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An Integral PEST Study of Biomass as Energy Resource

Daniel Mendoza Casseres[1], Guillermo Eliecer Valencia[2] and Javier Cárdenas Gutiérrez[3]

[1] Industrial Engineering Program, Faculty of Engineering
Universidad del Atlántico, Carrera 30 No 8 – 49, Puerto Colombia, Colombia

[2] Efficient Energy Management Research Group, Universidad del Atlántico
Carrera 30 No 8 – 49, Puerto Colombia, Colombia

[3] Civil Engineering Program, Faculty of Engineering
Universidad Francisco de Paula Santander Colombia – Cúcuta, Colombia

Abstract

The present work was carried out in order to evaluate the world's scientific production with respect to the topic of biomass, based on articles published from 2007 onwards. The data were obtained from the Web of Science data collection, and analyzed, through the HitsCite metadata processor, within which indicators were highlighted, such as the number of total publications, the countries that publish the most, in different periods of years, to establish the trend graphically and in the future, to be able to predict the behavior that will occur. The results show that of the 874 articles published to date, 168 were published by the United States, which is equivalent to 19.2%, followed by China, Italy and finally the United Kingdom with 65 articles published (7.4%), 64 articles (7.3%) and 56 articles published (6.4%) respectively. In addition, a PEST analysis was developed to analyses the behavior of the number of publications in relation to the political, economic, social and technological fields for each country studied, in order to be able to create means of prediction in the future.

Keywords: Biomass, biomass energy, PEST analysis, renewable energy

1. Introduction

The excessive use of fossil fuels has brought with it environmental problems such as greenhouse gases, global warming and climate change, which has led to the need to create strategies to minimize these damages, such as the Paris agreement [1] and the Kyoto protocol [2], which in turn seek new sources of energy, which has allowed alternative fuels such as biomass to be investigated with greater concern [3]. In addition, with the excessive increase in energy demand, it is expected that non-alternative energy sources will not be sustainable for long, especially in countries where oil reserves are scarce [4]. One of the advantages is that through biomass, hydrogen can be produced at a low cost [5], in addition to the diversification of the energy matrix of many countries. On the other hand, the development and use of biomass as energy can help to change the ways in which energy is produced and consumed, so as to establish a sustainable energy system that can effectively promote a good development of the national economy while strengthening the protection and preservation of the environment [6]. Today, biomass is recognized as an important source of renewable energy with enormous production potential [7], and the use of its raw material for energy generation is growing steadily throughout Europe [7], and it is also being studied as a primary source for the year 2100 [8], but its potential has not been maximized [4], in fact, the world's potential for biomass production is great, but is not sufficient to replace more than a small percentage of fossil fuel [9], currently, its contribution is limited to between 7 and 10% of global energy consumption [10], [11], because the technology for handling this type of energy is expensive, in addition to having low efficiency [12], and an increase in the amount of production would probably lead to a reduction in the security of obtaining food.

Although the use of biomass as a fuel is quite useful, it also has some difficulties, which in some ways make its qualities invisible. The most common example is the burning of the same. With the economic crisis of 2008, the burning of biomass grew, which became an important contribution of air pollution in the European Union, which could be the cause of respiratory and cardiovascular infections [13], the number one cause of infant mortality in developed countries [14], The biomass incineration is the largest domestic energy source developed in several countries [15], and as many renewable energy sources have risks that must be mitigated, if not managed with the necessary care, biomass can be harvested at unsustainable rates, damaging ecosystems, consuming huge amounts of water [16]. Even so, Pakistan has bet on this energy alternative [17], Turkey has created projects capable of generating up to 45MW and two 30MW plants in the near future in order to avoid dependence on conventional energy sources [18]. In Sweden and the USA they plan to continue producing and using bioenergy [19], due to the improvement in the environmental impact and profitability of the same.

Based on the aspects mentioned above, this study was carried out with the aim of finding out the progress of countries in alternative energy sources through the number of articles published on biomass energy during the years 2007 to 2017, in addition to investigating the relationship that it has with decision-making in each

country, from political, economic, social and technological indicators through the development of a PEST analysis.

