energies for future decades, as well as the needs of nations to create the conditions for true energy and economic independence from dirty energy sources such as oil, through cultural work , social, legal and political of the different sectors of the country (Pereira 2015, 235). In the particular case of the European Union, there are models of distribution, transport and emission of biomass energy that are being replicated around different sectors of the continent, through energy models of forest residues similar to those used in the United States projected for the second decade of the 21st century (European Commission 2017, 28).

In the case of Latin America, we have particular cases such as Argentina, where around 193 million tons of dry residual bases of multiple types of waste are produced per year that can be used as energy sources (BIOMETRANS 2018,3). In the particular case of Mexico, it is possible to use large forest and jungle spaces, in addition to the fact that the country has multiple mountain systems and natural diversities that make it possible to create forest biomass recovery programs (Barton and Merino 2004, 21). .

III. Conclusions

Each of the processes mentioned throughout this annotated bibliography, show the deep energy need and opportunity that Mexico must face in the technological, logistical and scientific market of the new century, without creating multiple forms of pollution and global warming. of the country (García et al. 2013,95). Since the country has always had to face diverse and complex socio-environmental challenges between the national and international, after the successful oil expropriation (Vázquez 2015, 12). However, global bioenvironmental paradigms require new energy and social development strategies (Zeromski 2013, 2). Each of these new paradigms must be developed by the different sectors of citizenship, government and private industry for a good energy transition "... the energy transition to an ecological transition and empowers the local administration, companies and citizens to take an active part in the process of transforming the energy system" (Alvaro and Larrea 2018).

A true development of energy independence is only possible under multiple national and international conditions that adapt to the global paradigms of the free market, where it is necessary to study the conditions of new ways of understanding the geopolitics of the global, investments, technological innovations and of the use of energy resources (IRENA 2019, 21)

All this, raised from a vision far from the nationalization of energy economies by the State, since this type of process inhibits internal and external investment that enables the arrival of innovative technologies and multiple private projects in favor of clean energy (Coviello et al., 2012, 19). The conditions of the characteristics of the waste, the sustainability and the economic values of each energy proposal, must be analyzed under the great variations and ecological, social and financial metrics that allow creating the conditions for efficient projects in energy matters (Bennett 2021, 11). All this, in order to reduce various problems resulting from the radical climate change of recent decades, since the change in economic praxis in energy-related issues will allow a reduction in various temperature problems, hurricanes and other types of disasters. The United Nations Office of Ecological Hazards and Disasters has in fact reported an exponential growth in this type of problem as a result of the severe climatic changes in temperature that the planet has suffered, in Latin America this type of situation has affected around of 121 million people only in the period from 1990 to 2011 (Martínez, Jano, 1 2021).

The use of surplus or reused materials through economic and ethical principles of the circular economy system, proposes a radical change in consumption habits, energy creation, and fundamentally to create more responsible and sustainable political practices. In this way, the creation of sustainable and clean energy opportunities is not only presented to us as a profound need, but also as a development opportunity for the country, within the framework of a new era of production, distribution and use of clean energy. such as biomass, wind, hydroelectric and solar sources (Rodrgiuez 2019). The future lies in the opportunity of entropy in thermodynamic, chemical and physical methods (Popovic 2019), and the creation of more efficient and productive energy conditions in all rural, agricultural and industrial sectors, these types of conditions are determines as the opportunity of the sustainable bioeconomy (Jaramillo 2018). The biomass growth trend in recent decades shows the pattern of the study of new residual resources, from bamboo, miscanthus, arundo, wood and other resources. Biomass emerges as a new way to reform the way of producing economy and create more dignified sustainability conditions for the countries and the world.

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