2. Methodology

The information used was obtained, through the Web of Science data collection, using the biomass energy indicator, where a total of 874 articles published from 2007 to the end of 2017 were obtained.

2.1.Review of concepts: Biomass

Biomass is considered a bulk material, such as coal or iron ore, and can be obtained by burning wood and other organic materials [20]. Among the different types of biomass used as energy resources, we have the natural one, which is the one produced without human intervention, the residual one that can be dry or wet and is nothing more than the residue of agro-industrial activities and finally the energy crops, among which we can highlight cereals, beets and whose primary purpose is to produce biomass that can be transformed into fuel. Among its advantages for energy purposes are the reduction of CO_2, sulphur levels, energy production costs and dependence on non-renewable energy sources [21].

2.2.Biomass technology

At present, the technology applied to biomass is undergoing a great development, so that research has focused on increasing energy efficiency, minimizing environmental impacts and making this alternative competitive in the market, however, its disadvantages are quite notable as the low density of raw materials and high seasonal dependence [23]. Among the processes for the use of biomass as an energy resource are biological and thermochemical processes. Biological processes are represented by the fermentation of biomass, to convert it into alcohol, and biodigestion where organic matter is converted to biogas, while thermochemical processes are divided into combustion, which is the most widely used process in the world and consists of the oxidation of biomass by oxygen contained in the air, and is only applicable if the moisture content of the biomass is less than 50%, gasification, where only a fraction of the oxidant required for combustion is used, and finally pyrolysis, which is the conversion of biomass into liquid, solid and gaseous fractions by heating in the absence of an oxidant [24].

2.3.Application of Pest analysis for USA, China, Italy and UK.

In order to evaluate the relationship between the number of articles published and the number of articles on biomass energy, a tool was used that was widely used due to the variety in its management for all types of projects and plans for different estimated deadlines, called Pest analysis, that uses political, economic, social and technological indicators to see the change of a study variable.

3. Results

3.1.Publications results

In order to show the relationship between the number of articles published and the political, economic, social and technological fields, a PEST analysis was carried out for the countries of the United States, China, Italy and the United Kingdom, since they represent the countries with the greatest number of publications to date. The years with the highest number of publications were 2013 and 2014 with 130 and 150 articles respectively. This was due to the fact that in 2012, biomass accounted for 2/3 of renewable energy consumption in the European Union. On the other hand, in the United States there was a 60% growth in the energy generated in 2013 compared to 2002. Thanks to support policies from different public spheres, mainly tax credits, production and investment, which have increased biomass installations, in 2013 there were 556 MW, 106 MW and 140 MW, for 2014 and 2015 respectively, managing 20% of the energy matrix in renewable energy, providing employment for more than 18,000 people in rural areas, and that is that these wastes are in large quantities, which when used in energy reduce waste and pollution levels which translates into lower environmental impact. From the technological point of view, 22 million dollars have been invested to become the world leader in marine biomass. As for China, a law for renewable energy (including biomass) was enacted in 2005, which served as a framework for a renewable energy development strategy aimed at increasing the supply of energy for the continued development of the economy and society [25]. In 2008, 102 plants were built, with a total production capacity of 200,000 tons, equivalent to 7% of China's total production. By 2020 the capacity of the biomass plants installed will be 30GW, with the annual use of 50 million tons of biomass pellets. Biomass in China produces the equivalent of about 460 million tons of coal per year. As far as technology is concerned, China has gone from producing 100-200 kg/h of biomass pellets in 1990 to 1 t/h. For China, it has an abundant source of biomass as energy from agriculture [26]. Italy has made significant progress in the last decade in terms of renewable energy. In 2011, the contribution of renewable energy (including hydropower) was 11%, of which 1/3 came from biomass [27]. The adoption of Directive 2009/28/EC promoted the use of energy from renewable sources, with a target of 17% of final energy consumption and another 10% for the transport sector by 2020 [27]. In 2014, it was considered the country with the highest production of solar energy, the same year in which it produced more than 40% of its electricity, using solar, wind and biomass energy. In the case of biomass, it is expected to stimulate the installation of new plants, while the raw material is expected to be supplied by local farmers [27]. This country was the first to create a plant capable of using geothermal energy and biomass capable of generating 37 GWh of electricity per year, which translates into a reduction of 17,000 tons of CO_2 per year, in addition to promoting the use of biomass with solar energy to produce 1 to 5 MW, 24 hours a day. These advances in green technology are reflected in the environmental impact. Finally, the United Kingdom, which, like its policy to reduce its environmen-

tal impact, has created incentives for the implementation, use and production of biomass, many studies show that by 2050 biomass could supply 44% of energy, so that it plans to invest 600 million euros, for the construction of the world's largest biomass power plant capable of generating 299MW for self-supply and export, this project will generate renewable energy for over 600,000 households in the UK, and it is estimated that the construction phase alone will generate 1,100 jobs. This behaviour has been reflected in energy infrastructures such as Drax, which provides around 8% of the UK's energy supply [28], which has converted 3 of its 6 coal plants to biomass, to the extent that it is exploring how to make it 4, using low-quality, sustainably sourced wood, and generating 16% renewable electricity in the UK. All strategies are used to reduce coal emissions by 50% compared to 1990 by 2027. The most important aspects mentioned above can be seen in Table 1.

The country with the most articles published in biomass energy is the United States with 168 articles equivalent to 19.2%, with the most fruitful years such as 2011 with 30 articles, followed by 2014, 2012 and 2013, with 26, 25 and 25 articles published respectively. On the other hand, it had a decline in 2015 and 2016, in which no article was published in the two years. The following countries in descending order are China with 65 items (7.4%), followed by Italy with 64 (7.3%) and completing the top 4 UK with 56 (6.4%). The sum of the published articles of these 4 countries represent 40.39% worldwide, that is to say 353 articles, the above is represented graphically as shown in Fig. 1.

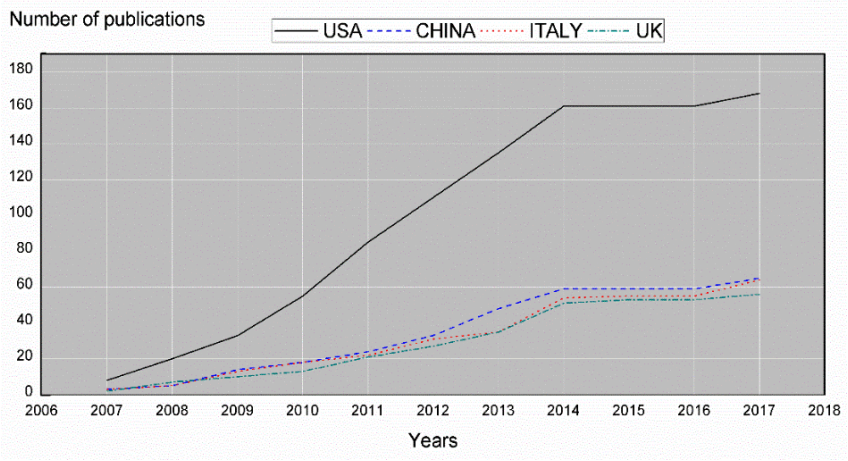

Fig 1. Trends in scientific production for the top 4 countries, 2007-17

Table 1. PEST analysis to USA, China, Italy and UK.

Criteria	USA	China	Italy	UK
Policies	The government has worked on support policies from different public spheres, mainly tax credits, production and investment, have increased biomass installations, with the aim of diversifying its energy matrix by 20%.	In 2005 the renewable energy law was enacted to support development in this as a framework for the development strategy, which increased the country's energy supply. In 2006, the law became operational and served on a national level.	Directive 2009/28/EC promoted the use of energy from renewable sources, with a target of 17% of final energy consumption and a further 10% for the transport sector by 2020.	As a promoter of climate change, in 2008 the UK implemented taxes to limit the maximum amount of carbon, which benefits from the use of renewable energy such as biomass, which has been the focus of valuable efforts to become independent of coal.
Economic Aspects	Biomass resources have been widely distributed, ensuring that all communities can benefit both financially and environmentally from increased biomass production.	China has become a country with a large biomass energy source, particularly in rural areas [26], producing a variety of raw materials, and promoting the disuse of non-renewable energy to make its economy cleaner and more sustainable.	As a country dependent on fossil fuels, the implementation of new trends such as biomass will benefit social and economic sectors, as solar energy has done in addition to diversifying the energy matrix.	It is planned to invest approximately 600 million to build the biomass plant as the world's largest energy resource, with a capacity of 299 MW.
Technology	Investments of 22 million dollars have been made to make the country the world leader in marine biomass, in addition to the progress made, in order to improve efficiency in the transformation processes.	Technological advances are gigantic, with production increasing from 200 kg/h to 1-3 t/h in biomass pellets, and in terms of briquettes, small industries produce 2,800,000 tons per year, which represents more than 90% of annual production. In 2008, 102 plants were built, representing 7% of total production.	Its progress has been such that it has been able to create plants using geothermal and biomass, which generate 37GWh of electricity per year, and not only that, but also plants that use biomass with solar energy.	There are several plans that provide financial support for renewable energy systems to foster technological development that will benefit better economy and cost reduction in order to reach the goals of 30% renewable energy production by 2030.
Society	Apart from the reduction of CO_2, there have been positive aspects for society such as the 18,000 jobs created by the creation of this type of project.	Strategies have been developed from the law enacted in 2005, which has benefited the economic and social development of the country. Producing more than 100 plants, which has given employment to the country of Asian origin. In addition to catapulting it as one of the countries with the greatest momentum in biomass, reaching the potential to be number 2 in the ranking, strategies have been developed from the law enacted in 2005, which has benefited the economic and social development of the country.	The creation of new plants reduces CO_2 emissions by almost 17,000 tons, the raw material will be provided by local farmers, which benefits the country's agro-industrial sector.	The creation of the largest biomass plant as an energy resource in the port of Teesside, will provide, in addition to an improvement in environmental indicators such as greenhouse gas reduction and climate change mitigation, renewable energy to more than 600,000 homes, and approximately 1,100 jobs in its construction phase.

On the other hand, and in order to evaluate the research trends, the behavior of the articles published between 2007-12 and 2013-17 was evaluated as shown in Fig 2. In which it was evident that of the 15 countries selected. It was shown that only 3 countries were surpassed in terms of what was published in the past, which were Italy and the United Kingdom with a difference of 2 articles, and Finland with a difference of 5. This behavior was due in large part to the production of the countries in 2016, due to the fact that it was nil for the 80 countries found in the database.

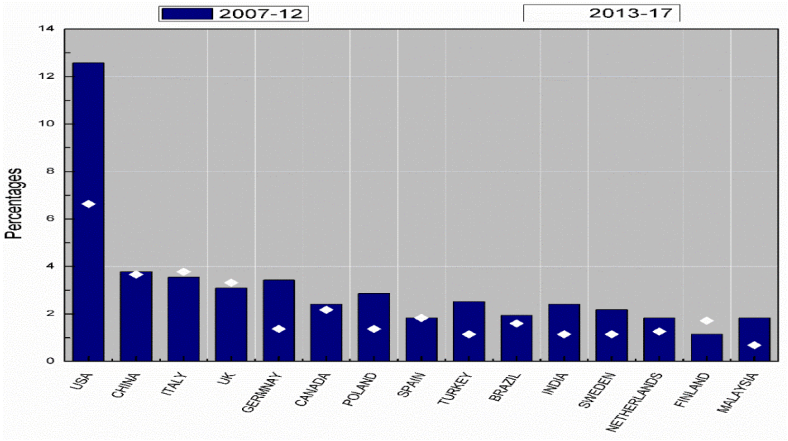

Figure 2. Top 15 countries, share of world scientific publication output, 2007-12 and 2012-17

4. Conclusions

The measures taken by the different countries have undoubtedly benefited the economy and the technological aspects, which translates into a higher percentage of dependence on non-renewable energy sources, that is, a diversification of the energy matrix, which benefits in non-interconnected areas. The United States is the country with the highest number of publications with a total of 168 articles, followed by China with 65, then Italy with 64 and finally the United Kingdom with 56. Although the trend towards research on biomass energy is declining, investments in plants of this type are increasing. All countries want to be the protagonists of this renewable movement, which undoubtedly benefits the environmental impact of our planet.

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